KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Faculty of Science and Technology

'A' Grade
NAAC Re-accredited
(3rd Cycle)

F. Y. B. Sc. BOTANY

Theory and Practical Syllabus

(CBCS Pattern)

As Per U. G. C. Guidelines

Semester – I

To Be Implemented From

Academic – Year 2022 - 2023

BOT. – 101: Diversity of Lower Cryptogams

BOT. – 102: Morphology of Angiosperms

BOT. – 103: Practical Based on BOT.-101 and BOT.-102

F.Y. B.Sc. Semester: I

Paper: I BOT. 101: Diversity of Lower Cryptogams		Lecture 30
Aims and Objectives: 1. To study the diversity among microbes. 2. To study systematic, morphology and structure of Bacteria, Viruses, Algae and Fungi. 3. To study the life cycle pattern of Bacteria, Viruses, Algae and Fungi. 4. To study the useful and harmful activities of Bacteria, Viruses, Algae and Fungi. **Course outcomes:** 1. Provide identification technique of microbes, Viruses, Bacteria, Algae and Fungi. 2. Understand the systems of classification of Microbes, Viruses, Bacteria, Algae and Fungi, and its interdisciplinary approaches. 3. Provide lab-based training in writing short species descriptions and illustration. 4. Recognise members of the major microbes, Viruses, Bacteria, Algae, Fungi and their medicinal, economic importance for human welfare.		
Unit 1	**Microbes:** 1.1: Introduction and main groups of microbes: Prions, Viroids, Viruses, Rickettsias, Mycoplasmas, Bacteria, Cyanobacteria. 1.2: Classification of microorganisms – R.H. Whittaker's (1969) five kingdom concept.	**02 L**
Unit 2	**Viruses:** 2.1: Introduction, discovery and characteristics of Viruses. 2.2: General morphology of viruses: Helical, Polyhedral, Enveloped and Complex viruses. 2.3: Nature of viruses (living and non-living) 2.4: Ultra structure of viruses 2.5: DNA Virus (T-Phase) and RNA, Virus (TMV) 2.6: Reproduction of Bacteriophage: Lytic and Lysogenic cycle. 2.7: Economic importance 2.8: Plant diseases caused by viruses w.r.t. causal organism, symptoms and control measures of. i. Yellow vein mosaic disease of Lady's finger. ii. Bunchy top of Banana.	**06 L**
Unit 3	**Bacteria:** 3.1: Introduction, discovery and general characters. 3.2: Classification of Bacteria on the basis of morphology. 3.3: Ultrastructure of Bacterial Cell 3.4: Gram positive and Gram negative Bacteria	**06 L**

	3.5: Reproduction - Asexual and Sexual (Conjugation) 3.6: Economic importance of Bacteria - useful and harmful activities 3.7: Study of Bacterial diseases w.r.t. causal organism, symptoms and control measures of i) Citrus canker ii) Black arm of Cotton.	
Unit 4	**Algae:** 4.1: Introduction, definition and general characters of algae 4.2: Habitats of algae: aquatic, terrestrial and algae unusual habitats 4.3: Thallus structure in algae. 4.4: Reproduction: vegetative, asexual and sexual 4.5: Classification of algae according to G. M. Smith (1955) up to classes with reasons giving at least two examples from each class. 4.6: Economic importance of algae in; i) Agriculture ii) Food iii) Industries iv) Medicine 4.7: A] Study of life cycle of ***Nostoc*** w.r.t. Systematic position Occurrence, structure of colony and filament, ultrastructure of ***Nostoc*** cell and reproduction B] Study of life cycle of ***Sargassum*** w.r.t. Systematic position, occurrence, external and internal structure of thallus, reproduction and alternation of generation.	**07 L**
Unit 5	**Fungi:** 5.1: Introduction, definition and general characters 5.2: Thallus structure, reproduction and mode of nutrition 5.3: Classification of Fungi, according to G.M. Smith up to classes with reasons giving at least two example of each class. 5.4: Economic importance of Fungi i) Agriculture ii) Food iii) Industries iv) Medicine 5.5: A] Study of life cycle ***Agaricus*** w. r. t. Systematic position, structure of mycelium, internal structure, (T.S. of gills) and reproduction. B] Study of life cycle ***Aspergillus.*** w. r. t. Systematic position, structure of mycelium and reproduction.	**07 L**
Unit 6	**Lichens and Mycorrhiza:** 6.1 Lichens: definition, characters, types - Crustose, Foliose, Fruticose and economics importance. 6.2 Definition, general account, significance of Mycorrhiza, 6.3 Types: Ectomycorrhiza and Endomycorrhiza.	**02 L**
Suggested readings:		

1. Agrawal, S. B. and Srivastav (1985)Modern Text Book of Botany Vol. I Algae, Fungi, Bacteria Viruses and Lichen, Universal Publication, Agra.
2. Biswas, S. B. and Amita Biswas (1986 Ed.)An Introduction to Viruses, Vikas Publishing House (P) Ltd. New Delhi.
3. Vashista, B.R. (2010) S. A Text Book of Algae S. Chand and Company (P.)Ltd New Delhi.
4. Vashista, B.R. (2010) S. A Text Book of Fungi S. Chand and Company (P.)Ltd New Delhi.
5. Sarabhai, B. P. &Arora C.K. (1995). A Text Book of Algae Anmol Publication, New Delhi.
6. Salle, A.J. (1974) Fundamental Principles of Bacteriology (TMH Ed.) New Delhi.
7. Gangulee, H.C. and Kar, A.K. (1998) College Botany Vol. II New Central Book Agency, Kolkota.
8. Pandey B. P. (2014) College Botany Volume 1S. Chand publications, New Delhi.
9. Pandey, S. N. and Trivedi (1997) A Text Book of Botany Vol. I Vikas Publishing House, New Delhi.
10. Sharma, P D. (1998) A Text Book of Fungi Rastogi Publication, Meerut.
11. Sharma, P D. (2009) A Text Book of Algae Tata McGraw Hill Publication, New Delhi

F.Y. B.Sc. Semester I

Paper II BOT 102: Morphology of Angiosperms	Lecture 30

Aims and objectives:

1. To inculcate the students with angiosperm plant body.
2. To study vegetative characteristics of angiosperm plants.
3. To study reproductive characteristics of angiosperm plants.
4. To study modifications and functions of plant organs.

Course outcomes:

1. Students will able to understand ground plan of angiospermic plant.
2. Students will aware about vegetative and reproductive characteristics of angiospermic plant.
3. Students will able to understand the modifications and functions of plant parts.

Unit 1	**Introduction:** 1.1 Definition and scope of Morphology 1.2 Plant body – Root system, Shoot system	**02 L**
Unit 2	**Root:** 2.1 Definition 2.2 Characteristics of root 2.3 Functions of root 2.4 Types of root 2.5 Modifications of root for: a) Food storage:- Fusiform, Conical, Napiform, Tuberous root. b) Support:-roots, Stilt roots, Climbing roots c) Breathing:- Pneumatophores d) Special functions:- Epiphytic roots, Sucking roots	**04 L**
Unit 3	**Stem:** 3.1 Definition 3.2 Characteristics of stem 3.3 Functions of stem 3.4 Forms of stem: a) Strong form :- Herb, Shrub, Tree b) Weak form:- Creepers, Trailers and Climbers 3.5 Modifications of stem: a) Underground:- Rhizome, Stem tuber, Bulb and Corm b) Sub-aerial:- Runner, Stolon, Offset and Sucker c) Aerial:- Phylloclade, Cladode, Thorn, Stem tendril and Bulbil	**04 L**
Unit 4	**Leaf:** 4.1 Definition 4.2 Parts of leaf	**04L**

	4.3 Types of stipules 4.4 Types of leaf 4.5 Functions of leaf 4.6 Phyllotaxy:- definition and types: Alternate, Opposite (Decussate and Superposed) and Whorled. 4.7 Venation:- Definition and types: Reticulate and Parallel venation 4.8 Modifications of leaf:- leaf spines, leaf tendrils, fleshy leaves, phyllode, pitcher and bladder.	
Unit 5	**Inflorescence :** 5.1 Definition, Significance and parts of inflorescence 5.2 Types of inflorescence a) Racemose:- Raceme, Spike, Spikelet, Catkin, Spadix, Corymb, Umbel, Capitate and Head or Capitulum b) Cymose:- Solitary, Uniparous, Biparous and Multiparous c) Special type of inflorescence:-Cyathium, Verticillaster and Hypanthodium	**05L**
Unit 6	**Flower:** 6.1 Definition 6.2 Parts of typical flower 6.3 Types of flower:- Hypogynous, Epigynous and Perigynous 6.4 Symmetry of flower :- Actinomorphic and Zygomorphic 6.5 **Calyx:**- Polysepalous calyx, Gamosepalous calyx, Caducous calyx, Deciduous calyx, Persistent calyx and Petaloid calyx 6.6 **Corolla:** a) Forms of polypetalous corolla: Cruciform, Caryophyllaceous, Rosaceous and Paplionaceous b) Forms of gamopetalous corolla:- Campanulate, Infundibuliform, Tubular, Rotate, Hypocrateriform, Ligulate, Bilabiate and Personate 6.7 Perianth:-Polyphyllous and Gamophyllous 6.8 Aestivation:-i) Definition ii) Types of Aestivation. 6.9 **Androecium:** a) Attachment of anther to filament:- Basifixed, Dorsifixed and Versatile b) Cohesion and Adhesion of stamens. 6.10 **Gynoecium:** a) Apocarpous, Syncarpous, Monocarpellary, Bicarpellary and Polycarpellary b) Placentation: Definition and types of Placentation.	**06 L**
Unit 7	**Fruits:** **7**.1 Definition 7.2 Parts of typical fruit : nature of Pericarp 7.3 Types of fruits:- a) Simple fruits:- **i) Dry fruits:**	**05 L**

	a) Dehiscent:- Legume and Loculicidal Capsule b) Schizocarpic:-Lomentum and Regma c) Indehiscent:- Caryopsis, Cypsela **ii) Fleshy fruits:-** a) Drupe and Hesperidium b) Aggregate fruits:- Etaerio of berries and Etaerio of follicle c) Composite fruits:- Sorosis and Syconus.	

Suggested readings:

1. Gangulee H.C. Das K.S., Dutta C. (2014) College Botany Volume I, New Central Book Agency (P) Ltd. Kolkata.
2. Dutta A.C. (2013) Botany for Degree Students, Sixth edition, Oxford University Press, New Delhi.
3. Sachdeva S.K. (1990) Angiosperms – Morphology, Anatomy, Taxonomy, Evolution, Kalyani Publication, Ludhiana.
4. Pandey S.N. Mishra S.P. (2009) Taxonomy of Angiosperms, Ane Books Pvt. Ltd., New Delhi.
5. Singh M.P. Sharma A.K. (2002) Textbook of .Botany, Anmol Publication, Pvt. Ltd., New Delhi.
6. Sundararajan S. (2003) Practical Manual of Plant Morphology, Anmol Publication, Pvt. Ltd., New Delhi.
7. Bendre A. Kumar A. (1999) A Textbook of Practical Botany II, Rastogi Publication, Meerut

F.Y. B.Sc. Semester I

Paper III
Bot-103: Practical (Based on Bot.101 and Bot.102)

Practical – 1 : Study of Equipment, Chemicals and Stains used in Botany laboratory:

A) Equipment: Dissecting microscope, Compound Microscope

B) Chemicals:

i) Preservatives: FAA

ii) Stains: Safranin, Light green, Fast green, Cotton blue, Crystal violet,

iii) Mounting media; Glycerine, Lactophenol.

Practical - 2:.A) Study of viruses and bacteria using electron photomicrographs (TMV, Bacteriophage, Cocci, Bacillus, Spirillum Bacteria).

B) Technique of Gram staining of bacteria.

Practical – 3 & 4 : A) Study of Plant diseases w.r.t. causal organism, symptoms and control measures of the following:

a. Virus.

i. Yellow vein mosaic disease of Lady's finger

ii. Bunchy top of Banana

b. Bacteria

i. Citrus canker

ii. Black arm of cotton

c. Fungi

i. Green mould of citrus fruits

ii. White rust disease (Specimen/P.S.)/Tikka disease on groundnut [P.S.] (Any one)

B) Study of growth forms of lichens (Crustose, Foliose and Fruticose) specimens / P.S./ Photographs

C) Study of Mycorrhiza: (Ectomycorrhiza and Endomycorrhiza) by Photographs.

Practical -5& 6: Study of systematic position, vegetative and reproductive structures of the following:

A. ***Nostoc***

i) Vegetative structure -Filament and cell

ii) Reproductive structure (P.S.)

B. ***Sargassum***

i) Vegetative structure

ii) T. S. of main axis

iii) Reproductive structure male and female conceptacles (P.S.)

C. *Aspergillus*

i) Structure of thallus: mycelium,

ii) Reproductive structures asexual (Conidiophore and Conidia)

D. *Agaricus*

i) Structure of basidiocarp

ii) Reproductive structures: basidia and basidospores (V. S. of Gill)

Practical -7: Study of morphology of root and stem modifications as per theory.

Practical – 8 : Study of

a) Parts of leaf
b) Types of stipules
c) Types of leaf
d) Types of phyllotaxy
e) Types of venation
f) Modifications of leaf as per theory

Practical – 9 : Study of types of inflorescence as per theory.

Practical – 10 : Study of

a) Calyx – types of calyx as per theory
b) Corolla – forms of corolla as per theory
c) Types of aestivation

Practical -11: Study of

a) Androecium – Cohesion and Adhesion
b) Gynoecium– types of placentation.

Practical -12: Study of types of fruits as per theory.

Submission: 1. Excursion tour report

Note: Short or long excursion tour and visit to any botanical garden are compulsory.

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Faculty of Science and Technology

कवयित्री बहिणाबाई चौधरी उत्तर महाराष्ट्र विद्यापीठ

अंतरी पेटवू ज्ञानज्योत

1990

‘A’ Grade
NAAC Re-accredited
(3rd Cycle)

F. Y. B. Sc. BOTANY

Theory and Practical Syllabus

(CBCS Pattern)

As Per U. G. C. Guidelines

Semester – II

To Be Implemented From

Academic Year 2022 - 2023

BOT. – 201: Diversity of Higher Cryptogams

BOT. – 202: Taxonomy of Angiosperms

BOT. – 203: Practical Based on BOT.-201 and BOT.-202

F.Y. B.Sc. Semester II

Paper I Bot-201: Diversity of Higher Cryptogams		Lecture 30
Aims and objectives: 1. To study salient features of higher Cryptogams. 2. To know the morphology and systematics of higher cryptogams. 3. To study the life cycles of selected genera. 4. To study economic importance of higher cryptogams. To make the students aware about conservation and sustainable use of plants. **Course outcomes:** 1. Student will be able to understand the basic knowledge of the subject. 2. To understand the basic structure and study the comparative characteristic of Bryophytes and Pteridophytes. 3. Also, to understand the structural similarities and differences among both the groups. 4. Student will be able to aware developmental stages of life cycle of higher cryptogamic plants. To facilitate students for taking up and shaping a successful career in botany.		
Unit 1	**Introduction:** 1.1: Introduction, definition and diversity of higher cryptogams. 1.2: Bryophytes - a) Introduction. b) Habit and habitat. c) General characteristics of Bryophytes. d) Alternation of generations. 1.3: Classification of Bryophytes according to G. M. Smith (1955) up to classes with reasons, giving at least two examples from each class. 1.4: Economic and ecological importance of Bryophytes.	**05 L**
Unit 2	**Study of life cycle of *Riccia*:** 2.1: Systematic position with reasons. 2.2: Habit and habitat. 2.3: External and internal structure of gametophyte. 2.4: Vegetative reproduction. 2.5: Sexual reproduction (Development of sex organs not expected) 2.6: Fertilization. 2.7: Structure of mature sporophyte. 2.8: Structure and germination of spores. 2.9: Alternation of generation.	**05 L**
Unit 3	**Study of life cycle of *Funaria*:** 3:1. Systematic position with reasons. 3.2: Habit and habitat. 3.3: External and internal structure of gametophyte. 3.4: Vegetative reproduction.	**05 L**

	3.5: Sexual reproduction (Development of sex organs not expected) 3.6: Fertilization. 3.7: Structure of mature sporophyte. 3.8: Alternation of generation**.**	
Unit 4	**Pteridophytes:** 4.1: Introduction, definition and general characteristics of Pteridophytes. 4.2: Habit and Habitat. 4.3: Classification of Pteridophytes according to G. M. Smith (1955) up to classes with reasons, giving at least two examples from each class. 4.4: Economic importance of Pteridophytes.	**04 L**
Unit 5	**Study of life cycle of *Selaginella*:** 5.1: Systematic position with reasons. 5.2: Habit and habitat. 5.3: External and internal structure of sporophyte. 5.4: Asexual reproduction: position and structure of strobilus. 5.5: Sporangia (megasporangium and microsporangium). 5.6: Structure and germination of spores. 5.7: Structure of male and female gametophyte. 5.8: Position and structure of sex organs. (Development of sex organs not expected) 5.9: Fertilization. 5.10: Structure of mature embryo. 5.11: Alternation of generations. 5.12: Heterospory and its significance	**06L**
Unit 6	**Study of life cycle of *Adiantum*** : 6.1: Systematic position with reasons. 6.2: Habit and habitat. 6.3: External and internal structure of sporophyte. 6.4: Asexual reproduction: position and structure of sorus. 6.5: Structure of sporangium. 6.6: Structure and germination of spore. 6.7: Structure of mature gametophyte. 6.8: Position and structure of sex organs. (Development of sex organs not expected). 6.9: Fertilization. 6.10: Alternation of generation.	**05 L**

Suggested readings:

1. Gangulee, H.C. and Kar, A.K. (2001). College Botany Vol. II. Books and Allied Press Ltd. Kolkata.
2. Pandey, S.N. and Trivedi, P.S. (1997). A Text Book of Botany Vol. II, Vikas Publishing House (P.) Ltd. New Delhi.
3. Parihar, N.S. (1977). Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.

4. Parihar, N.S. (1984). An Introduction to Embryophyta Vol. I Bryophyta. Central Book Depot, Allahabad
5. Rashid, A. (1996). An Introduction to Bryophyta. Vikas Publishing House Ltd. New Delhi.
6. Rashid, A. (1996). An Introduction to Pteridophyta. Vikas Publishing House Ltd
7. Saxena, A.K. and Sarbhai, R.M. (1992). A Text Book of Botany Vol. II Embryophyta.
8. Ratan Prakashan Mandir, Agra.
9. Smith, G.M. (1995). Cryptogamic Botany. Vol. II (Bryophytes and Pteridophytes).
10. Mc Graw-Hill Book Company, New york and London.
11. Sporne, K.R. (1995). The Morphology of Pteridophyta. The Hutchinson University Library, London, U.K.
12. Vashistha, B.R. (1997). Botany For Degree Students-Bryophyta. S. Chand and company (P.) Ltd. New Delhi.
13. Vashistha, P.C. (1984). Pteridophytes. S. Chand and company (P.) Ltd. New Delhi

F.Y. B.Sc. Semester II

Paper II Bot-202: Taxonomy of Angiosperms	Lecture 30

Aims and objectives:

1. To study the diversity of angiosperms.
2. To study of comparative account among the families of angiosperm.
3. To study the economic importance of the angiospermic plants.
4. To study the distinguishing features, medicinal and economic importance of angiosperm families.
5. To study botanical garden and herbarium techniques.

Course outcomes:

5. Understanding of angiospermic plants Causes of phenomenal succession and alternation of generation.
6. Understand the systems of classification of angiosperms, nomenclature and interdisciplinary approaches.
7. Provide lab-based training in writing short species descriptions and illustration.
8. Recognise members of the major angiosperm families by identifying their diagnostic features, economic and medicinal importance.
9. Understand botanical gardens and herbarium technique

Unit 1	**Introduction** 1:1 Definition, scope and importance of taxonomy. 1:2 General characters of Angiosperms. 1:3 Causes of phenomenon succession of Angiosperms. 1:4 Alternation of generations. 1:5 Taxonomy and systematics: synonyms.	**06 L**
Unit 2	**Taxonomic hierarchy** 2:1 Functions of Taxonomy: identification, classification and nomenclature. 2:2 Ranks of classification; major categories. 2:3 Binomial nomenclature. 2:4 Author citation and rejection of name. 2:5 Numerical Taxonomy; definition and applications.	**06 L**
Unit 3	**Classification** 3:1 Types of classification a) Artificial b) Natural c) Phylogenetic 3:2 Outline of Bentham and Hooker's system of classification up to series. 3:3 Merits and demerits.	**06L**

Unit 4	**Study of plants families w.r.t. systematic position, general characters, distinguishing characters and economic importance.** a) Malvaceae b) Papilionaceae (Fabaceae). c) Rubiaceae d) Solanaceae e) Euphorbiaceae f) Cannaceae	**06 L**
Unit 5	**Botanical Gardens and Herbarium.** 5:1) Botanical garden. a) Definition and Functions b) Special feature of following Botanical Garden. i) Indian Botanical Garden, Kolkata ii) Royal Botanical Garden, Kew England. 5:2) Herbarium. a) Definition, techniques and functions. b) Importance of herbaria.	**06L**

Suggested readings:

1. Gangully , H.C & K.S Das (1986) College Botany Vol. – 1 (6th Edition) , New Central book Agency, Calcutta , India.
2. Gangully H.C., K. S.Das and C.T Datta (1968) college Botany Vol.1 , New Central Book Agency , Calcutta , India.
3. Kumar, N.C (1992) An Introduction to Taxonomy of Angiosperm, Himalaya Publishing House, Bombay India.
4. Lawrence G.H.M (1951) Taxonomy of Vascular plants. Macmilan , New York , USA.
5. Naik , V. N (1984) Taxonomy of Angiosperms . Tata McGraw – Hil publishing Company Ltd , New Delhi , India
6. Pandey B.P. (1997) Taxonomy of Angiosperms . S. Chand & Company Ltd., New Delhi, India.
7. Sharma , O.P. (1997) Plants Taxonomy . Tata McGraw – Hill Publishing Co.Ltd . New Delhi, India
8. Shivarajan , V.V . (1984) Introduction to Principles of Principles of Plants Taxonomy . Oxford & IBHP publishing Co.New Delhi , India
9. Singh V. And Jain , D.K (1992) Taxonomy of Angiosperms. Rastogi publication , Meerut, India.
10. Subramanyam , N.S. (1997) Modern plants Taxonomy . Vikas Publishing house, New Delhi ,India.
11. MukerjeeSusilkumar (1984) College Botany Vol.3 Published by J.N.SenB.S.I.New central Book Agency Calcutta.
12. Vashistha , P.C. (1992) Taxonomy of Taxonomy of Angiosperms. R.Chand& Co. Publishers , New Delhi , India.

F.Y. B.Sc. Semester II

Paper III
Bot-203: Practical (Based on Bot.201 and Bot.202)

Practical - 1: Study of diversity of Bryophytes w.r.t systematic position and morphology of:
a) *Marchantia b*) *Anthoceros* c) *Sphagnum*

Practical - 2: Study of *Riccia:*
2.1: Systematic Position with reasons
2.2: External morphology
2.3: Mounting of scales and rhizoids
2.4: V. S. of Thallus
2.5: V. S. of thallus showing antheridia [P. S.]
2.6: V.S. of thallus showing archegonia [P.S.]
2.7: V.S. of sporophyte [P.S.]

Practical - 3: Study of *Funaria:*
3.1: Systematic Position with reasons
3.2: External morphology
3.3: T. S. of axis
3.4: V.S. of antheridial head [P.S.]
3.5: V.S. of archegonial head [P.S.]
3.6: V.S. of Capsule [P.S.]
3.7: Mounting of spores and peristomial teeth

Practical - 4: Study of diversity of Pteridophytes w.r.t systematic position and morphology of:
a) *Psilotum* b) *Lycopodium* *c*) *Equisetum*

Practical - 5: Study of *Selaginella*:
5.1: Systematic Position with reasons
5.2: External morphology
5.3: T. S. of Stem
5.4: Mounting of micro and megaspores
5.5: T. S. of Leaf [P.S.]
5.6: V. S of Strobilus [P.S.]

Practical - 6: Study of *Adiantum*:
6.1: Systematic Position with reasons
6.2: External morphology
6.3: T. S. of Rachis
6.4: T. S. of Sorus [P. S.]
6.5: Mounting of spores

Practical -7: How to describe Angiospermic plant.

Practical -8, 9&10: Study of plant families according to syllabus w.r.t Systematic position, morphological characters, floral formula and floral diagram.
i) Malvaceae iii) Rubiaceae v) Euphorbiaceae
ii) Papilionaceae/ Fabaceae iv) Solanaceae vi) Cannaceae

Practical -11: Preparation of artificial key based on vegetative & reproductive characters.

Practical -12: Herbarium and its techniques.

Submission: 1. Any five photographs of higher cryptogamic plants
2. Any five wild plant (Weeds) herbarium/photograph.
3. Excursion tour report

Note: Short or long excursion tour and visit to any botanical garden are compulsory.

Equivalence

	Old Syllabus w.e.f. June, 2018		New Syllabus, w.e.f. June 2022	
Sr. No.	Paper	Title	Paper	Title
		SEMESTER-I		
1	BOT.101	Microbial Diversity of Algae and Fungi	BOT.101	Diversity of Lower Cryptogams
2	BOT.-102	Plant Taxonomy	BOT.-102	Morphology of Angiosperms
3	BOT.-103	Practical Course based on BOT-101 and BOT.-102	BOT.-103	Practical Course based on BOT-101 and BOT.-102
		SEMESTER-II		
4	BOT.201	Diversity of Archegoniate	BOT.201	Diversity of Higher Cryptogams
5	BOT.-202	Plant Ecology	BOT.-202	Morphology of Angiosperms
6	BOT.-203	Practical Course based on BOT-201 and BOT.-202	BOT.-203	Practical Course based on BOT-201 and BOT.-202

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Faculty of Science and Technology

SYLLABUS FOR CORE AND SKILL ENHANCEMENT COUESES IN BOTANY

As Per U. G. C. Guidelines

Based on

Choice Based Credit System (CBCS)

S. Y. B. Sc. BOTANY SEMESTER-WISE SYLLABUS

(Theory and Practicals)

Semester-III

- **Bot. 301:** Plant Anatomy
- **Bot. 302:** Plant Physiology
- **Bot. 303:** Practical Based on Bot: 301 and Bot: 302
- **Bot. 304:** Mushroom Culture Technology

Semester-IV

- **Bot. 401:** Plant Embryology
- **Bot. 402:** Plant Metabolism
- **Bot. 403:** Practical Based on Bot: 401 and Bot: 402
- **Bot. 404:** Nursery and Gardening

w. e. f. June, 2019

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Structure of S.Y. B.Sc. Botany Syllabus under CBCS Pattern

w.e.f. June, 2019

Year	Sem.	Paper	Code	Title of Course	Marks		Credits
					Int.(CA)	Ext.(UA)	
II	III	I	Bot. 301	Plant Anatomy	40	60	2
		II	Bot. 302	Plant Physiology	40	60	2
		III	Bot. 303	Practical (LAB – I)	40	60	2
		IV	Bot. 304	Mushroom Culture Technology (SEC)	40	60	2
	IV	I	Bot. 401	Plant Embryology	40	60	2
		II	Bot. 402	Plant Metabolism	40	60	2
		III	Bot. 403	Practical (LAB – I)	40	60	2
		IV	Bot. 404	Nursery and Gardening (SEC)	40	60	2

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Syllabus of S.Y.B.Sc. Botany w.e.f. June, 2019

CBCS Pattern

Semester: III

PAPER-I

BOT. - 301: PLANT ANATOMY

Lectures: 30

AIMS AND OBJECTIVES

1. To know scope and importance of plant anatomy
2. To study various tissue systems
3. To know primary structure of dicot and monocot plants
4. To study normal secondary growth in plants and their causes
5. To study protective tissue system

Unit-1: **Introduction** **02 L**

1.1 Definition, Scope and Importance

Unit- 2: **Plant Tissues** **08 L**

2.1 Definition

2.2 Meristematic tissues: Classification based on position and origin

2.3 Tissues and it's types:

(a) Simple tissues:

i) Parenchyma: Arenchyma, Chlorenchyma and Palisade

ii) Collenchyma

iii) Sclerenchyma: Fiber and Sclereids / Stone cells

(b) Complex tissues:

i) Xylem and its elements

ii) Phloem and its elements

Unit-3: Protective Tissue System **07 L**

3.1 Epidermal Tissue System: Definition and Function

3.2. Types of Epidermal Appendages

a) Unicellular, Multicellular (Uniseriate and Multiseriate) Trichomes

b) Glandular, Non-glandular Trichomes

c) Stellate, Dendroid Trichomes and Peltate scales

3.3 Types of Stomata

i. Ranunculaceous (Anomocytic)

ii. Cruciferous (Anisocytic)

iii. Rubiaceous (Paracytic)

iv. Caryophyllaceous (Diacytic)

v. Graminaceous

Unit-4: **Primary Structure** **08 L**

4.1 Dicotyledonous (Sunflower)

i. Root

ii. Stem

iii. Leaf

4.2 Monocotyledonous (Maize)

i. Root

ii. Stem

iii. Leaf

Unit- 5: Secondary Growth **05L**

5.1 Vascular cambium- Structure and function, seasonal activity

5.2 Secondary growth in root and stem of Sunflower

5.3 Wood- Heartwood and sapwood

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PAPER – II

BOT.302: PLANT PHYSIOLOGY

Lectures: 30

AIMS AND OBJECTIVES

1. To know importance and scope of plant physiology.
2. To study plant and plant cell in relation to water.
3. To study different process in relation with structure of organism and its environment.
4. To understand mechanism of absorption of water, gases and solutes.
5. To understand growth at various level.

Unit: 1.Introduction **01 L**

1.1 Definition, scope and importance of plant physiology.

Unit: 2. Plant cell and water relation **05 L**

2.1 Diffusion, Definition, mechanism of diffusion with suitable example, Diffusion Pressure, Graham's law of diffusion and significance of diffusion.

2.2 Osmosis: Introduction, definition, mechanism of osmosis with suitable Osmometer, osmotic pressure, turgor pressure and wall pressure, DPD and its relation with OP, TP, and WP. Types of solution- Hypotonic, Hypertonic and Isotonic. Type of Osmosis- Exosmosis and Endosmosis, significance of osmosis , Plasmolysis, de-plasmolysis.

2.3 Imbibition**:** Definition, mechanism, imbibition pressure, Importance of imbibition.

Unit: 3. Absorption of water **05 L**

3.1 Importance of water.

3.2 Mechanism of water absorption.

a. Active absorption- Osmotic theory and non-osmotic theory.

b. Passive absorption.

3.3 Factors affecting water absorption.

Unit: 4. Ascent of Sap **05 L**

4.1 Introduction and definition

4.2 Theories of ascent sap.

a. Vital theories

b. Root pressure theory.

c. Physical force theories

d. Transpiration pull theory.

Unit: 5. Transpiration **05 L**

5.1 Definition, Magnitude and types of transpiration, Structure of stomata, mechanism of opening and closing of stomata.

5.2 Theories of stomatal opening and closing.

a. Theory of Starch- Glucose interconversion and stomatal opening in Succulent plants(Steward's Theory)

b. K^+ pump theory.

5.3 Factors affecting rate of transpiration.

5.4 Significance of transpiration.

Unit: - 6. Mineral nutrition and absorption of mineral salt **05 L**

6.1 Introduction, essential and non essential elements, Macro and micro nutrient elements.

6.2 Specific functions and deficiency symptoms of- Nitrogen, Sulphur, Phosphorus, Potassium, Magnesium and Boron.

6.3 Mechanism of mineral salt absorption.

a) Passive absorption- Mass flow theory, Ion exchange and Donnan's equilibrium.

b) Active absorption- Carrier concept theory- Protein lecithin as carrier.

Unit: 7 .Plant growth and Phytohormones **04 L**

7.1 Introduction, Definition of growth, Development and Differentiation

7.2 Definition of Phytohormones and role of Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid.

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PAPER- III

BOT. 303:Practical (Based on BOT. - 301 and BOT. - 302)

Practical No.1&2

i) Study of meristem (Permanent slides/ Photographs).

ii) Study of Simple Tissues:
Parenchyma, Collenchyma and Sclerenchyma (Permanent Slides/ Photographs)

iii) Macerated xylem and phloem elements (Permanent slides/ Photographs).

iv) Study of dicot leaf(Sunflower) and monocot leaf (Maize) (permanent slides.)

Practical No: 3 and 4: Study of primary structure of dicot stem (Sunflower) and monocot stem (Maize).

Practical No.5: Study of primary structure of dicot root (Sunflower) and monocot root(Maize) (Permanent slides).

Practical No.6 and 7: Study of secondary growth structure in dicot stem and root (Sunflower)

Practical No. 8:

Study of trichomes (any three types) and stomata (any three types) with the help of locally available plant materials.

Practical No. 9: To determine DPD by using potato tuber.

Practical No.10: Determination of osmotic potential of plant cell sap by plasmolytic method.

Practical No. 11: To study the effect of two environmental factors (light and wind) on transpiration by excised twig.

Practical No.12and 13: Qualitative assessment of minerals in plant ash (any two from Macro and Micro elements)

Practical No.14. Demonstration experiments.

1. Osmosis by Curling experiment.
2. Osmosis-Thistle funnel experiment.
3. Bolting (Specimen or photograph)

Practical No.15. Demonstration experiments.

1. Suction due to transpiration.
2. Relative Transpiration.
3. Imbibition Pressure.
4. Ringing experiment.

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PAPER – IV

SKILL ENHANCEMENT COURSE (SEC)

BOT. 304: MUSHROOM CULTURE TECHNOLOGY

Lectures: 30

AIMS AND OBJECTIVES

1. To learn the history, scope and importance of mushroom technology
2. To understand nutritional and medicinal values of edible mushrooms
3. To know about the storage, marketing and various food preparations of mushrooms.
4. To understand the economics of mushroom cultivation.

Unit l: Introduction **05 L**

1.1: Scope and importance.

1.2: Nutritional and medicinal value of edible mushrooms.

1.3: Edible and non-edible mushrooms.

1.4: Morphology and distinguishing characteristics of following mushrooms:

a. Button (*Agaricus bisporus*)

b. Oyster (*Lentinus sajor-caju*, Syn. *Pleurotus sajor-caju*)

c. Paddy straw *(Volvariella volvacea*)

Unit 2: Cultivation Technology **15 L**

2.1: Mushroom farm layout and requirements

2.2. Materials for compost preparation, Different formulations, Selection of composting materials, Commonly used formulations, Synthetic compost and its advantages,

2.3: Spore culture and preparation of spawn.

2.4: Casing and its Importance, Quality parameters of casing mixture and commonly used materials for casing.

2.5: Cultivation procedure of: a. *Agaricus bisporus b. Pleurotus sajor-caju*.

Unit 3: Storage **04 L**

3.1: Short-term storage (Refrigeration - upto 24 hours)

3.2: Long term storage (canning, pickling). Drying, storage in salt solutions.

3.3: Marketing

Unit 4: Food Preparation **06 L**

4.1: Types of foods prepared from mushroom: Soup, Cutlet, Omlette, Samosa, Pickles, Curry.

4.2 Training Centres: National and Regional level.

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9.Google.co.in

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Semester: IV

PAPER- I

BOT. - 401: PLANT EMBRYOLOGY

Lectures: 30

AIMS AND OBJECTIVES

1. To know the scope and Importance of Embryology
2. To study structure of micro and megasporangium.
3. To study pollination, fertilization, Endosperm and Embryogeny.
4. To give exposure of techniques in embryology

Unit 1: Introduction **01L**

1.1: Definition, Scope and importance of Embryology

Unit 2: Microsporangium (Anther) **04 L**

2.1: Structure of anther- Epidermis, endothecium, middle layer sporogenious tissue and Tapetum.

2.2: Tapetum types- a) Amoeboid or plasmodia b) Secretary or glandular

2.3: Functions of Tapetum

2.4: Microsporogenesis- karyokinesis and cytokinesis (simultaneous and successive)

2.5: Structure of pollen and Male gametophyte

2.6: Types of pollen tetrad – linear, isobilateral, tetrahedral, decussate, T- shaped.

Unit 3: Megasporangium (Ovule) **05 L**

3.1: Structure of Ovule.

3.2: Types of ovule: i) Orthotropous ii) Anatropous iii) Amphitropous iv) Hemianatropous v) Compylotropous vi) Circinotropous

3.3: Types of Embryo sac. i) Monosporic (*Polygonum*) ii) Bisporic (*Allium*) iii) Tetrasporic (*Peperomia*)

Unit 4: Pollination and Fertilization **05 L**

4.1: Definition and Types of Pollination: Anemophily, Entomophily, Hydrophily

4.2: Fertilization i) Definition ii) Entry of pollen tube into ovule - Porogamy, chalizogamy and mesogamy

iii) Process of double fertilization and tripl fusion

iv) Significance of double fertilization mechanism.

Unit 5: Endosperm **03L**

5.1: Definition.

5.2: Structure and function of endosperm.

5.3: Types of Endosperm. i) Nuclear ii) Cellular iii) Helobial.

Unit 6: Embryo **03L**

6.1: Definition

6.2: Structure of Dicot Embryo e.g. *Capsella brussa pastories* (Development not expected)

6.3: Structure of monocot embryo e.g. *Sagittaria* (Development not expected)

Unit 7: Seed structure and dispersal **06L**

7.1: Definition, structure of seed.

7.2: Appendages and dispersal mechanism of seed- Aril, Coma, Caruncle

7.3 Dispersal Mechanism:

i. By Wind - (Anemochory):

a. Winged seed and fruits b. Parachute mechanism c. Hairs

ii. By Water (Hydrochory): a. Floating devices b. Protective covering

iii. By Animal (Zoochory): a. Hooked fruits and seeds b. Sticky Fruit c. Edible fruit

Unit 8: Apomixis and polyembryony. **03L**

8.1: Apomixis: Definition and types – Non- recurrent, recurrent , adventive embryony and veg. reproduction

8.2: Polyembryony: Definition

8.3 Types of polyembryony: i. Simple ii. Cleavage iii Rosette

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REFERENCES:

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PAPER- II

BOT.-: 402 PLANT METABOLISM

Lectures 30

AIMS AND OBJECTIVES

1. To know the scope and importance of plant metabolism.
2. To study the properties, mechanism and classification of enzymes.
3. To study the process of photosynthesis in higher plants, C3, C4 and CAM pathways.
4. To study respiration in higher plants.

Unit 1: Introduction **02 L**

1.1: Definition

1.2: Plant cell as organic Laboratory

1.3: Anabolism and catabolism

Unit 2: **Enzymes** **04 L**

2.1: Definition, Structure and properties.

2.2: Classification of enzymes

2.3: Mode of enzyme action: Lock and key Model, Induced fit model

Unit 3: **Photosynthesis** **11 L**

3.1: Definition, photosynthetic apparatus (Structure of Chloroplast)

3.2: Role of photosynthetic pigments: Chlorophyll (Chl- a, Chl- b), Carotenoids and Phycobillins

3.3: Photosystem I and II

3.4: Mechanism

a : Light Reaction: Cyclic and Non Cyclic Photophosphorylation.

b : Dark Reaction: C3, C4 and CAM pathways.

3.6: Photorespiration: Definition, Sites and Mechanism of photorespiration.

3.7: Factor affecting the process of photosynthesis.

Unit 4: Respiration **07 L**

4.1: Introduction, Definition and Types of respiration.

4.2: Mechanism of Aerobic respiration.

a) Glycolysis.

b) Kreb's cycle.

c) Electron Transfer System (ETS)

4.3 Mechanism of Anaerobic respiration: Alcoholic Fermentation

4.4 Factor affecting the process of respiration.

Unit 5: Nitrogen metabolism **06 L**

5.1: Introduction.

5.2: Types of Nitrogen fixation.

5.3: Biological nitrogen fixation.

5.4: Nitrate and ammonia assimilation.

5.5: Importance

REFRENCES:-

1. Kochhar P. L. (1962) Plant Physiology, Atmaram and Sons, Delhi, India
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PAPER- III

BOT.403: Practical (Based on BOT. - 401 and BOT. - 402)

Practical No.1: Study of the following with the help of P.S. / photographs.

i) T.S. of microsporangium (Anther)

ii) Tapetum – a) Amoeboid b) Secretory

Practical No 2: Study of types of ovules with the help of P.S. / Photographs as per theory.

Practical No 3: Study of different kinds of embryo sac with the help of P.S / Photographs

i) Monosporic - *Polygonum*

ii) Bisporic - *Allium*

iii) Tetrasporic - *Peperomia*

Practical No 4: Mounting of embryos from suitable seeds (*Cucumis / Cymopsis / Citrus*).

Practical No 5: Study of structure of dicot and monocot seed

Practical No 6 and 7: Study of seed dispersal mechanism.

i: Winged – *Moringa, Hiptage*

ii: Parachute – Pappus (*Tridax*)

iii: Hair – *Calatropis*

iv: Floating – Coconut

v: Animal – *Xanthium, Achyranthes*

vi: Sticky – *Plumbago / Cleome / Boerrhaavia*

Practical No 8 and 9: Study the activity of catalase and study the effect of pH and enzyme concentration.

Practical No 10 and 11: To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.

Practical No 12: Comparison of the rate of respiration in any two parts of a plant by using Ganong's potometer.

Practical No 13: Separation of amino acids by paper chromatography.

Practical No 14 and 15: Demonstration experiments

i. To demonstrate the presence of starch in chloroplast

ii. CO_2 essential for Photosynthesis

iii. R.Q. (Respiratory Quotient)

iv. Kuhne's Tube experiment

v . Isolation and Inoculation of *Rhizobium*

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PAPER – IV

SKILL ENHANCEMENT COURSE (SEC)

BOT.404: NURSERY AND GARDENING

Lectures: 30

AIMS AND OBJECTIVES

1. To know the concept of nursery and Gardening.
2. To improve the skills for growing fresh and safe vegetables.
3. To create awareness about home gardening.
4. To develop different skills regarding the gardening operations among the students

Unit 1. Nursery **04 L**

Definition, objectives and scope, building up of infrastructure for nursery, planning and seasonal activities. Planting :direct seedling and transplant.

Unit 2. Seed structures and types **04 L**

Seed dormancy, causes and methods of breaking dormancy, Seed storage: Seed banks, factors affecting seed viability and genetic erosions.

Unit 3. Vegetative propagation **05 L**

Cutting and Air-layering: selection, techniques of cutting, rooting medium, planting and hardening of plants in green house or glass house.

Harvesting, Packing, Storage and Marketing of Nursery stock.

Unit 4. Gardening **07 L**

Definition, objectives and scope,. Different types of gardening: Landscape, home gardening and park, and its Components, suitable plants, soil, manuring and watering.

Unit 5. Indoor Gardening **04 L**

Definition, characters of indoor plants, containers, selection of indoor plants, Potting media, watering tips.

Botanical name, cultivation practices, Ornamental value, maintenance and care of Cycads and Pothas (Two examples each)

Unit 6: Cultivation practices **06 L**

Introduction, study of cultivation of some vegetables: Brinjal and Tomato w.r.t.

i) Sowing ii) Transplanting of seedling

iii) Varieties iv) Mannuaring and irrigation

v) Pest, Diseases and control measures vi) Harvesting

vii) Storage and Marketing

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1.Bose T.K. and Mukherjee. D. (1972). Gardening in India, Oxford and IBH Publishing Vo., New Delhi.

2.Sandhu, M. K., (1989), Plant Propagation. Wile Eastern Ltd., Bangalore, Madras.

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Equivalence: Theory and Practicals
Class: S. Y. B. Sc.
Subject : Botany

PAPER	**Old Courses (W.E.F. June, 2016)**	**PAPER**	**New Courses (W.E. F. June, 2019)**
SEM-III			
BOT. 231	Bryophytes and Pteridophytes	Bot. 402	Plant Metabolism
BOT. 232	Morphology of Angiosperms	Bot. 401	Plant Embryology
BOT. 233	Based on BOT.231, BOT.- 232,	Bot. 403	Practical (LAB – I) Based on Bot. 401 and Bot. 402
SEM-IV			
BOT. 241	Plant Physiology	Bot. 302	Plant Physiology
BOT. 242	Taxonomy of Angiosperms	Bot. 301	Plant Anatomy
BOT. 243	Based On BOT.-241 and BOT.-242	Bot. 303	Practical (LAB – I) Based on Bot. 301 and Bot. 302

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Faculty of Science and Technology

(NAAC Re-Accredited)

SYLLABUS FOR CORE AND SKILL ENHANCEMENT COUESES IN BOTANY

As Per U. G. C. Guidelines

Based on

Choice Based Credit System (CBCS)

T. Y. B. Sc. BOTANY SEMESTER - WISE SYLLABUS

(Theory and Practicals)

To Be Implemented From

Academic Year 2020 - 2021

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Faculty of Science and Technology

SYLLABUS FOR CORE AND SKILL ENHANCEMENT COUESES IN BOTANY

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Based on

Choice Based Credit System (CBCS)

T. Y. B. Sc. BOTANY SEMESTER - WISE SYLLABUS

(Theory and Practicals)

SEMESTER - V

DISCIPLINE SPECIFIC COURSES

Bot. 501: Lower Cryptogams

Bot. 502: Morphology and Systematics of Angiosperms

Bot. 503: Cell biology and Genetics

Bot. 504: Plant Physiology and Biochemistry

SKILL ENHANCEMENT COURSE

Bot. 505: Biofertilizers

ELECTIVE COURSES

Bot. 506A: Analytical Techniques in Plant Sciences

Bot. 506B: Horticulture

PRACTICAL COURSES

Bot. 507: Practical - I: Based on BOT. 501 & BOT. 505

Bot. 508: Practical - II: Based on BOT. 502 & BOT. 506 A & BOT. 506B

Bot. 509: Practical - III: Based on BOT. 503 & BOT. 504

W. E. F. JUNE. 2020

SEMESTER - V

Discipline	Core Course Type	Course Code	Course Title	Credits	Total Hrs./ Week	Total Teaching Hrs.	Total Mark (100)	
							CA	UA
Discipline Specific Course (DSC)	Paper - I	BOT.501	Lower Cryptogams	3	3	45	40	60
	Paper - II	BOT.502	Morphology and Systematics of Angiosperms	3	3	45	40	60
	Paper -III	BOT.503	Cell Biology and Genetics	3	3	45	40	60
	Paper -IV	BOT.504	Plant Physiology and Biochemistry	3	3	45	40	60
DSC Skill Enhancement Course	Paper - V	BOT.505	Biofertilizer	3	3	45	40	60
DSC Elective Course (Any one)	Paper -VI	BOT.506 A	Analytical Techniques in Plant Sciences	3	3	45	40	60
		BOT.506 B	Horticulture	3	3	45	40	60
DSC Core Practicals	Practical I	BOT.507	Practicals Based on BOT.501 and BOT.505	4	4/Batch	60	40	60
	Practical II	BOT.508	Practicals Based on BOT.502 and BOT.506A or Bot.506B	4	4/Batch	60	40	60
	Practical III	BOT.509	Practicals Based on BOT.503 and BOT.504	4	4/Batch	60	40	60
Non-Credit Audit Course (Any One)	Paper-VII	AC-510	NSS	No Credit	2	30	100	--
		AC-511	NCC					
		AC-512	Sports					

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Equivalence of the T. Y. B. Sc. Botany CBCS Syllabus

Paper	Course	SEMESTER - V CBCS Syllabus (New)	Course	SEMESTER - V CGPA Syllabus (Old)
I	Bot. 501	Lower Cryptogams	Bot. 351	Cryptogams
II	Bot. 502	Morphology and Systematics of Angiosperms	Bot. 352	Angiosperm Taxonomy
III	Bot. 503	Cell biology and Genetics	Bot. 353	Cell and Molecular Biology
IV	Bot. 504	Plant Physiology and Biochemistry	Bot. 354	Advanced Plant Physiology
V	Bot. 505	Biofertilizers	Bot. 355	Plant Ecology and Phytogeography
VI	Bot.506A/ Bot.506B	Analytical Techniques in Plant Sciences/ Horticulture	Bot.356.1/ Bot.356.2/ Bot.356.3/ Bot.356.4	Plant Biotechnology/ Ethnobotany/ Gardening/Seed Technology and seed pathology

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Syllabus of T. Y. B. Sc. Botany w. e. f. June, 2020

CBCS Pattern

DISCIPLINE SPECIFIC COURSE (DSC)

SEMESTER - V

PAPER - I

BOT. 501: LOWER CRYPTOGAMS (Lectures: 45)

AIMS AND OBJECTIVES:

1. To study salient features of cryptogamic plants.
2. To make students aware about the status of cryptogams as a group in plant kingdom.
3. To study the life cycles of selected genera.
4. To study economic and ecological importance of cryptogramic plants.

Unit 1: An introduction to Algae (09 Lectures)

1.1. Definition and general characters
1.2. Habit and habitat
1.3. Organization of thallus
1.4. Similarities, differences with fungi and Bryophytes
1.5. Reproduction
1.6. Life cycle patterns: Haplontic, Diplontic and Diplohaplontic
1.7. Outline classification of Algae according to F. E. Fritsch (1945) up to classes with suitable examples

Unit 2: Study of Life cycle with emphasis on systematic position, occurrence, morphology, reproduction and alternation of generation of ***Chara*** and ***Sargassum*** **(09 Lectures)**

Unit 3: An introduction to fungi (09 Lectures)

3.1. Definition and General Characters
3.2. Habit and habitat
3.3. Structure of thallus
3.4. Reproduction
3.5. Outline classification of fungi according to Ainsworth (1973) up to classes with suitable examples.

Unit 4: Study of Life cycle of fungi with reference to systematic position, thallus structure, reproduction of *Albugo* and *Uncinula* **(09 Lectures)**

Unit 5: Applied Phycology and Mycology (09 Lectures)

5.1. Role of Algae in i) Agriculture ii) Industry iii) Biotechnology iv) Water Pollution
5.2. Role of Fungi in i) Agriculture ii) Industry iii) Food iv) Medicine
5.3. Contribution of following Phycologists
i) Prof. M. O. P. Iyengar ii) Prof. T. V. Deshikachary
5.4. Contribution of following mycologists

i) Prof. E. J. Buttler ii) Prof. C. V. Subramanian

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DISCIPLINE SPECIFIC COURSE (DSC)

SEMESTER - V

PAPER - II

BOT. 502: MORPHOLOGY AND SYSTEMATICS OF ANGIOSPERMS (Lectures: 45)

AIMS AND OBJECTIVES:

1. To study vegetative and floral morphology of angiospermic plants
2. To study the status of angiosperm in plant kingdom
3. To study the origin of angiosperm with respect to age and probable ancestors
4. To study various angiosperm families emphasizing their morphology, salient features etc.
5. To know the role of anatomy and embryology in taxonomy

Unit1. Vegetative Morphology **(09 Lectures)**

1.1. Definition and scope of Morphology

1.2. Root: Definition, General characters and functions
Types of root: Tap and Adventitious

1.3. Stem: Definition, General characters and functions

1.4. Leaf: Definition,

a) Parts of typical leaf.

b) Types of leaf: Simple, Compound: Pinnately and Palmately.

c) Phyllotaxy: Alternate, Opposite and whorled.

d) Venation: Reticulate and parallel

1.5. Leaf Modifications: Phyllode, Pitcher

Unit 2: Floral Morphology **(09 Lectures)**

2.1. Inflorescence: Definition, Parts of Inflorescence

Types of Inflorescence:

a) Racemose - Raceme, Spike, Catkin, Spadix, Corymb, Umbel and Capitulum

b) Cymose: Solitary, Uniparous, Biparous and Multiparous cyme

c) Special Types: Cyathium, Verticillaster, Hypanthodium

2.2. Flower: Definition, Parts of typical flower and their functions

2.3. a) Insertion of floral leaves on thalamus: Hypogynous, Perigynous and Epigynous

b) Symmetry: Actinomorphic, Zygomorphic and Asymmetric

2.4. Calyx: Polysepalous, Gamosepalous

2.5. Corolla:

a) Regular polypetalous - Cruciform, Caryophyllaceous and Rosaceous

b) Irregular polypetalous - Papilionaceous,

c) Regular gamopetalous: Campanulate, Tubular, Infundibuliform, Rotate and Hypocrateriform

d) Irregular gamopetalous: Bilabiate, Ligulate and Personate

2.5. Androecium:

i) Cohesion of Stamen:

a) Adelphy: Monadelphous, Diadelphous, Polyadelphous

b) Syngeny

c) Synandry

ii) Adhesion of stamen: Episepalous, Epipetalous, Epiphyllous and Gynandrous

2.6. Gynoecium: Apocarpous and Syncarpous pistil, Monocarpellary, Bicarpellary and polycarpellary

Types of Placentation: Marginal, Basal, Axile, Parietal, Free central and superficial

2.7. Fruit: Definition, Parts of typical fruit

Types: a) Simple - Loculicidal capsule

b) Aggregate - Etaerio of berries

c) Composite - Syconus

Unit 3: Study the origin of Angiosperms **(09 Lectures)**

3.1. Definition, Distinguishing Characters of Angiosperms

3.2. Taxonomy : Aims of taxonomy - Empirical and Interpretative approach

3.4. The origin of Angiosperms: w. r. t.

i) Age of Angiosperms

ii) Probable ancestors of angiosperms:

a) The Anthostrobilus (Bennettitalean) theory

b) The Gnetales theory

Unit 4: Systems of Classification and Modern Trends in Taxonomy **(09Lectures)**

4.1. Study of Systems of Classification w. r. t. outline, merits and demerits of Hutchinson's system and Engler and Prantl’s system

4.2. Modern Trends in Taxonomy

Role of following with suitable examples:

a) Anatomy

b) Embryology

Unit 5: Study of Angiosperm Families **(09 Lectures)**

(*Sensu* Bentham and Hooker’s system of classification)

Study of following families w. r. t. geographical distribution, systematic position, morphological characters (vegetative and floral), salient features, floral formula and economic importance of the following families.

1. Annonaceae
2. Rutaceae
3. Caesalpiniaceae
4. Compositae (Asteraceae)
5. Sapotaceae
6. Asclepiadaceae
7. Amaranthaceae

8. Liliaceae

Point of biological interest of Asclepiadaceae

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DISCIPLINE SPECIFIC COURSE (DSC)

SEMESTER - V

PAPER - III

BOT. 503: CELL BIOLOGY AND GENETICS (Lectures: 45)

AIMS AND OBJECTIVES:

1. To study the Prokaryotic and eukaryotic cell
2. To study the cell components and their functions
3. To study the cell cycle
4. To introduce the students with "Science of Heredity"
5. To study linkage and crossing over

Unit 1: Cell and Cell Cycle (09 Lectures)

1.1. Introduction, definition and history of cell, types of cell, Characteristics of Prokaryotic and eukaryotic cells, Cell theory

1.2. Cell Wall and Cell Membrane: Definition, Physical and chemical Properties and functions of plant cell wall and Membranes Unit Membrane model, Fluid Mosaic model

1.3. Various phases of Eukaryotic cell cycle, Mitosis and Meiosis

Unit 2: Cell organelles (09 Lectures)

2.1. Mitochondria: Ultra Structural organization and function of Mitochondria

2.2. Chloroplast: Ultra Structural organization and function of Chloroplast

2.3. Endoplasmic reticulum: Ultra Structure, types and functions

2.4. Golgi Complex: Ultra Structure and function

2.5. Nucleus: Structure, Morphology and Ultra structure (Nuclear envelope, Nucleoplasm, Chromatin material and Nucleolus)

2.6. Chromosome: Morphology, Types of chromosomes on the basis of centromere

Genetics

Unit 3: Introduction (09 Lectures)

3.1. Genetics: Introduction, History and scope

3.2. Mendelian Genetics: Mendelism, History, Terminology, Mendel's laws, Monohybrid, Dihybrid cross.

3.3. Gene interaction: Lethal gene, Complementary gene, Duplicate and Dominant epistatic.

3.4. Cytoplasmic inheritance: Definition, chloroplast inheritance in variegated 4o clock plant (*Mirabilis jalapa*). Cytoplasmic male sterility in maize.

3.5. Multiple alleles: Definition, characters and examples (*Nicotiana* sps.).

Unit 4: Linkage and Crossing over (09 Lectures)

4.1. Introduction: Concept and history of linkage, Kinds of Linkages, Hypothesis of Linkages (Bateson and Punnett)

4.2. Crossing over: Introduction, Definition, Mechanism and types (Single and Double)

Unit 5: Chromosomal aberrations **(09 Lectures)**

5.1. Introduction, Definition.

5.2. Types of Chromosomal Aberrations

5.3. Numerical change: Euploidy, aneuploidy and its types

5.4. Structural changes: Addition, deletion, substitution, translocation and inversion

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DISCIPLINE SPECIFIC COURSE (DSC)

SEMESTER - V

PAPER - IV

BOT. 504: PLANT PHYSIOLOGY AND BIOCHEMISTRY (Lectures: 45)

AIMS AND OBJECTIVES:

1. To study the growth pattern of plant
2. To know the phenomenon of photoperiodism and effect of phytochrome on flowering
3. To study the vernalization process
4. To know the path of translocation
5. To study the biomolecules in plants
6. To study secondary metabolites and their role in plants

Plant Physiology

Unit 1: Plant growth and Movement (09 Lectures)

1.1. Plant growth: Introduction and Definition
1.2. Phases of growth
1.3. Growth curve
1.4. Factors affecting growth
1.5. Plant movement: Introduction and Definition
1.6. Types of plant movement: i) Tropic ii) Tactic iii) Nastic

Unit 2: Physiology of flowering (09 Lectures)

2.1. Photoperiodism:
a) Introduction, Definition
b) Classification of plants: SDP, LDP, DNP
c) Photoperiodic induction
d) Phytochrome and role of phytochrome in flowering

2.2.Vernalisation:
a) Introduction and Definition
b) Mechanism of vernalization, hypothesis of phasic development and hypothesis of hormonal involvement
c) Devernalization

Unit 3: Translocation of organic solutes (09 Lectures)

3.1. Definition
3.2. Path of translocation
3.3. Evidences for phloem transport
3.4. Mechanism of translocation: Pressure flow theory, Diffusion
3.5. Source to sink relationship
3.5. Phloem loading and unloading
3.6. Factors affecting phloem translocation i) External: temperature, light ii) Internal: Hormonal and metabolic inhibition

Biochemistry

Unit 4: Biomolecules **(09 Lectures)**

4.1. Introduction

4.2. Carbohydrates: Introduction, definition, classification, properties and functions of carbohydrates

4.3. Amino acids and proteins: Introduction, definition, properties of amino acids. Role of amino acids in plants. Classification of proteins (Primary and secondary proteins), properties and functions of proteins

4.4. Lipids: Introduction, definition, classification, properties and functions of lipids

Unit 5: Secondary Metabolites **(09 Lectures)**

5.1. Introduction, Definition

5.2. Distribution of Secondary metabolites

5.2. Brief account of sec. metabolites w. r. t. occurrence in plants, and function of a) alkaloids, b) flavonoids c) Terpenes.

5.6. Role of Secondary metabolites in plants

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DSC SKILL ENHANCEMENT COURSE

SEMESTER - V

PAPER - V

BOT. 505: BIOFERTILIZERS **(Lectures: 45)**

AIMS AND OBJECTIVES:

1. To introduce application of Biofertilizer technology in Agriculture
2. To familiarize students with microbes used as biofertilizers
3. To demonstrate the low cost media preparation and cultural practices in biofertilizers
4. To aware the students about benefits of applications of biofertilizers
5. To create self employment opportunities among the students

Unit 1: Introduction **(09 Lectures)**

1.1. Introduction, Scope and importance of Biofertilizers

1.2. General account of the microbes used as Biofertilizers

1.3. Isolation of *Rhizobium*, Identification, Mass multiplication, Carrier based inoculants

Unit 2: Bacterial Biofertilizers **(09 Lectures)**

2.1. *Azospirillum* isolation and mass multiplication, carrier based inoculants and associative effect of different organisms

2.2. *Azotobacter*, classification and characteristics

2.3. Crop response to *Azotobacter* inoculums, Mass multiplication of *Azotobacter*

2.4. Applications of *Azospirillum*

Unit 3: Algal Biofertilizers **(09 Lectures)**

3:1. Cyanobacteria (Blue Green Algae): Isolation of *Anabaena* from *Azolla*, Mass Multiplication of *Anabaena*

3.2. *Azolla* - *Anabaena* relationship

3.3. Biological Nitrogen fixation

3.4. Blue Green algae in a rice cultivation.

3.5. Applications of BGA

Unit 4: Fungal Biofertilizers **(09 Lectures)**

4.1. Introduction, Occurrence and Distribution of Mycorrhizal association.

4:2. Types of Mycorrhizal association, growth and yield - colonization of VAM - Vesicular Arbuscular Mycorrhiza

4.3. Mycorrhizal applications in agriculture

Unit 5: Compost and Manure **(09 Lectures)**

5.1. Organic Farming, green manuring, organic manures and their uses

5.2. Recycling by composting method of biodegradable, municipal, agricultural and industrial wastes

5.3. Biocompost making methods, Types and methods of vermicomposting

5.4. Benefits of vermicompost, field applications

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DSC ELECTIVE COURSE

SEMESTER - V

PAPER - VI

BOT. 506 A: ANALYTICAL TECHNIQUES IN PLANT SCIENCES (Lectures: 45)

AIMS AND OBJECTIVES:

1. To study Imaging technique for the study of plants
2. To study micrometry and calibration of microscope.
3. To study techniques of slide preparation and staining.
4. To know the principle and working of Instruments.
5. To study chromatography techniques
6. To study statistical analysis methods.

Unit 1: Microscopy **(09 Lectures)**

1.1. Introduction,

1.2. Principles of microscopy; Image quality, Magnification concept, Choice of eye piece and objective combinations to ensure optimal magnification, magnification power,

1.3. Resolution - phenomenon, resolving power of microscope, contrast and resolution of images

1.4. Light microscopy; Fluorescence microscopy

1.5. Brief account of Transmission and Scanning electron microscopy

Unit 2: Micrometry and Micro technique **(09 Lectures)**

2.1. Introduction,

2.2. Principle, micrometer types, Eye piece Reticle/inserts, stage micrometer

2.3. Calibration of ocular scale and microscope

2.4. Micro technique: Introduction, preparations for microscopic observation - WM, smears, squashes, sections, Materials - cover glass, micro slides

2.5. Stains: nature and use of Haematoxyline, Cotton blue, Light Green, Safranin, Sectioning - Free hand

Unit 3: Biophysicochemical techniques **(09 Lectures)**

3.1. Centrifugation: Principle of Centrifugation; types centrifuge and applications.

3.2. Spectrophotometry**:** Introduction, types, Principle and its application in biological research

Unit4: Chromatography **(09Lectures)**

4.1 Principle

4.2 Paper chromatography

4.3 TL chromatography

4.4. HPLC

Unit 5: Biostatistics **(09 Lectures)**

5.1. Introduction to Statistics
5.2. Sampling Methods: Random, Systematic
5.3. Representation of Data: Tabular, Graphical
5.4. Measures of central tendency, Arithmetic mean, mode, median
5.5. Measures of dispersion: Range, mean deviation
5.6. Standard deviation
5.7. Chi square test

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DSC ELECTIVE COURSE

SEMESTER - V

Paper - VI

BOT. 506B: HORTICULTURE **(Lectures: 45)**

AIMS AND OBJECTIVES:

1. To know horticulture, its scope, disciplines and importance
2. To understand different horticultural practices and their methods
3. To study importance, principles and types of Bahar treatment
4. To study role played by green and poly houses in horticulture
5. To understand methods of preservations and preparations of preserved products prevailing especially in this part of the state

Unit: 1 Introduction **(04 Lectures)**

1.1. Definition, Scope and importance of Horticulture

1.2. Disciplines of Horticulture

i) Pomology ii) Olericulture iii) Floriculture

iv) Ornamental horticulture v) Landscape horticulture

1.3. Nutritive value of Fruits and Vegetables

Unit2: Propagation of Horticultural plants **(10 Lectures)**

2.1. Sexual Propagation: Advantages and Disadvantages

2.2. Asexual /Vegetative Propagation: Advantages and Disadvantages

2.3. Natural methods of vegetative propagation:

Bulb, Corm, Tuber, Rhizome, Runner, Offset, Sucker

2.4. Artificial methods of vegetative propagation

A) Cutting:

a) Definition

b) Types of Cutting:

i) Stem cutting - Soft wood cutting and Hard wood Cutting

ii) Leaf Cutting

iii) Root Cutting

B) Layering:

a) Definition

b) Types of Layering:

i) Simple layering

ii) Compound layering

iii) Air layering/Gootee

C) Budding:

a) Definition

b) Types of Budding - i) Shield/T - Budding ii) Patch Budding

D) Grafting:

a) Definition

b) Types of Grafting - i) Whip grafting ii) Tongue grafting

Unit3: Special Horticultural Practices **(12 Lectures)**

3.1. Training and pruning of Plants:
  a) Definition
  b) Objectives of Training and Pruning
  c) Advantages of Training and Pruning
  d) Difference between Training and Pruning
  e) Methods of Training: i) Central leader system ii) Open centre system
  iii) Modified leaders
  f) Methods of Pruning: i) Heading back ii) Thinning out

3.2. Bahar Treatment:
  a) Definition, Principles and Importance
  b) Types of Bahar: i) Ambe Bahar ii) Mrig Bahar
  iii) Hasta Bahar

3.3. Cultural practices:
  a) Definition
  b) Types of cultural practices: i) Ringing ii) Girdling
  iii) Notching iv) Bending

Unit 4: A) Fruits (Grapes) and vegetables (Tomato) production technology **(09 Lectures)**

i) Introduction
ii) Soil and climate requirement
iii) Commercial varieties
iv) Pest and disease management
v) Harvesting and post harvest management

B) Polyhouse, Green house and Glass house technology with reference to Ornamental Horticulture, Scope and importance

Unit5: Preservation of Fruits and Vegetables **(10 Lectures)**

5.1. Introduction, scope and importance of fruits and vegetables preservation

5.2. Methods of preservation:
  a) Temporary preservation:
  i) Asepsis ii) Exclusion of moisture
  i. e. Drying of vegetables e. g. Potato, Cabbage, Onions, Bitter Gourd, Green Pea, Spinach
  iii) Use of mild antiseptic iv) Pasteurization
  v) Low temperature

b) Permanent preservation:
  i) Sterilization and Processing: Use of sugar, salts, vinegar or preservation by food additives i. e. Chemical preservatives: citric acid. Potassium meta-bisulphite, sodium benzoate, Sulphur-dioxide
  ii) Drying, Dehydration and concentration of fruits and vegetables
  iii) Ionizing radiation

5.3. Preparation of preserved products:
  a) Mix fruit Jam

b) Wood apple/Guava Jelly
c) Lemon/ Orange Squash
d) Tomato ketchup

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SEMESTER - V

PRACTICAL COURSES

PRACTICAL PAPER - I

BOT. 507: Based on Theory Paper - I & V

(BOT. 501 and BOT. 505)

Practicals Based on Bot. 501: Lower cryptogams

Practical - 1 & 2: Study of range of thallus structure in algae with the help of materials or Permanent slides (any one from the examples):

a) Unicellular thallus: *Chlamydomonas*, *Chlorella*

b) Colonial thallus: *Pandorina*, *Eudorina*, *Volvox*, *Hydrodictyon*

c) Filamentous thallus: *Pithophora*, *Chaetophora*, *Coleochaetae*, *Stigeoclonium*, *Drapanaldia*, *Fritscheilla* and *Oedogonium*

d) Siphonaceousthallus: *Vaucheria*, *Caulerpa*

e) Pseudoparenchymatous: (Uniaxial/Multiaxial) thallus: *Batrachospermum*, *Polysiphonia*

f) Parenchymatousthallus: *Ulva*, *Enteromorpha*

Practical - 3: Study of life cycle of ***Chara***

Practical - 4: Study of life cycle of ***Sargassum***

Practical - 5: Study of fungal forms (any four)

i) *Stemonitis*	ii) *Saprolegnia*	iii) *Rhizopus*
iv) *Eurotium*	v) *Puccinia*	vi) *Alternaria*

Practical - 6: Study of life cycle of ***Albugo***

Practical - 7: Study of life cycle of ***Uncinula***

Practical - 8: Culture of Algae (Venkatraman method)/Culture of Fungi on PDA medium

NOTE: Study tour is compulsory. Students are expected to submit two forms of Algae and Fungi each. Photographs of any two forms Algae and Fungi along with tour report.

Practicals Based on Bot. 505: Biofertilizers

Practical - 9: Diversity of BGA with the help of locally available specimens - *Nostoc*, *Anabaena*, *Oscillatoria*, *Gloecapsa* (Any three)

Practical - 10: Preparation of Yeast Extract Mannitol Agar Medium (YEMA Medium)

Practical - 11 and 12: *Rhizobium* culture with the help of healthy leguminous root nodules.

Practical- 13: Mass culture of BGA (Venkatraman method)

Practical - 14: Preparation of Compost, FarmYard Manure (FYM).

Practical - 15: Study of Ectomycorrhiza and Endomycorrhiza with the help of PS/ Photograph.

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PRACTICAL PAPER - II

BOT. 508: Based on Theory Papers - II and VI

(BOT. 502 and BOT. 506A/BOT. 506B)

Practicals Based on Bot. 502: Morphology and Systematics of Angiosperms

Practical - 1: Study of Leaf Morphology (as per theory): Phyllotaxy and Types of leaf

Practical - 2: Study of Inflorescences (as per theory)

Practical - 3: Study of Flower: Types of Flower and Forms of Corolla

Practical - 4 to 6: Study of **any six** plant families as per theory with respect to systematic position, morphological characters (vegetative and floral), floral formula and floral diagram (*sensu* Bentham and Hookers system)

Practical - 7: Identification of genus and species (any suitable) by using local, regional, state and national flora

NOTE : i) Excursion tour is compulsory

ii) Submission of photograph of any ten plants and tour report at the time of practical examination.

Practicals Based on Bot. 506 A: Analytical Techniques in Plant Sciences

Practical - 8 & 9: Extraction and Separation of amino acids by paper chromatography

Practical -10: Isolation of chloroplasts by solvent method

Practical - 11: Study of different microscopic techniques light and fluorescence by using photographs

Practical - 12: Preparation of different types of stains (Permanent and temporary)

Practical -13: Preparation of permanent slides (double staining)

Practical - 14 & 15: Computation of mean, mode, median, variance and standard deviation from the given data.

Practicals Based on Bot. 506B: Horticulture

Practical - 8: Study of Garden tools and equipment: Sprayer, Duster, Pruning knife, Sprinkler.

Practical - 9: Study of propagation requirement:

i) Media ii) Containers iii) Potting iv) Repotting

Practical - 10 & 11: Study of propagation methods:

a) Cutting b) Layering c) Budding d) Grafting

Practical - 12 to 15: Preparations of different types of fruit products (Any three)

a) Mix fruit Jam b)Wood apple/Guava Jelly

b) Lemon/Orange Squash c)Tomato ketchup

Note: Visit to any one Nursery Unit, Commercial orchard

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PRACTICAL PAPER - III

BOT. 509: Based on Theory Papers - III and IV

(BOT. 503 and BOT. 504)

Practicals Based on Bot. 503: Cell Biology and Genetics

Practical - 1: To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs

Practical - 2: Study of the Ultra structure of cell organelles with the help of Photomicrographs

Practical - 3: To prepare temporary stained preparation of mitochondria from onion peal using vital stain Janus green.

Practical - 4 & 5: Study of mitosis and meiosis (temporary mounts and permanent slides).

Practical - 6: Measure the cell size (either length or breadth/diameter) by micrometry

Practical - 7: Study of salivary gland chromosome in Chironomous larvae

Practicals based on Bot. 504: Plant Physiology and Biochemistry

Practical - 8: Estimation of soluble proteins by Lowery *et. al.* method.

Practical - 9 & 10: Demonstration:

a) Ringing experiment for path of solute translocation.

b) Geotropic Movement of root, by using germinating seeds

c) Phototropic movement

Practical - 11 & 12: Separation of sugar by paper chromatography

Practical - 13: Qualitative tests for primary metabolites starch, lipids and proteins by using available plant materials

Practical - 14 & 15: Qualitative tests for Secondary metabolites: alkaloids, terpenes, Flavonoids by using available plant materials.

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KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Faculty of Science and Technology

(NAAC Re-Accredited)

SYLLABUS FOR CORE AND SKILL ENHANCEMENT COUESES IN BOTANY

As Per U. G. C. Guidelines

Based on

Choice Based Credit System (CBCS)

T. Y. B. Sc. BOTANY SEMESTER - WISE SYLLABUS

(Theory and Practicals)

SEMESTER - VI

To Be Implemented From

Academic Year 2020 - 2021

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Faculty of Science and Technology

SYLLABUS FOR CORE AND SKILL ENHANCEMENT COUESES IN BOTANY

As Per U. G. C. Guidelines

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T. Y. B. Sc. BOTANY SEMESTER - WISE SYLLABUS

(Theory and Practicals)

SEMESTER - VI

DISCIPLINE SPECIFIC COURSES

BOT. 601, Paper - I: Higher Cryptogams

BOT. 602, Paper - II: Gymnosperms & Paleobotany

BOT. 603, Paper - III: Molecular Biology

BOT. 604, Paper - IV: Economic Botany

SKILL ENHANCEMENT COURSE

BOT. 605, Paper - V: Floriculture

ELECTIVE COURSES

BOT. 606.A, Paper - VI: Herbal Techniques

BOT. 606.B, Paper - VI: Plant Breeding

PRACTICAL COURSES

BOT. 607, Practical - I: Based on BOT. 601 and BOT. 605

BOT. 608, Practical - II: Based on BOT. 602 and BOT. 606

BOT. 609, Practical - III: Based on BOT. 603 and BOT. 604

W. E. F. JUNE - 2020

SEMESTER - VI

<table>
<tr><th rowspan="2">Discipline</th><th rowspan="2">Core Course Type</th><th rowspan="2">Course Code</th><th rowspan="2">Course Title</th><th rowspan="2">Credits</th><th rowspan="2">Total Hrs./ Week</th><th rowspan="2">Total Teaching Hrs.</th><th colspan="2">Total Marks (100)</th></tr>
<tr><th>CA</th><th>UA</th></tr>
<tr><td rowspan="4">Discipline Specific Course (DSC)</td><td>Paper-I</td><td>BOT.601</td><td>Higher Cryptogams</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td>Paper-II</td><td>BOT.602</td><td>Gymnosperms and Paleobotany</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td>Paper-III</td><td>BOT.603</td><td>Molecular Biology</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td>Paper-IV</td><td>BOT.604</td><td>Economic Botany</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td>DSC Skill Enhanceme Course</td><td>Paper- V</td><td>BOT.605</td><td>Floriculture</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td rowspan="2">DSC Electi Course (Any one)</td><td rowspan="2">Paper-VI</td><td>BOT.606 A</td><td>Herbal Technology</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td>BOT.606 B</td><td>Plant Breeding</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td rowspan="3">DSC Core Practicals</td><td>Practical I</td><td>BOT.607</td><td>Practicals Based on BOT.601 and BOT.605</td><td>4</td><td>4 /Batch</td><td>60</td><td>40</td><td>60</td></tr>
<tr><td>Practical II</td><td>BOT.608</td><td>Practicals Based on BOT.602 and BOT.606A/Bot.566B</td><td>4</td><td>4/Batch</td><td>60</td><td>40</td><td>60</td></tr>
<tr><td>Practical III</td><td>BOT.609</td><td>Practicals Based on BOT.603 and BOT.604</td><td>4</td><td>4/Batch</td><td>60</td><td>40</td><td>60</td></tr>
<tr><td rowspan="3">Non-Credit Audit Cour (Any One)</td><td rowspan="3">Paper-VII</td><td>AC-610</td><td>Soft Skill</td><td rowspan="3">No Credit</td><td rowspan="3">2</td><td>30</td><td>100</td><td>--</td></tr>
<tr><td>AC-611</td><td>Yoga</td><td></td><td></td><td></td></tr>
<tr><td>AC-612</td><td>Practicing Cleanliness</td><td></td><td></td><td></td></tr>
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KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Equivalence of the T. Y. B. Sc. Botany CBCS Syllabus

Paper	Course	SEMESTER - VI CBCS Syllabus (New)	Course	SEMESTER - VI CGPA Syllabus (Old)
I	Bot. 601	Higher Cryptogams	Bot. 361	Gymnosperms & Paleobotany
II	Bot. 602	Gymnosperms and Paleobotany	Bot. 362	Anatomy & Embryology
III	Bot. 603	Molecular Biology	Bot. 363	Genetics, Plant Breeding and Evolution
IV	Bot. 604	Economic Botany	Bot. 364	Plant Biochemistry
V	Bot. 605	Floriculture	Bot. 365	Applied Botany
VI	Bot.606.A/ Bot.606.B	Herbal Technology/ Plant Breeding	Bot. 366.1/ Bot. 366.2/ Bot. 366.3/ Bot. 366.4	Botanical Techniques/ Medico botany and Pharmacognosy/ Horticulture/ Plant Protection

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Syllabus of T. Y. B. Sc. Botany w. e. f. June, 2020

CBCS Pattern

DISCIPLINE SPECIFIC COURSE (DSC)

SEMESTER - VI

Paper - I

BOT. 601: HIGHER CRYPTOGAMS (Lectures: 45)

AIMS AND OBJECTIVES:

1. To study salient features of cryptogamic plants.
2. To make students aware of the status of cryptogams as a group in plant kingdom.
3. To study the life cycles of selected genera.
4. To study economic importance of cryptogamic plants.

Unit 1: Introduction (09 Lectures)

A) Bryophytes

1.1. General characters of Bryophyta

1.2. Classification of Bryophyta up to classes giving reasons with at least two examples of each class as per G. M. Smith (1955).

1.3. Alternation of generation in Bryophytes

1.4. Contribution of Indian Bryologist - Prof. Shiv Ram Kashyap

1.5. Economic importance

B) Pteridophytes

1.6. General characters of Pteridophytes

1.7. Classification of Pteridophytes up to classes giving reasons with at least two examples of each class according to Prof. G. M. Smith.

1.8. Contribution of Indian Pteridologist - S. S. Bir

1.9. Economic importance

Unit 2: A) Life History of *Marchantia* with respect to (11 Lecture)

2.1. Systematic position, habit and habitat

2.2. External and internal morphology of gametophytes.

2.3. Reproduction: Vegetative and sexual.

2.4. Structure of sex organs. (Development is not expected)

2.5. Fertilization,

2.6. Structure of sporophyte.

2.7. Dehiscence of capsule and dispersal of spores,

2.8. Structure and germination of spores

2.9. Graphical representation of Alternation of Generation

B) *Anthoceros*

2.10. *Anthoceros* is synthetic type discuss

2.11. Elaborate detail structure of sporophyte of *Anthoceros*

Unit 3: Life History of *Polytrichum* with respect to (07 Lecture)

3.1. Systematic position, habit and habitat
3.2. External and internal morphology of gametophytes.
3.3. Reproduction: Vegetative and sexual
3.4. Position and structure of sex organs. (Development is not expected)
3.5. Fertilization,
3.6. Structure of sporophyte,
3.7. Dehiscence of capsule and dispersal of spores,
3.8. Structure and germination of spores

Unit 4: Life History **(11 Lecture)**

A) *Psilotum* with respect to

4.1. Systematic position, habit and habitat
4.2. External and internal morphology of sporophyte
4.3. Reproduction, vegetative and asexual
4.4. Morphological nature and dehiscence of synangium.
4.5. Structure and germination of spores,
4.6. Structure of mature gametophyte (Prothallus),
4.7. Structure of mature male and female sex organ.
(Development is not expected)
4.8. Fertilization.
4.9. Structure of embryo.
4.10. Graphical representation of alternation of generation.

B) *Lycopodium* with respect to:

4.11. Systematic position, habit and habitat
4.12. External and internal morphology of sporophyte.
4.13. Reproduction: Vegetative and Asexual
4.14. Position and structure and dehiscence of sporangium.
4.15. Structure and germination of spores.
4.16. Structure of gametophyte
4.17. Structure of mature sex organs. (Development is not expected)
4.18. Fertilization.
4.19. Structure of embryo
4.20. Graphical representation of alternation of generation.

Unit 5: A) Life History of *Marsilea* with respect to: **(07 Lecture)**

5.1. Systematic position, Habit and habitat
5.2. External and internal morphology of sporophyte,
5.3. Reproduction
5.4. External and internal morphology of sporocarp,
5.5. Morphological nature and dehiscence of the sporocarp.
5.6. Structure of microspore and megaspore.
5.7. Structure of male and female gametophytes (Development is not expected)
5.8. Fertilization
5.9. Structure of embryo,
5.10. Graphical representation of alternation of generation,

B) Heterospory and its significance

REFFERENCE BOOKS

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DISCIPLINE SPECIFIC COURSE (DSC)

SEMESTER - VI

Paper - II

BOT. 602: GYMNOSPERMS AND PALEOBOTANY (Lectures: 45)

AIMS AND OBJECTIVES:

1. To study Gymnosperms with respect to distinguishing characters, comparison with Angiosperms, and classification.
2. To study the life cycles of *Pinus* and *Gnetum*.
3. To study the scope of Paleobotany, types of fossils and geological time scale.
4. To study the various fossil genera representing different fossil groups.

GYMNOSPERMS (30 Lectures)

Unit 1: General topics (06 Lectures)

1.1. Introduction
1.2. Distinguishing features of the group
1.3. Comparison of Gymnosperms with Angiosperms
1.4. Economic importance of Gymnosperms
1.5. Classification of Gymnosperms by K. R. Sporne up to orders giving reasons

Unit 2: Life cycle of *Pinus* with respect to (12 Lectures)

2.1. Distribution in India
2.2. Systematic position
2.3. External morphology
2.4. Internal morphology
    a) Primary structure of root, stem and leaf
2.5. Reproductive structure
    a) Male cone
    b) Structure & development of Male gametophyte
    c) Female cone
    d) Structure & development of Female gametophyte
2.6. Pollination
2.7. Fertilization
2.8. Structure of embryo and polyembryony
2.9. Seed structure and germination
2.10. Alternation of generation

Unit 2: Life cycle of *Gnetum* with respect to (12 Lectures)

2.1. Distribution in India
2.2. Systematic position
2.3. External morphology
2.4. Internal morphology
    a) Primary structure of root, stem and leaf

b) Anomalous Secondary growth in *Gnetum ula*

2.5. Reproductive structure

a) Male cone

b) Structure and development of Male gametophyte

c) Female cone

d) Structure and development of Female gametophyte

2.6. Pollination

2.7. Fertilization

2.8. Structure of embryo and polyembryony

2.9. Seed structure and germination

2.10. Alternation of generation

2.11. Resemblance with Angiosperms

PALEOBOTANY (15 Lectures)

Unit 4: Introduction (06 Lectures)

4.1. Introduction, definition and scope

4.2. Contribution of Birbal Sahani in Paleobotany

4.3. Definition of Fossil

4.4. Fossilization process, Conditions favorable for fossilization

4.5. Geological time scale. Eras, Periods, Epochs and major plant groups

4.6. Types of fossils: Impression, Compression, Petrifaction, Cast, Coal ball, Amber

Unit 5: Study of the following fossil groups w. r. t. morphology and structure (09 Lectures)

5.1. Psilopsida: *Rhynia*

5.2. Lycopsida: *Lepidostrobus* (Cone)

5.3. Sphenopsida: *Annularia* (Leaf)

5.4. Pteridopsperm: *Lyginopteris oldhamia* (Stem)

5.5. Bennettitales: *Cycadeoidea* (Flower)

5.6. Angiosperm: *Sahanipushpum* (Flower)

REFERENCE BOOKS

GYMNOSPERMS

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PALEOBOTANY

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DISCIPLINE SPECIFIC COURSE (DSC)

SEMESTER - VI

PAPER - III

BOT. 603: MOLECULAR BIOLOGY (Lectures: 45)

AIMS AND OBJECTIVES:

1. To study molecular biology in relation to genetic material, its inheritance, modification, replication
2. To study the mitochondria and chloroplast DNA
3. To study transcription, translation post translation modification of protein.
4. To study gene regulation in prokaryotes and eukaryotes.

Unit 1: Nucleic acids: Carriers of genetic information (02 Lectures)

1.1. Historical perspective

1.2. DNA as the carrier of genetic information Griffith's, Hershey & Chase, Avery, McLeod & McCarty experiment

Unit 2: The Structures of DNA and RNA / Genetic Material (10 Lectures)

2.1. Types of genetic material, Types of DNA

2.2. DNA Structure: Watson and Crick - historic perspective, Salient features of double helix

2.3. Organization of DNA: Prokaryotes (*E. coli*) and Eukaryotes

2.4. Types of RNA

2.5. Organelle DNA - Mitochondria and Chloroplast DNA

2.6. Chromatin structure - Nucleosome, Euchromatin, Heterochromatin - Constitutive and Facultative heterochromatin

Unit 3: DNA replication (10 Lectures)

3.1. General principles - bidirectional, semi conservative and semi discontinuous replication, RNA priming

3.2. Various models of DNA replication, including rolling circle, θ (theta) model of replication, replication of linear ds - DNA, replication of the 5'end of linear chromosome

3.3. Enzymes involved in DNA replication

3.4. The Central Dogma

3.5. Genetic code: Nature and properties

Unit 4: Transcription and Gene Regulation (10 Lectures)

4.1. Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation

4.2. Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E. coli.*

4.3. Eukaryotes: Eukaryotic transcriptional regulation (promoter enhancer and silencer, Gene battery) and post transcriptional regulation

Unit 5: Processing and modification of RNA (13 Lectures)

5.1. Split genes concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways

5.2. RNA editing and mRNA transport
5.3. Ribosome structure and assembly, mRNA,
Charging of tRNA, aminoacyl tRNA synthetases
5.4. Various steps in protein synthesis, proteins involved in
initiation, elongation and termination of polypeptides
5.5. Inhibitors of protein synthesis, Post translational modifications of proteins.

REFFERENCE BOOKS

1. Watson J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, 6th Ed. Pearson Benjamin Cummings, CSHL Press, New York, U.S.A.
2. Snustad, D. P. and Simmons, M. J. (2010). Principles of Genetics, 5th Ed. John Wiley and Sons Inc., U.S.A.
3. Klug, W. S., Cummings, M. R., Spencer, C. A. (2009). Concepts of Genetics, 9th Ed. Benjamin Cummings, U.S.A.
4. Russell, P. J. (2010). I - Genetics - A Molecular Approach, 3rd Ed. Benjamin Cummings, U.S.A.
5. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., Doebley, J. (2010). Introduction to Genetic Analysis, 10th Ed. W. H. Freeman and Co., U.S.A.
6. Verma, Agarwal, (2005). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company, New Delhi, India.
7. Powar, C. B. (2003). Genetics I & II. Himalaya Publishing House, Nagpur, India.
8. Sadhasivam and Manickam (2005). Biochemical Methods. New Age International Pvt. Ltd. New Delhi, India.

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DISCIPLINE SPECIFIC COURSE (DSC)
SEMESTER - VI
PAPER - IV
BOT. 604: ECONOMIC BOTANY **(Lectures: 45)**

AIMS AND OBJECTIVES:

1. To know useful bio resources of prime importance to mankind.
2. To acknowledge students about various groups of plants of the world as well of India.
3. To know botanical, chemical and nutritional values and value additions of food grains, legumes, sugars, vegetable, fruits, spices, etc.

3) To reveal new *vis-a-vis* forgotten food sources and their current practices.
4) To know the general account and uses of rubber, fiber and Timber.

Unit 1: Introduction and Origin of Cultivated Plants **(09 Lectures)**

1.1. Scope and Importance
1.2. Green Evolution in Indian context
1.3. Concept of Centers of Origin, their importance with reference to Vavilov's work
1.4. Examples of major plant introductions
1.5. Crop domestication and loss of genetic diversity
1.6. Evolution of new crops/varieties,
1.7. Importance of germplasm diversity

Unit 2: Cereals, Legumes and Millets, Sources of Sugars and Starches **(09 Lectures)**

2.1. Origin, morphology, processing and uses of Wheat and Rice
2.2. Origin, morphology and uses of Chick pea and Pigeon Pea
2.3. Origin, morphology, processing and uses of Pearl millet and Sorghum
2.4. Sources of Sugars, Morphology and processing of sugarcane
2.5. Products and byproducts of sugarcane industry
2.6. Morphology, propagation and uses of Potato

Unit 3: Spices, Beverages and Drugs **(09 Lectures)**

3.1. Spices: Listing of important spices, their family and part used
3.2. Economic importance with special reference to clove and black pepper
3.3. Beverages: Morphology, processing and uses of Tea and Coffee
3.4. Drugs: Morphology, processing, uses and health hazards of C*inchona* and *Papaver*

Unit 4: Oils and Fats **(09 Lectures)**

4.1. General description, classification of oils
4.2. Extraction, their uses and health implications of groundnut and Soybean (Botanical name, family & uses)
4.3. Essential Oils: General account, extraction methods of *Eucalyptus* oil comparison with fatty oils and their uses

Unit 5: Rubber, Fiber and Timber yielding plants **(09 Lectures)**

5.1. Para rubber: tapping, Industrial processing and uses

5.2. Fibres: Definition, Structure and classification based on the origin of fibers, morphology, extraction and uses of Cotton and Coir
5.3. Timber: Botanical Source, structure of wood and uses of Teak and *Pinus*

REFFERENCE BOOKS

1. Aiyer, A. K. Y. N. (1954). Field Crops in India. The Banglore Printing And Publishing Company, Banglore.
2. Bendre, Ashok and Ashok Kumar (1998 - 1999). Economic Botany for undergraduate Students. Rastogi Publications, Meerut, India.
3. Hill, A. F. (1952). Economic Botany, 2nd Ed. McGraw Hill Co. Pvt. Ltd. New York.
4. Pandey, S. N. and Archana (1996). Economic Botany. Vikas Publishing house, New Delhi.
5. Pal, B. P. (1996). Wheat Monograph. Council of Agricultural Research, New Delhi.
6. Pruthi, J. S. (1976). Spices and Condiments. National Book Trust, Delhi.
7. Sambamurthy, A. V. S. S. and Sambamurthy, N. S. (1889). A Textbook of Economic Botany. Wiley Estern Ltd. New Delhi.
8. Sharma, B. K. and Awasthi, P. B. (1984). Economic Botany. Prakash book Depot, Bareilley.
9. Kochhar, S. L. (2012). Economic Botany in Tropics. MacMillan & Co. New Delhi, India.
10. Wickens, G. E. (2001). Economic Botany: Principles & Practices, Kluwer Academic Publishers, The Netherlands.
11. Chrispeels, M. J. and Sadava, D. E. (1994). Plants. Genes and Agriculture, Jones & Bartlett.
12. Jacob Thankamma (1975). Foods, Drugs And Cosmetics: A Consumer Guide. The Mac millan Company of India Ltd. Delhi.
13. Parthasarathy, S. V. (1972). Sugarcane in India. K. C. P. Ltd., Madras.
14. Kannaiyana, S. and A. Gopalam (Ed.) (2007). Agro biodiversity: Crop Genetic Resources And Conservation. Vol. I. Associated Publishing Co., New Delhi, India.
15. Majumdar, D. K. (2011). Pulse Crop Production: Principles And Technologies. RHZ Learning (P.) Ltd., New Delhi, India.
16. Mitra, S. K. and Borse, T. K. (Ed.) (1996). Fruits: Tropical And Subtropical. Naya Prakash, Calcutta, India.
17. Patil, D. A. (2019). Food Crops: Evolution, Diversity and Advances. Scientific Publishers, Jodhpur, India.
18. Patil, D. A. and Dhale, D. A. (2013). Spices and Condiments: Origin, History and Applications. Daya Publishing House, New Delhi, India.
19. Patil, D. A. (2008). Useful Plants: Origin, History and Civilization. Navyug Publishers and Distributors, Delhi, India.

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DSC SKILL ENHANCEMENT COURSE

SEMESTER - VI

PAPER - V

BOT. 605: FLORICULTUR **(Lectures: 45)**

AIMS AND OBJECTIVES:

1. To know floriculture, its scope and importance.
2. To know the commercial floriculture.
3. To study the different features of garden.
4. To study methods of propagation.
5. To study diseases and pests of ornamental Plants.

Unit 1: Introduction: **(09 Lectures)**

1.1. History of gardening
1.2. Importance and scope of floriculture
1.3. Landscape gardening
1.4. Some Famous gardens of India
1.5. Landscaping Places of Public Importance
  a. Landscaping highways
  b. Landscaping of Educational institutions

Unit 2: Nursery Management and Routine Garden Operations: **(09 Lectures)**

2.1. Sexual and vegetative methods of propagation
2.2. Soil sterilization
2.3. Seed sowing: i) Pricking ii) Planting and transplanting
  iii) Shading iv) Stopping or pinching
  v) Defoliation vi) Wintering
  vii) Mulching
2.4. Topiary
2.5. Role of plant growth regulators

Unit 3: Study of Ornamental Plants w.r.t. list of plants, description and cultivation method of at least two examples of each: **(09 Lectures)**

3.1. Flowering annuals
3.2. Herbaceous perennials
3.3. Climbers
3.4. Shade and ornamental trees
3.5. Ornamental bulbous and foliage plants
3.6. Cacti and succulents
3.7. Palms and Cycads
3.8. Ferns and Selaginellas
3.9. Bonsai

Unit 4: Principles of Garden Designs: **(09 Lectures)**

4.1. i) English ii) Italian iii) French
  iv) Persian v) Mughal vi) Japanese gardens.
4.2. Features of a garden

i) Garden wall ii) Fencing iii) Path and roads
iv) Hedge v) Edging vi) Lawn
vi) Flower beds vii) Shrubbery viii) Borders
ix) Water garden. x) Arches and Pergolas

Unit 5: Commercial Floriculture: **(09Lectures)**

5.1. Factors affecting flower production
5.2. Production and packaging of cut flowers
5.3. Flower arrangements
5.4. Methods to prolong vase life
5.5. Cultivation of Important cut flowers
i) Carnation ii) Aster iii) Chrysanthemum
iv) Gerbera v) Gladiolous vi) Marigold
vii) Rose viii) Lilium
5.6. Diseases and Pests of Ornamental Plants: Rose and Gladiolus

REFFERENCE BOOKS

1. Arora J. S. (1998). Introductory Ornamental Horticulture. Kalyani Publishers Pvt. Ltd., W. Bengal.
2. Bhattacharjee S. K. (2004). Landscape gardening and design with plants.Pointer Publishers Pvt. Ltd., Jaipur.
3. Bhattacharjee S. K., and De L. C. (2005). Post harvest technology of flowers and ornamental plants. Pointer Publishers, Jaipur.
4. De L. C. (2011). Value addition in flowers and Orchids. New India Publishing Agency, New Delhi.
5. Nowak J., Rudnicki R. M. and Duncan A. A. (1990). Post Harvest handling and storage of cut flowers, florists greens and pottled plants. Timber Press, INC. Portland, Oregon.
6. Randhawa G. S, and Mukhopadhyay A. (2007). Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.
7. Randhawa, G. S. and Mukhopadhyay, A. (1986). Floriculture in India. Allied Publishers.

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DSC ELECTIVE COURSE

SEMESTER - VI

PAPER - VI

BOT. 606.A: HERBAL TECHNOLOGY **(Lectures: 45)**

AIMS AND OBJECTIVES:

1. To create optimum awareness and interest amongst the students about Medicinal Plants.
2. To conserve the biodiversity of Medicinal Plants in Maharashtra.
3. To strengthen the educational system and research on Medicinal Plants.
4. To increase students awareness about the efficacies of herbal drugs.
5. To develop awareness for utilization of herbal medicines for home remedies.

Unit 1: Herbal medicines **(06 Lectures)**

1.1. History, scope and importance

1.2. Definition of herbal medicines

1.3. Role of medicinal plants in Siddha systems of medicine

1.4. Herbal foods : future of pharmacognosy

Unit 2: Pharmacognosy **(09 Lectures)**

2.1 Systematic position and medicinal uses of the following herbs in curing various ailments **-**

i) Tulsi, ii) Ginger, iii) Fenugreek,

iv) Amla v) Ashoka (*Saraca indica*)

Unit 3: Herbal phytochemistry **(10 Lectures)**

3.1 Active principles and methods of their testing, identification and utilization of the medicinal herbs -

i) *Catharanthus roseus* (cardiotonic)

ii) *Withania somnifera* (drugs acting on nervous system)

iii) *Clerodendron phlomoides* (antirheumatic)

iv) *Centella asiatica* (memory booster).

Unit 4: Analytical pharmacognosy **(10 Lectures)**

4.1. Drug adulteration

4.2. Types and methods of drug evaluation

4.3. Biological testing of herbal drugs

4.4. Phytochemical screening tests for secondary metabolites

i) Alkaloids, ii) Phenolic compounds

Unit 5: Cultivation, harvesting, processing, storage, marketing and utilization of following medicinal plants **(10 Lectures)**

5.1. *Aloe vera*

5.2. *Mentha*

REFFERENCE BOOKS

1. Chopra, R. N., Nayar S. L. and Chopra, I. C. (1956). Glossary of Indian medicinal plants. C. S. I. R, New Delhi.
2. Kanny, Lall, Dey and Raj Bahadur, (1984). The indigenous drugs of India. International Book Distributors, Dehradun, India.
3. Agnes Arber, (1999). Herbal plants and Drugs. Mangal Deep Publications, Jaipur, India.
4. Sivarajan V. V. and Balachandran Indira (1994). Ayurvedic drugs and their plant source. Oxford IBH Publishing Co., Delhi,India.
5. Miller, Light and Miller, Bryan, (1998). Ayurveda and Aromatherapy. Banarsidass, Delhi, India.
6. Anne Green, (2000). Principles of Ayurveda. Thomsons, London.
7. Kokate C. K. *et al*. (1999). Pharmacognosy. Nirali Prakashan, Pune, India.

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DSC ELECTIVE COURSE

SEMESTER - VI

PAPER - VI

BOT. 606.B: PLANT BREEDING **(Lectures: 45)**

AIMS AND OBJECTIVES:

1. To introduce the student with science of plant breeding
2. To introduce the student with branch of plant breeding for the survival of human being from starvation.
3. To study the techniques of production of new superior crop verities.

Unit 1: **Plant breeding** **(08 Lectures)**

1.1. Introduction, Scope and objectives

1.2. Breeding systems: Inbreeding and outbreedings

1.3. Modes of reproductions in crop plants, Self pollination, Cross pollination and Geitonogamy

1.4. Important achievements and undesirable consequences of Plant breeding

Unit 2: **Methods of Crop Improvements** **(14 Lectures)**

2.1. Introduction

2.2. Centre of origin and domestification of crop plants

2.3. Plant genetic resources of wild relatives of domesticated crops

2.4. Procedure, advantages and limitations of

i) Plant introduction and Acclimatization

ii) Selection: Pure line selection, Mass selection and clonal selection

iii) Hybridization: Bulk method, Single cross and double cross method Interspecific hybridization for improvement of clonal crops

2.7. Procedure, advantages and limitations

Unit 3: Male Sterility (**08 Lectures)**

3.1. Genetic male sterility

3.2. Cytoplasmic male sterility

3.3. Genetic Cytoplasmic male sterility

3.4. Use of male sterility in hybrid seed production

Unit 4: Inbreeding depression and heterosis **(07 Lectures)**

4.1. History

4.2. Genetic basis inbreeding depression and heterosis

4.3. Applications

Unit 5: Crop improvement and breeding **(08 Lectures)**

5.1. Role of followings in crop improvement with suitable examples one from each

a) Mutation breeding

b) Polyploidy breeding

c) Distant hybridization

d) Genetically modified crops

REFERENCE BOOKS

1. Agrawal, R. L. (1998). Fundamentals of Plant Breeding and Hybrid seed production. Oxford and IBH Publishing Co. New Delhi, India.
2. Allard, R.W. (1960). Principles of plant breeding. John Wiley and Sons, New York.
3. Hayes, H. K. (2017).Breeding Crops Plants.Shree Publishersbooks in India.
4. Chaudhary, H. K. (2001). Plant Breeding, Theory and Practice. Oxford IBH (P.) Ltd. New Delhi, India.
5. Gupta, P. K. (1998). Genetics, Plant Breeding and Evolution. Rastogi Publication, Meerut, India.
6. Xijendro Das, L. D. (1998). Plant Breeding. New age International Publication India.
7. Phundan, Sings (2006). Essential of Plant Breeding. Kalyani Publishers, New Delhi.
8. Poehlman, J. M. and Borthakur D. (1995). Breeding Asian Field Crops. Oxford IBH (P.) Ltd. New Delhi, India.
9. Phundan, Singh (2006). Principles of Plant Breeding.Rastogi Publication Meerut, India.
10. Sheenivas, Y. S. Seed Technology and Seed Pathology. Shree Publishers.
11. Sharma, J. R. (1994). Principles and Practice of Plant Breeding. Tata McGraw Hill Publishing Company Ltd. New Delhi.
12. Singh, B. D. (2006). Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
13. Singh, B. D. (1996). Plant Breeding. Kalyani Publishers, New Delhi.

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SEMESTER - VI

PRACTICAL COURSES

PRACTICAL PAPER - I

BOT. 607: Based on Theory Paper - I and V

(BOT. 601 and BOT. 605)

Practicals based on Bot. 601: Higher Cryptogams

Practical - 1 and 2: Study of life cycle of *Marchantia* w. r. t.

a) Systematic Position
b) External morphology: Mounting of rhizoids & scales
c) Internal morphology: i) T. S. of Thallus
ii) V. S. of thallus through gemma cup (P.S)
d) V. S. of antheridiophore (P. S.)
e) V. S. of archegoniophore (P. S.)
f) V. S. of sporophyte (P. S.)

Practical - 3: Study of life cycle of *Anthoceros* w. r. t.

a) Systematic Position
b) External morphology: Mounting of rhizoids
c) Internal morphology: i) T. S. of Thallus,
d) T. S. of thallus through antheridia (P. S.)
e) T.S. of thallus through archegonia (P. S.)
f) L. S. of sporophyte (P. S.)

Practical - 4: Study of life cycle of *Polytrichum* w. r. t.

a) Systematic Position
b) External morphology
c) Internal morphology
i) T. S. of axis
ii) T. S. of Leaf
d) L. S. of Sporophyte (P. S.)

Practical - 5: Study of life cycle of *Psilotum* w. r. t.

a) Systematic Position
b) External morphology
c) Internal morphology
i) T. S. of stem
ii) T. S. of rhizome (P. S.)
d) T. S. of synangium (P. S.)

Practical - 6: Study of life cycle of *Lycopodium* w. r. t.

a) Systematic Position
b) External morphology
c) Internal morphology: T. S. of stem
d) Mounting of Sporangium and Spores
e) L. S. Strobilus (P. S.)

Practical - 7 and 8: Study of life cycle of *Marsilea* w. r. t.

a) Systematic Position

b) External morphology
c) Internal morphology
i) T. S. of stem/rhizome
ii) T. S. of petiole
d) External structure of sporocarp
e) Internal structure of sporocarp in different planes:
i) H. L. S. of sporocarp
ii) V. T. S. of sporocarp
iii) V. L. S. of sporocarp

NOTE: Study tour is compulsory. Students are expected to submit two forms or photographs of Bryophytes and Pteridophytes along with tour report.

Practicals based on Bot. 605: Floriculture

Practical - 9: Arrangement of Flowers
i) In Container ii) Bouquet iii) Floral carpet (Any Two)

Practical - 10: Technique and aftercare of a Bonsai.

Practical - 11 and 12: Study of different
i) Flowering annuals ii) Herbaceous perennial iii) Palms and Cycad plants. (One examples of each) with respect to Botanical name, ornamental value & place of choice.

Practical - 13 and 14: Study of different ornamental plants such as
i) Shrubs ii) Trees iii) Climbers iv) Cacti & succulents
v) Ferns and Selaginellas (one examples of each) with respect to Botanical name, ornamental value & place of choice.

Practical - 15: Visit to suitable garden to study various salient features such as layout, components, list of plants and special features (if any) OR Visit to nearby nursery to observe various operations in nurseries.

Note: Students should submit Report of visit to garden/Nursery at the time of examination.

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PRACTICAL PAPER - II

BOT. 608: Based on Theory Paper - II and VI

(BOT. 602 and BOT. 606)

Practicals based on Bot. 602: Gymnosperms & Paleobotany

Practical - 1 and 2: Study of *Pinus* w. r. t.

a) Systematic Position

b) External morphology

c) Internal morphology

i) T. S. of stem

ii) T. S. of Needle

d) Male cone

i) Morphology (Specimen)

ii) L. S. of male cone (P. S.)

iii) Microsporophyll (Specimen/P. S.)

iv) Mounting of pollen grains

e) Female cone

i) Morphology (Specimen)

ii) L. S. of female cone (P. S.)

iii) Megasporophyll (Specimen/P. S.)

iv) V. S. of mature ovule (P. S.)

Practical - 3 and 4: Study of *Gnetum* w. r. t.

a) Systematic Position

b) External morphology

c) Internal morphology:

i) T. S. of stem

ii) T. S. of leaf

iii) Secondary growth in the stem of *G. ula* (P. S.)

d) Morphology of male cone (Specimen)

e) Female cone

i) Morphology (Specimen)

ii) V. S. of mature ovule (P. S.)

Practical - 5 and 6: Study of different types of fossils.

Practical - 7 and 8: Study of the following with the help of slides/specimens

i) *Rhynia* ii) *Lepidodendron* iii) *Lepidostrobu*s

iv) *Calamites* v) *Annularia* vi) *Lyginopteris*

vii) *Cycadeoidea* viii) *Rhizopalmoxylan*

Practicals based on Bot. 606.A: Herbal Technology

Practical - 9 and 10: Study of following w. r. t. classification, botanical source, part used and medicinal uses of

i) Tulsi ii) Ginger iii) Fenugreek,

iv) Indian Goose berry v) Ashoka

Practical - 11 and 12: Study of botanical source, active principles and Medicinal uses of

i) *Catharanthus roseus* ii) *Withania somnifera*,
iii) *Clerodendron phlomoides* iv) *Centella asiatica.*

Practical - 13 to 15: Phytochemical screening test of
i) Alkaloids ii) Flavonoids iii) Steroids
iv) Triterpenoids v) Phenolic compounds

Bot. 606.B: Plant Breeding

Practical - 9: Study of factors promoting self pollination (By demonstration Flower/Photograph)
- Bisexuality (Hermaphroditism) ------------------- (Wheat, Rice)
- Cleistogamy -- (Wheat, Rice)
- Homogamy ------------------------------- (Tomato, Lady's finger)

Practical - 10: Study of factors promoting cross pollination (By demonstration Flower/Photograph)
- Dichogamy (i) Protandary --------------------------------- (Maize)
  (ii) Protogyny --------------------------- (Pearlmillet)
- Unisexuality (i) Monoecious ---------------- (Maize, Pumpkins)
  (ii) Dioecious ------------------ (Hemp, Asparagus)
- Self incompatibility ---------------------------- (Radish, Cabbage)

Practical - 11 &12: Techniques of Hybridization in Self Pollinated and Cross Pollinated Crops

Practical - 13: Estimation of heterosis
i) Standard heterosis
ii) Mid Parent heterosis
iii) Useful or Economic heterosis

Practical - 14: Pollen viability test by
i) Aceto Carmine method
ii) Sugar solution method

Practical - 15: To show artificial induction of polyploidy

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PRACTICAL PAPER - III

BOT. 609: Based on Theory Paper - III and IV

(BOT. 603 and BOT. 604)

Practicals based on Bot.603: Molecular Biology

Practical - 1: DNA isolation from any suitable material.

Practical - 2: DNA estimation by diphenylamine reagent/UV Spectrophotometry.

Practical - 3 and 4: RNA estimation by orcinol reagent/ UV Spectrophotometry.

Practical - 5: Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).

Practical - 6: Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.

Practical - 7: Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery *et. al*, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)

Practical - 8: Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Practicals based on Bot.604: Economic Botany

Practical - 9 & 10: Study of cereals, Legumes and Millets

Wheat (habit sketch, L. S/T. S. of grain, starch grains)

Rice (habit sketch, study of paddy and grain, starch grains)

Chick pea, Pigeon Pea Pearl millet, Sorghum (Morphology of plant and grain)

Practical - 11 & 12: Sources of sugars and starches

Sugarcane (habit sketch; cane juice - micro chemical tests),

Potato (habit sketch, tuber morphology, T. S. of tuber to show localization of starch grains)

Legumes: Soybean, Groundnut (habit, fruit, seed structure).

Practical - 13: Spices, Beverages and Drugs

Morphology of Clove, Black pepper, Tea, Coffee, Papaver, Cinchona (Plant Specimen and products)

Practical - 14: Oils and fats

Coconut: Nut Morphology

Essential oil yielding plants: Habit sketch of *Eucalyptus* (specimens/ photographs).

Practical - 15: Rubber: a) Specimen, photograph/model of tapping, samples of rubber products.

b) Characteristic features of Coir and Teak/*Pinus* wood

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KBC NORTH MAHARASHTRA UNIVERSITY, JALGAON

Syllabus for F.Y.B.Sc. ZOOLOGY under CBCS Pattern

With Effect from June 2022

Semester	Core Course (CC)	Structure	Code & Title of the paper	Credit
I	CC A-I	Theory	ZOO 101 Invertebrate Zoology	02
		Theory	ZOO 102 Grasshopper- The Nonchordate	02
		Practical	ZOO 103 Corresponding to Zoo 101 and Zoo 102	02
II	CC A-II	Theory	ZOO 201 Vertebrate Zoology	02
		Theory	ZOO 202 Frog-The Chordate	02
		Practical	ZOO 203 Corresponding to Zoo 201 and Zoo 202	02
			Total Credits Sem I & II = 12	

Credit 2 = Lectures 45 = 60 Marks

F.Y.B. Sc. Zoology Semester I

Core Course A-I Theory			
Zoo: 101: Invertebrate Zoology			
	Course objective: • To familiarize the student with the basic concept of Invertebrate Zoology. • To understanding of the ecological relationships of the local species. • To identify common and unknown species. • To understand the invertebrate taxonomy and diversity.		
	Learning outcomes: After successful completion of this course, students are expected to: • Know the basic concept of Invertebrate Zoology. • Acquire the ecological relationships of the local species. • Know common and unknown invertebrate species. • Understand of the – Invertebrate phyla, anatomy, natural history, collection, preservation, behavior and evolution.		
Unit	**Name of Topic**	**Lectures 45**	**Marks: 60**
Unit-1	Introduction to the animal kingdom. **A) Porifera:** General characteristics and classification up to class. **B) Cnideria:** General characteristics and classification up class. **C) Ctnophora**: General characteristics and classification up to class.	**08**	**12**
Unit-2	**A) Platyhelminthes**: General characteristics and classification up to class. **B) Aschelminthes:** General characteristics and classification up to class. **C) Annelida:** General characteristics and classification up to class.	**10**	**12**
Unit-3	**A) Arthropoda**: General characteristics and classification up to class with two examples. **B) Mollusca:** General characteristics and classification up to class with two examples.	**10**	**12**
Unit- 4	**A) Echinodermata**:- General characteristics and classification up to class with two examples. **B) Hemichordata:-** General characteristics and classification up to class with two examples.	**07**	**10**
Unit- 5	**General Topics** • Canal system in Porifera. • Polymorphism in Coelenterates.	**10**	**14**

	• Parasitic adaptation in Flat worm. • Metamerism in Annelida. • Metamorphosis in insect. • Economic importance in Mollusca. • Water vascular system in Echinodermata.		

Suggested Readings

- Kershaw, D. R. :Animal Diversity, Redwood Burn Ltd, Trowbridge
- Parker J. and Haswell, W.: Text-Book of Zoology, ELBS Edition
- Vidyarthi: Text-Book of Zoology - Agrasia Publishers, Agra.
- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
- Kotpal R L (2009): Modern textbook of Zoology Invertebrates, Rastogi Publication.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
- Kotpal R.L.: Protozoa to Echinodermata series.
- Prasad S.N.: Life of Invertebrates, Vikas Publishing house, New Delhi.
- Jorden,E.L.: The Invertebrates, S.C. Chand, New Delhi.
- Prof P S Lohar *et al*: FYBSz Zoo 101 & 102: Atahrva Publication, Jalgaon

F.Y.B. Sc. Zoology Semester I

	Core Course A-I Theory		
	Zoo: 102: Grasshopper-The Nonchordate		
	Course objective: • To provide thorough knowledge about external morphological features of grasshopper • To develop an understanding about internal structural and functional details of grasshopper including its reproductive system and life cycle.		
	Learning outcomes: After successful completion of this course, students are expected to: • Acquire knowledge about external morphological features of grasshopper • Understand internal structural and functional details of grasshopper • Develop deeper knowledge about reproduction and life cycle of grasshopper		
Unit	**Study of Grasshopper (*Poekilocerus pictus*) with respect to following points**	**Lectures 45**	**Marks: 60**
Unit-1	**1.1 External Characters and sexual dimorphism** a) Shape, size and Colour b) Division of the body c) Sexual dimorphism **1.2 Digestive system:** a) Mouth parts b) Alimentary canal, Digestive glands, c) Food, feeding and Digestion	**08**	**12**
Unit-2	**2. Respiratory system:** a) Tracheal system b) Types of spiracles c) Mechanism of respiration	**09**	**12**
Unit-3	**3. Circulatory system**: a) Type of circulatory system b) Heart, sinuses c) Haemolymph - Composition and functions	**10**	**12**
Unit- 4	4.1 **Nervous system** : Brain, nerve cord and sense organs 4.2 **Excretion** in grasshopper	**06**	**10**
Unit- 5	5.1 Male & Female **Reproductive system** 5.2 **Life cycle** of grasshopper 5.3 Economic importance of grasshopper	**12**	**14**
	Suggested Readings		

- Parker J. and Haswell, W.: Text-Book of Zoology, ELBS Edition
- Vidyarthi: Text-Book of Zoology - Agrasia Publishers, Agra.
- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Kotpal R L (2009): Modern textbook of Zoology Invertebrates, Rastogi Publication.
- Kotpal R.L.: Arthropods
- Prasad S.N.: Life of Invertebrates, Vikas Publishing house, New Delhi.
- Jorden,E.L.: The Invertebrates, S.C. Chand, New Delhi.
- Prof P S Lohar *et al*: FYBSz Zoo 101 & 102: Atahrva Publication, Jalgaon

F.Y.B. Sc. Zoology Semester I

<table>
<tr><td colspan="4">Core Course A-I Practical
Zoo 103 (Corresponding to Zoo 101 & Zoo 102)</td></tr>
<tr><td colspan="4">Zoo: 101: Invertebrate Zoology and Zoo 102: Grasshopper-The Nonchordate</td></tr>
<tr><td></td><td>Course objective:
• To understand habit, habitat and taxonomic status of invertebrate animals
• To explain the basic aspects of structural and functional details of grasshopper</td><td></td><td></td></tr>
<tr><td></td><td>Learning outcomes:
After successful completion of this course, students are expected to:
• Know the basic concept of Invertebrate Zoology.
• Understand common and unknown invertebrate species.
• Acquire practical knowledge about structural and functional aspects of grasshopper</td><td></td><td></td></tr>
<tr><td>Part</td><td>Title of Practical</td><td>Lectures 45</td><td>Marks: 60</td></tr>
<tr><td>A</td><td>Study of the following Invertebrate specimens :
Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Hyalonema, and Euplectella,Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio,Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria and Antedon.</td><td>15</td><td>20</td></tr>
<tr><td>B</td><td>Study of phylum specific characteristic features:
• Canal system in Porifera.
• Polymorphism in Coelenterates.
• Parasitic adaptation in Flat worm.
• Metamerism in Annelida.
• Metamorphosis in insect.
• Economic importance in Mollusca.
• Water vascular system in Echinodermata</td><td>10</td><td>10</td></tr>
<tr><td>C</td><td>Study of Grasshopper with respect to following
• External characters and sexual dimorphism
• Mounting of mouth parts, wings, legs, trachea and spiracles, gizzard, malpighian tubules ootheca
• Digestive system
• Circulatory system
• Nervous system
• Male and female reproductive system
• Life cycle of grasshopper</td><td>20</td><td>30</td></tr>
</table>

Suggested Readings

- Parker J. and Haswell, W.: Text-Book of Zoology, ELBS Edition
- Vidyarthi: Text-Book of Zoology - Agrasia Publishers, Agra.
- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Kotpal R L (2009): Modern textbook of Zoology Invertebrates, Rastogi Publication.
- Kotpal R.L.: Arthropods
- Prasad S.N.: Life of Invertebrates, Vikas Publishing house, New Delhi.
- Jorden,E.L.: The Invertebrates, S.C. Chand, New Delhi.
- Prof P S Lohar *et al*: Practical Handbook for FYBSz Zoo 103: Atahrva Publication, Jalgaon

F.Y.B.Sc. Zoology Semester II

Core Course A-II Theory			
Zoo: 201: Vertebrate Zoology			
	Course objective: ➢ To understand General Characters, habit, habitat and distribution of vertebrate animals. ➢ To understand the classification of vertebrate animals. ➢ To learn about general topics like • Accessory Respiratory Organs • Migration in Fishes • Metamorphosis in frog and Parental care in Amphibians • Poisonous and non-poisonous snakes, Importance of snake venom • Flight adaptations in birds, Migration in birds • Origin and Evolution of mammals		
	Learning outcomes: After successful completion of this course, students are expected to: • Gain the knowledge of the systematic position, habit and habitat of vertebrate animals • Acquire the knowledge about classification of vertebrates • Understand the general topics related to vertebrate animals.		
Unit	**Name of Topic**	**Lectures 45**	**Marks: 60**
Unit-1 A **Unit-1 B** **Unit-1 C**	**Introduction**, General characters of Chordates **Protochorda** 1.1 General characters, habit, habitat and distribution of Hemichordates, Urochordates and Cephalochordates **Agnatha** 1.2 General characters, habit, habitat and distribution of Agnatha 1.3 Classification of cyclostomes up to classes	**08**	**12**
Unit-2 A **Unit-2 B**	**Pisces** 2.1 General characters, habit, habitat and distribution, 2.2 Classification up to orders; **Amphibia** 2.3 General characters, habit, habitat and distribution 2.4 Classification up to orders	**10**	**12**
Unit-3 A **Unit-3 B**	**Reptiles** 3.1 General characters, habit, habitat and distribution 3.2 Classification up to orders; **Aves** 3.3 General characters, habit, habitat and distribution 3.4 Classification up to orders	**10**	**12**

Unit- 4	**Mammals** 4.1 General characters, habit, habitat and distribution 4.2 Classification up to orders;	**07**	**10**
Unit- 5	**General Topics** **a)** Accessory Respiratory Organs **b)** Migration in Fishes **c)** Metamorphosis in frog and Parental care in Amphibians **d)** Poisonous and non-poisonous snakes, Importance of snake venom **e)** Flight adaptations in birds, Migration in birds **f)** Origin and Evolution of mammals	**10**	**14**
Suggested Readings	• Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press. • Grove, Newell and Carthy . Animal Biology University Tutorial Press Ltd. London • Kotpal R L (2009): *Modern textbook of Zoology Vertebrates*, Rastogi Publicationa. . • Lal S.S. (1996): Textbook of Practical Zoology Vertebrates, Rastogi Publications • Varma P. S. A Manual of Practical Zoology Chordates. S. Chand & Company Ltd. Delhi • Dhami & Dhami Chordate Zoology R. Chand & Co. New Delhi • Jayaraman : Fishes of India. • Salim Ali, : Indian Birds. • Vishwapremi K.K., : Economic Zoology (Akashdeep Pub.House,New Delhi). • Dalela, R.C. : A text book of Chordate Zoology, (Jai Prakash Nath publications, Meerut.). • Newman, H.H. : The phylum Chordate, (Satish Book Enterprise, Agra). • Jordon, E.L.: Vertebrate Zoology, (S. Chand and Co., New Delhi.). • Parker and Haswell Vol. II. A. Z. T. B. S. Publishers and distributers, New Delhi.		

F.Y.B.Sc. Zoology Semester II

<table>
<tr><td colspan="4">Core Course A-II Theory</td></tr>
<tr><td colspan="4">Zoo: 202: Frog-The Chordate</td></tr>
<tr><td rowspan="2"></td><td>Course objective
• To understand habit, habitat and taxonomic status of vertebrates
• To explain the basic aspects of structural and functional details of Frog</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Learning outcomes
After successful completion of this course, students are expected to:
• Understand the systematic position, habit and habitat of Frog
• Acquire the knowledge about structural and functional details about Frog.</td></tr>
<tr><td>Unit</td><td>Study of Frog (Hoplobatrachus tigerinus) with respect to following points</td><td>Lectures 45</td><td>Marks: 60</td></tr>
<tr><td rowspan="2">1</td><td>1.1 External Characters and sexual dimorphism
d) Shape, size and Colour
e) Division of the body
f) Sexual dimorphism</td><td rowspan="2">08</td><td rowspan="2">12</td></tr>
<tr><td>1.2 Digestive system:
d) Alimentary canal
e) Digestive glands,
f) Food, feeding and
g) Digestion</td></tr>
<tr><td rowspan="2">2</td><td>2.1 Respiratory system:
a) Types and process of respiration</td><td rowspan="2">08</td><td rowspan="2">12</td></tr>
<tr><td>2.2 Circulatory system:
a) Heart,
b) Arterial system,
c) Venous system,
d) Blood- Composition and functions</td></tr>
<tr><td rowspan="3">3</td><td>3.1 Nervous system:
a) Brain,
b) Ventricles and
c) Spinal cord</td><td rowspan="3">12</td><td rowspan="3">12</td></tr>
<tr><td>3.2 Sense organs:
a) Eye and
b) Ear</td></tr>
<tr><td>3.3 Excretory system:
a) Kidney
b) Ureters
c) Urinary bladder
d) Cloaca</td></tr>
<tr><td>4</td><td>Reproductive system:
a) Male Reproductive system:
Testes, Vasa efferntia, Urino-genital duct and Cloaca
b) Female Reproductive system:
Ovaries, Oviduct, Cloaca</td><td>10</td><td>12</td></tr>
</table>

5	**Frog Development:** a) Structure of egg and sperm, b) Amplexus and Fertilization c) Cleavage, Tadpoles d) Metamorphosis	**7**	**12**

Suggested Readings

- Robert Rugh: The Frog: Its reproduction and development - Tata McGraw Hill Edition, New Delhi.
- Ganguly, B.B., Sinha, A.K., Adhikari, S.: Biology of Animals - New Central Book Agency, Kolkata
- Bhamrah, MS and Juneja, K.: Introduction to Amphibia - Amol Publications, Delhi.
- Young, J. Z.:Life of Vertebrates - III Edition, Clarendon Press, London
- Goodnight and others: General Zoology, IBH Publishing Co.
- Prasad, ASN. : Life of Vertebrates - Vikas Publishing House, New Delhi
- Prasad, S. N. and Kashyap V.: Textbook of Vertebrate Zoology - New Age India Publishers, New Delhi
- Kotpal, R. L: Modern Text-Book of Zoology, Vertebrates, Rastogi and Co., Meerut.
- Jhingran, JG.: Fish and Fisheries of India, Hindustan Publishing corporation, New Delhi
- Kershaw, D. R. :Animal Diversity, Redwood Burn Ltd, Trowbridge
- Parker J. and Haswell, W.: Text-Book of Zoology, ELBS Edition
- Vidyarthi: Text-Book of Zoology - Agrasia Publishers, Agra.
- Jordan E.L and Verma P.S.: Chordate Zoology , S. Chand and Co., New Delhi
- Nigam, HC and Sobti, R.: Functional Organization of Chordate (parts I and II), S. Chand and Co., New Delhi

F.Y.B.Sc. Zoology Sem II

Core Courses A-II **Zoo - 203: Practical II (Corresponding to Zoo 201 & 202)**			
Zoo 201: Vertebrate Zoology & Zoo 202: Frog-The Chordate			

	Course objective:
	➢ To acquire the practical skill about classification of Vertebrate animals
	➢ To perform mountings of various significant parts of Vertebrate animals like
	  ➢ Fins and scales of fishes.
	  ➢ beaks and feet in birds
	  ➢ poisonous and non-poisonous snakes
	➢ To understand the concept of systematics or taxonomic features of vertebrate animals.		

	Learning outcomes: After successful completion of this course, students are expected to: • Enlighten themself with knowledge related to systematic features of vertebrate animals. • Enrich themselves with understandings of accessory organs. • Know the poisonous and nonpoisonous snakes.		
	Title of Practical	**Lectures 45**	**Marks 60**
	• Study of external morphology body forms, fins and scales of the fishes. • Systematic position, habit and habitat of *Balanoglossus* (Hemichordata), *Herdmania Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/ Ureotyphlus, Salamandra, Bufo, Hyla, Chelone,Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis,* Any six common birds from different orders, *Sorex*, Bat, *Funambulus, Loris* • Economic importance of two animals from each class. • Study of beaks and feet in birds. • Identification of poisonous and non-poisonous snakes. **Study of Frog with the help of diagrams / chart / model / simulations / etc**. a) External characters and sexual dimorphism b) Digestive system c) Respiratory system d) Circulatory system – Arterial and Venous system		

	e) Excretory and Reproductive system – Male and Female f) Brain – Dorsal and Ventral view g) Permanent slides of – Sperm, Egg, Blastula and Gastrula, Tadpole Larvae • Report on compulsory visit to a Zoo/Sanctuaries.		
Suggested Readings	• Kotpal R L (2009): Modern textbook of Zoology Vertebrates, Rastogi Publications. • Lal S.S. (1996): Textbook of Practical Zoology Vertebrates, Rastogi Publications • Varma P. S. A Manual of Practical Zoology Chordates. S. Chand & Company Ltd. Delhi • Jayaraman : Fishes of India. • Salim Ali : Indian Birds. • Dalela, R.C.: A text book of Chordate Zoology, (Jai Prakash Nath publications, Meerut.).		

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

FYBSc Zoology (CBCS Pattern)

Equivalence of courses in old syllabus 2018-19 to new syllabus 2022-23

Old Courses in 2018-19	**New course in 2022-23**
ZOO-101: Animal Diversity I	ZOO 101: Invertebrate Zoology
ZOO-101: Animal Diversity II	ZOO 102: Grasshopper- The Nonchordate
ZOO-201: Comparative Anatomy of Vertebrates	ZOO 201: Vertebrate Zoology
ZOO-202: Developmental Biology of Vertebrates	ZOO 202: Frog- The Chordate
ZOO-103 (Ist Sem) and ZOO-203 (IInd Sem): Practical Courses	ZOO-103 (Ist Sem) and ZOO-203(IInd Sem): Practical Courses

SYBSc Zoology

Equivalence for old courses (2016-17) to new courses (2019-20)

Old courses	New (Equivalence)
ZOO 231	ZOO 301 Physiology
ZOO 232	ZOO 302 Biochemistry
ZOO 233	Practical ZOO 303 Physiology & Biochemistry
ZOO 241	ZOO 401 Genetics
ZOO 242	ZOO 402 Evolutionary Biology
ZOO 243	Practical ZOO 403 Genetics & Evolutionary Biology

Kavayitri Bahinabai Chaudhari

NORTH MAHARASHTRA UNIVERSITY

JALGAON 425001, INDIA

SYLLABUS UNDER

FACULTY OF SCIENCE & TECHNOLOGY

UNDER CBCS

FOR COURSES RELATED TO SUBJECT

ZOOLOGY

S.Y.B.Sc. (Semester I and II)

WITH EFFECT FROM

ACADEMIC YEAR 2019-2020

KBC NORTH MAHARSHTRA UNIVERSITY, JALGAON

Syllabus for SYBSc ZOOLOGY under CBCS Pattern

(wef June 2019)

Examination Pattern 60:40

Semester	Core Course	Structure	Code & Title of the paper	Credit
III	DSC 1-C CC A-III	Theory	ZOO 301 Physiology	02
		Theory	ZOO 302 Biochemistry	02
		Practical	ZOO 303 Physiology & Biochemistry	02
	SE Course I	Section I	SEC I Apiculture	02
	AEC III	Section I	English/Marathi Communication (2 periods per week)	02
IV	DSC 1-D CC A-IV	Theory	ZOO 401 Genetics	02
		Theory	ZOO 402 Evolutionary Biology	02
		Practical	ZOO 403 Genetics & Evolutionary Biology	02
	SE Course II	Section II	SEC II Medical Diagnostics	02
	AEC IV	Section II	English/Marathi Communication (2 periods per week)	02
Total Credits Sem III & IV= 16+4=20				

DSC = Discipline selective course
SEC= Skill Enhancement Course
AEC = Ability Enhancement course
Credit 2= 2 hrs/ week = 30 periods per semester

CORE COURSE III

SYBSc Zoology Semester III

ZOO 301 PHYSIOLOGY

THEORY **(CREDITS 2)**

Unit 1: Nerve and muscle (5)
Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction

Unit 2: Digestion (3)
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

Unit 3: Respiration (5)
Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Unit 4: Excretion (4)
Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 5: Cardiovascular system (5)
Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle

Unit 6: Reproduction and Endocrine Glands (8)
Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle, Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal

ZOO 302 BIOCHEMISTRY

THEORY **(CREDITS 2)**

Unit 1: Carbohydrate Metabolism (8)
Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain

Unit 2: Lipid Metabolism (6)
Biosynthesis and β oxidation of palmitic acid, Lipogenesis, Lipolysis

Unit 3: Protein metabolism (8)
Biosynthesis of amino acid, Transamination, Deamination, Decarboxylation and Urea Cycle

Unit 4: Enzymes (8)
Introduction, Classification of Enzymes, Mechanism of action, Enzyme Kinetics, Factors affecting rate of enzyme mediated reactions, Inhibition and Regulation

ZOO 303 PHYSIOLOGY AND BIOCHEMISTRY

PRACTICAL **(CREDITS 2)**

1. Preparation of hemin and hemochromogen crystals
2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
3. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage
4. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)
5. Estimation of total protein in given solutions by Lowry's method.
6. Study of activity of salivary amylase under optimum conditions

SUGGESTED READINGS

- Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*, XII Edition, John Wiley & Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) *Vander's Human Physiology*, XI Edition., McGraw Hill
- Guyton, A.C. and Hall, J.E. (2011). T*extbook of Medical Physiology*, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). *Biochemistry*. VI Edition. W.H Freeman and Co.
- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). *Principles of Biochemistry*. IV Edition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). *Harper's Illustrated Biochemistry*. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.
- Prakash S.Lohar (2008)Endocrinology:Hormones and Human Health, MJP Publshers , A unit of Tamilnadu Book House, Triplicane, Chennai

Skill Enhancement Course I (Section I)

SEC I

Apiculture

Credit 2

Unit 1: Biology of Bees (4)

History, Classification and Biology of Honey Bees, Social Organization of Bee Colony

Unit 2: **Rearing of Bees** (12)

Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth Bee Pasturage Selection of Bee Species for Apiculture, Bee Keeping Equipment Methods of Extraction of Honey (Indigenous and Modern)

Unit 3: **Diseases and Enemies** (5)

Bee Diseases and Enemies Control and Preventive measures

Unit 4: **Bee Economy** (4)

Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis, Pollen, etc)

Unit 5: **Entrepreneurship in Apiculture** (5)

Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

SUGGESTED READINGS

- Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
- Bisht D.S., Apiculture, ICAR Publication.
- Singh S., Beekeeping in India, Indian council of Agricultural Research, NewDelhi.

CORE COURSE IV
SYBSc Zoology Semester IV

ZOO 401 GENETICS

THEORY **(CREDITS 2)**

Unit 1: Introduction to Genetics (4)
Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

Unit 2: Mendelian Genetics and its Extension (10)
Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co dominance, Polygenic inheritance, Multiple alleles, Lethal genes, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

Unit 3: Linkage, Crossing Over and Chromosomal Mapping (6)
Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, definition of gene mapping.

Unit 4: Mutations (6)
Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations

Unit 5: Sex Determination (4)
Chromosomal mechanisms and methods

ZOO 402 EVOLUTIONARY BIOLOGY

THEORY **(CREDITS 2)**

Unit 1: History of Life (2)
Major Events in History of Life

Unit 2: Introduction to Evolutionary Theories (4)
Lamarckism, Darwinism, Neo-Darwinism

Unit 3: Direct Evidences of Evolution (4)
Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

Unit 4: Processes of Evolutionary Change (8)
Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

Unit 5: Species Concept (4)
Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

Unit 6: Macro-evolution (4)
Macro-evolutionary Principles (example: Darwin's Finches)

Unit 7: Extinction (4)
Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

ZOO 403 GENETICS AND EVOLUTIONARY BIOLOGY

PRACTICAL **(CREDITS 2)**

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal).
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/ pictures
6. Study of Picture/Charts with reference to:
   a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
   b) Darwin's Finches with diagrams/ cut outs of beaks of different species
7. Visit to Natural History Museum and submission of report

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India.
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings.
- Russell, P. J. (2009). *Genetics- A Molecular Approach.* III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co.
- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates

Skill Enhancement Course II (Section II)

SEC II

Medical Diagnostics

THEORY **Credit 2**

Unit 1: **Introduction to Medical Diagnostics and its Importance** (2)

Unit 2: **Diagnostics Methods Used for Analysis of Blood** (10)

Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

Unit 3: **Diagnostic Methods Used for Urine Analysis** (6)

Urine Analysis: Physical characteristics, normal and abnormal constituents

Unit 4:**Non-infectious Diseases** (6)

Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/ diagnostic kit

Unit 5: **Infectious Diseases** (3)

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

Unit 6: **Tumours** (3)

Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

SUGGESTED READINGS

- Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
- Godkar P.B. and Godkar D.P. Textbook of Medical Laboratory Technology
- Edition, Bhalani Publishing House Cheesbrough M., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
- Guyton A.C. and Hall J.E. Textbook of Medical Physiology, Saunders
- Robbins and Cortan, Pathologic Basis of Disease, VIIIEdition, Saunders
- Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.

Kavayitri Bahinabai Chaudhari

North Maharashtra University,

Jalgaon

'A' Grade

NAAC Re-Accredited

(3rd Cycle)

Proposed Structure of Syllabus for B.Sc.

T. Y. B. Sc. (ZOOLOGY)

Choice Based Credit System (CBCS)

2020-21

T. Y. B. Sc. ZOOLOY (CBCS Structure)

(With Effect from June 2020)

Semester V and VI

Preamble:

The choice based credit system (CBCS) was introduced at FYBSc since academic year 2018-19. It was then opted for SYBSc during academic year 2019-20 and CBCS system shall be effective for third year students form 2020-21. The contents have accommodated the widening horizons of the discipline of Biological Sciences. They reflect the current changing needs of the students; specifically, the subjects on biotechnology, bioinformatics and research methodology have been incorporated.The well organized curricula including basic as well as advanced concepts in Zoology from first year to third year. The course content also lists the new practical exercises so that the students get a hands-on experience of the latest techniques that are in current usage. The curricula shall inspire the students for pursuing higher studies in Zoology and for becoming an entrepreneur and also enable students to get employed in the Biological research Institutes, Industries, Educational Institutes and in the various concerning departments of State and Central Government based on subject Zoology.

Introduction:

At first year of under-graduation the topics related to the fundamentals of zoology, including exposure to diversity of animals, comparative anatomy of vertebrates and developmental biology are coveredin semester I and II. The practical course is aimed at to equip the students with skills required for animal identification, morphological, technical description, classification,anatomical, developmental phenomenon and also applications of zoology in the various fields.

At second year under-graduation, insemester III and IV coursessuch as Physiology, Biochemistry, Genetics and Evolutionary Biology, the level of the theory and practical courses increased one step ahead of the first year B.Sc.

At third year under-graduation: Theory and practical courses in semester Vshall deal with the further detailed studies of the various disciplines of the Zoology inform of core courses such as Reproductive biology, Cell and Molecular Biology, Mammalian Histology, and

Animal Biotechnology. Skill based course on Public health and hygiene is included as well as students can select either Pest Management or Apiculture as discipline elective course. Semester VI shall cover the theory and practical courses such as Comparative study of representative of invertebrate and vertebrate, Chick embryology, Applied Zoology, Microtechnique as core courses. Research Methodology shall skill enhancement course that shall help students for research in Zoology and students can also select either Bioinformatics or Sericulture as discipline elective course.

Learning Objectives:

- To provide thorough knowledge about animal classification and associated taxonomic groups various animal sciences from primitive to highly evolved animal groups.
- To develop an understanding of and ability to apply basic zoological principles.
- To provide quality education in different specializations in Zoology.
- To facilitate higher education and research in zoology.
- To make the students aware of applications of Zoology subject in various industries
- To equip the students with skills related to laboratory as well as field based studies.
- To make the students aware about conservation and sustainable use of biodiversity.
- To inculcate interest and foundation for further studies in Zoology.
- To address the socio-economical challenges related to animal sciences.
- To provide quality education offering skill based programs and motivate the students for self employment in applied branches of Zoology.

Program specific objectives (PSO)

- To achieve excellence in academic and scientific research in the field of Zoology.
- To develop and implement ways and means to ensure quality performance and outputs of Zoology program.
- To use modern technology in education and scientific research in Zoology.
- To implement advanced training to improve the skills of graduates in Zoology and related fields.
- To create academic and scientific environment to attract outstanding faculty, researchers and students.
- To improve the national and international partnerships with academic institutions and research centres.

Program outcome (PO)

- To possess a good command of fundamentals in Zoology and its relationship to other disciplines.
- To know the theories and scientific facts in the sections of Zoology and interrelations among organisms and their biosphere
- To memorize the concepts of laboratory management, organization and evaluation.
- To recognize the management and concepts of bio-systems, organization and evaluation.
- To outline the policy and legislation of animal Science and ethics.
- To design and conduct experiments in Zoology
- To communicate effectively through writing reports, giving presentations, and participating in discussions.
- To demonstrate skill in the usage of computers, networks, and software packages relevant to Zoology
- To learn the principles of research methodology.

Course outcome (CO)

- Describe the diversity in form, structure and habits of invertebrates and vertebrates
- Explain the reproductive patterns in animal world
- Develop deeper understanding of life is and how it functions at cellular level as well as histological structure of tissues.
- Understand applications of animal biotechnology, bioinformatics and research methodology
- Familiar with various stages involved in the developing embryo
- Acquire skills in the microtechniques, apiculture, sericulture and other applied branches of Zoology.

Duration: The duration of B.Sc. degree program shall consists of three years.

Medium of instruction: The medium of instruction for the courses shall be English.

Examination pattern

- Each theory and practical course will be of 100 marks comprising of 40 marks internal and 60 marks external examination.
- Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each).
- Internal examination (40 marks) and
- Practical examination (CA of 40 marks and UA of 60 Marks)

Structure of curriculum of TYBSc (Zoology) Semester V

Discipline	Course Type	Course Code	Course title	Credits	Hours/ week (Clock Hours)	Total Teaching hours	Marks (Total 100)	
							CA	UA
Discipline Specific Course (DSC)	Core l	Zoo-501	Reproductive Endocrinology	3	3	45	40	60
	Core I	Zoo-502	Cell and Molecular Biology (CMB)	3	3	45	40	60
	Core III	Zoo-503	Mammalian Histology	3	3	45	40	60
	Core IV	Zoo-504	Animal Biotechnology	3	3	45	40	60
DSC Skill Enhancement Course [SEC]	Skill Based	Zoo-505	Public health and hygiene	3	3	45	40	60
DSC Elective Course	Elective Course (Any one)	Zoo-506 (A)	Pest Management	3	3	45	40	60
		Zoo-506 (B)	Aquarium Fish Keeping					
DSC	Core (Practical)	Zoo-507	Practical related to Zoo-501& Zoo502 (CB)	2	4 (Per batch)	60	40	60
		Zoo-508	Practical related to Zoo 502 (MB)& Zoo 503	2	4 (Per batch)	60	40	60
		Zoo-509	Practical related to Zoo504	2	4 (Per batch)	60	40	60
Non Credit Audit Course	Elective audit course (Any one)	AC-501A	NSS	No credit	2	30	100	----
		AC-501 B	NCC					
		AC-501 C	Sports					

Structure of curriculum of TYBSc (Zoology) **Semester VI**

Discipline	Course Type	Course Code	Course title	Credits	Hours/ week (Clock Hours)	Total Teaching hours	Marks (Total 100)	
							CA	UA
Discipline Specific Course(DSC)	Core l	Zoo-601	Study of Leech & Calotes	3	3	45	40	60
	Core I	Zoo-602	Chick Embryology	3	3	45	40	60
	Core III	Zoo-603	Applied Zoology	3	3	45	40	60
	Core IV	Zoo-604	Microtechnique	3	3	45	40	60
DSC Skill Enhancement Course [SEC]	Skill Based	Zoo-605	Research Methodology	3	3	45	40	60
DSC Elective Course	Elective Course (Any one)	Zoo-606(A)	Bioinformatics	3	3	45	40	60
		Zoo-606 (B)	Sericulture					
DSC	Core (Practical)	Zoo-607	Practical related to Zoo-601	2	4 (Per batch)	60	40	60
		Zoo-608	Practical related toZoo 602 & Zoo 603	2	4 (Per batch)	60	40	60
		Zoo-609	Practical related toZoo 604	2	4 (Per batch)	60	40	60
Non Credit Audit Course	Elective audit course (Any one)	AC-601 A	Soft skill	No credit	2	30	100	----
		AC-601 B	Yoga					
		AC-601 C	Practicing Cleanliness					

CA: Class assessment {Internal examination}; UA: University assessment

Semester V

<table>
<tr><td colspan="3">DSC Core Courses</td><td></td></tr>
<tr><td colspan="3">Zoo - 501: Reproductive Endocrinology</td><td></td></tr>
<tr><td></td><td>Course objective
• To learn about the various aspects of reproductive biology and endocrinology.
• To acquire a broad understanding of the hormonal regulation of physiological processes.
• To create awareness of new technologies in assisted reproduction as well as contraceptive methods.</td><td>Teaching Hours :45</td><td>Credits : 03</td></tr>
<tr><td></td><td>Learning outcomes
After successful completion of this course, students are expected to:
• understand the functioning of male and female reproductive systems particularly in humans.
• comprehension of the interplay of various hormones in the functioning and regulation of the male and female reproductive systems
• know about modern contraceptive devices.</td><td></td><td></td></tr>
<tr><td>Unit</td><td>Topics</td><td>Lectures 45</td><td>Marks 60</td></tr>
<tr><td>Unit I</td><td>Introduction: Definition and Scope of Reproductive endocrinology</td><td>02</td><td>05</td></tr>
<tr><td>Unit II</td><td>Structure, Morphology, Histology and Reproductive functions of - Pituitary gland, Thyroid and Adrenal gland.</td><td>10</td><td>13</td></tr>
<tr><td>Unit III</td><td>Male and Female Gonads:
3.1 Testis:
3.1.1 Structure (Histology) and Endocrine Regulation.
3.1.2 Hypophysical Control (Testicular androgens).
3.1.3 Role of testosterone in the foetal development.
3.1.4 Effect of testosterone on development of sexual characteristics.
3.2 Ovary:
3.2.1 Structure (Histology) and Endocrine Regulation.
3.2.2 Hypophysial Control.</td><td>13</td><td>17</td></tr>
<tr><td>Unit IV</td><td>Female Reproductive Cycle:
4.1 a)Oestrous cycle, b)Menstrual cycle, c) Endocrine Regulation of female Sexual cycle.
4.2 Function of Ovarian Hormone.
4.3 Regulation of Endometrial cycle by ovarian Hormone.
4.4 Hypophysial Control.</td><td>10</td><td>13</td></tr>
<tr><td>Unit V</td><td>Hormonal Control on Pregnancy, Parturition, Lactation and Fertility</td><td>10</td><td>12</td></tr>
</table>

Suggested Readings	1) Austin C. R. and R. V. Short, 1972 Reproduction in Mammals, Vol-1-8, Cam. Uni. Press. 2) Copenhaver Wilfred M., Douglas E. Kelly and Richard L. Wood- Bailey's text book of histology, Williams and Wilkins, Baltimore / London. 3) Gibian P. and E. J. Platz, eds, 1970, Mammalian Reproduction, Springer Verlag. 4) Guide to learning in Reproductive Endocrinology and Infertility ABO+ G. First in women health. The American Board of Obstetrics and Gynaecology, Inc. 2915, Vine Street: Dallas, TX 75204 Fellowship @ obog. org.www.obog.org. 5) Hogarth P. J., 1978- Biology of Reproduction Wiley, New York. 6) Lohar Prakash S. - 2012- Endocrinology-Hormones and Human Health, MJP Publishers, Chennai. 7) Perry J. S., 1971, The Ovarian cycle of animals, Oliver and Boyed. 8) Williams Robert H., 1981, Text Book of Endocrinology, W. B. Saunders Company.		

DSC Core Courses			
Zoo - 502: Cell and Molecular Biology (CMB)			
	Course objective: • To understand the basic structure of cells, tissues and their working system. • Know the handling skill in laboratory methods of estimation, determination, working of cells and their molecules. • Use of binocular research microscope and bioinstrumentation in laboratory.	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes: After successful completion of this course, students are expected to: • achieve the knowledge of cell structure and cellular system. • predict the outcome of various cellular reactions carried out in cell and cellular system under various conditions. • predict the role of genes and its relevance to human genetics and diseases.		
Unit	**Topics**	**Lectures 45**	**Marks 60**
Unit I	**Introduction to Cell and Molecular Biology:** a) Cell Biology. b) Molecular Biology. c) Prokaryotic and Eukaryotic cells, Virus, Mycoplasma. d) Structure of plasma membrane: i) Bilayer model of Danielli and Devon, ii) Fluid mosaic model. e) Study of cell organelles with reference to ultrastructure and functions of: Nucleus, Endoplasmic Reticulum, Golgi bodies, Lysosomes and Mitochondria	**12**	**15**
Unit II	**Cell Division and Cell Signaling:** a) Cell division – Definition, Stages of mitosis and meiosis. b) Stages of cell cycle – G1, S, G2 and M- Phase. c) G-Protein coupled receptor and role of second messenger (cAMP)	**10**	**10**
Unit III	**Nucleic Acid:** a) Salient features of DNA and RNA b) Watson and Crick model of DNA molecule. c) Forms of DNA and Types of RNA(Genetic & non genetic) d) DNA replication in Prokaryotes and Eukaryotes.	**10**	**12**

Unit IV	**Protein Biosynthesis:** a) Transcription in Eukaryotes: RNA polymerase, Transcriptional Unit, Mechanism of transcription, Processing of m-RNA and r-RNA. b) Translation: Genetic Code, Wobble hypothesis, Synthesis and charging of t-RNA.	**08**	**15**
Unit V	**Gene Regulation:** Principles of transcriptional regulation in Eukaryotes: Activators, Enhancer, Gene silencing, Genetic imprinting	**05**	**08**
Suggested Readings	1) Conn et al: Outline of Biochemistry (Wiley) 2) De Roberties and De Roberties: Cell and Molecular Biology,Saunders College. 3) Edward Gasque: Manual of Laboratory Exp. in Cell Biology,W.C. Brown Publishers. 4) Geoffrey M. Cooper and Robert E. Housman: The Cell – A Molecular Approach. 4th edition. 5) Lodish et al: Molecular and Cell Biology,Scientific American Book. 6) Lohar Prakash S. (2014) Cell and Molecular biology, MJP Publishers, Chennai. 7) Prescott, DM: Reproduction in eukaryotic cells,Academic Press. 8) Strickberger, M.W.: Genetics, 2ndedition, Macmillan Publishing Co. Inc. New York. 9) Verma P. S. and V. K. Agrawal: Cytology 10) Watson J. D. et al: Molecular Biology of Gene (Benzamin / Cumming) 11) Wilson, EB: Cell in Development and Inheritance (MacMillan)		

DSC Core Courses			
Zoo - 503: Mammalian Histology			
	Course objective: • To study the Histology of different tissues and systems of mammals.	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes: After successful completion of this course, students are expected to: • enrich themselves with histology of different tissues and systems for research and job opportunities in Pathology and Cancer research centers.		
Unit	**Topics**	**Lectures 45**	**Marks 60**
Unit I	**Tissue and Skin:** 1.1 Definitions of Histology. Differentiation and derivative of three germinal layers 1.2 Tissue: Types and Characteristics (Definition and location only). 1.3 Types – 1.3.1 Epithelial tissues- a) Simple epithelial tissues, b) Compound epithelial tissues, 1.3.2 Connective tissue, 1.3.3 Muscular tissue and 1.3.4 Nervous tissue- a) Structure and types of neurons (nerve cell), b) Medullated and non-medullated nerve fibres. 1.4 Skin: Structure and function. 1.5 Derivatives of skin - Horns, Nails, Hair, Sweat and Sebaceous gland.	**13**	**12**
Unit II	**Digestive and Respiratory system:** 2.1 Histology of tooth and tongue: Structure and functions. 2.2 Histology of alimentary tract: histological structure of oesophagus, stomach, duodenum, colon and rectum. 2.3 Histology of digestive glands – salivary gland, liver, pancreas (exocrine and endocrine). 2.4 Histological structure of trachea and lung.	**08**	**12**
Unit III	**Circulatory, Excretory system:** 3.1 Structure and function of blood vessels: Artery, Vein and Capillary. 3.2 Blood: Composition, types of blood cells and their functions. 3.3 Histology of Kidney: L.S. of Kidney, microscopic structure of uriniferous tubules, Juxtra Glomerular complex (JG complex), Bowman's capsule & Glomerulus.	**08**	**12**

Unit IV	**Nervous system and Sense Organs:** 4.1 Brain meninges:Structure and function. 4.2 Spinal cord:Structure and function. 4.3 Eye: Structure- V. S. of eye ball. 4.4 Ear: Structure of external, middle and internal ear	**08**	**12**
Unit V	**Reproductive and Endocrine system:** 5.1 Histological structure of Testis, Structure of sperm 5.2 Histological structure of Ovary, Structure of ovum 5.3 Histological structure of Pituitary gland. 5.4 Histological structure of Thyroid and Parathyroid gland. 5.5 Histological structure of Adrenal gland	**08**	**10**
Suggested Readings	1) Arthur W. Ham: Ham's Histology, 9th ed. Philadelphia: Lippincott, 1987.Freeman W. H:, An advanced atlas of Histology 2) Muzammih Ullah: Histology and Genetics 3) Roy O. Greep.: Histology 4) Turner and Bungera: General Endocrinology 5) William F.Windle: Text book of Histology		

<table>
<tr><td colspan="3">DSC Core Courses</td><td></td></tr>
<tr><td colspan="3">Zoo - 504: Animal Biotechnology</td><td></td></tr>
<tr><td></td><td>Course objective:
• Studying animal cell and tissue culture techniques
• Developing genetically engineered products for human animal welfare,
• Developing gene transfer technologies, cloning, transgenic animals
• Studying hybridoma technique and production of antibodies
• Impart knowledge about stem cell research</td><td>Teaching Hours :45</td><td>Credits : 03</td></tr>
<tr><td></td><td>Learning outcomes:
After successful completion of this course, students are expected to:
• acquire knowledge about animal cell and tissue culture techniques.
• become familiar with genetically engineered products for human animal welfare.
• developing embryo - transfer technology, cloning, transgenic animals.
• understand applications of hybridoma technique and functions of antibodies.
• acquire knowledge about stem cell research and its ethical issues.</td><td></td><td></td></tr>
<tr><td>Units</td><td>Topics</td><td>Lectures 45</td><td>Marks 60</td></tr>
<tr><td>Unit I</td><td>1.1 Introduction, scope and significance of Biotechnology
1.2 Animal cell and tissue culture
1.2.1 Definition and Types of culture media
1.2.2 Advantages and disadvantages of animal cell/tissue culture
1.2.3 Laboratory facility for animal tissue culture
1.2.4 Applications of animal cell and tissue culture
1.2.5 Primary culture, Examples of Cell lines
1.2.6 Applications of somatic cell fusion
1.3 Examples of Tissue and organ cultures</td><td>12</td><td>15</td></tr>
<tr><td>Unit II</td><td>Recombinant DNA technology
2.1 Introduction
2.2 Restriction enzymes- classification with examples
2.3 Identification and isolation of desired gene
2.4 Types and properties of vectors
2.5 Construction of genomic and cDNA libraries
2.6 Application of genetic engineering e.g. production of human Insulin, Growth hormone, TPA and vaccines</td><td>12</td><td>15</td></tr>
</table>

Unit III	**Transgenic animals** 3.1 Introduction 3.2 Methods of Transfection (Physical, Chemical, Viral and Bacterial) 3.3 Examples and significance of transgenic animals	**08**	**10**
Unit IV	**Hybridoma technology** 4.1 Introduction 4.2 Methods for production of monoclonal and polyclonal antibodies 4.3 Significance of Monoclonal antibodies 4.4 Types and significance of immunoglobulin	**08**	**12**
Unit V	**Stem Cell Biotechnology** 5.1 Introduction 5.2 Types of Stem Cell and their uses 5.3 Now and Future of Stem cell Biotechnology 5.4 Ethical issues in stem cell technology	**05**	**08**
Suggested Readings	1) Brooks G (ed.) (2002) Gene therapy. *The use of DNA as a drug*. Pharmaceutical Press, London. 2) Gerald C., (1996) *Cell and Molecular Biology – Concept and Experiment*, John Wiley and Sons, Inc., U.S.A. 3) Lewin, B., (2004), *Genes VIII*, Oxford University Press, New York 4) Lohar Prakash S. (2012) Textbook of Biotechnology ISBN: 9788180941047 MJP Publishers, Chennai 5) Sing, B.D.(2014) Biotechnology Expanding horizons. Kalyani Publishers, Delhi. 6) Stem Cell Biology (2001) Cold Spring Harbor Laboratory Press 7) Watson, J.D. *et al*, (1987) *Molecular Biology of Gene*, 4th ed., The Benjamin / Cummings Publishing Company, Inc. U.S.A.		

DSC Skill Enhancement Course [SEC]			
Zoo - 505: Public Health and Hygiene			
	Course objective • To provide knowledge and understanding regarding life style diseases. • To promote an understanding of the value of good life style practices, physical fitness and healthy food habits for life style disease management. • To motivate them to practice yoga and meditation in day-to-day life	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes After successful completion of this course, students are expected to: • get familiarised with various aspects of environmental risks and hazards. • acquire knowledge regarding epidemiology, prevention, control and management of diseases of public health importance. • learn about diagnosis of various diseases and methods to prevent them.		
Units	**Topics**	**Lectures 45**	**Marks 60**
Unit I	**Public Health and Hygiene:** 1.1 Introduction and scope, 1.2 Nutrition and health, 1.3 Classification of food, 1.4 Nutritional deficiencies, 1.5 Vitamin deficiencies, 1.6 Hygiene: Introduction, definition and types of hygiene.	**10**	**12**
Unit II	**Environment and health hazards:** 2.1 Environmental degradation, 2.2 Pollution and associated health hazards	**08**	**12**
Unit III	**Sanitation and Diseases:** 3.1 Definition and concept, 3.2 Disposal of human & animal waste, refuse sewage.	**08**	**12**
Unit IV	**Communicable disease and their control measures:** 4.1 Malaria 4.2 Typhoid 4.3 Hepatitis-types 4.4 Tuberculosis 4.5 Chikungunya 4.6 Dengue and 4.7 AIDS.	**10**	**12**
Unit V	**Non-communicable diseases** and **their preventive measures:** 5.1 Hypertension, 5.2 Coronary Heart disease,	**09**	**12**

	5.3 Stroke, 5.4 Obesity and 5.5 Mental ill health		
Suggested Readings	1) Basu, S.C. Preventive and Social Medicine. 2) Cliford Anderson R., Your Guide to Health. 3) Gibney, Clinical Health, Blackwell. 4) Gibney, Public Health Nutrition, Blackwell. 5) Goel, S.O.L. Public Health Administration. 6) Mahajan B.K., M.C. Gupta, Preventive and social medicine in India, 2013, 4th Edn.,JaypeeBroyhers Medical Publishers, New Delhi, India. 7) Park K. and Park S, 1995, Text Book of Preventive and Social Medicine. Banarsidas Bhanot Publishers, 1167 Prem Nager, Jabalpur – 482001. 8) Sanitarians Hand Book. Theory and Administrative Practice. Pearles Publications, New Orleans, USA. 9) Seshu Babu V.V.R, Review of community medicine, 2006, 2nd Edn.,Paras Medical Books Pvt. Ltd., Hydrabad. 10) Shoryock Harold and Hubert O. Swartout You and Your Health illustrated Dealing with Diseases.. 11) Sobti R. C., Medical Zoology and Medical Technology, Shobanlal and Co., Jalandher.		

DSC Skill Enhancement Course [SEC]			
DSC ELELCTIVE COURSE (Any one from 506 A or 506 B)			
Zoo – 506 (A): Pest Management			
	Course objectives: • To acquire basic skills in the observation and study of nature. • To inculcate interest in adopting biological control strategies for pest control. • To know various pests affecting our local crops and select the best method for their control. • To acquire basic knowledge and skills in agriculture management to enable the learner for self-employment.	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes: After successful completion of this course, students are expected to: • impart basic awareness regarding pest problem and crop loss due to their dominance. • understand various pests affecting our local crops and select the best method for their control. • acquire basic knowledge and skills in agriculture management to enable the learner for self-employment		
Unit	**Topics**	**Lectures 45**	**Marks 60**
Unit I	**Introduction** 1.1 Definition of pest 1.2 Classification of pest w.r.t. Systematic position, Marks of identification, Life cycle, Nature of damage and Control measures. 1.2.1 Agricultural pests: a) Pest of Cotton – *Dysdercus cingulatus* b) Pest of Banana – *Odoiporus longicollis* c) Pest of Vegetable (Brinjal) – *Leucinodes or bonalis guenee* d) Pest of Sugarcane – *Pyrilla perpusilla* e) Pest of Onion- *Thrips tabaci* 1.2.2 Stored grain pest – *Sitophilu soryzae* 1.2.3 Veterinary pest - *Flea* 1.2.4 Public health pest – C*imex* 1.2.5 Structural pest – *Odontotermes obesus*	**13**	**15**
Unit II	**Insect Vector:** 2.1 Definition of vector 2.2 Types of vector (Mosquito, house fly, cockroach)	**07**	**10**
Unit III	**Control Measures:** 3.1 Primary control and their types.	**09**	**13**

	3.2 Chemical control and their types. 3.3 Biological control and their types. 3.4 Concept of IPM		
Unit IV	**Types of Pesticides and Their Mode of Action:** 4.1 Stomach poison 4.2 Contact poison 4.3 Systemic poison 4.4 Fumigants 4.5 Pesticide appliances: a) Sprayer and b) Duster	**08**	**12**
Unit V	**Non Insect Pests:** Study of Non insect pests with reference to habit, habitat, Breeding potential, Nature of Damage and control techniques. 5.1 Rat 5.2 Birds. 5.3 Snail	**08**	**10**
Suggested Readings	1) Crop Pests and How to Fight Them, Director of Publicity, Govt. of Maharashtra. 2) Fadt,: Fundamental of Entomology. 3) Gupta: Essentials of biotechnology. 4) Little and Little: General and Applied Entomology. 5) Pedigo: Entomology and Pest management. 6) Pradhan,: Insect Pest of Crops. 7) Pruthi, H.S.: Textbook of Agricultural Entomology. 8) Ravindranathan K. R.: Economic Zoology, Dominant Pub., New Delhi 9) Shukla and Upadhyay: Economic Zoology, Rastogi publication. 10) Tembhare D.B.: Text Book of Modern Entomology.		

DSC Skill Enhancement Course [SEC]			
DSC ELELCTIVE COURSE (Any one from 506 A or 506 B)			
Zoo – 506 (B): Aquarium Fish Keeping			
	Course objective • To impart basic knowledge of ornamental fish Industry and inculcate its scope as an Avenue for career development in Entrepreneurship or as an Aquariculturist. • To equip the students with self-employment capabilities. • To acquire basic knowledge and skills in aquarium management	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes After successful completion of this course, students are expected to: • Acquire knowledge about different kinds of fishes, their compatibility in aquarium. • Know the basic needs to set up an aquarium and the ways to make it cost-effective. • Become aware of Aquarium as commercial, decorative and of scientific studies. • Develop personal skills on maintenance of aquarium.		
Unit	**Topics**	**Lectures 45**	**Marks 60**
Unit I	**Introduction to Aquarium Fish Keeping:** 1.1 Introduction to Aquarium Fish Keeping 1.2 The potential scope of Aquarium Fish Industry as a Cottage Industry, 1.3 Varieties of aquarium fishes - Exotic and Endemic	**10**	**12**
Unit II	**Biology of Aquarium Fishes:** Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes: Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish.	**15**	**18**
Unit III	**Food and feeding of Aquarium fishes:** 3.1 Use of live fish feed organisms. 3.2 Preparation and composition of formulated fish feeds.	**06**	**10**
Unit IV	**Fish Transportation:** 4.1 Live fish transport – Fish handling, packing and forwarding techniques.	**05**	**8**
Unit V	**Maintenance of Aquarium:** 5.1 Maintenance of Aquarium: 5.1.1 Aquarium maintenance;	**09**	**12**

	5.1.2 Equipments, 5.1.3 Water analysis 5.1.4 Aquarium fish diseases and treatment 5.2 Budget for setting up an Aquarium Fish Farm as a Cottage Industry;		
Suggested Readings	1) Bailey Mary, Gina Sandford; The Complete Guide to Aquarium Fish Keeping (Practical Handbook) Publishers: Lorenz Books. 2) Dawes, J. A. (1984), The Freshwater Aquarium, Roberts Royee Ltd.London. 3) Gunther, A. (1980), An Introduction to the Study of Fishes. A and C. Black Edinburgh. 4) Jhingran, V.G.(1982),Fish and Fisheries in India. Hindustan publ.Corp, India. 5) Mills, Dick; Keeping Aquarium Fish (Teach Yourself General) Publisher : Teach Yourself 6) Pandey, K and J.P. Shukla (2013),Fish and Fisheries, Rastogi Publication.		

DSC Core Practical			
Zoo - 507: Corresponding practical to DSC Zoo 501& Zoo502 (CB)			
	Course objective • To learn the various aspects of reproductive biology and endocrinology. • To know the basic structure of cells, tissues and their working system.	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes After successful completion of this course, students are expected to: • understand the functioning of male and female reproductive systems particularly in humans. • achieve the Knowledge of cell structure and cellular system.		
	Reproductive Endocrinology		
Practical	**Major Experiments:**		
1	Estimation of total gonadal cholesterol from Ovary / Testis.		
2	Estimation of Ascorbic acid from Ovary / Testis.		
3	Estimation of Protein from Ovary / Testis by Lowry's method		
4	Estimation of Glycogen from Ovary / Testis by Anthrone Method		
	Minor Experiment:		
5	Study of Histological Structure of Ovary, Testis and Fallopian tube with the help of Permanent slide.		
6	Demonstration of various endocrine glands from Rat / Mice with the help of chart / model / figure.		
7	Cellular structure of Pituitary, thyroid and Adrenal gland with the help of permanent slide.		
8	Pregnancy test (any suitable method)		
	Cell Biology		
9	Preparation of permanent slide to show the presence of Barr body in human female Blood / Cheek cells. (E)		
10	Preparation of temporary stained squash of onion root tip to study various stages of Mitosis. (E)		
11	Study of various stages of Meiosis. (D)		
12	Study of cell organelles from photomicrographs (D)		
Suggested Readings	1) Austin C.R. and R.V. Short, 1972, Reproduction in Mammals, Vol-1-8, Cam. Uni. Press. 2) De Roberties and De Roberties: Cell and Molecular Biology (Saunders College) 3) Lohar Prakash S., 2012, Endocrinology, MJP Publishers, Chennai		

Zoo - 508: Corresponding practical to DSC Zoo 502 (MB)& Zoo503			
	Course objective • To know the handling skill in laboratory methods of estimation, determination, working of cells and their molecules. • To study the histology of different tissues and systems of mammals.	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes After successful completion of this course, students are expected to: • predict the outcome of various cellular reactions carried out in cell and cellular system under various conditions. • enrich with Histology of different tissues and systems for research and job opportunities in Pathology and Cancer research centers.		
Practical	**Molecular Biology**		
1	Quantitative estimation of RNA from suitable material by Orcinol reagent. (E)		
2	Quantitative estimation of DNA from suitable material by Diphenylamine reagent. (E)		
3	Preparation of Polytene chromosome from Chironomus /Drosophila larva. (E)		
4	Study and interpretation of electron micrographs/photographs showing. (D) a) DNA replication, b) Transcription, c) Split genes.		
	Mammalian Histology		
5	**Study of following tissue with the help of chart / permanent slides /simulations (D).** a) Squamous epithelial tissue b) Cuboidal epithelial tissue c) Columnar epithelial tissue d) Ciliated epithelial tissue e) Areolar connective tissue f) Blood smear permanent slide.		
6	**Temporary preparation of the following tissue of preserved Rat (E).** a) Striated muscle fibre b) Smooth muscle fibre c) Medullated nerve fibres d) Hyaline cartilage.		
7	**Study of histological permanent slide of mammalian skin.**		
8	**Study of following histological permanent slide of digestive and respiratory organs. (D)** a) V. S. of Tooth b) V. S. of Tongue c) C. S. of Salivary gland(Parotid gland) d) T. S. of oesophagus e) T. S. of stomach f) T. S. of duodenum g) T. S. of rectum		

	h) T. S. of pancreas i) C. S. of liver j) C. S. of trachea k) C. S. of lung		
9	**Study of following histological permanent slide of blood vessels, excretory and reproductive systems. (D)** a) T. S. of artery b) T. S. of vein c) T. S. of capillary. d) L. S. of kidney e) T. S. of testis f) L. S. of ovary		
10	**Study of following histological permanent slide of endocrine glands. (D)** a) T. S. of pituitary gland b) T. S. of adrenal gland c) C. S. of thyroid gland		
Suggested Readings	1) De Roberties and De Roberties: Cell and Molecular Biology (Saunders College) 2) Freeman W. H., An advanced atlas of Histology 3) Lodish et al: Molecular and Cell Biology (Scientific American Book) 4) Lohar Prakash S. (2014) Cell and Molecular biology, MJP Publishers, Chennai 5) Pearse A.G.E., Histochemistry – Vol. I and II 6) Tembhare D.B., Techniques in Life Sciences. 7) William F.Windle, Text book of Histology		

DSC Core Practical			
Zoo - 509: Corresponding practical to DSC Zoo 504			
	Course objective • Studying animal cell and tissue culture techniques • Developing genetically engineered products for human animal welfare, • Developing gene transfer technologies, cloning, transgenic animals • Studying hybridoma technique and production of antibodies • Impart knowledge about stem cell research.	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes After successful completion of this course, students are expected to: • acquire knowledge about animal cell and tissue culture techniques • become familiar with genetically engineered products for human animal welfare, • developing embryo - transfer technology, cloning, transgenic animals • understand applications hybridoma technique and functions of antibodies • acquire knowledge about stem cell research and its ethical issues.		
Practical	**Animal Biotechnology**		
1	Estimation of DNA in a given sample by Diphenylamine method		
2	Estimation of RNA in a given sample by Orcinol method		
3	Working principle and application of laminar air flow and autoclave (D)		
4	Isolation of microorganisms on nutrient agar by streak plate/dilution plate method (E)		
5	Production ethanol by fermentation using yeast.(E)		
6	Culture of bacteria in liquid medium and agar plates.(E)		
7	Preparation of primary culture media for cell, tissue, organ. (D)		
8	Separation of serum proteins by Agarose or polyacrylamide gel electrophoresis(E)		
9	Study of Biogas plant/ model (D)		
10	Visit to dairy / pharmaceutical / tissue culture laboratory and submission of report.		

Suggested Readings	1) Brooks G (ed.) (2002), Gene therapy. The use of DNA as a drug. Pharmaceutical Press, London. 2) Gerald C., (1996),Cell and Molecular Biology – Concept and Experiment, John Wiley and Sons, Inc., U.S.A. 3) Lewin, B., (2004), *Genes VIII*, Oxford University Press, New York 4) Lohar Prakash S. (2012), Textbook of Biotechnology ISBN: 9788180941047 MJP Publishers, Chennai 5) Sing, B.D.(2014), Biotechnology Expanding horizons.Kalyani Publishers, Delhi. 6) Stem Cell Biology (2001), Cold Spring Harbor Laboratory Press 7) Watson, J.D. *et al*, (1987),Molecular Biology of Gene,4th ed., The Benjamin / Cummings Publishing Company, Inc. U.S.A.		

SEMESTER VI

DSC Core Courses			
Zoo - 601: Study of Leech And Calotes			
	Course objective • To understand habit, habitat and taxonomic status of Leech as invertebrates and Calotes as vertebrates • To explain the basic aspects of structural and functional details of Leech and Calotes	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes After successful completion of this course, students are expected to: • understand the systematic position, habit and habitat of Leech and Calotes • acquire the knowledge about structural and functional details about Leech as invertebrates and Calotes as vertebrates • compare structural and functional details in Leech and Calotes.		
Unit	**Topics**	**Lectures 45**	**Marks 60**
Unit I	**Study of Leech:** a) Systematic position, habit, habitat external characters, body wall. b) Digestive system, food, feeding and digestion. c) Excretory system	**10**	**12**
Unit II	d) Nervous system and sense organs. e) Reproductive system, copulation, f) Fertilization, cocoon formation, and development.	**10**	**14**
Unit III	**Study of Calotes** a) Systematic position, habit, habitat external characters, b) Digestive system, food feeding and digestion	**05**	**10**
Unit IV	c) Respiratory system and respiratory mechanism d) Excretory system and physiology of excretion	**10**	**12**
Unit V	e) Nervous system and sense organs f) Reproductive system, copulation, fertilization and development.	**10**	**12**
Suggested Readings	1) Hall B.K. and Hallgrimsson B. (2008),Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc. 2) JordenE. L., Invertebrate Zoology, S.C.Chand, New Delhi. 3) JordanE.L. and P.S.Verma, Chordate Zoology, S.Chand and Company New Delhi. 4) Kotpal R.L (1991), Zoology phylum Annelida,		

	Rastogi publication. Meerut. 5) Kotpal R.L. (2016), Modern text book Vertebrate zoology. Fourth edition. Rastogi Publication, Meerut 6) Lal S.S. (1996), Textbook of Practical Zoology Invertebrates, Rastogi Publications. 7) Lal S. S. (1996), Textbook of Practical Zoology Vertebrates, Rastogi Publications. 8) Prasad S. N., Life of Invertebrates. 9) Young, J. Z. (2004),The Life of Vertebrates. III Edition. Oxford university press.		

DSC Core Courses			
Zoo - 602: Chick Embryology			
	Course objective • To study the various stages involved in the developing embryo • To study the initial developmental procedures involved in chick • To know the processes involved in embryonic development and practical applications of studying the chick embryology.	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes After successful completion of this course, students are expected to: • Understand various stages involved in the developing embryo • Understand the initial developmental procedures involved in chick. • Understand the processes involved in embryonic development and practical applications of studying the chick embryology.		
Unit	**Topics**	**Lectures 45**	**Marks 60**
Unit I	**Embryology:** 1.1 Definition and Concept of embryology **1.2** Spermatotogenesis and 1.3 Oogenesis.	**05**	**08**
Unit II	**Fertilization:** 2.1 General mechanism of fertilization 2.2 Eggs:Structure of Hen's egg	**05**	**08**
Unit III	**Cleavage:** 3.1 Patterns of cleavages. 3.2 Blastulation 3.3 Gastrulation	**10**	**12**
Unit IV	**Development of Chick Embryo:** 4.1 18 hours chick embryo **-** (Primitive streak formation, mesogenesis, somite formation) 4.2 24 hours chick embryo 4.3 33 hours chick embryo 4.4 48 hours chick embryo 4.5 72 hours chick embryo	**15**	**18**
Unit V	**Extra-embryonic membranes:** 5.1 Yolk Sac, structure and its functions. 5.2 Amnion, structure and its functions. 5.3 Chorion, structure and its functions. 5.4 Allantois, structure and its functions	**10**	**14**

Suggested Readings	1) Agarwal, V.K. and UshaGuptha, S (1998). Chand's simplified course in Zoology, Chordate Embryology and Histology. S. Chand & Co Ltd. 2) Balinsky. B.I. (2004). An Introduction to Embryology. W.B. Saunders & Co. 3) Berry, A.K. (2008). An Introduction to Embryology. Emkay Publications. 4) Boby Jose et al., Developmental biology, Experimental biology, Manjusha Publications, Calicut. 5) Gibbs. (2006).Practical Guide to Developmental Biology. Oxford University Press. 6) Gilbert. S.F. (2000). Developmental Biology. Sinauer Associates, Inc. Publishers. 7) Goel, S.C. (1984). Principles of animal developmental biology. Himalaya Publ. House, Bombay. 8) Huettner,A.F. (1959). Comparative Vertebrate Embryology. MacMillan. 9) Mc Even. (1970). Vertebrate Embryology. Oxford-IBH 10) Nelson. (1960). Comparative Embryology of Vertebrates. MacMillan. 11) P.C.Jain. (2007). Elements of Developmental Biology, 6th Edn. Rastogi Publications. 12) Rough. (1960). Frog- Reproduction and development. Oxford University Press. 13) Verma, P.S. and V.K. Agarwal (2007). Chordate Embryology. S. Chand and Co. Ltd.		

DSC Core Courses			
Zoo - 603: Applied Zoology			
	Course objective: • To acquire basic knowledge and skills in applied branches of zoology • To equip the students with self-employment capabilities. • To provide scientific knowledge of profitable farming. • To get technical awareness of vermitechnology and vermicomposting technique. • To convert unwanted, organic matter, particularly food scraps and paper into fertile soil. • To learn about all aspects of raising poultry for their meat and eggs. • To know the economics, problems and prospects of Vermicomposting and Poultry.	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes: After successful completion of this course, students are expected to: • practice of vermicomposting,vermiculturing and poultry farming. • aspire to work in preparing bio compost, vermicomposting and vermiculturing and get employment accordingly. • start business for rearing and production of birds and get employment accordingly.		
	Topics	**Lectures 45**	**Marks 60**
Units	**Vermiculture**		
Unit I	1.1 Introduction and scope 1.2 Characteristics features of earthworm 1.3 Species of Earthworm – *Eisenia foetida* and *Eudrilus eugeniae*	**05**	**08**
Unit II	2.1 Methods of vermicomposting – Small and Large scale. 2.2 Set up of Vermiwash unit. 2.3 Role of earthworm in solid waste management. 2.4 Economic importance of vermicompost and vermiwash	**10**	**12**
Unit III	3.1 Introduction : Definition and concept 3.2 Study of Indian fowl, *Gallus gallus domesticus* w.r.t. a) Systematic position b) Habits and Habitat c) External Morphology	**05**	**05**
	Poultry		
Unit IV	4.1 Types of Poultry breeds: with respect to origin, characters and standard weight.	**20**	**30**

	a) American breed – White Plymoth rock b) Mediterranean breed – White Leghorn c) The English breed – White Cornish d) Asiatic breed – Brahma e) Indian breed – Assel, Kadaknath 4.2 Brooding and Rearing : a) Natural and artificial breeding b) Housing and Equipment of poultry c) Poultry house equipment d) Poultry Nutrition 4.3 Poultry Diseases: a) Viral Diseases – Fowl pox, Infectious bronchitis (IB) and Infectious bursitis (IBD), b) Bacterial Diseases - Pullorum and Chronic Respiratory Disease (CRD), c) Fungal Diseases – Aspergillosis, Thrush, d) Parasitic Diseases – i) Ectoparasites – Lice and Ticks, ii) Endoparasites – Round worm and Caecal worm, e) Protozoal Diseases – Coccidiosis – Caecal and Intestinal.		
Unit V	5.1 Economics of poultry : a) Nutritive value of egg of hen b) Economic importance of poultry manure 5.2 Poultry care management and marketing	**05**	**05**
Suggested Readings	1) Banerjee, G. C., A textbook of Animal Husbandry, Oxford and IBH publishing Co. Pvt. Ltd. New Delhi. 2) Banerjee, G. C., Animal Husbandry, Oxford and IBH publishing Co. 3) Gupta P.K., Vermicomposting for sustainable agriculture - Publisher - Agrobios, Jodhpur (India). 4) Shukla and Upadhyay, Economic Zoology, Rastogi publication. 5) Singh, R. A., Poultry introduction, Kalyani publishers, New Delhi. 6) Singh, R. A., Poultry production, Kalyani publishers, New Delhi. 7) Srivastava P. D. and N. C. Pant, Economic Zoology Vol. I and II, Commercial Publication Bureau, New Delhi. 8) YadavManju, Applied Entomology, Discovery publishing house, New Delhi 9) YadavManju, Economic Zoology, Discovery publishing house, New Delhi		

DSC Core Courses			
Zoo - 604: Microtechnique			
	Course objectives: To prepare the whole mounts microscopic slides and staining reactions.	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes: Cell tissue structure, histology of tissues and details of morphology of animals. Job opportunities in Health institutes, Hospitals and Pathological labs.		
Unit	**Topics**	**Lectures 45**	**Marks 60**
Unit I	**Introduction, Collection and Fixation** 1.1 Definition, Scope and Applications of Microtechnique. 1.2 Collection of specimen or tissue. 1.3 Kinds of preparation of specimen or tissue: 1.3.1 Whole mounts, Teasing and smearing. 1.4 Preparation whole mounts: Euglena, Paramoecium, Chick embryo. 1.5 Fixation: Definition and Importance and Theory of fixation. 1.6 Qualities of good fixative. 1.7 Types of fixative – 1.7.1 Primary-- Formaline, Ethyl alcohol.(Ethanol) 1.7.2 Compound fixatives- Bouin's fluid, Zenker's Fluid and Carnoy's fluid.	**10**	**12**
Unit II	**Washing, Dehydration, Clearing** 2.1 Washing: 2.1.1 Theory of washing 2.1.2 Significance of washing 2.2 Dehydrating agents: 2.2.1 Definition and types - Ethanol, Methanol, Acetone 2.2.2 Significance and use of dehydrating agents. 2.3 Clearing: 2.3.1 Definition and importance of clearing. 2.3.2 Clearing agents their merits and demerits - Xylene, Toluene, Benzene, Cedar wood oil, Clove oil. 2.4 Cold and hot infiltration.	**08**	
Unit III	**Embedding, Block making, Trimming and Mounting** 3.1 Cold and hot infiltration 3.2 Paraffin 3.2.1 Selection of paraffin according to need. 3.2.2 Melting and handling of paraffin. 3.3 Types of ovens and its uses.	**10**	**12**

	3.4 Embedding: 3.4.1 Embedding containers: a) Paper trays b) L-shaped metalPiecesc) Glass dishes/Lids. 3.4.2 Embedding procedure, multiple embedding and embedding faults. 3.5 Block making, labelling of block and storage of block. 3.6 Trimming 3.7 Mounting of trimmed block on microtome peg.		
Unit IV	**Section cutting and affixing** 4.1 Microtome:Types, its uses, precautions and handling of Rotary and Rocking microtome. 4.2 Microtome knives: Types, care, sharpening, honing and stropping of knife. 4.3 Section cutting: Defects, Possible causes and remedies during section cutting. 4.2 Affixing and processing of sections: i) Mayer's albumen, ii) Slide warmers.	**08**	**12**
Unit V	**Staining, Mounting, Clearing and camera lucida** 5.1 Theory of staining. 5.1.1 Types of stain: Acidic, basic, neutral and vital stain. 5.1.2 Preparation of Haematoxylin and Eosin stain. 5.1.3 Mordants: Definition, importance and common mordants. 5.1.4 Double staining: Processing of paraffin section during staining. 5.1.5 Special staining methods for Mitochondria and chromosomes. 5.2 Mounting media: DPX and Canada balsam. 5.3 Clearing, labelling and preservation of permanent slides. 5.4 Use of camera lucida and Micrometer scale.	**09**	**12**
Suggested Readings	1) Baker F.I and R.E Silverton, Introduction to Medical Laboratory Technique. 2) Baker J. R, Cytological Techniques 3) Davenport H.A., Histological and Histochemical Technique. 4) Gray P., Hand book of basic Microtechnique. 5) Indurkar A.K., Practical course in Cytology. 6) Lillie R.D., Histopathogenic Microtechniqe. 7) Me Mann J.F.A and R.W Mowry, Staining Methods (Histology and Histochemical) 8) Pathak, Microtechnique (Theory and Practical) 9) Patki, Bhalchanda and Jeevaji, Introduction to Microtechnique, S. Chand Publication. 10) Pearse A.G.E., Histochemistry – Vol. I and II		

DSC Skill Enhancement Course [SEC]			
Zoo - 605: Research Methodology			
	Course objective • To understand some basic concepts of research and its methodologies. • To select and define appropriate research problem and parameters. • Understand the various techniques of Data Collection-Observation, Questionnaire, Interview Schedule; Case Study, Social Survey, Content Analysis. • Describing various types of Sampling • Elaborate on Data Processing and Data Analysis • Writing of dissertations, project proposals, project reports, research papers.	**Total Hours: 45**	**Credits: 3**
	Learning outcomes After successful completion of this course, students are expected to: • understand some basic concepts of research and its methodologies. • differentiate between the Quantitative and Qualitative Research and understand different types of Research Design • select and define appropriate research problem and parameters. • organize and conduct research project in a more appropriate manner. • writing of dissertations, project proposals, project reports, research papers. • understand intellectual Property Rights – Biopiracy, copyrights, patent and traditional knowledge and plagiarism.		
Unit	**Topics**	**Lectures 45**	**Marks 60**
Unit I	**Foundations of Research** 1.1 Meaning of research 1.2 Objectives ofresearch 1.3 Motivation inresearch 1.4 Research methods versusmethodology 1.5 Types ofresearch a) Analytical *vs* Descriptive b) Quantitative *vs* Qualitative c) Basic *vs* Applied d) Conceptual *vs* Empirical	**06**	**06**

Unit II	**Research Design** 2.1 Meaning of research design 2.2 Need of research design 2.3 Features of good design 2.4 Importance concepts of research design a) Observation and Facts b) Prediction and Explanation c) Development of Models 2.5 Developing a research plan by using a) Problem identification b) Experimentation c) Determining experimental and sample designs	**10**	**15**
Unit III	**Data Collection, Analysis and Presentation** 3.1 Observation and Collection of Data 3.2 Methods of data collection - Sampling Methods 3.3 DataProcessing and AnalysisStrategies a) Tabulation of data: i. Variables(Definition, types withexample); Frequency distribution(Definition, types and example); ii. Measurement of central tendency(Definition, types of average – mean, median, mode withexample); iii. Standard deviation(SD) and iv. Standard error(SE) b) Data AnalysisStrategies i. Testing hypothesis ii. Chi-square test iii. Student ‘t’ test 3.4 Data presentation using MS Excel application of MS office. a) Charts: Types of Charts i) Column charts, ii) Line charts iii) Pie charts iv) Bar charts v) Area charts vi) Scatter charts vii) Stock charts viii) Surface charts ix) Radar charts x) Tree charts xi) Sunburst charts xii) Histogram xiii) Box and whisker charts xiv) Water fall charts xv) Funnel charts b) Elements of Bar charts c) Creation of Bar Charts using MS Excel application d) Creation of Sparkline Charts using MS Excel.	**12**	**18**

Unit IV	**Technical Reports and Thesis writing** 4.1Prepare Title, Author and Addresses, key words and Abstract (summary andsynopsis) 4.2 Writing of technical report and thesis - IMMRAD system (Introduction, Material methods, Result and Discussion), Acknowledgement, Summary, Conclusion andreferences. 4.3 Concept of scientificwriting 4.4 Meaning of scientificpaper 4.5 Write a letter to Editor of scientific journal for publishing a research paper.	**12**	**15**
Unit V	**Ethical Issues** 5.1 IntellectualpropertyRights, 5.2 Commercialization, 5.3 CopyRight, 5.4 Royalty, 5.5 Patentlaw, 5.6 Plagiarism, 5.7 Citation, 5.8 Impact factor 5.9 h-index	**05**	**06**
Suggested Readings	1) Anthony,M,Graziano,A.M.andRaulin,M.L.2009. Research Methods:A Process of Inquiry, Allyn and Bacon. 2) Coley,S. M. and Scheinberg, C. A.1990,“Proposalwriting”.StagePublications. 3) Gurumani, N. Research methodology for biological science, MJP publisher, Chennai. 4) Kothari C. R. Research Methodology, New Age International,2009 5) Robert A. Day, How to write and publish a Scientific papers (4th edition). 6) Tejinder Singh and N. G. Madhav, Better Thesis Writing 7) Wadhera, B. L. Law Relating to Patents, Trade Marks, Copyright Designsand Geographical Indications, 2002, Universal Lawpublishing 8) Walliman,N.2011.ResearchMethods - TheBasics. Taylor and Francis, London, New York.		

<table>
<tr><td colspan="3">DSC ELELCTIVE COURSE (Any one from 606 A or 606 B)</td><td></td></tr>
<tr><td colspan="3">Zoo – 606 (A) Bioinformatics</td><td></td></tr>
<tr><td></td><td>Course objective
• To get introduced to the basic concepts of Bioinformatics and its significance
• Explain generation and different types of computers with basic programing languages.
• Overview about types of Biological data and database search tools.
• To get exposed to computational methods, tools and algorithms employed for proteomics and genomics</td><td>Total Hours: 45</td><td>Credits: 03</td></tr>
<tr><td></td><td>Learning outcomes
After successful completion of this course, students are expected to:
• understand the basic concepts of Bioinformatics and its significance
• apply their knowledge of generations, types of computers and programming languages
• understand the process of sequence alignment methods using web resources
• Appreciate the tools used in proteomics and genomics their significance</td><td></td><td></td></tr>
<tr><td>Unit</td><td>Topics</td><td>Lectures 45</td><td>Marks 60</td></tr>
<tr><td>Unit I</td><td>1.1 Definition, Objectives and scope of Bioinformatics
1.2 Application of Bioinformatics in various Fields.</td><td>04</td><td>5</td></tr>
<tr><td>Unit II</td><td>2.1 Computer generations and Type of computer
2.2 Programming Languages: PERL and Java.</td><td>07</td><td>10</td></tr>
<tr><td>Unit III</td><td>3.1 Biological Databases- Concept and types of databases
3.2 Sequence alignment
3.2.1 BLAST, types and applications.
3.2.2 FASTA, format and application</td><td>10</td><td>10</td></tr>
<tr><td>Unit IV</td><td>4.1 Proteomics: Definition, Protein structure visualization tools-RasMol and SwissPDB viewer
4.2 Protein sequence databases- PIR, SWISS-PROT, TrMBL
4.3 Structural classification databases- SCOP, CATH,
4.4 Protein folding and disorders
4.5 Applications of Proteomics</td><td>12</td><td>15</td></tr>
<tr><td>Unit V</td><td>5.1 Genomics: Gene, Genotype, Genome of E. coli, S. cerevisiae, C. elegans, and Homo sapiens.</td><td>12</td><td>20</td></tr>
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	5.2 Single nucleotide polymorphisms (SNPs), Structure and application of DNA microarray. 5.3 Nucleotide sequence database, GenBank (NCBI, EMBL and DDBJ), cDNA libraries and ESTs, Databases of metabolic pathways- KEGG. 5.4 Genomics in medicine- disease monitoring, Drug designing and development.		
Suggested Readings	1) Aluru, Srinivas, (2006) ed. *Handbook of Computational Molecular Biology*. Chapman & Hall/Crc, ISBN 1584884061 (Chapman & Hall/Crc Computer and Information Science Series) 2) Attwood, T.K., Michie, A.D. and Jones, M.L. (1996): DbBrowser: integrated access to database worldwide. *TiBS*. Vol. 21(5), 191. 3) Barnes, M.R. and Gray, I.C.(2003) eds., *Bioinformatics for Geneticists*, first edition. Wiley, ISBN 0-470-84394-2 4) Curtis Jamison. (2003) Perl Programming for Biologists. By Hoboken, NJ: John Wiley & Sons, Inc. 5) Prakash S.Lohar (2011) Bioinformatics ISBN 978-81-8094-066-8 MJP Publishers, Triplicane, Chennai. 6) Lesk, A.M. (2001): *Introduction to Protein Architecture: The Structural Biology of Proteins* (Oxford: Oxford University Press). **7)** Pocock,M.R. et al. (2000) BioJava: open source components for bioinformatics. ACM SIGBIO		

DSC ELELCTIVE COURSE (Any one from 606 A or 606 B)			
Zoo – 606 (B) Sericulture			
	Course objective • To give scientific knowledge about mulberry cultivation, silkworm rearing techniques to the students. • To train the students in compressive silk production techniques.	**Total Hours: 45**	**Credits : 03**
	Learning outcomes After successful completion of this course, students are expected to: • develop an expert manpower to handle the own sericulture units/entrepreneurship/corporate sector units. • Provide gainful employment, economic development and improvement in the quality of life to the people in rural area.		
Unit	**Topics**	**Lectures 45**	**Marks 60**
Unit I	**Introduction** 1.1 Sericulture: Definition, history, present Status 1.2 Scope of sericulture 1.3 Silk producing centres 1.4 Taxonomic position 1.5 Types of silkworms and their Distribution (Muga, Eri, Tussar, Mulberry)	**09**	**12**
Unit II	**Biology of Silkworm:** 2.1 Life cycle of *Bombyx mori* w. r. t. external and internal morphology of Egg, larva, Pupa, adult 2.2 Structure and function of silk gland and secretion of silk 2.3 Digestive system of *Bombyx mori*	**09**	**12**
Unit III	**Cultivation of Mulberry:** 3.1 a) Selection of mulberry variety, b) Propagation, c) Climate, d)Soils, e)Planting, f)Raising of commercial nursery, g) Manuring, h) Interculture, i) Water management, j) Prunning and k) Quality of leaves 3.2 Harvesting of mulberry- a) Shoot Cutting b) Leaf plucking and c) Bud plucking. 3.3 Advantages and disadvantages of shoot rearing	**09**	**12**
Unit IV	**Silkworm Rearing:** 4.1 Rearing technique: a) Selection of quality seeds, b) Brushing, c) Quality of food, d) Shape and size of leaves, e)	**09**	**12**

	Preparation of feed bed for different rearing methods, f) Bed Cleaning methods, g) Spacing, moulting, mounting, h) Environmental conditions and care during spinning, i) Harvesting of cocoons, j) Sorting of cocoons and k) Post harvest processing of cocoons. 4.2 Rearing house 4.3 Rearing Appliances: a) Rearing stand, b) Ant wells,c) Rearing trays, d) Paraffin paper, e) Foam rubber strip, f) Chopsticks, g) Feathers, h) Leaf chamber, i) Chopping board, j) Chopping knives, k) Mats, l) Cleaning nets, m) Mountages, n) Feeding stand and o) Miscellaneous appliances		
Unit V	**Important Diseases and Pests:** 5.1 Protozon disease: Pebrine 5.2 Viral disease: Nuclear Polyhedrosis Virus (NPV) 5.3 Fungal disease: Muscardine - White, green, yellow 5.4 Pests of silkworm: Uzi flies, dermestid beetles, ants and vertebrates 5.5 Prevention and control of diseases and pests	**09**	**12**
Suggested Readings	1) Handbook of silkworm rearing: Agricultural and Technical manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972. 2) Jolly Ed.M.S., Appropriate Sericulture Techniques; Director, CSR & TI Mysore. 3) Krishnaswamy S., Improved Method of Rearing Young age silkworm; reprinted CSB, Bangalore, 1986. 4) Narsimhanna M.N., Manual of Silkworm Egg Production; CSB, Bangalore 1988. 5) Sengupta K., A Guide for Sericulture; Director, CSIR & TI, Mysore1989. 6) Silkworm Rearing; Wupang- Chun and Chen Da-Chung, Pub. By FAO, Rome 1988. 7) Ullal S.R. and M.N. Narsimhanna Handbook of Practical sericulture: CSB, Bangalore		

Zoo - 607: Corresponding practical to DSC Zoo 601			
	Course objective • To understand habit, habitat and taxonomic status of Leech as invertebrates and Calotes as vertebrates	**Teaching Hours :45**	**Credits : 03**
	• To explain the basic aspects of structural and functional details of Leech and Calotes		
	Learning outcomes After successful completion of this course, students are expected to: • understand the systematic position, habit and habitat of Lee Calotes • acquire the knowledge about structural and functional details about Leech as invertebrates and Calotes as vertebrates • compare structural and functional details in Leech and Calo		
Practical	**Zoo - 601: Study of Leech and Calotes**		
1	Study of systematic position and external charactersof leech with the help of chart or diagram.		
2	Study of Digestive system of leech with the help of chart or diagram.		
3	Study of Nervous system of leech, with the help chart or diagram.		
4	Study of reproductive system of leech, with the help chart or diagram.		
5	Study of systematic position and external characters of calotes, with the help chart or diagram.		
6	Study of Digestive system of Calotes, with the help chart or diagram.		
7	Study of Nervous system of Calotes, with the help chart or diagram.		
8	Study of Reproductive system of Calotes, with the help chart or diagram.		
Suggested Readings	1) Jordan E. L. and P. S. Verma, Chordate Zoology, S.Chand and Company New Delhi. 2) Kotpal R.L (1991), Zoology Phylum Annelida, RastogiPublication. Meerut. 3) Kotpal R.L. (2016), Modern text book Vertebrate Zoology. Fourth edition. Rastogi Publication, Meerut 4) Lal S.S. (1996): Textbook of Practical Zoology Invertebrates, Rastogi Publications 5) Lal S.S. (1996): Textbook of Practical Zoology Vertebrates, Rastogi Publications. 6) Young K.Z., A life of Vertebrate, ELBS Oxford University Press.		

<table>
<tr><td colspan="3">Zoo - 608: Corresponding practical to DSC Zoo 602 and Zoo 603</td><td></td></tr>
<tr><td></td><td>Course objective
To get technical awareness of vermitechnology, and poultry farming technique.
To learn the stages of embryology through permanent slides/charts.
To know the processes involved in embryonic development and practical applications of studying the chick embryology.</td><td>Teaching Hours :45</td><td>Credits : 03</td></tr>
<tr><td>Practical</td><td>Learning outcomes
After successful completion of this course, students are expected to:
Practice of vermicomposting, vermiculturing and poultry farming.
Aspire to work in preparing bio compost, vermicomposting and get employment accordingly.
Rearing and production of birds and get employment accordingly.</td><td></td><td></td></tr>
<tr><td></td><td>Zoo - 602: Chick Embryology</td><td></td><td></td></tr>
<tr><td>1</td><td>Study of Hens egg With the help of Chart/ Model/ Permanent slides (D)</td><td></td><td></td></tr>
<tr><td>2</td><td>Study of Cleavage, Blastula and Gastrula: With the help of Chart/ Model/ Permanent slides (D)</td><td></td><td></td></tr>
<tr><td>3</td><td>Study of Whole mounts of 18, 24, 33, 48, 72 and 96 hours of chick embryos with the help of Permanent slides / Chart / Model (D)</td><td></td><td></td></tr>
<tr><td>4</td><td>Temporary mounting of chick embryo (E)</td><td></td><td></td></tr>
<tr><td></td><td>Zoo-603 Applied Zoology</td><td></td><td></td></tr>
<tr><td>5</td><td>Study of External morphology of Earthworm</td><td></td><td></td></tr>
<tr><td>6</td><td>Study of species of Earthworm</td><td></td><td></td></tr>
<tr><td>7</td><td>Establishment of Vermicompost unit</td><td></td><td></td></tr>
<tr><td>8</td><td>Establishment of Vermiwash unit</td><td></td><td></td></tr>
<tr><td>9</td><td>Study of External morphology of Indian fowl and sexual dimorphism</td><td></td><td></td></tr>
<tr><td>10</td><td>Study of Poultry breeds</td><td></td><td></td></tr>
<tr><td>11</td><td>Study of Poultry equipment’s</td><td></td><td></td></tr>
<tr><td>12</td><td>Compulsory visits to a Vermiculture unit / Poultry farm</td><td></td><td></td></tr>
<tr><td>Suggested Readings</td><td>1) Shukla and Upadhyay, Economic Zoology, Rastogi publication.
2) Singh, R. A., Poultry production, Kalyani publishers, New Delhi.
3) Srivastava P. D. and N. C. Pant, Economic Zoology Commercial Publication Bureau, New Delhi.</td><td></td><td></td></tr>
</table>

DSC Core Practical			
Zoo - 609: Corresponding practical to DSC Zoo 604			
	Course objectives: To prepare the whole mounts microscopic slides and staining reactions.	**Teaching Hours :45**	**Credits : 03**
	Learning outcomes: Cell tissue structure, histology of tissues and details of morphology of animals. Job opportunities in Health institutes, Hospitals and Pathological labs.		
Practical	**ZOO 604 – Microtechnique**		
1	Preparation of permanent whole mounts of different kinds-5 slides.		
2	Preparation of permanent slides of histological sections from different mammalian tissues-5 slides.		
3	Study of Rotary and Rocking microtome.		
4	Vital staining of mitochondria by Janus green B stain.		
5	Calibration of micrometer scale of cell diameter from the given permanent slide.		
6	Sketching by camera Lucida.		
7	Submission of permanent slide (5 Whole mounts and 5 histological sections).		
Suggested **Readings**	1) Gray P., Hand book of basic Microtechnique. 2) Indurkar A.K., Practical course in Cytology. 3) Me Mann J.F.A and R.W Mowry, Staining Methods (Histology and Histochemical) 4) Pathak, Microtechnique (Theory and Practical) 5) Patki, Bhalchanda and Jeevaji, Introduction to Microtechnique, S. Chand Publication. 6) Pearse A.G.E., Histochemistry – Vol. I and II 7) Tembhare D.B., Techniques in Life Sciences 8) Weesner F.M., General Zoological Microtechnique.		

KBC North Maharashtra University, Jalgaon

TYBSc Zoology

Equivalence for old courses

Semester V

Course code (Old syllabus 2017)	Course code (New syllabus 2020)
Zoo 351	Zoo 501
Zoo 352	Zoo 502
Zoo 353	Zoo 503
Zoo 354	Zoo 504
Zoo 355	Zoo 505
Zoo 356	Zoo 506
Zoo 357	Zoo 507
Zoo 358	Zoo 508
Zoo 359	Zoo 509

Semester VI

Course code (Old syllabus 2017)	Course code (New syllabus 2020)
Zoo 361	Zoo 601
Zoo 362	Zoo 602
Zoo 363	Zoo 603
Zoo 364	Zoo 604
Zoo 365	Zoo 605
Zoo 366	Zoo 606
Zoo 367	Zoo 607
Zoo 368	Zoo 608
Zoo 369	Zoo 609

2022

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

KBCNMU

Syllabus

Class : F. Y. B. Sc.

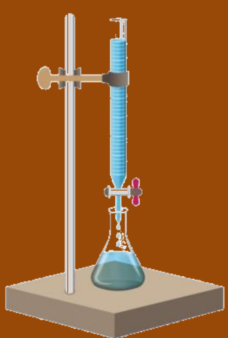
Subject : Chemistry

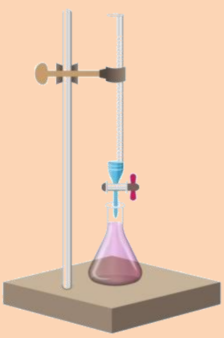
Choice Based Credit System (CBCS)

(With effect from June 2022)

Prepared By

Board of Studies in Chemistry,
Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon





asd;Dr.

Revised Syllabus of F.Y.B.Sc. Chemistry

(With effect from June 2022)

Choice Based Credit System (CBCS) Pattern

In the Faculty meeting chaired by Hon. Dean of Science faculty, the revised syllabus for F.Y.B.Sc. (Chemistry) is accepted and finalized as per guidelines of Academic Council and with reference to the U.G.C. model curriculum. The course structure for F.Y.B.Sc. (Chemistry) is as given below.

Course (Paper code)	Paper	Semester	No. of lectures	Credits	Internal Marks	External Marks
CH-101	Physical & Inorganic Chemistry (Core Course)	I	30	02	40	60
CH-102	Organic & Inorganic Chemistry (Core Course)	I	30	02	40	60
CH-103	Chemistry Practical	I	60	02	40	60
CH-201	Physical & Inorganic Chemistry (Core Course)	II	30	02	40	60
CH-202	Organic & Inorganic Chemistry (Core Course)	II	30	02	40	60
CH-203	Chemistry Practical	II	60	02	40	60

Note:

1. Each lecture is of one hour duration.
2. Each theory paper has two lectures per week.
3. Each practical course has four lectures per week.

Chairman B.O.S. **Dean Science Faculty**

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon
Revised Syllabus of F.Y.B.Sc. Chemistry (w.e.f. June 2022)
Choice Based Credit System (CBCS) Pattern

Semester I
Paper- CH: 101 Physical and Inorganic Chemistry

Chapter 1: Atomic Structure (Part-I) **(L: 06, M: 12)**

a) Atomic Models: Thomson Model, Rutherford's Nuclear Model

b) Emission and Absorption Spectra: Line spectra and band spectra, line spectra of Hydrogen atom,

c) Bohr Model for Hydrogen atom, explanation of line spectra of hydrogen atom, Limitations & Reasons for failure of Bohr Model

d) Quantum Mechanical Model of atom: Dual behaviour of matter, Davisson–Germer experiment, Heisenberg's Uncertainty Principle, Orbitals and quantum numbers and their importance

Ref: 1, 2 (relevant pages)

Learning Outcome

Students will develop knowledge about:

i) Various theories and principles applied to reveal atomic structure.

ii) Nature of matter and experiments which confirmed it.

iii) Significance of quantum numbers.

Chapter 2: Mathematical Preparation in Chemistry **(L: 06, M: 12)**

a) Logarithm: Rules of Logarithm (without proof), Characteristic and Mantissa of Logarithm, Negative Logarithm, numerical based on applications of Logarithm in calculating pH with change of base of logarithm, antilogarithm.

b) Graphical representation of equations: Rules for drawing graph co-ordinates etc., Equation of straight line, slope and intercept, plotting the graph from the given experimental data and numericals.

c) Derivative: Significance, Rules of differentiation (without proof), Algebraic, Logarithmic and exponential functions and numerical.

d) Integration: Significance, rules of integration (without proof), Integration with limit, Algebraic, Logarithmic and exponential functions and numerical.
e) Numericals of each method related to Chemistry.

Ref: 3 (relevant pages)

Learning Outcome

Students will be able to:

i) Apply the rules of logarithm for solving numericals in chemistry

ii) Draw, calculate the slope of various graphs for chemistry experiments

iii) Calculate derivative and integration of some simple functions especially related to chemical problems

Chapter 3: The Gaseous State (L: 08, M: 16)

a) Molar gas constant R, its values in different units and its significance, the kinetic theory of ideal gases. Assumptions of kinetic theory of gases. Kinetic gas equation and its Significance (Derivation not expected), Deductions of Avogadro's principle, Graham's law, kinetic energy of translation.
b) Deviation of real gases from ideal behaviour. Reasons for deviation, compressibility factor, Van der Waal's equation, its applications. Andrew's isotherms of CO_2, relation between critical constants and Van der Waal's constants, liquification of Gases, Joule Thomson effect, related numerical

Ref. 1, 2 (Relevant pages)

Learning Outcome

Students will develop knowledge about,

i) The basics of kinetics theory and concepts therein.

ii) Factors causing the deviations from ideal behaviour of gases

iii) Compressibility, liquification and related critical constants of a system

Chapter: 4 Atomic structure (Part-II) (L: 05, M: 10)

a) Long form of periodic table, Periodic law, modern periodic law, electronic configuration, Aufbau principle, Hund's rule, Pauli's Exclusion principle, Principle of stability.
b) Classification of elements based on electronic configuration and energy levels
c) Shapes of s, p and d-orbitals.

Ref: 9, 10 (Relevant pages)

Learning outcomes

Students will be able:

i) To know about the structure of atom.

ii) To acquire the knowledge about the arrangement of elements in a periodic table

iii) To familiar with the classification of elements in periodic table.

iv) To know about the principle involved in arrangements of electrons in atoms.

v) To understand the shapes of different types of orbitals present in atoms.

Chapter: 5 Periodic properties **(L:05, M:10)**

Periodicity in the following properties right through the periodic table:

a) Atomic and ionic size: Definition and explanation of atomic radius, ionic radius, covalent radius and Van der Waals radius, Variation of atomic size along a period and a group.

b) Ionisation energy: Definition and explanation, factors affecting ionisation energy, Variation of ionisation energy along a period and a group. Applications of I. E. to chemical behavior of an element.

c) Electron affinity: Definition and explanation, factors affecting electron affinity, Variation of electron affinity along a period and a group.

d) Electronegativity: Definition and explanation, factors affecting electronegativity, Variation of electronegativity along a period and a group, Pauling's electronegativity scale, Mullikan's approach of electro negativity, electro negativity and percent ionic character.

e) Metallic character: Variation of metallic character along a period and a group.

Ref: 9, 11 (Relevant pages)

Learning outcomes

Students will be able:

i) To understand the periodic law and systematic study of elements.

ii) To find the factors affecting periodic properties.

iii) To understand periodic properties and their general trends in groups and periods. (Atomic size, Ionization energy, Electron affinity, Electro negativity, Metallic properties).

iv) To correlate these periodic properties with the chemical behavior of elements.

v) To understand the different methods used to determine electronegativity.

References:

1. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M.S. Pathaniya
2. Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli, Arun Bahl (S. Chand & Co Ltd.)
3. Mathematical Preparation for Physical Chemistry, Farrington Daniels, Mc Graw- Hill Publication.
4. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007)
5. Atkins' Physical Chemistry, 10th edition (2014), Oxford University Press
6. Thomas Engel, Philip Reid; Physical Chemistry, Pearson Education (2006)
7. J. N. Gurtu, A. Gurtu, Advanced Physical Chemistry, Pragati Edition
8. Principles of Physical Chemistry 4th edition Samuel Maron, Carl F. Prutton, Oxford & IBH Publishing.
9. Concise inorganic chemistry – J. D. Lee (5th edition).
10. Principles of Inorganic Chemistry – Puri, Sharma, Kalia.
11. Advanced Inorganic Chemistry (Vol I) (Satyaprakash, G. D. Tuli, S. K. Basu, R. D. Madan) (S. Chand and Co Ltd.) Page Nos. 364-376.
12. Inorganic Qualitative Analysis—A I Vogel
13. Practical chemistry (for B.Sc. I, II and III year students) – O P Pandey, D. N. Bajpai and S. Giri (S Chand and company Ltd)
14. Theoretical Principles of Inorganic Chemistry – G S Manku.
15. Analytical Chemistry – G. D. Christian (6th Edition).
16. A new guide to Modern Valency Theory –G. I. Brown.

Paper- CH: 102 Organic and Inorganic Chemistry

Chapter 1: Basic principles of organic chemistry (L:12, M:24)

a) Introduction, general properties of organic compounds, applications of organic compounds in everyday life.
b) Covalent bond, double and triple bonds, structural formulae of organic compounds
c) Structure of benzene, stability of benzene (heat of hydrogenation), Huckel's rule of aromaticity, derivatives of benzene and their nomenclature (mono & disubstituted benzene only)
d) Structural effects: Inductive effect, resonance, hyperconjugation, steric effect, electromeric effect and their effect on the strength of acids and bases.
e) Fundamentals of organic reaction mechanism: Fission of covalent bond: homolytic and heterolytic fission, reactive intermediates: carbocations, carbanions and carbon free radicals, types of reagents: electrophiles and nucleophiles, types of organic reactions: addition, elimination, substitution and rearrangement reactions.
f) Isomerism, types of isomerism, structural isomerism
g) Purification of organic compounds: recrystallization (by water and alcohol), distillation and sublimation
h) Solvents, properties of solvents, types of solvents i) protic and aprotic ii) polar and nonpolar

Ref. 1,2,3,4,5 (relevant pages)

Learning outcomes

Students will be able to understand:

1. The properties of organic compounds.
2. Different types of bonds and structures of organic compounds.
3. Different types of structural effects and their effect on the strength of acids and bases.
4. Fundamentals of organic reaction mechanism, structural isomerism, methods of purification of organic compounds.
5. Different types of solvents used in organic reactions.

Chapter 2: Hydrocarbons (L:08, M:16)

a) Alkanes: Introduction to alkanes and cycloalkanes, SP^3 hybridization in ethane molecule, nomenclature (common and IUPAC system), isomerism in alkanes

b) Preparation of alkanes: by Wurtz reaction, by hydrogenation of alkenes. Reactions of alkanes: halogenation, nitration, combustion.

c) Alkenes: Introduction, SP^2 hybridization in ethylene molecule, nomenclature (common and IUPAC system), geometrical isomerism in alkenes

d) Preparation of alkenes: by dehydration of alcohols, dehydrohalogenation of alkyl halides, dehalogenation of vicinal dihalides and partial reduction of alkynes by Lindlar catalyst. Reactions of alkenes: Addition of halogen, hydrogen halide, Sulphuric acid and hydration.

e) Alkynes: Introduction, SP hybridization in acetylene molecule, nomenclature (common and IUPAC system), acidity of acetylene and terminal alkynes.

f) Preparation of alkynes: by Double Dehydrohalogenation of vicinal and geminal dihalides, by alkylation of acetylene.

g) Reactions: Addition of halogens, hydrogen halides, hydration, hydrogenation, ozonolysis.

Ref. 1,2,3,4 (relevant pages)

Learning outcomes

Students will be able to understand:

1. SP^3, SP^2 and SP hybridizations.
2. Nomenclature of alkanes, alkenes and alkynes.
3. Different methods of preparation of alkanes, alkenes and alkynes.
4. Different reactions of alkanes, alkenes and alkynes.

Chapter: 3 Hybridization and shapes of covalent molecules (L: 10, M: 20)

a) Hybridization: Definition, need of hybridization, steps involved in hybridization, characteristics of hybridization. Types of hybridizations involving s, p and d orbitals: SP^3d, SP^3d^2, SP^3d^3 and dSP^2 hybridizations.

b) Applications of hybridization concept: geometries of molecules like PCl_5, SF_6, IF_7 and $[Ni(CN)_4]^{2-}$ ions.

c) Valence Shell Electron Pair Repulsion (VSEPR) Theory: assumptions, need of theory, Applications of the theory to explain geometry of irregular molecules like $SnCl_2$, NH_3, H_2O, ClF_3, SF_4, BrF_5, ICl_2^-, ICl_4^-. Limitations of VSEPR theory.

Ref: 8, 9, 10 (relevant pages)

Learning outcomes

Students will be able to understand:

1. Concept of hybridization, steps involved in hybridization, characteristics and types of hybridization.
2. Applications of hybridization concept to understand geometries of different molecules.
3. Valence Shell Electron Pair Repulsion (VSEPR) Theory and its applications to explain geometry of irregular molecules.
4. Limitations of VSEPR theory.

Reference Books

1) Organic chemistry - Francis A Carey (6th Edition)
2) Organic chemistry - Morrison and Boyd (6th Edition)
3) Organic chemistry - Stanley H pine (5th Edition)
4) A Text book of Organic chemistry- Arun Bahl and B S Bahl, S Chand publication.
5) Guide book to mechanism in organic chemistry -Peter Sykes (6th Edition)
6) Undergraduate organic chemistry volume I – Jagdamba Singh and LDS Yadav
7) Organic Chemistry (Volume 1) – I L Finar
8) Concise inorganic chemistry – J. D. Lee (5th edition).
9) Principles of Inorganic Chemistry – Puri, Sharma, Kalia.
10) Advanced Inorganic Chemistry (Vol I) (Satyaprakash, G. D. Tuli, S. K. Basu, R. D. Madan) (S. Chand and Co Ltd.) Page Nos. 364-376.
11) Inorganic Qualitative Analysis—A I Vogel
12) Practical chemistry (for B.Sc. I, II and III year students) – O P Pandey, D. N. Bajpai and S. Giri (S Chand and company Ltd)
13) Theoretical Principles of Inorganic Chemistry – G S Manku.
14) Analytical Chemistry – G. D. Christian (6th Edition).
15) A new guide to Modern Valency Theory –G. I. Brown.

Semester II

Paper- CH: 201 Physical and Inorganic Chemistry

Chapter 1: Liquid State **(L: 06, M: 12)**

a) Introduction, Intermolecular forces in liquid state and their types.
b) Surface tension of liquid, units of surface tension, factors affecting surface tension, Unit of Surface tension, determination of surface tension of liquids by single capillary rise method and Drop formation method.
c) Viscosity of liquid, units of viscosity, measurement of viscosity of liquid by Ostwald's method, related numerical.

Ref. 2, 3 (Relevant pages)

Learning outcomes

Students will be able:

i) To gain knowledge about origin of surface tension.

ii) To determine surface tension.

iii) To get idea regarding viscosity.

iv) To determine viscosity.

Chapter 2: Chemical Equilibrium **(L: 06, M: 12)**

a) Introduction, reversible reaction, characteristics of chemical equilibrium, law of mass action, equilibrium constant: equilibrium law, equilibrium constant in terms of partial pressures, calculations involving Kp, liquid systems, heterogeneous equilibria.
b) Le Chatelier's principle, effect of change in concentration, pressure, temperature, conditions for maximum yield in industrial processes, synthesis of ammonia (Haber process), related numerical.

Ref. 2 (Relevant pages)

Learning outcomes

i) Students will be able to understand equilibrium.

ii) Students will be able to understand different factors affecting equilibrium.

iii) Students gain knowledge about Le Chatelier's principle.

Chapter 3: Second and Third Law of Thermodynamics **(L: 08, M: 16)**

a) Introduction, Limitations of first law of thermodynamics, spontaneous and non-spontaneous process with examples, Statements of second law of thermodynamics,

b) Entropy, Units of entropy, Physical Significance of entropy, entropy changes in isolated systems, entropy changes for systems only, entropy of mixing of gases, entropy changes in ideal gases and physical transformation.

c) Statement of third law of thermodynamics, list its applications, Numerical.

Ref.: 1 and 2

Learning outcomes

h) Students will be able to apply thermodynamic principles to physical and chemical process.

ii) Students will be able to understand spontaneity and non-spontaneity.

iii) Calculations and significance of entropy.

iv) Third law of thermodynamics and its applications.

Chapter: 4 Principles involved in Inorganic Qualitative Analysis (L: 06, M: 12)

a) Difference between crystalline and amorphous substance, meaning of dry and wet tests, precipitate, Group reagents.

b) Ionic product, Solubility product, Common ion effect.

c) Use of Cobalt nitrate, Sodium carbonate, Hydrogen sulphide and Ammonium chloride in qualitative analysis.

Ref: 10, 11 (Relevant pages)

Learning outcomes

Students will be able:

i) To familiar with the Inorganic Qualitative Analysis.

ii) To understand the basic principles behind the group precipitation of basic radicals like solubility product and common ion effect.

iii) To understand the role of some compounds in qualitative analysis viz. Use of Cobalt nitrate, Sodium carbonate, Hydrogen sulphide and Ammonium chloride in detection of basic radicals.

iv) To focus on systematic separation and detection of ions in aqueous solutions.

Chapter: 5 Ionic equilibria (L: 04, M: 08)

a) Strong and weak acids and bases, degree of dissociation, dissociation constants of acids and bases.

b) p^H and p^{OH}, numerical based on p^H and p^{OH} only, ionic product of water, Henderson-Hassalbalch’s equation of indicator.

c) Buffer solutions: Definition, types, buffer action, buffer capacity, applications of buffer solutions.

Ref: 8, 11, 12, 13 (Relevant pages)

Learning outcomes

Students will be able:

i) To understand the criteria of classification of acids and bases.

ii) To identify and write different types of equilibria of an electrolyte in solutions.

iii) To calculate the p^{H} and p^{OH} of different electrolytes.

iv) To know about the buffer solution and its applications.

References

1. Principles of Physical Chemistry, S. H. Maron and C. F. Prutton (4th edition).
2. Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli, Arun Bahl (S. Chand and Co Ltd.) (25th edition).
3. Elements of Physical Chemistry, S. Glasstone and D. Lewis (The Macmillan Press Ltd. (2nd edition).
4. Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli, Arun Bahl (S. Chand and Co Ltd.)
5. Physical Chemistry Barrow, G.M. Tata McGraw-Hill (2007)
6. Atkins' Physical Chemistry, 10th edition (2014), Oxford University Press
7. Concise inorganic chemistry – J. D. Lee (5th edition).
8. Principles of Inorganic Chemistry – Puri, Sharma, Kalia.
9. Advanced Inorganic Chemistry (Vol I) (Satyaprakash, G. D. Tuli, S. K. Basu, R. D. Madan) (S. Chand and Co Ltd.) Page Nos. 364-376.
10. Inorganic Qualitative Analysis—A I Vogel
11. Practical chemistry (for B.Sc. I, II and III year students) – O P Pandey, D. N. Bajpai and S. Giri (S Chand and company Ltd)
12. Theoretical Principles of Inorganic Chemistry – G S Manku.
13. Analytical Chemistry – G. D. Christian (6th Edition).
14. A new guide to Modern Valency Theory –G. I. Brown.

Paper- CH: 202 Organic and inorganic chemistry

Chapter 1: Haloalkanes and haloarenes (L:06, M:12)

a) Haloalkanes: Introduction, classification and nomenclature of haloalkanes (common and IUPAC system)

b) Mono halogen derivatives: Classification, methods of preparation: from alcohols (using HX, PX_3, PX_5, $SOCl_2$). Reactions: with aqueous alkali, sodium alkoxide, alc. KCN, silver salt of acid, alc. ammonia, NaSH/ KSH, dehydrohalogenation, formation of Grignard's reagent.

c) Di halogen derivatives: preparation of vicinal and geminal dihalides, reactions: hydrolysis with aq. NaOH.

d) Haloarenes: Introduction, nomenclature, reactions of haloarenes: nucleophilic substitution reactions with $NaNH_2$/ KNH_2, NaOH, NH_3, CuCN, Ullman reaction.

Ref. 1,2,3,4 (relevant pages)

Learning outcomes

Students will be able to understand:

1. Haloalkanes, their classification and nomenclature.
2. Different methods of preparation of mono halogen derivatives.
3. Different reactions of mono halogen derivatives.
4. Different methods of preparation and reactions of di halogen derivatives.
5. Different methods of preparation and reactions of haloarenes.

Chapter 2: Alcohols, phenols and ethers (L:06, M:12)

a) Alcohols: Introduction, classification, nomenclature (common and IUPAC system), methods of preparation of monohydric alcohols: from Grignard's reagent (using aldehydes and Ketones), by reduction of aldehydes and ketones, by hydroboration, by oxymercuration-demercuration. Preparation of dihydric alcohols by hydroxylation of alkenes.

b) Physical properties of alcohols. Reactions of alcohols: reaction with active metals, dehydration, oxidation and ester formation.

c) Phenols: Introduction, nomenclature, acidity of phenols, Preparation of phenol from benzene sulphonic acid, benzene diazonium chloride and from chlorobenzene.

d) Reactions of phenols: ester formation (acylation), formation of aryl ethers, Kolbe reaction, catalytic hydrogenation.

e) Ethers: Introduction, classification, nomenclature (common and IUPAC system), methods of preparation: by Williamson's synthesis, by dehydration of alcohols and from diazomethane. Reactions of ethers: reaction with hot and cold HI, hydrolysis with dil. H_2SO_4. Crown ethers (Introduction only)

Ref. 1,2,3,4 (relevant pages)

Learning outcomes

Students will be able to understand:

1. Alcohols, their classification and nomenclature.
2. Different methods of preparation and reactions of alcohols.
3. Different methods of preparation and reactions of phenols.
5. Different methods of preparation and reactions of ethers.

Chapter 3: Aldehydes and ketones **(L:08, M:16)**

a) Introduction, structure of carbonyl group, nomenclature of aldehydes and ketones (common and IUPAC system)

b) Aldehydes: Preparation of aldehydes: by reduction of acid chlorides, from Grignard's reagent and HCN, from terminal geminal dihalides and from calcium salt of acids. Preparation of benzaldehyde: by Gattermann Kotch reaction, by oxidation of toluene, by side chain chlorination of toluene.

c) Ketones: Preparation from Grignard's reagent and R-CN, from nonterminal geminal dihalides, from calcium salt of acids. Preparation of acetophenone: by oxidation of ethyl benzene, by F C acylation.

d) Reactions of aldehydes & Ketones: Reducing properties of aldehydes: reaction with Tollen's reagent and Fehling's solution, Clemmenson reduction, Wolff Kishner reduction, Aldol condensation, Cannizzaro reaction, addition of HCN, $NaHSO_3$, addition of derivatives of ammonia (hydroxyl amine, phenyl hydrazine, 2,4 DNP, semicarbazide), hydration, addition of alcohols, benzoin condensation of benzaldehyde.

Ref. 1,2,3,4 (relevant pages)

Learning outcomes

Students will be able to understand:

1. Carbonyl compounds like aldehydes & Ketones, their classification and

nomenclature.

2. Different methods of preparation and reactions of aliphatic and aromatic aldehydes.
3. Different methods of preparation and reactions of aliphatic and aromatic ketones.

Chapter: 4 Chemical bonding and structure (L: 04, M: 08)

a) Attainment of stable configuration, Types of bonds-
   1. Ionic bond-NaCl, $CaCl_2$
   2. Covalent bond (Lewis concept)- H_2, Cl_2, HF, NH_3, H_2O, O_2 and N_2, molecules.
   3. Coordinate bond- NH_4^+, H_3O^+
   4. Metallic bond.

b) Types of overlaps: S-S, S-P and P-P overlaps with examples of H_2, HF, F_2, O_2, and N_2 molecules.

c) Theories of bonding: Valence Bond Theory, Heitler-London theory and Pauling-Slater theory.

Ref: 8, 10, 15 (Relevant pages)

Learning outcomes

Students will be able:

i) To understand different types of bonds.

ii)To understand different types of overlaps

iii)To understand different theories of chemical bonding

Chapter: 5 Metals and Metallurgy (L: 06, M: 12)

Occurrence of metals, various steps involved in metallurgical processes, concentration of ore, Hand picking, gravity separation, Magnetic separation, froth floatation, calcinations, roasting, reduction to free metals, Flux, Types of fluxes, Slag, electrometallurgy, hydrometallurgy, refining of metals.

Ref: 9, 13 (Relevant pages)

Learning outcomes

Students will be able:

i)To understand the importance of metallurgy in industries.

ii)To know the various steps involved in metallurgical processes.

iii)To understand the basic principles involved in separation, extraction and refining techniques of metals.

Reference Books

1) Organic chemistry - Francis A Carey (6th Edition)
2) Organic chemistry - Morrison and Boyd (6th Edition)
3) Organic chemistry - Stanley H pine (5th Edition)
4) A Text book of Organic chemistry- Arun Bahl and B S Bahl, S Chand publication.
5) Guide book to mechanism in organic chemistry -Peter Sykes (6th Edition)
6) Undergraduate organic chemistry volume I – Jagdamba Singh and LDS Yadav
7) Organic Chemistry (Volume 1) – I L Finar
8) Concise inorganic chemistry – J. D. Lee (5th edition).
9) Principles of Inorganic Chemistry – Puri, Sharma, Kalia.
10) Advanced Inorganic Chemistry (Vol I) (Satyaprakash, G. D. Tuli, S. K. Basu, R. D. Madan) (S. Chand and Co Ltd.) Page Nos. 364-376.
11) Inorganic Qualitative Analysis—A I Vogel
12) Practical chemistry (for B.Sc. I, II and III year students) – O P Pandey, D. N. Bajpai and S. Giri (S Chand and company Ltd)
13) Theoretical Principles of Inorganic Chemistry – G S Manku.
14) Analytical Chemistry – G. D. Christian (6th Edition).
15) A new guide to Modern Valency Theory –G. I. Brown.

CH:103 Chemistry Practical (Semester I)

A) Physical Chemistry Experiments (Any 2)

1. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl)
2. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
3. Determination of dissociation constant of weak monobasic acid (CH_3COOH) by conductance measurement.
4. Determination of relative viscosity of liquid A and B by viscometer.
5. Determination of percentage composition (v/v) of given mixture of ethyl alcohol and water by viscometer.

B) Analytical Chemistry Experiments (Any 3)

1. Preparation of std. 0.1N oxalic acid solution and standardization of NaOH solution.
2. Preparation of std. 0.1N $K_2Cr_2O_7$ solution and standardization of ferrous ammonium sulphate solution.
3. Preparation of std. 0.1N NaCl solution and standardization of $AgNO_3$ solution.
4. Preparation of std. 0.1N $ZnSO_4$ solution and standardization of EDTA solution.
5. Determination of loss per gram and percentage purity of Zinc Carbonate gravimetrically.

(Instruction: Prepare standard solutions preferably by using 50 ml volumetric flask)

C) Organic Qualitative Analysis (Any 5 compounds)

1) Type determination
2) Preliminary tests
3) Physical constant
4) Functional group tests

(Structural formula not expected)

CH: 203 Chemistry Practicals (Semester II)

A) Physical Chemistry Experiments (Any 3)

1. Determination of surface tension of given liquid by drop number method using stalagnometer.
2. Determination of surface tension of given liquid by drop weight method using stalagnometer.
3. Determination of heat of solution of KNO_3 / NH_4Cl by water equivalent method.
4. Determination of normality and strength in g/l of acid (HCl or CH_3COOH) conductometrically.
5. Determination of Solubility of Sparingly soluble salt by conductance measurement.
6. To standardize commercial sample of HCl using Borax and to write material safety data of the chemicals involved.

B) Analytical Chemistry Experiments (Any 2)

1. Preparation of standard 0.1N Na_2CO_3 solution and standardization of HCl solution.
2. Preparation of 0.1 N oxalic acid solution and standardization of $KMnO_4$ solution.
3. Preparation of 0.1 N $Na_2S_2O_3$ solution and estimation of Cu (II) ions iodometrically.
4. Determination of total hardness of water.

(Instruction: Prepare standard solutions preferably by using 50 ml volumetric flask)

C) Inorganic Qualitative Analysis (Any 5 compounds)

Analysis of inorganic compound containing one cation and anion

External Examination Pattern

Chemistry Practical Semester I/ II (CH-103/203)

Time: 3 Hrs. Marks 60

Q. 1. Physical Chemistry / Analytical Chemistry experiment OR Inorganic/ Organic Qualitative analysis	40 Marks
Q. 2. Oral	10 Marks
Q. 3. Journal	10 Marks

Total: 60 Marks

Internal Examination Pattern

Chemistry Practical Semester I/ II (CH-103/203)

Time: 3 Hrs. Marks 40

Q. 1. Physical Chemistry/ Analytical Chemistry experiment OR Inorganic/ Organic Qualitative analysis	30 Marks
Q. 2. Oral	05 Marks
Q. 3. Attendance and Behavior	05 Marks

Total: 40 Marks

Note: Distribution of Experiments – One fourth of the total students in a batch will be given physical chemistry experiment, one fourth will be given an analytical chemistry experiment and one half of the students will be given an Inorganic / Organic qualitative analysis.

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KavayitriBahinabaiChaudhari
North Maharashtra University, Jalgaon
Syllabus
S.Y.B.Sc.
Subject: Chemistry
Choice Based Credit System

'A' Grade
NAAC Re-accredited
(3rd Cycle)

With Effect from June 2019

Prepared By
Chairman, Members of Board of Studies
And The Experienced Teachers in Chemistry,
North Maharashtra University, Jalgaon

KavayitriBahinabaiChaudhari
North Maharashtra University, Jalgaon
Revised Syllabus of S.Y.B.Sc. Chemistry (w.e.f. June 2019)
Choice Based Credit System (CBCS) Pattern

In the Faculty meeting chaired by Hon. Dean of Science faculty, the revised syllabus for S.Y.B.Sc. (Chemistry) is accepted and finalized as per guidelines of Academic Council and with reference to the U.G.C. model curriculum.
The course structure for S.Y.B.Sc. (Chemistry) is given below.

Course	Semester-III	Lectures	Marks		Credits
			Internal	External	
CH -301	**Physical And Inorganic Chemistry (Core Course)**	**30**	**40**	**60**	**02**
CH -302	**Organic and Inorganic Chemistry (Core Course)**	**30**	**40**	**60**	**02**
CH -303	**Practical Chemistry**	**60**	**40**	**60**	**02**
CH- 304 (SEC-1)	**Basic Analytical Chemistry (Skill Enhancement Course)**	**30**	**40**	**60**	**02**
	Semester- IV				
CH -401	**Physical And Inorganic Chemistry (Core Course)**	**30**	**40**	**60**	**02**
CH -402	**Organic and Inorganic Chemistry (Core Course)**	**30**	**40**	**60**	**02**
CH -403	**Practical Chemistry**	**60**	**40**	**60**	**02**
CH -404 (SEC-1I)	**Advanced Analytical Chemistry (Skill Enhancement Course)**	**30**	**40**	**60**	**02**

Note:
1. Each lecture is of one hour duration.
2. Each theory paper has two lectures per week.
3. Each practical course has four lectures per week.

Chairman B.O.S.Dean Science Faculty

KavayitriBahinabaiChaudhari
North Maharashtra University, Jalgaon
Revised Syllabus of Chemistry (w.e.f. June 2019)
Choice Based Credit System (CBCS) Pattern

Semester I

Core Course: CH - 301

Physical and Inorganic Chemistry

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1. Solutions (L-10, M-20/30)

Introduction, Solubility,Factors affecting solubility, Types of solutions,Different way of expressing the concentration of solution , Ideal and non-ideal solutions, Raoults law and its limitation, The vapour pressure of actual liquid pairs the vapour pressure of ideal solution. Classification of binary solution of completely miscible liquids (Type-I, Type-II and Type-III) on the basis of Raoults law), Boiling point diagrams of miscible binary mixtures, Distillation of binary miscible solutions, Azeotropes, the fractionating column, Solubility of partially miscible liquid pairs, Phase diagram Phenol-water system, Tri ethyl amine-water and Nicotine-water system

Ref.1: Pages 261-264,270-286,288-291
Ref. 2, 3, 4 Relevant Pages

2.Colligative Properties (L-10, M-20/30)

Introduction, lowering of vapour pressure of solvent, Calculation of molecular weight of solute from Lowering of vapour pressure of solvent. Boiling point elevation of solution, Calculation of molecular weight of solute from boiling point elevation of solution, Freezing point depression of solution, Calculation of molecular weight of solute from depression in Freezing point, Osmosis and osmotic pressure, Relation of osmotic pressure to vapour pressure, Van't –Hoff equation for osmotic pressure, Landberger's method for the determination of elevation of boiling point, Beckman's method for determination of depression in freezing point ,Berkley and Hearty's method, Solution of electrolyte, Colligative properties of electrolyte (Qualitative concept only), related numerical.

Ref.-1:- Pages 312-324, 325-330
Ref. 2, 3, 4 Relevant Pages

3. The d-block elements (L-10, M-20/30)

Elements of first, second and third transition series, General characteristics of d-block elements

a) Metallic character b) Molar volume and densities c) Atomic radii d) Ionic Radii

e) Melting and boiling points f) Ionization Energies g) Reactivity h) Oxidation states

i) Standard electrode potential j) Reducing Properties k) Colour l) Magnetic properties

m) Catalytic Properties n) Tendency to form complexes

Ref. 5-653-671
Ref. 6 -615 -624
Ref. 7-1128-1143

Reference books

1. Principles of Physical Chemistry by S. H. Maron and C. F. Prutton (4th edition) 2015

2. Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, ArunBahl, S. Chand (25th edn) Dec. 2010

3. Elements of Physical Chemistry S. Glasstone and D. Lewis (Macmillan Press Ltd.) (2nd edn) 2014

4. Physical Chemistry by Robert A. Alberty (John Willey and Sons) (7th edition) 1992

5. Concise Inorganic Chemistry by J.D.Lee.5th Edition. 2014

6. Principles of Inorganic Chemistry By Sharma, PuriKalia 30th edition Milestone Delhi. 2017

7. Advanced Inorganic Chemistry Volume - I, by Gurdeep Raj 23rd edition, Goel Publishing House, Meerut. 2016

Semester I

Core Course: CH - 302

Organic and Inorganic Chemistry

1: Stereoisomerism(L-12, M-24 / 36)

a) Isomerism, classification of isomerism, stereoisomerism, types of stereoisomerism.

b) **Projection formulae**

Fischer projection formula, Newman projection formula, Saw horse formula.

c) **Optical isomerism**

Optical activity, enantiomerism, chiral centre and chirality, elements of symmetry, dextrorotatory, laevorotatory, Configuration: R and S nomenclature system.

d) **Geometrical isomerism**

Geometrical isomers, condition for geometrical isomerism, nomenclature systems: Cis and Trans, E and Z, Syn and Anti.

e) **Conformational isomerism**

Conformational isomers, conformational isomerism in ethane and n- butane with energy profile diagrams.

f) Stereochemistry of Cyclohexane

Conformations of cyclohexane: chair and boat forms, axial and equatorial bonds in cyclohexane, factors affecting stability of conformations. Mono substituted cyclohexane.

(Use of models / ICT is expected for teaching this chapter)

Ref 2, 3, 4 (Relevant pages)

2: Heterocyclic and polycyclic aromatic compounds (L-08, M-16/24)

a) Five membered ring with one heteroatom

Introduction, preparation of furan, pyrrole and thiophene. Reactions: nitration, sulphonation, F C acylation, Reimer Tiemann reaction, catalytic hydrogenation.

b) Six membered ring with one heteroatom

Preparation of pyridine: from acrolein and from acetylene. Reactions: nitration, sulphonation, bromination, catalytic hydrogenation.

b) Polycyclic aromatic compounds

Introduction, structure of naphthalene, Haworth synthesis. Reactions: oxidation, reduction, nitration, halogenations, sulphonation, F C acylation.

Ref. 1, 2, 5, 6, 8 (Relevant pages)

3: Solvents, solutions Acids and Bases (L-10, M-20 / 30)

a) Donar and acceptor properties.

b) Molten salts, solvents for electrochemical reactions, purity of solvents.

c) Definition and approaches, solvent system concept, Lux-flood concept, Lewis concept, Generalized Acid-base concepts.

d) Differentiating and levelling solvents.

e) Co-solvating agents.

f) Hard and soft acids and bases: definitions, Pearson HSAB concept, theories of Hardness and softness, application and limitation of HSAB concepts.

Ref. - 9 : Page Nos. 220, 221, 223-229, 234-236.
Ref. - 10 : Page Nos. 238-249, 255-258, 263, 266, 269, 270.
Ref. - 11 : Page Nos. 374-386.

Reference Books

1) Organic chemistry - Francis A Carey (3rd Edition) 2017
2) Organic chemistry - Morrison and Boyd (6thEdition) 2018
3) Stereochemistry of organic compounds- E L Eliel 2008
4) Stereochemistry of organic compounds- P S Kalsi 2009
5) Organic chemistry - Stanley H pine (5th Edition) 1987
6) A Text book of Organic chemistry- ArunBahl and B S Bahl, S Chand publication.2016
7) A guide book to reaction mechanism in organic chemistry by Peter Sykes.5th Ed. 2003
8) Heterocyclic compounds by Leo Packet. 2006
9) Basic Inorganic chemistry 3rd edition by F.A. cotton, G. Wilkinson, Paul Guss John Wiley and Sons. 2007
10) Theoretical principals of Inorganic chemistry by G.S. Manku, Tata Mc. Graw Hill edition.
11) Advanced Inorganic chemistry by Gurudeep Raj., Vol. I, 23rd Edition, Goel publishing House Meerut.2015

Semester II

Core Course: CH- 401
Physical and Inorganic Chemistry

1.Electrochemistry (L-10, M-20/30)

Introduction, Electromotive force and its measurements , Reversible and Irreversible Cells, Standard cell ,Cell reaction and EMF, convention regarding sign of EMF, Single electrode potential, Standard hydrogen and calomel reference electrodes, Calculation of single electrode potential, Calculation of cell EMF from single electrode potential, Thermodynamics and EMF, ΔG, ΔH,ΔS from EMF data, Thermodynamics of electrode potential (Nernst equation), Standard potential and equilibrium constant, Classification of electrodes, Related numericals.

Ref.-1:- Pages 481-497
Ref.-2:- Relevant Pages.
Ref.-3:- Relevant Pages.

2.Chemical Thermodynamics (L-10, M-20/30)

Introduction, The Helmholtz free energy, ΔA for reactions, Gibb's free energy and, ΔG for reactions, Properties and significance of Gibb's free energy changes, Calculation of free energy changes, Fugacity and activity concepts, The reaction isotherm, Standard free energy change of formation, Criteria of equilibrium .

Physical equilibria involving pure substances, Clapeyron equation and its use, Vapour pressure of liquid and variation of vapor pressure with temperature**,** Clausius-Clapeyron equation, Different form of ClausiusClapeyron equation and is applications, Related numerical.

Ref.-1:- Pages 189-203, 206-213, 215-218
Ref.-2:- Relevant Pages.
Ref.-3:- Relevant Pages.
Ref.-4:- Relevant Pages.

3: Basic concepts of coordination chemistry(L-07, M-14 / 21)

Double salts and coordination compounds, co-ordination complexes and complex ions, coordination number, Unidentate, bidentate and polydentate ligands, chelating ligand and chelates, physical methods used in study of complex, Nomenclature of coordination compounds.

Ref. - 5:Page Nos. 729-735, 738-741.
Ref. -6: Relevent Pages.

4: Conductors, Insulators & Semiconductors(L-03, M-07 / 09)

General Properties of metals. Conductors, insulators and semiconductors. Intrinsic and extrinsic semiconductors. Applications of semiconductors.

Ref. 6 -121 - 144
Ref. 7-220-231
Ref. 8-175-179
Ref. 9-259-264

Reference books

1. Principles of Physical Chemistry

S. H. Maron and C. F. Prutton (4th edition) 2012

2. Essentials of Physical Chemistry

B. S. Bahl, G. D. Tuli, ArunBahl (S. Chand and Co Ltd.) (25th edition) 2010

3. Elements of Physical Chemistry

S. Glasstone and D. Lewis (The Macmillan Press Ltd.) (2nd edition) 2014

4. Physical Chemistry

Robert A. Alberty (John Willey and Sons) (7th edition) 1992

5. Principals of Inorganic Chemistry by B.R.Puri, L.R. Sharma, K.C. Kalia, Milestone publishers and distributors. 2017
6. Concise Inorganic Chemistry by J. D.Lee. 5th Edition. 2014
7. Theoretical Principles of Inorganic chemistry by G.S.Manku Tata McGraw Hill edition.1982
8. Principles of Inorganic Chemistry By Sharma, PuriKalia 30th edition Milestone Delhi. 2017
9. Advanced Inorganic Chemistry Volume - I , by Gurdeep Raj 23rd edition , Goel Publishing House, Meerut. 2016

Semester II

Core Course:CH - 402
Organic and Inorganic Chemistry

1: Synthetic Reagents (L-10, M-20 / 30)

Introduction, active methylene group

a) Acetoacetic ester

Preparation of acetoacetic ester. Synthesis of- alkyl acetic acid, dialkyl acetic acid, succinic acid, adipic acid, ∝-β unsaturated acid, methyl ketone (butanone).

b) Malonic ester

Preparation of malonic ester. Synthesis of- alkyl acetic acid, dialkyl acetic acid, succinic acid, glutaric acid, β keto acid(acetoacetic acid), ∝-β unsaturated acid.

Ref. 1, 2, 5, 6 (Relevant pages)

2:Organometallic compounds(L-10, M-20 / 30)

a) Nomenclature of organometallic compounds, carbon-metal bond in organometallic compounds.

b)**Organolithium compounds**

Preparation of organolithium compounds, Preparation of alcohols from organolithium compounds.

c) **Organomagnesium compounds**

Preparation of Grignard's reagent, reactions of Grignard's reagent with- esters, acid chlorides, with compounds containing active hydrogen.

d) **Organocopper compounds**

Preparation of organocopper compounds (Lithium dialkylcuprate) and synthesis of alkanes.

e) **Organozinc compounds**

Preparation of organozinc compounds, synthesis of cyclopropanes (Simmon Smith reaction), Reformatsky reaction.

Ref. 1, 2, 5, 6 (Relevant pages)

3. Molecular Orbital Theory (MOT) (L-10, M-20 / 30)

a) Molecular orbital method

b) LCAO Method

c) s-s, s-p, p-p, p-d and d-d combination of orbitals
d) Non Bonding combination of orbitals
e) Rules for linear combination of orbitals
f) Molecular orbital treatment for Homo nuclear Diatomic species – H_2, He_2, He_2^+, B_2, N_2 ,O_2 , O_2^- and O_2^{--}
g) Molecular orbital treatment for Hetero nuclear diatomic molecules –CO, NO, and HCl

Ref-9 Pages-89-102,104-112
Ref-10 Pages-333,334, 337-342,344-346,349-351,353,354,357,358,361,362

Reference Books

1)Organic chemistry - Francis A Carey (3rd Edition) 2017
2) Organic chemistry - Morrison and Boyd (6thEdition) 2018
3)Stereochemistry of organic compounds- E L Eliel 2008
4)Stereochemistry of organic compounds- P S Kalsi 2009
5)Organic chemistry - Stanley H pine (5th Edition) 1987
6) A Text book of Organic chemistry- ArunBahl and B S Bahl, S Chand publication. 2016
7)A guide book to reaction mechanism in organic chemistry by Peter Sykes.5th Ed.2003
8) Heterocyclic compounds by Leo Packet. 2006

9) Concise Inorganic Chemistry By J. D. Lee, 5th edition 2014
10) Advanced Inorganic Chemistry Volume-I by SatyaPrakash, G.D. Tuli, S.K. Basu, R. D. Madan S. Chand & Company Ltd (2004)

Semester I

Skill Enhancement Course
SEC-1: Basic Analytical Chemistry

Chapter 1: Introduction to Analytical Chemistry(L-08, M-16/24)

a) Introduction: Analytical chemistry, its interdisciplinary nature, importance of analytical chemistry, types of analysis: qualitative and quantitative analysis

b) Concept of sampling, definition, procedure of sampling, types of sampling

c) Accuracy, precision, significant figures, significance of zero, rounding off

d) Errors: Definition, types and sources of errors, minimisation of errors.

e) Good laboratory practices: Material safety data sheet (MSDS), fire safety, Handling of chemicals

Ref. 1, 2, 3, 4, 5 (Relevant pages)

Chapter 2: Acid base titrations (L-08, M- 16/24)

a) Principle,Acid–base indicators, Henderson-Hasselbalch equation, transition range of indicators.

b) Study of following acid base titrations with respect to: neutralization curve, selection of indicators and calculation of P^H

i) Strong acid versus strong base

ii) Weak acid versus strong base

c) Applications of acid base titrations.

Ref. 1, 2, 3, 4, 5 (Relevant pages)

Chapter 3: Precipitation titrations (L-06, M- 12/18)

a) Principle, precipitation titration curve**,**use of indicators in detectionof end point.

b) Preparation of $AgNO_3$ solution, its standardisation by Mohr's method.

c) Estimation of halides by Fajan's method

d) Applications of precipitation titrations.

Ref. 1, 2, 3, 4, 5 (Relevant pages)

Chapter 4: Chromatography (L-08, M-16/24)

a) Definition, Introduction, advantages and disadvantages of chromatography.
b) Principle of chromatography, classification of chromatography - partition, adsorption and ion exchange chromatography.
c) Paper chromatography: principle, technique, Rf value, ascending and descending techniques, paper chromatographic separation of metal ions, applications.
d) Thin layer chromatography (TLC): principle, technique and applications.
e) Ion exchange (Column) chromatography- cation and anion exchange resins, principle, technique and applications.

Ref. 1, 2, 3, 4, 5 (Relevant pages)

Semester II

Skill Enhancement Course

SEC-2: Advanced Analytical Chemistry

Chapter 1: Redox titrations (L-10, M-20/30)

a) Oxidation, reduction, redox reaction, oxidising agents, reducing agents, redox titrations.

b) Titration of Ce (IV) versus Fe (II), nature of titration curve, calculation of emf during titration.

c) Detection of end point- redox indicators, self indicator and starch indicator.

d) Titrations involving iodine: Iodimetry and Iodometry.

e) Determination of dissolved oxygen (DO) of a water sample.

f) Applications of redox titrations.

Ref. 1, 2, 3, 4, 5 (Relevant pages)

Chapter 2: Complexometric titrations (L-08, M- 16/24)

a) Complexes, ligands, types of ligands, chelates, chelating agents.

b) Formation of complex, formation constant.

c) Chelating agent EDTA, EDTA equilibria, EDTA titration curve.

d) Detection of end point- use of indicators, principle involved in colour change of indicator, characteristics of metal ion indicators.

e) Applications of complexometric titration with reference to analysis of soil: Estimation of calcium and magnesium ions by complexometric titrations.

Ref. 1, 2, 3, 4, 5 (Relevant pages)

Chapter 3: Gravimetric analysis (L-12, M- 24/36)

a) Introduction, advantages of gravimetric analysis

b) Solubility product (with problems), conditions for precipitation.

c) Steps of gravimetric analysis: Preparation of solution, precipitation, digestion.

Impurities in the precipitate: co-precipitation and post precipitation. Filtration, washing, drying or ignition, weighing

d) Applications – estimation of Ba as $BaSO_4$, Ni as Ni-DMG, Pb as $PbCrO_4$

Ref. 1, 2, 3, 4, 5 (Relevant pages)

Reference Books

1) Analytical chemistry – G D Christian (5^{th} Edition). 2006
2) Quantitative chemical analysis- J Mendham, R C Denny, Barnes, Thomas 2009
3 Analytical chemistry- D A Skoog, D M West, F J Holler 1992
4) Vogel's text book of quantitative inorganic analysis- Bassett, Denney, Jeffrery 1989
5) Basic concepts of analytical chemistry- S M Khopkar. 2008

Semester I
CH-303 Chemistry Practical

A) PHYSICAL CHEMISTRY EXPERIMENTS (Any Two)

1. Determination of molecular weight of solute (acetanilide / m- dinitrobenzene / sulphur) by depression of freezing point method.
2. Determination of molecular weight of non-volatile solute (KCl/ $BaCl_2$/ Urea) by using Landsberger apparatus.
3. Determination of standard electrode potential of Cu/Cu^{+2} or Ag/Ag^+, Zn/Zn^{+2} electrodes potentiometrically.

4. Conductometric titration of $Pb(NO_3)_2$Vs Na_2SO_4

B) VOLUMETRIC ANALYSIS (Any Five)

1. Estimation of acetic acid in commercial vinegar using NaOH.
2. Estimation of aspirin in drug sample.
3. Estimation of chloride by Mohr's method.
4. Estimation of Fe (II) by redox titration with $KMnO_4$.
5. Estimation of copper iodometrically.
6. Estimation of Mg^{+2} by complexometric titration with EDTA.
7. Determination of dissolved oxygen (DO) in water sample.

C) CHROATOGRAPHY (Any One)

1. Separation of mixture of o-nitro aniline and p-nitro aniline by Thin Layer Chromatography and to determine their Rf values.
2. Separation of mixture of any two amino acids by paper chromatography.

D) ORGANIC PREPARATIONS (Any Two)

1. Aniline to acetanilide by using Zn / Acetic acid.
2. Semicarbazone derivative of Aldehydes / Ketones.
3. Benzoyl derivative of – OH/ - NH_2.

Semester II
CH-403 Chemistry Practical

A) PHYSICAL CHEMISTRY EXPERIMENTS (Any Two)

1. Determination of critical solution temperature of phenol-water system
2. Determination of normality and strength of HCl titrating with standard NaOHPotentiometrically.
3. Construction of Daniel cell and determination of thermodynamic parameters. ΔG, ΔH, ΔS of the cell
4. Determination of molecular weight of liquid by steam distillation technique

B) ORGANIC QUALITATIVE ANALYSIS (Any five compounds)

Determination of a) Type b) Preliminary tests
c) Physical constant d) Elements (Sodium fusion test)
e) Functional groups f) Structure

C) GRAVIMETRIC ANALYSIS (Any Two)

1. Estimation of Ni as Ni-DMG (by Counterpoise method)
2. Estimation of Ba as $BaSO_4$ (by Ignition using filter paper)
3. Estimation of Pb as $PbCrO_4$ (by Gooch crucible / counterpoise method)

D)INORGANIC PREPARATIONS (Any One)

1. Tetramine Cu (II) sulphate.
2. Hexamine Ni (II) chloride.
3. Ferrous ammonium sulphate (Mohr's salt).

NOTE:
1) In all volumetric experiments it is expected from students to calculate quantity of primary standard substances and to prepare its solution. Then the other solution should be standardised.
2) Before starting the experiment, students must study Material safety data sheet (MSDS) of all chemicals used in experiments. Possibly the experiment should be declared one week earlier, so that it will be easy for students to do so.

Structure ofInternalPractical Examinations

Time:3Hours **Maximum Marks: 40**

1. Any one of the following experiments **30 Marks**

Physical chemistry experiment / Volumetric analysis / Chromatography / Organic Preparation

(For semester I)

Physical chemistry experiment / Gravimetric analysis / Organic qualitative analysis / inorganic Preparation**(For semester II)**

2. Oral **10 Marks**

Structure ofExternal PracticalExaminations

Time:3Hours	**Maximum Marks: 60**

1. Any one of the following experiments 40 Marks

Physical chemistry experiment / Volumetric analysis / Chromatography / Organic Preparation**(For semester I)**

Physical chemistry experiment / Gravimetric analysis / Organic qualitative analysis / inorganic Preparation**(For semester II)**

2. Oral	**10 Marks**
3. Journal	**10 Marks**

Note: A student will not be permitted to appear at the practical examination unless he / she have performed the practicals and produced a certified journal.

EquivalencefortheS.Y.B.ScSyllabus

New Syllabus		Old Syllabus	
Course	**Semester-III**	**Course**	**Semester-III**
CH -301	**Physical And Inorganic Chemistry (Core Course)**	**CH -231**	**Physical And Inorganic Chemistry**
CH -302	**Organic and Inorganic Chemistry (Core Course)**	**CH -232**	**Organic and Analytical Chemistry**
CH -303	**Practical Chemistry**	**CH -233**	**Practical Chemistry**
CH- 304 (SEC-1)	**Basic Analytical Chemistry (Skill Enhancement Course)**		
	Semester- IV		**Semester- IV**
CH -401	**Physical And Inorganic Chemistry (Core Course)**	**CH -241**	**Physical And Inorganic Chemistry**
CH -402	**Organic and Inorganic Chemistry (Core Course)**	**CH -242**	**Organic and Analytical Chemistry**
CH -403	**Practical Chemistry**	**CH -243**	**Practical Chemistry**
CH -404 (SEC-1I)	**Advanced Analytical Chemistry (Skill Enhancement Course)**		

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon

Syllabus

T.Y.B.Sc.

Subject: Chemistry

Choice Based Credit System

With Effect from June -2020

As Per U.G.C. Guidelines

Prepared By

Board of Studies

Chemistry,

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon

Syllabus

Class- T.Y.B.Sc. Subject- Chemistry

Choice Based Credit System (CBCS) (60-40) Pattern

with effect from June-2020

Structure of Curriculum of T.Y.B.Sc. (Chemistry)

Semester – V

Course Type	Course code	Course Title	Credits	Hours per week	Teaching Hours
Core I	CH – 501	Principles of Physical Chemistry-I	3	3	45
Core II	CH – 502	Inorganic Chemistry	3	3	45
Core III	CH – 503	Organic Reaction Mechanism	3	3	45
Core IV	CH – 504	Industrial Chemistry	3	3	45
Skill Enhancement (SEC)	CH – 505	Analytical Instrumentation	3	3	45
Elective **(Any One)**	CH – 506 (A)	Biochemistry	3	3	45
	CH – 506 (B)	Green Chemistry	3	3	45
Core course **(Practical)**	CH – 507	Physical Chemistry Practical	2	4 (Per Batch)	60
	CH – 508	Inorganic Chemistry Practical	2	4 (Per Batch)	60
	CH – 509	Organic Chemistry Practical	2	4 (Per Batch)	60
Non-Credit Audit Course **(Any One)**	AC-510	NSS	No Credit	2- Batches	60
	AC-511	NCC		2- Batches	60
	AC-512	Sports		2- Batches	60

Note:

1. Each lecture is of one hour (60 Minutes) duration.
2. Each theory paper has three lectures per week.
3. Each practical course has four lectures per week.
4. An industrial study tour is compulsory for the T.Y.B.Sc. Students. The students should submit their tour reports at the time of practical examination of VIth Semester.

5. Use of Chart/Text book/Hand book of practical is allowed during examination.
6. Scientific calculator (non-programmable) is allowed during theory and practical examination.
7. All units should be in SI unit.

Semester VI

Course Type	Course code	Course Title	Credits	Hours per week	Teaching Hours
Core I	CH – 601	Principles of Physical Chemistry-II	3	3	45
Core II	CH – 602	Chemistry of Inorganic Solids	3	3	45
Core III	CH – 603	Spectroscopic Methods of Structure Determination	3	3	45
Core IV	CH – 604	Chemistry of Industrially Important Products	3	3	45
Skill Enhancement	CH – 605	Analytical Techniques	3	3	45
Elective **(Any One)**	CH – 606 (A)	Polymer Chemistry	3	3	45
	CH – 606 (B)	Research Methodology for Chemistry	3	3	45
Core course **(Practical)**	CH – 607	Physical Chemistry Practical	2	4 (Per Batch)	60
	CH – 608	Inorganic Chemistry Practical	2	4 (Per Batch)	60
	CH – 609	Organic Chemistry Practical	2	4 (Per Batch)	60
Non-Credit Audit Course **(Any One)**	AC-610	Soft Skill	No Credit	2- Batches	60
	AC-611	Yoga		2- Batches	60
	AC-612	Practicing Cleanliness		2- Batches	60

Note:

1. Each lecture is of one hour (60 Minutes) duration.
2. Each theory paper has three lectures per week.
3. Each practical course has four lectures per week.

4. An industrial study tour is compulsory for the T.Y.B.Sc. Students. The students should submit their tour reports at the time of practical examination of VI Semester.
5. Use of Chart/Text book/Hand book of practical is allowed during examination.
6. Scientific calculator (non-programmable) is allowed during theory and practical examination.
7. Values required for spectral problems should be provided in the question paper.
8. All units should be in SI unit.

Chairman B.O.S. **Dean Science Faculty**

Aims and Objectives

To enable the students-

- To promote understanding of basic facts and concepts in Chemistry while retaining the excitement of Chemistry.
- To make students capable of studying Chemistry in academic and Industrial courses.
- To expose the students to various emerging new areas of Chemistry and apprise them with their prevalent in their future studies and their applications in various spheres of chemical sciences.
- To develop problem solving skills in students.
- To expose the students to different processes used in Industries and their applications.
- To develop ability and to acquire the knowledge of terms, facts, concepts, processes, techniques and principles of subjects,
- To develop ability to apply the knowledge of contents of principles of chemistry.
- To inquire of new knowledge of chemistry and developments therein.
- To expose and to develop interest in the fields of chemistry
- To develop proper aptitude towards the subjects.
- To develop the power of appreciations, the achievements in Chemistry and role in nature and society.
- To develop skills required in chemistry such as the proper handling of apparatus and chemicals.

NOTE:

1. There are in all Six theory courses (4 Core courses, 1 Skill Enhancement course, 1 Elective) and Three practical (Core course practical) courses for each semester.
2. Each theory paper carry 100 Marks out of which 40 Marks are allotted for internal assessment and 60 Marks for external assessment.

3. As per the directions given by University, at the end of each semester internal examination will be conducted for 40 marks and University Examination will be conducted for 60 Marks.
4. The student has a right to choose any one of the optional paper for Vth semester either CH-506 (A) OR CH-506 (B), Similarly The students has a right to choose any one of the optional paper for VIth semester either CH – 606 (A) OR CH – 606 (B).
5. A student is expected to submit a journal certified by the Head of the Department/Head of the Institution for each semester.
6. A student will not be permitted to appear for the practical examination unless he/she produce a certified journal. If the journal is lost, the student should produce a certificate from Head of the department / Head of the Institution stating that he/she has satisfactorily completed the practical work.
7. Industrial tour is compulsory for all the students.

Rules for Personal Safety in Chemistry Laboratory:

- A long sleeved, knee length laboratory coat/ apron is recommended. Long pants and closed toed shoes must be worn for individual safety. Loose clothing, open style shoes and sandals are prohibited. Long hair must be tied up. Each student will have to get his / her own necessary protection items.
- For eye protection, safety goggles must be worn in the laboratory whenever necessary. If the student wears contact lenses, full protection goggles, which provide total seal around eyes, must be worn. All students are expected to wear safety goggles.
- Prior to the practical examination, the teacher-in-charge will check all protective equipment to ensure that they are in order.
- Pipetting by mouth should be avoided. Use of pro-pipette bulbs is recommended.
  - All laboratories should be equipped with safety chart, adequate first aid requirements and fire extinguishers.

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon

T.Y.B.Sc Chemistry Syllabus

(CBCS) Pattern

Semester V **Core Course I**

CH-501

Subject- Principles of Physical Chemistry-I

(Theory: Lectures = 45 hrs. Marks 60) **(Credits: 03)**

Course objectives

- To orient and acquaint the students towards the basic concepts of Quantum Chemistry
- To acquire knowledge about rates of chemical reactions and distinguishing the reaction of different order and their characteristics.
- To understand the basic principles of phase rules and phase diagrams.
- To learn the underlying principles of electrode reactions, electrochemical cells and applications of EMF.

Learning outcomes

After successful completion of this course, students are expected to:

- Understand the significance of wave function and postulates of quantum mechanics.
- Deduce rate equations and half-life equations for first and second order reactions
- Draw and explain the one and two component system phase diagrams.
- Explain the principles of electrode processes and apply them during Practicals.

UNIT-1. Basic Quantum Chemistry **(L-11, M-15)**

Failures of Classical Mechanics, Origin of quantum mechanics, Particle aspect of radiation: Blackbody radiation, Photoelectric effect, Compton Effect, de Broglie’s hypothesis: Matter waves, Heisenberg uncertainty principle, Application of Heisenberg’s principle, Interpretation of wave function, Significance of ψ and ψ^2, Normalization of wave function Operators and operator algebra, Eigen functions and Eigen values, various operators in quantum mechanics: Linear momentum, Kinetic energy and Total energy operator (only equations no derivations), Postulates of quantum mechanics.

Ref. 1: 3, 5-10, 12, 13, 30, 31, 36, 37, 79-84, 115-121

Ref. 2: 3-9, 18, 27-29, 36-39, 43-48

Ref. 4: 21, 24, 32-36, 38-44

UNIT-2. Chemical Kinetics (L-11, M-15)

The concept of reaction rates. Effect of temperature, Pressure, Catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal initial concentrations of reactants) Half–life of a reaction, Pseudo order reactions, General methods for determination of order of a reaction. Effect of temperature on reaction rate, Arrhenius equation (exponential and integrated form), Collision theory, Concept of activation energy and its calculation from Arrhenius equation, Related numerical.

Ref. 3: 732, 734-744, 751-759

Ref. 4: 970-971, 975-978, 984, 988-990, 992, 993

UNIT-3. Phase Equilibrium (L-11, M-15)

Phases, Components and Degrees of freedom of a system, Criteria of phase equilibrium. Gibbs Phase rule and its thermodynamic derivation. Derivation of Clausius –Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, Congruent and Incongruent melting points (lead-silver, $FeCl_3$-H_2O only), Related Numerical.

Ref. 3: 697-714, 719-721

Ref. 4: 605-607, 609-614, 616, 617, 623, 626, 627, 631, 632

UNIT- 4. Electrochemical Cell (L-12, M-15)

Introduction, overview of electrode processes, Faradaic and Non-Faradaic Processes, Introduction to electrical double layer, Factors affecting electrode reaction rate and current.

Classification of electrochemical cell, EMF expression for chemical cell with and without transference, Liquid junction potential, Types of liquid junction potential, Minimization of liquid junction potential.

Application of EMF measurement for pH using Hydrogen gas electrode, Quinhydrone electrode and Glass electrode, Related numerical.

Ref. 5: 1-4, 9, 10, 12-14, 23, 24, 64, 72, 73, 74

Ref. 4: 807, 808, 811, 812, 816-818

References and Suggested Readings

1. *Quantum Chemistry, Donald A. McQuarie, , Viva student edition, Viva Books*
2. *Quantum Chemistry, 4th edition, R. K. Prasad, New Age international Publishers.*
3. *Essentials of Physical Chemistry, Arun Bahl, B. S. Bahl, G. D. Tuli, S., Multicolor edition, S. Chand Publication.*
4. *Principles of Physical Chemistry, 44th edition, Puri, Sharma and Pathaniya, Vishal Publishing Co.*
5. *Electrochemical Methods Fundamentals and Applications, 2nd edition, Allen J. Bard and Larry R. Faulkner, John Wiley & Sons.*
6. *Chemical Kinetics, 2nd edition, K. J. Laidler,*
7. *An Introduction to Electrochemistry, S. Glasstone, East-West Press.*

Semester VI **Core Course I**

CH-601

Subject- Principles of Physical Chemistry-II

(Theory: Lectures = 45 hrs, Marks 60) **(Credits: 03)**

Course objectives

- To learn the basics of molecular spectroscopy and rotational spectra.
- To understand the basic principles and applications of nuclear chemistry.
- To learn the consequences of light absorption by atoms and molecules and photochemical reactions.
- To learn the laws of crystallography and basics of crystal structure.

Learning outcomes

After successful completion of this course, students are expected to:

- Analyze the rotational spectra of diatomic molecules and determine the bond length.
- Explain and apply the radioactivity principles for various chemical and biological investigations.
- Describe the mechanism of fluorescence, phosphorescence and photochemical reactions.
- Analyze the given crystal structure and determine the indices of planes, inter-planer distances and type of crystal structure.

UNIT-1. Investigation of Molecular Structure **(L-11, M-15)**

Introduction, Dipole Moment, Induced dipole moment, Electrical polarization of molecules. Orientation of dipole in an electric field, Debye equation. Method of determination of dipole moment, Vapour temperature method, Molecular structure and dipole moment

Interaction of electromagnetic radiation with molecules, Various types of spectra Rotational, Vibration and Electronic energy levels; with principle and example of each type.

Rotational spectroscopy: Rigid and non-rigid rotor diatomic molecule-Moment of inertia, Energy Levels, Selection rule, Intensities of spectral lines, Determination of bond lengths of diatomic and linear triatomic molecules, Isotopic substitution. Related numerical

Ref. 1: 253-257, 259-261

Ref. 3: 5-9, 33-46

UNIT-2. Nuclear Chemistry (L-12, M-15)

Introduction, Radioactive elements, Types of radioactive decay, Decay schemes, General characteristic of radioactive decay, Decay kinetics, Decay constant, Half-life period, Mean life, Units of radioactivity.

Application of radioactivity – Radiochemical principle of tracer technique; Application of tracer technique – Chemical investigation reaction mechanism- esterification, hydrolysis, Oxidation - Oxidation of CO, Structure determination - PCl_5 molecules, Thiosulphate ion, C-14 dating and tritium dating, Medical applications- Thyroditis, Bone fracture Healing, Brain tumor location, Defects in Blood Circulation.

Nuclear Fusion / Fission as source of energy with example

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management with case study. Related numerical

Ref. 4: 118-125, 225, 247, 248, 373-378, 402, 403, 407-411

Ref. 1: 103-105, 108-110, 113-115, 120-122, 136-138

Ref 6: 87-94, 108-112

UNIT-3. Photochemistry (L-11, M-15)

Laws of photochemistry, Quantum yield, Examples of low and high quantum yields, Consequence of light absorption by atoms and molecules, Jablonski diagram, Fluorescence, Phosphorescence, Quenching. Experimental setup for determination of quantum yield with actinometer as detector

Photochemical gas reactions, Photolysis of ammonia, Combination of H_2 and Cl_2 reaction, Reaction between H_2 and Br_2, Photosensitized gas reaction, H_2 and O_2, H_2 and CO, Chemiluminescence, Related numerical.

Ref. 1: 1045-1055

Ref. 2: 1044, 1045, 1048, 1049, 1054, 1055, 1059-1061

UNIT-4. Crystal Structure (L-11, M-15)

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law and Bragg's method. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals: Shottkey and Frenkel defects. Liquid Crystal, Types and Applications. Related numerical

Ref. 1: 449-454, 456-463, 472-474

Ref. 2: 1085-1087, 1099, 1100, 1104-1107, 1123, 1130, 1131

References and Suggested Readings

1. *Essentials of Physical Chemistry, Arun Bahl, B. S. Bahl, G. D. Tuli, S. Multicolor edition, S. Chand Publication.*
2. *Principles of Physical Chemistry, 44th edition, Puri, Sharma and Pathaniya, Vishal Publishing Co.*
3. *Fundamentals of Molecular Spectroscopy, 4th Edition, C. N. Banwell and E. M. McCash, Tata McGraw-Hill: New Delhi*
4. *Essentials of Nuclear Chemistry, Revised 4th Edition, H. J. Arnikar, New Age International Publishers.*
5. *Advance Physical Chemistry, Gurtu and Gurtu, Pragati Publication.*
6. *Environmental Pollution and Health, V. K. Ahluwalia, The Energy and Resources Institute (TERI), 2005.*

Semester V **Core Course II**

CH-502

Subject-Inorganic Chemistry

(Theory: Lectures = 45 hrs, Marks 60) **(Credits: 03)**

Course objectives:

- To describe the VSEPR theory to predict shape of molecules from electron pairs.
- To describe the bonding in simple compounds using VBT.
- To describe the principles of VBT to predict hybridization of orbitals.
- To understand how CFT explains electronic structure, colour and magnetic properties of co-ordination compounds.
- To introduce the basic principles of MOT and electronic geometry of molecules.

Learning outcomes:

- Learn about the VSEPR theory and how it can be used to explain molecular shapes.
- Learn about the VBT to describe the formation of covalent bonds in terms of atomic orbital overlap.
- Learn about stability of complexes using CFSE.
- Learn about MOT to draw energy diagrams and to predict bond order.

UNIT-1: Structure and Reactivity of Molecules **(L-09, M-12)**

Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone-and bond-pairs of electrons multiple bonding, prediction of shapes of irregular molecules and ions like - Sulphur tetra fluoride, Bromine trifluoride, Dichloroiodate (I) anion, Penta fluoro telluurate (IV) anion, Tetrachloroiodate (III) anion, Nitrogen dioxide, Phosphorus trihalides, Carbonyl fluoride, Summary of VSEPR rules Drawbacks of VSEPR theory.

Ref.1: 206-207

Ref. 3: Relevant pages.

UNIT 2: Modern Theories of Coordination Compound Part –A (L-09, M-12)

Assumptions, Werner theory and isomerism, EAN, Stability of complex ion, Factors affecting stability of complex ion, Irving William series, Stabilization of unstable oxidation state, Stereochemistry of coordination compound with C.N. 4 and 6, Isomerism in coordination compounds.

Ref. - 1: 735-737, 742-745, 748--757.

Ref. - 2: Relevant Pages.

UNIT 3: Modern Theories of Coordination Compound Part –B (L-09, M-12)

Assumptions of V.B.T., V.B. Theory as applied to structural and bonding in complexes of 3d series elements. Examples of square planar, Tetrahedral and Octahedral complexes, inner and outer orbital complexes, Magnetic properties of complexes of 3d series elements, limitations of V.B.T., Assumptions of CFT, Degeneracy of 'd' orbital's, Application of CFT to octahedral complexes, Weak and strong ligand field splitting, spectrochemical series.

Ref. 1: 759 - 766

Ref.2: Relevant Pages

UNIT 4: Modern Theories of Coordination Compound Part –C (L-09, M-12)

Definition of C.F.S.E., Calculation of C.F.S.E. in weak and strong field octahedral complexes, Evidences of C.F.S.E., Factor's affecting 10 Dq, CFT and magnetic properties, spin only magnetic moment equation, Electron occupancy in CFT, Application of CFT to tetrahedral a nd Calculation of C.F.S.E. in tetrahedral complexes. Tetragonal distortions from octahedral geometry, Jahn-Teller theorem Application of CFT to square planer complexes, Problems related to calculation of spin only magnetic moment for square planer, tetrahedral and octahedral complexes (for high spin and low spin complexes).

Ref.1: 766 -772,

Ref.2: Relevant pages

UNIT 5: Modern Theories of Coordination Compound Part –D (L-09, M-12)

Crystal field effects- Variation of lattice energies, enthalpies of hydration and crystal radii variations in halides of first and second row transition metal series and spinel structures, limitations of CFT, experimental evidences in support of metal ligand bond overlaps. ACFT, Assumptions of Molecular orbital theory, composition of ligand group orbitals, Molecular orbital treatment (Qualitative) of octahedral complexes (strong & weak field), Effect of pi-bonding, Charge transfer spectra, Comparison of VBT, CFT and MOT.

Ref. 1: 794-796,774-778

Ref. 2: Relevant Pages

References:

1. *Principle of Inorganic Chemistry, B. R. Puri, L. R. Sharma, K. C. Kalia, Milestone Publisher and distributor.*
2. *Concise Inorganic Chemistry, 5th Edition, J. D. Lee.*
3. *Inorganic Chemistry Principles of Structure and Reactivity, 4th Edition, James E. Huheey,*
4. *Ellen A. Keiter. Richard L. Keitler.*

Semester VI **Core Course II**

CH-602

Subject- Chemistry of Inorganic Solids

(Theory: Lectures = 45 hrs, Marks 60) **(Credits: 03)**

Course Objectives:

- To describe basic principles of nanomaterials.
- To describe basic synthesis of nanoparticles.
- To describe composition and technological importance of inorganic solids.
- To describe composition of cement, lime and alloys.
- To describe manufacture of fertilizers.

Learning Outcomes:

- Learn about basic principles and synthesis of nanomaterials.
- Learn about classification, composition and processing of cement.
- Learn about classification and composition of alloys.
- Learn about types manufacture and applications of fertilizers.

UNIT 1: Synthetic Methods of Nanomaterials **(L-09, M-12)**

Introduction to Nano science, nanostructure and nanotechnology (basic idea), Size dependent properties of nanomaterials (basic idea) a) Semiconducting nanoparticles b) Metallic nanoparticles. Synthesis routes of nanomaterials: a) Bottom up approaches i) Chemical vapor deposition (CVD) ii) Spray pyrolysis iii) Sol gel process b) Top down approaches: mechanical alloying, Role of surfactant in shape and size control of nanomaterials

Ref:1: 602-604, 624, 653-655.

Ref:2: 66-70,74-77, 79,85-87.

Ref.3: 656-658, 707-712,721-724

UNIT 2: Inorganic Solids of Technological Importance **(L-09, M-12)**

Inorganic pigments, Coloured solids, White and black pigments, Molecular materials and fullerides, Molecular material chemistry – One dimensional metals, Molecular magnets, Inorganic liquid crystals, Solid electrolytes (a) solid cationic electrolytes (b) solid anionic electrolytes .

Ref:- 1: 607-609,642-644,647-650.

Ref.3: 661-664,696-699,703-707.

UNIT 3: Cement and Lime **(L-09, M-12)**

Classification of cement, Ingredients and their role, Manufacture of cement and the setting process, Quick setting cements. Manufacture of lime and applications

Ref.4: Relevant pages

Ref.5: Relevant pages

UNIT 4: **Fertilizers** **(L-09, M-12)**

Plant Nutrients, Different types of fertilizers, need for fertilizers, requisite qualities of fertilizers, symptom of deficiency, Manufacture of following fertilizers:- Urea, Ammonium nitrate, Calcium ammonium nitrate, Ammonium phosphate, Super phosphates, Compound and Mixed fertilizers, Potassium chloride and Potassium sulphate.

Ref.5: Relevant pages

Ref.6: Relevant pages

UNIT 5: **Alloys** **(L-09, M-12)**

Classification of alloys, Ferrous and Non-ferrous alloys, Specific properties of elements in alloys, Manufacture of steel, Removal of silicon, decarburization, demagnetization and desulphurization. Composition and properties of different types of steels

Ref.7: Relevant pages

Ref.8: Relevant pages

Reference:

1. *Inorganic Chemistry, 4th /5th edition, Shriver and Atkins*
2. *Textbook of Nano Science and technology, B. S. Murthy, P. Shankar, Badev Raj, B. B. Rath and James Murday, University Press III M, Metallurgy and Material Sciences.*
3. *Inorganic Chemistry, 6th Edition, Weller, Overton, Rourke & Armstrong.*
4. *Shriver Chemical Process Industry, 5th edition, George T. Austin.*
5. *Industrial Chemistry, 14th edition, B. K. Sharma,2004.*
6. *Riegels Handbook of Industrial chemistry, 9th Edition, James A. Kent, CBS Publishers and Distributors*

7. *Engineering Chemistry, S. S. Dara.*
8. *Engineering Chemistry, B. K. Sharma, Goel Publishing House, Meerut.*
9. *Engineering Chemistry, P. C. Jain and M. Jain Dhanpat Rai and Sons Delhi.*

Semester V **Core Course III**

CH-503
Subject- Organic Reaction Mechanism

(Theory: Lectures = 45 hrs, Marks 60) **(Credits: 03)**

Learning Objectives

- To study different types of organic reactions.
- To understand the mechanisms of different types of reactions.
- To distinguish between types of substrates and types of reagents.
- To understand ways of attack of reagent, breaking and formation of bonds in different reaction mechanisms.
- To study kinetics, evidences and factors affecting different types of reactions.
- To study stereochemistry of different reactions.
- To understand role of different reagents in different reactions.

Course Outcomes

- Students will learn organic reactions like nucleophilic substitution, electrophilic substitution, nucleophilic addition, electrophilic addition and elimination.
- Students will be able to write/ explain mechanisms of those types of reactions.
- Students will understand how a reaction takes place in one or more steps.
- Students will understand the types of intermediates formed in different reactions.
- Students will learn how reagent attacks the substrate molecule and accordingly how bonds break and formed.
- Students will learn how change in structure of substrate, reagent and solvent changes the product formed and its stereochemistry.

- Students will be able to predict the products and to suggest the mechanisms.

UNIT 1. Nucleophilic Substitution at Saturated Carbon (9 L, 12M)

SN^1, SN^2 and SN^i reactions, Mechanism and stereochemistry, regioselectivity and stereo specificity of substitution reaction. Scope at saturated carbon, allylic carbon and vinylic carbon. Factors affecting rate of SN^1, SN^2 and SN^i reactions (Effect of nature of substrate, nucleophile, leaving group and solvent).Neighboring group participation (norbornyl & norbornenyl systems), Non-classical carbocation's.

Ref:- 1: 328-359, 931-937.

Ref:- 2: 293-369.

Ref: - 3: 257-328.

Ref: - 4: 179-200.

UNIT 2. Electrophilic Addition to C=C (9 L, 12M)

Introduction, Mechanism of electrophilic addition to C=C bond (Ad_{E}^{2} Mechanism)**,** addition of hydrogen halides, orientation of addition: Markownikoff's and Anti Markownikoff's addition (peroxide effect), stereochemistry, addition of halogens: experimental evidences for two step mechanism, mechanism of addition of bromine, factors affecting anti-stereoselectivity, effect of substituents on rate of addition, addition of hypohalous acids (HOX), Hydroxylation (Mechanism of formation of cis and trans 1,2-diols), Hydroboration- Oxidation (Formation of alcohol), Hydrogenation (Formation of alkane), Ozonolysis (formation of aldehydes & ketones).

Ref:- 1: 427-447.

Ref:- 2: 734-742, 783-788.

Ref: - 4: 323-360, 425-440

UNIT 3. Nucleophilic Addition to C=O (9 L, 12M)

Introduction, Structure of carbonyl group, reactivity of carbonyl group,

Addition of Hydrogen cyanide, alcohols, thiols, water, ammonia derivatives.

Aldol and Cannizzaro Reaction, Perkin reaction, Wittig reaction, Reformatski reactions,

Reduction reactions using $NaBH_4$, $LiAlH_4$ with mechanism.

Ref:- 1: 222-239.

Ref:- 2: 879-919.

UNIT 4. Aromatic Substitution Reactions **(09 L, 12M)**

Electrophilic substitution

Introduction, arenium ion mechanism, Effect of substituent group (Orientation, o/p directing and meta directing groups). Classification of substituent groups (activating and deactivating groups) Mechanism of: Nitration, Sulfonation, Halogenation, Friedal-Crafts reactions (alkylation and acylation), Diazo Coupling reactions, Ipso-substitution.

Nucleophilic substitution

Addition- elimination (SNAr), Elimination-addition (Benzyne) mechanism with evidences, Chichibabin reaction

Ref:- 1: 471-527.

Ref:- 2: 501-521, 641-653.

Ref: - 4: 517-545, 943-967.

UNIT 5. Elimination Reactions: **(9 L, 12M)**

Introduction, The reaction mechanisms: E1, E2, E1CB with evidences and factors affecting the reaction.E1 v/s E2 and Elimination v/s substitution. Anti and Syn elimination, Stereo electronic factors. Bredt's rule. Dehydrohalogenation, Dehalogenation, Dehydration, Hoffmann and Saytzeff's elimination, Pyrolytic elimination.

Ref:- **1: 382-406.**

Ref:- 2 : 982-1010.

Ref: -4 : 273-310.

References

1. *Organic Chemistry, Second Edition. J. Clayden, N. Greeves & S. Warren and P. Wothers (Oxford).*
2. *Advanced Organic Chemistry-Reactions, Mechanisms and Structure, 5th Edition, Michael B. Smith, Jerry March.,Wiley-VCH, Weinheim, 2000,*
3. *Advanced Organic Chemistry Part A- Structure and Mechanisms, 3rd Edition, A. Carey and R.J. Sundberg. Springer US, Third Edition*
4. *Organic Chemistry, 6th Edition, R. T. Morrison and R. N. Boyd.*
5. *Web- Organic Chemistry Portal*

Semester VI **Core Course III**

CH-603

Subject- Spectroscopic Methods of Structure Determination

(Theory: Marks 60 Lectures = 45 hrs) **(Credits: 03)**

Course Objectives

- To study principle of spectroscopy and to understand wave parameters and terms involved in spectroscopy.
- To study different types of spectroscopy.
- To understand principle, concept and the terms used in each type of spectroscopy.
- Interpretation of UV, IR, NMR spectra.
- Use of spectral data for determination of structure of unknown organic compounds.
- To study different applications of each type of spectroscopy.

Learning Outcomes

- Students will learn interaction of radiations with matter. They will understand different regions of electromagnetic radiations. They will know different wave parameters.
- Students will learn principle of mass spectroscopy, its instrumentation and nature of mass spectrum.
- Students will understand principle of UV spectroscopy and nature of UV spectrum. They will learn types of electronic excitations.
- Students will be able to calculate maximum wavelength for any conjugated system. And from the value of λ-max they will be able to find out extent of conjugation in the compound.
- Students will understand principle of IR spectroscopy, types of vibrations and the nature of IR spectrum.

- From IR spectrum, they will be able to find out IR frequencies of different functional groups. And thus, they will be able to find out functional groups present in the compound.
- Students will understand principle of NMR spectroscopy and will understand various terms used in NMR spectroscopy. They will learn measurement of chemical shift and coupling constants.
- Students will be able to interpret the NMR data and they will be able to use it for determination of structure of organic compound.
- Students will be able to determine structure of simple organic compounds on the basis of spectral data such as λ max values, IR frequencies, chemical shift (δ values).

UNIT 1. A) Introduction to Spectroscopy (9L, 12M)

Introduction, meaning of spectroscopy, nature of electromagnetic radiation, wave length, frequency, energy, amplitude, wave number, and their relationship, different units of measurement of wavelength and frequency, different regions of electromagnetic radiations. Interaction of radiation with matter. Excitation of molecules with different energy levels, such as rotational, vibrational and electronic level. Types of spectroscopy, advantages of spectroscopic methods

Ref:- 2: 1-19.

Ref:- 4 : 13-19.

B) Mass spectroscopy

Basic theory, Nature of mass spectrum, Importance of molecular ion peak, isotopic peaks, base peak, nitrogen rule, rule of 13 for determination of empirical formula and molecular formula.

Ref:- 1: 170-186.

Ref:- 2: 415-424.

Ref:- 3 : 2-15.

Ref:- 4 : 401-417.

UNIT 2. Ultra Violet Spectroscopy (9L, 12M)

Introduction, nature of UV spectrum, Beer's law, absorption of UV radiation by organic molecule leading to different excitations. Terms used in UV Spectroscopy: Chromophore, Auxochrome, Bathochromic shift (Red shift), hypsochromic shift (Blue shift), hyperchromic and hypochromic effect. Effect of conjugation on position of UV band. Calculation of λ-max by Woodward and Fisher rules: for dienes and enone system, Applications of UV Spectroscopy: Determination of structure, determination of stereo chemistry (cis and trans), problems.

Ref:- 1: 1-27.

Ref:- 2: 9-53.

Ref:- 4: 367-398.

UNIT 3. Infra-red Spectroscopy (9 L, 12M)

Introduction, Principle of IR Spectroscopy, fundamental modes of vibrations (3N-6, 3N-5) Types of vibrations (Stretching and bending), Regions of IR Spectrum: functional group region, finger print region and aromatic region, Characteristic IR absorption of functional groups: Alkanes, alkenes, alkynes, alcohol, ethers, alkyl-halides, carbonyl compounds (-CHO, C=O, -COOR, -COOH), amines, amides and Aromatic Compounds and their substitution Patterns. Factors affecting IR absorption: Inductive effect, resonance effect, hydrogen bonding. Applications of IR Spectroscopy: determination of structure, chemical reaction and hydrogen bonding, Problems.

Ref:- 1 : 28-57.

Ref:- 2 : 65-154.

Ref:- 3 : 71-109.

Ref:- 4 : 26-93.

UNIT 4. NMR Spectroscopy (9L,12M)

Introduction, Principles of NMR Spectroscopy, Magnetic and nonmagnetic nuclei, Precessional motion of nuclei without mathematical details, Nuclear resonance, chemical shift, shielding, & deshielding effect. Measurement of chemical shift, delta and Tau-scales. TMS as reference and its advantages, peak area, integration, spin-spin coupling, coupling constants, *J*-value (Only first order coupling be discussed), problems.

Ref:- 1: 63-145.
Ref:- 2 : 185-356.
Ref:- 3 : 144-216.
Ref:-4 : 108-160.

UNIT 5. Combined Problems Based on UV, IR, NMR & Mass (9 L, 12M)

Determination of structure of simple organic compounds on the basis of spectral data such as λ max values, IR frequencies, chemical shift (δ values), coupling constant, peak values provided to the students.

Reference Books:

1. *Spectroscopic Methods in Organic Chemistry, D. H. Williams & I. Fleming, 5th Ed.*
2. *Spectroscopy of Organic Compounds, P. S. Kalsi, New Age Int. Pub., 6th Ed., 2007*
3. *Spectrometric Identification of Organic Compounds, R. M. Silverstein and F. X. Webster , John Wiley and Sons Inc, 7th Edition.*
4. *Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz and J. R. Vyvyan. Indian Edition. Cengage Learning; 5th edition (2015)*

Semester V **Core Course IV**

CH-504

Subject- Industrial Chemistry

(Theory: Lectures 45 hrs, Marks 60) **(Credits: 03)**

Course objectives

- To produce graduates with enhanced skills, applied knowledge, aptitude to carry out higher studies or research and development in the various industrial areas.
- To make the student cognizant about important aspects of Chemical Industries, Industrial work culture and environment.
- To prepare the students for immediate entry to the workplace with sound theoretical knowledge and some basic experimental concepts in the area of various industries viz. Sugar Industry, Fermentation Industry, Petroleum and Petrochemicals.
- To offers the synergism between basic concepts of Chemistry with Industrial applications.
- To equip the students with knowledge of some industrial organic synthesis as requirement of diverse chemical industries.
- Empower the students to understand the concepts in chemical processing, engineering and industrial development.

Learning outcomes

From the course CH: 504 Industrial Chemistry**,** the student will be able to understand….

- Basic requirements of Chemical Industry, different terms, operations and processes involved in chemical Industry.
- Describe Copy Right Act, Patent Act and Trade Marks, Bureau of Indian Standards (BIS) and International Organization for Standardization (ISO).

- Basic requirements, raw materials, different processes and operations involved in Sugar Industry and also different grades of sugar and uses of by-products of sugar industry.
- Importance of fermented products, basic requirements, theory and process of alcohol making, fractional distillation and various terms involved in Fermentation Industry.
- Understand Occurrence of Petroleum, theories of formation of Petroleum and different terms Viz. Knocking, Anti-Knock Compounds, Octane number, Cetane number, Gasohol and Power alcohol etc.
- Manufacturing processes involved in Industrial Organic Synthesis such as Methanol, Isopropanol, Glycerol, Acetylene and Aromatic hydrocarbon i.e. Toluene from petroleum with their uses.

UNIT 1: General Aspects of Industrial Chemistry (L-9, M-12)

Introduction, Basic Requirements of Industrial Chemistry, Chemical Production, Raw Materials, Unit Process and Unit Operations, Quality Control, Quality Assurance, Process Control, Research and Development, Pollution Control, Human Resource, Safety Measures, Classification of Chemical Reactions, Batch and Continuous Process, Conversion, Selectivity, Yield, Copy Right Act, Patent Act and Trade Marks. Bureau of Indian Standards (BIS), International Organization for Standardization (ISO)

Ref.1: Chapter 2(26, 27, 31 to 36)

Ref.4: Chapter 1 and 2 (Relevant Pages)

Ref.6: Chapter 1, 2 and 3 (Relevant Pages)

Ref: Websites and Web Pages

www.wikipedia.org/wiki/patentact , www.wikipedia.org/wiki/trademarks,
www.wikipedia.org/wiki/trademarks,www.wikipedia.org/wiki/bis
www.wikipedia.org/wiki/iso

UNIT 2: Sugar Industry (L-9, M-12)

Introduction, Sugar Industry in Maharashtra and India, Manufacture of Cane Sugar- [Refining (with flow sheet)], General Idea of Sulphitation and Carbonation, Concentration /Evaporation, Crystallization Separation of crystals. Grades, Baggase, Cellotex

Ref.3: Chapter 38 1208 to 1218 (Relevant Points Only)

UNIT 3: Fermentation Industry **(L-9, M-12)**

Introduction, Alcohol fermentation, Uses of alcohol, Theory underlying process of making alcohols beverages, Manufacture of Beer, Manufacture of Spirit, Alcohol from Cane Sugar Molasses, Theory of fractional distillation – Coffey'still, Rectified spirit, Absolute alcohol, Fusel oil, Proof spirit, Denatured alcohol.

Ref.2:578-596.

Ref.3: Chapter 36, 1175-1190 (Relevant Points Only)

UNIT4: Petroleum Industry. **(L-9, M-12)**

Occurrence, Petroleum producer countries in the world, Exploration Methods, Composition of Petroleum, Refining or Distillation of Petroleum, Anti-Knock Compounds, Octane number, Cetane number, Petrohol (their definitions only), Manufacture of Petrol or Gasoline by Bergius Method, Cracking process- Thermal, Catalytic, Hydro cracking.

Ref.1: 340 to 352, 356 to358 and 363 to 368.

Ref.3: Chapter 4, 217 to 311 and Chapter 5, 312 to 342 (Relevant Points only)

UNIT 5: Industrial Organic Synthesis **(L-9, M-12)**

Manufacture of methanol from synthesis gas, Isopropanol from propylene, Glycerol from propylene via allyl chloride, Acetone by catalytic dehydrogenation of isopropanol. (with flow sheet diagram), Unsaturated Hydrocarbon –preparation of Acetylene from Natural gas (with flow sheet), Aromatic hydrocarbon- Preparation of toluene (with flow sheet)

Ref.3: Chapter 11, 439 to 451 and Chapter 14, 493 to 522 (Relevant Points Only).

References:

1. *Principles of Industrial Chemistry, Chris A Clausen III and Guy Mattson, John Wiley and Sons, Inc. Somerset, 1978, New York.*
2. *Shreve's Chemical Process Industries, George T. Austin, 5 th Edition, The McGraw-Hill, 1984, New York.*
3. *Industrial Chemistry, B. K. Sharma, 16th Edition, Goel Publishing House, Meerut,(U.P.) 2011, India.*
4. *Comprehensive Industrial Chemistry, P.G. More, 1st Edition, Pragati Prakashan, Meerut, (U.P.) 2010, India.*

5. *Chemistry and Technology of the Cosmetics and Toiletries Industry, D.F. Williams and W.H. Schmitt Blackie Academic &. Professional First edition 1992 Second edition 1996 © Chapman & Hall ISBN-13 :978-94-0 10-7194-9 e-ISBN-13:978-94-009-1555-8*
6. *Handbook of Industrial Chemistry Organic Chemicals, Mohammad Farhat AIi, Bassam M. El AIi, James G. Speight, The McGraw-Hill Companies, 2005, ISBN 0-07-141037-6*

Semester VI **Core Course IV**

CH-604

Subject- Chemistry of Industrially Important Products

(Theory: Lectures 45 hrs, Marks 60) **(Credits: 03)**

Course objectives

- To make student perceptive about various commodity industries viz. Cosmetics and Perfumes, Dyes and Pharmaceuticals, Pesticides, Soaps and Detergents, related diversified and multidisciplinary fields of chemical industry.
- To produce graduates with enhanced skills, knowledge and research aptitude to carry out higher studies or research and development in the various industrial areas.
- To equip students with advance knowledge about various industrially important products.
- To makes students ready for immediate entry to the workplace with sound theoretical and basic experimental knowledge in the areas of various industries.
- To engender the substantial interest in the students to understand the concepts in chemical processing, engineering and industrial development of present era viz. Cosmetics and Perfumes Industry, Dyes and Pharmaceuticals, Pesticides, Soaps and Detergents, related multidisciplinary and diversified fields of chemical industry.
- To describe the industrial production of a number of important organic and inorganic compounds / chemicals and products of end use.
- To gain comprehensive knowledge of cutting-edge developments in a field of different chemical industries by discussions and exchange of experiences and knowledge.
- To develop proficiency in application of current aspects of industrial chemistry.

Learning Outcomes

On successful completion of the course **CH: 604 Chemistry of Industrially Important Products**, the student will be able to understand….

- Describe the industrial production of a number of important organic and inorganic compounds / chemicals and products of end use.
- Gain comprehensive knowledge of cutting-edge developments in a field of different chemical industries.
- Importance of Cosmetics Industry and a general study including preparation and uses of the Hair dye, hair spray, shampoo, suntan lotions, lipsticks, talcum powder, nail enamel, creams (cold, and shaving creams).
- Perfumes and identify the distinguishing features of its components and also an essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone etc.
- Know about pesticides both natural and synthetic, benefits and adverse effects of it, also synthesis, manufacture and uses of pesticides viz. Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Anilides (Alachlor and Butachlor).
- Definition, classification, raw material used in soaps and detergents, reaction involved in it, Manufacture of Soaps and cleansing action of soaps and detergents.
- Definition, properties of good dyes, relation between colour and constitution, classification of dyes according to their mode of application and chemical constitution.
- Importance's, definition and meaning of the different terms involved in Drugs and Pharmaceuticals Industry and also synthesis, uses, properties and industrial manufacture of Paracetamol, Aspirin, and Chloramphenicol.

UNIT 1: Chemistry of Cosmetics (L-9, M-12)

Introduction, Raw materials and general study including preparation and uses of the following: Hair dye, shampoo, suntan lotions, lipsticks, talcum powder, nails enamel, creams (cold and shaving creams).

Ref.: 6 Chapter -1, 1 to 34, Chapter -2, 36 to 100, Chapter -3, 104 to 145, Chapter - 4 149 to 181 and Chapter- 9, 290 to 309. Relevant Points Only

UNIT 2: Chemistry of Perfumes (L-9, M-12)

Essential oils A general study including properties, uses and importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone and antiperspirants and artificial flavours.

Ref. 3: Chapter 53, 1520 to1544 Relevant Points Only.

Ref.6: Chapter 8, 272 to 289, Chapter 10, 310 to 344, Relevant Points Only.

UNIT 3: Pesticide Chemistry (L-9, M-12)

General introduction to pesticides and their changing concepts (natural and synthetic), benefits and adverse effects of pesticides, structure activity relationship, synthesis and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Anilides (Alachlor and Butachlor).

Ref.3: Chapter 41, 1280 to1318 Relevant Points Only.

Ref.7: Chapter 11, 381 to 426 Relevant Points Only.

UNIT 4: Soap and Detergents (L-9, M-12)

Soaps, Surfactants and its Importance, Raw Materials used in Soap Manufacture, Manufacture of Soaps (Continuous Process), Cleansing action of Soap, Classification of Soaps, Detergents, Principal group of Synthetic Detergents, Detergents builders and Additives, Comparison between Soap Detergent.

Ref.3: Chapter 39, 1219 to1251 and Chapter 40,1252 to1279 Relevant Points Only.

Ref. 6: Chapter- 5, 123 to160 Relevant Points Only.

UNIT 5: Dyes, Drugs and Pharmaceuticals. (L-9, M-12)

(a) Dyes: Introduction, properties of dyes, Otto Witts theory only, Classification of dyes according to their mode of application and Chemical Constitution.

Ref.3: Chapter 54, 1545 to1608 Relevant Points Only.

Ref.6: Chapter 8, 259 to 288 Relevant Points Only.

(b) Drugs and Pharmaceuticals: Introduction, Importance, Qualities of good drugs, Functional and chemotherapeutic drugs, Meaning of the terms: Prescriptions, Doses, Analgesic, Antipyretics, Antibiotics, Anti-inflammatory, Anti-viral, Cardiovascular, Cough and Cold Preparations, Sedatives and Hypnotics, contraceptives. Synthesis, uses, manufacture and properties of Paracetamol, Aspirin, Chloramphenicol

Ref.4: Chapter 8, 144 to194 Relevant Points Only.

Ref.6: Chapter 10, 331 to 379 Relevant Points Only.

References:

1. *Principles of Industrial Chemistry, Chris A Clausen III and Guy Mattson, John Wiley and Sons, Inc. Somerset, 1978, New York.*
2. *Shreve's Chemical Process Industries, George T. Austin, 5 th Edition, The McGraw-Hill, 1984, New York.*
3. *Industrial Chemistry, B. K. Sharma, 16th Edition, Goel Publishing House, Meerut,(U.P.) 2011, India.*
4. *Comprehensive Industrial Chemistry, P.G. More, 1st Edition, Pragati Prakashan, Meerut,(U.P.) 2010, India.*
5. *Chemistry and Technology of the Cosmetics and Toiletries Industry, D.F. Williams and W.H. Schmitt Blackie Academic &. Professional First edition 1992 Second edition 1996 © Chapman & Hall ISBN-13 :978-94-0 10-7194-9 e-ISBN-13:978-94-009-1555-8*
6. *Handbook of Industrial Chemistry Organic Chemicals, Mohammad Farhat AIi, Bassam M. El AIi, James G. Speight, The McGraw-Hill Companies, 2005, ISBN 0-07-141037-6*

Semester V **Skill Enhancement Course**

CH-505

Subject- Analytical Instrumentation

(Theory: Lectures = 45 hrs, Marks 60) **(Credits: 03)**

Course Objectives

- To develop an understanding of the range and uses of analytical methods in chemistry.
- To understand and establish the role of chemistry in quantitative analysis.
- To enhance the Analytical instrumental skill of the students.

Learning Outcomes

- Explain the fundamentals of analytical methods and instruments for qualitative and quantitative Analysis.
- Express the role of analytical chemistry in science.
- Students will be able to function as a member of an interdisciplinary problem solving team.

UNIT 1:-Spectrometry **(9L, 12M)**

Origin of spectra Interaction of electro-magnetic radiation with matter, Electro-magnetic Spectrum, The Absorption of Radiation, Solvents for Spectrometry, Quantitative Calculations, Beer's Law, Principles of instruments - Sources, Monochromators (prism, diffraction gratings, Optical filters), Cells, detectors, Slits Width, Single Beam Spectrometer, Spectrometric Errors, Deviation from Beer's Law - Chemical deviation, Instrumental deviation, Problems.

Ref.-1:- 398-401, 410-411, 413--435, 439-443.
Ref. 2 -6:-Relevant Pages

UNIT 2: Infrared Spectrometry **(9L, 12M)**

Infra red Spectrometry – Principles, Theory, Instrumentation, Source, monochromator, detectors, Single beam, Double beam, Types, Sampling Technique, Solvents, Spectrometric error, FTIR introduction, General applications.

Ref.-2: 447 – 458

Ref.-4: 527-576

Ref. 2-6: Relevant Pages

UNIT 3. A: Emission Spectrometry (9L, 12M)

Flame Emission Spectroscopy – Principles, Theory, Instrumentation, Experimental techniques, Interferences and applications , Advantages and disadvantage, Plasma Emission Spectrometry – Principles, Plasma as excitation source, inductively coupled Plasma source, ICP-AES Instrumentation, Applications.

Ref.-1: 462 - 467

Ref. 2-6: Relevant Pages

B:-Atomic Absorption Spectrophotometry

Introduction, Principles, Advantages over FES, Instrumentation – Sources, Burners, Flames, Interferences – Spectral Interferences, Ionization Interferences, Refractory Compound Formation,Hallow cathode lamps, Physical Interferences, Use of Organic Solvents, Sample Preparation, Applications of AAS. Comparison of AAS with atomic emission methods

Ref.-1: 467 - 475

Ref. 2-6:Relevant Pages

UNIT 4:-Potentiometry (9L, 12M)

Potentiometer, The Cell for Potential Measurements, Combination Electrode, Theory of Glass Membrane Potential, The Alkaline Error, The Acid Error, Standard Buffers, Ion-selective Electrodes - Glass Membrane Electrodes, Precipitate Electrodes, Solid-State Electrodes, Liquid-Liquid Electrodes, Plastic Membrane/Ionophore Electrodes, Coated Wire electrodes, Enzyme Electrodes.

Ref.-1: 312-313,316-325

Ref.-2 -6: Relevant Pages

UNIT 5:-P^{H}metry (9L, 10M)

Introduction to pH meter, The Glass pH Electrode Principle, Accuracy of pH Measurements, Measurements with the pH-meter, Making the pH Measurement, Fundamental limitations, Maintenance.

Ref.-8: 327-333

Ref.-2 - 8: Relevant Pages

Reference Books:-

1. *Analytical Chemistry, G.D. Christian, 5th Edition.*
2. *Analytical Chemistry Principal- J. H. Kennedy. 2nd Edition (1990)*
3. *Analytical Chemistry, An Introduction, Skoog, West and Holler, 6 th Edition*
4. *Instrumental Method of Chemical Analysis, Chaitwal and Anand, 5th Edition.*
5. *Basic Concept of Analytical Chemistry, S.M. Khopkar*
6. *Instrumental Methods of Chemical Analysis- Willard, Merritt, Dean and Settle, 6th Edition*
7. *Introduction to Instrumental Analysis, R.D. Braun*
8. *Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas, 6th Edition,*

Important Instrument web links

Instruction Manual Operation Guide UV-1800 Shimadzu Spectrophotometer,

http://www.sustainable-desalination.net/wp-content/uploads/2013/05/UV-1800.pdf

Instruction Manual Operation Guide Agilent 5500 Series FTIR,

https://www.agilent.com/cs/library/usermanuals/public/5500_series_ftir_operation_manual.pdf

Instruction Manual Operation Guide Agilent 700 Series ICP Optical Emission Spectrometers,

https://www.agilent.com/cs/library/usermanuals/public/8510230100_700SeriesICP_UserManual.pdf

Instruction Manual Operation Guide Flame Atomic Absorption Spectrometry,

https://www.agilent.com/cs/library/usermanuals/Public/0009.pdf

Instruction Manual Operation Guide Potentiometry,

http://nhp.mowr.gov.in/docs/HP2/MANUALS/Water%20Quality/5014/-download-manuals-WaterQuality-WQManuals-32PotentiometricAna.pdf

http://shop.hannasingapore.com/media/pdf/2016-01-11-HI901C-Full.pdf

User Manual pH meter F-71, HORIBA, Ltd. 2011

http://library.metergroup.com/Manuals/Horiba/BenchtopPh/F-71%20Manual.pdf

Semester VI **Skill Enhancement Course**

CH-605

Subject- Analytical Techniques

(Theory: Lectures = 45 hrs, Marks 60) **(Credits: 03)**

Course Objectives

- To provide knowledge of instruments which are used in Chemical, Pharma, Petroleum, and insecticide and pesticide industry
- To increase student technical skill as per industry need.
- To develop an understanding of the range and uses of analytical methods in chemistry.

Learning Outcomes

- Compare the Instrumental methods and non instrumental methods and there advantages.
- Solve the problem of detection and separation using analytical instruments.
- Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.

UNIT 1:- Solvent Extraction **(9L, 12M)**

The Distribution Co-efficient, The Distribution Ratio, Percent Extracted, Solvent Extraction of Metals - Ion Association Complex and Metal Chelates, The Extraction Process, The Separation Efficiency of Metal Chelates, Analytical Separations, Multiple Batch Extractions, Countercurrent Distribution, Simple numerical problems on Percent Extracted and Multiple Extraction, Problems

Ref.1: 484 to 498.

Ref. 2-6: Relevant Pages

UNIT 2:- High-Performance Liquid Chromatography (9L, 12M)

Introduction, Principles, Equipment for HPLC, Choice of Column Materials for HPLC, Application

Ref.1: 537 to 545

Ref.2-6: Relevant Pages

UNIT 3:- Gas Chromatography (9L, 12M)

Introduction, Principles, Gas chromatography Columns, Gas Chromatography Detectors, Column Efficiency in Chromatography- Theoretical Plates, 1) Van Deemter Equation, 2) Capacity Factor and 3) Resolution, Problems

Ref.1: 522 to 528, 511 to 515

Ref.2-6:- Relevant Pages

UNIT 4:- Ion Exchange Chromatography (9L, 12M)

Introduction, Cation Exchange Resins, Anion Exchange Resins, Cross-linkage, Effect of pH Separation of Amino Acids, Effect of Complexing Agents-Separation of Metal ions on Anion Exchange Columns, Applications of Ion Exchange Chromatography

Ref.1: 517 to 522

Ref. 2-6: Relevant Pages

UNIT 5:-Thermal Methods (9L, 12M)

General Discussion, Thermogravimetry- Instruments for thermogravimetry, Applications of thermogravimetry, Differential Techniques- Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC), Instruments for DTA and DSC, Experimental and Instrumental Factors, Applications of DTA and DSC, Problems

Ref.-6: 503 - 519

Ref. 1-6: Relevant Pages

Reference Books:-

1. *Analytical chemistry, G.D. Christian, 5th Edition,*
2. *Instrumental Methods of Chemical Analysis, Chatwal and Anand*
3. *Basic Concept of Analytical Chemistry, S.M. Khopkar, 2nd edition,*
4. *Chemical Analysis by A. K. Shriwastawa, P. C.Jain, S. Chand and Company.*
5. *Quantitative Analytical Chemistry, James S. Fritz, George H.Schenk,5th Edition.*
6. *Vogel's Text Book of Quantitative Chemical Analysis, J. Mandham, R.C.Denney, J. D. Barnes, M. Thomas, B. Shivashankar, 6th Edition.*

Important Instrument web links

The LC Handbook Guide to LC Columns and Method Development,

https://www.agilent.com/cs/library/primers/public/LC-Handbook-Complete-2.pdf

Handbook and user manual of Gas chromatography

https://www.agilent.com/cs/library/usermanuals/Public/G3430-90011.pdf

Handbook and user manual of Ion Exchange Chromatography

https://www.agilent.com/cs/library/primers/Public/5991-3775EN_BioIEX_HowTo_LR.pdf

Handbook and user manual of Ion Differential Scanning Calorimetry

https://www.perkinelmer.com/CMSResources/Images/46-74542GDE_DSCBeginnersGuide.pdf

Semester V **Elective Course**

CH-506(A)

Subject- Biochemistry

(Theory: Lectures = 45 hrs, Marks 60) **(Credits: 03)**

Learning Objectives

- To study different types of biomolecules.
- To study structure of biomolecules.
- To study classification of each type of biomolecules.
- To study reactions of the biomolecules.
- Study of metabolism and thus, study of metabolic processes and reactions involved.
- To study energetics of the metabolic processes.
- Students should understand: Structure and role of Carbohydrates, Amino acids, Proteins, Enzymes, lipids, Nucleic Acids and energy rich compounds in biochemical reactions.

Course Outcomes

- Students will study biomolecules like carbohydrates, amino acids, proteins, enzymes, lipids and nucleic acids.
- Students will understand definitions, classifications and examples of these biomolecules.
- Students will learn the detailed structure of these biomolecules along with types of bonds or linkages present in their molecules.
- Students will learn the chemical properties of these biomolecules and the action of some reagents on them in the form of reactions or graphical presentation.
- Students will understand biochemical energetics of common energy rich compounds along with hydrolytic reactions.

- Students will learn metabolisms like Glycolysis, TCA cycle, Transamination, deamination and β- oxidation through reactions, enzymes involved, outlines and energetics.

Unit 1. Carbohydrates (L-09, M-12)

a) Introduction, definition, classification.

b) Monosaccharaides: structure of glucose (open chain and ring structures). Kiliani Fischer synthesis of D-glucose. Reactions of glucose: oxidation with bromine water and nitric acid, reduction, acetylation, addition of HCN, NH_2OH and phenyl hydrazine, mutarotation.

c) Disaccharides: structure of sucrose, lactose and maltose.

d) Polysaccharides: storage polysaccharides, structure of starch, Structural polysaccharides, structure of cellulose.

Ref 1 and 2: Relevant pages

Unit 2. Amino Acids and Proteins (L-09, M-12)

a) Amino acids: Introduction, structure of ammo acids, classification of amino acids, amphoteric nature of amino acids, reactions of amino acids: with FDNB and Dansyl chloride, formation of peptide bond

b) Proteins: Introduction, classification of proteins: based on functions and based on shape, structure of proteins: primary, secondary, tertiary and quaternary structure). Study of some proteins: α keratins and hemoglobin. Separation of amino acids and proteins by paper electrophoresis and dialysis

Ref 1 and 2: Relevant pages

Unit 3. Enzymes and Lipids (L-09, M-12)

a) Enzymes: Introduction, specificity of enzymes, classification, role of enzymes in biochemical reactions, Michaelis Menten equation (no derivation). Effect of substrate concentration, P^H and temperature on enzyme catalyzed reactions. Enzyme inhibitors: introduction and types.

b) Lipids: Introduction, classification of lipids, fatty acids, nomenclature of fatty acids, triacyl glycerols, hydrogenation of oils, Saponification value and iodine value of oils, phospholipids and waxes.

Ref 1 and 2: Relevant pages

Unit 4. Nucleic Acids and Energy Rich Compounds (L-09, M-12)

a) **Nucleic acids**: Introduction, Components of nucleic acids: sugars, bases, nucleosides and nucleotides. Watson and Crick model of DNA, types of RNA (structure not expected)

b) **Energy rich compounds**: Introduction, Pyrophosphates, acyl phosphates, enolic phosphates, thiol esters (structure, hydrolytic reaction and energetics). Energy carriers in biological redox systems: NAD^+ and FAD

Ref 1 and 2- Relevant pages

Unit 5. Metabolism (L-09, M-12)

Definition of metabolism,

a) Carbohydrate metabolism: Glycolysis: reactions involved and energetics, TCA cycle (Kreb cycle): Reactions involved and energetic

b) Amino acid Metabolism: Transamination, deamination (by enzymes - glutamic dehydrogenase, ammonia lyases, deaminases and deamidases), decarboxylation

c) Lipid Metabolism: β- oxidation of fatty acids, reactions involved in β –oxidation, energetics of β –oxidation of palmitic acid.

Ref 1 and 2- Relevant pages

Reference Books

1. *Outlines of Biochemistry, Conn and Stumpf (4th Edition)*
2. *Principles of Biochemistry, A. L. Lehninger (2nd Edition)*

Semester V **Elective Course**

CH-506(B)

Subject- Green Chemistry

(Theory: Lectures = 45 hrs, Marks 60) **(Credits: 03)**

Course Objectives:

- There is rising concern since 1970 about environmental pollution, depleting resources, climate change, ozone depletion, legislation which is getting stringent with strict environmental laws, rising cost of waste deposits, health concern and so on.
- We are facing the challenge to work towards sustainable development. Since 1990, today's society is moving towards becoming more and more environmentally conscious.
- Green chemistry has been introduced in1990 for overall sustainable development against the environmental concerns.
- Green chemistry is not a new branch of chemistry, but it is a new way chemistry, which should be practiced regularly.
- Innovations and applications of green chemistry in education has helped companies not only to gain environmental benefits but at the same time to achieve economic and societal goals also.
- This is possible because these undergraduate students are ultimate scientific community of tomorrow.

Learning Outcomes:

- With this course, the graduate students will be able to understand the twelve principles of green chemistry that will help to build the basic understanding of toxicity, hazards and risk of chemical substances.
- The course will help to understand stoichiometric calculations and relate them to green chemistry metrics. The students will learn about atom economy and understand its importance over percentage yield.

- The students will learn to design safer chemicals, products and processes that are less toxic than the conventional chemistry, understand significance of catalysis, use of renewable feed stock, renewable energy sources, importance of green solvents, etc.
- The course will train the students to appreciate green chemistry and boost the students to think and develop the skills to innovate and search for the solutions to environmental problems.
- Green chemistry is only way of future chemistry to ensure sustainability with absolute zero waste. The success stories and real-world cases will motivate the young generation to practice green chemistry.

UNIT 1. Introduction to Green Chemistry **(L-04, M-04)**

Definition of Green Chemistry. Drawbacks of conventional chemistry. Need of Green Chemistry, Minamata Disease. Goals of Green Chemistry

Ref:1 Relevant Pages

Ref:6 Relevant Pages

UNIT 2. Principles of Green Chemistry and Designing a Chemical Synthesis **(L-12, M-18)**

Twelve principles of Green Chemistry, role of Paul T. Anastas, importance of green chemistry with examples: Prevention of waste/by-products, Atom economy, Prevention or Minimization of hazardous products, Designing safer chemicals, Energy requirements for synthesis, Selection of suitable solvents, Selection of starting materials, Use of protecting groups, Use of catalysts, Designing of biodegradable products, Prevention of chemical accidents, Strengthening of analytical techniques, industrial safety.

Ref:1 Relevant Pages

Ref:2 Relevant Pages

UNIT 3. Techniques in Green Chemistry **(L-12, M-16)**

a) Microwave assisted synthesis- Introduction and importance, Applications- Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction,Hofmann Elimination.

b) Ultrasound assisted reactions- Introduction and importance, Application- Esterification, saponification, aromatic substitution reactions, alkylation, oxidation, reduction.

Ref:1 Relevant Pages

Ref:3 Relevant Pages

UNIT 4. Solvents, Reagents and Catalysts in Green Chemistry (L-14, M-18)

a) Solvents- Introduction and Importance, Examples-Michael Addition in water, Bis-indolyl methane in ionic liquid, tetrazole synthesis in deep eutectic solvent.

b) Reagents- Introduction and Importance, Examples- Alkylation using dimethyl carbonate, Solid phase peptide synthesis using Merrifield reagent.

c) Catalysts- Introduction and Importance, Examples- Reduction of carbonyl group using Baker's yeast, Esterification using Lipase enzyme, Zeolite clay and Cyclodextrin.

Ref:1 Relevant Pages

Ref 2: Relevant Pages

UNIT 5. Future Trends in Green Chemistry (L-03, M-04)

Biomimetic, Photochemical reactions, Multifunctional Reagents, Green chemistry in sustainable development.

Ref:1 Relevant Pages

Ref 3: Relevant Pages

Ref 5: Relevant Pages

Reference Books:

1. *New Trends in Green Chemistry, V.K. Ahluwalia and M.R. Kidwai: Anamalaya Publishers (2005).*
2. *Green Chemistry- Theory and Practical, P.T. Anastas and J.K. Warner: Oxford University Press (1998).*
3. *Introduction to Green Chemistry, A. S. Matlack: Marcel Dekker (2001).*
4. *Real-World Cases in Green Chemistry, M.C. Cann & M.E. Connely: American Chemical Society, Washington (2000).*
5. *Introduction to Green Chemistry, M. A. Ryan & M. Tinnesand, American Chemical Society, Washington, (2002).*
6. *Silent Spring, Rachel Carson, Houghton Mifflin Company, (1962).*

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Semester VI **Elective Course**

CH-606(A)

Subject- Polymer Chemistry

(Theory: Lectures = 45 hrs, Marks 60) **(Credits: 03)**

Learning Objectives

- The course offers the basic concepts of polymer, polymerization, classes of polymers, important properties, and poly(lactic acid) as a biodegradable polymer.
- The course also offers to study preparation, properties, and applications of industrially important selected polymers.
- The course will give chance to study various mechanisms of polymerization and learn different techniques of polymerization.
- The student will be able to understand glass transition temperature and factors affecting on it and various ways to express molecular weight of polymers.

Course Outcomes

After completing this course, the graduate should be able to

- Define terms like monomer, polymer, polymerization, polydispersity index, etc., classify polymers based on their origin, native backbone chain, and thermal response.
- Know glass transition temperature and its determination, various ways to express molecular weights of polymers and polydispersity index.
- Identify different mechanisms of polymerizations *viz*. free radical, ionic, and condensation polymerizations.
- Distinguish techniques of polymerization based on physical conditions required for the preparation of polymers in laboratory or industry.
- Familiar with preparation, properties, and applications of industrially important selected polymers.

UNIT 1. Basic Concepts of Polymers **(L-09, M-12)**

Introduction, brief history, monomers and polymers, degree of polymerization, functionality, linear, branched and cross linked polymers, homopolymers, Types of copolymers:- random, alternate, block and graft copolymers, Tacticity (stereochemistry) of polymers: isotactic, syndiotactic and atactic polymers. Classification of polymers:- based on a) origin- natural and synthetic polymers b) native backbone chain – organic and inorganic polymers c) thermal response – thermoplastic and thermo setting polymers d) ultimate form and use – plastic, elastomer, fibre and liquid resin, Degradation of polymers:- types of degradation: chain end and random degradations.

Ref. 1 and 2: Relevant pages

UNIT 2. Chemistry of Polymerization **(L-09, M-12)**

Introduction, chain growth polymerization (initiation, propagation, termination, and kinetics): free radical polymerization, ionic (cationic and anionic) polymerizations, step growth polymerization (mechanism and kinetics), ring opening polymerization.

Ref. 1 and 2: Relevant pages

UNIT 3. Polymerization Techniques & Polymer Processing Techniques **(L-9, M-12)**

Polymerization techniques: - Bulk polymerization, solution polymerization, suspension polymerization, emulsion polymerization, interfacial condensation polymerization.

Polymer processing techniques:- Calendaring, die casting, film casting, and compression moulding.

Ref. 1 and 2: Relevant pages

UNIT 4. Study of Some Important Polymers **(L-09, M-12)**

Preparation, properties and applications of - Polyethylene [PE], Polypropylene [PP], Poly(vinyl chloride) [PVC], Polystyrene [PS], Polyacrylonitrile [PAN], Polycarbonates [PC], Phenol-formaldehyde resins [PF], Epoxy resins, Polyester - Polyethyleneterephthalate[PET], Polyamides (Nylon-6 and Nylon-6,6), Poly(vinyl alcohol) [PVA], Poly(lactic acid) [PLA], Polyaniline, and Polybutadiene.

Ref. 1 and 2: Relevant pages

UNIT 5. Glass Transition Temperature (L-09, M-12)

Glass transition temperature:- Definition and explanation, factors affecting glass transition temperature, Glass transition temperature and molecular weight, Glass transition temperature and melting point, importance of glass transition temperature, determination of glass transition temperature by dilatometry.

Molecular weights of polymers:-types of molecular weights-number average molecular weight, weight average molecular weight, viscosity average molecular weight, sedimentation average molecular weight, and poly dispersity index.

Ref. 1 and 2: Relevant pages

Reference Books

1. *Polymer Science, V. R. Govarikar, N. V. Viswanathan, JayadevSreedhar, New Age International (P) Ltd., New Delhi, 1997.*
2. *Text books of Polymer Science, F. W. Billmeyer, John Wiley & Sons; 3rd edition,1984.*

Semester VI **Elective Course**

CH-606(B)

Subject- Research Methodology for Chemistry

(Theory: Lectures = 45 hrs, Marks 60) **(Credits: 03)**

Course Objectives:

- To familiarize students towards basics of research, process of research and methods.
- To enable the student in conducting research work and formulating research synopsis and report.
- To learn the analysis of primary research articles and peer review articles.
- To improve student understanding of how scientific questions are developed and posed through proposals and dissemination of research results.
- To learn the scientific method of collecting and analyzing information.
- To learn the presentation of scientific information
- To aware the students about proper laboratory safety and techniques.

Learning outcomes:

The learning outcomes for this course of the following Chemistry Graduate Program Goals:

- Students will learn about what is research, research methods and impact of chemical research on society through pure and applied research.
- Students will learn how to analyze research in chemistry drawn from contemporary primary chemical literature.
- Student will formulate thesis topic, explain its significance and propose the methodology to be used in the thesis topic research.
- Student will demonstrate proficiency in scientific writing which includes:

- Ability to interpret and synthesize primary research literature related to the student's thesis topic.
- Ability to write a coherent narrative that explains the significance of the thesis research with regard to the primary research literature.
- Ability to report original research results in a coherent narrative.
- Ability to explain and defend conclusions draw from original results in narrative form.
- Prepare and present scientific topics orally utilizing presentation software such as PowerPoint.

- Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
- Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- Students will be able to communicate the results of scientific work in oral, written and electronic formats.
- Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behaviour in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.

UNIT 1: Introduction to Research (L-9, M-12)

Definition of Research, Objectives of Research, Importance, and need for Research in a related field. Motivation in Research Methods versus Methodology, Classification and types of Research, Pure and applied Research, Difference between Computational lab and wet lab research, theoretical and experimental models, Criteria of Good Research Application of theoretical knowledge in designing of experiments. Methods of Data Collection

List of National Importance Institutes and List of CSIR Laboratories

Ref. 3: 1-24.

UNIT 2: Print Literature Resources (L-9, M-12)

Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index with examples.

Ref. 1: 299-317;

Ref. 2: 1569-1603

UNIT 3: Digital Literature Resources (L-9, M-12)

The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information. Web resources, E-journals, Journal access, TOC alerts, Citation index, Impact factor, H-index, UGC infonet, E-books. The introduction of Search engines, Scirus, Google, Google Scholar, Chem Industry, Wiki- Databases, ChemSpider, American Chemical Society, Royal Society of Chemistry, Wiley-inter science, Science Direct, Springer, SciFinder, Scopus, C&EN News Reaxys.

Ref. 1: 299-317;

Ref. 2:1569-1603

UNIT 4: Writing Scientific Reports (L-9, M-12)

Writing Skills, Reporting practical and project work, Referencing, Organizing a poster display. Communication Skills, Body Language, Giving an oral presentation. Content of Research Papers, How to download Research Paper? How to Read Research Paper, Abstract and Summary. What are Paper, Patent and Review? Introduction of Plagiarism and self Plagiarism.

Ref. 1: 325-348; Ref. 3: 344-360.

UNIT: 5 Chemical Safety and Ethical Handling of Chemicals (L-9, M-12)

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, incineration and transportation of hazardous chemicals.

Ref. 6: 1.31–1.36, 1.40, 2.1-2.16, 5.79-5.85, 7.41-7.50, 8.25-8.31.

Reference Books:

1. *Practical Skills in Chemistry, 2nd Ed, .Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. and Jones, A. Prentice-Hall, Harlow (2011)*
2. *APPENDIX A: The Literature of Organic Chemistry March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Seventh Edition, by Michael B. Smith and Jerry March Copyright John Wiley & Sons, Inc. (2013)*
3. *Research Methodology: Methods And Techniques, 3rd edition, Kothari, C.R. Published by New Age International (P) Ltd., Publishers (2004),*
4. *How to Use Excel in Analytical Chemistry and in general Scientific Data Analysis. Levie, R. de, Cambridge Univ. Press (2001).*
5. *Chemical Safety Matters – IUPAC – IPCS, Cambridge University Press, (1992).*
6. *OSU Safety Manual 1.01*
7. *Laboratory Safety for Chemistry Students, Hill R. H., Finster D. C. 8th ed.; John Wiley and Sons: Hoboken, NJ, March (2017).*

T.Y.B.Sc. Chemistry

Semester -V **Course No:- CH-507**

Subject: Physical Chemistry Practical

(Practical: Lectures = 60 hrs, Marks 60) **(Credits: 02)**

Course Objectives

- To develop skills required in chemistry such as the appropriate handling of apparatus, instruments and chemicals.
- The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research.
- To expose the students to an extent of experimental techniques using modern instrumentation.
- The student will develop the ability to effectively communicate scientific information and research results in written and oral formats.

Learning Outcomes

- Students will get basic analytical and technical skills to work effectively in the various fields of chemistry.
- Students will able to calibrate and handle instruments like conductometer, potentiometer, pH meter, colorimeter, spectrophotometer, polarimeter.
- They have ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.
- They get skills required in chemistry such as the proper handling of apparatus and chemicals.
- They will have ability to present scientific and technical information resulting from laboratory experimentation in both written and oral formats.

- Students will apply conductometer, potentiometer, pH meter, colorimeter, spectrophotometer, polarimetery techniques for analysis and measurement.

Instructions:

- The student should perform at least 10 experiments from each semester. It is expected to perform at least one experiment from each technique.
- Use dilute solutions and in minimum amount.
- Use 50 ml volumetric flasks for preparation of solutions
- Scientific calculators (non-programmable) and practical handbooks are allowed during practical examination.

Conductometry:

1. Conductometric titration of mixture of acids and hence determine the strength of acids.
2. Determine the degree of hydrolysis and hydrolysis constant of sodium acetate conductometrically.

Potentiometry:

1. Determine Ecal and pH of buffer solution (Citric acid + Na_2HPO_4) using quinhydrone electrode.
2. Determine the pKa and Ka of weak monobasic acid by potentiometric titration.

P^{H}metry:

1. Determine the amount of aspirin in the given tablet.
2. Determine the pKa of various mixtures of sodium acetate and acetic acid in solution and hence to find the dissociation constant.

Polarimetry:

1. To study the kinetics of inversion of cane sugar by polarimeter.
2. Determine the concentration of given solution of an optically active substance (cane sugar) by polarimetric measurement.

Flame Photometry:

3. Estimation of Na / K by flame photometer in the given sample.

Refractometery:

1. Determine the refractive indices of series of KCl solution and hence unknown concentration of given KCl solution**.**

Chemical Kinetics:

1. Study the hydrolysis of methyl acetate in presence of hydrochloric acid.
2. Determine the energy of activation of the reaction between $K_2S_2O_8$ and KI. (Equal initial concentration)
3. Investigate the kinetics of iodination of acetone (zero order reaction).

Viscosity:

1. Determine the molecular weight of high polymer using its solution of different concentration.

Partition coefficient:

1. Determine the partition coefficient of iodine between carbon tetrachloride and water**.**

T.Y.B.Sc. Chemistry

Semester -VI **Course No:- CH-607**

Subject: Physical Chemistry Practical

(Practical: Lectures = 60 hrs, Marks 60) **(Credits: 02)**

Instructions:

- The student should perform at least 10 experiments from each semester. It is expected to perform at least one experiment from each technique.
- Use dilute solutions and in minimum amount.
- Use 50 ml volumetric flasks for preparation of solutions.
- Scientific calculators (non programmable) and practical handbooks are allowed during practical examination

Conductometry:

1. Determine the relative strength of monochloro acetic acid and acetic acidconductometrically.
2. Determine the basicity of organic acid by conductometric measurement.

Potentiometry:

1. Determine the amount of sodium chloride in a given solution by potentiometric titration with silver nitrate.
2. Determine formal redox potential of Fe^{2+} to $Fe^{3+}$by potentiometric titration.

Colorimeter / Spectrophotometer:

1. Determination of λ max and concentration of unknown Cu^{2+} solution and verify Beer's law.
2. Verify Beer's law, determine unknown concentration and molar extinction coefficient of Potassium permanganate.

P^Hmetry:

1. Determine the pKa and Ka of weak monobasic acid by pH metric titration.
2. Determine the degree of hydrolysis and hydrolysis constant of aniline hydrochloride pH metrically.

Polarimetry:

1. Determine the percentage of two optically active substances (d- sucrose and d-tartaric acid) in a mixture polarimetrically**.**

Radioactivity:

1. Determine the E_{max} of Beta particle.

Refractometry:

1. Determine the refractive index of four liquids, hence specific and molarrefraction.
2. Determine the molar refraction of homologous methyl, ethyl and propylalcohol and show that constancy configuration to molar refraction by $-CH_2$group.

Chemical Kinetics:

1. Investigate the reaction between H_2O_2 and KI by gas burette method.
2. Determine the order of the reaction between potassium persulphate and potassium iodide by fractional change method.

Viscosity:

1. Determine the radius of glycerol/sucrose molecule by viscosity measurement.

References:-

1. *Findley's Practical Physical Chemistry, B.P.Levitt, 9th Edition, Longman group Ltd.*
2. *Advanced Physical Chemistry Experiments, J.N.Gurtu and Amit Gurtu, Pragati Prakashan*
3. *Systematic Experimental Physical Chemistry S.W. Rajbhoj, Dr. T.K. Chondekar, 3rd edition, Anjali Publication, Aurangabad.*
4. *Experimental Physical Chemistry, V.D.Athawale, P. Mathur, New age International Ltd,New Delhi.*
5. *Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publishing House, Meerut*
6. *Advanced Practical's in Physical Chemistry. Dr. Pande, Dr. Mrs. Datar, Dr. Mrs. Bhadane, 4th revised Edition, Manali Publication, Pune.*
7. *Experimental Physical Chemistry, R.C. Das, B.Behra, Tata McGrawHill.*

STRUCTURE OF INTERNAL PRACTICAL EXAMINATION

Time allowed – 3 Hours **Marks – 40**

Q.1 Any One experiment from (CH-507/607)	**30 Marks**
Q.2 Oral	**10 marks**

	Total: 40 Marks

STRUCTURE OF EXTERNAL PRACTICAL EXAMINATION

Time allowed: 3 Hours **Marks: 60**

Semester V (CH-507)

Q. 1. Any One experiment from CH-507	**40 Marks**
Q.2 Oral	**10 Marks**
Q.3 Certified Journal	**10 Marks**

	Total: 60 Marks

STRUCTURE OF EXTERNAL PRACTICAL EXAMINATION

Time allowed: 3 Hours **Marks: 60**

Semester VI (CH-607)

Q. 1. Any One experiment from CH-607)	**40 Marks**
Q.2 Oral	**10 Marks**
Q.3 Certified Journal	**05 Marks**
Q.4 Industrial Tour Report	**05 Marks**

-

Total: 60 Marks

T.Y.B.Sc. Chemistry

Semester -V **Course No:- CH-508**

Subject: Inorganic Chemistry Practical

(Practical: Lectures = 60 hrs, Marks 60) **(Credits: 02)**

Course Objectives:

- To analyze the inorganic mixtures.
- To determine metal from ore and alloy analysis.
- Using colorimetric analysis to determine amount of metal.

Learning outcomes:

- Student will able to determine cation & anion from inorganic mixtures by using qualitative analysis.
- Student will able to determine metal from ore & alloys.
- Students will be able to design & carry out scientific experiments as well as accurately record & analyze the results of experiments.
- Students will be able to handle colorimeter for estimation of metal ions.

1. **Inorganic Qualitative Analysis: (Any Five)**
   Binary mixtures containing common anions (Excluding phosphates and borates)
2. **Ore Analysis: (Any Two)**
   i) Heamatite ore - Estimation of Iron volumetrically
   ii) Pyrolusite ore- Estimation of Manganese volumetrically
   iii) Dolomite ore - Estimation of Calcium volumetrically
3. **Alloy Analysis: (Any Two)**
   i) Estimation of Zn from Brass alloy .
   ii) Estimation of Tin gravimetrically as SnO_2 from solder alloy.
   iii) Estimation of Copper iodometrically from nichrome alloy.
   iv) Determination of iron gravimetrically from stainless steel.
4. **Colourimetric analysis (any one)**
   i) Colourimetric titration of Cu(II) against EDTA method .
   ii) Estimation of Titanium using hydrogen peroxide.

IMPORTANT NOTE:

- For volumetric analysis pipette out solution should be 10 ml
- Preparation of stock solution or standard solution should be in **100/50ml volumetric flask** in order to avoid wastage of chemicals.

References

1. *A Text Book of Quantitative Inorganic Analysis, A. I. Vogel, 4th edition*
2. *Vogel's Qualitative Inorganic Analysis, A. I. Vogel.*
3. *Practical Chemistry, O. P. Pandey, D. N. Bajpai, S. Giri, S. Chand Publication, New Delhi.*
4. *Post Graduate Practical Chemistry, H. N. Patel, S. P. Turakhia, S. S. Kelker, S. **R.** Puniyani, Himalaya Publishing House.*
5. *College Practical Chemistry, H. N. Patel, S. P. Turakhia, S. S. Kelker, S.R. Puniyani, Himalaya Publishing House.*
6. *Practical Chemistry, K. K. Sharma, D. S. Sharma, Vikas Publication.*

T.Y.B.Sc. Chemistry

Semester -VI **Course No:- CH-608**

Subject: Inorganic Chemistry Practical

(Practical: Lectures = 60 hrs, Marks 60) **(Credits: 02)**

Course Objectives:

- To determine metal from gravimetric estimations.
- To determine amount of metal by volumetric analysis.
- To determine preparation /synthesis of co-ordination compound.
- To study separation techniques of metals.
- To use colorimetric analysis of metal.

Learning Outcomes:

- Students will be able to prepare co-ordination compounds.
- Students will be able to determine amount of metal by using quantitative analysis.
- Students will be able to calculate Rf value of metal.
- Students will be able to design & carry out scientific experiments as well as accurately record & analyze the results of experiments.
- Students will be able to explain why chemistry is an integral activity for addressing social, economic & environmental problems.

1. **Gravimetric Estimations: (Any Two)**
   i) Fe as Fe_2O_3
   ii) Zn as $Zn_2P_2O_7$
   iii) Pb as lead chromate
   iv) Al as Al_2O_3
2. **Volumetric Analysis: (Any Two)**
   i) Manganese by Volhards method.
   ii) Estimation of Nickel by EDTA method.
   iii) Determination of strength of NaOH and Na_2CO_3 in a given solution.

iv) Estimation of ferrous and ferric by dichromate method.

3. **Inorganic Preparations: (Any Three)**

i) Bis (ethylenediamine) copper (II) sulphate.

ii) Potassium trioxalato chromate (III).

iii) Tris (acetylacetonato) Iron (III).

iv) Hexaaquonickel (II) chloride.

v) Potassium tris oxalatoaluminate (III)trihydrate.

vi) Synthesis of ZnO nanoparticles using Zinc acetate dihydrate

4. **Colourimetric Analysis: (Any One)**

i) Estimation of iron using thiocynate method.

ii) To determine the concentration of cobalt in the given solution using R-nitroso salt by colourimetry.

5. **Paper Chromatography: (Any Two mixtures)**

Separation and identification of binary mixture of cations (Fe^{3+},Ni^{2+}, Cu^{2+},Co^{2+}, Mn^{2+},Zn^{2+})

IMPORTANT NOTE:

- For volumetric analysis pipette out solution should be 10 ml
- Preparation of stock solution or standard solution should be in **100/50 mL volumetric flask** in order to avoid wastage of chemicals.

References:

1. *A Text Book of Quantitative Inorganic Analysis, 4th edition, A. I. Vogel,*
2. *Vogel's Qualitative Inorganic Analysis, A. I. Vogel.*
3. *Practical Chemistry, O. P. Pandey, D. N. Bajpai, S. Giri, S. Chand Publication, New Delhi.*
4. *Post Graduate Practical Chemistry, H. N. Patel, S. P. Turakhia, S. S. Kelker,* ***S.*** *R. Puniyani, Himalaya Publishing House.*
5. *College Practical Chemistry, H. N. Patel, S. P. Turakhia, S. S. Kelker, S.R. Puniyani Himalaya Publishing House.*
6. *Practical Chemistry, K. K. Sharma, D. S. Sharma, Vikas Publications.*

STRUCTURE OF PRACTICAL EXAMINATION

Inorganic Chemistry Practical

CH-508, Semester-V

Internal Examination Pattern

Time Allowed: 3Hrs. **Max. Marks: 40**

Q 1. Inorganic Qualitative Analysis/Ore Analysis/ Alloy Analysis	**30 Marks**
Q 2. Oral	**10 Marks**
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	40 Marks

External Examination Pattern

Time Allowed: 3Hrs. **Max. Marks: 60**

Q 1. Inorganic Qualitative Analysis/Ore Analysis/ Alloy Analysis	**40 Marks**
Q 2. Oral	**10 Marks**
Q 3. Journal (completed and certified)	**10 Marks**
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	60 Marks

Inorganic Chemistry Practical

CH-608, Semester-VI

Internal Examination Pattern

Time Allowed: 3Hrs. Max. Marks: 40

Q 1. Gravimetric Estimations/Volumetric Analysis/colorimetric Analysis/ Inorganic Preparation and Paper Chromatography	**30 Marks**
Q 2. Oral	**10 Marks**
	40 Marks

External Examination Pattern

Time Allowed: 3Hrs. Max. Marks: 60

Q 1. Gravimetric Estimations/Volumetric Analysis/colorimetric Analysis/ Inorganic Preparation and Paper Chromatography	**40 Marks**
Q 2. Oral	**10 Marks**
Q 3. Journal (completed and certified)	**05 Marks**
Q 4. Industrial Tour Report	**05 Marks**
	60 Marks

T.Y.B.Sc. Chemistry

Semester -V **Course No: - CH-509**

Subject: Organic Chemistry Practical

(Practical: Lectures = 60 hrs, Marks 60) **(Credits: 02)**

Course Objectives

- To develop skills required in chemistry such as the appropriate handling of apparatus and chemicals.
- The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research.
- To expose the students to an extent of experimental techniques using modern instrumentation.
- The student will develop the ability to effectively communicate scientific information and research results in written and oral formats.

Learning Outcomes

- Separate and analyze binary water insoluble mixture.
- Separate and analyze binary water soluble mixture.
- Estimate - Acetamide, Glucose and Glycine by volumetric method,
- Estimate basicity of various acids.
- Synthesis of various organic compounds through greener alternatives.
- Understand Thin Layer Chromatographic techniques and physical constant.
- Understand the purification technique use in organic chemistry.

I) Separation of Binary Mixtures and Qualitative Analysis **(Any 6)**

a) Solid-Solid (4 Mixtures) b) Solid-Liquid (1 Mixture) c) Liquid-Liquid (1 Mixture)

At least one mixture from each of the following should be given-Acid-Base, Acid-Phenol, Acid-Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral and Neutral- Neutral. (Solid-solid mixtures must be insoluble in water)

Note:

- Students are expected to determine type of the mixture and to separate the mixture.
- Separation of the Mixture should be done by chemical method only.
- It is expected to perform preliminary tests, physical constants, detection of elements and determination of functional groups of separated compounds.
- On the basis of above tests, students are expected to determine structure of compounds.
- The separated compounds should be purified and then melting point of purified compound should be determined. The purified samples of the separated components should be submitted.
- Separation and qualitative analysis of the binary Mixtures should be carried out on micro scale using micro scale.

II) Organic Estimations **(Any 2)**

1. Estimation of acetamide
2. Estimation of basicity (Number of -COOH groups) of acid
3. Estimation of glycine
4. Saponification value of oil

III) Green Chemistry Preparation **(Any 2)**

1. Synthesis of acetanilide from aniline by using Zn dust / acetic acid.
2. Synthesis of dibenzalpropanone from benzaldehyde and acetone. using $LiOH.H_2O/NaOH$
3. Synthesis of p- bromo acetanilide from acetanilide by using KBr.
4. Synthesis of dihydropyrimidinone from ethyl ace to acetate, benzaldehyde and urea
5. Diels-Alder reaction between furan and maleic acid [4+2] Cycloaddition Reaction

T.Y.B.Sc. Chemistry

Semester -VI **Course No:- CH-609**

Subject: Organic Chemistry Practical

(Practical: Lectures = 60 hrs, Marks 60) **(Credits: 02)**

I) Organic preparations **(Any 6)**

1. Benzoquinone from Hydroquinone (Oxidation by $KBrO_3$ or $K_2Cr_2O_7$)
2. Preparation of Sudan-I (Diazocoupling)
3. p-nitroacetanilide from Acetanilide (Nitration)
4. 2-Naphthyl ether from 2-Naphthol (Methylation by DMS, NaOH)
5. Hippuric acid from Glycine (Benzoylation)
6. p-Iodonitrobenzene from p-Nitroaniline (Sandmeyer Reaction)
7. m- Nitro aniline from m-Dinitrobenzene (Reduction)
8. Benzoic acid from Ethyl benzoate (Ester hydrolysis)
9. Isolation of Starch from Potato
10. Adipic acid from Cyclohexanone (Oxidation by Con. HNO_3)

II) Preparation of derivatives **(Any 3)**

1. Oxime derivative of aldehydes or Ketones
2. Aryloxy acetic acid derivative of Phenol
3. 2, 4 DNP derivative of aldehydes or Ketones
4. Glucosazone derivative of Glucose
5. Anilide derivative of acid

III) Purification techniques **(Any 1)**

1. Solvent extraction using separating funnel
2. Preparative TLC
3. Steam distillation

Note:

- The Preparation or derivative should be carried out on small scale and the starting compound should not be given more than one gm.

- Purity of the sample in Preparation and derivative can be checked by thin layer Chromatography (TLC).
- If product is impure, it should be purified.
- The Head of the Department must see that the industrial tour will be arranged collectively by the Department staff members.

Reference Books

1. *Practical Organic Chemistry, A. I. Vogel, Pearson, 5th Edition, 2005.*
2. *Practical Organic Chemistry, O. P. Agarwal, Krishna Prakashan Media (P) Ltd, 2014.*
3. *University Practical Chemistry, P. C. Kamboj, Vishal Publishing Co.; 1st (Reprint) Edition, 2013.*
4. *Comprehensive Practical Organic Chemistry-Qualitative Analysis, V. K. Ahluwalia and Renu Aggarwal, Universities Press, 2016.*
5. *R.B. Woodward and H. Baer, J. Am. Chem. Soc. 1948, 70, 1161.*
6. *D. C. Rideout and R. Breslow, J. Am. Chem. Soc. 1980, 102, 7816.*
7. *Green Chemistry: Theory and Practice, Anastas, P.T and Warner, J.C. Oxford University Press (1998).*
8. *Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, DST*

STRUCTURE OF INTERNAL PRACTICAL EXAMINATION

Time allowed – 3 Hours **Marks – 40**

Q.1 Any One experiment from CH-509/609)	**30 Marks**
Q.2 Oral	**10 marks**

STRUCTURE OF EXTERNAL PRACTICAL EXAMINATION

Time allowed: 3 Hours **Marks: 60**

Semester V (CH-509)

Q.1 Separation of Binary Mixtures and Qualitative Analysis of any one Compound **OR** Organic Estimation **OR** Green Chemistry Experiment	**40 Marks**
Q.2 Oral	**10 Marks**
Q.3 Journal (completed and certified)	**10 Marks**

Semester VI (CH-609)

Q.1 Organic Preparation / Derivative / Purification technique	**40 Marks**
Q.2 Oral	**10 Marks**
Q.3 Journal (completed and certified)	**05 Marks**
Q.4 Industrial Tour Report	**05 Marks**

Instructions

- In case of binary mixture experiment, examinee should identify type of mixture and should separate the mixture. After separation, examiner should ask the examinee to analyze any one compound from the mixture.
- In case of preparation of organic compounds and derivatives, product should be purified by recrystallization.
- Industrial tour is compulsory for each student.

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon
T.Y.B.Sc Chemistry
(CBCS) Pattern equivalence

Equivalence in accordance with titles and contents of papers (for revised syllabus from June 2020) are as follows…

Sr. No.	Title of Old Paper		Title of New Paper	
	Semester-V			
1.	CH -351	Physical Chemistry	CH – 501	Principles of Physical Chemistry-I
2.	CH -352	Inorganic Chemistry	CH – 502	Inorganic Chemistry
3.	CH -353	Organic Chemistry	CH – 503	Organic Reaction Mechanism
4.	CH -354	Analytical Chemistry	CH – 504	Industrial Chemistry
5.	CH -355	Industrial Chemistry	CH – 505	Analytical Instrumentation
6.	CH -356 (A)	Bio Chemistry	CH – 506 (A)	Biochemistry
7.	CH -356 (B)	Environment Chemistry	CH – 506 (B)	Green Chemistry
8.	CH -357	Physical Chemistry Practical	CH – 507	Physical Chemistry Practical
9.	CH -358	Inorganic Chemistry Practical	CH – 508	Inorganic Chemistry Practical
10.	CH -359	Organic Chemistry Practical	CH – 509	Organic Chemistry Practical
11.	Non-Credit Audit Course **(Any One)**		AC-510	NSS
			AC-511	NCC
			AC-512	Sports
	Semester-VI			
1.	CH -361	Physical Chemistry	CH - 601	Principles of Physical Chemistry-II
2.	CH -362	Inorganic Chemistry	CH - 602	Novel Inorganic Solids
3.	CH -363	Organic Chemistry	CH - 603	Spectroscopic Methods of Structure Determination
4.	CH -364	Analytical Chemistry	CH - 604	Chemistry of Industrially Important Products
5.	CH -365	Industrial Chemistry	CH - 605	Analytical Technique
6.	CH -366 (C)	Polymer Chemistry	CH – 606 (A)	Polymer Chemistry
7.	CH -366 (D)	Chemistry In Every Day Life	CH – 606 (B)	Research Methodology for Chemistry
8.	CH -367	Physical Chemistry Practical	CH – 607	Physical Chemistry Practical
9.	CH -368	Inorganic Chemistry Practical	CH – 608	Inorganic Chemistry Practical
10.	CH -369	Organic Chemistry Practical	CH - 609	Organic Chemistry Practical
11.	Non-Credit Audit Course **(Any One)**		AC-610	Soft Skill
			AC-611	Yoga
			AC-612	Practicing Cleanliness

__Faculty of Science and Technology__

KBC North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Syllabus

For

F. Y. B.Sc. (Electronics)

(*As per Choice Based Credit System*)

(With effect from July - 2022)

Preamble

The University Grants Commission (UGC) has initiated several measures to bring distinction, quality and uniformity in the Higher Education System of the country. The important measures taken to enhance academic standards include enhancements in curriculum, teaching-learning process and examination and evaluation systems. In view of this, KBC North Maharashtra University, Jalgaon has taken several initiatives to upgrade and improve the academic excellence, examination reforms for overall development of the students. As per the expectations of UGC, KBC North Maharashtra University, Jalgaon is going to implement the Choice Based Credit (CBCS) pattern to undergraduate program. As per the initiatives led by the Honorable Vice Chancellor, Pro-Vice Chancellor and Dean of the Faculty of Science and Technology and academic bodies of our university, one day workshop was organized for syllabus framing. Participants in the workshop cooperated with their constructive minds of re-structuring the syllabi of F.Y.B.Sc. (Electronics) as per the CBCS pattern and it has been finalized during the workshop and the same will be effectively implemented from the academic year 2022-23. The main objective of reforming the syllabi of F.Y.B.Sc. (Electronics) is to create man power that can cater the present needs of the society with perfect understanding of Electronics and complete skill to serve the industry and country. It is expected that the students studying Electronics will apply their practical minds to solve real life problems of the society and the world in future by becoming entrepreneur to serve the mankind.

Board of Studies (Electronics and Instrumentation),
KBC North Maharashtra University, Jalgaon

Objectives:

1. To prepare students as a successful person in a life which cater needs of the society and serve country.
2. To prepare the students for successful career in industry and motivate them for higher education.
3. To provide strong platform for analyzing electrical and electronics problems.
4. To provide knowledge on basic electronics to Digital electronics and Integrated circuit chips and their applications for the society.
5. To provide necessary foundation on computational platforms and software simulation tools.
6. To develop observational skills, confidence in using electronics equipment and relate the knowledge of practical concepts for the development of the society.
7. To provide comprehensive knowledge and understanding in the relevant fields and enable students to pursue the Electronics subject at an advanced level later and to attract outstanding students from all backgrounds.

BOS (Electronics and Instrumentation)
Faculty of Science and Technology

KBC North Maharashtra University, Jalgaon

Class: **F. Y. B. Sc.**

Subject: **Electronics**

Choice Base Credit System (With effect from July 2022)

The Board of Studies in Electronics in its meeting has unanimously accepted the revised syllabus (as per CBCS pattern) prepared by different committees, discussed and finalized in workshop for F.Y.B.Sc. Syllabi revision. The titles of the papers for F.Y.B.Sc. (Electronics) are as given below:

Semester	Course as per UGC Guidelines	Core Course		No. of Credits	Clock Hour/ Semester	Marks	
		Course Code	Course Title			Int.	Ext.
I	**Electronics-DSC 1A:** Network Analysis and Basics of Digital Electronics (Credits: Theory-04, Practicals-02)	ELE-101	Circuit Components and Network Analysis	2	30	40	60
		ELE-102	Basics of Digital Electronics	2	30	40	60
	ELECTRONICS LAB	ELE-103	ELECTRONICS LAB -I	2	60	40	60
II		Course Code	Course Title	No. of Credits	Clock Hour/ Semester	Marks	
						Int.	Int.
	Electronics-DSC 1B: Analog Electronics and Digital Circuits (Credits: Theory-04, Practicals-02)	ELE-201	Analog Electronics	2	30	40	60
		ELE-202	Digital Circuits	2	30	40	60
	ELECTRONICS LAB	ELE-203	ELECTRONICS LAB -II	2	60	40	60

KBC North Maharashtra University, Jalgaon

Syllabus of F. Y. B. Sc. Electronics

(Choice Based Credit System)

Semester I

ELECTRONICS-DSC 1 A: Network Analysis and Basics of Digital Electronics

Theory: 60 clock hours

(Credits: Theory-04, Practicals-02)

Course description:

This course is aimed at introducing the fundamentals of Electronics, Network Theorems Electronic Devices to Under Graduate students and provide them practical exposure.

Course objectives:

1. To impart knowledge of basic concepts in Electronics.
2. To provide the knowledge and methodology necessary for building electronics circuits.
3. To provide exposure of linear and digital electronics circuits.
4. To have practical exposure of electronic circuits.
5. To predict the behaviour and characteristics of electronics devices and circuits using simulation tools.

Course outcome:

Learner will be able to ….

1. Apply knowledge to develop circuits using electronic devices.
2. Apply the concept and knowledge of electronics devices to real life problems.
3. Simulate complex circuits and understand the behaviour of the systems.
4. Understand and analyse, linear and digital electronic circuits.
5. Review, prepare and present technological developments.

F.Y.B.Sc. (Electronics) Sem-I Paper-I (Credit:02)

ELE-101: Circuit Components and Network Analysis (30 clock hour)

Course Content

Unit 1: Basic Circuit Components

Resistors: Introduction of resistor, Resistive circuits: Series circuit, characteristics of series circuit, series voltage divider, open and short in series circuit, Parallel circuit, laws of parallel circuit, open and short in parallel circuit, series-parallel circuits

Inductors: Self and mutual inductance, Inductance in series and parallel

Capacitors: Principles of capacitance, capacitors in series and parallel

Transformers –Step-up and Step-down Transformers, Turn-Ratio, Voltage and Current Ratio. Types of Transformer (introduction only)

Relays and Switches- Electromagnetic Relay, Relay as Switch, Concept of Pole and Throw, Types of Switches – SPST, SPDT, DPST and DPDT. **(8 hour, 16 Marks)**

Unit 2: Circuit Analysis

Concept of Voltage and Current Sources. Kirchhoff's Current Law, Kirchhoff's Voltage Law. Mesh Analysis. Node Analysis. Star and Delta networks, Star-Delta Conversion. Problems based on KCL, KVL and Problem on Star-Delta conversion. **(7 hour, 14 Marks)**

Unit 3: Network Theorems

Principal of Duality. Superposition Theorem. Thevenin's Theorem. Norton's Theorem. Reciprocity Theorem. Maximum Power Transfer Theorem. Problems based on these theorems. **(7 Hour 14 Marks)**

Unit 4: AC Fundamentals

Types of Alternating Waveforms, Basic AC Generator, Definitions of Cycle, Time Period, Frequency and Amplitude, Characteristics of a Sine Wave, Audio and Radio Frequencies, Different Values of Sinusoidal Voltage and Current, Phase of an AC ,Phase Difference, Vector Representation of an Alternating Quantity, AC through pure resistance , inductance and capacitance. Concept of Reactance and Impedance, RL, RC and RLC circuits, Passive RC filters (Low pass, high pass and band pass filters). Series and parallel resonance **(8 hour, 16 Marks)**

Reference Books:

- Electric Circuits, S. A. Nasar, Schaum's outline series, Tata McGraw Hill (2004)
- Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill (2005)
- Electrical Circuits, K.A. Smith and R.E. Alley (2014) Cambridge University Press
- Network, Lines and Fields, J.D.Ryder, Prentice Hall of India.
- Electrical Circuit Analysis, Mahadevan and Chitra, PHI Learning.
- Alternating Current Fundamentals, Stephen Herman et.al.

F.Y.B.Sc.(Electronics) Sem-I Paper-II (Credit:02)

ELE-102: Basics of Digital Electronics (30 clock hour)

Course Content

Unit 1: Number System and Codes: Introduction, Concept of Radix, Number Systems: Decimal Number System, Binary Number System, Octal Number System, Hexadecimal Number System, Base conversion
Codes: BCD Code, Excess-3 Code, ASCII code. **(8 hour, 16 Marks)**

Unit 2: Logic Gates: Concept of Positive and Negative Logic, Basic Gates (Symbol and Truth table): OR Gate, AND Gate, NOT Gate, Derived Gates: NAND gate, NOR Gates, EX-OR Gate, EX-NOR Gate, NAND and NOR as Universal Logic Gates
Applications of XOR gate: Controlled inverter, Parity Tester **(6 hour, 12 Marks)**

Unit 3: Binary Arithmetic and Boolean algebra
Binary Arithmetic: Addition and Subtraction, 1's Complement, 2's Complement of binary number, Binary Subtraction**:** Using 1's Compliment & 2's Complement, Half adder and Full Adder, Basic Laws of Boolean Algebra, De Morgan's Theorems, Simplifications of Boolean expression (Numerical) **(8 hour, 16 Marks)**

Unit 4: Combinational logic Circuits: Introduction, Standard representation of Canonical forms: Sum of Product (SOP), Product of Sum (POS), Minterms and Maxterms, Conversion between SOP and POS
Karnaugh Map (K Map) Simplification: K map structure, Plotting K map, Representation of Boolean expression using K map (Grouping-Pair, Quad and Octet, overlapping and rolling), Don't care condition, Minimization of SOP expression (Up to 4 variables)
Numerical based on above topics **(8 hour, 16 Marks)**

Reference Books:

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- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., (2011)
- Tata McGraw Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, (2009) PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, (2011) Tata McGraw Hill.
- Digital Fundamentals, Thomas L. Flyod, , Pearson Education Asia (1994)
- Digital Principles, R. L. Tokheim, Schaum's Outline Series, Tata McGraw- Hill (1994)

ELECTRONICS LAB: DSC 1A LAB: Network Analysis and Basics of Digital Electronics Lab
(60 clock hour)

ELE-103: ELECTRONICS LAB-I

(**Section A experiments are compulsory,** and students should perform at least **04** experiments from each **Section B & C** means total **10** experiments.)

Course Objectives:

Students are expected to:

1. Familiarize with basic electronics components, testing and measuring instruments.
2. Understand the practical use of various networks theorems
3. Study the electronics circuits analysis and verification of the circuits
4. Have the knowledge of passive filters and skill to build and test the circuits
5. Familiarize with logic gate ICs and have the knowledge of truth tables of logic gates.
6. Study various digital combinational circuits.

Section A: Circuit Components and Network Analysis

1.	To familiarize with basic electronic components (Switch, fuse, Batteries, R, C, L, transformer, Relays, diodes, LED, transistors etc.), digital Multimeter, Function Generator and Oscilloscope.
2.	Measurement of AC (Amplitude, Frequency and Phase Difference) and DC (Voltage) signal parameters using Oscilloscope

Section B: Network Analysis and Semiconductor diode

1.	Verification of Thevenin's theorem.
2.	Verification of Norton's theorem
3.	Verification of Superposition Theorem
4.	Verification of Reciprocity Theorem.
5.	Verification of the Maximum Power Transfer Theorem
6.	To study the properties of delta-star connection
7.	To study the characteristics of sine wave
8.	To study of passive low pass filter
9.	To study of passive high pass filter
10.	To study of passive band pass filter
11.	To study the series resonance circuit
12.	To study the series RL Circuit
13.	To study the series RLC Circuit
14.	To study the Parallel RLC Circuit

Section C: Basics of Digital Electronics	
1.	Verification of truth table of logic gates OR, AND, NOT, NOR, NAND, XOR using ICS
2.	(a) Verification of Universal gates (NAND) (b) Verification of Universal gates (NOR)
3.	Verification of D-Morgan's Theorem
4.	(a) To design a combinational logic system for a specified Truth Table. (b) To convert Boolean expression into logic circuit and design it using logic gate ICs. (c) To minimize a given logic circuit
5.	Study of Half Adder and Full Adder
6.	Study of Full Subtractor

Reference Books:

- Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill (2005)
- Networks, Lines and Fields, J.D.Ryder, Prentice Hall of India.
- J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (2001)
- Allen Mottershead, Electronic Devices and Circuits, Goodyear Publishing Corporation.
- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., (2011) Tata McGraw
- R. L. Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw- Hill (1994)
- Digital Electronics, S.K. Mandal (2010) 1st edition, McGraw Hill

Course Outcomes (COts):

	Course Outcomes	**Cognitive level**
	Handle various electronics devices	L2
	Build and test electronic circuits	L2
	Verify various network theorems	L2, L3
	Handle digital ICs and circuits	L2

Semester II

ELECTRONICS-DSC 1 B: Analog Electronics and Digital Circuits

Theory: 60 clock hours

(Credits: Theory-04, Practicals-02)

Course description:

This course is aimed at introducing the concepts of integrated circuits including linear and digital chips to Under Graduate students and provide hands on training of handling integrated circuit chips.

Course objectives:

1. To impart knowledge of electronics devices and digital integrated circuits.
2. To provide the knowledge and methodology necessary for using digital integrated circuit chips.
3. To have practical exposure of handling Electronics devices and IC chips.

Course outcome:

Learner will be able to ….

1. Apply the concept and knowledge of digital integrated circuit chips to develop new systems.
2. Apply practical knowledge to solve real life problems of the society.
3. Understand of the course and create scientific temperament and give exposure to the students for independent use of digital integrated circuit chips for innovative applications.
4. Model complex circuits and simulate them.
5. Handle simulation software to analyse analog and digital electronics circuits.

F.Y.B.Sc.(Electronics) Sem-II Paper-I (Credit:02)

ELE-201: Analog Electronics (30 clock hour)

Course Content

Unit 1: Junction Diode

PN junction diode –formation/construction, Formation of Depletion Layer, forward and reverse biasing, Diode Equation and I-V characteristics. Idea of static and dynamic resistance, Zener diode- I-V characteristics, Zener and avalanche breakdown, Reverse saturation current. **(8 hour, 15 Marks)**

Unit 2: Applications of Junction Diodes

Rectifiers- Half wave rectifier, Full wave rectifiers (center tapped and bridge), circuit diagrams, working and waveforms, PIV, ripple factor and efficiency (Derivation not expected). Comparison of rectifiers, Filter-Shunt capacitor filter, its role in power supply, output waveform, and working. Zener diode as a voltage regulator, Problems on Zener regulator **(8 hour, 15 Marks)**

Unit III: Bipolar Junction Transistor

Construction and operation of BJT (NPN and PNP), CB, CE and CC configuration, characteristics of transistor in CE and CB configurations, h parameter definitions for CE, Regions of operation (active, cut off and saturation), Current gains α and β, Relations between α and β, Need of dc biasing, Biasing methods, dc load line and Q point.

(8 hour, 15 Marks)

Unit 4: Unipolar Devices

JFET. Construction, working and I-V characteristics (output and transfer), Pinch off voltage. JFET as an amplifier, Concept of MOSFET, UJT, basic construction, working, equivalent circuit and I-V characteristics. UJT as a relaxation oscillator. **(6 hour, 15 Marks)**

Reference Books:

- Electronic Devices and Circuits, David A. Bell, 5th Edition (2015), Oxford University Press.
- Electronic Circuits: Discrete and Integrated, D.L. Schilling et. al. , Tata McGraw Hill
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, (2014), 6th Edn., Oxford University Press.
- J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (2001)
- J. J. Cathey, 2000 Solved Problems in Electronics, Schaum's outline Series, Tata McGraw Hill (1991)
- Basic Electronics, Bernod Grob, McGra-Hill, India.

- Applied Electronics, R. S. Sedha; S. Chand and Company, New Delhi.

F.Y.B.Sc.(Electronics) Sem-II Paper-II (Credit:02)

ELE-202: Digital Circuits (30 clock hour)

Course Content

Unit 1: Data Processing circuits

Idea of Multiplexing and DeMultiplexing, Multiplexer: 2 to 1, 4 to 1, DeMultiplexer: 1 of 2, 1 of 4, IC's of Multiplexer and Demultiplexer, Decoder: BCD to decimal decoder, Encoder: Decimal to BCD encoder using OR-gates. **(6 hour, 12 Marks)**

Unit 2: Flip-Flops

Introduction to sequential logic circuit, Comparison of Combinational and Sequential logic circuits, 1-bit memory cell, RS-FF using NAND and NOR gates, Clocked RS - FF, D- FF, JK - FF, Level and Edge triggered FF, PRESET and CLR, Race around condition, Master Slave J-K FF, T-FF, Difference between latch and flip flop **(8 Hours, 16 marks)**

Unit 3: Shift Register

Introduction to Shift Register, Classification of Register and Types of Registers: Serial in Serial out (SISO), Serial in Parallel out (SIPO), Parallel in Serial out (PISO), Parallel in Parallel out (PIPO), Universal shift register, Applications of Shift Register, Ring counter.

(6 Hours, 12 marks)

Unit 4: Counters

Concept of counter, Asynchronous counter (3-bit), Decade counter, Synchronous counter (3-bit), Comparison between Synchronous and Asynchronous counter, Down counter, Up-Down counter. **(5 Hours, 10 marks)**

Unit-5: Data Converters

Introduction, Need of ADC and DAC, Types of converters, Digital to analog converters (DAC): weighted resistor type and R-2R ladder type converter. Drawbacks of weighted resistor type DAC, Binary or R-2R type D to A convertor, Analog to Digital Converter: Simultaneous or Parallel ADC, Successive approximation type ADC. **(5 Hours, 10 marks)**

Reference Books:

- Digital principles and applications - A. P. Malvino & D. P. Leach
- Modem digital electronics - R. P. Jain
- Digital Electronics - William Gothman
- Digital fundamentals (3rd Edition)- Thomas Floyd

- Digital Systems: Principles and Applications, R.J.Tocci, N.S.Widmer, (2001) PHI Learning.

F.Y.B.Sc.(Electronics) Sem-II Paper-III (Credit:02)

ELECTRONICS LAB- DSC 1B LAB: Analog Electronics and Digital Circuits Lab

ELE-203: ELECTRONICS LAB-2 (60 clock hour)

(Students should perform at least any **05** experiments from each **Section A and B** means total **10** experiments.)

Course Objectives: **Students are expected to:** 1. Familiarize with various Semiconductor devices. 2. To understand the behavior of semiconductor devices. 3. Understand the practical use of various semiconductor devices. 4. Familiarize with combinational and sequential circuit ICs. 5. Design of various combinational and sequential circuits. **6.** Study various data processing circuits.	
Section A: Analog Electronics	
1.	Study of the I-V Characteristics of (a) p-n junction Diode, and (b) Zener diode.
2.	Study of (a) Half wave rectifier (b) Centre-taped Full wave rectifier and (c) Bridge Full wave rectifier.
3.	To study Zener diode as a voltage regulator on the output of FWR.
4.	Study of the I-V Characteristics of BJT in CE configuration.
5.	Study of the I-V Characteristics of UJT.
6.	To design and Study of the UJT relaxation oscillator
7.	Study of the output characteristics of common source JFET.
8.	To study Transistor as a switch (LED ON/OFF)
Section B: Digital Circuits	
1.	Study of clocked R-S / D-type flip flop using logic gates.
2.	Study of JK / T- flip flop using logic gates/ICs.
3.	Study of 4:1 line multiplexer and 1:4 line demultiplexer.

4.	Study of decade counter using IC7490.
5.	Study of Up-down- counter using IC74191.
6.	Study of shift register using IC 7495.
7.	Study of DAC using R-2R ladder.
8.	To study BCD to Seven Segment Decoder using IC-7447/7448

Reference Books:

- Electronic Devices and Circuits, David A. Bell, 5th Edition (2015), Oxford University Press.
- Basic Electronics, Bernod Grob, McGra-Hill, India.
- Applied Electronics, R. S. Sedha, S. Chand and Company, New Delhi.
- Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill (2005).
- Solid State Electronic Devices, Ben G Streetman and S. Banerjee, Pearson Education
- Integrated Electronics, J. Millman and C. C. Halkias, Tata McGraw Hill (2001).
- Electronic Devices and Circuits, Allen Mottershead, Goodyear Publishing Corporation.
- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., (2011) Tata McGraw
- Digital Principles, R. L. Tokheim, Schaum's Outline Series, Tata McGraw- Hill (1994)
- Digital Electronics, S.K. Mandal (2010) 1st edition, McGraw Hill
- Digital System Design, M. Morris Mano, Pearson Education Asia,(Fourth Edition)

Course Outcomes (COts):

	Course Outcomes	**Cognitive level**
	Handle various semiconductor devices	L2
	Test basic electronic circuits	L2
	Understand the behavior and applications of semiconductor devices	L2, L3
	Handle digital ICs and circuits	L2

Equivalent Courses with Credits

Semester	Core Course		No of Credits	Clock Hours/ Semester	Marks		Old Syllabus Code
	Course Code	Course Title			Int.	Ext.	
I	ELE-101	Circuit Components and Network Analysis	2	30	40	60	ELE 101: Network Analysis and Semiconductor Diodes
	ELE-102	Basics of Digital Electronics	2	30	40	60	ELE 102: Digital Integrated Circuits
	ELE-103	ELECTRONICS LAB -I	2	60	40	60	ELE-103: Electronics Lab I
II	Course Code	Course Title	No of Credits	Clock Hours/ Semester	Marks		Old Syllabus Code
					Int.	Int.	
	ELE-201	Analog Electronics	2	30	40	60	ELE 201: Analog Electronics
	ELE-202	Digital Circuits	2	30	40	60	ELE – 202 – Linear Integrated Circuits
	ELE-203	ELECTRONICS LAB -II	2	60	40	60	ELE-103: Electronics Lab II

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

‘A’ Grade
NAAC Re-Accredited
(3rd Cycle)

Syllabus

For

S. Y. B.Sc. (Electronics)

(*As per Choice Based Credit System*)

(With effect from June - 2019)

Preamble

The University Grants Commission (UGC) has initiated several measures to bring distinction, quality and uniformity in the Higher Education System of the country. The important measures taken to enhance academic standards include enhancements in curriculum, teaching-learning process and examination and evaluation systems. In view of this, North Maharashtra University, Jalgaon has taken several initiatives to upgrade and improve the academic excellence, examination reforms for overall development of the students. As per the expectations of UGC, North Maharashtra University, Jalgaon is going to implement the Choice Based Credit (CBCS) pattern to undergraduate program. As per the initiatives led by the Honorable Vice Chancellor, Pro-Vice Chancellor and Dean of the Faculty of Science and Technology and academic bodies of our university, one day workshop was organized for syllabus framing. Participants in the workshop cooperated with their constructive minds of re-structuring the syllabi of S.Y.B.Sc. (Electronics) as per the CBCS pattern and it has been finalized during the workshop and the same will be effectively implemented from the academic year 2019-20. The main objective of reforming the syllabi of S.Y.B.Sc. (Electronics) is to create man power that can cater the present needs of the society with perfect understanding of Communication Electronics, microprocessors and microcontrollers and complete skill to serve the industry and the country. It is expected that the students studying this course will apply their practical minds to solve real life problems of the society to serve the mankind.

Board of Studies (Electronics and Instrumentation),
KBC North Maharashtra University, Jalgaon.

Objectives:

1. To develop ability of students to apply concepts of Electronics to real life problems.
2. To prepare the students for successful career in industry and motivate them for higher education.
3. To provide exposure to the students for analyzing electronics problems.
4. To provide knowledge on analog and digital communication and their applications for the society.
5. To provide necessary foundation on microprocessors and microcontrollers.
6. To develop observational skills and confidence in using microprocessors and microcontrollers and relate the knowledge of practical concepts for the development of the society.
7. To apply the concepts of Electronics at an advanced level in everyday life of people and appreciate its role to analyze the emerging problems from a societal perspective.

BOS (Electronics and Instrumentation)
Faculty of Science and Technology

KBC North Maharashtra University, Jalgaon

Class: **S. Y. B. Sc.**

Subject: **Electronics**

Choice Base Credit System (With effect from June 2019)

The Board of Studies in Electronics in its meeting has unanimously accepted the revised syllabus (as per CBCS pattern) prepared by different committees, discussed and finalized in workshop for S.Y.B.Sc. Syllabi revision. The titles of the papers for S.Y.B.Sc. (Electronics) are as given below:

Semester	Course as per UGC Guidelines	Core Course		No. of Credits	Clock Hour/ Semester	Marks	
		Course Code	Course Title			Int.	Ext.
III	**Electronics-DSC 2C:** Analog Communication and Microprocessors (Credits: Theory-04, Practicals-02) ELECTRONICS LAB	ELE-301	Analog Communication	2	30	40	60
		ELE-302	Microprocessors and Applications	2	30	40	60
		ELE-303	ELECTRONICS LAB -III	2	60	40	60
	Skill based course I	ELE-304	Electrical Circuits and Network Skills	2	30	40	60
IV	**Electronics-DSC 2D:** Digital Communication and Microcontrollers (Credits: Theory-04, Practicals-02) ELECTRONICS LAB	Course Code	Course Title	No. of Credits	Clock Hour/ Semester	Marks	
						Int.	Int.
		ELE-401	Digital Communication	2	30	40	60
		ELE-402	Microcontrollers and Applications	2	30	40	60
		ELE-403	ELECTRONICS LAB -IV	2	60	40	60
	Skill based course II	ELE-404	Computational Techniques in Electronics	2	30	40	60

KBC North Maharashtra University, Jalgaon

Syllabus of S. Y. B. Sc. (Electronics)

(Choice Based Credit System)

Semester III

ELECTRONICS-DSC 1 A: ANALOG COMMUNICATION and MICROPROCESSORS

Theory: 60 clock hours

(Credits: Theory-04, Practicals-02, Skill based-02)

Course description:

This course is aimed to provide exposure of analog communications, microprocessors and electrical circuits and networks to students and make them analyze practical circuits of modulation and use of 8085 microprocessor.

Course objectives:

1. To impart knowledge of analog communication.
2. To provide the knowledge and methodology necessary for building modulation circuits.
3. To provide exposure of 8085 microprocessor.
4. To have practical exposure of microprocessor and their applications.
5. To analyse various modulation techniques and explore their potential in consumer electronics.

Course outcome:

Learner will be able to ….

1. Apply knowledge to develop circuits of analog modulation and demodulation.
2. Apply the concept and knowledge of microprocessors to real life problems.
3. Analyse modulation circuits and understand the behaviour of the systems.
4. Understand and analyse 8085 microprocessor and its programming.
5. Review, prepare and present technological developments.

S.Y.B.Sc. (Electronics) Sem-III Paper-I (Credit:02)

ELE-301: Analog Communication (30 clock hour)

Unit 1: Basics of Electronic communication:

Importance of Electronic communication, Types of Signals-Analog signal, Digital signal & base band signal (Definition only), Block diagram of an electronic communication system. Types of electronic communications-Simplex, half and full duplex, Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage, Concept of Noise, signal-to-noise(S/N) ratio. **(6 Hour, 12 Marks)**

Unit-2 Amplitude Modulation:

Basics of modulation, Need of modulation, Types: Amplitude Modulation (AM), Angle modulation (Frequency and Pulse Modulation), Amplitude Modulation: Mathematical representation of AM wave and its meaning, Modulation index, frequency spectrum, power relations, Concept of side bands(DSB-SC, SSB-TC, SSB-SC,VSB) modulation, Transistorized AM Modulator(Emitter modulator), Advantages, disadvantages and applications of AM, Block diagram of AM Transmitter and its operation, AM Super heterodyne receiver- Block diagram and it's working with waveforms, Demodulation-AM Diode detector. **(10 Hour, 20 Marks)**

Unit 3: Angle Modulation:

Basic concept of angle modulation, Frequency Modulation (FM)-modulation index and frequency spectrum, equivalence between FM and PM, Comparison of AM and FM, Advantages, disadvantages and applications of FM, Generation of FM using VCO, FM detector (Ratio detector). **(8 Hour, 16 Marks)**

Unit 4: Analog Pulse Modulation:

Introduction, Need and Advantages of pulse Modulation, Basic Principles of PAM, PWM and PPM modulation, Multiplexing: introduction of FDM and TDM.

(6 Hour, 12 Marks)

Reference Books:

- Electronic Communications, D. Roddy and J. Coolen, Pearson Education, India.
- Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
- Modern Digital and Analog Communication Systems, B.P. Lathi, 4th Edition, 2011, Oxford University Press.
- Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGrawHill.
- Principles of Electronic communication systems – Frenzel, 3rd edition, McGrawHill
- Communication Systems, S. Haykin, 2006, Wiley India
- Electronic Communication system, Blake, Cengage, 5thedition.
- Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

S.Y.B.Sc.(Electronics) Sem-III Paper-II (Credit:02)

ELE-302: Microprocessors and Applications (30 clock hour)

Unit 1: Fundamentals of Microcomputer

Simple Microcomputer Architecture, Input/output Devices, Address bus, Data bus, Control bus, Data storage (idea of RAM and ROM). Computer memory, Memory Interfacing, Memory Map. High level language, Low level language, Assembler, Compiler. **(4 Hour, 8 Marks)**

Unit 2: Architecture of 8085 Microprocessor.

Features of 8085, Block diagram, function of each block, Registers, ALU, Stack memory, Stack Pointer, Program counter, Concept of Interrupt, Hardware interrupts. Pin-out diagram of 8085, function of each pin, Data and address buses, De-multiplexing the Bus AD7-AD0, Timing states (T-state), Machine Cycle, Instruction cycle. Timing diagram for Read and write operation (MOV A,M and MOV M,A) **(8 Hour, 16 Marks)**

Unit 3: Instruction set of 8085 Microprocessor.

Study of addressing mode for 8085:-Implied Addressing, Register Addressing, Immediate Addressing, Direct Addressing, Register Indirect Addressing, Instruction set: Data transfer instructions, Arithmetic Instructions, Logical Instructions, Branching Instructions, Stack, I/O and Machine Control Instructions. **(8 Hour, 16 Marks)**

Unit 4: Assembly Language Programming.

Assembly Language Format, Arithmetic Programs: - 8-bit addition, 8-bit subtraction, Decimal addition and subtraction of two 8-bit numbers, 8-multiplication, one's and two's complement of 16-bit numbers, find largest and smallest Number from a series of given number.

Code Conversion Programs: Hex to ASCII conversion, BCD to binary conversion.

(6 Hour, 12 Marks)

Unit 5: Microprocessor and Interfacing Applications

Intel 8255 pin diagram, block diagram, Control word format, modes of operation, Bit Set/Reset mode , DAC (IC 1408) and ADC (IC 0801) and their Interfacing with 8085.

(4 hour, 8 Marks)

Reference Books:

- Hall D.V.,"Microprocessor and Interfacing-Porgramming and Hardware" 2nd Ed., Tata McGraw-Hill Publishing Company Limited, 2008
- Gaonkar R.S., ''Microprocessor Architecture, Programming and Applications", 5th Ed., Penram International,2007.
- 8080A/8085 Assembly Language Programming by Lance A. Leventhal

ELECTRONICS LAB: DSC 1A LAB: ANALOG COMMUNICATION and MICROPROCESSORS Lab (60 clock hour)

ELE-303: ELECTRONICS LAB-III

(Student should perform at least 4 experiments from section A using Kits and 5 from section B)

Section A: Analog Communication

1. To build and test an Amplitude Modulator using transistor
2. To build and test diode detector for demodulation of AM signal
3. To study FM generator and detector circuit
4. To study AM transmitter and receiver
5. To study FM transmitter and receiver
6. To study TDM
7. To study FDM

Section B: Microprocessors

1. Assembly Language Program for addition/subtraction of two 8-bit numbers using direct addressing mode.
2. Assembly Language Program for addition/subtraction of numbers using indirect addressing mode.
3. Assembly Language Program to multiply 8-bit unsigned number by 8-bit unsigned number using repeated addition.
4. Assembly Language Program to divide 8-bit unsigned number by 8-bit unsigned number using repeated subtraction.
5. Assembly Language Program to add two 16-bit Numbers.
6. Assembly Language Program to calculate the sum of the series of number using subroutine.
7. Assembly language program to transfer a block of data from one location to another location of memory.
8. Assembly Language Program to convert 8 bit decimal number into hexadecimal form
9. Assembly Language program to convert the hex number into an ASCII character.
10. Assembly Language to find smallest/largest number from series of numbers.
11. Assembly Language program to convert BCD number into hexadecimal number.

Reference Books:

- Communication Systems, S. Haykin, 2006, Wiley India
- Electronic Communications, D. Roddy and J. Coolen, Pearson Education, India.
- 8080A/8085 Assembly Language Programming by Lance A. Leventhal

S.Y.B.Sc.(Electronics) Sem-III Paper-IV (Credit:02)

ELE-304: Electrical Circuits and Network Skills **(30 clock hour)**

Objective: The main goal of designing this course is to expose students to practical aspects of electronics. Therefore, it is not expected anywhere to teach physics behind topics covered in the syllabus.

Unit 1: Electrical Drawing and Symbols

Circuit Symbols of all Electronics devices, Electrical Equipment, Blueprint – Only definition, Reading of Circuit Schematic **(3 hour, 6 Marks)**

Unit 2: Basic Electricity Principles and Devices

Voltage, Current, Resistance, Power, Ohm's Law, Series-parallal circuits, AC and DC supply, Use of multimeter, voltmeter and ammeter in measurement. Resistor, capacitor and Inductor (Only different Types of each), Series and parallel combinations of R, C and L , power meter

(6 hour, 12 Marks)

Unit 3: Generators, Motors and Transformers

AC generator – working principle and diagram, Single phase and three phase motor-working principal and construction(Design), Step up and Step down transformer-working principal and construction. **(8 hour, 16 Marks)**

Unit 4: Electrical Wiring

Different types of Conductors and cables – Solid and Stranded, Different types of electrical joints, Insulation-classification, Rubber Elastomers Insulation, Cable Tray, Soldering material, flux, Procedure, Technique, Breadboard, Preparation of Extension board- wiring diagram of two, three pin plug and switch. **(8 hour, 16 Marks)**

Unit 5: Electrical Protection

Types of Relays (Solid state, Reed, Electromagnetic), Fuse – role, current rating, voltage rating, cartridge fuse and SMD fuse (Only diagrams), Circuit breakers (MCB) – Principle, and Advantages MCB over fuse Grounding and Isolation. Concept of earthing.

(5 hour, 10 Marks)

Reference Books:

- Cables and Wiring by John Cadick Delmar publishers Chapter 4
- Basic Electronics: Solid State by B.L. Theraja
- A text book of Electrical Technology Vol-II A.C. and D.C. Machines by B. L. Theraja, S.Chand
- Modern Electronic Equipment: Troubleshooting, Repair and Maintenance by R. S. Khandpur, Tata McGraw Hill Publishing Company Limited

Semester IV

ELECTRONICS-DSC 2D: Digital Communication and Microcontrollers

Theory: 60 clock hours

(Credits: Theory-04, Practicals-02)

Course description:

This course is aimed at introducing the concepts of digital communication including mobile and satellite communication to Under Graduate students and provide hands on training of handling microcontrollers and digital communication circuits.

Course objectives:

1. To impart knowledge of pulse modulation, mobile and satellite.
2. To provide the knowledge and methodology necessary for using microcontroller chips
3. To have practical exposure of handling microcontroller and interfacing applications.

Course outcome:

Learner will be able to ….

1. Apply the concept and knowledge of digital communication to develop new systems.
2. Apply practical knowledge of microcontrollers to solve real life problems of the society.
3. Understanding of the course and create scientific temperament and give exposure to the students for independent use of microcontroller for innovative applications.
4. Gain knowledge of microcontroller programming.
5. Handle hardware and software to shoot problems of the society.

S.Y.B.Sc.(Electronics) Sem-IV Paper-I (Credit:02)

ELE-401: Digital Communication (30 clock hour)

Unit1: Basics of Digital Communication:

Block diagram of Digital communication system, Communication channel types and their characteristics (bit rate, bandwidth, repeater distance), Chanel modelling, Channel noise and its effect, Comparison of analog and digital communication system, Advantages and disadvantages of digital communication. **(6 hour, 12 Marks)**

Unit 2: Pulse Code Modulation:

Sampling process, Nyquist sampling theorem, quantization process, Quantization error, Quantization noise, Pulse Code Modulation (PCM): Block diagram and working of PCM transmitter and receiver, Advantages and disadvantages of PCM.

(6 hour, 12 Marks)

Unit 3: Digital Modulation Techniques:

Amplitude Shift Keying (ASK): Generation (Concept), waveforms, advantages, disadvantages and applications (list).

Frequency Shift Keying (FSK): Generation (Concept), waveforms, advantages, disadvantages and applications (list).

Phase Shift Keying (PSK)/Binary Phase Shift Keying (BPSK).: Generation(Concept),, waveforms, advantages, disadvantages and applications (list). **(4 hour, 8 Marks)**

Unit 4: Satellite communication:

Introduction, need, geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Block diagram of transponders, path loss, ground station, simplified block diagram of earth station. Uplink and downlink. Applications of Satellite. Introduction to GPS, VSAT network. **(5 hour, 10 Marks)**

Unit 5: Mobile Telephony System:

Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, frequency reuse, handshaking, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts. **(9 hour, 18 Marks)**

Reference Books:

- Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGrawHill.
- Communication Systems, S. Haykin, 2006, Wiley India
- Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

S.Y.B.Sc.(Electronics) Sem-IV Paper-II (Credit:02)

ELE-402: Microcontrollers and Applications (30 clock hour)

Unit 1: Introduction to Microcontroller

Block diagram of microcontroller, Advantages of microcontroller, Comparison between microprocessor and microcontroller, Applications of microcontroller (list only) **(3 hour, 6 Marks)**

Unit 2: Architecture of 8051 Microcontroller

8051 microcontroller – Features, Block diagram, Pin out diagram, CPU registers, Flags and Program Status Word, Program Counter, Data Pointer, Special Function Registers& their Format, Stack& Stack Pointer, Internal RAM /ROM, Oscillator & Clock, Concept External Memory, Ports-0,1,2 & 3,Counter and Timers, Serial data input/ output transfers, Interrupts. **(8 hour, 16 Marks)**

Unit 3: Addressing Modes and Instructions

Addressing modes, data moves Instructions, Arithmetic Instructions, Logical Instructions, Jump and Call and Loop Instructions, flag manipulation instructions.

(8 hour, 16 Marks)

Unit 4: 8051 Microcontrollers Programming

Assembly language programming- simple data transfer, arithmetic, logical, looping and code conversion programming (packed BCD to ASCII conversion, Binary to ASCII conversion. **(8 hour, 16 Marks)**

Unit 5: 8051 I/O port Programming

Introduction of I/O port programming, I/O port pins description and their functions, I/O port programming in 8051 (using assembly language), I/O programming: Bit manipulation. **(3 hour, 6 Marks)**

Reference Books:

- 8051 microcontroller and embedded systems using assembly and C, M.A. Mazidi, Pearson Education India
- 8051 microcontrollers, Satish Shah, Oxford University Press
- Embedded Microcontroller Systems: Real time interfacing, J. W. Valvano, 2011, Cengage Learning

ELECTRONICS LAB- DSC 1B LAB: Digital Communication and Microcontrollers

ELE-403: ELECTRONICS LAB-2 (60 clock hour)

Section-A: Digital Communication (Any 4)

(Following experiments should be performed using simulation only)

1. To study PCM
2. To study PAM
3. To study PWM
4. To study PPM
5. To study ASK
6. To study FSK
7. To study PSK

Section-B: Microcontroller (Any 4)

1. Write a program to add/subtract two 8 bit numbers.
2. Write a program to compute 1+2+3+……..+N (say N=10).
3. Write a program to find average of five 8 bit numbers.
4. Write a program to find that the given numbers is prime or not.
5. Write a program to find the factorial of a number.
6. Write a program to covert an ASCII number to Hex number.
7. Write a program to the smallest of an array of N 8 bit unsigned numbers (N is an 8 bit numbers).

Section-C: Interfacing Applications (Any 2)

1. Use one of the four ports of 8051 for interfacing eight LED. Simulate binary counter (8 bit) on LED.
2. Program to glow first four LED then next four using TIMER application.
3. Program to run a count down from 9-0 in the seven segment LED display.
4. Interface 7 segment display with 8051 and display HELP on it.
5. Interface stepper motor to 8051 and write program to move the motor through given angle in clockwise or anti-clock wise direction.

Reference Books:

- Communication Systems, S. Haykin, 2006, Wiley India
- Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press
- 8051 microcontroller and embedded systems using assembly and C, M.A. Mazidi, Pearson Education India
- 8051 microcontrollers, Satish Shah, Oxford University Press
- Embedded Microcontroller Systems: Real time interfacing, J. W. Valvano, 2011, Cengage Learning

ELE-404: Computational Techniques in Electronics (30 clock hour)

Objective: The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role and gain skills to students in solving problems in Electronics.

* **Instruction: It is advised to teach this course using ICT tools.**

Unit 1: Algorithms and Flowchart

Algorithm: Definition, properties and development, examples, Flowchart: Concept of flowchart, symbols, guidelines, types, examples **(02 Hours, 04 Marks)**

Unit 2: Fundamentals of C

Basic structure of C program, Character set, C tokens, Keywords and Identifiers, Constraints, Variables, Data Types, Declaration of variables, Assigning values to variables, Operators - arithmetic, relational, logical, assignment, increment and decrement, conditional, bitwise, special operators, Evaluation of Arithmetic expressions, Operator precedence and Associativity, I/O statements: Reading and writing a single character, Standard and Formatted Input and Output statements, Preprocessor Directives, Simple programming exercises **(04 Hours, 08 Marks)**

Unit 3: Decision making, Branching and Looping

Statements – if, if-else, Nesting of if-else, else-if Ladder, switch, break, ?: Operator, goto, Entry and Exit controlled loops, Statements – while, do-while, for, Features of for loops, Nesting of for loops, Jumping out of a loop, Skipping a part of a loop - Use of continue statement, Simple programming exercises **(02 hour, 4 Marks)**

Unit 4: Arrays and User Defined Functions

One-dimensional array – Declaration and Initialization, Introduction to two and multi -dimensional arrays, Simple programming exercises. Need for user defined functions, Form of C functions, Return values and their types, Calling a function, Category of Functions, Use of keyword –void, Recursion, Functions with arrays, ANSI C function definition and declaration, Simple programming exercises **(5 hour, 10 Marks)**

Unit 5: Numerical Techniques using C language

Roots of Equations: Bisection method, Problems Based on these methods.
Numerical Integration: Trapezoidal Rule, Simpson's 1/3rd Rule, Problems
Numerical Differentiation: Runge Kutta Method, Problems
System of Linear Equations: Gauss Elimination Method, Problems.**(14 hour, 28 Marks)**

Unit 5: Numerical Simulation of Simple Circuits

RC, RL and RLC circuits using differential and integral methods, Loop current analysis using Gauss Elimination Method, Average and RMS value of current using integral methods. **(3 hour, 6 Marks)**

Reference Books:

- . Yashavant Kanetkar, Let Us C , BPB Publications
- Programming in ANSI C, Balagurusamy, 2nd edition, TMH.
- Introduction to Numerical Analysis", S. S. Sastry, Prentice Hall India.

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

1990

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Syllabus
For

T. Y. B.Sc. (Electronics)

(*As per Choice Based Credit System*)

(With effect from June - 2020)

Preamble

The University Grants Commission (UGC) has initiated several measures to bring distinction, quality, and uniformity in the Higher Education System of the country. The important measures taken to enhance academic standards include enhancements in curriculum, teaching-learning process and examination and evaluation systems. In view of this, KBC North Maharashtra University, Jalgaon has taken several initiatives to upgrade and improve the academic excellence, examination reforms for overall development of the students. As per the expectations of UGC, KBC North Maharashtra University, Jalgaon is going to implement the Choice Based Credit (CBCS) pattern to undergraduate program. As per the initiatives led by the Honorable Vice Chancellor, Pro-Vice Chancellor and Dean of the Faculty of Science and Technology and academic bodies of our university, several meetings of board of studies members and concern teachers were organized for syllabus framing. All the participants cooperated with their constructive minds of re-structuring the syllabi of T.Y.B.Sc. (Electronics) as per the CBCS pattern and it has been finalized and the same will be effectively implemented from the academic year 2020-21. The main objective of reforming the syllabi of T.Y.B.Sc. (Electronics) is to create man power that can cater the present needs of the society with perfect understanding of Embedded Systems, Advanced microprocessors and microcontrollers etc. and complete skill to serve the industry and the country. It is expected that the students studying this course will apply their practical minds to solve real life problems of the society to serve the mankind.

Board of Studies (Electronics and Instrumentation),
KBC North Maharashtra University, Jalgaon.

Objectives:

1. To develop ability of students and motivate them to apply advanced concepts of Electronics to solve real life problems.
2. To prepare the students for successful career in industry and motivate them for higher education.
3. To provide exposure to the students for analyzing applications of embedded systems.
4. To provide knowledge on advanced microprocessors and microcontrollers and their applications for the society.
5. To provide necessary foundation on consumer and power electronics.
6. To develop observational skills and confidence in using hardware and software and relate the knowledge of practical concepts for the development of the society.
7. To apply the concepts of advanced Electronics in everyday life of people and appreciate its role to analyze the emerging problems from a societal perspective and development of country.

BOS (Electronics and Instrumentation)
Faculty of Science and Technology
KBC North Maharashtra University, Jalgaon

KBC North Maharashtra University, Jalgaon

Class: **T. Y. B. Sc.**

Subject: **Electronics**

Choice Base Credit System (With effect from June 2020)

The Board of Studies in Electronics in its meeting has unanimously accepted the revised syllabus (as per CBCS pattern) prepared by different committees, discussed, and finalized for T.Y.B.Sc. The titles of the papers for T.Y.B.Sc. (Electronics) are as given below:

Structure of curriculum of T. Y. B. Sc. (Electronics)

Semester V

Discipline	Course Type	Course Code	Course title	Credits	Hours/week (Clock hours)	Total Teaching hours	Marks (Total 100)	
							CA	UA
DSC	Core I	ELE-501	Semiconductor Electronics	3	3	45	40	60
	Core II	ELE -502	Advanced Digital System Design using VHDL	3	3	45	40	60
	Core III	ELE-503	Advanced Microprocessors	3	3	45	40	60
	Core IV	ELE-504	Electronic Instrumentation	3	3	45	40	60
DSC Skill Enhance ment Course (SEC)	Skill Based	ELE-505	Medical Electronics	3	3	45	40	60
DSC Elective course	Elective Course (Any one)	ELE-506 (A)	Embedded C	3	3	45	40	60
		ELE-506 (B)	Basics Fiber Optic Communication					
DSC	Core (Practical)	ELE-507	Practical Lab I	2	4 (per batch)	60	40	60
		ELE-508	Practical Lab II	2	4 (per batch)	60	40	60
		ELE-509	Project Part I	2	4 (per batch)	60	40	60
Non Credit Audit Course	Elective audit course (Any one)	AC-501 : A	NSS	No credit	2	30	100	--
		AC-501 : B	NCC					
		AC-501 : C	Sports					

Semester VI

Discipline	Course Type	Course Code	Course title	Credits	Hours/week (Clock hours)	Total Teaching hours	Marks (Total 100)	
							CA	UA
DSC	Core I	ELE-601	Power Electronics	3	3	45	40	60
	Core II	ELE-602	Consumer Electronics	3	3	45	40	60
	Core III	ELE-603	Microprocessor Interfacing Techniques	3	3	45	40	60
	Core IV	ELE-604	Computer Network	3	3	45	40	60
DSC Skill Enhancement Course (SEC)	Skill Based	ELE-605	Embedded Systems	3	3	45	40	60
DSC Elective Course	Elective Course (Any one)	ELE-606 (A)	Electrodynamics	3	3	45	40	60
		ELE-606 (B)	Antenna & Wave Propagation					
DSC	Core (Practical)	ELE-607	Practical Lab I	2	4 (per batch)	60	40	60
		ELE-608	Practical Lab II	2	4 (per batch)	60	40	60
		ELE-609	Project Part II	2	4 (per batch)	60	40	60
Non Credit Audit Course	Elective audit course (Any one)	AC-601 : A	Soft skill	No credit	2	30	100	--
		AC-601 : B	Yoga					
		AC-601 : C	Practicing Cleanliness					

CA: Class assessment (Internal examination); UA: University assessment

Note: ***The Study tour: Industrial visit/Research lab visit is compulsory for the students of T.Y.B.Sc. (Electronics)***

Scheme for B.Sc. Program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		
1	Core courses	Credits each	Courses	Credits each	Courses	Credits Each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	(i)Theory	4	4	4	4	4	3	4	3					4X14=56
	(ii)Practical	2	4	2	4	2	3	2	3					2X14=28
2	Ability enhancement compulsory course (AECC)(2)	2	1	2	1	2	1	2	1					2 X4 = 08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1					2X 2 = 04
4	Discipline Specific Core DSC													
	(i) Core I to IV									3	4	3	4	3X8=24
	(ii) Core (Practical)									2	3	2	3	2X6=12
5	Skill Enhancement Course (SEC): Skill Based course									3	1	3	1	3 X 2 = 06
6	Elective Course (any one)									3	1	3	1	3 X 2 = 06
7	Elective Audit Course (out of 3)									None Credit	Any one	None Credit	Any one	--
	Total Credit value (Credit x No .of Courses)	26		26		22		22		24		24		144

Equivalence of the courses for T. Y. B. Sc. (Electronics)

Old Syllabus (June 2016) (Semester pattern 60:40)		New Syllabus (June 2019) CBCS pattern (Semester pattern 60:40)	
Course code	Paper	Course code	Paper
Semester V			
ELE 351	Semiconductor Physics	ELE 501	Semiconductor Electronics
ELE 352	Basic Communication Systems	ELE 506 (B)	Basics of Fiber Optic Communication
ELE 353	8086 Microprocessor	ELE 503	Advanced Microprocessors
ELE 354	The C Programming Language	ELE 504	Electronic Instrumentation
ELE 355	Microcontroller 8051	ELE 505	Medical Electronics
ELE 356	Advanced Digital System Design	ELE 502	Advanced Digital System Design using VHDL
ELE 357	General Lab – I Semiconductor Physics, Basic Communication, SPICE & VHDL	ELE 507	**Practical Lab I** (Semiconductor Electronics, Electronic Instrumentation, Basics of Fiber Optic Communication and Medical Electronics)
ELE 358	µP, µC and C/MATLAB Lab – I Microprocessor, Microcontroller & C	ELE 508	**Practical Lab II** (µP and VHDL)
ELE 359	Project Part-I	ELE 509	Project Part I
Semester VI			
ELE 361	Electrodynamics	ELE 606 (A)	Electrodynamics
ELE 362	Advanced Communication System	ELE 602	Consumer Electronics
ELE 363	Microprocessor Interfacing Techniques and Advanced Microprocessors	ELE 603	Microprocessor Interfacing Techniques
ELE 364	Numerical Simulation in Electroni	ELE 604	Computer Network
ELE 365	Embedded Systems	ELE 605	Embedded Systems
ELE 366	Industrial and Power Electronics	ELE 601	Power Electronics
ELE 367	General Lab - II Advanced Communication, Power and Industrial Electronics	ELE 607	**Practical Lab I** (Power Electronics, Consumer Electronics and Computer Network)
ELE 368	µP, µC and C/MATLAB Lab – II	ELE 608	**Practical Lab II** (µP, Embedded systems and Antenna & Wave propagation)
ELE 369	Project Part-II	ELE 609	Project Part II

Distribution of Course papers for T. Y.B. Sc. (Electronics) Semester: V

Discipline	Course Type	Course Code	Course title	Credits	Hours/week (Clock hours)	Total Teaching hours	Marks (Total 100)	
							CA	UA
DSC	Core I	ELE-501	Semiconductor Electronics	3	3	45	40	60
	Core II	ELE -502	Advanced Digital System Design using VHDL	3	3	45	40	60
	Core III	ELE-503	Advanced Microprocessors	3	3	45	40	60
	Core IV	ELE-504	Electronic Instrumentation	3	3	45	40	60
DSC Skill Enhancement Course (SEC)	Skill Based	ELE-505	Medical Electronics	3	3	45	40	60
DSC Elective course	Elective Course (Any one)	ELE-506 (A)	Embedded C	3	3	45	40	60
		ELE-506 (B)	Basics Fiber Optic Communication					
DSC	Core (Practical)	ELE-507	Practical Lab I	2	4 (per batch)	60	40	60
		ELE-508	Practical Lab II	2	4 (per batch)	60	40	60
		ELE-509	Project Part I	2	4 (per batch)	60	40	60
Non Credit Audit Course	Elective audit course (Any one)	AC-501 : A	NSS	No credit	2	30	100	--
		AC-501 : B	NCC					
		AC-501 : C	Sports					

DSC Core Courses

ELE- 501: Semiconductor Electronics

Total Hours: 45		**Credits: 3**

Course objective

- To enrich the understanding of fundamentals of semiconductor devices.
- To have an awareness of IC fabrication techniques.

Learning outcomes

After successful completion of this course, students are expected to:

- Estimate the number of carriers at a given temperature for a semiconductor.
- Understand the importance of doping to change carrier density.

Unit	Topics	Lectures, Marks
Unit-1	**Crystal Structure:** Classification of solids: Single crystal, Poly crystal, Amorphous, Lattice, Basis and Crystal Structure, Translational Vectors, Unit cell, Primitive cell, Primitive Translational Vectors for SC, BCC and FCC, Co-ordination number, Atomic radii, Packing for SC, BCC and FCC structure, Miller indices.	**09 H** **12 M**
Unit-2	**Semiconductor Basics:** Bonding forces in solids, Energy bands, Energy bands in Metals, Semiconductors and Insulators, Variation of energy bands with alloy, Concept of Effective mass, Fermi level, Acceptor, Donor, Intrinsic and Extrinsic Semiconductor, Semiconductor material (Elemental and Compound), Direct and Indirect band gap semiconductors, Degenerate and Non-degenerate semiconductors.	**09 H** **12 M**
Unit-3	**Carrier Transport Phenomenon:** Density of states, Carrier concentration, Electron-hole concentration at equilibrium, Dependence of Fermi level on temperature and doping concentration, Carrier drift, Mobility, Resistivity, Conductivity, Hall effect.	**09 H** **12 M**
Unit-4	**P-N Junction:** Fabrication of P-N Junction: Mention different methods of fabrication, Diffusion method. Equilibrium conditions: contact potential, space charge at junction, forward and reverse bias junction: Qualitative description of current flow at a junction, Reverse-bias break-down: Zener and avalanche breakdown.	**09 H** **12 M**
Unit-5	**Integrated Circuits (IC) Fabrication:** Introduction and classification of ICs, Advantages and disadvantages of ICs over discrete components, Manufacturing process of monolithic ICs: Lithography, Etching, Diffusion and Metallization, Fabrication of discrete devices: Monolithic fabrication of BJT, Passive Components-Integrated circuit Resistor, Capacitor.	**09 H** **12 M**
Suggested Readings	**1.** Charles Kittle, 'Introduction to Solid State Physics', John Wiley and Sons. **2.** Ben G. Streetman and Sanjay Kumar Banergee, 'Solid State Electronic Devices', PHI Publication. **3.** S O Kasap, 'Principle of Electronic Materials and Devices', Tata McGraw Hill Education. **4.** S. M. Sze and Kwok K. Ng, 'Physics of Semiconductor Devices', Wiley Student Edition. **5.** D. Roy Choudhury&Sahil B. Jain, 'Linear Integrated Circuits', New Age International Publisher. **6.** U. A. Bakshi, A. P. Godse, A. V. Bakshi, 'Linear Integrated Circuits', Technical Publications. **7.** Neil H. E. Weste, David Harris and Ayan Banergee, 'CMOS VLSI Design', Pearson Education.	

ELE 502: Advanced Digital System Design using VHDL

Total Hours:45		Credits: 3

Course Objective

- ✓ To familiarize students with designing techniques of combinational and sequential circuits.
- ✓ Introduction of VHDL to students for different combinational and sequential circuits.

Learning outcome

After successful completion of this course, students are expected to:

- ✓ Students will able to design digital circuits according to requirements.
- ✓ Student will able to write VHDL code for digital circuit with the help of different modeling style.

Unit	Topics	Lectures, Marks
UNIT-1	**Introduction to VHDL** Introduction, library, entity, architecture, modeling style, concurrent and sequential statements, identifier, data object and data types, attributes.	05H, 10M
UNIT-2	**Combinational Logic Circuits** Introduction to combinational circuits, Revision of K-Map, Combinational logic examples (half and full adder, full subtractor, four bit binary adder, multiplexer and demultiplexers, any combinational circuits up to 3 input) *Ref. 1. (N. G. Palan)* *VHDL Programming:* half and full adder, full subractor, four bit binary adder, multiplexer and demultiplexers Idea of seven segment display (Common anode, common cathode) and designing of BCD to seven segment decoder. *Ref. 1 (N. G. Palan)*	12H, 14M
UNIT-3	**Flip Flop Circuits** Introduction to R-S, J-K, T and D flip flops, Excitation table of flip flops, flip flop conversions: R-S to J-K, S-R to T, J-K to D and T to D *VHDL Programming:* Flip flops S-R, D, J-K, J-K master Slave and T Applications of Flip flops, *Ref. 2 (A. Anand kumar)*	14H, 18M
UNIT-4	**Sequential Logic Design** State table, state diagram, state equation and state reduction in sequential logic design, Brief revision of counters: Design of Asynchronous counters - Design of Mod-6 counter using T flip flop, Design of Mod-10 counter using T flip flop *VHDL Programming:* Mod-6 asynchronous counter ***Design of Synchronous counters***- Design of synchronous 3 bit up-down counter using J-K flip flop, Design of synchronous 3 bit up counter, Design of synchronous 3 bit down counter, Design of synchronous Mod-10 bit up-down counter using T flip flop, Design of synchronous modulo 6 Grey code counter. *VHDL Programming:* 3 bit up-down counter.	14H, 18M
Suggested Readings	1. “VHDL Primer”, J. Bhaskar, Pearson Prentice Hall India 2. “VHDL Programming by Example”, Douglas L Perry, McGraw Hill Professional. 3. “Digital Electronics and Logic Design”, N. G. Palan, Technova Publications, Pune. 4. “Fundamentals of Digital Circuits” A. Anand Kumar, PHI Publication 5. “Digital Design”, M. Morris Mano, Michael D. Ciletti, Pearson India 6. “Digital Logic and Computer Design”, M Morris Mano, Prentice Hall India 7. “Modern Digital Electronics”, R. P. Jain, Tata McGraw Hill Publishing. 8. “Digital Circuits and Design”, S. Shalivahanan, Vikas Publishing House	

ELE 503: Advanced Microprocessor

Total Hours: 45	Credits: 3

Course objective

- To learn the architecture of 8086.
- To learn the assembly language programming of 16 bit microprocessor
- To understand the architecture of advanced microprocessor 80386.
- To understand the feature of Pentium.

Learning outcomes

After successful completion of this course, students will be able to:

- Student will be able to Aware about the microprocessor and its architecture considerations & Capable to analyze the operating modes
- Understand the assembly language programming
- Student will be able to understand the advanced microprocessor 80386 and operation of paging mechanism.
- To gain the Knowledge about the Pentium series processor

Unit	Topics	Lectures
UNIT-1	**The Processor 8086** Register organization of 8086, Architecture, Pin diagram and its functions, Signal Descriptions of 8086, Physical memory organization, General bus operation, I/O addressing Capability, activities, concept of stack. Minimum and Maximum mode 8086, System Bus Timing.	10H, 14M
UNIT-2	**8086 Instruction Set** Machine language instruction formats, Addressing mode of 8086, Instruction set of 8086:- Data Copy / Transfer Instructions, Arithmetic and Logical Instructions, Branch Instructions, Loop Instructions, Machine control Instructions, Flag Manipulation Instructions, Shift and Rotate Instructions, String Instructions.	10H, 12M
UNIT-3	**Assembler Directives and Operator** Data Definition and Storage Allocation, Structures, Records, Assigning Names to Expressions, Segment Definition, Program Termination, Alignment Directives, Value-Returning Attribute Operators.	10H, 10M
UNIT-4	**Programming of 8086** Simple assembly language program, Loop program and String processing program.	08H, 12M
UNIT-5	**Intel 80386 & Pentium Operators** Key features of Intel 80386 – internal architecture of 80386 - operating modes - paging mechanism, Pentium processor – its features	07H, 12M
Suggested Readings	1. "Advanced microprocessor and peripherals (Architecture Programming and Interfacing)",A.K. Ray, K. M. Bhurchandi, TMH Publication. 2. "Microprocessor system: 8086/8088 family Architecture Programming and design)", Yu Cheng Liu and G.A.Gibson, PHI Publication. 3. "Microprocessor and Interfacing", D. Hall 1995, TMH Publication. 4. "The 8088 and 8086 microprocessor (Programming, Interfacing, Software, Hardwareand applications)", Walter A. Triebel, Autarsingh. 5. "Microprocessor and Interfacing Techniques", A. P. Godse. D. A. Godse, Technical Publication, Pune.	

ELE – 504: Electronic Instrumentation

Total Hours: 45	Credits: 3

Course objective

- To provide adequate knowledge in electrical instruments and measurements techniques.
- To make the student have a clear knowledge of the basic laws governing the operation of the instruments, relevant circuits and their working.
- Introduction to general instrument system, error, calibration etc. Emphasis is laid on analog and digital techniques used to measure voltage, current, energy and power etc.
- Exposure to various transducers and data acquisition system.

Learning outcomes

After successful completion of this course, students are expected to

- Understand the concept of measurement systems and its various characteristics
- Learn about different types of transducers and their working principle.
- Know the different electronics measuring instruments and develop the skill to handle them.
- Aquent the knowledge of testing instruments.

Unit	Topics	Lectures
UNIT-1	**Basic Measurement Concepts** Measurement systems, Fundamental elements of measurement system, Static and Dynamic characteristics, Accuracy and Precision, Sensitivity, Linearity, Resolution, Repeatability; Errors such as Gross error, Systematic error, Absolute and Relative error, Random error	8H, 10M
UNIT-2	**Transducers and sensors:** Classification of transducers, Basic requirement/ characteristics of transducers, active & passive transducers, Resistive (Potentiometer, Strain gauge– Working Principle and applications), Capacitive (Variable Area Type – Variable Air Gap type – Variable Permittivity type), Inductive (LVDT) and piezoelectric transducers	8H, 10M
UNIT-3	**Signal generators and Oscilloscopes** **Signal Generators**: Introduction, Block diagram of standard signal generator, AF sine and square wave generator, Function generator, Square and Pulse generator, Sweep generator, Frequency synthesizer. **Cathode Ray Oscilloscopes (CRO)-**block diagram, front panel controls, and measurement of amplitude, frequency and phase. Dual trace and dual beam CRO.	12H, 16M
UNIT-4	**Digital Measuring Instruments** Digital Storage Oscilloscope (DSO)-Block diagram, advantages and applications. Digital Multimeter (DMM)-Block diagram and working, Digital Frequency Meter (DFM)-Working principle, Block diagram, measurement of frequency and time.	9H, 14M
UNIT-5	**Data Acquisition System and Data logger** **DAS:** Introduction, general block diagram of DAS, Single channel and multi-channel DAS, PC based data acquisition, ADC and DAC, Typical on board DAQ card, Representation of analog signals in the digital domain, Resolution and sampling frequency, Multiplexing of analog inputs, Single-ended and differential inputs, Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card. **Data Loggers:** Characteristics of data loggers, Block diagram and basic operation of data logger. (H S Kalsi)	8H, 10M

Suggested Readings	1. Albert D. Helfrick and William D. Cooper, “Modern Electronic Instrumentation and Measurement Techniques”, Pearson / Prentice Hall of India, 2007. 2. B.C. Nakra and K.K. Choudhry, “Instrumentation, Measurement and Analysis”, 2nd Edition, TMH, 2004. 3. H.S. Kalsi, “Electronics Instrumentation”, Tata McGraw Hill, 2012 4. A. K. Sawhney, “A Course in Electrical & Electronic Measurements & Instrumentation”, Dhanpat Rai and Co, 2004. 5. Joseph J. Carr, “Elements of Electronics Instrumentation and Measurement”, Pearson India 6. Alan. S. Morris, “Principles of Measurements and Instrumentation”, 2nd Edition, Prentice Hall of India 2003 7. David A. Bell, “Electronic Instrumentation and Measurements”, Prentice Hall of India Pvt. Ltd, 2003. 8. James W. Dally, William F. Riley, Kenneth G. McConnell, “Instrumentation for Engineering Measurements”, 2nd Edition, John Wiley, 2003	

DSC Skill Enhancement Course (SEC) SEC-III: Skill Based

ELE- 505 : Medical Electronics

Total Hours: 45	Credits: 3

Course objective

- To aware students with the role of electronics in medical industry
- Aware the students with concepts of electrical signals that can be measured
- To orient with electronic circuits required in medical equipment
- To introduce the application of advanced biomedical electronics

Learning outcomes

After successful completion of this course, students are expected to:

- Familiarize with human assist devices
- Learn biological signals present in human body
- Learn the various blocks of biomedical sensors
- The electrodes which are normally used to measure the biological signals
- Understand the working principles of various therapeutic and monitoring systems
- Understand recording and analysis of prominent biosignals of human
- Understand the measurement and analysis techniques for physiological parameters
- Understand the patient imaging and monitoring systems

Unit	Topics	Lectures
UNIT-1	**Bioelectric signals and Physiological transducers:** Cell characteristics, ***Bio-electric potential:*** Origin, Resting and action potential, depolarization and repolarisation, propagation of action potentials, ECG, EEG and EMG waveforms with typical characteristics. ***Electrodes:*** Types, Electrodes used for ECG, EEG and EMG. Selection of physiological transducers, ***Physiological transducers:*** Pressure, Temperature, photoelectric & ultrasound Transducers. Measurement in ***Respiratory system:*** Physiology of respiratory system, Measurement of breathing mechanics, Humidifiers, Nebulizers Aspirators.	**12 H** **10 M**
UNIT-2	**Unit – 2: Basic recording systems** Block diagram of ECG, isolated preamplifier, ECG leads, effects of artifacts on ECG recordings, Multichannel ECG machine, Block diagram of EEG machine, 10-20 electrode placement system for EEG, and Evoked potential, Working of EMG with block diagram.	**07 H** **12 M**
UNIT-3	**Unit – 3: Therapeutic Equipment** ***Cardiac pacemakers***- external and implantable pacemakers and programmable pacemaker. ***Defibrillator***-internal and external, AC and DC defibrillators, block diagram of microprocessor based defibrillator. ***Diathermy***- types, schematic of microwave diathermy unit, Surgical diathermy – principle, working of solid state surgical diathermy machine. ***Laser***- different types of lasers and their applications in medicine, ***Ventilators***- Working, microprocessor based ventilator, high-frequency ventilator.	**10 H,** **15 M**
UNIT-4	**Unit – 4: Bio Amplifier** Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier, Chopper amplifier, Power line interference.	**08 H,** **14 M**
UNIT-5	**Unit- 5: Biochemical sensors and Patient safety** ***Biochemical sensors*** - pH, pO2 and pCO2, ***Blood glucose sensors*** - Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer ***(simplified schematic description)***. ***Patient safety*** - Physiological effects of electric current, micro and macro shock-preventive measures, Precaution, safety codes for electro medical equipment, Electric safety analyzer, E-waste- Sources and disposal.	**08 H,** **09 M**
Suggested Readings	**Text Books** 1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2004. **(Units 5)** 2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata	

	McGraw-Hill, New Delhi, 2003**. (Units 4)** 3. Joseph J. Carr& John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson. 4. Shakti Chatterjee, “Textbook of Biomedical Instrumentation System”, Cengage Learning. 5. Bertil Jacobson & John G. Webster- Medicine and clinical Engineering, PHI. 6. Prof. S. K. Venkata Ram- Bio-Medical Electronics and Instrumentation, Galgotia Publications 7. Principals of Biomedical Electronics and Biomedical Instrumentation, C Raja Rao, University Press 8. Introduction to Biomedical Engineering, Michal Domach, Pearson Education 9. Introduction to Biomedical Instrumentation –Mandeep Singh, PHI Learning 10. Principles of Medical Electronics and biomedical Instrumentation- S.K. Guha, University Press India Ltd. 11. Biomedical Instrumentation –Dr. M. Arumugam **References:** 1. Leslie Cromwell, “Biomedical Instrumentation and measurement”, Prentice hall of India, New Delhi, 2007. **2.** Myer Kutz, “Standard Handbook of Biomedical Engineering and Design”, McGraw Hill Publisher, 2003. 3. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”.	

DSC Elective Course (Any one)

ELE 506 (A): Embedded C

Total Hours: 45		Credits: 3

Objectives:

1. To know about programming used for embedded system and robotics
2. To provide experience to integrate hardware and software for embedded applications systems.
3. To acquaint students with methods of executive device control and to give them opportunity to apply and test those methods in practice.

Learning Outcomes

After successful completion of this course, students are expected to:

1. Learn structure oriented programming concepts required in all other languages.
2. After completion of this course students are able to built real world applications based on embedded system and automation.

Unit	Topics	Lectures
Unit 1	**Fundamentals of Embedded C** What is an Embedded System? Programming Embedded Systems. Factors for Selecting the Programming Language. Difference in C and Embedded C. Basic Structure of an Embedded C Program (Template for Embedded C Program). Different Components of an Embedded C Program. Examples of Basic Embedded C Program.	**06 H, 08M**
Unit 2	**Introduction of Embedded C** Keywords and Identifiers, Constant, Variables. Data Types: Primitive, derived and User defined. Declaration of variables. Assigning values to variables. Storage Classes: External, Global, Static, Auto. Operators: Arithmetic operator, Relational operator, Logical operator, Assignment operator, Increment-decrement operator, Conditional operator, Ternary operator, Bitwise operator, Special operators. Operator precedence and Associativity. I\O statements: Reading and writing a single character, Standard and Formatted Input and Output statements, Preprocessor Directives (#define, #include, etc), Simple programming exercises	**10 H, 12 M**
Unit 3	**Decision Making, Branching and Looping** Statements – if, if-else, Nested if-else, else-if Ladder, switch, break, continue, goto. Entry and Exit controlled loops: while loop, do-while loop, for loop. Difference in while and do-while loop, Features of for loops, Nesting of for loops, Simple programming exercises.	**09 H, 12 M**
Unit 4	**Arrays and Character strings** One-dimensional array – Declaration and Initialization, Traversing of array. Two-dimensional array – Declaration and Initialization, Traversing of array. String – Declaring and Initializing string. Reading strings from terminal. Writing strings to screen. String Operations: copy, length, compare, search, manipulate. Simple programming exercises.	**06 H, 10 M**
Unit 5	**User Defined Functions** Need of functions, Form of functions, Calling function, Function returning value, Category of Functions, Recursion, Simple programming exercises	**06 H, 08 M**
Unit 6	**Real World Interfacing using Embedded C Programming** Introduction. Interface: LED, DC motor, stepper motor, LCD, 7-seg. display, Matrix keyboard, temperature sensor, ADC and DAC. (**Note:** This chapter is based on interfacing the basic but most common devises used in automation. It is expected that the interfacing should be done on 8051 development board (or any other controller) rather than simulator)	**08 H, 10M**
Reference books:	1. First Steps with Embedded Systems, by Byte Craft Limited. 2. Embedded C, by Michael J. Pont, Addison-Wesley. 3. Embedded C programming Techniques and Applications of C and PIC MCUS, by Mark Siegesmund. 4. C Programming for Embedded Systems, by Kirk Zurell. **5.** The 8051 Microcontroller and Embedded Systems using Assembly and C, by Muhammad Ali Mazidi.	

ELE-506(B): Basics of Fiber Optic Communication

Total Hours: 45	Credits: 3

Course objectives

- To provide the essential concepts of optical fiber communication.
- To study different types of fibers, losses, signal distortion.
- To learn the various optical sources, materials and fiber splicing.
- To acquire knowledge of the fiber optical receivers.

Learning outcomes

After successful completion of this course, students are expected to:

- Recognize and classify the structures of Optical fiber and types.
- Classify the Optical sources, detectors and to discuss their principle.
- Understanding losses and dispersion.
- Awareness of analog and digital links.

Unit	Topics	Lectures
Unit-1	**Introduction to Optical Fiber Communication System**: Introduction to optical fiber, general optical fiber system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, **Ray theory:** Total Internal Reflection, Acceptance Angle, Numerical Aperture, **Optical Fibers**: fiber materials, fiber optic cables. Step index-single mode fibers, Graded index-Single mode fibers, Step index-Multimode fibers and Graded index-Multimode fibers.	**09 H** **12 M**
Unit-2	**Transmission Characteristics of Optical Fiber:** Attenuation, absorption, scattering losses, bending losses, core and cladding losses, signal dispersion, intra modal dispersion, material dispersion, waveguide dispersion, polarization mode dispersion, intermodal dispersion, dispersion optimization of single mode fiber, characteristics of single mode fiber, R-I Profile and cutoff wave length, mode field diameter.	**10 H** **13 M**
Unit-3	**Optical Sources and Detectors:** Types of Optical Sources, Characteristics of optical sources required for OFC system, LED's :Structure, Planer LED, Dome LED, LASER diodes: Types of Photo detectors, characteristics features of Photo detector required for OFC system, Photo diodes (Physical Principle, PIN and avalanche Photodiode), comparison of different photo detectors.	**08 H** **11 M**
Unit-4	**Fiber Couplers and Connectors:** Fiber alignment, mechanical misalignment, lensing scheme for coupling improvement. Fiber Splices, Types: fusion, mechanical. Fiber connectors, Principle of good connector design. Types: SC, ST, MT-RJ, Butt Joint connectors, Commercial connectors (student expected to know only names of these connectors)	**08 H** **12 M**
Unit-5	**Optical Receiver and Transmitter:** Introduction to Optical Receiver and Transmitter, Block diagrams with basic elements, working operation, sensitivity of receiver, quantum limit, eye diagrams, coherent detection, burst mode receiver operation, Analog receivers, Optical transmitter specifications, spectral line-width and extinction ratio. Simple point to point link and it's design considerations.	**10 H** **12 M**

Suggested Readings	**1.** Gerd Keiser, 'Optical Fiber Communication', 4^{th} Ed., Mc-Graw Hill, 2008. **2.** John M. Senior, 'Optical Fiber Communications', 3^{rd} edition, 2007, Pearson Education. **3.** Govind P. Agarwal,' Fiber-Optic Communications Systems', 4^{th} edition, A John Wiley & Sons, Inc., Publication. **4.** Joseph C Palais,' Fiber Optic Communication', 4^{th} Edition, Pearson Education. **5.** V.S. Bagad,'Optical Fiber Communication System', Technical Publication, Pune.	

DSC Core (Practical)

ELE – 507: Practical Lab I

Total Hours: 60 **Credits: 4**

A) **Semiconductor Electronics (Any two)**

1. Measurement of Resistivity of a given sample by four probe method.
2. To find Hall coefficient of a given sample using Hall probe.
3. Measurement of energy band gap of given diode/ Measurement of energy band gap of given sample using four probe method.
4. Study characteristics of pn junction using MATLAB simulation.
5. Study output of RC integrator/differentiator using MATLAB simulation.

B) Electronic Instrumentation (Any four)

1. Measure the angular displacement using potentiometric (resistive) transducer.
2. To study the characteristics of capacitive transducer.
3. Measurement of torque using strain gauge.
4. Measurement of strain using strain gauge.
5. Study of Linear Variable Displacement Transducer (LVDT).
6. Measurement of frequency and time period using digital frequency meter.
7. Study and measurement of voltage, frequency and phase difference of a.c. quantities using C.R.O.
8. Study and measurement of quantities using D.S.O.
9. Study of function generator (IC8038).
10. Built and test square and triangular wave generator using opamps.
11. Study of Data Acquisition System.

C) Medical Electronics(Any four)

1. Study of ECG/EEG/EMG electrodes
2. Study of temperature sensor for contact measurement (LM35//Thermistor).
3. Study of non-contact temperature measurement system (Infrared thermometers).
4. Study of ultrasonic sensors (Sensitivity/Directivity)/ Study of social distance maintenance equipment.
5. Study of heart rate sensor
6. To operate and familiarize with BP apparatus, ECG machine, ventilator, incubator, Boyle's apparatus, pulse oxymeter.
7. Study instrumentation Amplifier using Opamps.
8. To design and setup a bio-amplifier for a gain of 10 and to calculate the CMMR (Simulation/Actual Circuit)
9. To design and setup a threshold detector circuit using op-amp for a voltage level of 5V(Simulation/Actual Circuit)
10. Design a band pass filter to filter out the 'QRS complex' from the amplified ECG signals (Simulation/Actual Circuit).
11. To design a band pass filter to obtain the alpha frequency band of an amplified EEG signal (Simulation/Actual Circuit).

D) Basics of Fiber Optic Communication

1. To Study and compare I-V characteristics of three LEDs with different colors.
2. To study the I-V characteristics of Photo diode
3. To study opto-coupler characteristics.
4. To establish analog link using Optical Fiber.
5. To establish voice link using optical fiber.
6. To measure Propagation loss in optical fiber.
7. To measure bending loss in optical fiber.
8. To Transmit and receive Pulse Amplitude Modulated (PAM) signal using optical fiber
9. To measure Numerical Aperture and Acceptance angle of Optical Fiber

Note:

1. Student offering Elective course **ELE 506 (A) Embedded C**, should perform Any two practical from group A, any four practical from group B and C (Total 10 Practical).
2. Student offering Elective course **ELE 506 (B) Basic Fiber Optics Communication**, should perform any two practical from group A & B, any three practical from group C & D (Total 10 Practical).

ELE – 508: Practical Lab II (Microprocessor and VHDL)

Total Hours: 60	**Credits: 4**

A)	**Microprocessor (Any five)**
	1. Write a program to display A to Z with one space and ten characters in one line. 2. Write a program to display A to Z in one line and 0 to 9 in next line. 3. Write a program to display a string. 4. Write a program to change upper case to lower case / lower case to upper case. 5. Write a program to find sum of given numbers. 6. Write a program to find the average of given numbers. 7. Write a program to find factorial of a given number. 8. Write a program to convert 8 bit decimal number to hexadecimal number. Write a program to find the hexadecimal number of a given BCD number.
B)	**VHDL programming (Any five)**
	1. Simulation of logic gates using VHDL 2. Simulation of half Adder using VHDL 3. Simulation of full Adder using VHDL 4. Simulation of full subtractor using VHDL 5. Simulation of four bit binary adder using VHDL 6. Simulation of multiplexer using VHDL 7. Simulation of demultiplexers using VHDL 8. Simulation of S-R Flip flop using VHDL 9. Simulation of D Flip flop using VHDL 10. Simulation of Mod-6 Asynchronous counter using VHDL 11. Simulation of 3 bit up-down counter using VHDL

ELE – 509: Project Part I

Total Hours: 60	**Credits: 4**

During project work, follow the following guidelines –

1. Title of the project must be well defined.
2. Planning of the project must be specified.
3. Aim, Objectives, Designing and theoretical background of the work should be specified in detail.
4. Actual work done must be reported along with experimental procedure.
5. There must be observations, results and conclusions of the project work.
6. In case of the projects related to the development of computer software algorithm, program strategy, module wise description etc must be provided.
7. Applications of the work must be specified clearly.
8. Further extension / future scope of the work may be suggested for better outcome of the project.
9. References must be specified

Semester wise Planning & Evaluation of the project work

Work assigned	Marks	Total
1. Selection of Project and Literature Survey	20	60
2. Study Tour: Industrial/Research Lab Visit	20	
3. Presentation of the Project Progress Report	20	

Distribution of Course papers for T. Y.B. Sc. (Electronics) Semester: VI

Discipline	Course Type	Course Code	Course title	Credits	Hours/week (Clock hours)	Total Teaching hours	Marks (Total 100)	
							CA	UA
DSC	Core I	ELE-601	Power Electronics	3	3	45	40	60
	Core II	ELE-602	Consumer Electronics	3	3	45	40	60
	Core III	ELE-603	Microprocessor Interfacing Techniques	3	3	45	40	60
	Core IV	ELE-604	Computer Network	3	3	45	40	60
DSC Skill Enhancement Course (SEC)	Skill Based	ELE-605	Embedded Systems	3	3	45	40	60
DSC Elective course	Elective Course (Any one)	ELE-606 (A)	Electrodynamics	3	3	45	40	60
		ELE-606 (B)	Antenna & wave propagation					
DSC	Core (Practical)	ELE-607	Practical Lab I	2	4 (per batch)	60	40	60
		ELE-608	Practical Lab II	2	4 (per batch)	60	40	60
		ELE-609	Project Part II	2	4 (per batch)	60	40	60
Non Credit Audit Course	Elective audit course (Any one)	AC-601 : A	Soft skill	No credit	2	30	100	--
		AC-601 : B	Yoga					
		AC-601 : C	Practicing Cleanliness					

<table>
<tr><td colspan="3">DSC Core Courses</td></tr>
<tr><td colspan="3">ELE – 601 Power Electronics</td></tr>
<tr><td colspan="2">Total Hours: 45</td><td>Credits: 3</td></tr>
<tr><td colspan="3">Course objective
• Familiarize the students to the construction details, operation and characteristics of different semiconductor power electronics devices along with their few applications.
• Introduction of different power conversion circuits.
• To make strong base of students for further study of power electronics circuits and systems</td></tr>
<tr><td colspan="3">Learning outcomes
<u>After successful completion of this course, students are expected to:</u>
• have fundamental knowledge of semiconductor power electronic device
• can apply this knowledge for designing power electronic circuits</td></tr>
<tr><td>Unit</td><td>Topics</td><td>Lectures/ Mark</td></tr>
<tr><td>UNIT-1</td><td>Power Devices: Need for Semiconductor Power Devices, Power Diodes, Enhancement of Reverse Blocking Capacity, Introduction to Family of Thyristors.
Basic Structure, symbol, working, I-V Characteristics, Applications of SCR, DIAC and TRIAC.
Ratings: Latching Current, Holding Current, dv/dt & di/dt rating, I^2t rating, surge current rating.
List of applications of SCR</td><td>12 H, 14 M</td></tr>
<tr><td>UNIT-2</td><td>Switching circuits for SCR
Methods of Triggering: Gate triggering, Voltage triggering, Thermal triggering and Radiation triggering, Triggering of SCR using UJT, Triggering of SCR using BJT.
Turn off circuits- Natural & Forced Commutation, types of forced commutation (all classes).</td><td>8 H, 12 M</td></tr>
<tr><td>UNIT-3</td><td>Controlled Rectifiers
Single Phase Circuits: Thyristor half wave Rectifier (Resistive load), Thyristor half wave Rectifier (Inductive load), Thyristor Full Converter (Resistive load), Thyristor Full Converter (Inductive load).</td><td>7 H, 10 M</td></tr>
<tr><td>UNIT-4</td><td>Inverters and Converters
Inverters - Introduction, Industrial applications, types of inverters, Single Phase Bridge inverter, Single Phase Centre Tapped Inverter, Series Inverter.
Converters (choppers) - Introduction, Principle of Step down Chopper (variable frequency and constant frequency control), Step up chopper, Chopper Classification, Chopper Configurations.</td><td>10 H, 12 M</td></tr>
<tr><td>UNIT-5</td><td>Applications of SCR and High frequency heating
Applications of SCR - Uninterruptible power supplies, over voltage protection, simple battery charger, fan regulator using DIAC and TRIAC.
High frequency heating applications -
Induction heating – principle, application as induction heater
Dielectric Heating – principle, application in sterilization</td><td>8 H, 12 M</td></tr>
<tr><td>Suggested Readings</td><td>1. “A Text Book on Power Electronics”, H.C. Rai, Galgotia Publication,
2. “Power Electronics” H.C. Rai, Galgotia Publication
3. “Industrial Electronics” G. K. Mithal, Khanna Publishers
4. “Thyristor & Their Applications”, M. Ramamoorty, EWP.
5. Principles of Electric Machines and Power Electronics, 3rd Edition</td><td></td></tr>
</table>

ELE 602: Consumer Electronics

Total Hours:45	Credits: 3

Course Objectives:

- To give students an in depth knowledge of various electronic audio and video devices and systems.
- Introduce the students with working principles, block diagram, main features of consumer electronics gadgets/goods/devices.
- To develop the capabilities of assembling, fault diagnosis and rectification in a systematic way.
- To create skill of installation of various electronics appliances like Set Top box (D2H), CATV and Dish TV, water purifier, Air conditioner etc.

Learning outcomes

After successful completion of this course, students are expected to:

- Understand the various type of microphones and loud speakers.
- To identify the various digital and analog signal.
- Understand the various type of consumer goods and acquaint the skill of fault findings.
- Develop the skill of electronics appliances like Set Top Box, CATV and Dish TV, water purifier, Air conditioner etc.
- Acquaint the knowledge of different types of Television Technology.

Unit	Topics	Lectures/ Marks
UNIT-1	**Audio System**	
	Microphone: Characteristics of microphone, different types of microphone, Electret & carbon microphones (principle, construction, working and characteristics). **Special Microphones:** Lavalier microphone, Tie-clip microphone, Radio microphone and Noise cancelling microphone. **Loudspeaker:** Characteristics of Loudspeaker, Horn type, Multiway speaker system (Woofers & Tweeters). **P.A. System:** Need and Use, Block diagram of P.A. system, Requirements of PA system, typical P.A. Installation planning (P.A. system for a public meeting in Public Park and P.A. System for an auditorium having large capacity)	**10H, 14M**
UNIT-2	**Digital Television and Video**	
	Introduction to Liquid Crystal Display, Plasma, LED and OLED Screen Televisions, Basic block diagram of LCD and LED Television and their comparison. Concept of HD TV, smart TV, closed circuit TV. Introduction of Direct to home satellite TV (D2H), Block diagram of D2H TV system, Cable TV system, (R.G. Gupta p.n. 346), Personal Video Recorders (PVRs), Video on Demand. (S. P. Bali, p.n. 706)	**10H, 14M**
UNIT-3	**Office Appliances**	
	Computer System (Block Diagram, function of each block), Scanners, Barcode reader, Printers, Photocopier (Xerox Machine)- block diagram, features and specification. Multifunction units (Print, Scan, fax, and copy).	**08H, 10M**
UNIT-4	**Modern Home Appliances**	**17H,**

	Microwave Oven – Principle of Operation, Block Diagram, Safety instructions -Care andCleaning, features and specifications **Washing Machine -** Principle of Operation, fuzzy logic, Washing machine with fuzzy logic, Block Diagram, features and specifications. **Remote Control:** Operating Principle, Block Diagram, Operation and features. **Electronic Weighing Systems** - Operating principle, Block diagram, features. **Home security system,** I Introduction of **Air conditioners (AC)**, Components of AC, Types of AC, **Water Purifier**.	**22M**
Suggested Readings	1. Consumer Electronics by R. P. Bali, Pearson Education (2008) 2. Audio and Video systems by R. G. Gupta, Tata McGraw Hill (2004) 3. Consumer Electronics by J. S. Chitode, Technical Publication Pune 4. Electronic and Electrical Servicing Consumer and Commercial Electronics, by Ian Sinclair & John Dunton.	

ELE 603: Microprocessor Interfacing Techniques

Total Hours: 45 **Credits: 3**

Course objective

- To learn the interfacing of I/O devices with microprocessor.
- To learn interfacing techniques.
- To learn about the basic peripherals interfacing.
- To learn about the programmable interval timer and their Interfacing

Learning outcomes

After successful completion of this course, students will be able to:

- Student will be able to Aware about the concept of microprocessor and its interfacing & Capable to analyze the operation and priorities of Interrupt
- Understand the concept of memory mapping & DMA
- Student will be able to understand the ADC & DAC interfacing
- To gain the Knowledge about the programmable interval timer and communication interface 8251 & analyze the operating modes.

Unit	Topics	Lectures
UNIT-1	**Special Architectural Features and Related Programming** Interrupts and interrupt service routines, interrupt cycle of 8086, NMI and maskable Interrupt, interrupt Programming, Macros. Programming using Dos Interrupt: INT 21H (Function 01H, 02H, 09H, 4CH, 10H).	**11H, 15M**
UNIT -2	**I/O Programming and Interfacing** Fundamental I/O Considerations, Programmed I/O, Interrupt I/O, Interfacing in I/O, Mapped I/O, Interfacing in Memory Mapped I/O, DMA Controller IC 8257- its features, block diagram and interfacing with 8086	**11H, 14M**
UNIT-3	**Basic & Special Programmable Peripheral devices and their Interfacing** Block diagram of ADC -0808 and its interfacing, DAC 0800 interfacing, Stepper motor interfacing. Programmable Interval Timer 8253 – Internal block diagram, operating mode of 8253	**12H, 16M**
UNIT -4	**Communication Interface Peripheral** Serial Communication interface, Asynchronous and synchronous communication, Parallel communication interface, Programmable communication interface 8251- Internal Architecture and operating modes	**11H, 15M**
Suggested Readings	**Reference Books:** 1. "Advanced microprocessor and peripherals (Architecture Programming and Interfacing)",A. K. Ray, K. M. Bhurchandi, TMH Publication. 2. "Microprocessor system: 8086/8088 family Architecture Programming and design)", Yu Cheng Liu and G.A.Gibson, PHI Publication. 3. "Microprocessor and Interfacing", D. Hall 1995, TMH Publication. 4. "The 8088 and 8086 microprocessor (Programming, Interfacing, Software, Hardware and applications)", Walter A. Triebel, Autarsingh. 5. "Microprocessor and Interfacing Techniques", A. P. Godse. D. A. Godse, Technical Publication, Pune.	

ELE 604: Computer Network

Total Hours: 45		Credits: 03

Course Objectives:

- To develop an understanding of computer networking basics.
- To develop an understanding of different components of computer networks, various protocols, modern technologies and their applications.

Learning Outcomes:

- Recognize the technological trends of Computer Networking.
- Discuss the key technological components of the Network.
- Evaluate the challenges in building networks and solutions to those.

Unit	Topics	Lectures
Unit 1	**Fundamentals of Computer Network** 1.1.Needs, uses of Computer Network, Applications of Computer, Network, Benefits of Computer Network: Sharing of Information, Sharing Resources, Centralized Management of resources, backing up of data. 1.2.Classification of Networks: Geographical Classification, Classification Based on Transmission Technology, Classification Based on Network Relationships 1.3.Basics of network computing models: per-to-peer, client server, distributed Network Operating System (NOS): its types, features and applications.	**08 H, 10 M**
Unit 2	**Network Components and Topologies:** 2.1.Basic Components of Computer Network: Cables. Host, Communication Subnet. NJC. 2.2.Network Devices and their role: Repeaters, Hub, Bridge, Switches, Router 2.3.Network Topologies: Concept Significance, Bus, Star, Ring, Tree, Mesh,	**08 H, 10 M**
Unit 3	**Reference Models for Computer Networks:** 3.1.Protocol Hierarchies-Layered Approach 3.2.Interfaces, Services, Protocols and Packets 3.3.Design issues for layering. 3.4.OSI reference Model: layers and their functions. 3.5.TCP/JP Protocol: Layers and their functions 3.6.OSI Model Vs.TCP/IP	**10 H, 12 M**
Unit 4	**TCP/IP Protocol Suite:** 4.1.Host-to-Network Layer Protocols: SLIP ,PPP 4.2.Internet Layer Protocols: IP, ARP,RARP,ICMP. 4.3.Transport Layer Protocols: TCP, UDP. 4.4.Application Layer Protocols: FTP, HTTP, SMTP, TELNET, DNS, BOOTP, DHCP	**08 H, 10 M**
Unit 5	**Wireless LANS & Virtual Circuit Networks** 5.1.Introduction, 5.2.Wireless LANS: IEEE 802.11 project, 5.3.Bluetooth, Zigbee. 5.4.Connecting devices and Virtual LANS.	**05 H, 08 M**
Unit 6	**Introduction and Cloud Computing Technology:** 6.1.Shift from distributed computing to cloud computing; 6.2.Principles and characteristics of cloud computing- IaaS, PaaS, SaaS; 6.3.Service oriented computing and cloud environment, 6.4.Client systems, Networks, Server systems and security from services perspectives, 6.5.Accessing the cloud with platforms and applications; cloud storage.	**06 H, 10 M**
Suggested Readings	1. Computer networks : Tanenbumb, Andrew S. PHI learning New Delhi 2. TCP/Ip Protocol Suit : Forouzm Behrouz A. McGrawHill ,New Delhi,2006 3. Data Communication and networking :Forouzm Behrouz A. McGrawHill	

	,New Delhi 2006 4. Data Communication and networks : Godbole ,Achyut McGrawHill ,New Delhi 2006 5. Computer network Topdown approach : Korus Pearson **6.** Cloud Computing – A Practical Approach, Anthony T. Velte, Toby J. Velte and Robert E, TMH 2010. **7.** Cloud Computing – Web based Applications: Michael Miller, Pearson Publishing, 2011.	

DSC Skill Enhancement Course (SEC) SEC-IV Skill Based

ELE 605: Embedded Systems

Total Hours: 45	Credits: 3

Course objective

- To know about 8051 microcontroller programming
- To learn the 8 bit microcontroller interfacing.
- To learn about the SPI & two wire interface

Learning outcomes

After successful completion of this course, students will be able to:

- To gain the knowledge about the 8051-microcontroller programming such as timer & counter and serial port programming
- Understand the basic concept of interfacing with microcontroller
- Understand the interfacing principle with Stepper motor and temperature sensor
- To gain the Knowledge about the serial peripheral interface and two wire interface.

Unit	Topics	Lectures/ Marks
UNIT-1	**Introduction to Embedded System (06M)** Introduction to Embedded Systems, Stand-alone and real-time embedded systems. Requirements of embedded systems, Components of embedded system. Programming languages and tools. Embedded operating system. Embedded system Application examples	06H, 06M
UNIT -2	**Timer and Counter Programming** Single bit Programming, Timer modes, Programming the timers in various modes (Mode 1 and Mode2), Counter Programming. To generate delay of milliseconds & square wave.	10H, 14M
UNIT-3	**Serial Port Programming** Basic of serial communication (Serial Vs Parallel data Transfer, Simplex, Duplex), Serial port of 8051, Baud rate in 8051, Programming the 8051 to transfer and to receive data serially, Importance of TI and RI flags, Baud rate doubling.	11H, 15M
UNIT -4	**Interrupts Programming** Interrupts in 8051, enabling and disabling the interrupts, Programming timer interrupts, Programming external hardware interrupts, Level and edge triggered interrupts.	08H, 10M
UNIT -5	**Unit 5: 8051 Interfacing** Interfacing of 8255 to 8051 & programming Introduction, Interfacing-keyboard (matrix), Displays (seven segment & LCD), Stepper motor, ADC, DAC (Sine wave & Square wave), Temperature Sensor (LM 35). Analog Comparator, Serial Peripheral Interface (SPI), Two Wire Interface (TWI) / I2C bus	10H, 15M
Suggested Readings	**Reference Books:** 1. “Introduction to Embedded System”, Shibu K V, Tata McGraw Hill. 2. “Embedded Systems” Rajkamal, Tata McGraw Hill. 3. The 8051 Microcontroller and Embedded Systems”, Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, Pearson Education. 4. “The 8051 Microcontroller Architecture, Programming, & Applications”, Kenneth J. Ayala, Penram International. 5. “The 8051Microcontroller and Embedded System using Assembly and C”, K. J. Ayala, D. V. Gadre, Cengage Learning, Indian Edition. 6. “Programming and Customizing the 8051, Microcontroller”, Myke Predko, Tata McGraw Hill.	

DSC Elective Course (Any one)

ELE-606 (A) Electrodynamics

Total Hours: 45 | **Credits: 3**

Course objective

- To enrich the understanding of fundamentals concepts of electrodynamics and electromagnetics.
- To have basic knowledge of electromagnetic waves and their propagation.

Learning outcomes

After successful completion of this course, students are expected to:

- Apply Gauss Law, Amperes Force Law, Lorentz's force, Biot-Savarts Law, Faraday's Law for solving the problems in Electrostatic and Electromagnetic Fields.
- Apply the principle of electrostatic to the solutions of problems related to electric field and electric potential, boundary value problem in electrostatic field.
- Understand the concept of Faradays law, Lenz's Law and Maxwell Equation
- Apply the Maxwell's equation in free space, linear isotropic media and varying fields, energy and electrostatic fields.

Unit	Topics	Lectures
UNIT-1	**Electrostatics** Electric Field, electric flux, Field lines, Gauss' Law (integral form, for an internal & external point), application of Gauss' Law (field due to spherically symmetric charge distribution), Introduction to electrostatic potential, electrostatic energy, relation between electric field and electrostatic potential, electrostatic Energy.	**10H, 12M**
UNIT-2	**Boundary Value Problems in Electrostatic Field** Poisson's and Laplace Equation, solution of Laplace's equation in rectangular coordinate, Laplace's equation in spherical polar coordinates, electrostatic potential energy, simple boundary value problem, electrostatic images, point charge and conducting sphere.	**06H, 10M**
UNIT-3	**Magnetostatics** Introduction, electric current, Steddy current, Ohm's law, electrical conductivity, calculation of resistance, current density, magnetic induction, force on a current element Amper's force law, Lorentz force and force on a current, Biot-Savart's law, simple applications. resistance and radiated power[6]	**08H, 10M**
UNIT-4	**Electromagnetic Induction** Electromotive force, Faraday's Law of electromagnetic induction, Inductance Energy in magnetic field , Lenz law, integral and differential form of Faraday's law, equation of continuity, displacement current, Maxwell's Equations (differential form), derivation of Maxwell's equations, Maxwell's equation in integral form and its derivation, Maxwell's equation in free space, linear isotropic media and varying fields, energy in electromagnetic fields: Poynting theorem.	**11H, 16M**
UNIT-5	**Electromagnetic Wave and its Propagation** Physical significance of wave equations for free space conditions and plane electromagnetic waves in free space (Cover figure of EM wave and E-H parameter on the basis of last equation, No derivation expected), plane electromagnetic wave propagation in isotropic dielectric (non conducting media), polarization of electromagnetic wave, reflection and refraction of EM wave at non conducting boundaries.	**10H, 12M**

Suggested Readings	1. "Electrodynamics" Dr. Gupta, Dr. Kumar, Singh, Pragati Prakashan. 2. "Electromagnetics", B. B. Laud, Wiley Eastern Limited. 3. "Foundations of Electromagnetic Theory", John Reits, Narosa Publishing House. 4. "Classical Electrodynamics", John David Jackson, Wiley Student Education. 5. "Introduction to Electrodynamics", David J. Griffiths, Pearson Education India. 6. "Classical Electrodynamics", S. P. Puri, Tata McGraw Hill Publishing	

ELE-606 (B) Antennas and Wave propagation

Total Hours: 45	Credits: 3

Course objective

- To provide fundamental knowledge of electromagnetic wave radiation and reception through antenna.
- To understand physical properties of antenna.
- To study different antenna structures
- To understand transmission of radio waves around the surface of earth.

Learning outcomes

After successful completion of this course, students are expected to:

- The student will be able to Understand how the electromagnetic wave propagate from an antenna
- Learn the concept of RF feeding to an antenna
- To calculate the various parameters of antenna to know its efficiency.
- Study the various types of antennas used in recent communication systems.
- Understand the wave propagation through space.

Unit	Topics	Lectures
UNIT-1	**FUNDAMENTALS OF ANTENNA** Introduction, Antenna radiation mechanism, Functions of antenna, Properties of antenna, Applications of Antenna Antenna Parameters : Radiation pattern- field pattern and phase pattern, Directive gain, Directivity and power gain, Field Intensity, Antenna Resistance, Bandwidth, Beam width , Polarization, Efficiency, Antenna temperature[1,3], Effective height and aparture[5] , FBR, Problems based on parameters.	09 H, 12M
UNIT-2	**TRANSMISSION LINES** Principal and types of transmission lines- Coaxial, Twisted pair, standing waves, Losses in transmission lines, Input impedance/characteristic impedance, Impedance matching [3].	06H, 10M
UNIT-3	**RADIATING STRUCTURES** Basic of Antenna Elements, Radiation of alternating current element, Radiated power and radiation resistance of AC element, Hertzian dipole, Radiation Induction and Electrostatic Field, Numerical on radiated resistance and radiated power[6]	09H, 12M
UNIT-4	**ANTENNAS** Monopole antenna, half wave dipole – current and voltage distribution Folded dipole, concept of Loop antenna and structures, Idea of Bioconical antenna, concept of Patch Antenna and its types, Aperture antenna, Array antenna, Parabolic Reflector antenna, List of antenna application	09 H, 12M
UNIT-5	**WAVE PROPAGATION** Fundamentals of electromagnetic wave-radiation absorption, Ground waves, Sky wave propagation- Ionosphere, Space waves, Tropospheric scatter propagation, wave propagation in ionosphere, Definition: Critical frequency, Skip distance, virtual height, Maximum Usable frequency; Wave propagation in mobile radio environment[4].	12H, 14M
Suggested Readings	1. Constatine A. Balanis. (2012) Antenna theory : Analysis and Design,3rd Edition, John Wiley & Sons 2. Sisir K Das & Annapurna Das.(2013)Antenna and wave propagation ,1st Edition, Tata Mcgraw Hill Publication 3. G. Kennedy.(1999) Electronic Communication systems,3rd Edition, Tata Mcgraw Hill Publication 4. Willian C. Y. Lee.(1986) Mobile communications design fundamentals, Willey Series in Telecommunication 5. R. L. Yadava.(2011)Antenna and wave propagation, 1st Edition, PHI Learning Private Limited. 6. G.S.N Raju.(2004)Antennas and Wave Propagation, 1st Edition, Pearson Education.	

DSC Core (Practical)		
ELE – 607: Practical Lab I		
Total Hours: 60		**Credits: 4**
A)	**Power Electronics (Any four)** 1. Build and test DC to DC converter using transistor and IC-555. 2. Study of characteristics of SCR. 3. Study of characteristics of TRIAC. 4. Study of half wave/full wave rectifier using SCR. 5. Study of fan regulator/ light dimmer using Diac and TRIAC. 6. Study of time delay circuit using SCR and UJT. 7. Build and test over voltage protection using SCR for a given voltage. Build and test triggering of SCR using LDR	
B)	**Consumer Electronics (Any three)**	
	1. Plot the Directional response of Microphone 2. Plot the directional response of a Loud Speaker 3. Installation of Public Address System. 4. Installation of CCTV system 5. Installation of Dish Antenna for best reception 6. Assembling of water purifier 7. Market Survey of Products (At least one from each module) 8. Installation of Printer 9. Identification of blocks of computer system and tracing the system. 10. Computer Assembling/Disassembling Installation of operating system	
C)	**Computer networking (Any three)**	
	1. Study of Network components (To observe Components of Network in your Computer Network Lab and its type and network features) 2. Prepare a Straight Cable and Network Cross over Cable and test by Line Tester. (connecter connection is expected) 3. To Connect Computers in Star Topology using Wired Media and any Network control Device. 4. Preparing setting up wireless network 5. To connect two hubs/switch by creating crossover connection and to Configure Peer-to-Peer Network. 6. To Share Printer and Folder in Network. 7. Troubleshooting network 8. Preventive maintenance 9. Handling network admin function 10. To visit server room and prepare report on 1. Proxy Server 2. Server Configuration 3. Router Configuration 4. Firewall Configuration 5. Network setup details (Topology, Back up, IP range, network software, UPS)	

ELE – 608: Practical Lab II

(µP, Embedded systems and Antenna & Wave propagation)

Total Hours: 60 **Credits: 4**

A) Microprocessor Interfacing (Any five)

1. Write a program to interface LEDs
2. Write a program to interface Switch and buzzer
3. Write a program to interface the Relay
4. Write a program to interface Keyboard matrix
5. Write a program to interface Seven Segment display
6. Write a program to drive stepper motor.
7. Write a program to interface DC motor
8. Write a program to interface LCD
9. Write a program to interface the IR Sensor
10. Write a program to interface the LDR
11. Interfacing ADC to 8086.
12. Interfacing DAC to 8086.

Note: Experiments to be performed on microprocessor 8086 trainer kit/ simulator

B) Embedded Systems Lab (Any five)

1. Write a program to make LED ON and OFF continuously.
2. Write a program to drive stepper motor continuously.
3. Write a program to generate square wave.
4. Use the potentiometer to change the red LED intensity from 0 to maximum in 256 steps.
5. Interface DC motor using L293D Motor Driver.
6. Write a program to interface Seven Segment display
7. Write a program to interface LCD
8. Interface LM35 temperature sensor and monitor temperature.
9. Write a program to add strings of byte and store in memory.
10. Write a program to count no. of character stored in string which is terminated by escape character.

Note:- Experiments to be performed on microcontroller 8051 trainer kit/simulator

C) Antenna and Wave Propagation

Perform the following experiments by simulation using MATLAB/SciLab

1) To study Antenna Parameters
   a. Radiation pattern b. Directivity c. Power Gain d. Power radiated e. Efficiency
2) Determine the radiated field strength and the total power radiated and also the radiation resistance.
3) Determine radiation pattern in loop antenna.
4) Determine field strength and induced voltage in loop.
5) Determine Gain, Bandwidth and capture area a parabolic reflector antenna for different diameters.

Determine loss and power received with varying frequency.

Note:

- Students offering course **ELE 606 (A) Electrodynamics** should perform any five practical from group A and group B. (Total 10 practical)
- Students offering course **ELE 606 (B) Antenna and wave Propagation** should perform any four practical from group A, and any three practical from group B & C. (Total 10 practical)

ELE – 609: Project Part II

Total Hours: 60	**Credit: 4**

During project work, follow the following guidelines –

1. Title of the project must be well defined.
2. Planning of the project must be specified.
3. Aim, Objectives, Designing and theoretical background of the work should be specified in detail.
4. Actual work done must be reported along with experimental procedure.
5. There must be observations, results and conclusions of the project work.
6. In case of the projects related to the development of computer software algorithm, program strategy, module wise description etc. must be provided.
7. Applications of the work must be specified clearly.
8. Further extension / future scope of the work may be suggested for better outcome of the project.
9. References must be specified

Semester wise Planning & Evaluation of the project work

Work assigned	Marks	Total
1. Fabrication and Testing of the Project Circuit	20	60
2. Preparation of the Project Report	20	
3. Final Presentation of the Project	20	

FACULTY OF SCIENCE & TECHNOLOGY

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS
FOR
F. Y. B. Sc. (PHYSICS)

(AS PER CHOICE BASED CREDIT SYSTEM PATTERN OF UGC)

(With effect from June - 2022)

Preamble

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process and examination and evaluation systems.

In that context in the last decade, North Maharashtra University, Jalgaon has taken several initiatives to upgrade and enhance the academic excellence, examination reforms and developing the skilled minds and skilled hands. As per the directions of UGC, from last year our KBC North Maharashtra University, Jalgaon has implemented the Choice Based Credit (CBCS) pattern to undergraduate programs run by various colleges affiliated to NMU, Jalgaon. As per the directions given by the Honorable Vice Chancellor, Pro-Vice Chancellor and Dean of the Faculty of Science and Technology of our university, one day workshop was organized for syllabus framing. The teachers of the affiliated colleges and university department were participated in the workshop of re-structuring the syllabi of F. Y. B.Sc. (Physics) as per the CBCS pattern and it has been finalized during the workshop and the same will be effectively implemented from the academic year 2022-23.

The main objective of the re-structuring the syllabus of F. Y. B. Sc. (Physics) is to create skilled minds and therefore expectation is to equip the students with the knowledge and understanding of concepts of physics rather than the ability to remember facts so that they may have a reasonable comprehensive and complete grasp of principles of physics. It is expected that the students should study physics with keen interest, develop their experimental skill and problem solving ability. The students should communicate their knowledge of Physics to the Society, to make them to understand physics around us. The students should use their knowledge of Physics for betterment of our Society, our nation and the World.

Board of Studies (Physics),
North Maharashtra University, Jalgaon

OBJECTIVES

1. To provide education in physics of the highest quality at the undergraduate level and generate graduates of the caliber sought by industries and public service as well as academic teachers and researchers of the future.
2. To acquire deep knowledge in fundamental aspects of Physics and basic knowledge in the specialized thrust areas like Mechanics, Dynamics and Properties of Matter , Electricity, Electrostatics, Dielectrics, Magnetism, Electromagnetism and Mathematical physics.
3. To develop ability among the students to identify, remember and grasp the meaning of basic facts, concepts and principles of Physics.
4. To develop observational skills, confidence in using scientific equipment and relate the knowledge of scientific concepts to quantitative and physical measurement.
5. Acquire knowledge, skills, working methods and ways of expression which will reflect on all round development of the students' attitudes towards scientific thinking and its applications.
6. To develop attitudes such as concern for accuracy and precision, objectivity, and Enquiry.
7. The overall aim is to provide comprehensive knowledge and understanding in the relevant fields and enable students to pursue the physics subject at an advanced level later and to attract outstanding students from all back grounds.

BOS (PHYSICS)-Faculty of Science & Technology

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

Class: **F. Y. B. Sc.** Subject: **Physics**

Choice Base Credit System (With effect from June 2022)

The Board of Studies in Physics has unanimously accepted the revised syllabus prepared by different committees, discussed and finalized in the **Workshop on Syllabus restructuring at F. Y. B. Sc. Physics (CBCS Pattern)** held on 11th April 2022.

The titles of the papers for F.Y.B.Sc. (Physics) are as given below:

Semester	Credits	Course code	Course Title	No. of Credits	Hours/ semester	Marks	
						Internal	External
I	Theory-04 Practicals-02	PHY 101	Basic Mechanics	02	30	40	60
		PHY 102	Dynamics and Properties of Matter	02	30	40	60
		PHY 103	LAB -I	02	60	40	60
II	Theory-04 Practicals-02	PHY 201	Electricity and Electrostatics	02	30	40	60
		PHY 202	Dielectrics, Magnetism and Electromagnetism	02	30	40	60
		PHY 203	LAB -II	02	60	40	60

Note: The industrial/study tour is compulsory for students of F. Y. B. Sc. (Physics).

Semester I
PHY 101: Basic Mechanics
(Credits: 02): (30 Lectures 60 Marks)

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Course description:

This course is aimed at introducing the concepts of Basic Mechanics to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Basic Mechanics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept and knowledge of Basic Mechanics to understand and solve real life problems.
2. Understanding of the course will create scientific temperament.

……………………………………………………………………………………………….

Unit 1. Vectors

Vector algebra, Scalar and vector products (Dot, Cross, Scalar Triple Product, Vector Triple Product, Derivatives of a vector with respect to a parameter. **(04 Lectures, 12 Marks)**

Unit 2. Ordinary Differential Equations

Types of differential equations, degree and order of differential equation (definitions only), linear and non-linear differential equations (definitions only), homogeneous and non-homogeneous differential equations (definitions only), 1^{st} order homogeneous differential equations, 2^{nd} order homogeneous differential equations with constant coefficients (definitions with examples). **(08 Lectures, 16 Marks)**

Unit 3. Laws of Motion

Frames of reference, Newton's Laws of motion, Dynamics of a system of particles, Centre of Mass, Centre of mass of two particle system, Centre of mass of n-particle system, Centre of mass of a rigid body, Centre of mass of a circular ring. **(10 Lectures, 16 Marks)**

Unit 4. Momentum and Energy

Conservation of momentum, Work and energy, Conservation of energy, Motion of rockets.

(04 Lectures, 08 Marks)

Unit 5. Rotational Motion

Angular velocity and angular momentum, Torque, Conservation of angular momentum.

(04 Lectures, 08 Marks)

Reference Books:

1. University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison-Wesley
2. Mechanics Berkeley Physics course, V-1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.
3. Physics: Resnick, Halliday & Walker 9/e, 2010, Wiley
4. Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford UniversityPress
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
6. New Simplified Physics : S. L. Arora, Dhanpat Rai and CO. (A reference book for class XI, Volume I)
7. Concept of Physics, H. C. Verma, Volume I.

Semester I
PHY 102: Dynamics and Properties of Matter
(Credits: 02): (30 Lectures 60 Marks)

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Course description:

This course is aimed at introducing the concepts of Dynamics and Properties of Matter to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Dynamics and Properties of Matter.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept and knowledge of Dynamics and Properties of Matter to understand and solve real life problems.
2. Understanding of the course will create scientific temperament.

…………………………………………………………………………………………….

Unit 1. Gravitation

Newton's Law of Gravitation, Central force, Motion of a particle in the central force field Kepler's Laws (Statement only), Conservation of angular momentum, Areal velocity is constant, Satellite in circular orbit, Geosynchronous orbit, Applications of satellites, Weightlessness, Basic idea of global positioning system(GPS). **(08 Lectures, 16 Marks)**

Unit 2. Surface Tension

Concept of surface tension, Examples of surface tension, surface tension, surface energy, Angle of contact, Wettability, Relation between surface tension, Excess pressure and Curvature, Factors affecting surface tension, surface tension of water by Jaeger's method, Applications of surface tension. **(07 Lectures, 14 Marks)**

Unit 3. Elasticity

Hooke's law, Stress-strain diagram, Elastic moduli, Relation between elastic constants (Y, k and η), Poisson's Ratio, Expression for Poisson's ratio in terms of elastic constants, Work done in stretching and work done in twisting a wire, Torsional pendulum, To determine Y, k,η and σ by Searle's method. **(07 Lectures, 14 Marks)**

Unit 4. Fluid Dynamics and Viscosity:

Introduction, General concept of fluid flow, Streamline and turbulent flow, Critical velocity, Different forms of energy possessed by liquids, Bernoulli's theorem, Applications of Bernoulli's theorem- Venturimeter and Pitot tube to find the rate of flow. Concept of viscosity, Definition, Newton’s law of viscosity, Velocity gradient, Rate of flow of liquid in a capillary tube-determination of coefficient of viscosity of a liquid by Poiseuille’s formula, Viscosity of water by Poiseuille’s method, Dependence of viscosity of a liquid on temperature.

(08 Lectures, 16 Marks)

Reference Books:

1. University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison-Wesley
2. Mechanics Berkeley Physics course, V-1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.
3. Physics: Resnick, Halliday & Walker 9/e, 2010, Wiley
4. Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford UniversityPress
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
6. Elements of properties of matter- D. S. Mathur, Shamlal Charitable Trust, New Delhi
7. General Properties of Matter- J. C. Upadhyaya, Ramprasad and Sons, Agra
8. Mechanics- J. C. Upadhyaya, Ramprasad and Sons, Agra.
9. New Simplified Physics: S. L. Arora, Dhanpat Rai and CO. (A reference book for class XI, Volume II)
10. Concept of Physics, H. C. Verma, Volume I.

Semester I
PHY 103: LAB II
(Credits: 02): (60 Lectures 60 Marks)

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On successful completion of this course students will be able to:

1. To demonstrate their practical skills.
2. To understand and practice the skills while doing Physics practical.
3. To understand the use of apparatus and their use without fear.
4. To correlate Physics theory concepts through practical.
5. Understand the concepts of errors and their estimation.

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(Students should perform at least ten experiments from the following list)

1. Calculation of errors from given data.
2. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
3. Determine the acceleration due to gravity ‘g’ of an object falling freely using Kinematic equation
4. To determine ‘g’ by Bar Pendulum.
5. To determine ‘g’ by Kater’s Pendulum.
6. To determine ‘g’ and velocity for a freely falling body using Digital Timing Technique
7. To determine the restoring force per unit extension of a spiral spring by statistical and dynamical methods and also determines the mass of the spring.
8. To study the Motion of a Spring and calculate (a) Spring Constant (b)Value of ‘g’
9. To determine the Moment of Inertia of a Disc.
10. To determine Y by using flat spiral spring.
11. To determine Y of a rectangular beam by bending.
12. To determine η by using flat spiral spring.
13. To determine η by torsional oscillations.
14. To find the torsional rigidity (C) and torsion constant ($\alpha = Cl$) of the given string using torsional pendulum.
15. To determine ‘Y’ by vibrational cantilever.

16. To determine the Young's Modulus of a Wire by Optical Lever Method.
17. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
18. To determine the Elastic Constants of a Wire by Searle's method.
19. To determine Poisson's Ratio of rubber by using rubber cord/tube.
20. To determine the Moment of Inertia of a Flywheel.
21. Determination of coefficient of viscosity of water by Poiseuille's method.
22. Verification of Bernoulli's theorem.
23. To determine surface tension by Jaeger's method.
24. To determine the angle of prism (A) using spectrometer.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T.Worsnop,1971,Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. Engineering Practical Physics, S. Panigrahi & B. Mallick,2015,Cengage Learning India Pvt. Ltd.
4. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011,KitabMahal, New Delhi.
5. A text Book of Experimental Physics-Dr. V.Y. Rajopadhye, V. L. Purohit and A .S. Deshpande (Continental Prakashan, Poona-30)
6. Practical Physics by R. K. Shukla, Anchal Srivastava (NewAge International).
7. Advance Practical Physics by S. P. Singh (Pragati).
8. Practical Physics: Gupta and Kumar (Pragati Prakashan Meerut)
9. University Practical Physics by D. C. Tayal, Himalaya Publishing House.

Semester II
PHY 201: Electricity and Electrostatics
(Credits: 02): (30 Lectures 60 Marks)

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Course description:

This course is aimed at introducing the concepts of Electricity and Electrostatics to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Electricity and Electrostatics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept and knowledge of Electricity and Electrostatics to understand and solve real life problems.
2. Understanding of the course will create scientific temperament.

………………………………………………………………………………………………

Unit 1. Network theorems in current electricity

Kirchhoff's laws and loop analysis by Kirchhoff's laws, Network theorems: Thevenin's theorem and Norton's theorem with illustrations, Maximum power transfer theorem (D. C. Source only), Electric power, Electricity bill calculation, Joule's law. **(10 Lectures, 20 Marks)**

Unit 2. Vector Analysis

Gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume, integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only). Six vector identities without proof:

(a) $\nabla \times \nabla\phi = 0$ (b) $\nabla \cdot (\nabla \times \mathbf{A}) = 0$ (c) $\nabla \cdot (\phi \mathbf{A}) = \phi (\nabla \cdot \mathbf{A}) + \mathbf{A} \cdot (\nabla \phi)$

(d) $\nabla \times (\phi \mathbf{A}) = \phi (\nabla \times \mathbf{A}) + (\nabla \phi) \times \mathbf{A}$ (e) $\nabla \cdot (\mathbf{A} \times \mathbf{B}) = \mathbf{B} \cdot (\nabla \times \mathbf{A}) - \mathbf{A} \cdot (\nabla \times \mathbf{B})$

(f) $\nabla \times (\nabla \times \mathbf{A}) = \nabla(\nabla \cdot \mathbf{A}) - \nabla^2 A$ **(05 Lectures, 10 Marks)**

Unit 3. Basics of Electrostatics

Coulomb's Law**,** Coulomb's Law in vector form, Principal of superposition: Force calculation for three charges and n-charges, Distribution of charges: discrete and continuous charge distribution, Concept of charge density: Linear, surface and volume, Coulomb's Law for continuous charge distribution. Electrostatic Field, electric flux, Electric field due to system of point charges (use of principal of superposition for three charge system and n-charge system), Electric potential, Electric potential as line integral of electric field, potential due to a point charge. **(08 Lectures, 16 Marks)**

Unit 4. Gauss's theorem and electric dipole

Gauss's theorem of electrostatics, Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. **(07 Lectures, 14 Marks)**

Reference Books

1. Mathematical Physics: B.S. Rajput, Pragati Prakashan (19th Edition, 2007).
2. Principles of electronics: V. K. Mehta
3. Basic Electronics: B. L. Thereja
4. Fundamentals of Physics: Robert, Resnick, David Halliday & Jearl Walker, [8th ed]
5. Electricity and Magnetism: D. C. Tayal, 1988, Himalaya Publishing House.
6. Engineering Physics: R.K Gaur and S.L.Gupta,
7. Basic Electrical engineering , B. H. Deshmukh, Nirali Prakashan, Dhanpat Rai and Sons, New Delhi.
8. Electromagnetics: B. B. Laud, New York ; Toronto : Wiley
9. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
10. Electricity and Magnetism, J.H. Fewkes& J. Yarwood. Vol. I, 1991, Oxford Univ.Press.
11. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.11
12. Introduction to Electrodynamics, 3rd Edn,D.J. Griffiths, 1998, Benjamin Cummings.
13. Electrodynamics- D. J. Griffiths.
14. New Simplified Physics : S. L. Arora, Dhanpat Rai and CO. (A reference book for class XII, Volume I)
15. Concept of Physics, H. C. Verma, Volume 2.

Semester II
PHY 202: Dielectrics, Magnetism and Electromagnetism
(Credits: 02): (30 Lectures 60 Marks)

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Course description:

This course is aimed at introducing the concepts of Dielectrics, Magnetism and Electromagnetism to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Dielectrics, Magnetism and Electromagnetism.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept and knowledge of Dielectrics, Magnetism and Electromagnetism to understand and solve real life problems.
2. Understanding of the course will create scientific temperament.

………

Unit 1. Capacitance and dielectrics

Introduction, Calculation of effective/equivalent capacitance for series and parallel combination, Parallel plate capacitor with and without dielectric, Cylindrical capacitor and Spherical capacitor, Energy per unit volume in electrostatic field, Dielectric constant, Electric polarization, Gauss's law in dielectrics, Three electric vectors $\overline{E}, \overline{D}, \overline{P}$ and the relation between them, Introduction to super capacitors and its applications. **(10 Lectures, 20 Marks)**

Unit 2. Magnetism

Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility, Brief introduction of diamagnetic, paramagnetic and ferromagnetic materials. Hard and Soft magnetic materials, Introduction to Magnetostatics: Biot-Savart's law and its applications-straight conductor, circular coil, solenoid carrying current, Divergence and curl of magnetic field, Magnetic vector potential, Ampere's circuital law (statement only).

(08 Lectures, 16 Marks)

Unit 3. Electromagnetic induction:

Faraday's laws of electromagnetic induction, Lenz's law, self inductance and mutual inductance, L of single coil, M of two coils, Reciprocity theorem of mutual induction, Energy stored in a magnetic field. **(05 Lectures, 10 Marks)**

Unit 4. Maxwell`s equations and Electromagnetic wave propagation

Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector for plane wave, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization. **(07 Lectures, 14 Marks)**

Reference Books:

1. Electromagnetics, 2nd Edition, B.B. Laud, Wiley Eastern Limited
2. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
3. Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ.Press.
4. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.11
6. Introduction to Electrodynamics, 3rd Edn,D.J. Griffiths, 1998, Benjamin Cummings.
7. Electrodynamics- D. J. Griffiths.
8. Electrodynamics, Kumar, Gupta and Singh
9. New simplified Physics, S. L. Arora, Dhanpat Rai and Co., (A reference book for class XII, Volume I)
10. Concept of Physics, H. C. Verma, Volume 2.

Semester II
PHY 203: LAB II
(Credits: 02): (60 Lectures 60 Marks)

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On successful completion of this course students will be able to:

6. To demonstrate their practical skills.
7. To understand and practice the skills while doing Physics practical.
8. To understand the use of apparatus and their use without fear.
9. To correlate Physics theory concepts through practical.
10. Understand the concepts of errors and their estimation.

……

(Students should perform at least ten experiments from the following list)

1. Study of Analog /Digital Voltmeter, Ammeter (AC, DC, ranges and least count)
2. To use a Multimeter for measuring:
   - i) Resistances,
   - ii) A.C. and D .C. Voltages,
   - iii) D.C. Current (in a simple circuit)
   - iv) Checking electrical fuses.
3. Verification of Kirchhoff's laws.
4. To verify Thevenin's theorem
5. To verify Norton's theorem
6. To verify Maximum Power Transfer Theorem. (Note : Use personal computer/laptop for graph plotting is necessary.)
7. To verify Joule's law.
8. To find electrical energy consumed in a circuit using Joule's law.
9. To determine time constant of R-C circuit using charging and discharging of condenser through resistor.
10. To compare capacitances using De'Sauty's bridge.
11. Determination of time constant of L-R circuit.
12. Ballistic Galvanometer:
    - i) Measurement of charge and current sensitivity

ii) Measurement of CDR

13. Determine a high resistance by Leakage Method.
14. To determine Self-Inductance of a Coil by Rayleigh's Method.
15. Measurement of field strength Band its variation in a Solenoid (Determine dB/dx).
16. To study the Characteristics of a Series RC Circuit.
17. Verification of laws of capacitances.
18. To determine a Low Resistance by Carey Foster's Bridge.
19. Electric billing with energy meter.
20. Frequency of a. c. using vibrating wire and magnet.
21. Study of transformer.
22. To determine efficiency and turns ratio of transformer.
23. To determine unknown wavelength using spectrometer.

Reference Books

1. Advanced Practical Physics for students, B. L. Flint & H.T.Worsnop,1971, Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
3. Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015,Cengage Learning India Pvt. Ltd.
4. Advanced level Physics Practicals, Michael Nelson and Jon M.O gborn,4 th Edition, reprinted 1985, Heinemann Educational Publishers.
5. Practical Course in Electronics by Prof. J. R. Patil and other (Jaydeep Prakashan).
6. Advance Practical Physics by S. P. Singh (Pragati).
7. Practical Physics: Gupta and Kumar (Pragati Prakashan Meerut).
8. University Practical Physics by D. C. Tayal (Himalaya Publishing House).

CAREER OPPORTUNITIES FOR B. Sc. PHYSICS STUDENTS

B.Sc. Physics students can find jobs in public as well as in private sectors. There are many opportunities available for B. Sc Physics students in technical as well as scientific fields. They can work as Science and Mathematics Teachers, Quality Control Manager, Laboratory assistant, Laboratory Technician, School Science Technician in any government or private organization.

Private Sector:

There are many opportunities available in IT field for B. Sc (Physics) graduates. Many IT companies such as Infosys, Wipro and TCS are recruiting B. Sc. Physics graduates for software jobs. They can also get jobs in Energy Plants. Another jobs available for these graduates is Technician in Electronic Industry. They can apply for jobs in many companies in automobile industry. Some of those companies are Maruti Udyog, TATA Motors and Tech Mahindra. The B. Sc. (Physics) graduates can apply and secure their job in Solar devices production industries, electrical or electronic industries with their skills developed while studying. B.Sc. Physics graduates can get opportunities in Fibers Optics industries, Glass or Lens making industries etc.

Government Sector:

There are vast opportunities available for B. Sc graduates in Government sector. They can apply for jobs in Scientific Research and Development Organizations such as The Defense Research and Development Organization (DRDO), CSIR, Physical Research Laboratory (PRL) Ahmedabad, Saha Institute of Nuclear Physics Kolkata and Nuclear Science Centre New Delhi. They can also apply for various jobs in popular government organizations such as Bhabha Atomic Research Centre (BARC), Atomic Energy Regulatory Board (AERB), Oil and Natural Gas Corporation (ONGC), Bharat Heavy Electricals Limited (BHEL), National Thermal Power Corporation (NTPC).

They can also apply for the various competitive exams conducted by Union Public Service Commission such as IFS, IPS and IAS. Several other government exams conducted for recruiting B. Sc Physics graduates are Tax Assistant Exam, Statistical Investigator Exam, Combined Graduate Level Exam.

Another option available for B. Sc Physics graduate is to apply for jobs in public sector banking. Several banks are conducting exam every year for recruiting graduates to the post of Probationary Officers. They can also find many jobs in Railway sector. They should qualify the exams conducted by Railway Recruitment Board to get a job in Railway sector. These graduates can also apply for Combined Defense Services Exams conducted for recruiting candidates to various posts in Defense Department.

Equivalence Courses

Semester	Course code	Course Title	No. of Credits	Hours/ semester	Marks		OLD Syllabus code
					Internal	External	
I	PHY 101	Basic Mechanics	02	30	40	60	PHY 101
	PHY 102	Dynamics and Properties of Matter	02	30	40	60	PHY 102
	PHY 103	LAB -I	02	30	40	60	PHY 103
II	PHY 201	Electricity and Electrostatics	02	30	40	60	PHY 201
	PHY 202	Dielectrics Magnetism and Electromagnetism	02	30	40	60	PHY 202
	PHY 203	LAB -II	02	30	40	60	PHY 203

FACULTY OF SCIENCE & TECHNOLOGY

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

‘A’ Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS
FOR
S. Y. B. Sc. (PHYSICS)

(AS PER CHOICE BASED CREDIT SYSTEM PATTERN OF UGC)

(With effect from June - 2019)

Preamble

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process and examination and evaluation systems.

In that context in the last decade, North Maharashtra University, Jalgaon has taken several initiatives to upgrade and enhance the academic excellence, examination reforms and developing the skilled minds and skilled hands. As per the directions of UGC, from last year our KBC North Maharashtra University, Jalgaon has implemented the Choice Based Credit (CBCS) pattern to undergraduate programs run by various colleges affiliated to NMU, Jalgaon. As per the directions given by the Honorable Vice Chancellor, Pro-Vice Chancellor and Dean of the Faculty of Science and Technology of our university, one day workshop was organized for syllabus framing. The teachers of the affiliated colleges and university department were participated in the workshop of re-structuring the syllabi of S.Y.B.Sc. (Physics) as per the CBCS pattern and it has been finalized during the workshop and the same will be effectively implemented from the academic year 2019-20.

The main objective of the re-structuring the syllabus of S.Y.B.Sc. (Physics) is to create skilled minds and therefore expectation is to equip the students with the knowledge and understanding of concepts of physics rather than the ability to remember facts so that they may have a reasonable comprehensive and complete grasp of principles of physics. It is expected that the students should study physics with keen interest, develop their experimental skill and problem solving ability. The students should communicate their knowledge of Physics to the Society, to make them to understand physics around us. The students should use their knowledge of Physics for betterment of our Society, our nation and the World.

Board of Studies (Physics),
North Maharashtra University, Jalgaon

OBJECTIVES

1. To provide education in physics of the highest quality at the undergraduate level and generate graduates of the caliber sought by industries and public service as well as academic teachers and researchers of the future.
2. To acquire deep knowledge in fundamental aspects of Physics and basic knowledge in the specialized thrust areas like Thermodynamics, Basic electronics, Waves, Sound, Optics, LASERS, Energy harvesting and electrical circuit skills.
3. To develop ability among the students to identify, remember and grasp the meaning of basic facts, concepts and principles of Physics.
4. To develop observational skills, confidence in using scientific equipment and relate the knowledge of scientific concepts to quantitative and physical measurement.
5. Acquire knowledge, skills, working methods and ways of expression which will reflect on all round development of the students' attitudes towards scientific thinking and its applications.
6. To develop attitudes such as concern for accuracy and precision, objectivity, and Enquiry.
7. The overall aim is to provide comprehensive knowledge and understanding in the relevant fields and enable students to pursue the physics subject at an advanced level later and to attract outstanding students from all back grounds.

BOS (PHYSICS)-Faculty of Science & Technology

Kavayitri bahinabai Chaudhari

North Maharashtra University, Jalgaon

Class: **S. Y. B. Sc.** Subject: **Physics**

Choice Base Credit System (With effect from June 2019)

The Board of Studies in Physics in its meeting held on **4th July 2018** has unanimously accepted the revised syllabus (as per CBCS pattern) prepared by different committees, discussed and finalized in workshop restructuring of S.Y.B.Sc. Syllabus.

The titles of the papers for S.Y.B.Sc. (Physics) are as given below:

Semester	Course		No. of Credits	Hours per semester	Marks	
	Course code	Course Title			Internal marks	External marks
III	PHY 301	Thermodynamics and Kinetic theory of gases	02	30	40	60
	PHY 302(A) OR PHY 302(B)	Electronics-I OR Instrumentation	02	30	40	60
	PHY 303	LAB-III	02	60	40	60
	PHY 304: (Skill Enhancement course I)	Renewable energy and Energy Harvesting	02	30	40	60
IV	PHY 401	Waves, Oscillations and acoustics	02	30	40	60
	PHY 402	Optics and LASERS	02	30	40	60
	PHY 403	Lab IV	02	60	40	60
	PHY 404: (Skill Enhancement course II)	Electrical Circuits and Network Skills	02	30	40	60

Note: The industrial/study tour is compulsory for students of S. Y. B. Sc. (Physics).

Semester III: Physics paper I

PHY 301: Thermodynamics and Kinetic theory of gases

(Credits: 02) :(30 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Thermodynamics and kinetic theory of gases to Under Graduate students.

Course objectives:
1. To impart knowledge of basic concepts in Thermodynamics and kinetic theory of gases.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:
Learner will be able to ….
1. Apply the concept of use of knowledge of Thermodynamics and kinetic theory of gases to real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Basics of thermodynamics and its First Law: (08 L, 15 M)
Thermodynamic Description of system, Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes.

Unit 2: Second and Third Law of Thermodynamics and Entropy: **(08 L, 15 M)**
Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible and irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero, Enthalphy.

Unit 3: Heat Engines: (07 L, 15 M)
Carnot's Engine, Otto Engine and Cycle, Diesel Engine and Cycle, Efficiencies of all heat engines.

Unit 4: Kinetic Theory of Gases: (07 L, 15 M)
Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

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Reference Books:

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Heat and Thermodynamics, M. W. Zemasky and R. Dittman, 1981, McGraw Hill 13
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W. Sears & G. L. Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications

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Semester III: Physics paper II
PHY 302 (A): Electronics –I
(Credits: 02) :(30 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Electronics of gases to Under Graduate students.

Course objectives:
1. To impart knowledge of basic concepts in Electronics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:
Learner will be able to ….
1. Apply the concept of use of knowledge of Electronics to real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1 Semiconductor diodes (07 L, 14 M)
(Revision on metal, insulator and semiconductors, Intrinsic and Extrinsic semiconductor), Semiconductor Diodes: p and n type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle, Construction, Working and Characteristics of (1) LEDs (2) Photodiode (3) Solar Cell (P-N Junction), (4) Zener Diode

Unit 2: Rectifiers and Power Supplies (05 L, 10M)
Introduction to Rectifiers, Types: Half-wave & Full-Wave Rectifiers (Centre-tapped and Bridge Rectifiers), Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, D.C. power Supply (unregulated and regulated), Zener Diode as a voltage regulator.

Unit 3: Bipolar junction transistor (06L, 12M)
Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC configurations. Active, Cutoff, and Saturation Regions. Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line and Q point.

Unit 4: Digital Electronics (12 L, 24 M)
Binary Numbers, Decimal to Binary and Binary to Decimal Conversion, Binary Addition, Binary Subtraction using 2's Complement Method, AND, OR and NOT Gates (Realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates, XOR and XNOR Gates,
De Morgan's Theorems, Boolean Laws, Simplification of Logic Circuit using Boolean Algebra, Fundamental Products, Min terms and Max terms, Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh's Map,
Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor.

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Reference Books:

1. Electronic Principles – A. P. Malvino, Mc Graw-Hill Publishing House
2. Electronic fundamentals and applications – J. D. Ryder, Prentice Hall 4th Edition
3. Principles of Electronics – V. K. Mehta, S. Chand Publications, New Delhi
4. Electronic Devices and Circuits – Allen Mottershead, Good year Publishing Company
5. Digital Principles and Applications – Malvino and Leach, Mc Graw-Hill Publication.
6. Modern Digital Electronics – R. P. Jain, Tata Mc Graw-Hill Pvt. Ltd., New Delhi
7. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
8. Electronic devices and circuits, S. Salivahanan and N. Suresh Kumar, 2012, Tata Mc-Graw Hill.
9. Microelectronic Circuits, M.H. Rashid, 2ndEdn.,2011, Cengage Learning.
10. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
11. Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2009, PHI Learning Pvt. Ltd.

Semester III: Physics paper II

PHY 302 (B): Instrumentation

(Credits: 02) :(30 Lectures 60 Marks)

[Note: For students opting electronics as one of the subjects at F. Y. B. Sc. Class]

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Course description:
This course is aimed at introducing the fundamentals of Instrumentation to Under Graduate students.

Course objectives:
1. To impart knowledge of basic concepts in Instrumentation.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:
Learner will be able to ….

1. Apply the concept of use of knowledge of Instrumentation to real life problems.
2. Understanding of the course will create scientific temperament.

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Unit-I Fundamentals of Measurements: (04L, 8M)

Functional elements of typical measurement system, Standards of measurements and calibration, Static performance characteristics: Accuracy, Precision, Accuracy versus precision, Sensitivity, Linearity, Concept of Errors and their types.

Unit-II Measurement of Temperature: (10L, 20M)

Non - electrical Methods : Liquid- in-glass Thermometer, Pressure Thermometer construction and their types: constant volume gas thermometer and Vapour pressure Thermometer, **Electrical Methods :** Thermo-electric Sensors (Thermocouple), Metallic resistance Thermometer (Platinum resistance thermometer), Semiconductor resistance sensors (Thermistor).

Radiation Methods (Pyrometry) : Total Radiation Pyrometer, Selective Radiation Pyrometer.

Unit-III: Measurement of Pressure: (08L, 16M)

High pressure Measurement, Measurement of low pressure (Vacuum): McLaud Guage, Pirani Gauge, Calibration & Testing (Dead - weight tester)

Unit-IV: Acoustics (Sound) Measurement: (08L, 16M)

Characteristics of sound, Sound pressure level, Sound power level, Variation of intensity of sound with distance, Typical sound measuring system (Sound level Meter), Microphones : Condenser or capacitor type Microphone, Electrets Microphone, Electrodynamics types of Microphone, Carbon granules type Microphone

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Reference Books :

1. Instrumentation, Measurement & Analysis by (Nakra and Chaudhary), 2nd Edition
2. Instrumentation : Devices & Systems by (Rangan, Mani & Sarma), 2nd Edition
3. Basic Electronics by B. L. Thereja.
4. A Course In Electrical & Electronics Measurement & Instrumentation by A. K. Sawhney
5. Modern electronic instrumentation and Measurement Techniques by Helfrick & Cooper.

Semester III: Physics paper III:

PHY 303: Lab III

(Credits: 02): (60 L, 100M (40 Internal + 60 External))

(Note: Total 10 experiments should be performed. Minimum 05 experiments from both sections should be performed.)

Section A: General Physics-I

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the mechanical equivalent of heat (J) with the help of Joules calorimeter.
3. To determine the coefficient of thermal conductivity of a bad conductor by Lee's method and Charlton's disc method.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine thermal conductivity of rubber by tubing method.
7. To determine thermal conductivity of metal by Forbe's method.
8. To Verify Clausius-Clapeyron equation.
9. Jolly's steam calorimeter.
10. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
11. To study the variation of thermo e. m. f. across two junctions of a thermocouple with temperature.
12. Stefan's fourth power law using bulb.
13. To determine angle of prism and familiarization with Schuster`s focusing.
14. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
15. To determine Dispersive Power of the Material of a given Prism using Mercury Light.
16. To determine Stefan's constant.

Section B: Electronics

1. Study of full wave rectifier with capacitor filter and to calculate its ripple factor.
2. Study of zener diode as a voltage regulator.
3. Study of CE transistor characteristics to find out 'β' of the transistor.
4. Study of logic gates (AND, OR and NOT) using diodes and transistors.
5. Verification of De Morgan's Theorems (using ICs).
6. To study the characteristics of Light Emitting Diode (LED).
7. Experimental verification of NAND gate as a universal building block.
8. Experimental verification of NOR gate as a universal building block.
9. To study I – V characteristic of (i) a resistor and (ii) a p–n junction diode and compare it.
10. Frequency response of CE single stage transistor amplifier and to calculate its bandwidth.
11. To determine fill factor and efficiency of solar cell.
12. Comparison of luminous intensities of two light sources by using photo voltaic cell.

OR Section B: Instrumentation

1. Use of C.R.O as a measurement tool for different electrical parameters (frequency, a.c. /d.c. voltage, pulse height, pulse width, rise time and fall time).
2. To obtain Lissajous figures using C.R.O.
3. To determine characteristics of Thermistor and to find an unknown temperature by using thermistor.
4. Use of thermocouple for measurement of temperature.
5. Measurement of errors.
6. Directional characteristics of a microphone.

7. Platinum resistance thermometer. (Determine the melting temperature of Wax)
8. Velocity of sound by phase shift method.
9. Measurement of Noise by Using Sound Pressure level Meter.

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Reference Books:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
4. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.
5. A text Book of Experimental Physics – Dr. V.Y. Rajopadhye, V.L.Purohit and A. S. Deshpande (Continental Prakashan, Poona-30).
6. AN ADVANCED COURSE IN PRACTCIAL PHYSICS- D. Chattopadhyay and P.C. Rakshit.
7. Practical Physics by R. K. Shukla, Anchal Srivastava (New Age International).
8. B.Sc. Practical Physics by Harnam Singh and Dr. P.S. Hemne (S. Chand).
9. Advance Practical Physics by S.P.Singh (Pragati).
10. College Practical Physics: Khanna and Gulati (S. Chand and Co. Ltd , Delhi)
11. Practical Physics: Gupta and Kumar (Pragati Prakashan Meerat)
12. Advanced Level Practical Physics: J. M.Nelkon, J.M.Ogloom (EIBS)
13. A Text book of practical Physics: Shrinivasan and Balasubranian
14. A Text book of practical Physics: Indu Prakash and Ramkrishna.
15. B.Sc. Practical Physics by C.L. Arora (S. Chand and Co. Ltd , Delhi)
16. Practical Course in Electronics by Prof. J.R.Patil and other (Jaydeep Prakashan).

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Semester III: Physics paper IV

PHY 304: Skill Enhancement Course I (SEC-I)

Renewable energy and Energy Harvesting (Credits: 02) Theory: (30 L, 60M)

[The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible]

Unit 1.Conventional and Non-conventional energy Sources: Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. (**02L, 04M**)

Unit 2 . Solar Energy

Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. Solar energy utilization by Solar roof panels. **(06 L,12 M)**

Unit 3. Ocean, geothermal, Hydro and Biomass energy resources.

a. **Ocean Energy**: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. **(03 L,06M)**
   Tidal energy,Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power. **(02 L,04M)**
b. **Geothermal Energy**: Geothermal Resources, Geothermal Technologies. **(02 L,04M)**
c. **Hydro Energy**: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. **(02 L, 04M)**
d. **Biomass energy:** biomass, biochemical conversion, biogas generation, Ocean biomass **(02L,04M)**

Unit 4. Energy Harvesting:

a. **Wind Energy harvesting**: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies **(03 L,06M)**
b. **Piezoelectric Energy harvesting**: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power **(04 L,08M)**
c. **Electromagnetic Energy Harvesting**: Linear generators, physics mathematical models, recent applications, **(02 L,04M)**
d. Carbon captured technologies, cell, batteries, power consumption **(01 L,02M)**
e. Environmental issues and sustainability of renewable energy sources,. **(01 L,02M)**

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Demonstrations and Experiments

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of mechanical energy (vibration) into voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

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Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhatme Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable_energy

Semester IV: Physics paper V

PHY 401: Waves, Oscillations and Acoustics

(Credits: 02) : (30 Lectures 60 Marks)

Course description:
This course is aimed at introducing the fundamentals of Waves and Sound to Under Graduate students.

Course objectives:
1. To impart knowledge of basic concepts in Waves and Sound.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:
Learner will be able to ….
1. Apply the concept of use of knowledge of Waves and Sound to real life problems.
2. Understanding of the course will create scientific temperament.

Unit I: Composition of two S. H. M.'s
Composition of two S.H.M.s of equal frequencies along same line (co-linear) of vibration (analytical method only), Composition of two S.H.M.s of equal frequencies acting at right angles (analytical method with different cases), Composition of two S.H.M.'s right angles to each other (time period in the ratio 1:2), Lissajous figures- demonstration by mechanical, optical and electrical methods, applications of Lissajous figure (list only). **(06L, 16M)**

Unit II: Waves Motion
General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Plane waves, Spherical waves, Wave intensity. **(05L, 8 M)**

Unit - III: Forced oscillations
Idea of forced oscillations, Resonance and its types- Mechanical resonance (Barton's pendulum), Acoustic resonance (resonance tube), Electrical resonance (LCR circuit) and Optical resonance (sodium vapour lamp), Differential equation of forced oscillations and its solution, Amplitude of forced oscillations, Amplitude resonance, Application to series L-C-R circuit. **(08L, 16M)**

Unit IV: Sound:
Parameters of Sound: Sound intensity, Loudness, Pitch, Quality and timber, Acoustic intensity level measurement, Acoustic pressure and its measurement. Reverberation and time of reverberation.
Ultrasonics: Classification of sound frequencies, Piezoelectric effect, Generation of ultrasonic waves by Piezoelectric oscillator (using transistor), Application of ultrasonic waves (list only).
Doppler effect: Doppler effect in sound, Expression for apparent frequency (no derivation), discussion of different cases when source, observer and medium are in relative motion, Asymmetric nature of Doppler effect in sound, Doppler effect in light, Symmetric nature of Doppler effect in light, Applications of Doppler effect in sound and light. **(11L, 20M)**

Reference Books:
1. Waves and oscillations- Brijlal and Subramaniyam (Vikas Publishing House)
2. Waves and Oscillations- R.N. Chaudhari, New Age International (Pvt.) Ltd.
3. Conceptual Physics- A. P. Taggarase, Jivan Sheshan (Himalaya Publishing).
4. The Physics of Waves and Oscillations- N. K. Bajaj (Tata McGraw Hill).
5. Oscillations and Waves- B. S. Agarwal (KedarNath, Ram Nath Publishers)
6. Sound- Mee and Heinmann, London Edition

Semester IV: Physics paper VI

PHY 402: Optics and LASERS

(Credits: 02) : (30 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Optics and LASERS to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Optics and LASERS.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:
Learner will be able to ….

1. Apply the concept of use of knowledge of Optics and LASERS to real life problems.
2. Understanding of the course will create scientific temperament.

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Unit I: Geometrical Optics: Deviation produced by thin lenses, equivalent focal length of two thin lenses separated by a distance and when in contact. Power of lens, Spherical aberration in lens, reduction of spherical aberration (without derivation), Chromatic aberration, Achromatism; (two lenses in contact and separated by finite distance without derivation). **(04L, 10M)**

Unit II: Interference: Principle of superposition of two, Concept of interference, Intensity distribution in the interference pattern, Division of amplitude and division of wavefront. Young's Double Slit experiment, Expression for fringe width, Fresnel's Biprism and Lloyd's Mirror. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). fringe width in case of fringes of equal thickness. Newton's rings-experimental setup, theory and its application to determine wavelength of source and refractive index of liquids **(10L, 20M)**

Unit III : Diffraction: Definition of diffraction, Concept of diffraction, Types of diffraction, Fresnel Diffraction: Half-period zones, Zone plate, Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis, Fraunhofer diffraction: Single slit; Double Slit. Multiple slits and Diffraction grating. **(08L, 14M)**

Unit IV: Polarization: Polarization, Polarization by reflection, Brewster's law, Polarization by double refraction in uniaxial crystals, Maluss Law Double refracting crystals, Positive and negative crystals, Production and detection of circularly and elliptically polarized light, Nicol prism, Optical activity, Rotation of the plane of polarization, Specific rotation, Polarimeter or Sacherimeter, (Principle and working). **(04L, 10M)**

Unit V: Non-linear optics: Principle of LASER, Characteristics of LASER, Basic steps required to form a LASER: absorption, spontaneous emission, stimulated emission, Metastable state, population inversion, optical pumping, Types of LASER- He-Ne LASER, Applications of LASER (list only) **(04L, 06M)**

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Reference Books:

1. Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
2. Principles of Optics, B.K. Mathur, 1995, Gopal Printing
3. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
4. University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986.Addison-Wesley
5. Lasers and nonlinear optics – B. B. Laud
6. An Introduction to Laser – Theory and applications – M. N. Avadhanale
7. A textbook of Optics: Dr. N. Subrahmanyam, Brijlal and Dr. M.N.Avadhanulu, S.Chand Publishing,Co.Ltd.
8. Optics: Singh and Agrwal, Pragati Prakashan, Meerut.
9. Optics and Thermodynamics- Sarkar and Sharma, Himalaya Publishing House

Semester IV: Physics paper VII:

PHY 403: Lab IV - General Physics II

(Credits: 02): (60 L, 100M (40 Internal + 60 External))

(Note: Total 10 experiments should be performed.)

1. To investigate the motion of coupled oscillators.
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ_2 – T Law.
3. To study Lissajous Figures and demonstration of Lissajous figures by using C.R.O.
4. Study of acoustic resonance by using bottle as a resonator.
5. Determination of velocity of sound by using Kundt's tube.
6. Study of resonance using Kater's pendulum.
7. Log decrement
8. Damping coefficient
9. Study of acoustic resonance by using resonance tube.
10. To determine the Resolving Power of a Prism.
11. To determine the value of Cauchy Constants of a material of a prism.
12. To determine wavelength of sodium light using Fresnel Biprism.
13. To determine wavelength of sodium light using Newton's Rings.
14. To determine the refractive index of a liquid by using Newton's rings apparatus.
15. Determination of specific rotation α of optically active substance using Polarimeter.
16. Measurement of beam size of a LASER beam.
17. Measurement of beam divergence of a LASER beam.
18. To determine the wavelength of light from LASER source using Diffraction grating.
19. To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating
20. To determine the Resolving Power of a Plane Diffraction Grating.
21. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

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Reference Books:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
4. B.Sc. Practical Physics: C. L. Arora, S. Chand Publishing Co. Ltd., New Delhi

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Semester IV: Physics paper VIII
PHY 404: Skill Enhancement Course II
Electrical Circuits and Network Skills
(Credits: 02) : (30 Lectures 60 Marks)

[The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode]

Unit 1. Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. **(03 L, 06 M)**

Unit 2. Understanding Electrical Circuits: Main electric circuit elements (R,L,C) and their combination. Rules to analyze DC sourced electrical circuits (KCL, KVL) Current and voltage drop across the DC circuit elements, Diode and rectifiers, . Response of inductors and capacitors with DC or AC sources Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components AC source. Power factor. Saving energy and money. **(07 L, 14 M)**

Unit 3. Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. **(04L, 08M)**

Unit 4.Generators and Transformers: Types of DC Power sources. Principle of DC/AC generators, construction of DC generator, Operation of transformers. **(03 L, 06 M)**

Unit 5.Electric Motors: Single-phase AC & DC motors (Basic design). Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. **(04 L, 8 M)**

Unit 6.Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device) **(04L, 08 M)**

Unit 7.Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board. **(05 L, 10 M)**

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Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand & Co.
2. A text book of Electrical Technology - A K Theraja
3. Performance and design of AC machines - M G Say ELBS Edn.
4. Electrical Technology by V.K.Meheta

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FACULTY OF SCIENCE & TECHNOLOGY

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

‘A’ Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS
FOR
T. Y. B. Sc. (PHYSICS)

(AS PER CHOICE BASED CREDIT SYSTEM PATTERN OF UGC)

(With effect from June - 2020)

Preamble

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process and examination and evaluation systems.

In that context in the last decade, North Maharashtra University, Jalgaon has taken several initiatives to upgrade and enhance the academic excellence, examination reforms and developing the skilled minds and skilled hands. As per the directions of UGC, from last year our KBC North Maharashtra University, Jalgaon has implemented the Choice Based Credit (CBCS) pattern to undergraduate programs run by various colleges affiliated to NMU, Jalgaon. As per the directions given by the Honorable Vice Chancellor, Pro-Vice Chancellor and Dean of the Faculty of Science and Technology of our university, one day workshop was organized for syllabus framing. The teachers of the affiliated colleges and university department were participated in the workshop of re-structuring the syllabi of T.Y.B.Sc. (Physics) as per the CBCS pattern and it has been finalized during the workshop and the same will be effectively implemented from the academic year 2020-21.

The main objective of the re-structuring the syllabus of T.Y.B.Sc. (Physics) is to create skilled minds and therefore expectation is to equip the students with the knowledge and understanding of concepts of physics rather than the ability to remember facts so that they may have a reasonable comprehensive and complete grasp of principles of physics. It is expected that the students should study physics with keen interest, develop their experimental skill and problem solving ability. The students should communicate their knowledge of Physics to the Society, to make them to understand physics around us. The students should use their knowledge of Physics for betterment of our Society, our nation and the World.

Board of Studies (Physics),
North Maharashtra University, Jalgaon

OBJECTIVES

1. To provide education in physics of the highest quality at the undergraduate level and generate graduates of the caliber sought by industries and public service as well as academic teachers and researchers of the future.
2. To acquire deep knowledge in fundamental aspects of Physics and basic knowledge in the specialized thrust areas like Thermodynamics, Basic electronics, Waves, Sound, Optics, LASERS, Energy harvesting and electrical circuit skills.
3. To develop ability among the students to identify, remember and grasp the meaning of basic facts, concepts and principles of Physics.
4. To develop observational skills, confidence in using scientific equipment and relate the knowledge of scientific concepts to quantitative and physical measurement.
5. Acquire knowledge, skills, working methods and ways of expression which will reflect on all round development of the students' attitudes towards scientific thinking and its applications.
6. To develop attitudes such as concern for accuracy and precision, objectivity, and Enquiry.
7. The overall aim is to provide comprehensive knowledge and understanding in the relevant fields and enable students to pursue the physics subject at an advanced level later and to attract outstanding students from all back grounds.

BOS (PHYSICS)-Faculty of Science & Technology

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

Class: **T. Y. B. Sc.** Subject: **Physics**

Choice Base Credit System (With effect from June 2020)

The Board of Studies in Physics has unanimously accepted the revised syllabus (as per CBCS pattern) prepared by different committees, discussed and finalized in the **Online Workshop on Curriculum Development in Physics at T. Y. B. Sc.** held on15th and 16th May 2020.

The titles of the papers for T.Y.B.Sc. (Physics) are as given below:

Sem	Course type	Course code	Course title	Cre dits	Total hrs /week	Total teaching periods	Total marks	
							CA	UA
V	Discipline specific Course (DSC)	PHY 501	Mathematical Physics	3	3	45	40	60
		PHY502	Solid State Physics	3	3	45	40	60
		PHY 503	Atomic and molecular physics	3	3	45	30	60
		PHY 504(A) Or PHY 504(B)	Electronics-II Or Instrumentation -II	3	3	45	40	60
	Skill Enhancement course (SEC)	PHY 505	Solar Energy and applications	3	3	45	40	60
	DSE Elective course (Any one)	PHY 506(A) PHY 506(B) PHY 506(C) PHY 506(D) PHY 506 (E)	Technical Electronics- I or Refrigeration and Air conditioning- I or Vacuum Technology-I or Microprocessor-I or Programming in C++ I	3	3	45	40	60
	DSC CORE Practicals	PHY 507	Physics Practical I	2	4 (per batch)	60	40	60
		PHY 508	Physics Practical II	2	4 (per batch)	60	40	60
		PHY 509	Physics Practical III or Project	2	4 (per batch)	60	40	60
	Non credit audit course (Any one)	AC 501(A)	NCC	No credit	2	30	100	
		AC 501(B)	NSS					
		AC 501 (C)	Sports					
			Total credit	24				

Sem	Course type	Course code	Course title	Credits	Total hrs /week	Total teaching periods	Total marks	
							CA	UA
VI	Discipline specific Course (DSC)	PHY 601	Quantum mechanics	3	3	45	40	60
		PHY602	Material Science	3	3	45	40	60
		PHY 603	Nuclear Physics	3	3	45	30	60
		PHY 604	Modern Physics	3	3	45	40	60
	Skill Enhancement course (SEC)	PHY 605	Basic Instrumentation Skills	3	3	45	40	60
	DSE Elective course (Any one)	PHY 606 (A) PHY 606 (B) PHY 606 (C) PHY 606 (D) PHY 606 (E)	Technical Electronics- I or Refrigeration and Air conditioning- II or Vacuum Technology-II or Microprocessor-I or Programming in C++ II	3	3	45	40	60
	DSC CORE Practicals	PHY 607	Physics Practical I	2	4 (per batch)	60	40	60
		PHY 608	Physics Practical II	2	4 (per batch)	60	40	60
		PHY 609	Physics Practical III or Project	2	4 (per batch)	60	40	60
	Non credit audit course (Any one)	AC 601(A)	Soft skill	No credit	2	30	100	
		AC 601(B)	Yoga					
		AC 601(C)	Practicing Cleanliness					
			Total credit	24				

Note: The industrial/study tour is compulsory for students of T. Y. B. Sc. (Physics).

Semester V: (DSC): Physics paper I
PHY 501: Mathematical physics
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the concepts of Mathematical physics to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Mathematical physics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept and knowledge of Mathematical physics to understand and solve real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Vector Analysis
Gauss divergence theorem, Stokes' theorem, Green's first and second theorem, Green's theorem in the plane. (Statements, proofs and problems) **(5P, 6M)**
Unit 2: Differential Equation
Introduction to Cartesian (X, Y, Z), Spherical polar (r, θ, φ) and Cylindrical (ρ, φ, z) co-ordinate systems and their transformation equations, Degree, order, linearity and homogeneity of partial differential equation, Method of separation of variables in Cartesian, Spherical polar and Cylindrical co-ordinate system (Wave equation and Laplace's equation), Singular points, Singular points of Legendre and Hermite differential equation, Statement of Fuche's theorem, Frobenius method of series solution, series solution of linear simple harmonic oscillator and Legendre differential equation **(11P, 16M)**
Unit 3: Special Functions
Generating functions for Legendre Polynomial $P_n (x)$, Hermite polynomial $H_n (x)$,and Bessel functions of first kind $J_n(x)$. Proof of following properties
1) $(n +1) P_{n+1} (x) = (2n +1) x P_n (x) – n P_{n-1}(x)$. 2) $P_n(x) = P'_{n+1} (x) – 2x P'_n(x) + P'_{n-1}(x)$.
3) $H_{n+1} (x) = 2 x H_n (x) - 2n H_{n-1} (x)$. 4) $H'_n (x) = 2n H_{n-1}(x)$.
5) $J_{n+1}(x) + J_{n-1}(x) = 2n / x J_n(x)$. 6) $J_{n-1}(x) - J_{n+1}(x) = 2 J'_n(x)$. **(8P, 10M)**
Unit 4: Complex Analysis
Complex numbers and their graphical representation, Argand diagram, Conjugate of a complex number, Basic mathematical operations with complex numbers, Euler's formula, De-Moivre's theorem, Roots of complex numbers, Functions of complex variables, Analyticity and Cauchy - Riemann conditions, Singular functions, Examples. **(10P, 14M)**
Unit 5: Special Theory of Relativity
Newtonian relativity, absolute space, Galilean transformations, Michelson-Morley experiment, postulates of special theory of relativity, Lorent'z transformation equations, Length contraction, time dilation, relativity of simultaneity, variation of mass with velocity, addition of velocities, mass-energy relation, energy momentum relation. **(11P, 14M)**
(Total: 45 Periods, 60 Marks)

References:

1. Mathematical Physics: B.S. Rajput, Pragati Prakashan (19th Edition, 2007).
2. Mathematical Physics: B. D. Gupta.
3. Mathematical Methods for Physics: G. Arfken, Hens Weber (4th Edition, 1995).
4. Mathematical Methods in the Physical Science: Mary L. Boas.
5. Vector Analysis: Murray R. Spiegal, Schaum's series.
6. Introduction to Special theory of Relativity – Robert Resnick, Wiley Eastern Ltd.
7. Mathematical physics: Ghatak
8. Complex variables and applications: J. W. Brown

Semester V: (DSC): Physics paper II
PHY 502: Solid State physics
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Solid state Physics to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Solid state Physics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept and use of knowledge of Solid state Physics understand and solve the real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: The Crystal Structure
Classification of solids, Lattice, Basis & crystal structure, translational vector, Unit cell, Primitive unit cell, symmetry operations, Types of lattices (2D & 3D), Miller indices, Interplaner spacing, Number of atoms per unit cell, co- ordination number, atomic radius and packing fraction for SC, BCC and FCC structures, Study of CsCl, NaCl and ZnS structures, Concept of reciprocal lattice and its properties with proofs. **(10P, 14M)**
Unit 2: X-Ray Diffraction
Crystal as a grating for X-rays, Bragg's diffraction condition in direct lattice and reciprocal lattice, Ewald's construction, X-ray diffraction methods: Laue method, Rotating crystal method and Powder method, Analysis of cubic crystal by powder method, Brillouin zones (1D & 2D). **(08P, 10M)**
Unit 3: Cohesive energy and Bonding in solids
Cohesive energy and formation of molecules, Definition of dissociation energy of molecule, Types of bonding, Ionic bond, Covalent bond, Molecular bond, Metallic bond and Hydrogen bond, Madelung energy, Madelung constant for one dimensional ionic crystal. **(09P, 12M)**
Unit 4: Lattice vibrations and Thermal Properties
Lattice heat capacity, Classical theory of specific heat, Einstein's theory of specific heat, Vibrational modes in one dimension monoatomic lattice, Debye's model of specific heat of solids, Limitations of Debye model. **(09P, 12M)**
Unit 5: Free electron theory of metals and Band theory of solids
Drude-Lorentz classical theory, Sommerfield's quantum theory: Free electron gas in 1-D and 3-D, Fermi level and fermi energy, Density of states, Formation of Energy band, Distinction between metals, semiconductors and insulators, Hall Effect, Hall co-efficient and mobility. **(09P, 12M)**
(Total: 45 Periods, 60 Marks)

References:

1. Introduction to Solid State Physics: Charles Kittle.
2. Solid State Physics: A.J. Dekkar
3. Solid state Physics: R. L. Singhal
4. Solid State Physics: S.L. Gupta, V. Kumar.
5. Solid State Physics: S.L. Kakani, C. Hemrajan
6. Solid State Physics: C.M. Kachhava
7. Solid State Physics: R.L.Singhal, Kedar Nath, Ram Nath & Co.
8. Fundamentals of Solid State Physics: B.S. Saxena, R.C. Gupta, P.N. Saxena, Pragati Prakashan, Meerut
9. Concepts of Solid State Physics: J.N. Mandal, Pragati Prakashan, Meerut.
10. Solid State Physics: R. K. Puri and V. K. Babbar
11. Solid State Physics, H.Ibach and H Kutha, Springer (Online available book)

Semester V: (DSC): Physics paper III
PHY 503: Atomic and Molecular physics
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:

This course is aimed at introducing the fundamentals of Atomic and Molecular Physics to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Atomic and Molecular Physics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept and knowledge of Atomic and Molecular Physics to understand and solve the real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Vector Atom Model

Introduction, Quantum numbers, Physical interpretation of quantum numbers, Electron spin, Larmor precession of electron orbit, Pauli's exclusion principle, Definition of L-S coupling and j-j coupling, Spin-Orbit interaction, Spectral terms, Selection rules, Spectra of single valence electron system (sodium), Problems. **(08P, 11M)**

Unit 2: Two Valence Electron System

Introduction, Spin-spin and orbit-orbit interaction, L-S and j-j coupling schemes, Singlet triplet separations, s-p and p-d configuration in L-S coupling and j-j coupling, Lande Interval rule, Spectra of Helium, Problems. **(10P, 13M)**

Unit 3: Zeeman & Paschen Back effect

Introduction, Magnetic dipole moment, , Zeeman Effect: Experimental set up, Normal and Anomalous Zeeman Effect for single valence electron system, Lande 'g' factor for two valence electron system (L-S and j-j coupling), Paschen Back effect for single valence electron system, Problems. **(10P, 13M)**

Unit 4: X-ray spectra

Origin and nature of X-ray, Characteristic X-ray spectra, Moseley's law and its importance, Energy level of Cadmium, Regular and Irregular doublets and their laws, Applications of X-ray (List only) **(07P, 10M)**

Unit 5: Molecular spectra

Introduction, Regions of electromagnetic spectrum, Types of molecular spectra, Rotational spectra of rigid diatomic molecule, Rotational energy levels of rigid diatomic molecule, Vibration of atoms in a diatomic molecule, Vibrational energy levels for Diatomic molecule, Raman spectra – Experimental set up, Explanation of Stoke's and Anti-stoke's lines, Applications of Raman effect. **(10 P, 13M)**

(Total: 45 Periods, 60 Marks)

References:

1. Introduction to Atomic Spectra: H.E. White, McGraw Book Company, Inc.
2. Fundamental of Molecular spectroscopy: C.N. Banwell, Tata McGraw hill, 3rd edition.
3. Spectra of Diatomic Molecules: G Hertzberg, D Van Nastrand compony, Inc., NewYork.
4. Perspectives of Modern Physics: Arthur Beiser, McGraw Hill Kogakusha Ltd, Tokyo.
5. Atomic spectra and Molecular spectra: Raj kumar, Kedarnath Ramnath Prakashan.
6. Introductory Raman spectroscopy: Elsevier publication.
7. Theoretical Atomic physics (Fourth Edition): Harald Friedrich.
8. Physics of Atoms and Molecules(Second edition):B. H. Bransden & C. J. Joachain.
9. The fundamentals of Atomic and Molecular Physics: Robert L. Brooks.

Semester V: (DSC): Physics paper IV
PHY 504(A): Electronics-II
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Electronics and Digital Electronics to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Electronics and Digital Electronics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept and use of knowledge of Electronics and Digital Electronics to real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Transistor biasing and Transistor amplifiers
Need of biasing, Different methods of biasing (only list), Voltage Divider bias method in detail, Single stage RC coupled Common emitter amplifier: Working, voltage gain, frequency response and bandwidth, Definition of Voltage amplifier and Power amplifier, Class A, B , C and AB power amplifiers (only load line diagram and explanation) and application list of each type. **(09P, 11M)**
Unit 2: Transistorised Sinusoidal Oscillators
Types of feedbacks, Barkhausen Criterion, Oscillatory circuit (tank circuit), Types of Oscillators (List only), Hartley oscillator, RC phase shift Oscillator **(04P, 07M)**
Unit 3: Semiconductor switching devices
FET: Types (n-channel and p-channel), Constructional detail, electronic symbol, working principle and I-V Characteristics, FET parameters, Introduction to MOSFET, Applications: FET as a VVR, FET as an amplifier.
UJT: Constructional detail, Equivalent circuit, symbol, working principle and I-V Characteristics, Applications: UJT as a switch, UJT as a relaxation oscillator
SCR: Constructional detail, symbol, Equivalent circuit of SCR, working principle and I-V Characteristics, Transistor analogy and its working, Important terms (break over voltage, holding current, forward current rating), Applications: SCR as a switch, Controlled rectification using SCR. **(09P, 12M)**
Unit 4: Digital Electronics
A) Flip-flops: Logic circuit, truth table, working and symbols of R-S Flip Flop, J-K Flip Flop. **(06 P, 08M)**
B) Counters: Types of counters (Asynchronous and Synchronous), 3 bit Asynchronous up counter (Serial counter), 3 bit Asynchronous down counter, 3-bit Asynchronous Up-down counter, 3 bit Synchronous up counter (Parallel counter), modulus of counter, mod-3 counter, mod-5 counter, and mod 10. **(07P, 10M)**
C) Data Processing circuits:
Multiplexer (2 to 1 & 4 to 1 line), De-multiplexer (1 to 2 & 1 to 4 line), Decoder (1 to 2 & 1 to 4 line, BCD to decimal decoder), Encoder (Decimal to BCD encoder). **(05P, 6M)**
D) Timer: Functional block diagram of IC-555 (Timer), Pin configuration, Astable, Monostable and Bistable multivibrator using IC 555, Application: Square wave Generator **(05P, 6M)**
(Total: 45 Periods, 60 Marks)

References

1. Principles of Electronics – V. K. Mehta, S. Chand Publications, New Delhi.
2. Basic Electronics: B. L. Theraja, S. Chand Publications, New Delhi.
3. Digital Principles and Applications – Malvino and Leach, McGraw-Hill Publication.
4. Electronic Principles – A. P. Malvino, Mc-Graw-Hill Publishing House.
5. Modern Digital Electronics – R. P. Jain, Tata McGraw-Hill Pvt. Ltd., New Delhi.
6. Integrated Circuits - K. R. Botkar, Khanna Publishers (2004).
7. Electronic fundamentals and applications – J. D. Ryder, Prentice Hall 4th Edition.
8. Electronic Devices and Circuits – Allen Mottershead, Good year publishing Company.

Semester V: (DSC): Physics paper IV
PHY 504(B): Instrumentation-II
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:

This course is aimed at introducing the fundamentals of Instrumentation to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Instrumentation.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept and use of knowledge of Instrumentation to understand and to solve real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Introduction to Instrumentation

Definitions: Resolution, Threshold, Range and span, Hysteresis, Dead band, Backlash, Drift, Impedance loading and matching. Functional elements of measurement system (Brief description), Classification of instruments- Deflection and Null type, Manually operated and automatic type, Analog and Digital types, Self-generating and power-operated types, Contacting and Non-contacting types. Dynamic Characteristics of Instruments: Dynamic response of zero order, First order, & Second order instrument.**(10P, 12M)**

Unit 2: Transducers

Introduction, Analog transducers- Electromechanical type, Potentiometric Resistance-type, Inductive type, Self-generating type, Non-self generating type, Capacitance type, Piezo-electric type, Resistance-strain gauges, Opto-electric transducer, Digital transducers: Frequency domain transducers, Digital encoders, Optical encoders, Shaft encoder. **(11P, 16M)**

Unit 3: Data Acquisition Systems

Introduction, Data converters, Digital to analog converters- Binary weighted and R-2R ladder. Analog to digital converters - Successive approximation method, Single and dual slopeintegration type ADC. Data transmission elements-Electrical-type, Pneumatic-type, Positiontype,Radio-Frequency type. **(12P, 16M)**

Unit 4: Data Presentation Systems

Indicating elements- Digital voltmeters, Digital Multimeter, CRO (Analog & Digital),Recorders- Strip chart, X-Y recorder,Digital data recording (CD Recording system).Display elements- Classification of displays, Display devices- LED, LCD, 7-segment display, Dot matrix display, Electro luminescent display. **(12P, 16M)**

(Total: 45 Periods, 60 Marks)

References:

1. Instrumentation: Measurement and analysis - Nakra and Chaudhary
2. Electronic Instrumentation – H.S. Kalsi
3. Electronic Instrumentation and Measurement Techniques - Helfrick and Cooper
4. Instrumentation: Device and system - Rangan, Mani, Sharma
5. Transducers & Instrumentation- D.V.S. Murty, PHI Publication.
6. Electrical and Electronic Measurement & Instrumentation - A.K. Sawhney
7. Transducers and display systems: B. S. Sonde, Tata McGraw-Hill Publishing Company.
8. Data Converters– B. S. Sonde, Tata McGraw-Hill Publishing Company Limited.
9. Audio and Video Engineering System: R.G. Gupta, Tata McGraw-Hill Publishing Company.

Semester V: (SEC): Physics paper V
PHY 505: Solar energy and applications
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:

The aim of this course is not just to impart theoretical knowledge solar energy fundamentals and applications to the students but to provide them with exposure and hands-on learning wherever possible.

Course objectives:

1. To impart knowledge of basic concepts of clean, safe and affordable energy.
2. To provide the knowledge about variety of solar energy applications.
3. To provide the knowledge and methodology of conversion of solar energy into heat& electricity.

Course outcome:

Learner will be able to ….

1. Apply the concept of use of knowledge of energy resources, solar radiations and conversion to real life problem.
2. Understanding of the course will create scientific temperament.
3. To impart knowledge of basic concepts of solar cell fundamentals.
4. To provide the knowledge and methodology of conversion of solar energy into electricity.

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Unit 1: Solar Radiation:

The Sun, structure of the sun, solar constant, spectral distribution of extra-terrestrial radiation, Solar radiation at the earth's surface (terrestrial radiation), solar time and equation of time, Definitions: air mass, beam radiation, diffuse radiation, global radiation, irradiance, solar insolation. Solar radiation geometry, Empirical equation (derivation not expected) for Monthly Average: 1) Daily global radiation, 2) Daily diffuse radiation, 3) Hourly global radiation, 4) Hourly diffuse radiation. Solar radiation on tilted surfaces. Instruments for measuring solar radiation: Pyranometer, Pyrheliometer. **(05P, 08M)**

Unit 2: Solar Collectors:

Flat plate collector: Types (Liquid flat-plate type, Evacuated Tube collector type, flat-plate with Al-insulator, Polymer solar collector), materials for collectors (Absorber plate, Insulation and Cover plate),Efficiency of flat plate collector, Loss coefficients and Heat transfer, Heat Removal Factor, Improvement in efficiency.

Solar Concentrating Collectors: Flat plate collector with reflector, Cylindrical parabolic collector, Thermal analysis, Performance analysis. **(10P, 12M)**

Unit 3: Solar Photovoltaics:

A P-N junction, Energy level diagram of semiconductors, Fermi level in doped semiconductors, Photovoltaic principals, Materials for Solar cell, Single crystal silicon cell: Principle, construction, working, equivalent circuit, I-V characteristics of solar cell, Fill factor, Power-voltage characteristics of solar cell, Maximum conversion efficiency, Actual conversion efficiency, Limitations to cell efficiency, Multicrystalline silicon cell, Thin Film Solar Cell, Short circuit current, Open circuit voltage, Maximizing the performance, Cell size. **(10P, 12M)**

Unit 4: Solar Thermal Applications:

Solar water heater: Direct natural circulation type, Direct forced circulation type, Design consideration of solar water heater, Series and Parallel Arrays, Solar drying of food (Direct type and Indirect mode type),Solar cooling and refrigeration, Solar thermal power generation, Solar furnace (Direct incident type). **(10P, 14M)**

Unit 5: Solar PV Applications:

PV Systems: Classification, Basic Photovoltaic power system, Stand-alone PV system, Solar Cell Modules (Solar PV arrays), Series and Parallel combination of PV Modules, Grid-connected system, Solar power satellite, Power conditioning and control. Design of PV System: Array size and Battery size.

Energy storage: electro chemical batteries, large capacity approaches.

PV Applications: Industrial applications, Social applications, Consumer applications. **(10P, 14M)**

(Total: 45 Periods, 60 Marks)

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Demonstrations and Experiments:

(Note: Total 4 experiments are expected to be taken in the LAB by the teacher of this course while teaching the course.)

A) Solar Thermal Applications (Any two of the following)

1. Study of Solar Box Cooker
2. Study of Concentrating type Solar Cooker.
3. Solar Energy Measurements using Pyranometer.
4. Solar Energy Measurements using Pyrheliometer.
5. Study of Solar still for Water distillation.
6. Study of Solar Dryer: Hot air collector.

B) Solar PV Applications (Any two of the following)

1. Measurement of V_{OC} and I_{SC} of a Solar cell.
2. Determination of I-V & P-V Characteristics of a Solar cell.
3. Determination of I-V & P-V Characteristics of Series and Parallel combination of PV Modules.
4. Effect of Shading on Solar PV Module Output Power.
5. Study of Power versus load characteristics of Solar Photovoltaic panel
6. Study of Solar Lantern/ Street light

Note: For Solar energy modelling techniques, the software used for simulation in solar energy field, comparative review of software for solar photovoltaics, solar thermal systems and buildings. Use of software such as TRNSYS, PVSYST, PVSOL, SAM, SOLTRACE, HOMER, Meteonorm etc is advised.

References:

1. Solar Energy- S. P. Sukhatme and J K Nayak, Fourth Edition, Tata Mac Graw Hill Co. Ltd.
2. Solar Energy Fundamentals and Applications – H P Garg and J Prakash, Tata McGraw Hill Co. Ltd.
3. Solar Energy Utilisation – G D Rai, Khanna Publishers.
4. Solar Engineering and Thermal Processes – Duffie J. and W. Beckman (1991), John Willey and Sons Inc.
5. Solar Power Engineering – Magal B. S. (1990), Tata Mac Graw Hill Co. Ltd.
6. Renewable Energy Sources and Conversion Technology – Bansal N. K., M. K. M. Meliss (1990), Tata Mac Graw Hill Co. Ltd.

Semester V: (DSE): Physics paper VI
PHY 506(A): Technical Electronics-I
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Technical Electronics to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Technical Electronics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept of use of knowledge of Technical Electronics to real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Components and devices
Resistors, Capacitors, Inductors (Types, construction and specification), Identification of resistor and capacitor values, Transformers: Types, (Single phase power transformer, auto transformer, isolation, AF, RF, IF), Switches, Types of switches, Relay: Types (list only), Electromagnetic relay: Principle, Construction and Working. [Ref. 1 to 6] **(06P, 09M)**
Unit 2: Optoelectronic Devices
LED (Construction, Working & Applications), Seven Segment Display, Liquid Crystal Display (LCD), Photodiode (Construction, working, characteristics & applications), Introduction to phototransistor. [Ref. 2 to 5, 8] **(05P, 08M)**
Unit 3: Printed Circuit Board
Idea of PCB, advantages, copper clad, Etching processes, Different steps for making PCB, Precautions while making PCB, Principle of Photolithography (For PCB).[Ref.2,3 & 4] **(06P, 7M)**
Unit 4: DC Power Supplies
Block diagram of unregulated and regulated power Supply, their merits and demerits, Series regulated power supply, Voltage regulation (Load and Line). Study of Monolithic voltage regulators: Precision voltage regulator (IC 723), Three-terminal general purpose regulators ICs- 78xx and 79xx.[Ref 1 to 3, 15]
(07P, 10M)
Unit 5: Operational amplifier and its applications
Introduction to differential amplifier, Block diagram of Opamp, Schematic symbol and Pin diagram of IC 741, Important terms of OPAMP such as input impedance, output impedance, input offset voltage, open loop voltage gain, input bias current, slew rate. Ideal and practical parameters of Op-Amp, Concept of virtual ground, inverting and non-inverting amplifier with gain expressions, off-set null, Applications: Adder, Subtractor, Integrator, Differentiator, Comparator. [Ref 2, 3, 13,14] **(12 P, 14M)**
Unit 6: Data Converters
D to A Converters: Resistive divider network, Binary ladder network. A to D Converters: Successive approximation type, Single slope, Dual slope, Voltage to Time, Voltage to Frequency. [Ref. 7 to 12]
(09P, 12M)
(Total: 45 Periods, 60 Marks)

References:

1. Principles of Electronics – V. K. Mehta, S. Chand Publications, New Delhi.
2. Basic Electronics (Solid State): B.L. Thereja, Publisher:S. Chand &Company, New Delhi.
3. Basic Electronics: B. Grob, Publisher: McGraw Hill Book Co. New York,
4. A Textbook of Applied Electronics – R S Sedha, Publisher: S Chand & Company, New Delhi.
5. Electronic Instrumentation: H.S. Kalsi, Tata McGraw-Hill Publishing Company Limited,New Delhi.

6. Electronic components and Materials-Principles, Manufacture and Maintenance: S. M. Dhir, Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. Measurement and Instrumentation Principles: Alan S. Morris., Publisher: Butterworth-Heinemann.
8. Transducers and display systems: B. S. Sonde, Tata McGraw-Hill Publishing Company Limited, New Delhi.
9. Digital Principles and Applications: A.P. Malvino and D. P. Leach. Tata McGraw-Hill Publishing Company Limited, New Delhi.
10. Data Converters–: B.S. Sonde, Tata McGraw-Hill Publishing Company Limited, New Delhi.
11. Modern Electronic Instruments and Measurement techniques: Albert D. Helfrick, Willam D. Cooper, Prentice Hall India Pvt. Ltd, New Delhi.
12. A course in Electrical and Electronic Measurements and Instruments: A. K. Sawhney, Dhanpat Rai and Sons.
13. Op-Amps & Linear Integrated Circuits - R. A. Gaikwad, Publisher: Pearson.
14. Operational Amplifier - G. B. Clayton
15. Integrated Circuits - K. R. Botkar, Khanna Publishers (2004).
16. Optoelctronics: J. D. Ryder
17. Power supplies: B. S. Sonde

Semester V: (DSE): Physics paper VI

PHY 506(B): Refrigeration and Air conditioning-I

(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Refrigeration and Air conditioning to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Refrigeration and Air conditioning.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept and use of knowledge of Refrigeration and Air conditioning to understand and solve the real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Heat Transfer:
Introduction, Conduction through slab, pipe, hollow sphere, Convection, Heat transfer by convection, Expression for heat transfer coefficient ,combined conduction and convection heat transfer, Fins and their applications. (Ref. 1: Chapter -15) **(6L, 10M)**

Unit 2: Air Refrigeration system:
Introduction, Reversed Carnot cycle and as most efficient refrigerator, C.O.P. and its dependence on source and sink temperature, Bell-Coleman air refrigeration system, Advantages and disadvantages of air refrigeration system. (Ref. 1: Chapter - 3) **(7L, 10M)**

Unit 3: Vapour Refrigeration system:
i) **Simple Vapour Compression Refrigeration system**:
Vapour compression refrigerator, Construction of various lines on T–S chart, P- H diagram for vapour compression refrigeration, Analysis of vapour compression system Advantages and disadvantages of vapour compression refrigeration over air refrigeration system. (Ref.1: Chapter-4)
ii) **Absorption Refrigeration system:**
Introduction, Simple absorption system, Practical ammonia absorption system, C.O.P. of the absorption refrigeration system, Domestic Electrolux refrigerator, Advantages and disadvantages of absorption refrigeration over compression refrigeration system. (Ref. 1: Chapter -6) **(14L, 16M)**

Unit 4: Refrigerants:
Classification of refrigerants: primary and secondary refrigerants, Desirable thermodynamic, safe working and physical properties of refrigerants, important refrigerants, refrigerant nomenclature, selection of refrigerant. (Ref.1: Chapter -11) **(06L, 8M)**

Unit 5: Refrigeration equipments:
Compressors: Functions, Reciprocating compressor, hermetically sealed compressor, Rotary compressor with sealing blade and eccentric motor. **Condensers:** Functions, Air cooled and water cooled condensers, Evaporative condensers, Cooling towers. **Evaporators:** Functions, Primary and Secondary evaporators, flooded evaporators, Dry expansion systems, Shell & coil evaporators.
Expansion Devices: Functions, Automatic expansion valve, Thermostatic expansion valve, Solenoid control valve, Low side and high side float valves. (Ref.1: Chapter -13)
(12 L, 16M)
(Total: 45 Periods, 60 Marks)

Reference Books:
1. A course in Refrigeration and Air –Conditioning: S.C. Arora & S. Domkundwar. Dhanpat Rai & Co. 7th Edition
2. Basic Refrigeration and Air –Conditioning: P.N. Ananthanarayanan , Tata Mcgraw Hill, New Delhi 3rd Edition
3. Principles of Refrigeration: Roy J Dossat , Pearson Education (Singapur) Ltd. 4th Edition

Semester V: (DSE): Physics paper VI

PHY 506(C): Vacuum Technology-I

(Credits: 03) :(45 Lectures 60 Marks)

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Course description:

This course is aimed at introducing the fundamentals of Vacuum technology to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Vacuum technology.
2. To introduce the concepts and offer a fundamental insight to vacuum technology, the principles involved, pumps and gauges used.
3. To provide the knowledge and methodology necessary to create and maintain vacuum.
4. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept and use of knowledge of Vacuum technology to understand and solve real life problems.
2. Get knowledge of which pump to use to create vacuum.
3. Knowledge of which gauge to use for measuring vacuum.
4. Understanding of the course will create scientific temperament.

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Unit 1: Basics for Vacuum

Atmosphere and Vacuum, Gas pressure, Equations of ideal gas, Fundamental assumptions of kinetic theory of gas, Mean free path, Gas diffusion, Viscosity of gas, Thermal conductivity,

(7P, 8M)

Throughput and Speed, Different units of measurement of vacuum, Ranges of vacuum, Vacuum circuits: Impedance and Conductance, Mechanism of gas flow, pumping speed of vacuum pump.

(10P, 12M)

Unit 2: High vacuum pumps

Rotating vane type rotary pump: principle, construction, working, ultimate pressure attainable, factors on which the optimum performance of the pump depends, pump characteristics. Oil diffusion vapour pump (single stage, multistage): principle, construction, working, ultimate pressure attainable, factors on which the optimum performance of the pump depends, pump characteristics. **(8P, 12M)**

Unit 3: Ultrahigh vacuum pumps

Turbomolecular pump, Sorption pump, Ion pump, Cryogenic pump: principle, construction, working, ultimate pressure attainable. **(10P, 14M)**

Unit 4: Vacuum gauges

U-tube manometer, Mc-Leod gauge, Thermal conductivity gauges- Thermocouple gauge, Pirani gauge, Semiconductor gauge, Ionization gauges- Hot cathode and Cold cathode gauge, Bayard-Alpert gauge. **(10P, 14M)**

(Total: 45 Periods, 60 Marks)

References:

1. Introduction to Theory and Practical of High Vacuum Technology : L.Ward & J.P. Bunn, Butterworths.
2. High Vacuum Techniques : J. Yarwood.
3. Design and Construction of Vacuum systems : G.W. Green.
4. Vacuum Sealing Techniques : A. Roth
5. High Vacuum Engineering : A.E. Barrington
6. Handbook of Vacuum Technology: Karl Jousten
7. Vacuum Physics and Techniques, T. A. Delchar, Chapman and Hall.

Semester V: (DSE): Physics paper VI

PHY 506(D): Microprocessor-I

(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Microprocessor to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Microprocessor.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept and use of knowledge of Microprocessor to understand and to solve real life problems.
2. Understanding of the course will create scientific temperament.

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Unit-1: Fundamentals of Microcomputer
Simple microcomputer architecture, Microcomputer operation, Address bus, Data bus, control bus, memory, Semiconductor and Magnetic memory, Cache memory, RAM and ROM, High level and Low level language, Assembler, Compiler and Interpreter. **(12P, 16M)**
Unit-2: Architecture of 8085 Microprocessor
The 8085 pin diagram and function of each pin, Microprocessor communication and bus timings, Demultiplexing the bus AD7- AD0, Microprocessor Architecture and function of each block. **(12P, 16M)**
Unit-3: Instruction Set of 8085 Microprocessor
Study of addressing mode for 8085:- Implied addressing, Register addressing, Immediate addressing, Direct addressing and Indirect addressing. Instruction set: Data transfer instructions, Arithmetic instructions, Logical instructions, Branching instructions, Stack/PUSH and POP instructions, I/O and Machine control instruction. **(15P, 20M)**
Unit-4: Stack and Subroutines
Stack, Subroutine, types of Subroutine and Macro **(06P, 08M)**
(Total: 45 Periods, 60 Marks)

References:
1. Fundamentals of Microprocessors and Microcomputers – Badri Ram, Dhanpat Rai& Sons, Delhi.
2. Microprocessor Fundamentals – Roger L. Tokheim.
3. 8085 Assembly Language Programing – L. A. Leventhal.
4. Microprocessor Architecture programming and Applications 8080 & 8085 – Ramesh Gaonkar.
5. 8086 Microprocessor programming and Interfacing – Gibson.
6. Advanced Microprocessor and peripherals (Architecture, programming and interfacing) – A. K. Ray, K. M. Bhurchandi.
7. Microprocessors and Microcomputers- Soumitra Kumar Mandal.

Semester V: (DSE): Physics Paper VI
PHY 506 (E): Programming in C ++ - I
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamental Concept of Computer Programming language C++.
Course Objectives:
1. The course is designed to provide basic knowledge of C++ Programming.
2. C++ Programming is intended for software engineers, system analysts, program managers.
3. To learn how to design programs and applications using C ++.
4. To develop problem-solving skills and their implementation through C++ Programming.

Course Outcome: At the end of the course, the student will be able to
1. Explain basic principles of C ++ programming language
2. Concept of Variable, Operators, Control structure, Functions used in C++ programming.
3. Develop skills in writing a simple C++ program using a different statement.
4. Apply the best features of mathematics, engineering, and natural sciences to program real-life problems.

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Unit 1: Elements of C++ **[L: 04 M: 8]**
What is C++?, applications of C++, comments, I/O streams, the structure of the C++ program.
Unit 2: Variable and Expressions **[L: 08 M: 12]**
Variables, tokens, keywords, identifiers and constants, basic data types, user-defined data types & derived data types. Declaration and initialization of variables.
Unit 3: Operators in C++ **[L: 08 M: 14]**
Scope resolution operators, member dereferencing operator, memory management operators, manipulators, type cast operator, expressions and their types.
Unit 4: Control structure **[L: 10 M: 10]**
If, if-else, else-if, switch, break, continue.
Loop structures: while, do-while, for, nested for loop.
Unit 5: Functions in C++ **[L: 10 M: 10]**
Introduction, function prototyping, call by value & call by reference, Inline functions, reference arguments and default arguments. Math library functions.
Unit 6: Introduction to arrays, structures & union in C++ **[L: 05 M: 6]**
Definition, declaration, examples.

[Total: 45 Periods, 60 Marks]

References :

1. Master in C++ - K.R.Venugopal
2. C++ Programming - E.Balaguruswami
3. Turbo C++ Programming - Robert Lafore
4. C++ Programming - Yashwant Kanitkar.

Semester V: (LAB): Physics paper VII

PHY 507: Physics practical -I

(Credits: 02): (60 L, 100M (40 Internal + 60 External))

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Perform any ten experiments:

1. Moment of Inertia by Bifilar suspension.
2. Y and η by Searl's method.
3. Y by Koenig's method.
4. Y by Newton's rings.
5. Searl's Goniometer.
6. Lloyd's single mirror.
7. To estimate temperature of Na flame.
8. Measurement of resistivity by four probe method.
9. Frequency of AC/ Tuning fork by stroboscope.
10. Variation of resistance of a filament of a bulb with its temperature.
11. Determination of velocity of sound using ultrasonic Interferometer.
12. Electromagnetic Pendulum.
13. Determination of circular aperture of LASER.
14. Measurement of self-inductance of a coil by Anderson's bridge.
15. To determine the human audibility.
16. Study of I-V characteristics of solar cell.
17. Determination of fill factor and efficiency of solar cell.
18. To determine the solar constant.

Semester V: (LAB): Physics paper VIII
PHY 508: Physics practical -II
(Credits: 02): (60 L, 100M (40 Internal + 60 External))

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Group A: Perform any five experiments (Solid state physics, Electronics, Instrumentation):

1. Hall effect.
2. Analysis of XRD pattern.
3. Measurement of resistivity by two probe method.
4. Characteristics of JFET.
5. UJT characteristics.
6. UJT as relaxation oscillator.
7. Study of RC/LC filter(Low pass and High Pass)
8. Study of Heartly oscillator. (Calculation of frequency and verification of frequency from sinusoidal output waveform)
9. Measurement of self inductance using Maxwell's induction bridge.
10. Multiplexer (2 to 1 or 4 to 1) and/or De-multiplexer (1 to 2 or 1 to 4).

{For more knowledge and understanding, one can help the students to study, understand and use the VESTA software for determination of crystal structure on the basis of given data.}

Group B: Perform any five experiments from the following any one optional courses:

A) Technical Electronics:

1. To make two PCB's i) Using discrete components ii) Using IC components.
2. To study inverting and non inverting configuration of Op amp.
3. To study of OP AMP as an adder.
4. DAC (R- 2R ladder, without OP- AMP).
5. To study reverse bias characteristics of photodiode.
6. To study characteristics of photo transistor.
7. To design and study of regulated power supply using IC 723.
8. Designing and fabrication of transformer.
9. Triangular, square wave generator using OP AMP.
10. V to F converter using IC-741.
11. V to T converter using IC-741.
12. Study of function generator.
13. To study fixed voltage regulator using 78XX and 79XX.

{For more knowledge and understanding, one can help the students to study, understand and use the SKYLAB software to write and execute programs to study out put of inverting or non- inverting configuration of OPAMP, Opamp as adder or subtractor etc}

B) Refrigeration and Air conditioning:

1. Study of different tools used in Refrigeration and Air Conditioning.
2. To carry out the following operations on Copper tube i) Cutting ii) Bending iii) Flaring.

3. Study of hermetically sealed compressor used in refrigeration systems.
4. To carry out Swaging and Brazing of Copper tubes.
5. Study of thermostatic switch, LP/HP cut out switch and filters used in Refrigeration and A. C. systems.
6. Leakage testing and charging of a refrigeration system.

C) Vacuum technology:

1. To describe function of various parts of Rotary pump (with schematic diagram).
2. To describe the constructional details & working of vapour diffusion pump.
3. To measure the pumping speed of vacuum system by steady state method.
4. Study of McLeod gauge.
5. To calibrate & study the function of Pirani gauge.
6. To evacuate a system with a rotary pump (measurement of vacuum with & without ballast using McLeod gauge).

D) Microprocessor:

1. Diode matrix ROM.
2. Application of DAC (square/triangular sweep wave).
3. Up-down counter (4-bit).
4. Hexadecimal/decimal counter.
5. Multiplexer/Demultiplexer (using IC).
6. Study of shift register (using IC).
7. Shift an 8-bit and 16-bit number left by one bit.
8. One's and Two's Complement of number.

E) Programming in C++:

1. Write a C++ program to display the string "T. Y. B. Sc. Physics"
2. Write a C++ program to make addition, subtraction, multiplication & division
3. Write a C++ program to demonstrate the use of scope resolution operator
4. Write a C++ program to check whether given no. is palindrome or not
5. Write a C++ program to demonstrate the use of the inline function for finding a maximum of two numbers
6. Write a C++ program to accept array elements as positive and negative nos. & only print positive nos. as output (use continue statement) e.g. {10, -20, 3, 5,-7} O/P: {10,3,5}
7. Write a C++ program to generate Fibonacci series up to 20 terms e.g. 1, 1, 2, 3, 5, 8,……… (20 terms)
8. Write a C++ program to create the following structure Roll-No. Stud-Name Class. Enter at least five records

Semester V: (LAB): Physics paper VII
PHY 509: Project -I
(Credits: 02): (60 L, 100M (40 Internal + 60 External))

ASSESSMENT OF PROJECT- FIRST TERM:

Student should submit a Progress Report on the work done by him/her during the First Phase of the project i.e. on the topics :

1. Project Selection
2. Literature Search Strategy
3. Literature Review
4. Project Planning.
5. Experimental work (30 to 40 %)

Instructions:

1. The topic of project of the first term must be continued in the second term.
2. The project report of first term should be maintained and should be produced to examiner of second term.
3. The student will have to give a seminar on the project topic in the practical exam.
4. The student must perform his project presentation by PPT on LCD projector.

Semester VI: (DSC): Physics paper I
PHY 601: Quantum Mechanics
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Quantum Mechanics to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Quantum Mechanics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept and use of knowledge of Quantum Mechanics to real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: The Schrodinger Equation
Introduction to Quantum Mechanics, Wave function and its Physical interpretation, normalized and orthogonal wave functions, Requirements of wave function, Formulation of time dependent and time independent Schrödinger equation (Steady state equation), Probability current density and equation of continuity, Solution of Schrodinger's equations, Energy eigenvalues and eigenfunctions, Expectation value, Ehrenfest's theorem, Postulates of Quantum Mechanics. (Ref:1, 2 and 9)
(14P, 14M)

Unit 2: Applications of Schrödinger steady state equation
Particle in a one dimensional rigid box (derivation of energy eigenvalues and eigenfunctions), Step potential (Probability of reflection (R) and transmission (T)), Linear Simple Harmonic oscillator (derivation of energy eigenvalues and eigenfunctions) (1D). (Ref: 2,6 and 7) **(12P, 16M)**

Unit 3: Quantum theory of Hydrogen atom
Schrödinger equation in spherical polar co-ordinate system, Schrödinger equation for Hydrogen atom-separation of radial and angular part, Solutions of R,Θ,Φ equations, Significance of quantum numbers n, l, m_l and m_s. (Ref: 1). **(09P, 14M)**

Unit 4: Operators in Quantum Mechanics
Operators and linear operators, Position, Momentum operator, angular momentum operator, and total energy operator (Hamiltonian), Commutator bracket, Commutator algebra, Commutator brackets using position, momentum and angular momentum operator, Commutation relations and Hamiltonian operator; Commutation rules for components of orbital angular momentum; Commutation relations of L^2 with components of orbital angular momentum; Commutation relation of components of orbital angular momentum with position operator, Ladder operators L_+, L_- Concept of parity, parity operator and its eigenvalues.(Ref: 2 and 4) **(10P, 16M)**

(Total: 45 Periods, 60 Marks)

References:
1. Perspectives of Modern physics : Arthur Beiser.
2. Advanced Quantum Mechanics: Satya Prakash, Kedarnath Ram Nath, Meerut
3. Quantum Mechanics: Gupta, Kumar, Sharma. Sultan Chand & Sons
4. Quantum Mechanics: Chatwal and Anand. Himalaya Publ. Co.
5. Quantum Mechanics: L.I.Schiff.
6. Quantum Mechanics: Powell and Crasemann, Addison-Wesley Pub. Co.
7. Introduction to Quantum Mechanics: D. Griffiths Published by Prentice Hall,
8. Quantum Physics: 2nd Ed. H.C. Verma, Surya Publications, Ghaziabad (UP), 2009.
9. Quantum Mechanics: Concepts and Applications, Nouredine Zettili, Wiley Publications.

Semester VI: (DSC): Physics paper II
PHY 602: Material Science
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:

This course is aimed at introducing the fundamentals of Material Science to Under Graduate students.

Course objectives:

1. To impart knowledge of basic concepts in Material Science.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.

Course outcome:

Learner will be able to ….

1. Apply the concept of use of knowledge of Material Science to real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Introduction to materials

Classification of materials

Properties of Materials: **Mechanical Properties**:. Interpretation of tensile stress – strain curve, Stress, strain (tensile, compressive and shear), strength, elasticity, plasticity, ductility, malleability, hardness, toughness, creep, fatigue, stiffness, Isotropy, Anisotropy, Deformation, Elastic and Plastic deformation, factor affecting the mechanical properties, **Thermal Properties**: Heat capacity, Thermal expansion, Thermal conductivity, **Electrical Properties**: Conductivity, resistivity, dielectric strength, piezoelectricity. **Optical Properties**: Wavelength spectrum of electromagnetic waves. Refraction, Reflection, absorption and Transmission of non-metallic materials. **(12P, 15M)**

Unit 2: Atomic disorder in materials

Solid solution: Types of solid solution - Substitutional and Interstitial solid solution, Hume Rothery Rules of solid solubility. **Imperfections or defects in solids**: (i) Point defects: vacancies, Frenkel defect, Schottky defect, (ii) Line defects (Dislocation): Edge dislocation, screw dislocation**,** (iii) Surface defects or interfacial defects and (iv)Volume defect. **Plastic deformation**: Mechanism by slip system. **(06P, 10M)**

Unit 3: Diffusion of solid material

Atomic diffusion- Introduction, Classification of Diffusion.

Diffusion mechanism – Vacancy mechanisms, Interstiitial mechanism, Direct interchange mechanism. Diffusivity, Self diffusion in nickel, Steady state Diffusion (Fick's first law of diffusion) and Non steady state Diffusions (Fick's second law of diffusion), variation of diffusivity with temperature ,Activation energy for diffusion, factor affecting the diffusion. **(09 P, 12M)**

Unit 4: Phase Diagram

Phase diagram, Phase equilibrium, Construction of phase diagram, Interpretation of phase diagram, Gibb's Phase rule, classification of phase diagram - Unary Phase diagram, Binary Phase Diagram, Binary Phase Diagram for: i) Sugar-Water, ii) NaCl-water, Eutectic reaction, lever rule, Sb-Bi phase diagram, Pb-Sn phase diagram**.** **(10 P, 13M)**

Unit 5: Organic Materials:

Polymers: Properties of polymer, Molecular weight, Molecular structure, **Types of Polymers**: Plastics and elastomers, Plastic: Thermoplast, Thermosets Polymerization, Mechanism of polymerization, Degree of polymerization, Addition Polymerization, Co-Polymerization, and Condensation Polymerization. **(08P, 10M)**

(Total: Periods 45, Marks 60)

References:

1. Materials Science & Engineering: An Introduction (6th Edition): William D. Callister
2. Elements of Materials Science & Engineering: Van Vlack
3. First Course in Materials Science & Engineering: V Raghavan.
4. Material Science: S. L. Kakani, Amit Kakani. New Age International Publishers.
5. Material Science : G.K.Narula and K.S.Narula, Tata McGraw Hill.
6. Material Science and Processes : S.K.Hajra – Chaudhari, Indian Book Distributing company.

Semester VI: (DSC): Physics paper III
PHY 603: Nuclear Physics
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Nuclear Physics to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Nuclear Physics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept and use of knowledge of Nuclear Physics to understand and solve the real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Nucleus and Nuclear Forces
Nuclear compositions:- Constituents, charge, size, density, atomic mass of nucleus, nuclear magnetic moment, concept of parity(even and odd), classification of nuclei, mass defect and binding energy, stability of nuclei, packing fraction, Problems. Nuclear forces: Nuclear force, features of nuclear forces, saturation and short range nuclear forces, charge symmetry and charge independence, spin dependence of nuclear force, Meson exchange theory of nuclear forces, Elementary particles (List only). **(9L, 12M)**
Unit 2: Radioactivity
Introduction, Law of radioactive decay, half life, mean life, specific activity, partial radioactive decay, successive disintegration, Applications of radioactivity (Agricultural, Biological, Medical and industrial), Problems. **(06L, 08M)**
Unit 3: Nuclear Models
Types of nuclear models (List only), Single particle shell model**:** Introduction, Assumptions, Evidence of shell model, Theory of nuclear shell potential, nuclear spin and parities, limitations
of shell model. Liquid drop model**:** Introduction, assumptions, semi-empirical mass formula. Limitations of Liquid drop model, Problems**.** **(07L, 09M)**
Unit 4: Nuclear Reactions
Introduction, Theories of nuclear reactions, conservation laws, Q-value equation, Energetic of exoergic reactions, Energetic of endoergic reactions, Threshold energy, Problems. **(07L, 09M)**
Unit 5: Nuclear Energy
Introduction, Nuclear fission, Explanation on the basis of liquid drop model, energy available from fission:- Estimation of energy from masses of fission fragments and from binding energy, Nuclear chain reaction, Nuclear Fusion, Nuclear Reactor: Basic principle, classification, constituents parts, Heterogeneous reactor, Swimming pool reactor, Power reactor, Problems. **(10L, 14M)**
Unit 6: Nuclear Detectors and Accelerators
Types of detectors, Geiger-Mueller counter, Scintillation counter, Classification of accelerators**:**
Cyclotron and Betatron. **(06L, 08M)**
(Total: 45 Lectures, 60 Marks)

References:
1. The atomic Nucleus: R D Evans, McGraw Hill Book Company.
2. Nuclear Physics: D C Tayal, Himalaya Publishing House, Bombay.
3. Nuclear Physics: Irving Kaplan, Narosa Publishing House, New Delhi.
4. Basic Nuclear Physics and Cosmic Rays: B N Srivastava, Pragati Prakashan, Meerut.
5. Concepts of Modern Physics – Arthur Beiser (5th Edition).
6. Atomic Physics: J.B. Rajam.
7. Introduction to Nuclear Physics: H.A. Enge (Addition Wesely Co.)

Semester VI: (DSC): Physics paper IV
PHY 604: Modern and Applied Physics
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Modern and Applied Physics to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Modern and Applied Physics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept and use of knowledge of Modern and Applied Physics to understand and solve the real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Plank's Quantum theory:
Planck's quantum theory, properties of photon, Planck's constant and light as a collection of photons; photo-electric effect and Compton effect, Experimental verification of Compton's effect. **(04 P, 06 M)**
Unit 2: Bohr's and Sommerfield theories of hydrogen atom
Introduction of atomic spectra, Inadequacy of classical planetary model of hydrogen atom, Bohr's theory of hydrogen atom, Extension of Bohr's theory, Experimental verification of discrete atomic energy levels, correspondence principle, Bohr's Sommerfield model and relativistic effects, Limitations of quantum mechanical model. **(09 P, 12 M)**
Unit 3: Matter Waves (Foundation of Quantum mechanics)
Need of quantum mechanics, Wave particle duality of matter, de-Broglie hypothesis, Expression for matter waves, Electron diffraction , Davission and Germer experiment, concept of wave group , phase velocity, group velocity, particle velocity and relations between them, Uncertainty principle, Thought experiment (Gamma ray microscope), different forms of uncertainty principle, applications of uncertainty principle (Non existence of electron in nucleus, determination of ground state of electron and size of hydrogen atom). (**09 P, 12 M**)
Unit 4: Fiber Optics
Introduction, construction of optical fiber, principle of operation, concept of acceptance angle, numerical aperture, attenuation in optical fiber and attenuation limit, preparation of optical fiber, optical fiber materials, types of optical fiber Single mode and multimode fibers, advantages and disadvantage of optical fiber, communication, Applications of fiber optics, Detail discussions on following applications: Temperature sensor, displacement sensor, fiber optic endoscopy, fiber optic communications.
(07P, 09 M)
Unit 5: Holography and its application
Concept of monochromatic and coherent source, basic idea of hologram, construction and re-construction hologram, types of hologram (list only), application of holography in microscopy and character recognition. **(07P, 09 M)**
Unit 6: Introduction to bioelectricity
Electricity observed in living systems, examples and origin of bioelectricity, sodium and potassium transport, Nernst equation, resting and action potential, conduction velocity. **(09 P, 12 M)**
Total: (45 Periods, 60 Marks)

References

1. Concepts of Modern Physics: S. L. Gupta, S. Gupta, Third Edition-1989, Publisher: Dhanpat Rai and Son's.
2. Modern Engineering Physics: A. S. Vasudevan, Publisher: S Chand.
3. Physics for Engineers: M.R. Srinivasan, Publisher: New Age International.

4. REFRESHER COURSE IN PHYSICS, VOLUME-II, C. L. Arora, Publisher: C. Chand and Company Ltd., New Delhi.
5. Modern Physics – B. L. Theraja, Publisher: C. Chand and Company Ltd., New Delhi.
6. Elementary Modern Physics - Atam P. Arya, Publisher: Addison Wesley Longman Publishing Co., New edition
7. An Introduction to Lasers -Theory and Applications - M. N. Avadhanalu, Publisher: C. Chand and Company Ltd., New Delhi.
8. Introduction to Fiber Optics: Ajoy Ghatak, K. Thyagarajan, Publisher: Cambridge University Press, 1998.
9. From Neuron to brain - Kuffer & Nicholas, Publisher: Sinauer Associates is an imprint of Oxford University Press; 5 edition (2011).
10. Biomedical Instrumentation and Measurements (II Edition) - L. Cromwell, F. J. Weibell, E. A. Pfeiffer (Pearson Education Singapore Pvt. Ltd.).

Semester VI: (SEC): Physics paper V
PHY 605: Basic Instrumentation Skills
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Basic Instrumentation skills to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Basic Instrumentation skills.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Handle and use various basic mechanical and electrical measuring instruments
2. Understanding of the course will create scientific temperament.

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(This course is to get exposure with various aspects of instruments and their usage throughhands-on mode. Experiments listed below are to be done in continuation of the topics.)

Unit 1. Use of basic measuring instruments:
Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Study of Vernier calliper, Screw gauge, travelling microscope and their utility to measure the dimension of a solid block, volume of cylindrical objects, diameter of a thin wire and capillary tube, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.
(04 P, 06M)

Unit 2. Electrical quantity measuring instruments:
PMMC, Voltmeter (D.C. and A.C), specifications and their significance. Ammeter (D.C. and A.C), specifications and their significance. Ohmmeter (Series and Shunt type), specifications and their significance. Multimeter, Steps of measurement of dc voltage and dc current, ac voltage, ac current and resistance using multimeter, Specifications of a multimeter and their significance. **(12 P, 14M)**

Unit 3: Cathode Ray Oscilloscope
Block diagram of basic CRO, Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence and chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance, Use of CRO for the measurement of voltage (dc and ac), frequency, time period and phase. Introduction of Dual trace CRO and digital oscilloscope, probes. **(12P, 14M)**

Unit 4: Signal Generators and Analysis Instruments
Block diagram, explanation and specifications of low frequency signal generators, pulse generator, and function generator. Brief idea for testing, specifications. **(07P, 10M)**

Unit 5: Digital Instruments
Principle and working of digital meters. Comparison of analog and digital instruments. Characteristics of a digital meter. Block diagram and Working principle of digital voltmeter (Ramp type only). Block diagram and working of a digital multimeter, Digital Frequency meter: Block diagram and Working principle: frequency and period measurement, accuracy and resolution.
(10P, 16M)
Total: (45 Periods, 60 Marks)

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The test of lab skills will be of the following test items:
1. Use of an oscilloscope.

2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter for measuring voltages
5. Trouble shooting a circuit

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. Measurement of voltage, frequency, time period and phase angle of a wave using CRO.
4. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times of a wave using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

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Reference Books:

1. Principles of Electronics – V. K. Mehta, S. Chand Publications, New Delhi.
2. Basic Electronics (Solid State): B.L. Thereja, Publisher: S. Chand and Company, New Delhi.
3. Electrical measurements and measuring instruments: R K Rajput, S. Chand and Co. New Delhi.
4. Digital Principles and Applications: A.P. Malvino and D. P. Leach. Tata McGraw-Hill Publishing Company Limited, New Delhi.
5. Modern Electronic Instruments and Measurement techniques: Albert D. Helfrick, Willam D. Cooper, Prentice Hall India Pvt. Ltd, New Delhi.
6. A course in Electrical and Electronic Measurements and Instruments: A. K. Sawhney, Dhanpat Rai and Sons.
7. Digital electronics, R P Jain
8. Basic Electronics: B. Grob, Publisher: McGraw Hill Book Co. New York,
9. Electronic Instrumentation: H.S. Kalsi, Tata McGraw-Hill Publishing Company Limited, New Delhi.
10. Digital instrumentation by A J Bouwens
11. A text book in Electrical Technology - B L Theraja – S. Chand and Co.
12. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
13. Logic circuit design, Shimon P. Vingron, 2012, Springer.
14. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
15. Electronic Devices and circuits, S. Salivahanan and N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
16. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
17. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Semester VI: (DSE): Physics paper VI
PHY 606(A): Technical Electronics II
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Technical Electronics to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Technical Electronics.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept of use of knowledge of Technical Electronics to real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Sound System
Microphones: characteristics, types (list only), carbon microphone and dynamic type microphone (Principle, construction and working), Loud speakers: Characteristics, Dynamic (Moving coil type) speaker, Multiway speaker system (woofer and tweeter), Connection type of speakers (series, parallel and series-parallel type). [R1, R2, R9]. **(08P, 12M)**

Unit 2: Public Address System
Block diagram of Public Address (P.A.) system and its explanation, requirements of P. A. system, typical P.A. Installation planning (Auditorium having large capacity, college sports), Volume control, Tone control and Mixer system, Concept of Hi –Fi system, Monophony, Stereophony, Quadra phony, Dolby A and Dolby B system, CD- Player: Block diagram of CD player and function of each block. [R1, R2, R9].
(10P, 14M)

Unit 3: Medical instruments.
Biopotential, Types of electrodes, ECG (principle, block diagram, features) Ultrasonography: working principle [R 3, 4, 5] **(07P, 8M)**

Unit 4: Transducer
Definition, Classification, Selection of transducer, Electrical transducer: Thermistor, Thermocouple, Pressure Transducer: Strain gauges (wire, foil, & semiconductor), Displacement transducer: LVDT, Peizo-electric Transducer, Optoelectronic transducers: LDR, Chemical sensors: pH sensor, Gas sensor (Fundamental aspects), Humidity sensor (Resistive). [R7, R8]. **(10P, 14M)**

Unit 5: Modern appliances
Remote Control: Operating principle, block diagram, features.
Microwave Oven: Operating principle, block diagram, features.
Cellular Phone: Operating principle, Block diagram, specifications, features, and functions performed.
Washing Machine: Operating principle, block diagram, features, Fuzzy Logic (Idea only),
Electronic Weighing Systems: Operating principle, Block diagram, features. [R8].
Infrared Thermometer: Operating principle, Block diagram, features. **(10P, 14M)**
(Total: 45 Periods, 60 Marks)

References:

1. Audio and Video Engineering System: R.G. Gupta, Tata Mc-GrawHill Publishing Company Ltd, New Delhi.
2. Basic Electronics: B. L. Thereja, S. Chand Publications, New Delhi.

3. Introduction to Bio-medical Electronics: Joseph-Du-bary, Tata Mc-Graw Hill Publishing Company Ltd, New Delhi.
4. Medical instrumentation Application and design: J. C. Wobster
5. Biomedical instruments and measurements: L. Cromwell, F. J. Weibell, Printice Hall of India of India Pvt. Ltd, New Delhi.
6. Transducers and display systems: B.S. Sonde, Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. Solid state Gas sensors- edited by P. T. Moseley and B.C. Tofeld, Harwell, Adam Hilger and Philadelphia
8. Measurement and Instrumentation Principles: Alan S. Morris, Butterworth-Heinemann.
9. Consumer Electronics: J.S. Chintode, Technical Publication, Pune.

Semester VI: (DSE): Physics paper VI
PHY 606(B): Refrigeration and Air conditioning II
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Refrigeration and air conditioning to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Refrigeration and air conditioning.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept and use of knowledge of Refrigeration and air conditioning to understand and solve the real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Psychrometry:
Introduction, Meaning of air conditioning, Five main factors of comfort air conditioning, Psychrometry and psychrometic properties, psychrometic relations: Dalton's law of partial pressure; relation between partial pressure & specific humidity; relation between degree of saturation & relative humidity, Types of psychrometers, Psychrometic processes, Bypass factor and its relation, Summer air conditioning systems for Hot & Dry; Hot & Humid out door conditions, Summer air conditioning with evaporative cooling, Winter air conditioning system for mild cold weather. (Ref. 1: Chapter -16) **(12L, 16M)**
Unit 2: Cooling load calculations & design of air conditioning systems:
Different heat sources, Heat flow due to conduction, Sun load, Occupants load, Equipment load, Infiltration load, Miscellaneous heat sources, Design aspects of air conditioning system, Cooling load and air quantities. (Ref. 1: Chapter -19) **(7L, 10M)**
Unit 3: Air Conditioning equipments:
Air cleaning and Air Filters: Functions, Types, Wet filters, Electronic filters, and Centrifugal dust collector. Cooling Coils: Bypass factor of multidepth coils. Humidifiers: Functions, Atomization type humidifiers, Impact type humidifiers, Pan & coil type humidifiers. Dehumidifiers: Functions, Refrigeration humidifiers, Spray type humidifiers, De-humidifying air washers. Fans and Blowers: Functions, Axial flow fans, Centrifugal fans. Grills and Registers. (Ref. 1: Chapter -25) **(10L, 14M)**
Unit 4: Air Conditioning Control systems:
Basic elements of control systems, Temperature control elements: Bimetal type thermostat, Sealed bellow type thermostat, Electrical resistance and thermocouple type thermostat. Humidity Control Elements: Hair type humidistat, Absorption type thermostat, Water vapour recorder. Actuators: Relays Introduction to Transmission systems:Pre heat and humidification control systems, Cooling dehumidification and reheat control system, Face and bypass control system. (Ref. 1: Chapter -26) **(10L, 12M)**
Unit 5: Solar Refrigeration System
Vapour Compression Refrigeration system using solar energy, Vapour absorption refrigeration system using solar energy, Solar refrigeration using a solid absorption cycle, Solar refrigerators sing Photovoltaic panels, (Ref.1: Chapter -28) **(6L, 8M)**
(Total: 45 Periods, 60 Marks)

Reference Books:
1. A course in Refrigeration and Air –Conditioning: S.C. Arora & S. Domkundwar.Dhanpat Rai & Co. 7th Edition
2. Basic Refrigeration and Air –Conditioning: P.N. Ananthanarayanan , Tata Mcgraw Hill, New Delhi 3rd
3. Principles of Refrigeration: Roy J Dossat , Pearson Education (Singapur) Ltd. 4th Edition

Semester VI: (DSE): Physics paper VI
PHY 606(C): Vacuum Technology-II
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Vacuum technology to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Vacuum technology.
2. The course should prepare the student for operating, simulating and construction of vacuum systems.
3. The course also involves the related experiments based on the theory.

Course outcome:
Learner will be able to ….
1. Apply important laws of physics which govern how a vacuum system works.
2. Account for which components are used in a vacuum system, their construction, function and use.
3. Account for troubleshooting a vacuum system.
4. Run simulations and write a specification for a simple vacuum system.

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Unit 1: Vacuum materials and components
Adsorption, Absorption, Desorption. Diffusion and penetration of gases through solid surfaces, Vapour pressure of different materials, Outgassing of materials, Desired properties of materials used for fabrication of vacuum system. **(7P, 8M)**
(i) Vaccum Seals: (a) Permanent seals- Welding, Brazing, Soldering (b) Demountable seals- Waxes, Resins and Adhesives, Gaskets seal: Elastomer, metal. Feedthroughs: Electrical Feedthroughs, Motion Feedthroughs: Wilson seal, Bellows seal. **(8P, 11M)**
(ii) Valves: (a) Roughing and For-line valves: Disk valve, Ball valve. (b) High vacuum valves: Gate valve, disk valve, flap valve, Butter-fly valve. (c) Gas admittance valves: disk valve, Needle valve. **(8P, 11M)**

Unit 2: Leak detection
Real and Virtual leaks, Leak detection method: (a) Over pressure method- Bubble method, Halide torch, Sniffer technique. (b) Low pressure method- Blocking (sealing) method, Tesla coil, Halogen leak detector, Organic vapour and gas probe with suitable pressure gauge as detector. **(11P, 14M)**

Unit 3: Vacuum system fabrication
General consideration of designing, Construction of High vacuum system (Combination of Rotary and Oil diffusion pump), Its operational procedure, Construction of Ultrahigh vacuum system and its operational procedure. **(8P, 11M)**

Unit 4: Application of Vacuum Technology
Applications of Vacuum technology in Research and Industry. **(3P, 5M)**

(Total: 45 Periods, 60 Marks)

References:

1. Introduction to Theory and Practical of High Vacuum Technology : L.Ward & J.P. Bunn, Butterworths.
2. High Vacuum Techniques : J. Yarwood.
3. Design and Construction of Vacuum systems : G.W. Green.
4. Vacuum Sealing Techniques : A. Roth
5. High Vacuum Engineering : A.E. Barrington
6. Handbook of Vacuum Technology: Karl Jousten
7. Vacuum Physics and Techniques, T. A. Delchar, Chapman and Hall.

Semester VI: (DSE): Physics paper VI
PHY 606(D): Microprocessor- II
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the fundamentals of Microprocessor to Under Graduate students.
Course objectives:
1. To impart knowledge of basic concepts in Microprocessor.
2. To provide the knowledge and methodology necessary for solving problems in Physics.
3. The course also involves the related experiments based on the theory.
Course outcome:
Learner will be able to ….
1. Apply the concept and use of knowledge of Microprocessor to understand and to solve real life problems.
2. Understanding of the course will create scientific temperament.

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Unit 1: Assembly Language Programming
Masking of 4- MSB and LSB of given number, One's and two's complement of 16- bit numbers, Shift 16- bit numbers left by one bit, 8- bit addition, 8- bit subtraction, Decimal addition and decimal subtraction of two 8 bit numbers, 8- bit multiplication, Find largest and smallest numbers from a series of given number, Find square root of given number from Look up table. Code conversion programs:-Hex to ASC II conversion, BCD to binary conversion, Decimal to seven segment conversion. **(15P, 20M)**

Unit 2: Interfacing of Memory and Peripheral Devices
Introduction, Interfacing with RAMS & ROMS, I/O interfacing basics, Interfacing with practical I/O memory mapped I/O and I/O mapped I/O schemes, Direct Memory Access (DMA). Data transfer. **(09P, 12M)**

Unit 3: Programming Peripheral Interface (PPI)
Architecture of Intel-8255, Pin diagram of Intel-8255, Functions of each pin, Control word format, Operations of Mode-0, Mode-1 & Mode-2**.,** Single-Bit Set/Reset (BSR) Mode and Applications of 8255 PPI (list only) . **(10P, 13M)**

Unit 4: Programming Communication Interface and Counter/Interval Timer
Architecture of Intel-8251, Pin diagram of Intel 8251, Functions of each pin, Mode word format, Control word format, Status word format, Architecture of Intel-8253, pin diagram of Intel-8253, Functions of each pin, Operations of Mode-0, Mode-1, Mode-2, Mode-3, Mode- 4 and Mode-5. **(11P, 15M)**
(Total: 45 Periods, 60 Marks)

References:
1. Fundamentals of Microprocessors and Microcomputers – Badri Ram, DhanpatRai& Sons, Delhi.
2. Microprocessor Fundamentals – Roger L. Tokheim.
3. 8085 Assembly Language Programing – L. A. Leventhal.
4. Microprocessor Architecture programming and Applications 8080 & 8085 – Ramesh Gaonkar.
5. 8086 Microprocessor programming and Interfacing – Gibson.
6. Advanced Microprocessor and peripherals (Architecture, programming and interfacing) – A. K. Ray, K. M. Bhurchandi.
7. Microprocessors and Microcomputers- Soumitra Kumar Mandal.

Semester VI: (DSE): Physics paper VI
PHY 606 (E): Programming in C+ + - II
(Credits: 03) :(45 Lectures 60 Marks)

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Course description:
This course is aimed at introducing the object-oriented concept Programming language C++.
Course Objectives:
- To learn Object-Oriented Design with C++ Programming
- Ability to write a computer program to solve a specific program
- To handle abnormal termination of a program using exception handling

Course Outcomes:
1. Acquire knowledge of Object and Class.
2. Explore polymorphism using function overloading and operator overloading.
3. Understand the different aspects of the hierarchy of classes and their extensibility
4. Understands the concept of Virtual function, streams, and files, Generic Programming.
5. Write programs for handling run time errors using exceptions

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Unit 1: Objects & Classes **[L: 06 M: 08]**
Simple classes (class specification, C++ objects, accessing class members), constructors and destructors, constant member functions.
Unit 2: Functions and operator overloading **[L: 10 M: 12]**
Overloading functions, introduction to operating overloading, overloading unary and binary operators, overloading arithmetic assignment operator.
Unit 3: Inheritance **[L: 10 M: 10]**
Derived class and base class, derived class constructors, public and private inheritance, multiple inheritances, hierarchical inheritance, multilevel inheritance, containership (classes within classes).
Unit 4: Virtual functions **[L: 06 M: 10]**
Virtual functions, pure virtual functions, friend functions, Static functions, copy constructor, this pointer.
Unit 5: Generic programming **[L: 05 M: 10]**
Introduction to a template, function within a template, introduction to exceptional handling.

Unit 6: File and streams **[L: 08 M: 10]**
Input/Output streams, classes for steam operation, opening and closing files, file pointers and their manipulations, error handling during file operations.

(Total: 45 Periods, 60 Marks)

References:

1. Master in C++ - K.R.Venugopal
2. C++ Programming - E.Balaguruswami
3. Turbo C++ Programming - Robert Lafore
4. C++ Programming - Yashwant Kanitkar.

Semester VI: (LAB): Physics paper VII
PHY 607: Physics practical -I
(Credits: 02): (60 L, 100M (40 Internal + 60 External))

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Perform any TEN experiments:

1. Surface tension by Quinke's method.
2. Surface tension by soap bubble method.
3. Characteristics of G.M. counter.
4. Diffraction by straight edge/cylindrical obstacle.
5. e/m using Thomson's method.
6. Viscosity by rotating cylinder method.
7. Determination of 'g' by conical pendulum.
8. Study of oscillatory charge and discharge through an inductance and resistance.
9. To determine value of Boltzmann Constant using V-I characteristics of PN diode.
10. To determine work function of material of cathode using photocell.
11. To determine value of Plank's constant using LEDS of at least four different colours.
12. To study intensity response of photocell and verify inverse square law of radiations.
13. To measure the numerical aperature of an optical fiber.
14. Study of bending loss in optical fiber.
15. Study of I-V characteristics of photocell.
16. Determination of Plank's constant of Photocell.
17. Study of Solar still for water distillation.
18. Study of box type Solar cooker.

Semester VI: (LAB): Physics paper VIII

PHY 608: Physics practical -II

(Credits: 02): (60 L, 100M (40 Internal + 60 External))

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Group A: Perform any Five experiments (Material Science, Electronics, Instrumentation):

1. Determination of curie temperature of Ferrite.
2. Determination of specific heat of graphite at different temperature
3. To study characteristics of thermisters.
4. Determination of thermoelectric power.
5. Study of Astable Multivibrator using IC 555.
6. Binary weighted DAC (R-2R ladder) using OP-AMP.
7. Determination of Core losses in transformers.
8. To study of clocked RS flip flop using NAND gates.
9. Study of IC 7490 as mod 2, mod 5 and mod 10 counter.
10. To study RC coupled Single stage transistor amplifier. (Voltage gain , Frequency response)

Group B: Perform any Five experiments from the following optional courses:

A) Technical Electronics:

1. To study characteristics of LDR.
2. Study of P. A. system (series and parallel connection of two speakers) and measurement of equivalence resistance.
3. Use of C.R.O as a measurement tool for different electrical parameters (frequency, a. c./d. c. voltage, pulse height, pulse width, rise time and fall time).
4. Use of thermocouple for measurement of temperature.
5. Study of OP AMP as substractor.
6. Study of OP- AMP as a differentiator.
7. Study of OP- AMP as an integrator.
8. Displacement measurement using LVDT.
9. Frequency response of loudspeaker (twitter, woofer, mid-range).
10. Study of E.C.G .
11. Thermister as a thermometer using IC 741.
12. Half wave precision rectifier using OP AMP.
13. Full wave precision rectifier using OP AMP.

B) Refrigeration and Air conditioning:

1. To find the COP of a domestic refrigeration system.
2. Detection of trouble/faults in a refrigerator and window air conditioner.
3. Dismantling of Window type A.C. and testing after assembly.
4. Visit to a cold storage plant.
5. Visit to a centrally air conditioned building.
6. Visit to a Ice plant.

C) Vacuum technology:

1. To measure the pumping speed of vacuum system (use of Gaedes equation).
2. Demonstration of oil diffusion pump & to evacuate the system & to measure the ultimate vacuum.
3. To study the effects of conductance of pumping speed of oil diffusion pumping module.
4. Deposition of metallic thin film.
5. To investigate the variation of pumping speed of vapour diffusion pumping module with the pressure in vacuum system.
6. Pumping speed measurements using the constant volume method.

D) Microprocessor:

1. Find square root/square of number using look up table.
2. 8-bit decimal addition/subtraction.
3. Find largest/smallest number from series of 8-bit numbers.
4. Conversion of Hexadecimal to ASCII code.
5. 8-bit binary multiplication.
6. LED interface (Time delay generation).
7. Interfacing of thumbwheel switch.
8. Conversion of 8-bit Hexadecimal number to binary number.

E) Programming in C++:

1. Write a C++ program to implement string operations i) strlen ( ) ii) strcat ( ) as class members. Write a C++ program to display the string "T. Y. B. Sc. Physics"
2. Write a C++ program to swap two integers, two floats and two-character variables using function overloading.
3. Write a C++ program to demonstrate the use of constructors and destructors.
4. Write a C++ program to overload + operator to add two complex nos.
5. Write a C++ program to implement hierarchical inheritance.
6. Write a C++ program to implement multiple inheritances.
7. Write a C++ program to implement virtual functions.
8. Write a C++ program to demonstrate the use of function templates

Semester VI: (LAB): Physics paper VIII
PHY 609: Project II
(Credits: 02): (60 L, 100M (40 Internal + 60 External))

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ASSESSMENT OF PROJECT- SECOND TERM:

Student should submit a Final Project Report on the work done by him/her during the First and Second Phase of the Project i.e. on the topics:

1. Experimental work. (remaining further work in continuation with the work in the first term)
2. Characterize the samples, if any.
3. Discussion of the results.
4. Conclusions.

Instructions:

1. The topic of project of the first term must be continued in the second term.
2. The project report of first term should be maintained and should be produced to examiner of second term.
3. The student will have to give a seminar on the project topic in the practical exam.
4. The student must perform his project presentation by PPT on LCD projector.

CAREER OPPORTUNITIES FOR B. Sc. PHYSICS STUDENTS

B.Sc. Physics students can find jobs in public as well as in private sectors. There are many opportunities available for B. Sc Physics students in technical as well as scientific fields. They can work as Science and Mathematics Teachers, Quality Control Manager, Laboratory assistant, Laboratory Technician, School Science Technician in any government or private organization.

Private Sector:

There are many opportunities available in IT field for B. Sc (Physics) graduates. Many IT companies such as Infosys, Wipro and TCS are recruiting B. Sc. Physics graduates for software jobs. They can also get jobs in Energy Plants. Another jobs available for these graduates is Technician in Electronic Industry. They can apply for jobs in many companies in automobile industry. Some of those companies are Maruti Udyog, TATA Motors and Tech Mahindra. The B. Sc. (Physics) graduates can apply and secure their job in Solar devices production industries, electrical or electronic industries with their skills developed while syudying.

Government Sector:

There are vast opportunities available for B. Sc graduates in Government sector. They can apply for jobs in Scientific Research and Development Organizations such as The Defense Research and Development Organization (DRDO), CSIR, Physical Research Laboratory (PRL) Ahmedabad, Saha Institute of Nuclear Physics Kolkata and Nuclear Science Centre New Delhi. They can also apply for various jobs in popular government organizations such as Bhabha Atomic Research Centre (BARC), Atomic Energy Regulatory Board (AERB), Oil and Natural Gas Corporation (ONGC), Bharat Heavy Electricals Limited (BHEL), National Thermal Power Corporation (NTPC).

They can also apply for the various competitive exams conducted by Union Public Service Commission such as IFS, IPS and IAS. Several other government exams conducted for recruiting B. Sc Physics graduates are Tax Assistant Exam, Statistical Investigator Exam, Combined Graduate Level Exam.

Another option available for B. Sc Physics graduate is to apply for jobs in public sector banking. Several banks are conducting exam every year for recruiting graduates to the post of Probationary Officers. They can also find many jobs in Railway sector. They should qualify the exams conducted by Railway Recruitment Board to get a job in Railway sector. These graduates can also apply for Combined Defense Services Exams conducted for recruiting candidates to various posts in Defense Department.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

A' Grade NAAC
Re-Accredited
(3rd Cycle)
Choice Based Credit System (CBCS)
Syllabus For
F.Y.B.Sc

Computer Science
(With effect from June 2022)

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Proposed Syllabus for F.Y.B.Sc. (Computer Science)

(w.e.f. June-2022)

YEAR I: CORE SUBJECTS (DSC)

Semester	Course as per UGC	Course code	Course Title	Lectures	Credits	Workload (hr)
I	CS-DSC 1 A:	CS 101	Essential of Computer Science	30	02	02
	(Credits: Theory-04, Practicals-02)	CS 102	Programming in C-I	30	02	02
	CS LAB	CS 103	Practical	60	02	04
II	CS-DSC 2A: (Credits: Theory-04,	CS 201	Internet Computing	30	02	02
	Practicals-02) CS LAB	CS 202	Programming in C-II	30	02	02
		CS 203	Practical	60	02	04

Semester I

Computer Science-DSC 1 A:

(Credits: Theory-04, Practicals-02)

Theory: 30 Hours

CS 101: Essential of Computer Science

CS 101: Essential of Computer Science

Unit-1. Introduction to Computer Components

[H: 8]

1.1 Definition of computer
1.2 Block Diagram of Computer, Types of computer, Neumann machine
1.3 Input Devices and Output Devices
1.4 Memory: RAM, ROM, EPROM, PROM, SSD
1.5 Definition: Data, Information, Algorithm, Flowchart, Program, Hardware, and Software:
System Software, Application, Software, Firmware, Interpreter, compiler
1.6 Programming Languages: High level, Middle Level, Low Level

Unit-2 Basics of Algorithms and Flowcharts

[H: 8]

2.1 What is Algorithm? , Steps for creation of Algorithm.
2.2 Properties of Algorithm and Examples
2.3 What is Flowchart?, Symbols for drawing Flowcharts, Examples
2.4 Advantages of algorithm and flowcharts.

Unit -3. Concepts of network

[H:7]

3.1 What is Computer Network?
3.2 Types of Networks (with Features and Application): LAN, WAN, MAN
Wired Network, Wireless Network,
3.3: Introduction and application of Internet
3.4 Network Topology
3.5 Study of Web Browsers and Search Engines

Unit -4. Operating System

[H: 7]

4.1 What is booting, POST, Bootstrap, Boot Drive.
4.2 Definition of operating system, functions of operating system
4.3 Introduction of operating systems: DOS, Windows, Linux, Android
4.4 Applications of Operating System,
4.5 Comparison Of various Operating Systems

References:

1. V. Rajaraman, "Fundamentals of Computers", PHI publication, ISBN: 8120340116, 9788120340114
2. Fundamentals of Data Structures in C by Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed.
3. Fundamentals of Computer Algorithms by Ellis Horowitz, Sartaj Sahni, Sanguthever
4. Abraham Silberschatz, Peter B. Galvin, Greg Gagne," Operating System concepts", ISBN:1119017475, 9781119017479
5. Andrew S. Tanenbaum, David J. Wetheral, "Computer Network", ISBN 0133072622, 9780133072624

Computer Science-DSC 1 A:
(Credits: Theory-04, Practicals-02) Theory: 30 Hours

CS 102: Programming in C-I

UNIT-1. Fundamentals of C (5 Hrs., 15 M)

1.1 Introduction to C- History, character set, structured programming paradigm
1.2 Applications areas and Features
1.3 Structure of C-program
1.4 Program development steps- Introduction to editor, Compilation, Execution and Debugging of C-program

UNIT-2. Element of 'C' Program (7 Hrs., 20 M)

2.1 Variables and Identifiers, Declaration of variables, keywords
2.2 Data types and Qualifiers
2.3 Constants and types of constants, Comments
2.4 Input Output Statements (Standard and formatted)
2.5 Introduction and features of 'C' preprocessor
2.6 Directives and Macros: #define, File inclusion (#include), Conditional Compilation Directives

UNIT -3. Operators and Expression (7 Hrs., 20 M)

3.1 Types of Operators –Arithmetic, Relational, Logical, Assignment, Compound assignment operator (short hand assignment), Bitwise, Increment-Decrement, Conditional Operator, Special Operator – Comma, sizeof operator
3.2 Operator Precedence and Associativity
3.3 Type Conversion – implicit and explicit
3.4 Library Functions: abs (), sqrt( ), pow( ), ceil( ), floor( )

UNIT -4. Conditional Statements and looping (6 Hrs., 20 M)
4.1 If Statement, if-else Statement, nested if-else Statement, else-if ladder, Switch Statement
4.2. Break, continue and goto statements
4.3 Looping Concepts -While, do-while, for loop Nested loops Concept

UNIT-5. Arrays (5 Hrs., 15 M)
5.1 Definition: Array: declaration and Initialization
5.2 Types of array (One Dimensional and Multidimensional)
5.3 Advantages and disadvantages of array
5.4 Applications of array

References:-

1. Denis Ritchie. "C" Programming – Prentice Hall Software Series- ***ISBN***. 10 9 8 7
2. Yashwant P. Kanetkar - ANSI C ,BPB publication. ***ISBN***: 9788183333245
3. Byron Gottfried – Programming with C –Tata McGRAW-Hill ***ISBN***-10: 0070145903
4. Yashwant P. Kanetkar -Understanding pointers in "C" -BPB publication. ***ISBN***-13: 978-8176563581
5. E.Balguruswami -Programming in ANSI- C- Tata McGRAW-Hill- ***ISBN***-10: 933921966X
6. Mike McGrath - C programming in easy step – Wiley publication I***SBN***-10: 1840785446

CS LAB: DSC 1A LAB: Lab Course on Essential of Computer and Programming in C-I
Credit -2

CS 103: LAB (Students should perform at least ten experiments from the following list)

Part –A Lab Course on Essentials of Computer

1. Introduction to Computer, Input devices, Output devices, Booting – POST.
2. Installation of Software and operating system
3. Introduction to Web Browsers
4. Creation of an e-mail account, sending and receiving emails with attachment
5. Searching information text, videos
6. How LAN work in laboratory, Sharing of Computer and printer in Network.

Part – B Lab Course on Programming in C-I

1. Program using standard input output Statements (getchar(),putchar(),gets(),puts()) and formatted input output statements.
2. Program to illustrate various operators like arithmetic, relational, logical, Conditional etc.
3. Program to illustrate various control statement (if, if-else, nesting if-else, Switch) at least one program on each control statement.)
4. Program using various loops (for, while, do-while, nested loops) (eg no. is palindrome, prime ,factorial, fibbonacci, Armstrong etc.)
5. To write sample program using goto, continue, break, and return statement.
6. Program using 1-D and 2-D arrays.

Semester -II

Computer Science-DSC 1 B: (Credits: Theory-04, Practicals-02)

CS 201: Internet Computing

Theory: 30 Hours

Unit-1 Introduction to Website: [H: 05]

1.1. Web page and its types
1.2.Website and Types of Website
1.3 What is Navigation?
1.4 Web Process Model- Modified Waterfall Model, JADModel

Unit-2 Introduction to HTML Programming: [H: 09]

2.1 Introduction and features of HTML
2.2 Structure of HTML Document
2.3 Text Formatting Tags and Character Entity References
2.4 List Tags
2.5 Anchor Tag
2.6 Image Tag
2.7 Map Tag
2.8 Table Tags
2.9 Media Elements: Audio tag, Video tag

Unit 3:- Forms and Frames in Html [H: 06]

3.1. Frame in HTML
3.2. Form Tag with Form elements and Form methods
3.3. Script Tag

Unit-4 Introduction to CSS [H: 5]

4.1. What is CSS
4.2. Types of Style sheet (Internal, External, and Inline)
4.3. Syntax of CSS with Example
4.4. Selectors (Class, ID, Group, Element)

Unit 5: CSS Properties [H:05]

5.1 CSS Background
5.2 CSS colors
5.3 CSS Font
5.4 CSS Text
5.5 CSS Links
5.6 Opacity Property

References:

1. Thomas A. Powell, “The Complete reference –Web Design”, Second Edition, TMH, ISBN:0-07-041186.
2. Internet in easy steps By Dremtech press.
3. James L. Mohler, “How to become web master in 14 days” TechMedia, ISBN:81-
4. E.Stephen Mack &Janan Platt, “HTML 4.0” BPB publication, ISBN:9780782121438
5. Thomas A. Powell, “The Complete reference HTML & CSS ”, Fifth Edition, TMH,

Computer Science-DSC 1 B:
(Credits: Theory-04, Practicals-02)
CS 202: Programming in C-II **Theory: 30 Hours**

Unit-1 Function (7 Hrs., 20 M)
1.1 Definition and Need of Function
1.2 Declaration and Prototypes
1.3Function calling (Call by value, call by reference)
1.4 Function with return and Function with argument
1.5 Recursion
1.6 String Function: strcpy(), strlen(), strcmp(), strcat(), strrev()

Unit-2 Pointers (7 Hrs., 20 M)
2.1 Introduction
2.2 Address and arguments
2.3 Declaration, accessing value through a pointer
2.4 Operations on Pointers: Pointers and Arrays, Array of Pointer, Pointer to Function, Pointer to pointer
2.5 Dynamic memory allocation and releasing dynamically allocated memory.

Unit-3 Structure and union (5 Hrs., 20 M)
3.1 Introduction, Declaration and accessing of structure and union
3.2 Need of structure and union
3.3 Nested structure
3.4 Self Referential Structure
3.5 Array of structure, typedef

Unit-4 Graphics (5 Hrs., 15 M)
4.1 Introduction to Graphics in C
4.2 Graphics functions: Initgraph(), putpixel(),closegraph(),outtextxy(), setcolor(),line(),circle(),rectangle(),ellipse(),arc(), bar()

Unit-5 File handling in C (6 Hrs., 15 M)
5.1 Concept of files, records, field
5.2 Various mode of file opening and closing files.
5.3 File Processing putc(), getc(), getw(), putw() etc. -fopen() , fclose(),fprintf(),fscanf()
5.4 Command line arguments

References:-

1. Denis Ritchie. “C” Programming – Prentice Hall Software Series- ***ISBN***. 10 9 8 7
2. Yashwant P. Kanetkar – ANSI C, BPB publication. ***ISBN***: 9788183333245
3. Byron Gottfried – Programming with C –Tata McGRAW-Hill ***ISBN***-10: 0070145903
4. Yashwant P. Kanetkar -Understanding pointers in “C” -BPB publication. ***ISBN***-13: 978-8176563581
5. E.Balguruswami -Programming in ANSI- C- Tata McGRAW-Hill- ***ISBN***-10: 933921966X
6. Mike McGrath - C programming in easy step – Wiley publication I***SBN***-10: 1840785446

CS LAB: DSC 1A LAB: Lab Course on Essential of Computer and C Programming

Credit -2

CS 203: LAB (Students should perform at least ten experiments from the following list)

Part-A Lab Course on Internet Computing

1. Demonstration of the Basic Tags of HTML
2. Demonstrate the List Tags
3. Design Web Page showing information of your college using various text-
4. Formatting tags.
5. Design Web Page to create image gallery using image and link tags.
6. Demonstrate the use of Audio tag.
7. Demonstrate the use of Video tag.
8. Demonstrate the use of Table tag.

Part-B Lab Course on C-Programming-II

1. Program to illustrate concept of function (call by value, call by reference, recursive)
2. Write program using Function with return and Function with argument
3. Program using user defined function to find length of string
4. Write the program using std. string functions(like strlen(). strcat(),strcmp(), strrev(), strcpy()etc.)
5. Program using pointers (arrays, functions, structures)
6. Program using structures (at least two practical)
7, Program using graphics function (at least two practical using all graphics functions)

KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY, JALGAON

Faculty of Science and Technology

Syllabus for S. Y. B. Sc.
(Semester CBCS Pattern)

Computer Science
(w. e. f. June 2019)

Details about the courses for S.Y.B.Sc. Computer Science Under CBSC Pattern

<table>
<tr><th rowspan="2">Semester</th><th colspan="2">Core Course</th><th rowspan="2">Number of Credits</th><th rowspan="2">Hours per Semester</th><th rowspan="2">Work Load</th><th colspan="2">Marks</th></tr>
<tr><th>Course Code</th><th>Course Title</th><th>INT</th><th>EXT</th></tr>
<tr><td rowspan="5">Sem-III</td><td rowspan="3">CS-DSC 2 C (Credits: Theory-04, Practical-02</td><td>Data Structure-I</td><td>2</td><td>30</td><td>2+1</td><td>40</td><td>60</td></tr>
<tr><td>Programming in C++ - I</td><td>2</td><td>30</td><td>2+1</td><td>40</td><td>60</td></tr>
<tr><td>Practical Course</td><td>2</td><td>60</td><td>4</td><td>40</td><td>60</td></tr>
<tr><td>CS SEC-I (Skill Enhancement Course-I)</td><td>Software & Hardware Installation Skills</td><td>2</td><td>30</td><td>2+1</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">ENG/MAR Communication-I (Ability Enhancement course III)</td><td>2</td><td>30</td><td>2</td><td>40</td><td>60</td></tr>
<tr><td rowspan="5">Sem-IV</td><td rowspan="3">CS-DSC 2 D (Credits: Theory-04, Practical-02</td><td>Data Structure-II</td><td>2</td><td>30</td><td>2+1</td><td>40</td><td>60</td></tr>
<tr><td>Programming in C++-II</td><td>2</td><td>30</td><td>2+1</td><td>40</td><td>60</td></tr>
<tr><td>Practical Course</td><td>2</td><td>60</td><td>4</td><td>40</td><td>60</td></tr>
<tr><td>CS SEC-II (Skill Enhancement Course-II)</td><td>Network Security</td><td>2</td><td>30</td><td>2+1</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">ENG/MAR Communication - II (Ability Enhancement course III)</td><td>2</td><td>30</td><td>2</td><td>40</td><td>60</td></tr>
</table>

KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY, JALGAON

Syllabus for

S. Y. B. Sc.
(Semester Pattern)

Computer Science
(w. e. f. June 2019)

Faculty of Science and Technology

Note :-
1. Each period is of 60 minutes duration.
2. Each course is having weightage of two periods per week.
3. Each practical course is having weightage of four periods per week.
4. Question paper will be of 90 marks; students have to attempt 60 marks.

Sem - I Paper - I

Theory: 30 Hours

CS-DSC 2 C : COMP 211 : Data Structure – I

Unit 1. Introduction to Data Structure & Algorithm Notations **(L:04, M: 18)**

1.1 Introduction to Data Structure,
1.2 Types of data structure 1. Primitive 2.Non Primitive 3.Linear 4. Non linear
1.3 Need of data structure
1.4 Algorithm Notations.
  a. Format Convention
  b. Name of Algorithm
  c. Introductory Comment
  d. Steps
  e. Comments
1.5 Data Structure
  a. Arrays
  b. Dynamic Storage allocation
  c. Functions
  d. Procedures

Unit 2. Introduction to Algorithm analysis for Time and Space Requirement **(L:04, M:12)**

2.1 Rate of Growth
2.2 Basic time analysis of an algorithm
2.3 Order Notation
2.4 More timing Analysis
2.5 Space analysis of an algorithm

Unit 3. Stacks **(L: 06, M:18)**

3.1 Definition and concept
3.2 Representations – static
3.3 Operations – push, pop, peep, change
3.4 Applications – infix to postfix & prefix, postfix evaluation, Recursion using stack

Unit 4. Queues **(L: 06, M :18)**

4.1 Definition and Concept
4.2 Representation – static
4.3 Operations- Insert, Delete
4.4 Circular queue : Concept, Operations – insert, delete
4.5 DeQue : Concept
4.6 Priority queues : Concept

Unit 5. Linked List **(L: 10, M: 24)**

5.1 Introduction to Linked list
5.2 Implementation of List – Dynamic representation.
5.3 Types of Linked List
  a. Singly Linked list : Operations- Insert, delete, search
  b. Circular linked list : Operations- Insert, delete, search
  c. Doubly linked linear list : Operations- Insert, delete, search
5.4 Applications of linked list – polynomial manipulation

References :

1. Jean-Paul Trembley, Paul. G. Soresan, An introduction to data structures with applications, Mc-Graw Hill International Editions, ISBN-13: 978-0070651579,ISBN-10: 0070651574

2. Horowitz, Sahani, Data Structures :Galgotia publication
3. Aho, Hopcroft, Ulman, Data Structures and Algorithms, ISBN-13: 978-0201000238 ,ISBN-10: 0201000237

4. Nikaulus wirth, Algorithms- Data Structures Programs, ISBN-13: 978-0130224187,ISBN-10: 0130224189

5. Tannenbaum, Data Structures using C and C++; PHI., ISBN-13: 978-0130369970,ISBN-10: 0130369977

6. Thoms Horbron, -File systems – Structures and Algorithms; PHI. I
7. Bonald Knuth, - Art of Computer Programming Vol. I;, ISBN-13: 978-0201896831,ISBN-10: 9780201896831

Sem - I Paper - I

CS-DSC 2 C **Theory: 30 Hours**

CS-DSC 2 C : COMP-212 : Programming in C++-I

Unit 1.IntroductiontoC++ **(6 L,18M)**

1.1Basics of C++, Structure of C++ Program

1.2 keywords in C++,Data types hierarchy in C++

1.3 Operators in C++, Scope resolution operator, Insertion and Extraction operator, New and Delete operators, reference operators.

1.4 Manipulators : endl, setw, setfill,set precision.

Unit 2. Classes and objects **(8 L, 18M)**

2.1 Classes, object, Specifying a class, Access specifiers, Class members

2.2 Defining member functions: Inside and Outside the class definition

2.3 Creating objects.

2.4Array of objects , Pointer and object ,Array of pointer to object.

Unit 3 .Functions in C++

3.1 Basics of function and its need. **(6L,18M)**

3.2 Functions Prototype.

3.3 Call by value, Call by reference with object.

3.4 Functions with default arguments.

3.5 Inline function.

3.6 friend function, friend class.

Unit 4 .Function Overloading **(4L,18M)**

4.1 Concept of Polymorphism

4.2 Function overloading, function overloading with arguments

4.3 Scoping rules & features of function overloading.

Unit 5. Operator Overloading **(6 L,18M)**

5.1 Introduction to operator overloading, rules of operator overloading

5.2 Operator overloading:

- 5.2.1 Unary and binary operators,
- 5.2.2 Comparison, arithmetic, assignment operator,
- 5.2.3 Overloading new & delete operators

Reference Books:

1. Object oriented programming with C++, E Balgurusamy, **ISBN**-10: 9383286504; **ISBN**-13: 978-9383286508
2. Programming with C++ D Ravichandran, **ISBN**, 0070681899, **97800706**
3. Programming in C++ by John H Hubbard, **ISBN**-10: 0071353461
4. Mastering C++ by K Venugopal, Rajkumar, T Ravishankar, **ISBN**-10/ASIN: 0074634542

CS SEC-I (Skill Enhancement Course-I)

Theory: 30 Hours

Software & Hardware Installation Skills

Unit-1. Operating System Basics & Installation 6 L

Introduction to OS, Types of Operating systems, System files FAT and NTFS Dos 6.22, Windows 7 and RedHat Linux and Multi Boot Operating System.

Unit-2. Various types of Software Installation 6 L

MS-Office 2010, Photoshop 7 and CS5, Tally 7.0 and ERP, Acrobat Reader X, Java, Visual Studio, C & C++, Multimedia software's, and Internet Browsers like- IE9, Google Chrome, Mozilla Firefox .

Unit-3. Device Installation 6 L

Graphics Card, Sound Card, LAN Card, Wireless LAN Card, SCSI Card, External Drive, Flash Cards, Web Camera, CCTV Camera, Mobile Devices, Firewire Cards, Modem, Plotter, Wireless LAN, Access Point .

Unit-4. Diagnostic Tools & PC Maintenance 6 L

Introduction, Virus and its types, Effect of Virus for Computer System, Scanning and Antivirus remover tools, Antivirus Utilities for Diagnostic, Safety and Preventive Maintenance Tools, Data Recovery, Troubleshooting PC Hardware:- O/S Troubleshooting issues in computer System (Related Diagnostic Tools should be covered)

Unit-5 Basic Network Introduction & Installation 6 L

Introduction About Network, Installing Network Operating System Server and Windows 2008 Server, Cable Crimping, Network Sharing and user Permission, Internet Connection, E-Mail, Cloud Networking, Google Drive, SkyDrive, Dropbox etc.

REFRENCE BOOK:

(1) Windows XP Professional edition complete BPB Publication

(2) Office XP complete BPB publication

(3) Microsoft Windows Server 2008 Administration by STEVE SEGUIS, Mc Graw Hill Publication, **ISBN** 10: 0071493263 **ISBN** 13: **9780071493260**.

(4) Upgrading and Repairing PC by Scott Muller, **ISBN**-13: 978-0789756107,**ISBN**-10: 9780789756107

(5) https://www.makeuseof.com/tag/13-windows-diagnostics-tools-check-pcs-health/

Software & Hardware Installation Skills (SEM- I)

Practical (Demonstration to be performed in the Laboratory)

1. Installation : Windows 7 Operating Systems
2. Troubleshooting and Repair Operating System : Windows 7
3. Tacking Data Backup and System Formatting
4. Installation of Different Device and Drivers PCI, PCI-E, AGP
5. Installation of Ms-Office 2010
6. Installation of On Board and PCI Device Driver
7. Installation of Web Camera and CCTV Camera Drivers and Software
8. Installation of Application Software : Photoshop 7.0 , Tally
9. Installation Dual Operating System like: Windows XP and Windows 7
10. Installation and Troubleshooting of Laser Printer
11. Installation and Troubleshooting of Scanner (Photo & Bar Code Scanner)

12. To Run All Types of Network Troubleshooting Command

Sem I Paper III

CS-DSC 2 C: Lab Course on COMP 213 : PRACTICAL COURSE

PRACTICALS BASED ON DATA STRUCTURE : I

(Note :Implement all practical using 'C++' Language)

1.Write a program to implement Stack operations : push, pop, peep, change, Display

2.Write a program to convert given infix expression into postfix.

3.Write a program to implement Linear Queue operations : Insert, Delete, Display

4. Write a program to implement Circular queue with its operations: Insert, Delete, Display

5.Write a program to implement singly linked list with operations.

i)create ii)insert iii)delete iv)find

6. Write a program to implement doubly linked list with operations.

i)create ii)insert iii)delete.

PRACTICALS BASED ON C++ PROGRAMMING-I

1. Write a program to demonstrate all manipulators in C++.
2. Demonstrate the memory management operators: new, delete
3. Write a program to demonstrate the simple class for following objects

i) Student Information (Define function inside the class)

ii) Employee Information (Define function outside the class)

4. Write a C++ program to demonstrate the array of objects.
5. Write a C++ program to demonstrate inline function
6. Write a C++ program to demonstrate friend function
7. Write a C++ program to demonstrate

i) Function overloading. ii) Operator overloading

Sem – II Paper – I

Theory: 30 Hours

CS-DSC 2 D : Comp-221: Data Structure – II

Unit 1. Tree **(L: 10, M :23)**

1.1 Definition and Concept
1.2 Binary tree
1.3 Storage representation and Manipulation of Binary trees
    a. Sequential Storage representation of Binary Tree
    b. Linked Storage representation of Binary Tree
    c. Threaded storage representation of Binary Tree
1.4 Operations on Binary tree - Traversing
1.5 Operations & Algorithms on BST – Create, Insert, Delete
1.6 Concept: AVL tree. B- Tree

Unit 2. Graph **(L: 05, M:21)**

2.1 Definition and Concept
2.2 Matrix representation of graph
2.3 List Structures
2.4 Multi list representation of Graph
2.5 Traversal of graph : Breadth First Search and Depth First search
2.6 Applications of graph

Unit 3. Sorting **(L:10, M :28)**

3.1 Introduction
3.2 Sorting Techniques :
3.2.1 Selection Sort
3.2.2 Insertion sort
3.2.3 Bubble Sort
3.2.4 Merge Sort
3.2.5 Heap Sort
3.2.6 Quick Sort
3.2.7 Sorting Method Comparison on Time and space Complexity attribute

Unit 4. Searching Techniques **(L:05, M:18)**

4.1 Sequential Searching
4.2 Binary searching
4.3 Hash Table Method
4.3.1 Introduction
4.3.2 Hashing Function
4.3.3 Collision Resolution Technique

References :

1. Jean-Paul Trembley, Paul. G. Soresan, An introduction to data structures with applications, Mc-Graw Hill International Editions, ISBN-13: 978-0070651579,ISBN-10: 0070651574

2. Horowitz, Sahani, Data Structures :Galgotia publication

3. Aho, Hopcroft, Ulman, Data Structures and Algorithms, ISBN-13: 978-0201000238 ,ISBN-10: 0201000237

4. Nikaulus wirth, Algorithms- Data Structures Programs, ISBN-13: 978-0130224187,ISBN-10: 0130224189

5. Tannenbaum, Data Structures using C and C++; PHI., ISBN-13: 978-0130369970,ISBN-10: 0130369977

6. Thoms Horbron, -File systems – Structures and Algorithms; PHI. I

7. Bonald Knuth, - Art of Computer Programming Vol. I;, ISBN-13: 978-0201896831,ISBN-10: 9780201896831

Sem – II Paper – II

Theory: 30 Hours

CS-DSC 2 D : COMP-222 : Programming in C++-II

Unit 1. Constructors and Destructors (6 L, 20 M)

3.1 Concept of Constructor.
3.2Types of Constructor: Default Constructor, Parameterized Constructor, Copy Constructor.
3.3Overloaded Constructors in a class.
3.4Constructor with default arguments.
3.5 Destructors.

Unit 2. Inheritance and Extending Classes (10L, 20M)

2.1 Introduction to Inheritance
2.2 Types of Inheritance
2.3 Derived Class Constructors
2.4 Benefits of inheritance in C++
2.5this pointer.
2.6Abstract class, pure virtual function.

Unit 3. Exception Handling (4L,14M)

3.1Concept of Exception Handling mechanism
3.2 Concept of try, throw and catch
3.3 Multiple catch statements
3.4 Standard Exception in C++

Unit 4. Templates & Introduction to Standard Template Library (4L, 18M)

4.1Basic of templates, Function templates, Class templates
4.2 Templates with multiple parameter
4.3 Introduction to STL,
4.4Components of STL, Containers (Sequence, Associative & Derived)

Unit 5. Working with Files (6 L,18 M)

5.1 Introduction
5.2 Hierarchy of File Stream Classes.
5.3 Opening and Closing Files.
5.4 File modes
5.5 File Input/output with fstream class.

Reference Books:

1Object oriented programming with C++, E Balgurusamy, **ISBN**-10: 9383286504; **ISBN**-13: 978-9383286508

2. Programming with C++ D Ravichandran, **ISBN**, 0070681899, **97800706**

3. Programming in C++ by John H Hubbard, **ISBN**-10: 0071353461

4. Mastering C++ by K Venugopal, Rajkumar, T Ravishankar, **ISBN**-10/ASIN: 0074634542

CS SEC-II (Skill Enhancement Course-II)

Theory: 30 Hours

Network Security

Unit-1. Introduction 5 L

Need of Security, Security approaches, Principles of Security , Anti-virus Software, Access Control, Firewall, Smart cards, Biometric, Encryption, Physical Security Mechanisms .

Unit-2. Malicious Software 5 L

Types of Malicious Software , Viruses , Virus Countermeasures , Worms , Distributed Denial of Service Attacks,

Unit-3. Types of Attack 5 L

Snooping, Eavesdropping, Interception, Denial of Service attack, Hacking Techniques – Open Sharing, Bad Passwords, Programming Flaw, Sniffing Switch Network, IP Spoofing.

Unit-4. Firewalls 6 L

The Need for Firewalls , Firewall Characteristics , Types of Firewalls , Firewall Basing , Firewall Location and Configurations

Unit 5. Intrusion Detection System (IDS) 4 L

Introduction; IDS limitations – teardrop attacks, counter measures; Host based IDS set up

Unit-6. System security 5 L

Operating system hardening, general steps for securing windows operating system, Hardening Unix/Linux based operating system, updates: hot fix, patch, service pack

(* Delivery of Basic & practical knowledge of above topics is expected)

References :

1. Fundamental of Network Security – Eric Maiwald **ISBN**-10: 0072230932
2. Cryptography and Network security – Atul Kahate, **ISBN**-10: 0070151458
3. Cryptography and Network security- 5th Edition, William stalling, **ISBN**: 9788131761663

Practical Based on Network Security(Demonstration to be performed in the Laboratory)

1. Demonstration of Malware for using any Antivirus software
   - Viruses
   - Worms
   - Intrusion Tools
   - Spyware using
2. Secure Client of Network by using various permissions as well as password protection.
3. Apply Firewall rules for Inbound and Outbound services.
4. Create user groups and perform various roles for securing Network
5. Demonstration of securing Wireless Network.

Sem – II Paper – III
CS-DSC 2 D : Lab Course on COMP 223: PRACTICAL COURSE

PRACTICALS BASED ON DATA STRUCTURE: II
(Note: Implement all practical using 'C++' Language)

1. To Create a binary tree and Implement following Tree Traversal Techniques:
   i)Inorder ii) Preorder iii)Postorder.
2. Implement following Graph Search Techniques:
   i) BFS ii) DFS.
3. Implement Selection sort technique.
4. Implement Bubble sort technique
5. Implement Selection sort technique
6. Implement Insertion sort technique.
7. Implement Merge sort technique.
8. Implement Quick sort technique.
9. Implement: i) Linear Search ii) Binary Search

PRACTICALS BASED ON C++ PROGRAMMING-II

1. Write a C++ program to demonstrate following constructors and Destructor
   i) Default constructor ii) Parameterized constructor iii) Copy Constructor
2. Write a C++ program to demonstrate all types of Inheritances.
3. Write a C++ program to demonstrate the concept of virtual function.
4. Write a C++ program to demonstrate exception handling mechanism.
5. Write a C++ program to demonstrate:
   i) Function template ii) Class template.
6. Write C++ program to implement concept of file Handling.

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3^{rd} Cycle)

Choice Based Credit System (CBCS)

Syllabus For

T.Y.B.Sc.

Computer Science

(With effect from June 2020)

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon
T.Y.B.Sc. (Computer Science)
(w.e.f. June-2020)
Structure

Semester – V

Discipline	Course Type	Course Code	Course Title	Credits	Hours/Week (Clock Hours)	Total Teaching hours	Marks (Total 100)	
							CA	UA
DSC	Core I	CS - 501	System Programming	3	3	45	40	60
	Core II	CS – 502	Database Management System	3	3	45	40	60
	Core III	CS – 503	Software Engineering	3	3	45	40	60
	Core IV	CS – 504	Computer Aided Graphics	3	3	45	40	60
DSC Skill Enhancement Course (SEC)	Skill Based	CS – 505	Python Programming - I	3	3	45	40	60
DSC Elective Course	Elective Course (Any One)	CS – 506 (A)	**Elective –A** Internet Programming using PHP	3	3	45	40	60 60
		CS – 506 (B)	**Elective –B** JAVA Programming-I					
DSC	Core (Practical)	CS – Lab - 507	Lab on Python Programming - I	2	4 (per batch)	60	40	60
		CS – Lab 508	Lab on Computer Aided Graphics	2	4 (per batch)	60	40	60
		CS – Lab 509	**Elective –A** Lab on Internet Programming using PHP	2	4 (per batch)	60	40	60
			Elective –B Lab on JAVA Programming –I					
Non Credit Audit Course	Elective Audit Course (Any One)	AC – 501 (A)	NSS	No Credit	2	30	100	-----
		AC – 501 (B)	NCC					
		AC – 501 (C)	Sport					

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon
T.Y.B.Sc. (Computer Science)
(w.e.f. June-2020)
Structure

Semester – VI

Discipline	Course Type	Course Code	Course Title	Credits	Hours/Week (Clock Hours)	Total Teaching hours	Marks (Total 100)	
							CA	UA
DSC	Core I	CS - 601	Operating System	3	3	45	40	60
	Core II	CS – 602	R -DBMS	3	3	45	40	60
	Core III	CS – 603	Computer Network	3	3	45	40	60
	Core IV	CS – 604	Theoretical Computer Science	3	3	45	40	60
DSC Skill Enhancement Course (SEC)	Skill Based	CS – 605	Python Programming - II	3	3	45	40	60
DSC Elective Course	Elective Course (Any One)	CS – 606 (A)	**Elective –A** Web Programming using ASP.NET	3	3	45	40	60
		CS – 606 (B)	**Elective –B** JAVA Programming-II					60
DSC	Core (Practical)	CS – Lab - 607	Lab on Python Programming II	2	4 (per batch)	60	40	60
		CS – Lab 608	Lab on RDBMS	2	4 (per batch)	60	40	60
		CS – Lab 609	**Elective –A** Lab on ASP.NET **Elective –B** Lab on JAVA Programming II	2	4 (per batch)	60	40	60
Non Credit Audit Course	Elective Audit Course (Any One)	AC – 601 (A)	Soft Skill	No Credit	2	30	100	-----
		AC – 601 (B)	Yoga					
		AC – 601 (C)	Practicing Cleanliness					

Semester - V

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon
T. Y. B. Sc. (Computer Science)
(w.e.f. June -2020)
DSC (UG-CS-501) System Programming
Semester-V

Total lectures: 45
Total Marks: 90

Course Objectives:

- To understand use and development of software tools.
- To understand the design structure of Assembler and macro preprocessor
- To understand the design structure of compiler
- To understand the functions of linkers and loaders

Course Outcomes:

- Understand details about system software
- To do basic system program like development of editors lexical analyzers etc
- Students are familiar with language processing activities- functions of translators, loader and linkers

Unit-1 Introduction [L: 05, M: 10]
1.1 Types of program – System program and Application program
1.2 Difference between system programming and application programming.
1.3 Goal of system software
1.4components of system software
1.5 View of system software
Unit-2 Software Tools [L: 05, M: 10]
2.1 What is a Software Tools?
2.2 Software Tools for Program Developments
2.3 Editors
2.4 Debug Monitors
2.5 Programming Environments
Unit-3 Overview of Language Processors [L: 5, M:12]
3.1 Programming Languages and Language Processors
3.2 Language Processing Activities
3.3 Fundamentals of Language Processing
Unit-4. Assembler [L:10,M:16]
4.1 Definition.
4.2 Features of assembly language, advantages
4.3 Statement format, types of statements
4.4 Constants and Literals.
4.5 Advanced assembler directives
4.6 Design of assembler – Analysis Phase and Synthesis Phase.
4.7 Overview of assembly process
4.8 Pass Structure of Assembler – One pass, two pass assembler.
4.9 Problems of One-pass assembler
4.10 Design of Two-pass Assembler
Unit-5. Macro and Macro Preprocessor [L: 05, M: 14]
5.1 Macro Definition and Call

5.2 Macro Expansion
5.3 Nested Macro Calls
5.4 Tables used in Macro
5.5 Advanced Macro Facilities
5.6 Design of Macro Preprocessor

Unit-6. Compiler [L: 10, M:14]

6.1. What is Compiler?
6.2. Scanning and Parsing
6.2.1. Programming Language Grammars
6.2.2. Scanning
6.2.3. Parsing
6.3. Language Processors Development Tools

Unit-7. Linkers and Loaders [L: 05, M: 14]

7.1 Introduction
7.2 Relocation and Linking Concepts
7.3 Self Relocating Programs
7.4 Linking for Overlays
7.5 Dynamic Linking
7.6 Loaders

References:

1. D.M. Dhamdhere, “Systems Programming”, ISBN : 9780071333115, Tata McGraw-Hill Education, 2011
2. D.M. Dhamdhere, “Systems programming and operating system”. ISBN: 978-0074635797, Tata Mcgraw Hill Education Private Limited
3. John Donovan, “System programming.”, ISBN: 978-0-07-46

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon
T. Y. B. Sc. (Computer Science)
(w.e.f. June-2020)
DSC (UG-CS-502): Database Management System
Semester-V

Total lectures: 45
Total Marks: 90

Course Objectives

- To understand the fundamental concepts of database.
- To understand user requirements and frame it in data model.
- To understand creations, manipulation and querying of data in databases.

Course Outcomes

On completion of the course, student will be able to–

- Solve real world problems using appropriate set, function, and relational models.
- Design E-R Model for given requirements and convert the same into database tables.
- Use SQL.

Content

1. Introduction of DBMS **L 12: M 16**

1.1. Overview, Definition
1.2. Types of DBMS
1.3. Describing & storing data (Data models (relational,hierarchical, network)),
1.4. Levels of abstraction , data independence,
1.5. Queries in DBMS (SQL : DDL,DML,DCL,TCL), Users of DBMS, Advantages of DBMS

2. Conceptual Design (E-R model) **L 10 : M 16**

2.1. Overview of DB design,
2.2. ER data model (entities, attributes, entity sets, relations, relationship sets) ,
2.3. Conceptual design using ER (entities VS attributes, Entity Vs relationship, binary Vs ternary)

3. Relational data model **L 10 : M 18**

3.1. Relations (concepts, definition),
3.2. Conversion of ER to Relational model ,
3.3. Integrity constraints (key, referential integrity, general constraints)
3.4 Codd's Rules, Functional Dependency, Data Normalization (1NF, 2NF, 3NF, BCNF)

4. Relational algebra **L 08 : M 15**

4.1. Preliminaries
4.2. Relational algebra (selection, projection, set operations, renaming, joins, division)

5. Database Implementations **L-08 M:12**

5.1 Database security
5.2 Database integrity
5.3 Transaction Concept
5.4 Transaction State

5.5 Transaction Properties (ACID)

6. Concurrency control, Backup & recovery:- **L-09** **M-12**

6.1Lock-Based protocol,

6.2 Timestamp-Based protocol

6.3 Log base Recovery

6.4 Shadow Paging

6.5 Differed Updates.

Reference Books:-

1. Database System Concepts- Abraham Silberschatz, Henry F. Korth& S. Sudarshan,McGraw- Hill, 4th Edition / 5th Edition.

2. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, Fifth Edition, Pearson Education/Addison Wesley, 2007.

3. Database System Concepts – Alexis Leon & Mathews leon, Vikas Publication House Ltd, New Delhi.

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T. Y. B. Sc. (Computer Science)
(w.e.f. June-2020)
DSC (UG-CS-503)Software Engineering
Semester-V

Total lectures: 45
Total Marks: 90

Course Objective:
This paper helps to understand

- What is software and the process in development of software.
- It gives detailed knowledge about various models and requirements needed in developing software.
- It also elaborates the concepts of designing, testing & quality about software.

Course Outcomes:
After completion of the course:

- Students are able to perform the E-R Diagram, DFD, Data dictionary, Decision tree about software.
- They can also design the software in learned language using the course content.
- Get the knowledge of types of testing & how testing is performed in industry.

1. Introduction to Software Engineering **L-8 M-12**

1.1 Software and Software Engineering
1.2 Evolution of Software
1.3 Software Characteristics
1.4 Software Applications
1.5 Software Myths
1.6 Software Process
1.7 Software Development Life Cycle (SDLC)

2. Software Development Model **L-8 M-14**

2.1 Waterfall Model
2.2 Prototyping Model
2.3 Incremental Development Model
2.4 RAD model
2.5 Spiral Model

3. Requirement Analysis and Specification **L-8 M-12**

3.1 Requirements Engineering
3.2 Fact finding Techniques
3.3 Introduction to Types of Requirement Modeling
3.4 Data Modeling Concepts- Data Objects, Data Attributes & Relationship.

4. Design Engineering **L-7 M-14**

4.1 Characteristics of good Software Design
4.2 Design Concepts- Architecture, Modularity, Information Hiding
4.3 Cohesion & Coupling
4.4 Decision Table & Decision Tree
4.5 Data flow Diagram
4.6 Data Dictionary

5. Software Coding & Testing **L-7 M-12**

5.1 Coding standards & Guidelines

5.2 What is testing?
5.3 Testing Activities
5.4 Black box testing
5.5 White box testing
5.6 Introduction to Debugging Approaches – Brute force Method, Backtracking, Case Elimination Method, Programming Slicing

6. Software Quality **L-7 M-12**

6.1 What is Quality?
6.2 Software Quality - Garvin's quality dimensions, Mc Calls quality factors, ISO 9125 quality factors
6.3 Elements of Software Quality Assurance
6.4 ISO 9000 & Certification

References –

1. Roger S. Pressman , "Software Engineering a Practitioners Approach", ISBN 13: 9780071267823, 7 th edition, McGraw Hill International Edition.
2. Rajib Mall , "Fundamental of Software Engineering", ISBN- 978-81-203- 3819-7 3 RD Edition, , PHI Learning Private Limited.

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DSC (UG-CS-504): Computer Aided Graphics
Semester-V

Total lectures: 45
Total Marks: 90

Course Objectives

- Understanding Graphics Concept.
- Study the various graphics techniques
- Study the various graphics algorithms

Course Outcome:

- Differentiate between interactive and non-interactive graphics.
- Study line Drawing and Circle Drawing techniques and algorithms.
- Perform 2D and 3D transformation on different images.
- Know about detail working of 2D and 3D clipping and windowing.
- Understand raster graphics and hidden surface elimination.

Unit-1: Introduction to Graphics **[L:08 M:16]**

1.1 The origin of computer graphics
1.2 Application of Computer Graphics
1.3 Definitions: Pixel, Resolution, Aspect Ratio, Interactive, Non interactive graphics, Active graphics, Passive graphics
1.4 How the interactive graphics display works.
1.5 Display types: Random Scan and Raster Scan

Unit-2: Line Drawing Technique **[L:07 M:14]**

2.1 Co-ordinate Systems
2.2 The Simple DDA
2.3 The Symmetrical DDA
2.4 Bresenham's line drawing Algorithm
2.5 Bresenham's circle drawing Algorithm

Unit-3: Two Dimensional and Three Dimensional Transformations **[L:08 M:20]**

3.1 Transformation principles
3.2 Concatenations
3.3 2D Transformations, 2D Matrix Representation
3.4 3D Transformations, 3D Matrix Representation
3.5 Transformation in Viewing
3.6 The Perspective Transformation

Unit-4: Clipping and Windowing **[L:09 M:16]**

4.1 Definitions: Window, View port, Clipping
4.2 Cohen-Sutherland line clipping algorithm
4.3 Mid-point Subdivision line clipping algorithm
4.4 Polygon Clipping
4.5 The Windowing Transformation
4.6 3-D Clipping

Unit-5: Raster Graphics and Solid Area Scan-Conversion **[L:07 M:12]**

5.1 Introduction
5.2 Scan Converting Line and Polygon drawing
5.3 Coherence
5.4 (YX) Algorithm
5.5 Priority: Painter's Algorithm

Unit-6: Hidden Surface Elimination **[L:06 M:12]**

6.1 Object Space and Image Space Algorithms
6.2 The Depth Buffer Algorithm
6.3 Warnock's Algorithm

Reference:

1. William M. Newman and Robert F. Sproull, "Principles of Interactive Computer Graphics", ISBN : 9780074632932 (Second Edition), Tata-McGraw Hill Publication
2. Rogers," Procedural Interactive Computer Graphics", ISBN- 978-070486775, McGraw Hill Book Company Ltd.
3. Mathematical Elements of Interactive C.

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DSC SEC(UG-CS-505)Python Programming – I
Semester-V

Total lectures: 45
Total Marks: 90

Course Objectives:

- The course is designed to provide Basic knowledge of Python.
- Python programming is intended for software engineers, system analysts, program managers and user support personnel who wish to learn the Python programming language.
- To learn how to design and program Python applications.
- To develop problem solving skills and their implementation through Python.
- Master the fundamentals of writing Python scripts

Course Outcome: **At the end of the course, the student will be able to**

- Explain basic principles of Python programming language
- Construct and apply various filters for a specific task.
- Apply the best features of mathematics, engineering and natural sciences to program real life problems.

Unit – 1 Introduction to Python Programming L: 5 M:10

- **Introduction to Python**
- History of Python
- Version of Python
- Need, Featuresof Python
- Applications of Python
- Installing Python on Linux and Windows
- Installing Python IDE

Unit – 2Basics of Python Programming L:10 M: 20

- Python Identifiers, Variables and Keywords
- Putting Comments
- Expressions and Statements
- Standard Data Types – Basic, None, Boolean, Numbers.
- Type Conversion Function
- Operators in Python
- Operator Precedence
- Accepting Input and Displaying Output

Flow Control Statements

- Conditional Statements
- Looping Statements
- break, continue, pass Statements

Unit – 3Python Strings L: 10 M: 20

- Introduction to String
- String Literals
- Assign String to a Variable
- Multiline Strings
- Operations on Strings, Index Operator: Working with the Characters of a String, String Methods, Length, The Slice Operator, String Comparison,
- **Concepts of Python Lists:** Creating, Initializing and Accessing elements in lists, Traversing, Updating and deleting elements from Lists.
- List Operations: Concatenation, List Indexing, Slices
- Built- in List functions and methods
- Aliasing, Cloning Lists

Unit – 4Python Tuples and Dictionary L: 10 M: 20

Introduction to Tuples

- Creating Tuples.
- Deleting Tuples.
- Accessing elements in a Tuple.
- Tuples Operations: Concatenation, Repetition, Membership, Iteration.
- Built- in Tuples functions and methods

Introduction to Dictionary

- Dictionaries: Concept of key-value pair.
- Creating, Initializing and Accessing elements in a Dictionary.
- Traversing, Updating and Deleting elements in a Dictionary
- Built- in Dictionary functions and methods

Unit – 5Python Functions and ModulesL: 10 M: 20

Introduction to Functions

- Defining a Function (def)
- Calling a Function
- Function Arguments - Required arguments, Keyword arguments, Default arguments, Variable-length arguments
- Scope of Variables
- Void functions and function returning values
- Recursion
- Advance Function Topics: Anonymous Function Lambda, Mapping Functions, Functional Programming Tools: filter and reduce

Introduction to Modules

- Creating Modules and Packages
- Importing Modules
- Using the dir() Function
- Built-in Modules

References:

1. John V Guttag (2013), Introduction to Computation and Programming Using Python, Prentice Hall of India, 2013, ISBN: 9780262525008
2. Peter C. Norton, Alex Samuel and others, ―Beginning Python‖, Wrox Publication,2005 ISBN 10: 0764596543 ISBN 13: 9780764596544
3. R. NageswaraRao(2016), Core Python Programming, Dreamtech Press, 2016, ISBN-13: 9789351199427
4. Wesley J. Chun(2006), Core Python Programming - Second Edition, Prentice Hall, ISBN-13: 978-0132269933, ISBN-10: 0132269937
5. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser(2013), Data Structures and Algorithms in Pyhon", Wiley, 2013, ISBN : 978-1-118-54958-2, ISBN : 978-1-118-29027-9(HardCover)
6. Kenneth A. Lambert(2011), Fundamentals of Python – First Programs, CENGAGE Publication, 2011, ISBN 1111822700, ISBN 9781111822705
7. Luke Sneeringer(2015), Professional Python, Wiley Inc.,2015, ISBN: 1119070856

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DSC (UG-CS-506 A):Elective A - Internet Programming using PHP
Semester-V

Total lectures:45
Total Marks: 90

Objectives:

- To understand Core-PHP concepts, Server Side Scripting Language
- To acquaint knowledge of Database handling in PHP.

Outcomes:

- To Design dynamic and interactive Web pages.
- PHP framework for effective design of web applications.

Unit–1 The BasicsofPHP L:12M:24

- Introduction toPHP
- Working of PHP
- Structure ofPHP
  - Structure & Syntax of PHP
  - PHP withHTML
  - Comments
  - Data Types andVariables
  - Operators
- Flow ControlStatements
  - ConditionalStatements
  - Looping Statements
  - Exit, Return, Die, Include and RequireStatements

Unit – 2 Arrays, FunctionandString L:10 M:20

- Introduction toArray
  - Types ofArray: Index, Associative, MultidimensionalArray
  - Different array function inPHP
  - Traversing arrays, Sorting arrays
- Introduction toFunction
  - Defining and Calling afunction
  - Scope of variables infunction
  - Function Parameters
  - Returning Values from afunction

        - RecursiveFunctions
    - String functions inPHP
        - Printing functions
        - Comparing strings
        - Manipulating and Searchingstrings
    - RegularExpressions

Unit – 3Object-OrientedPHP **L:10 M:18**

- Introduction and Benefits ofOOPs in PHP
- Creating aClass in PHP
- Creating anObject in PHP
    - Adding aMethods
    - Adding aProperties
    - Visibility (Public, Private andProtected)
- Constructor andDestructors
- Inheritance (Extending aclass)
- Abstract classes, Finalclasses
- Interfaces
- Exception handling
- Serialization

Unit – 4WebTechniques **L:07 M:14**

- Introduction
- HTTPBasics
- ProcessingForms
    - Methods (Get and PostMethod)
    - Parameters ($_GET and$_POST)
    - Self-ProcessingPages
    - FileUploads
- Maintaining State
    - Cookies
    - Sessions
    - Combining Cookies andSessions

Unit – 5 PHPwithMySQL **L:06 M:14**

- Introduction toMySQL
- Interaction between PHP and MySQL
- Error Checking
- Execute DDLStatements
- Execute DMLStatements

References Books:

1. Ivan Bayross and Sharnam Shah , "PHP 5.1 for Beginners", ISBN: 9788184040753 SPD Publication 2007
2. Dave W. Mercer, Allan Kent, "Beginning PHP 5" ,ISBN: 978-0-7645-5783-5,Wrox publication , July2004.
3. W. Jason Gilmore , "Beginning PHP and MySQL",ISBN: 978-1-4302-3115-8, 3rd edition, Apress Publication.

4. RasmusLerdorfandKevin Tatroe, “ProgrammingPHP” ,ISBN: 978-1-56592-610-3, O'Reillypublication,2002.

5. Mastering PHP , BPB Publication.

6. PHP cookbook, O'Reilly publication.

Websites:

7. http://www.php.net.in/

8.http://www.w3schools.com

9.http://www.tutorialpoints.com

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Elective B
DSC (UG-CS-506B): JAVA Programming I
Semester-V

Total lectures: 45
Total Marks: 90

Course Objectives:

- To learn Object Oriented Design with JAVA
- Ability to write computer program to solve specific program
- To handle abnormal termination of a program using exception handling

Course Outcomes:

- Get knowledge of JDK environment
- Explore polymorphism using method overloading and method overriding
- Understand the different aspects of hierarchy of classes and their extensibility
- Understands the concept of streams and files
- Write programs for handling run time errors using exceptions

Unit-1 Introduction toJAVA **[L-04M-08]**

1.1 History ofJava

1.2 Comparison of Java and C++
1.3 Features - Simple, Object Oriented Distributed, Robust, Secure, Architecture neutral, Portable, Interpreted, High Performance, Multithreading,dynamic.
1.4 Java andInternet
1.5 JDK Environment (Java, Javac, Applet Viewer,Javadoc)

Unit-2 Basics of JAVA **[L-04M-10]**

2.1 Variables, Data Types, Casting, Operators
2.2 Compiling and running java program,
2.3 Command linearguments.
2.4 Accepting input from console (Using BufferedReaderclass,Scanner)
2.5Arrays

]Unit-3 Objects andClasses **[L-08M-14]**

3.1 Introduction – Classes andObjects
3.2 Data members,methods
3.3 Types of Constructors
3.4 Overloading
3.5 Packages
3.6 Accessmodifier
3.7 Innerclasses

Unit-4 FunctionsinJAVA **[L-07M-16]**

4.1 String functions - Concatenation, Substring, String editing, Testing forEquality,
4.2 Character extraction functions – CharAt, getChars, getByte
4.3 Formattingfunctions

4.4 Date and Time functions using Gregorian CalendarClass.

Unit-5Inheritance **[L-10 M-20]**

5.1 Inheritance- Inheritance Hierarchy, Super class, Overriding,Polymorphism
5.2 Use of final keyword related to method and class
5.3 Interfaces
5.4 Wrapperclasses
5.5 Reflection - 'Class'class
5.6 Use of abstract class and abstract methods

Unit-6Exception Handling **[L-06M-10]**

6.1 Dealing with errors - Types ofexceptions
6.2 Exception Handling Mechanism
6.3 Catching Exceptions.
6.4 Creating user defined exception

Unit-7 Streamsa n d Files [**L-06M-12]**

7.1 String class and StringBuffer Class
7.2 Using the File class
7.3 Stream classes-Byte Stream classes , Character Stream Classes
7.4 Creation of files
7.5 Reading/Writing characters and bytes
7.6 Handling primitive data types
7.7 Random Access files

References:

1. Cay’s Horstmann and Gary Cornell, “ Core Java Volume -1 Fundamentals”, ISBN: 81-7808-277-2
2. E. Balaguruswamy ,”Programming with Java – A primer”, ISBN: 978-0-07-061713-1
3. Herbert Schildt, “The complete reference JAVA-2”, ISBN:978-0-07-049543-2, Fifth Edition, (TMH)
4. Java 6 Programming Black Book

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(w.e.f. June-2020)
DSC UG-CS-507 LAB on Python Programming – I

Instruction:

- **At the time of Practical you can used any Python IDEs and Code Editors (PyCharm, Spyder, Thonny, etc.).**

1. Installing python and setting up environment. Simple statements like printing the names (“Hello World”), numbers, mathematical calculations, etc.
2. Write a program to find all prime numbers within a given range.
3. Write a program to print "n" terms of Fibonacci Series using Iteration
4. Write a program to demonstrate the use of slicing in string.
5. Programs related to string manipulation
6. Write a Programs related to functions & modules
7. Write a program that demonstrate concept of functional programming.
8. Write a program to demonstrate the use of list & related functions
9. Write a program to demonstrate the use of Dictionary& related functions
10. Write a program to demonstrate the use of tuple.

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DSC UG-CS-508: LAB on Computer Aided Graphics
Semester-V

Course Objectives

- To know how to implement Graphics Programs.
- To implement various graphics techniques
- To implement various graphics algorithms

Course Outcome:

- Understanding Graphics Concept Practically
- Hands on of using standard graphics library
- Hands on of implementation of DDA, Bresenham's Line,Circle Drawing Algorithm
- Hands on of implementation of 2D Transformation: Translation, Scaling and Rotation
- Hands on of implementation ofCohen-Sutherland line clipping algorithm

1. Draw the following pattern using standard graphics library:
   a. Block Diagram of Computer
   b. Display Flag of India
   c. Flow Chart Symbols, DFD Symbols, ER-Diagram Symbols
2. Implement Bresenham's Line Drawing Algorithm
3. Implement Bresenham's Circle Drawing Algorithm
4. Implement DDA line Drawing Algorithm
5. Implementing Translation transformation on polygon
6. Implementing Scaling transformation on polygons
7. Implementing Rotation transformation on polygons
8. Implement Cohen-Sutherland line clipping algorit

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T. Y. B. Sc. (Computer Science)
(w.e.f. June-2020)
Elective A
DSC (UG-CS-509 A): Internet programming using PHP
Semester-V

1. Design web pages using HTML that will contain online admissionforms.
2. Write PHP scripts that demonstrate fundamentalsPHP.
3. Write PHP script that will display grade based on criteria given below using the marks obtained in T.Y.Bsc.Examination.
   a. Distinction (70 andabove)
   b. First Class (60 -69)
   c. Pass (40 - 59)
   d. Fail (below 40)
4. Write a PHP script to demonstrate different Stringfunctions.
5. Write a PHP script to demonstratearray.
6. Write a PHP script to use Functions (Call by Value, Call byreference).
7. Write a PHP script to Demonstrate OOPS Concept inPHP.
8. Write a PHP script to demonstrate ExceptionHandling.
9. Write a PHP script to demonstrate Form Data Handling using Get andPost methods.
10. Design a database in MYSQL using PHP. Create table in database. Store, Update, Delete and Retrieve data from the table. Display the data from the table.
11. Write a PHP script to store, retrieve and delete cookies on your localmachine.
12. Write a PHP script to store, retrieve and delete data using sessionvariables.

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Elective B
DSC (UG-CS-509B): Lab on JAVA Programming I
Semester-V

Course Objectives:

- To learn Object Oriented Design with JAVA
- Ability to write computer program to solve specific program
- To handle abnormal termination of a program using exception handling

Course Outcomes:

- Get knowledge of JDK environment
- Explore polymorphism using method overloading and method overriding
- Understand the different aspects of hierarchy of classes and their extensibility
- Understands the concept of streams and files
- Write programs for handling run time errors using exceptions

1. Write a simple program in Java to print first fifty primenumber.
2. Write a program in Java to print factorial of given number using recursion
3. Write a program in Java to print Fibonacci seriesin given series
4. Write a program in Java to demonstrate command line arguments.
5. Write a program in Java to create student information using array
6. Write a program in Java to implement user defined package.
7. Write a program in Java to implement default & parameterized constructor.
8. Write a program in Java to demonstrate various operations on string functions.
9. Write a program in Java to demonstrate wrapper classes
10. Write a program in Java to demonstrate class.
11. Write a program in Java to implement inheritance.
12. Write a program inJava to demonstrate inner class.
13. Write a program in Java to demonstrate reflection.
14. WriteaprograminJavatodemonstrateexceptionhandling.
15. Write a program in Java to demonstrate text stream object that take input from user & write it into text file.

Semester –VI

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T. Y. B. Sc. (Computer Science)
(w.e.f. June-2020)
DSC (UG-CS-601):Operating System
Semester-VI

Total lectures: 45
Total Marks: 90

Objectives:

- To understand Operating system concepts and services.
- To understand the concept of a CPU scheduling, memory management, Disk Drum Scheduling and deadlock.

Outcomes:

- Students should familiar with Operating System Services.
- Understand CPU scheduling algorithms, memory Management Techniques, Disk Drum Scheduling algorithms, Deadlock preventions and avoidance.
- Introduction to android operating systems – its architecture, applications and uses.

Unit 1.Introduction L:04M:08
1.1 What is an operating system?
1.2 Types of Operating System
1.3 Services of Operating System
1.4 Functions of operating system.
Unit 2.CPU scheduling L:10M:16
2.1 Multiprogramming Concepts
2.2 Basic Concept of CPU scheduling: CPU-I/O burst cycle, CPU scheduler, Preemptive scheduling, Dispatcher
2.3Performance criteria's
2.3 Scheduling Algorithms:FCFS, SJF, Priority scheduling, Round-robin scheduling
2.4 Multilevel queues, multilevel feedback queue
Unit 3.Memory Management L: 10M: 20
3.1 Logical versus Physical Address space
3.2 Swapping
3.3 Multiple partition allocation MFT , MVT
3.4 Paging
3.5 Segmentation
3.6Virtual Memory Management – Background, Demand paging
Unit 4. Disk and Drum Scheduling L:06M:18
4.1 First Come first serve scheduling
4.2 Shortest Seek Time First Scheduling
4.3 SCAN Scheduling
4.4 C-SCAN Scheduling
Unit 5 Deadlocks L:10M:18
5.1 Concept of Deadlock
5.2 Deadlock Characterization
5.3 Deadlock Prevention
5.4 Deadlock Avoidance
5.5 Deadlock Detection
5.6 Recovery from Deadlock
Unit 6 Overview of Android Operating system L:05 M:10
6.1 What is android operating system.

6.2 Android Architecture
6.3 Features of Android operating system
6.4 Applications of android operating system
6.5 What is Google play store

Reference books:

1. Peterson Silberschatz, “Operating system concepts”, ISBN: 0-201-35251-6, Addison Wesley, 1ST Edition
2. Andrew S. Tanenbaum, “Modem operating system”, ISBN: 81-203-0974-X, P .H.I. New Delhi 3.
3. Achyut S. Godbole, “Operating Systems” ISBN: 9780070702035, McGraw Hill Education, 2010, Third Edition
4. .Marko Garaenta, “Learning Android ,Oreilly “, ISBN: 978-1449319236, O′ Reilly, second edition
5 Mike Wolfson, “Android developers tools ,Essential,Oreilly” ISBN:978-1

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(w.e.f. June-2020)
DSC (UG-CS-602):Relational Database Management Systems
Semester-VI

Total lectures: 45
Total Marks: 90

Prerequisites

- Basic Knowledge of DBMS
- Knowledge of SQL Queries
- Basics of relational design
- Basics of ER model

Course Objectives

- To teach fundamental concepts of RDBMS (PL/PgSQL)
- To teach database management operations
- Be familiar with the basic issues of transaction processing and concurrency control
- To teach data security and its importance

Course Outcomes

On completion of the course, student will be able to–

- Design E-R Model for given requirements and convert the same into database tables.
- Use database techniques such as SQL & PL/SQL.
- Explain transaction Management in relational database System.
- Use advanced database Programming concepts

Unit 1 INTRODUCTION TO RDBMS [L : 5 M: 10]
- Introduction to RDBMS,
- Introduction to Open Source software PostgreSQL,
- Installation of open source software PostgreSQL on Windows and Linux,
- Data types of PostgreSQL

Unit 2 DATABASE AND TABLE OPERATIONS [L : 05 M: 10]
- Database Operations - 1.Creating a Database 2.Dropping the Database
- Table Operations – 1. Create 2. Alter3. Drop

Unit 3 SQL – STATEMENTS, OPERATORS, FUNCTIONS [L : 10 M: 20]
- Statements - SELECT, INSERT, UPDATE, DELETE
- Null value and Default value
- Operators - Arithmetic, Logical, Comparison, Bitwise, Relational
- Functions - Aggregate functions, Date and Time functions, String functions

- Clauses:- where, order by, AND, OR, Between, Like, CASE, Distinct, Group by, Having

Unit 4 VIEW, JOIN and DATA CONSTRANTS in SQL [L : 10 M: 20]

- **Constraints -** Data Integrity, Entity Integrity
- Keys - PRIMARY KEY, UNIQUE, FOREIGN KEY, CHECK, Not Null
- **Views -** Create, Alter, Drop
- **Join -** Joins, Cross Join, Inner Join, Outer Join, Self-Join
- **Subquries** -Subqueries as Constants, Subqueries as Correlated Values, Subqueries as Lists of Values, NOT IN and Subqueries with NULL Values, Subqueries Returning Multiple Columns
- **Statement -** MERGE Statement
- **Set operations**-UNION, EXCEPT, and INTERSECT
- **Clauses** -ANY, ALL, and EXISTS Clauses

Unit 5 TRANSACTION COMMANDS , INDEX AND SEQUENCE[L : 5 M: 10]

- **Transaction commands-**Commit, Rollback
- **Indexing -**Creating an Index**,** Unique Indexes
- **Sequences-** Creating Sequence, using nextval(), currval() and setval()

Unit 6PL/PGSQL - SQL PROCEDURAL LANGUAGE[L : 15 M: 20]

- **Introduction to** PL/PGSQL-Advantages of PL/PGSQL, structure of PL/PGSQL, basic Statements and control structures
- **Function -**Creating functions, Removing functions
- **Cursors-**Creation of Cursors, Using Cursors, Looping
  Triggers-Introduction, Triggers Vs constraints, DML Triggers, DDL Triggers
- **Error handling** -Introduction Error Handling, RAISE Statement

REFERENCE BOOKS:

- Bruce Momjian , PostgreSQL Introduction and Concepts, Addison.Wesley, ISBN 0-201-70331-9
- NEIL MATTHEW AND RICHARD STONES **, Beginning Databases with PostgreSQL, From Novice to Professional, Second Edition,** ISBN (pbk): 1-59059-478-9

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T. Y. B. Sc. (Computer Science)
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DSC (UG-CS-603):Computer Network
Semester-VI

Total lectures: 45
Total Marks: 90

Course Objective:
This paper helps to understand

- How network works? & types of networks & its applications.
- It helps to understand the various models.
- It helps to understand various layers & their functionality.
- It get the idea of how cryptography works.

Course Outcomes:
After completion of the course:

- Students understand the information exchange done across the network with the help of OSI & TCP/IP models.
- Student understands how errors are captured & handled in network.
- Student understands various attack & its prevention techniques.

Unit-1 Introduction to Computer Network and Network Model **L-8 M- 12**

1.1 What is Computer Network?
1.2 Application of Computer Networks
1.3 Transmission Mode, Network Structure
1.4 Network Topologies
1.5 ISO OSI Reference Models, TCP / IP Reference Model & their Comparison.

Unit-2 Physical Layer **L-8 M- 15**

2.1 Guided Media:
    2.1.1 Twisted Pair
    2.1.2 Coaxial Cable
    2.1.3 Fiber Optics
    2.14 Satellite Communication
    2.15 Microwave Communication
    2.1.6 Submarine Cables.
2.2 Unguided Media
    .2.1. Electromagnetic Spectrum
    2.2.2. Radio Transmission
    .2.3. Microwave Transmission
    2.2.4. Infrared & Millimeter Waves
    2.2.5. Light wave Transmission

Unit 3 The Data link Layer **L-8 M- 15**

3.1 Services Provided to Network Layer
3.2 Framing, Error Control , Flow Control
3.3 Error Detection – Redundancy, Parity Check, Checksum & CRC

3.4 Error Correction – Hamming Code.

Unit 4 The Network Layer **L-7 M- 18**

4.1 Logical Addressing

4.1.1 IP v4 Addresses - Address Space - Classful Addressing - Classless Addressing

4.2. Routing Algorithm

4.2.1. Shortest Path

4.2.2. Multicast Routing

4.3. Congestion Control

4.3.1. Introduction to Congestion Control

4.3.2. Deadlocks

Unit-5 Transport Layer **L-7 M- 15**

5.1 Process to Process Delivery

5.1.1 Client-Server Paradigm

5.1.2 Multiplexing and Demultiplexing

5.1.3 Connectionless v/s Connection Oriented Services

5.1.4 Reliable v/s Unreliable Transmission

5.2 UDP and TCP

5.2.1 UDP – Operations and uses

5.2.2 TCP – Services and features

Unit-6 Cryptography and Public key Infrastructure **L-7 M-15**

6.1 Introduction:

6.1.1 Cryptography, Cryptanalysis, Cryptology, Substitution

6.1.2 Techniques: Caesar's cipher, Monoalphabetic and Polyalphabetic,

6.1.3 Transposition techniques – Rail fence technique, Simple Columnar

6.2 Public key infrastructures:

6.2.1 basics, digital certificates, certificate authorities, registration authorities, Digital Signature.

Reference Books: -

1. Andrew S.Tanenbaum , "Computer Networks " ISBN: 978-0130661029, Prentice Hall, Fourth Edition .
2. Behrouz A. Forouzan , "Data Communication & Networking", ISBN: 978- 0071232418 , McGraw Hill Higher Education , Third Edition 3.
3. U.D. Black , "Data Communication & Distributed Networks", ISBN: 9780835913416, Published by
   Prentice-Hall, Englewood Cliffs, N.J., 1987 , Second Edition ,
4. AtulKahate , " Cryptography and Network Security " Edition 3, McGraw Hill.

KBC North Maharashtra University, Jalgaon
T. Y. B. Sc. (Computer Science)
(w.e.f. June 2020)
Theoretical Computer Science (UG-CS-604)
Semester-VI

Total lectures: 45
Total Marks: 90

Course Outcome

1) Understanding the use of Sets, Relations and Graphs.
2) Understand Languages in TCS.
3) Introduction of Regular Languages and Expressions.
4) Understanding Pumping Lemma and its applications.
5) Explore the knowledge of Pushdown Automata.
6) Understanding Normal Forms with Examples.
7) Understanding Turing Machine.

Unit-1. Mathematical Preliminaries **[L-04 M-12]**

1.1 Symbol, Alphabet, String, Formal Language, Operation on languages
1.2 Sets, Relations
- 1.2.1 Sets and Subsets
- 1.2.2 Relations
- 1.2.3 Closure of Relations

1.3 Graphs & Trees
- 1.3.1 Graphs
- 1.3.2 Trees

1.4 Principal of Induction
- 1.4.1 Method of Proof by Induction

Unit-2. Finite Automata **[L-14 M-20]**

2.1 Definition of Automata
2.2 Why study Automata Theory?
- 2.2.1 Introduction to finite Automata
- 2.2.2 Structural representations
- 2.2.3 Automata and Complexity

2.3 Descriptions of Finite Automata, Transition Systems, Transition Functions
2.4 Deterministic Finite Automata (DFA)
2.5 Nondeterministic Finite Automata (NFA)
2.6 The Equivalence of DFA and NFA
2.7 Minimization of DFA
2.8 Finite Automata with ε-Moves
2.9 Melay and Moore Machines: Definition and Examples
2.10 Applications of Finite Automata

Unit-3. Regular Expressions & Regular Sets **[L-08 M-16]**

3.1 Regular Expressions
3.2 FA & Regular Expressions
- 3.2.1 Convert Regular Expression to FA
- 3.2.2 Construct FA from Regular Expression
- 3.3 Pumping Lemma for Regular Sets and applications

Unit-4. Context Free Grammars **[L-10 M-18]**

4.1 Introduction to Context Free Grammars

4.2 Derivation Trees

4.2.1 Ambiguity in CFG

4.3 Simplification of Context Free Grammars

- 4.3.1 Useless Symbols
- 4.3.2 Null Production
- 4.3.3 Unit Production

4.4 Normal forms for CFG

- 4.4.1 Chomsky Normal Form (CNF)
- 4.4.2 Greibach Normal Form (GNF)

Unit-5 Pushdown Automata **[L-04 M-12]**

5.1 Basic Definitions

5.2 Types of PDA

5.3 Acceptance by Pushdown Automata

5.4 PDA and Context Free Language

Unit-6 Turing Machine **[L-05 M-12]**

6.1 Introduction

6.2 Turing Machine Model

6.3 Representation of Turing Machine

6.4 Design of Turing Machine

References:

1. John E. Hopcraft,RajeevMotwani, Jeffery D. Ullman, "Introduction to Automata Theory, Languages & Computations", ISBN: 978-0321455369 , Pearson publication, Third edition

2. K. L. P. Mishra, N. Chandrasekaran, "Theory of Computer Science", ISBN: 9788120329683, Published by Prentice-Hall of India Pvt.Ltd , Third edition.

3. Daniel A. Cohen, "Introduction to Computer Theory",ISBN: 978-0471137726, John Wiley & Sons; 2nd Revised edition edition.

4. SmitaRajpal, "Theory of Automata and Formal Languages", GalgotiaPublications,ISBN: 1234027054

5. http://nptel.ac.in/

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon
T. Y. B. Sc. (Computer Science)
(w.e.f. June -2020)
DSC (UG-CS-605) Python Programming – II
Semester-VI

Total lectures: 45
Total Marks: 90

Course Objectives:

- The course is designed to provide advance knowledge of Python.
- Python programming is intended for software engineers, system analysts, program managers and user support personnel who wish to learn the Python programming language.
- To learn how to design and program Python applications.
- To develop problem solving skills and their implementation through Python.
- Master the fundamentals of writing Python scripts
- To develop the ability to write database applications in Python

Course Outcome: **At the end of the course, the student will be able to**

- Explain basic principles of Python programming language
- Implement object oriented concepts, database applications.
- Construct regular expressions for pattern matching and apply them to various filters for a specific task.
- Design and implement Database Application and Content providers.
- Apply the best features of mathematics, engineering and natural sciences to program real life problems.

Unit – 1Object Oriented Concepts in Python **L:05 M: 10**

- Overview of OOP Terminology
- Creating Classes
- Creating Instance Objects
- Accessing Attributes
- Built-In Class Attributes
- Garbage Collection: Constructor
- Overloading Methods and Operator
- Inheritance - Implementing a subclass, Overriding Methods

Unit – 2Python Exception Handling and Regular Expression **L: 10 M: 20**

- Introduction
- Syntax Error
- Handling Exception
- Multiple Except Clauses
- try…finally
- Raising Exception
- User Defined Exception

- List of Standard Exception
- Regular Expression

Unit – 3File Handling in Python L: 10 M: 20

- File Objects,
- Writing Text Files,
- Appending Text to a File,
- Reading Text Files,
- File Exceptions,
- Paths and Directories,
- Exceptions in os, Paths,
- Directory Contents,
- Obtaining Information about Files, Renaming, Moving, Copying, and Removing Files,
- Creating and Removing Directories, Globbing

Unit – 4GUI with Python L: 10 M: 20

- GUI Programming Toolkits for Python,
- Tkinter Introduction,
- Creating GUI Widgets with Tkinter,
- Resizing the Widget,
- Configuring Widget Options,
- Putting the Widgets to Work,
- Creating Layouts, Packing Order,
- Controlling Widget Appearances, Radio Buttons and Checkboxes, Dialog Boxes, Other Widget Types

Unit – 5Python with MySQL L: 10 M: 20

- Introduction to MySQL
- Installing MySQL Driver - MySQL Connector or MySQLdb
- MySQL Database connection with Python
- Creating Database in MySQL using Python
- Create a Table in MySQL with Python
- Insert, Select, Update and Delete Operation in MySQL with Python
- COMMIT Operation
- ROLLBACK Operation
- Disconnecting Database

References:

1. John V Guttag (2013), Introduction to Computation and Programming Using Python, Prentice Hall of India, 2013, ISBN: 9780262525008
2. Peter C. Norton, Alex Samuel and others, ―Beginning Python‖, Wrox Publication,2005 ISBN 10: 0764596543 ISBN 13: 9780764596544
3. R. NageswaraRao(2016), Core Python Programming, Dreamtech Press, 2016, ISBN-13: 9789351199427
4. Wesley J. Chun(2006), Core Python Programming - Second Edition, Prentice Hall, ISBN-13: 978-0132269933, ISBN-10: 0132269937
5. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser(2013), Data Structures and Algorithms in Pyhon", Wiley, 2013, ISBN : 978-1-118-54958-2, ISBN : 978-1-118-29027-9(HardCover)
6. Kenneth A. Lambert(2011), Fundamentals of Python – First Programs, CENGAGE Publication, 2011, ISBN 1111822700, ISBN 9781111822705
7. Luke Sneeringer(2015), Professional Python, Wiley Inc.,2015, ISBN: 1119070856

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon

T. Y. B. Sc. (Computer Science)
(w.e.f. June-2020)
DSC (UG-CS-606 A):
Elective A - Web Programming using ASP.NET
Semester-VI

Total lectures:45
Total Marks: 90

Objectives:

- To describe the .Net Framework, its components and features. ·
- To introduce the ASP.NET. ·
- To demonstrate the use of various controls to design a web application. ·
- To demonstrate the use of ADO.NET.

Outcomes:

- Upon completion of this course the students should be able to understand the .NET framework ·
- Develop a proficiency in the ASP.NET ·
- Develop ASP.NET web applications on any given scenario.

Unit1.Introduction **L-08, 20Marks**

- Introduction toAsp.Net
- Structure of Asp.NetPage
- ASP.Net CompilationModel
- Code BehindModel
- Execution Stages and Event Model for the PageClass

Unit 2.ASP.NETControls **L-08, 20Marks**

- Introducing WebForms
- HTMLControls
- WebControls
- BasicControls
- UserControls
- ASP.Net RichControls
- Validation Controls
- ASP.Net Page Directives

Unit 3. ASP.NetIntrinsicObjects **L-15, 20Marks**

- HTTP RequestObject, HTTP ResponseObject

- HTTP Server UtilityObject
- HTTP Application StateObject
- HTTP Session stateObject
- Object Contextobject

Unit 4. Data AccesswithADO.Net **L-14, 30Marks**

- ASP.Net Data ListControls
- Working With ADO.Net
- Using BasicSQL
- Working With ASP.NetObject
- Data ReaderObject
- Data TableObject
- Data RowObject
- Data Column Object
- Data RelationObject.

Books References: -

1. Kogent Learning Solutions, ".NET 4.0 Programming 6 in 1 Black BooK", ISBN: 9789350045107, by DreamtechPress,2013.
2. Crouch, Matt J, "Asp.Net and Vb.Net Web Programming"ISBN: 9780201734409, Addison-Wesley,2002.
3. J.Liberty,D.Hurwitz , Programming ASP.Net, ISBN: 978-0596529567, O'Reilly Media ,4TH Edition.

WEB References:-1. http://www.tutorialspoint.com

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon
T. Y. B. Sc. (Computer Science)
(w.e.f. June-2020)
Elective B
DSC (UG-CS-606B): JAVA Programming II
Semester-VI

Total lectures: 45
Total Marks: 90

Course Objectives:

- **To design User Interface using Swing and AWT**
- **Learn the advanced concept of java**
- **To aware about the applet programming**

Course Outcomes:

- Program using graphical user interface with Swing classes
- Handle different kinds of events generated while handling GUI components
- Create programs using menus and dialog boxes
- Program to create applets
- Understand advanced java concepts like JDBC, Java Beans

Unit-1GRAPHICSProgramming [L-08 M-14]

1.1 Introduction- frames, framelayouts
1.2 Displaying information in a frame, Graphics objects and paint componentmethod
1.3 Text andFonts, Colors
1.4 Drawing Shapes, FillingShapes
1.5 Paint mode andImages.

Unit-2 EventHandling [L-10M-18]

2.1 EventHandling Mechanism
2.2 Concept: AWT, Swing, Difference between AWT and Swing.
2.2 The AWT eventhierarchy
2.3 Event handling summary- event sources and listener, adapterclasses.
2.4 Low level events - Focus, window, keyboard, mouseevents.
2.5 Multicasting

Unit-3 User Interface ComponentsUsingSWING [L-10M-18]

3.1 Introduction to layout management - Panels, Border Layout, GridLayout,
3.2 Text Input- Text Field, Text Area, Passwordfield
3.3 Labels andButtons
3.4 Making choices - Check boxes, Radio buttons, List, Comboboxes

Unit-4 Menu andDialogBox [L-08M-14]

4.1 Menus - Buildingmenus
4.2 Menuevents,
4.3 Popupmenu,
4.5 Keyboard mnemonics and Accelerators, enabling and disablingmenus
4.6 Dialog boxes - opening dialogs using inbuilt dialogbox

Unit-5APPLETS [L-05 M-13]

5.1 Introduction to applet
5.2 Converting application to applets
5.3 Life cycle ofapplet
5.4 Applet tag, Param Tag

Unit-6 Introduction ToAdvancedJAVA **[L-04 M-13]**

6.1 Collections

6.2 Interfaces- List,Set

6.3 Classes- Array List,Vector

6.4 Database connectivity -JDBC

6.5 Introduction to JavaBeans- Servlets, Java Server Pages(JSP)

References:

1. Cay's Horstmann and Gary Cornell ,"CoreJavaVolume 2", ISBN: 978-0-13- 708160-8, 9TH edition, published by PrenticeHall
2. E. Balaguruswamy ,"Programming with Java – A primer", ISBN:978-0-07-061713-1
3. Herbert Schildt, "The complete reference JAVA-2", ISBN: 978-0-07-049543-2, Fifth Edition,(TMH)
4. Java Programming BlackBook.
5. Buyya, Selvi, Chu, , "Object Oriented Programming with Java", ISBN: 978- 0070678835, Tata McGraw Hill Education2010

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon
T. Y. B. Sc. (Computer Science)
(w.e.f. June-2020)
DSC UG-CS-LAB-607 LAB on Python Programming – II
Semester-VI

Instruction:

- **At the time of Practical you can used any Python IDEs and Code Editors (PyCharm, Spyder, Thonny, etc.).**

1. Write a program to demonstrate Exception Handling mechanism
2. Write a program to demonstrate Regular expression in python.
3. Write a program to demonstrate the working of classes and objects.
4. Write a program to demonstrate the working of Inheritance and Overloading Methods and Operator.
5. Write a program to demonstrate read & write file.
6. Write a program to demonstrate to Renaming, Moving, Copying, and Removing Files,
7. Write a program to demonstrate to learn GUI programming using Tkinter.
8. Write a program to create a database application for insert, update and delete in a table using MySQL.

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon

T. Y. B. Sc. (Computer Science)

(w.e.f. June-2020)

DSC (UG-CS-Lab 608): Lab on RDBMS

Semester-VI

Course Objectives

- To perform operations on relational database management systems.
- Understand basic database management operations.
- Design E-R Model for given requirements and convert the same into database tables.

Course Outcomes:-

On completion of this course, students will be able to :

- To use SQL & PL/SQL.
- To perform advanced database operations.
- Create database tables in postgreSQL.
- Write and execute simple, nested queries

Use of PostgreSQL 11

1. To create one or more tables with following constraints, in addition to the first twoconstraints (PK & FK)
    a. Check constraint
    b. Unique constraint
    c. Not null constraint
2. To drop a table, alter schema of a table, insert / update / delete records using tablescreated in previous Assignments. (use simple forms of insert / update / deletestatements)
3. To query the tables using simple form of select statement Select <field-list> from table [where <condition> order by <field list>] Select <field-list, aggregate functions > from table [where <condition> group by <> having <> order by <>]
4. To query table, using set operations (union, intersect)
5. To query tables using nested queries (use of 'Except', exists, not exists, all clauses
6. To create views
7. To create Stored Procedure
    - A Simple Stored Procedure
    - A Stored Procedure with IN, OUT and IN/OUT parameter
8. Stored Function
    - A Simple Stored Function
    - A Stored Function that returns
    - A Stored Function recursive

9. Cursors

- A Simple Cursor
- A Parameterize Cursor

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon
T. Y. B. Sc. (Computer Science)
(w.e.f. June-2020)
Elective A
DSC (UG-CS-609 A): Lab on Lab on ASP.NET
Semester-VI

Course Objectives:

Course Outcomes:

1. Write an ASP .net program that demonstrate use of HTMLControls
2. Write an ASP .net program that demonstrate use of webcontrols.
3. Write an ASP .net that return the windows name of your computer and URL of the page that you arevisiting.
4. Write an ASP .net program that demonstrate use of Validation Controls.
5. Write an ASP .net program that demonstrate use of IntrinsicObjects.
6. Write an ASP .net program that demonstrate Application and Session Scope Variables using Global. Ajax
7. Write an ASP .net program that demonstrate Pagedirectives.
8. Write an ASP .net page that used the connection object to connect the database and display information using data gridControls.

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon
T. Y. B. Sc. (Computer Science)
(w.e.f. June-2020)
Elective B
DSC (UG-CS-509 B): Lab on JAVA Programming II
Semester-VI

Course Objectives:

- **To design User Interface using Swing and AWT**
- **Learn the advanced concept of java**
- **To aware about the applet programming**

Course Outcomes:

- Program using graphical user interface with Swing classes
- Handle different kinds of events generated while handling GUI components
- Create programs using menus and dialog boxes
- Program to create applets
- Understand advanced java concepts like JDBC, Java Beans

1. Write a program in Java to display messages in various fonts in aframe
2. Write a program in Java to draw various geometric shapes like circle, line, rectangleetc.
3. Write a program in Java to demonstrate paintmode.
4. Write a program in Java to demonstrate windowevents.
5. Write a program in Java to demonstrate Mouseevents.
6. Write a program in Java to demonstrate Keyboard events.(key pressed, key released)
7. Write a program in Java to demonstratemulticasting
8. Write a program in Java to demonstrate user interface component list boxes and combo box.
9. Write a program in Java to demonstrate user interface component radio button and check box.
10. Write a program in Java to demonstrate menus as interfacecomponent.
11. Write an Applet to display humanface.
12. Write a program in Java to demonstrate Java Applet with parameter
13. Write a program in java to demonstrate collection interfaces. (List andSet).

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

Structure of syllabus

B. Sc. [Biotechnology]

F. Y. B. Sc.

Choice Based Credit System (CBCS)

With effect from June

[2022 - 23]

F. Y. B. Sc. Biotechnology (CBCS pattern)

Prologue

The 21st Century is recognized as the Century of Biotechnology. Biotechnology is established as an advanced interdisciplinary applied science in last few years. Biotechnology has pervaded in almost every arena touching practically every human activity. The applied aspect of Biotechnology is now getting established with its applications in Industry, Agriculture, Health and Environment. Biotechnology sector in academic, research and industry front is expanding at rapid rate and set to augur the next major revolution in the world. For this, Biotechnology demands a trained, skilled human resource to establish the industry and research sectors.The cumulative demand for trained and skilled workforce in the area of Biotechnology necessitate in depth functional acquaintance of biological science through hands-on training to the students.

Hence, the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. The need of the hour is to design appropriate syllabi that emphasize on teaching of technological as well as the economic aspects of modern biology.

Theory augmented with practical skill sets will support a graduate to benefit the opportunities in the applied fields (research, industry or institutions), without any additional training. Thus, the university/ college itself will be developing the trained and skilled man-power.
B.Sc. program in Biotechnology as one of the core subject is designed to cultivate a scientific attitude and interest towards the modern areas of biotechnology in particular and life science in general so that the students become critical and curious in their outlook. The courses are designed to impart the essential basics in Plant Science, Animal Science, Microbiology Biochemistry, Chemistry and Biotechnology.

Being an interdisciplinary subject, the present syllabus will amalgamate the principles of physical, chemical and biological sciences along with advanced technology. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles so that postgraduate syllabus will emphasize more on applied aspect.

The present syllabi is restructured anticipating the future needs of Biotechnology Sector with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in academics, research and industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Biotechnology Sector. The curriculum aims to impart basic knowledge with more emphasis on its applications to make the students industry ready.

- To acquaint with the concepts in various allied subjects
- To improve students' knowledge
- To help the students to build interdisciplinary approach
- To instill sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career

On this premise, Board of Studies in Life Sciences in its meeting held on 23/06/2018 resolved to accept the revised syllabus for F.Y.B.Sc. (Biotechnology) based on Choice Based Credit System (CBCS) of UGC guidelines.

Scheme for B.Sc. program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		
1	Core courses (16)	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	(i) Theory	4	4	4	4	4	3	4	3					4 X 14=56
	(ii) Practical	2	4	2	4	2	3	2	3					2 X 14=28
2	Ability enhancement compulsory course (AECC) (2)	2	1	2	1									2 X 2 =04
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	2	1	2	1	2 X 4 = 16
4	Discipline Specific Elective DSE (6)													
	(i) Theory									4	3	4	3	4 X 6 =24
	(ii) Practical									2	3	2	3	2 X 6 =12
	Total Credit value (Credit x No. of Courses)	26		26		20		20		20		20		132

Course Structure:

Duration: The duration of B.Sc. (Biotechnology) degree program shall be three years.

Medium of instruction: The medium of instruction for the course shall be English.

The present syllabus has been prepared to (i) accommodate the advanced topic on the Biotechnology discipline, (ii) build the basic science knowledge at the level of first year of Biotechnology and (iii) reflect the changing needs of the students, pertaining to the fields of Chemistry, Bioinformatics and Computational skills. The detailed syllabus for each paper is appended with a list of suggested readings.

At first year of under-graduation, students are given exposure to basic science to build the foundation of advance Biotechnology. For this purpose, more focus on relevant experimentation on the topics are included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of biotechnology like genetics, immunology, molecular biology, and bioprocess biotechnology. The relevant practicals are included to enrich their knowledge.

At third year under-graduation, six theory and three practical papers each for two semesters are included to uncover all applied areas of Biotechnology.

The courses codes and titles for the courses are as given below: BT: Biotechnology,

Core Courses [CC] (12 Courses)

Semester	CC - A and B	Paper code	Paper I	Paper code	Paper II	Practical paper code	Practical Paper
I	CC A I	BT 101	Cell Biology	BT102	Biochemical Tools	BT103	Practical paper I
II	CC AII	BT 201	Biomolecules	BT 202	Basic Microbiology	BT 203	Practical paper II
III	CC A III	BT 301	Basic Genetics	BT 302	Bioprocess Technology	BT 303	Practical Paper III
IV	CC A IV	BT 401	Molecular Biology	BT 402	Immune response	BT 403	Practical Paper IV

Discipline Specific Elective [DSE] (Six each semester)

	DSE	Paper code	Paper I	Paper code	Paper II	Practical paper code	Biotechnology Practical Paper
V	A I	BT 501	Advanced Genetics	BT 502	Immunology	BT 503	Practical Paper V
	A II	BT 504	Cell Physiology	BT 505	Cellular Metabolism	BT 506	Practical Paper VI

	A III	BT 507	Microbial Biotechnology	BT 508	Environmental Biotechnology	BT 509	Practical Paper VII
VI	A IV	BT 601	Plant Biotechnology	BT 602	Animal Biotechnology	BT 603	Practical Paper VIII
	A V	BT 604	Genetic Engineering	BT 605	Molecular Diagnostics	BT 606	Practical Paper IX
	A VI	BT 607	Bioinformatics	BT 608	Enzyme Technology	BT 609	Practical Paper X

More Options to Discipline Specific Elective

DSE	Paper I	Paper II	Practical Paper
DSE 4	Drug Design	Pharmaceutical Biotechnology	Practical Paper
DSE 5	Developmental Biology	Aquaculture Biotechnology	Practical Paper
DSE 6	Virology	Toxicology	Practical Paper
DSE 7	Nano-biotechnology	Food Biotechnology	Practical Paper
DSE 8	Project Dissertation Course		

Skill enhancement courses (SEC) (any Four):

Student has choice to study any four courses from respective semester subject to the availability of particular course at respective college

Semester	SEC	Course Title	SEC	Course Title
III	SEC I	Algal and Mushroom Cultivation	SEC II	Lignocellulosic Biomass Conversion Techniques
IV	SEC III	Animal and Plant Tissue Culture Techniques	SEC IV	Bioanalytical Instrumentation
V	SEC V	Biostatistics	SEC VI	Bioethics and Biosafety
VI	SEC VII	Intellectual Property Rights	SEC VIII	Business Management

Scheme for F. Y. B. Sc. (Biotechnology)

Semester	CORE COURSE				Ability Enhancement Compulsory Course (AECC)		
	DSC		Credits	Lectures		Credits	Lectures
I	DSC - 1 A: Core Course I: Biotechnology	Paper I Paper II Practical Paper	2 2 2	30 30 60	AECC 1: English/Marathi/C ommunication	2	60
	DSC - 2 A: Core Course II	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC - 3 A: Core Course III	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC - 4 A: Core Course IV	Paper I Paper II Practical Paper	2 2 2	30 30 60			
II	DSC - 1 B Core Course I: Biotechnology	Paper I Paper II Practical Paper	2 2 2	30 30 60	AECC 2: Environmental Science	2	60
	DSC- 2 B Core Course II	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC- 3 B: Core Course III	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC- 4 B: Core Course IV	Paper I Paper II Practical Paper	2 2 2	30 30 60			

Student has choice to study three subsidiary subjects from DSC 2, DSC 3 and DSE 4 among Chemistry/ Botany/ Zoology /Geography during I, II, III and IV semester; subject to availability of course at respective college.

Duration of Lecture: 30 Lectures of 60 minutes or 36 Lectures of 50 min. Each theory and practical course has to be completed in 30 and 60 lectures, respectively of 60 min duration

Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination.

Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:

- Question 1 (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
- Question 2, 3 and 4 (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
- Question 5 (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.

- Internal examination (40 marks each semester): Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.

- Practical Examination: Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am - 1pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practicals where incubation condition, allied aspect are essential. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination

Equivalence for F.Y. B.Sc. (Biotechnology) is furnished in the following table:

Old Syllabus (w. e. f. June 2018 -19) CBCS pattern (Semester pattern 60:40)	New Syllabus (w. e. f. June 2022-23) CBCS pattern (Semester pattern 60:40)
BT-101 Cell Biology	BT-101 Cell Biology
BT-102 Biochemical Tools	BT-102 Biochemical Tools
BT-201 Biomolecules	BT-201 Biomolecules
BT-202 Basic Microbiology	BT-202 Basic Microbiology

F. Y. B. Sc.
(Biotechnology)
Semester – I

Semester	CC -A and B	Paper code	Paper I	Paper code	Paper II	Paper code	Biotechnology Practical Paper
I	CC A I	BT101	Cell Biology	BT102	Biochemical tools	BT103	Practical paper I
II	CC A II	BT201	Biomolecules	BT202	Basic Microbiology	BT203	Practical paper II

CC A I: Paper Semester: I
BT101: Cell Biology
(Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Particular Topic	Lectures
Course objective	To introduce biotechnology and its various applications in various fields of human life and to apprise about basic concepts in cell biology		
Course Outcomes	Students are expected to: • learn basic knowledge pertinent to cell as unit, cell organelles and its architecture • know the structural and functional details of cell • find answers related to the scope of biotechnology • understand how science works • aware about biotechnology and its application in various fields		
Unit I	**Introduction and scope of biotechnology**	• Introduction to biotechnology and historic perspectives • Scope of biotechnology in Agriculture, Industry, Medical and Environment • Introduction to Genetic engineering, Bioinformatics and Nano-biotechnology • Applications of Biotechnology: Agriculture, Pharmaceutical, Environment, medicine and human health • Commercial opportunities in Biotechnology sector at national and	08
Unit II	**Cells**	• Cell: Introduction and classification of organisms by cell structure: Prokaryotic and Eukaryotic cell, cytosol, compartmentalization of eukaryotic cells, • Cell membrane and permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, cell recognition and membrane transport. • Membrane Vascular system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments.	12

Unit III	**Ultrastructure of cell**	• Endoplasmic reticulum: Structure, function including role in protein segregation • Golgi complex: Structure, biogenesis and functions including role in protein secretion. Lysosomes: Vacuoles and micro bodies: Structure and functions • Ribosomes: structure of prokaryotic and eukaryotic, and functional role in protein synthesis. • Mitochondria: Structure and function • Chloroplasts: Structure and function	10
	Suggested readings	1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments, 6th Edition, John Wiley & Sons. Inc. 2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology, 8th edition, Lippincott Williams and Wilkins, Philadelphia. 3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach, 5th edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. 4. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco.	

CC A I: Paper I
BT102: Biochemical Tools (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	To complement the students with routine biochemical tools adopted in biotechnology studies		
Course Outcomes	Students are expected to be able to: • Describe the concepts of pH and its biological significance, buffers, Henderson- • Demonstrate theory and practical skills in different types of microscopy and their handling techniques and staining procedures. • Understand the fundamental biochemical concepts and familiarize with standard Solution and buffer. • Know the terms and terminologies related to basic biochemical aspects in		
Unit I	**Biochemical concepts**	• Structure of atoms and molecules, and chemical • Chemical bonds (covalent, ionic, Hydrogen, van der waal's, hydrophobic. • Solution, and type of solutions (homo- and heterogeneous), standard solutions. • Concept of pH, pOH, buffer system, type of buffer solutions, biological buffers, • weak acid and weak base, dissociation constant of weak acid and base, • Concept of pKa and pH, pH scale, • Concept and definition of enzymes concept, active site, Transition state theory,	**10**
Unit II	**Microscopy**	• Basics of Microscopy: Magnification, Resolution, Numerical Aperture, Illumination system. • Principle with Ray diagram, Working and Significance of: Compound Microscope- Bright field and Dark filed Microscope, Phase Contrast microscope. • Oil immersion objective. • Concept and types of aberrations, correction for aberrations. • Micrometry: Occular micrometer, stage micrometer, calibration & measurement of cell size	**10**

Unit III	**Stains and staining techniques**	• Concept of dyes and biological stains. • Type of stains, mordents, fixatives, decolorizes. • Bacterial Staining techniques: Simple-(Monochromatic, and Negative), Differential-(Gram's and acid fast staining). • Fungal staining- Lactophenol cotton blue staining. • Plant and animal cell staining: Haematoxylin staining, Periodate staining (PAS), Thionyl staining and Fluorescence staining.	**10**
	Suggeste readings	1. Channarayappa (2006) Molecular Biotechnology: Principles and Practices, Universities Press Pvt. Ltd., Hyderabad 2. Wiley, JM, Sherwood, LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hillnternational, New York	
		3. Frobisher M. Hinsdill, Crabtree and Goodheart (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co. USA. 4. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms, 14th edition, Pearson International Edition, New Delhi 5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company, New York 6. Tortora, Funke and Case (2010). Microbiology, 10th edition, Brenjamin Cummings Inc, California. 7. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology 9th edition, Nirali Prakashan, Pune 8. Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad	

CC A I: Practical Paper I

BT103: Practical Paper I (Practical)

Total Hours: 60 **Credits: 2**

Sr., no.	Title of the Practical	Hours
Course objective	To acquaint students with instruments operation, safety aspects and train the students on the practical components of the theory courses	
Course Outcomes	Students are expected to: • Demonstrate practical skills in microscopy, laboratory equipment and their handling techniques and staining procedures • Know various stages of cell division and also understand the significance of each event during meiosis and mitosis • Perform routine tasks safely and effectively	
1.	First aid, Hazardous Chemicals, Antidotes to hazardous and toxic chemicals, Safety measures in laboratory	**4**
2.	Handling and care of instruments: Autoclave, Laminar air flow, Centrifuges, spectrophotometer,	**4**
3.	Handling and care of instruments: Centrifuges, spectrophotometer,	**4**
4.	Handling, use and care of compound microscope	**4**
5.	Study of bacterial morphology using Monochrome staining	**4**
6.	Study of bacterial morphology using Negative staining	**4**
7.	Study of Gram characteristics of bacteria using Gram's staining	**4**
8.	Study of acid fast charactristics of bacteria using Acid fast staining Nocardia spp/ Atypical mycobacteria)	**4**
9.	Study of fungal morphology using lacto phenol cotton blue stain.	**4**
10.	Principle of Colorimetry: Verification of Beer's Law	**4**
11.	Estimation of protein by Biuret/ Folin Lowry/ Bradford method.	**4**
12.	Study the structure of plant cell through temporary mounts of	**4**
13.	Preparation of standard solutions (Normal/ Molar/ Percentage)	**4**
14.	Study of Algae/BGA temporary mounts/ permanent slides (e,g. Spirogyra /Anabena / Nostoc/ Cyanobacteria)	**4**
15.	Study of cell organelles- temporary mounts/ permanent slides (e,g. Nucleus/ Golgi complex, ER/ chloroplast etc.)	**4**

Suggested readings	1. Atlas, R. M. (1997) Principles of Microbiology, 2nd edition, WM.T.Brown Publishers, Dubuque, USA. 2. Cappucino J and Sherman N. (2010) Microbiology: A Laboratory Manual, 9th edition, Pearson Education Limited, New Delhi 3. Parija S.C. (2005) Text Book of Practical Microbiology, 1st edition, Ahuja Publishing House, New Delhi. 4. Dubey RC and Maheshwari DK (2004) Practical Microbiology, 1st edition, S. Chand and Co., Delhi. 5. Harley, J. P. and Prescott L. M. (2002) Laboratory Exercises in Microbiology, 5th edition, The McGraw-Hill Co., New York 6. Benson H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York 7. Aneja K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi.	

F. Y. B. Sc. (Biotechnology) semester II

CC A I: Paper II
BT 201: Biomolecules
(Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objectiv	To complement the students with the basic concept about biomolecules		
Course Outcomes	Students are expected to: • Overview of major biomolecules –carbohydrates, lipids, proteins, amino acids, nucleic acids, classification, structure, function of the above mentioned biomolecules • Specify the biological significance of biomolecules in metabolism		
Unit I	**Carbohydrates**	• Definition, classification (glyceraldehydes, Simple • Aldose, Simple Ketoses, D-glucose, Conformation of D-glucose) and biological functions of carbohydrates. D and L isomers, dextrorotatory and levorotatory, reducing sugar and mutarotation • Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides, Homo- and Hetero-Polysaccharides, Mucopolysaccharides, • Structure and biological significance of lactose, sucrose and maltose • Polysaccharides: Homo- Cellulose, Glycogen and Starch	**10**

Unit II	**Lipids**	• Classification, nomenclature and properties of fatty acids, saturated and unsaturated fatty acids. • Definition, classification and biological functions of simple, compound and derived lipids • Structure and biological significance of • Phospholipid and cholesterol, Saturated (palmetic acid), Non-saturated (oleic acid), Use as signal, cofactor, pigment	**08**
Unit III	**Proteins and nucleic acids**	• Amino acids: Definition, physical and chemical properties, classification • Protein: Structure; primary, secondary, tertiary and quaternary, Bonds stabilizing structural conformation, Denaturation and renaturation of proteins. • Structural Components of Nucleic acids: Nucleosides and Nucleotides, purines and pyrimidines • DNA: Structure (Watson and Crick Model), Chargaff's Rule. • RNA: Structure and Significance of: mRNA, tRNA and rRNA.	**12**
	Suggested readings	1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) Biochemistry, VI Edition, W.H Freeman and Co., 2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Biologists. 3. Nelson, D.L., Cox, M.M. (2004) Lehningers' Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA. 4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology, John Wiley and Sons, 5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.,	

CC A I: Paper II
BT 202: Basic Microbiology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	To complement the students with fundamental concepts in Microbiology		
Course Outcomes	Students are expected to: • Understand the basic microbial structure and study the comparative characteristics of prokaryotes and eukaryotes and familiarize the structural • Similarities and differences among various microbes. • Know various Culture media and their applications and also understand various physical and chemical means of sterilization. • Know general bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae. • Learn aseptic techniques and be able to perform routine culture handling task safely and effectively. • Know the various Physical and Chemical growth requirements of bacteria and get.		
Unit I	**Diversity of microorganisms**	• Concept of microorganisms • Comparative account of prokaryotic and eukaryotic cells. • Morphology and cell structure of Bacteria, virus, Algae, Fungi, and Protozoa. • Classification of microorganisms: Whittaker's five kingdom system of classification, Microbial. Taxonomy, Microbial phylogeny and current classification of bacteria. • Morphological features of Bacteriophage	10
Unit II	**Microbial Growth and cultivation of microbes**	• Concept of Culture: Pure culture, axenic culture, mixed culture. • Cultivation of microbes: Media and media ingredients (water, peptone, malt extract, meat extract, yeast extract, trace elements, growth factors). • Types of media: complex, synthetic, natural, selective, differential, enriched media. • Isolation methods: Streak Plate, Spread Plate, Pour Plate, stab inoculation. • Cultivation of fungi: Slide culture technique. • Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture	10

Unit III	**Control of microorg a isms**	• Concept o f Sterilization, disinfectant, antiseptic, sanitizer, • Sterilization by filtration • Physical methods (Heat, radiation, filtration) and chemical (Ethylene oxide, formaldehyde) methods of sterilization. Biological indicators of sterilization • Definition of Disinfection, characteristics of ideal disinfectant, Mode of action of alcohol, phenolic compounds, halogen, heavy metals, H_2O_2, detergents.	12
	Suggested readings	1. Alexopoulos, CJ, Mims CW, and Blackwell, M. (1996) Introductory Mycology, 4th edition, John and Sons, Inc., 2. Jay, JM, Loessner, MJ and Golden, DA. (2005) Modern Food Microbiology, 7th edition, CBS Publishers and Distributors, New Delhi 3. Kumar, HD. (1990) Introductory Phycology, 2nd edition, Affiliated East Western Press, 4. Madigan, MT, Martinko, JM and Parker, J. (2009) Brock Biology of Microorganisms, 12th edition, Pearson/Benjamin Cummings, 5. Pelczar, MJ, Chan ECS and Krieg NR. (1993). Microbiology, 5th edition, McGraw Hill Book Company, 6. Stanier, RY, Ingraham, JL, Wheelis, ML, and Painter PR. (2005) General Microbiology, 5th edition, McMillan, 7. Tortora, GJ, Funke, BR, and Case, CL. (2008) Microbiology: An Introduction, 9th edition, Pearson Education. 8. Willey, JM, Sherwood, LM, and Woolverton, CJ. (2008) Prescott, Harley and Klein's Microbiology, 7th edition, McGraw Hill Higher Education,	

CC A I: Practical Paper II
BT 203: Practical Paper II (Practical)

Total Hours: 60 **Credits: 2**

Sr. no.	Title of the Practical	Hours
Course objective	To complement the students with basic biochemistry, cultivation techniques for microbes and familiarize with algae, fungi	
Course Outcomes	Students are expected to: • Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures. • Understand the basic microbial practices and study the comparative characteristics of prokaryotes and eukaryotes. • Prepare and view specimens using microscopy (bright field microscope). • Aware and train in aseptic handling of microbial specimens. • Practice safe microbiology, using appropriate protective and emergency procedures.	
1.	Qualitative test for carbohydrates	**4**
2.	Qualitative test for carbohydrates amino acids and Proteins.	**4**
3.	Qualitative test for liipids.	
4.	Extraction and detection of Starch from Potatoes/ maize.	**4**
5.	Extraction and detection of Casein from milk.	**4**
6.	Measurement of Microbial cell size using ocular micrometer and	**4**
7.	Study of Bacterial Motility by suitable techniques.	**4**
8.	Use and handling of autoclave, incubator, hot air oven	**4**
9.	Use and handling of Laminar Air Flow hood/aseptic cabinet	**4**
10.	Preparation of culture media for bacterial cultivation: (Nutrient broth, nutrient agar, nutrient stab and nutrient slant)	**4**
11.	Preparation of culture media for bacterial cultivation: (MacConkeys broth, MacConkes agar and MacConkes slant).	**4**
12.	Study micro-flora of the air and water on nutrient agar plates	**4**
13.	Isolation of bacteria by spread plate method from water/soil / Food sample.	**4**
14.	Study of colony characteristics of the isolates.	**4**
15.	Demonstrative preparation of paper model of DNA and web-based online observation of 3-D structure of protein	**4**

Suggested readings	• Atlas, RM. (1997) Principles of Microbiology, 2^{nd} edition, • WM.T.Brown Publishers, • Cappucino, J. and Sherman, N. (2010) Microbiology: A Laboratory Manual. 9^{th} edition. Pearson Education Limited, • Parija, S.C. (2005) Text Book of Practical Microbiology. 1st edition, Ahuja Publishing House, New Delhi. • Dubey, RC and Maheshwari, DK (2004) Practical Microbiology, 1^{st} • edition, S. Chand and Co., Delhi. • Harley, J. P. and Prescott, L.M. (2002) Laboratory Exercises in Microbiology 5^{th} edition, The McGraw-Hill Companies, • Benson, H. (2001) Microbiological Applications Lab Manual, 8^{th} edition, The McGraw-Hill Companies,	

Skills acquired and Job prospectus for the Biotechnology students

Biotechnology, being part of Life Science, has established as advanced interdisciplinary applied science. The interdisciplinary networking potential of biotechnology has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted current knowledge-based system to technology driven development and application in life sciences. In the milieu of research and industrialization for economic development and social renaissance, biotechnology emerged out as a major tool to work.

The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and studies from (i) molecular biology to cell biology, (ii) biochemistry to biophysics, (iii) genetic engineering to stem cell research, (iv) bioinformatics to genomics proteomics, (v) environmental biology to biodiversity, (vi) microbiology to bioprocess engineering, (vii) bioremediation to material transformation and so on. The application of the studies on cell bioprocesses is covered with the help of technology. Green, blue and white revolution was possible due to intrinsic understanding of biotechnology. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of biotechnology and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about biotechnology. At the end of the course, the students are expected to have good working knowledge in the field of Biotechnology. Students will surely have an urge to continue higher studies in Biotechnology and contribute significantly in the development.

Biotechnologists are always in demand as an efficient work force in fundamental research and industries. Education and research sectors require such interdisciplinary trained workforce to develop future generations of science leaders. Career opportunities for graduate students are created and expanding at the biotechnology parks and in manufacturing industries, teaching, research institutes and IT industry.

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

1990

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Structure of syllabus

Program: B.Sc. Biotechnology

S. Y. B. Sc.

Choice Based Credit System (CBCS)

(2019-20)

S. Y. B. Sc. Biotechnology (CBCS pattern) Semester: III and IV

Prologue

Biotechnology is an advanced interdisciplinary applied science that has pervaded in almost every human activity. Various application of Biotechnology is now established in Industry, Agriculture, Health and Environment. Biotechnology sector in academic, research and industry front are expanding at rapid rate and set to augur the next major revolution in the world. This necessitate cumulative demand for trained and skilled workforce with in depth functional acquaintance of biological science. Hence, the syllabus orientation is done to keep pace with developments in the education and industrial sector.

B.Sc. program in Biotechnology as one of the core subjects is designed to cultivate a scientific attitude and interest towards the modern areas of biotechnology and life science in general so that the students become critical and curious in their outlook. The courses are designed to impart the essential basics in Plant Science, Animal Science, Microbiology Biochemistry, Chemistry and Biotechnology with the objectives to (a) improve students' knowledge, (b) help the students to build interdisciplinary approach, (c) instill sense of scientific responsibilities and social and environment awareness and (d) help student's build-up a progressive and successful career.

The present syllabus tried to amalgamate the principles of physical, chemical and biological sciences along with advanced technology. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles so that postgraduate syllabus will emphasize more on applied aspect.

The present syllabi are restructured anticipating the future needs of Biotechnology Sector with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in academics, research and industrial sectors. The Theory and Practical course in new restructured course to impart skill-set essentials to further Biotechnology Sector. The curriculum aims to impart basic knowledge with more emphasis on its applications to make the students industry ready.

To On this premise, Board of Studies in Life Sciences in its meeting held on / / resolved to accept the revised syllabus for S. Y. B.Sc. (Biotechnology) based on Choice Based Credit System (CBCS) of UGC guidelines.

Scheme for B.Sc. Program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		
1	Core courses (16)	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	(i) Theory	4	4	4	4	4	3	4	3					4X14=56
	(ii) Practical	2	4	2	4	2	3	2	3					2X14=28
2	Ability Enhancement Compulsory Course (AECC) (2)	2	1	2	1	2	1	2	1					2 x 2 x 2 x 2 = 08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	2	1	2	1	2X4=16
4	Discipline Specific Elective DSE (6)													
	(i) Theory									4	3	4	3	4X6=24
	(ii) Practical									2	3	2	3	2X6=12
	Total Credit value (Credit x No. of Courses)	26		26		22		22		20		20		136

Course Structure:

Duration: The duration of B.Sc. (Biotechnology) degree program shall be three years.

Medium of instruction: The medium of instruction for the course shall be English.

The present syllabus has been prepared to (i) accommodate the advanced topic on the Biotechnology discipline, (ii) build the basic science knowledge at the level of first year of Biotechnology and (iii) reflect the changing needs of the students, pertaining to the fields of Chemistry, Bioinformatics and Computational skills. The detailed syllabus for each paper is appended with a list of suggested readings.

At first year of under-graduation, students are given exposure to basic science to build the foundation of advance Biotechnology. For this purpose, more focus on relevant experimentation on the topics are included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of biotechnology like genetics, immunology, molecular biology, and bioprocess biotechnology. The relevant practicals are included to enrich their knowledge.

The courses codes and titles for the courses are as given below: BT: Biotechnology,

Core Courses [CC]

Semester	CC-A and B	Paper code	Paper-I	Paper Code	Paper-II	Practical Paper Code	Practical Paper
I	CC A I	BT 101	Cell Biology	BT 102	Biochemical Tools	BT 103	Practical paper I
II	CC A II	BT 201	Biomolecules	BT 202	Basic Microbiology	BT 203	Practical paper II
III	CC A III	BT 301	Basic Genetics	BT 302	Bioprocess Technology	BT 303	Practical paper III
IV	CC A IV	BT 401	Molecular Biology	BT 402	Immune Response	BT 403	Practical paper IV

Structure for S. Y. B. Sc. (Biotechnology)

Semester	**Core Course**				**Ability Enhancement Compulsory Course**			**Skill Enhancement Courses**		
	DSC	**Paper**	**Credits**	**Lectures**	**AECC**	**Credits**	**Lectures**	**SEC**	**Credits**	**Lectures**
III (Total Credits = 22)	DSC-1C: Core Course I: Biotechnology	Paper I	2	30	AECC I: English/Hindi/MIL Communication III (Advance)	2	30	SEC I: Algae and Mushroom Cultivation	2	30
		Paper II	2	30	AECC II: General knowledge paper	Non-credit				
		Practical Paper	2	60						
	DSC-2C: Core Course II	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
	DSC-3C: Core Course III	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
IV (Total Credits = 22)	DSC-1D: Core Course I: Biotechnology	Paper I	2	30	AECC I: English/Hindi/MIL Communication III (Advance)	2	30	SEC II: Bioanalytical Instrumentation	2	30
		Paper II	2	30	AECC II: General knowledge paper	Non-credit				
		Practical Paper	2	60						
	DSC-2D: Core Course II	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
	DSC-3D: Core Course III	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						

Student has choice to study two subsidiary subjects from DSC 2, DSC 3 among Chemistry/ Botany/ Zoology /Geography during III and IV semesters; subject to availability of course at respective college.

- **Duration of Lecture:** 30 Lectures of 60 minutes or 36 Lectures of 50 min.

- Each theory and practical course have to be completed in 30 and 60 lectures, respectively of 60 min duration
- Each theory and practical course will be of 100 marks comprising of 40 marks internal and 60 marks external examination.
- **Theory examination** (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
- **Question 1 (12 marks):** 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
- **Question 2, 3 and 4 (12 marks each):** based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
- **Question 5 (12 marks):** answer only 3 out of 5 in brief, from all 3 units, Each 4 marks.
- **Internal examination (40 marks each semester):** Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.
- **Practical Examination:** Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am -1pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practicals where incubation condition, allied aspect is essential.

  There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor).

  Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination.

Equivalence for S.Y. B.Sc. (Biotechnology) is furnished in the following table:

Old Syllabus (June 2016-17) (Semester pattern 60:40)	New Syllabus (w. e. f. June 2019 -20) CBCS pattern (Semester pattern 60:40)
BT - 231: Cell Biology and Metabolism	BT 301 Basic Genetics
BT - 232: Molecular Biology	BT 302 Bioprocess Technology
BT - 241: Biophysics	BT 401 Molecular Biology
BT - 242: Immunology and Bioprocess Technology	BT 402 Immune Response
BT - 233: Practical Course in Biotechnology – I	BT 303 Practical paper III
BT - 243: Practical Course in Biotechnology – II	BT 403 Practical paper IV

S. Y. B. Sc. (Biotechnology) Semester – III and IV

Semester	CC-A and B	Paper code	Paper-I	Paper Code	Paper-II	Practical Paper Code	Practical Paper	Skill Enhancement Courses (SEC)	Ability Enhancement Compulsory Courses (AECC)
III	CC A III	BT 301	Basic Genetics	BT 302	Bioprocess Technology	BT 303	Practical Paper III	SEC I: Algae and Mushroom Cultivation	English/Hindi/MIL Communication III (Advance): Credit 2; General knowledge paper (Noncredit)
IV	CC A IV	BT 401	Molecular Biology	BT 402	Immune Response	BT 403	Practical Paper IV	SEC II: Bioanalytical Instrumentation	English/Hindi/MIL Communication III (Advance): Credit 2; General knowledge paper (Noncredit)

CC A III: Paper I
BT: 301 Basic Genetics (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Particular Topic	Lectures
Course Objective	To complement the students with the basic concept about Genetics.		
Learning Outcomes	Students will be able to: • understand basic concept of Gene, DNA. • study mutation and chromosomal variations • learn basic aspect about gametogenesis and cell cycle. • understand the Mendel's laws.		
Unit I Concept of DNA	• Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence, composition –unique & repetitive DNA, satellite DNA. Centromere and telomere • DNA sequences, middle repetitive sequences- VNTRs and dinucleotide repeats, repetitive transposed sequences- SINEs and LINEs, middle repetitive multiple copy genes, noncoding DNA. • Genetic organization of prokaryotic and viral genome. • Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function		**10 L**
Unit II Mutation and Chromosomal Variation	• **Chromosome and gene mutations:** Definition and types of mutations, causes of mutations • Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, Variations in chromosomes structure: deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, Chromosomal abnormalities: Aneuploidy and Euploidy		**10 L**
Unit III Mendelian Genetics	• **Cell Cycle:** Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms. • **Mendelian genetics:** Mendel's experimental design, monohybrid, di-hybrid and tri hybrid Crosses, Law of segregation and Principle of independent assortment.		**10 L**

	Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Applications of Mendel's Principles and Chromosomal basis of Mendelism • **Allelic interactions:** Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple alleles, Lethal alleles and Null alleles Non-allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant and recessive), duplicate genes and inhibitory genes, Phenocopy Organisms suitable for genetic experimentation and their genetic significance. Genetic linkage, Types of Linkage,	
Suggested Readings	1. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2006) Principles of Genetics. VIII Edition, John Wiley and Sons, New York. 2. Snustad, D.P. and Simmons, M.J. (2009) Principles of Genetics, V Edition, John Wiley and Sons Inc., London 3. Klug, W.S., Cummings, M.R.and Spencer, C.A. (2009) Concepts of Genetics. IX Edition, Benjamin Cummings, New York 4. Russell, P. J. (2009) Genetics: A Molecular Approach. III Edition Benjamin Cummings. **5.** Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (2009) Introduction to Genetic Analysis, IX Edition, W. H. Freeman and Co. 6. Krebs, J., Goldstein, E. and Kilpatrick, S. (2013) essential Genes,3rd edn., Jones and Bartlett Learning. 7. Pierce, B.A. (2012) Genetics: A Conceptual Approach, 4th edn., WH freeman and Company, New York	

CC A III: Paper II
BT 302: Bioprocess Technology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Particular Topic	Lectures
Course Objective	To understand the basic knowledge in Fermentation Technology and build a foundation for more advanced studies in Bioprocess Technology		
Learning Outcomes	Students will be able to: ➢ develop an understanding of the various aspects of Bioprocess Technology. ➢ aware with screening of Industrially Important Strains and culture collection centres. ➢ understand principles underlying design of Fermenter, Fermentation Process, upstream and downstream processing.		
Unit I : Introduction to Bioprocess Technology	• Concept and significance of bioprocess technology • Range of bioprocess technology and chronological development • Basic principal components of fermentation technology • Screening of industrially important microorganism- primary, secondary, crowded plate method; strain improvements • Working and principle of culture collection centres • National: NCIM, MTCC • International: ATCC		**10 L**

Unit II: Bioreactor	• Design and construction of bioprocess reactor: • Significance of impeller, baffles, sparger, stuffing box • Measurement and control of fermentation parameters: pH, temperature, DO, foaming and aeration • Bioreactors: Types, Working and Applications of- - Stirred tank bioreactor - Airlift bioreactor - Fluidized bed bioreactor - Packed bed bioreactor - Tower bioreactor - Photo bioreactor • Types of Bioprocesses: Solid state and Submerged - Batch fermentation - Continuous Fermentation - Fed Batch fermentation - SSF and SHF	**10 L**
Unit III: Introduction to Upstream and Downstream processes	• Principles of upstream processing - Media preparation, Raw material and criteria - Inoculum development and inoculum characteristics - Sterilization: sterilization of air and media • Introduction to downstream processes - Solid-solid separation: Flocculation, filtration and Centrifugation • Cell disruption: Physical: Homogenizer, ultra-sonication, freezing and thawing Chemical: Enzymatic, Detergent, Alkali treatment, Osmotic lysis - Extraction - Precipitation - Distillation - Evaporation - Chromatographic separation - Spray drying - Super critical separation	**10 L**
Suggested Readings	➢ Stanbury P.F., Whitakar and Hall S.J. (2006) Principles of Fermentation Technology, 2nd Edition, Elsevier Science Ltd. ➢ Casida L.E. Jr. (1991) Industrial Microbiology, New Age Intl Publ., Delhi ➢ Patel A.H. (1996) Industrial Microbiology, MacMillan India Ltd., Delhi. ➢ Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. (2001) Industrial Microbiology: An Introduction, 1st edn., Wiley-Blackwell, London ➢ Glaze, A.N. and Nikaido, H. (1995) Microbial Biotechnology: Fundamentals of applied Microbiology, 1st edn., W.H. Freeman Company ➢ Dubey R.C. and Maheshwari D.K. (2002) A Textbook of Microbiology, S. Chand Publication, New Delhi ➢ Dubey R.C. (2008) A Textbook of Biotechnology, S. Chand and Co. Ltd., New Delhi.	

CC A III: Paper III
BT 303: Practical Paper III (Practical)

Total Hours: 30 Credits: 2

Unit	Title of the Practical	Lectures
Course Objective	To acquaint students with basic genetics and industrial biotechnology also train the students on the practical components of the theory courses.	

Learning Outcomes	Students will be able to: • acquaint with different problems regarding genetics • know various stages of cell division and understand the significance of each event during meiosis and mitosis • develop skill about isolation of industrially important microorganism and familiar with analytical techniques	
1.	Problem sets in: Mendelian inheritance single point and two-point crosses Linkages- Two- and three-point cross.	4
2.	Permanent and temporary mount of mitosis in onion root tip	4
3.	Permanent and temporary mount of meiosis in grasshopper testis/ *Tradescantia* flower	4
4.	Study of polytene chromosome- Slide preparation	4
5.	Karyotyping study with the help of photographs/database	4
6.	Pedigree chart analysis for study of hereditary disorders.	4
7.	Studying effect of colchicine on mitosis	4
8.	Quantitative estimation of protein by Bradford's/Lowry's method	4
9.	Screening of amylase producing microbes	4
10.	Isolation of Auxotrophs by gradient plate method	4
11.	Validation of autoclave using bio-agent (*B. stearotermophilus*)	4
12.	Determination of MIC and MBC of antibacterial agent	4
13.	Estimation of acetic acid from vinegar	4
14.	Cultivation of edible mushroom.	4
15.	Industrial visit/ Excursion tour	4
Note:	Mandatory to complete at least 13 practicals	
Suggested Readings	1. Aneja K.R. (1996) Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International (Pvt.) Ltd., New Delhi. 2. Plummer D.T. (2005) An Introduction to Practical Biochemistry, 4th Edition, Tata McGraw Hill, New Delhi. 3. Sadasivam S. and Manikam A. (1996) Biochemical Methods, 2nd Edition, New Age International (Pvt) Ltd., New Delhi. 4. Jayaraman J. (1999) Laboratory Manual in Biochemistry, New Age International (P) Ltd., New Delhi. 5. Wilson K. and Walker J. (2010) Practical Biochemistry: Principles and Techniques of Biochemistry and Molecular Biology, 5th Edition, Cambridge Uni. Press, Cambridge. 6. Sawhney S.K. and Singh R. (2000) Introductory Practical Biochemistry Narosa Publisher, New Delhi. 7. Nigam, A. and Ayyagiri, A. (2007) Lab Manual in Biochemistry, Immunology and Biotechnology, Tata McGraw Hill, Kolkata 8. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc., London	

Skill enhancement course (SEC): Semester- III
SEC I: Algae and Mushroom Cultivation

Total Hours: 30 **Credits: 2**

<table>
<tr><th>Unit</th><th>Title</th><th>Topic</th><th>Lectures</th></tr>
<tr><td>Course Objectives</td><td colspan="3">➢ To understand commercial development of algal culture
➢ To aware about commercial utilization of algae
➢ To understand diversity of morphological and biochemical
➢ To know role of algae in industries
➢ Know about nutritional and medicinal value of edible mushrooms
➢ Learn about the cultivation techniques off mushrooms
➢ Gain knowledge on the present status of mushroom industry in india</td></tr>
<tr><td>Learning Outcomes</td><td colspan="3">Students will be able to:
➢ know the classification of different varieties of fungi
➢ understand the techniques used in the cultivation of edible mushroom
➢ know the harvesting of a mushroom crop
➢ learn about the post harvesting treatment of a mushroom crop
➢ gain adequate knowledge on comparative account of various algae
➢ determine the techniques used for cultivation of algae
➢ understand cultivation methods with algae biofuel technologies
➢ know about commercial and transportation issues of algae biomass</td></tr>
<tr><td>Unit I Mushroom Cultivation</td><td colspan="2">• Basic characteristic of fungi, classification, Cultivation and preservation of mushroom
• making mushroom compost, finishing the compost, spawning casing, pinning, cropping
• Spawn production, substrate, raw materials, The substrate preparation process
• Mushroom cultivation, ventilation system, air humidity, organization of space
• The cultivation process – incubation phase, fructification phase
• Preparation of growing unit / hygiene
• Hygiene of a growing unit problems in the production (in situ) and quality control</td><td>15</td></tr>
<tr><td>Unit II Algae Cultivation</td><td colspan="2">• Ecology and characteristic features of algae
• Algae Classification, cultivation and nutritional requirements
• Methods of algae cultivation
• Cultivation, harvesting, drying, extraction and processing of algae
• Single cell protein and its nutritive value e.g. Spirulina
• Post-harvest management: packing, storage and quality control
• Quantification of cultured algae
• Efficacy/ economic importance of algae cultivation Parasitic and symbiotic algae</td><td>15</td></tr>
<tr><td>Suggested Readings</td><td colspan="3">1. Pathak, V.N. Yadav, N. and Gour, M. (2011) Mushroom Production and Processing Technology, Agrobios (India). ISBN 10: 8177540068
2. Kannaiyan, S. and Ramasamy K. (1980) A Hand Book of Edible Mushroom, Today and Tomorrows Printers and Publishers, New Delhi
3. Nita Bahl (1984) Handbook on Mushrooms, Oxford and IBH Publishing Co.
4. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
5. Stein, J.R. (1973) Handbook of Phycological Methods. Culture methods and growth measurements. Cambridge University Press, Cambridge</td></tr>
</table>

	6. Graham, L.E., Graham, J.M., Wilcox, L.W. and Cook, M.E. (2015) Algae, 3rd edition, LJLM Press, Madison, ISBN 978-0-9863935-3-2

CC A IV: Paper I
BT 401: Molecular Biology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Particular Topic	Lectures
Course Objective	To complement the student with concepts of Molecular Biology		
Learning Outcomes	Students will be able to: ➢ understand basic structure of DNA ➢ understand central dogma of molecular biology ➢ understand the process of replication, transcription, translation. ➢ Learn regulation of all molecular processes.		
Unit I DNA structure and replication	• Central dogma of Molecular Biology • DNA as genetic material, Structure of DNA, Double helix and Triple helix, Cot curve, organization of eukaryotic DNA, Types of DNA • Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, • Replication complex: Pre-priming proteins, primosome, replicosome, Rolling circle replication, • Unique aspects of eukaryotic chromosome replication, Fidelity of replication		**10 L**
Unit II DNA damage, repair and homologous recombination	• **DNA damage and repair:** causes and types of DNA damage, mechanism of DNA repair: • Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining • Homologous recombination: models and mechanism		**10 L**
Unit III Transcription and RNA processing, Translation and Regulations	• **RNA structure and types of RNA, Transcription in prokaryotes:** Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains • **Transcription in eukaryotes:** Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing. • **Prokaryotic and eukaryotic translation:** ribosome structure and assembly, Charging of tRNA, amino acyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides • **Regulation of gene expression in prokaryotes:** Operon concept (inducible and repressible system), Genetic code and its characteristics.		**10 L**
Suggested Readings	1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc., London 2. de Robertis, E.D.P. and de Robertis, E.M.F. (2006) Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.		

	3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell, VII Edition. Pearson Benjamin Cummings Publishing, San Francisco. **4.** Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene, VI Edition, Cold Spring Harbour Lab. Press, Pearson Publishers. **5.** Gardner E.J., Simmons, M.J. and Snustad, D.P. (20008) Principles of Genetics, 8th edn., Wiley India

CC A IV: Paper II
BT 402: Immune Response (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Particular Topic	Lectures
Course Objective	To complement the students with basics human immunology and related response		
Learning Outcomes	Students will be able to: ➢ know the cellular ontogeny and organ involvement in immunity ➢ explain the principles of self-tolerance and autoimmunity ➢ know how the immune system can fight infections and cancer, including examples of immunodeficiency diseases ➢ know the difference between innate and adaptive immunity ➢ understand what antigens are and how they are presented ➢ understand the mechanisms involved in control of immune responses		
Unit I Basics of Immunology	• Introduction to Immune System; Haematopoiesis • Blood cell; Morphology, formation and function of Phagocytosis and Opsonisation. • Primary and secondary Immune response • Lymphoid organs (Bone marrow, Thymus, Lymph node, spleen, GALT, CALT) and Immune cells (Stem, T, B, NK, Macrophages, Dendric cells) • Properties of immune system; specificity, Diversity, self-versus Non-self-discrimination. • Innate and acquired immune response • Cellular and Humoral Immunity. • Immune responses; Primary and Secondary, Immunological memory, Immunological tolerance and Hypersensitivity.		**10 L**
Unit II Antigen and Antibody	• Concept of antigen, types of antigen: antigen and Immunogenic, Antigenic determinants, hapten, T-dependent and T-independent antigens, toxoid • Blood group antigen: A, B, O, D and Bombay blood group, Rh and D variants • Factors affecting antigenicity • Immunoglobulin: Structure, Types and properties, Antigenic determinants (Isotypic, allotypic, idiotypic)		**10 L**
Unit III Immuno-prophylaxis	• Active immunization: Vaccines and Vaccination: adjuvants, Cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines. • Passive immunization: types with examples and Immunization Schedule • Autoimmune diseases and Immunodeficiency: AIDS • ABO blood grouping and its significance.		**10 L**
Suggested Readings	➢ Coleman R.M, Lombard M.F, Sicard R.E., Rencocca, N.J. (1989) Fundamentals of Immunology, W.C. Brown Publishers. ➢ Delves P, Martin S, Burton D, Roitt I.M. (2006) Roitt's Essential Immunology, 11th edition, Wiley-Blackwell Scientific Publication, Oxford.		

	➢ Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology, 6th edition, W.H. Freeman and Company, New York. ➢ Peakman M, and Vergani D. (2009) Basic and Clinical Immunology, 2nd edition, Churchill Livingstone Publishers, Edinburg. ➢ Richard, C. and Geiffrey, S. (2009) Immunology, 6th edn., Wiley Blackwell Publ.

CC A IV: Paper III
BT 403: Practical Paper IV (Practical)

Total Hours: 30 **Credits: 2**

Unit	Title of the Practical	Lectures
Course Objective	To complement the students with basic immunology, Molecular Biology and familiarize with serological techniques.	
Learning Outcomes	**Students will be able to:** ➢ understand basics in serological practicals and its handling. ➢ aware of molecular biology techniques about isolation of genetic material. ➢ aware and train spectrophotometric estimations of metabolites ➢ know about the basic concept in immunology.	
1.	Preparation of reagents for molecular biology.	
2.	Blood group detection and Rh typing.	
3.	Determination of total RBC count from blood sample by haemocytometer	
4.	WBC staining by Leishman's stain	
5.	Total Leucocyte count by Newbaur haemocytometer	
6	Study of antigen antibody interaction: Ouchterlony double diffusion	
7.	Estimation of haemoglobin content from the blood.	
8.	Determination of blood clotting time.	
9.	Isolation of DNA from bacterial cell/ Plant cells/ Animal Cells/yeast	
10.	Estimation of DNA by DPA method	
11.	Isolation of RNA from suitable sample	
12.	Estimation of RNA by Orcinol method	
13.	Spontaneous mutation by Fluctuation analysis	
14.	Repair of DNA damage due to UV by Photo reactivation test	
15.	Visit to Local pathology Lab/Blood bank/ Industry	
Note:	**Mandatory to complete 13 Practicals**	
Suggested Readings	1. Aneja K.R. (1996) Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International (P) Ltd, New Delhi. 2. Plummer D.T. (1992) An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw Hill, Delhi. 3. Sadasivam S. and Manikam A. (1996) Biochemical Methods, 2nd Edition, New Age International (P) Ltd., New Delhi. 4. Jayaraman J. (1999) Laboratory Manual in Biochemistry, New Age International (P) Ltd., New Delhi. 5. Wilson K. and Walker J. (2010) Practical Biochemistry: Principles and Techniques of Biochemistry and Molecular Biology, 5th Edition, Cambridge Uni. Press, Cambridge. **6.** Sawhney S.K. and Singh Randhir (2000) Introductory Practical Biochemistry, Narosa Publisher, New Delhi. 7. Nigam, A. and Ayyagiri, A. (2007) Lab Manual in Biochemistry, Immunology and Biotechnology, Tata McGraw Hill, Kolkata	

	8. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edn., John Wiley and Sons, Inc.

Skill Enhancement Course (SEC): Semester- IV
SEC II: Bioanalytical Instrumentation

Total Hours: 30 **Credits: 2**

Unit	Title/ Particular Topic	Lectures
Course Objectives	➢ Explain the functioning, maintenance and safety aspects of the basic apparatus used in a Biotechnology lab. ➢ Explain the principles and applications of Bioanalytical instrumentation ➢ Utilize the knowledge for the separation of proteins/peptides by selecting appropriate separation techniques ➢ Characterize certain functionalities of biomolecules by using techniques.	
Learning Outcomes	Students will be able to: ➢ acquire comprehensive knowledge of the equipment used in Life sciences will be offered in the course an overview of the instruments used in isolation and separation of molecules will also be provided ➢ enable the students to understand all aspects of Bioinstrumentation and tools and techniques used therein	
Unit I Introduction of Bio-analytical tool	• Introduction: Analytical techniques, analyte, principle, construction, working and applications of pH meter, centrifuge, light and dark field microscope • Overview of bioinformatics and bioinformatics tools for sequence analysis, Database types, Sequence assembling using computers, Phylogenetics	**10**
Unit II Biotechniques	• Bioanalytical tools: Sample preparation, principle, construction, working, method development, optimization, analysis of results and applications • Chromatographic techniques: Adsorption, Partition and Affinity, Gel filtration, Ion exchange, GLC and HPLC • Spectroscopic techniques: Colorimetric, Spectrophotometric and spectrofluorometric • Electrophoretic techniques: Native, and SDS PAGE, IF, 2D, Agarose gel	**20**
Suggested Readings	1. Gunzler, Helmut and Williams, Alex (2001) Handbook of Analytical Techniques, 1st edn., Wiley-VCH, ISBN-13: 978-3527301652 **2.** Upadhyay, A., Upadhyay, K. and Nath, N. (2000) Biophysical Chemistry, Himalaya Publisher, Nagpur. **3.** Friefelder A. D. (1993) Physical Biochemistry, 2nd Edn., W. H. Freeman and Co., New York, USA. **4.** Skoog, D.A., Hollier, F.J. and Nieman, I.A. (1998) Principles of Instrumental Analysis, Harcourt Brace College Publishers, Orlando. **5.** Wilson, K. and Walker, J. (2000) Practical Biochemistry: Principles and Techniques, 5th Edn., Cambridge University Press, Cambridge. **6.** Willard, H.H. and Merrit, Jr. L.L. (1986) Instrumental Methods of Chemical Analysis, CBS Publishers, New Delhi. **7.** Wilson, K. and Goulding, K.H. (2010) Biologists Guide to Principle and Techniques of Practical Biochemistry, 7th edn., Cambridge University Press, Cambridge. **8.** Mikkelsen, S.R. and Corton, E. (2004) Bioanalytical Chemistry, Wiley Inter Science, New York, USA,	

Skills acquired and Job prospectus for the Biotechnology students

Biotechnology, being part of Life Science, established as interdisciplinary applied science. The interdisciplinary networking potential of biotechnology has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted current knowledge-based system to technology driven development and application in life sciences. In the milieu of research and industrialization for economic development and social renaissance, biotechnology emerged out as a major tool to work for the service of mankind.

The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and studies from (i) molecular biology to cell biology, (ii) biochemistry to biophysics, (iii) genetic engineering to stem cell research, (iv) Bioinformatics to genomics-proteomics, (v) environmental biology to biodiversity, (vi) microbiology to bioprocess engineering, (vii) bioremediation to material transformation and so on. The application of the studies on cell bioprocesses is covered with the help of technology. Green, blue and white revolution was possible due to intrinsic understanding of biotechnology.

The integration of various courses in the program help to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of biotechnology and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about biotechnology. At the end of the course, the students are expected to have good working knowledge in the field of Biotechnology. Students will surely have an urge to continue higher studies in Biotechnology and contribute significantly in the development.

Biotechnologists are always in demand as an efficient work force in fundamental research and industries. Education and research sectors require such interdisciplinary trained workforce to develop future generations of science leaders. Career opportunities for graduate students are expanding at the biotechnology parks and in manufacturing industries, teaching, research institutes and IT industry.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Structure of Syllabus

Program B. Sc.

T. Y. B. Sc. (Biotechnology)

Choice Based Credit System (CBCS)

(2020-21)

T.Y. B.Sc. (Biotechnology)

Preamble

Biotechnology has emerged as a multi-disciplinary subject that comprises many specialized areas including Microbiology, Biochemistry, Physics, Engineering, Technology etc. The subject has impacted in almost every segment of human life. The degree course of Bachelor of Science with Choice Based Credit System (CBCS) in Biotechnology has been designed with a multi-faceted approach so as meet the ever growing challenges in the field of Molecular Biology, Genetics, Immunology, Animal Tissue Culture, Bioengineering and Bioprocess Technology, Food and Pharmaceutical, Agriculture and Plant Biotechnology. The study program in Biotechnology as one of the core subjects is designed to cultivate a scientific attitude and an interest towards the modern area of Biotechnology. The beneficiaries of this course are entitled to get enriched with a wide range of theoretical and practical knowledge in the above fields. The aim is to inculcate interest in the subject and apply the knowledge gained for society, employment, business, as well as research. The subjects incorporated shall be updated with the novel technologies and innovative methods to go hand in hand with the developing demands of Life Sciences. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. It will help the students to become curious and critic in their outlook. The course is empowered with skills focused to gain proficiency in handling equipment and learning the norms and precautions needed to be strictly administered in a Biotechnology Laboratory. The B. Sc. course shall build graduates that shall apply the knowledge gained for collection and interpretation of data in research. They shall also be acquainted with skills for presentation of data in a standard scientific style. The course has the greatest asset to envisage the beneficiaries with the practical and theoretical skills needed in the subject once they qualify the degree and face the open challenges of Biotechnology in the world. The upcoming global challenges have been taken into consideration with priority during the designing of the course. This shall attract students to opt the subject so as foresee a sound knowledge in the subject and satisfy their curiosities. The motive is to lay a strong foundation for the student in the subject that shall help him grow and reach his targets in the global educational hub. The content of the syllabus has been prepared to accommodate the fundamental aspects as well as advanced developments in various disciplines of Biotechnology and to complement the needs of various applied sectors of Biotechnology.

There are 08 core courses which encompass all important aspects of the discipline of Biotechnology and are all compulsory courses. There are 04 choice-based Discipline Specific Elective (DSE) courses designed to give the students a chance to apply their knowledge of microbiology to study societal problems. The students have a freedom to select the courses of their choice. There are 02 Skill based Elective Courses (SEC) included to develop skills in areas related to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment.

The present syllabus is restructured anticipating the future needs of Biotechnology with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical courses in new restructured program will lead to impart skill-set essentials to further Biotechnology.

The candidates opting for the course shall get enough opportunities to select courses of his/her choice. This will bestow full justice to their interests. Restructuring of the syllabus has been done to suffice the needs of a choice-based credit system that shall strengthen the student's intellectual status at large. Board of Studies in Life Sciences has taken efforts to fulfil the components of Teaching-Learning-Evaluation process to a maximum extent during the compilation of the syllabi. The syllabus is vividly endowed with course objectives and learning outcomes for every subject. The guidelines laid down by University Grants Commission (UGC), New Delhi for the CBCS have been given due justice during the restructuring of the syllabi.

Hence, Board of Studies in Life Sciences in its meeting accepted the revised syllabus for T.Y.B.Sc. (Biotechnology) based on Choice Based Credit System of UGC guidelines. The path for a bright future of Biotechnology has been build up with a hope to achieve the goals in the form of fruitful program outcomes in the coming days.

There are 08 core courses which encompass all important aspects of the discipline of Biotechnology and are all compulsory courses. 04 choice-based Discipline Specific Elective (DSE) courses are designed which give the students a chance to apply their knowledge of Biotechnology to study societal problems. The students have a freedom to select the courses of their choice while Skill based Elective Courses (SEC) are also included to develop skills in areas which are related to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment.

Programme Outcome (PO):

As an outcome, the graduate students are expected to gain the following competencies upon completion of this program B.Sc.

- Students will understand the concepts and significance in the field of Biochemistry / Biotechnology / Microbiology that can be used for solving the real time problems.
- Students will acquire skills and ability in their field and find professional opportunities in industry, agriculture and higher studies.
- Students will have improved personal qualities and transferable skills to help them to groom as responsible citizens.

Program Specific Objectives (PSO):

- Graduate in Biotechnology shall acquire the basic knowledge of Biotechnology and can be eligible for pursuing higher education/ postgraduate education.
- Students will gain knowledge and develop specialized skill in the different area of Biotechnology.
- Graduate candidates will develop a sense of societal and ethical responsibility pertaining to bioinformatics, health, agriculture, dairy, genetic engineering, and fermentation industry.
- The knowledge shall promote our graduates to stand independently amidst the growing technological innovations in the subject.

Learning Objectives (LO):

- To acquaint the students with various disciplines of Biotechnology
- To articulate foundation and pillar level knowledge of Biotechnology for the beneficiaries to apply them for advanced studies in the subject.
- To enhance the practical skills with a sound theoretical background
- To apply the knowledge gained for higher education, research and profession of their choice.
- To analyze their interests among the various disciplines and implement them in their professional endeavours.

Programme Structure:

The programme includes 8 Discipline Specific Core Courses (DSC) of 3 credits each 4 each for the two semesters (Semester V and VI). There shall be inclusion of 02 Skill Enhancement Course (SEC) of 3 credits each, one for each Semester. The course has incorporated 4 Discipline Specific Elective Course (DSE) of 3 credits each, two for each Semester. The student shall have liberty to choose one of the two courses. There shall be 6 Discipline specific Core Practical courses of 2 credits each; 3 courses for each semester.

Eligibility:

Students completing Second Year CBCS (Semester III and IV) of B.Sc. (44 credits) shall be eligible for the admission to T.Y.B.Sc. (CBCS) Degree course.

Course Fee: As per University norms

Duration: The duration of B.Sc. (Biotechnology) degree program shall consist of three years.

Medium of instruction: The medium of instruction for the course shall be English.

Credit to contact hour/Duration of Lecture: 45 Lectures of 60 minutes or 54 Lectures of 50 minutes shall be conducted for 08 Discipline Specific Core courses, 02 Skill Enhancement Courses and 02 Discipline Specific Elective courses of 3 credits each. Each theory and practical course must be completed in 45 and 60 lectures, respectively of 60 minutes duration. The score allotted for 06 Discipline Specific Core practical courses is 2 credits for each course.

Attendance:

The candidates appearing for the final year examinations of B.Sc. Biotechnology need to fulfill a regular attendance record in theory and practical of not less than 80 %. Failing to fulfill the criteria, the student shall not be eligible for appearing for the T.Y.B.Sc. (CBCS) examination.

Exam Pattern

- Each theory and practical course will be of 100 marks comprising of 40 marks internal (College assessment) and 60 marks external examination (University assessment).
- Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each) while the tentative pattern of question papers shall be as follows;
- Question 1 (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
- Question 2, 3 and 4 (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
- Question 5 (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.

Internal examination (40 marks each semester):

Internal assessment (College assessment) of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.

Practical Examination:

Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5-6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am -1 pm / 2 pm- 5 pm for 2 consecutive days) in case of biotechnology practical where incubation condition, allied aspect is essential. There shall be 5 marks for laboratory logbook and well written journal, 10 marks for *viva-voce* and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one/ two expert and two examiners (external and internal) per batch for the practical examination.

Scheme

Scheme for T.Y.B.Sc. Program under the Faculty of Science and Technology includes in continuation with the First and Second Years two semesters namely Semester V and VI. Each semester shall include four Core courses, one Skill based course one Elective course, three Core practicals and one non-credit Elective Audit course.

Scheme for B.Sc. Program under Faculty of Science and Technology

Sr. No	Year → Course ↓	First Year				Second Year				Third Year				Total Credit Value
		Sem I		Sem II		Sem III		Sem IV		Sem V		Sem VI		
1	Core Courses (16)	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	i. Theory	4	4	4	4	4	3	4	3	3	4	3	4	4x14=56 3x8=24
	ii. Practical	2	4	2	4	2	3	2	3	2	3	2	3	2x14=28 2x6=12
2	Ability Enhancement Compulsory Course (AECC) (2)	2	1	2	1	2	1	2	1					2x2x2x2 =08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	3	1	3	1	2x2=04 3x2=06
4	Discipline Specific Elective (DSE) (6)									3	1	3	1	3x2=06
5	Elective Audit									No credit	Any 1	No credit	Any 1	--
6	Total Credit Value (Credit x No. of courses)	26		26		22		22		24		24		**144**

Structure of Curriculum of T.Y.B.Sc. (Biotechnology) Semester V

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	BT-501	Genetics and Molecular Biology	3	3	45	40	60
	Core II	BT-502	Agriculture Biotechnology	3	3	45	40	60
	Core III	BT-503	Animal Tissue Culture	3	3	45	40	60
	Core IV	BT-504	Bioengineering	3	3	45	40	60
SEC	Skill Based	BT-505	Food Biotechnology	3	3	45	40	60
DSE	Elective Course (Anyone)	BT-506A	Environmental Biotechnology-I	3	3	45	40	60
		BT-506 B	Bioinformatics					
DSC	Core (Practical)	BT-507	Practical Course: Industrial Biotechnology	2	4 / batch	60	40	60
		BT-508	Practical Course: Animal Biotechnology and Immunology	2	4 / batch	60	40	60
		BT-509	Practical Course: Applied and Environmental Biotechnology	2	4 / batch	60	40	60
AU	Elective Audit Course	AC-501A	NSS	No credit	2	30	100	--
		AC-501B	NCC					
		AC-501C	Sports					

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

NCC: National Cadet Corps

NSS: National Service Scheme

Structure of Curriculum of T.Y.B.Sc. (Biotechnology) Semester VI

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	BT-601	Recombinant DNA Technology	3	3	45	40	60
	Core II	BT-602	Plant Biotechnology	3	3	45	40	60
	Core III	BT-603	Immunology	3	3	45	40	60
	Core IV	BT-604	Bioprocess Technology	3	3	45	40	60
SEC	Skill Based	BT-605	Pharmaceutical Biotechnology	3	3	45	40	60
DSE	Elective course (Anyone)	BT-606 A	Environmental Biotechnology-II	3	3	45	40	60
		BT-606 B	Biostatistics					
DSC	Core (Practical)	BT-607	Practical Course: Plant Biotechnology	2	4 / batch	60	40	60
		BT-608	Practical Course: Genetics and Bioinformatics	2	4 / batch	60	40	60
		BT-609	Practical Course: Pharmaceutical Biotechnology	2	4 / batch	60	40	60
AU	Elective Audit Course	AC-601A	Soft Skill	No credit	2	30	100	--
		AC-601B	Yoga					
		AC-601C	Practicing Cleanliness					

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

Skill Enhancement Course (SEC):
To increase the potentiality of Biotechnology students in industries and to make them more employable, Food Biotechnology and Pharmaceutical Biotechnology have been introduced. This course will improve skills required in food and pharmaceuticals industries essential for Biotechnology students which will leverage their career in not only in industries, but also help them for their higher studies.

Discipline Specific Elective Course (DSE):
Elective course will give students choice to study the course of their interest. In 5th semester, student can choose either Environmental Biotechnology-I or Bioinformatics. Whereas in 6th semester they have choice between Environmental Biotechnology-II or Biostatistics. Student who has selected Environmental Biotechnology-I for 5th semester, compulsorily must take Environmental Biotechnology-II in 6th semester while one who has selected Bioinformatics shall opt for Biostatistics in 6th semester.

Audit Course (AU):
The syllabi for audit courses will be common for all courses and shall be available separately.

Equivalence of the courses for T. Y. B. Sc. (Biotechnology)

Old Syllabus (w. e. f. June 2017) (Semester pattern 60:40)		**Equivalent New Syllabus (June 2020) CBCS pattern (Semester pattern 60:40)**	
Course Code	**Paper**	**Course Code**	**Paper**
Semester V			
BT-351	Genetics	**BT-501**	Genetics & Molecular Biology
BT-352	Agricultural Biotechnology	**BT-502**	Agriculture Biotechnology
BT-353	Animal Biotechnology	**BT-503**	Animal Tissue Culture
BT-354	Industrial Biotechnology	**BT-504**	Bioengineering
BT-355	Food Biotechnology	**BT-505**	Food Biotechnology
BT-356	Environmental Biotechnology	**BT-506A**	Environmental Biotechnology-I
		BT-506B	Bioinformatics
BT-357	Practical Course- Industrial Biotechnology	**BT-507**	Practical Course- Industrial Biotechnology
BT-358	Practical Course- Animal Biotechnology & Immunology	**BT-508**	Practical Course- Animal tissue culture & Immunology
BT-359	Practical Course- Food and Environmental Biotechnology	**BT-509**	Practical Course- Applied and Environmental Biotechnology
Semester VI			
BT-361	Gene Biotechnology and Bioinformatics	**BT-601**	Recombinant DNA Technology
BT-362	Plant Biotechnology	**BT-602**	Plant Biotechnology
BT-363	Immunology	**BT-603**	Immunology
BT-364	Advanced Bioprocess technology	**BT-604**	Bioprocess Technology
BT-365	Pharmaceutical Biotechnology	**BT-605**	Pharmaceutical Biotechnology
BT-366	Biodiversity and Biometry	**BT-606A**	Environmental Biotechnology-II
		BT-606B	Biostatistics
BT-367	Practical Course- Plant biotechnology	**BT-607**	Practical Course- Plant biotechnology
BT-368	Practical Course- Genetics and Bioinformatics	**BT-608**	Practical Course- Genetics and Bioinformatics
BT-369	Practical Course- Pharmaceutical Biotechnology	**BT-609**	Practical Course- Pharmaceutical Biotechnology

T.Y.B.Sc. (Biotechnology) Semester-V

Discipline Specific Core (DSC) Course

DSC-I: BT-501: Genetics and Molecular Biology

Total Hours: 45 **Credits: 3**

Course objective

- To provide basic knowledge about the fundamental molecular process of living cells
- To introduce the students to the principles of ecology and genetic disorders.

Learning outcome

After successful completion of this course, students are expected to:

- Enrich knowledge base of biological processes through the investigation of the underlying molecular mechanisms.
- Students will gain an understanding of chemical and molecular processes that occur in and between cells.
- Aims at understanding structure, synthesis and replication of nucleic acids.

Unit	Title	Topic Particular	Lectures
Unit I	**Basic Molecular Biology**	• DNA: topological properties (linking, writhing, twisting number), • Base flipping, Palindrome, Inverted repeats and stem and loop. • Overview of DNA replication • RNA: Structure, types, functions • Denaturation and renaturation kinetics of nucleic acids • Proteins: Domain and motifs Histone proteins.	**11**
Unit II	**Transcription**	• RNA polymerase (prokaryotic and eukaryotic), • Process of transcription, Promoters and Transcription factors • mRNA processing, editing capping, adenylation, splicing, Exon shuffling, RNA Editing, mRNA transport • Regulation of Transcription: repressors and inhibitors • Transcriptional bursting/pulsing, specificity, enhancers, activators, co-activators and general transcription factors	**12**
Unit III	**Translation**	• Steps in translation: Initiation, Elongation, Termination • RNA-RNA interaction in translation, polyribosomes • Ribosome (structure and composition), Activation of tRNA, tRNA synthetase • Regulation of translation: Cytoplasmic polyadenylation, UTR sequence elements, RNA binding proteins, ribosomal regulation, non-sense mediated RNA decay, 5` decapping.	**11**

Unit IV	**Genetics, ecology and genetic disorders**	• Crossing over: Concept, mechanism, types. • Sex linked inheritance: Types of sex linkage, X and Y linked inheritance • Population, gene pool, gene frequency, genetic drift, speciation. • Hardy-Weinberg law • Concept and types of Eugenics and Euphenics • Disorders due to mutant genes: Causes, mechanism, diagnosis and treatment of Phenylketonuria urea, alkaptonuria and sickle cell	**11**

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- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8th Edn, W. H. Freeman and Company, New York.
- Brown T.A. (2016) Gene Cloning and DNA Analysis: An Introduction", 7th Edition, Wiley-Blackwell Publishers, UK ISBN: 978-1-119-07256-0
- E.D. D. De Robertis, E.M.F. De Robertis, Jr. (2012) Cell and Molecular Biology, Wolters Kluwer India Pvt. Ltd.
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- Lewin B (2013) Gene XI, Pearson Prentice Hall, Pearson Education, Inc., NT, USA.
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- Malacinski GM (2003) Essentials of Molecular Biology, 4th edn., Jones & Batiett, London. (ISBN: 0-7637-2133-6).
- Lodish Harvey, Berk Arnold, Zipursky S Lawrence, Matsudaira Paul, Baltimore David, and Darnell James (2000) Molecular Cell Biology. Media connected, W. H. Freeman and Company, New York.
- Verma P. S., Agarwal V.K. (2014) Cytology, S. Chand and Company Pvt. Ltd.
- Watson JD, Baker JA, Bell SP, Gann A, Lewin M, Losick R (2004) Molecular biology of gene, 7th edition. cold spring harbor, New York

Discipline Specific Core (DSC) Course

BT-502: Agriculture Biotechnology

Total Hours: 45 **Credits: 3**

Course objective

- This course presents application of plant biotechnology in agriculture, Nitrogen fixation and Biofertilizer, Rhizosphere microflora and its role in the rhizosphere.
- The course presents understanding of Plant pathology and disease control, horticulture and floriculture

Learning outcome

After successful completion of this course, students are expected to:

- Understand applications of biotechnology in agriculture, plant disease control and floriculture.
- Understand Nitrogen fixation and Biofertilizer, Rhizosphere microflora and its role in the rhizosphere.
- Understand the basics of Plant pathology and disease control, horticulture and floriculture

Unit	Title	Topic Particular	Lectures
Unit I	**Rhizosphere microflora and its role in the rhizosphere**	• Introduction: Rhizosphere and plant growth promoting rhizobacteria • PGPR forms (Intracellular and extracellular) • PGPR mechanism: Potassium solubilization, siderophore production, phytoharmone production, mycorrhizae and its significance, Indirect- production of antibiotics, lytic enzymes and exo-polysaccharide. • Functions of PGPR (biocontrol properties, bioinoculants, abiotic stress resistance, co inoculants • Drawbacks of PGPR	**12**
Unit II	**Nitrogen Fixation and Biofertilizer**	• Symbiotic nitrogen fixation - Legume-*Rhizobium* symbiosis, host specificity, nodule Development, mechanism of nitrogen fixation, Nitrogenase complex • Non-symbiotic nitrogen fixation - Diazotrophy, sites of nitrogen fixation in *Cyanobacteria*, *Azotobacter*, *Azospirillum.* • Assimilation of sulphur and phosphorus by plants • Biofertilizer- Concept, inoculum development for (Rhizobium and phosphate solubilizers) • Comparative account of biofertilizer and chemical fertilizer	**12**
Unit III	**Plant pathology and disease control**	• Classification of plant diseases based on symptoms. • Plant diseases - Causative agent, symptoms, pathogenesis and control of i) Bacterial blight (Telya) of Pomegranate; ii) Bacterial blight of cotton iii) Whip smut of sugar cane	**11**

		• Control methods a) Chemical control b) Eradication c) Biological (bacterial and fungal cultures) d) Integrated pest management (IPM) - development of insect resistant plant (BT crops), refugia, and ecological approach as a part of IPM.	
Unit IV	**Horticulture and Floriculture**	• Concept of horticulture and floriculture • Techniques in horticulture • Use of biotechnology in horticulture and floriculture • Floriculture market in India • Types of Green house, importance, functions and features of green house and their management.	**10**

References

- Bilgrami K.S and Dube H.G. (1994), Textbook of Modern Plant Pathology, Vikas Publications, New Delhi.
- Gupta P.K. (1998), Genetics and Biotechnology in Crop Improvement, Rastogi Publications, Meerut.
- Pathak V.N, Khatri N.K., Pathak M. (1996), Fundamentals of Plant Pathology, Agrobotanical Publications, Bikaner.
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- Vyas S., and Modi H. A. (1998), Biofertilizer and Organic Farming, Akta Prakashan, Nadiad, G.S, Meerut.

Discipline Specific Core (DSC) Course

BT-503: Animal Tissue Culture

Total Hours: 45 **Credits: 3**

Course objective

- To introduce the students to the basic principles of Animal tissue and cell culture
- The course will describe as to how animal cell culture is carried out for research and diagnostic purposes.
- How transgenic animals are generated, what are the pros and cons along with ethical issues associated with transgenesis.

Learning outcome

After successful completion of this course, students are expected to:

- Understand fundamental principles of animal cell and tissue culture
- Gain an understanding of cell culture techniques and their applications
- Understand concept of transgenesis, transgenic animals and their application as well as the human health care biotechnology

Unit	Title	Topic Particular	Lectures
Unit I	**Introduction to Animal Cell and Tissue Culture**	• History and scope of animal cell and tissue culture. • Principle, merits and demerits of animal cell/tissue culture • Laboratory facilities for Animal tissue culture. Culture media: a) Natural media b) Defined media. • Primary and established cell lines and their characterization • Primary culture, cultured cells and evolution of cell lines and their maintenance. • Large scale cultivation of mammalian cell. • Applications of animal cell culture to human health, medical and therapeutic purposes Pharmaceutical products of animal cell culture	**12**
Unit II	**Transformation in animal cells**	• Cell transformation - In vitro culture of oocytes/ embryos • DNA microinjection. • Embryogenic stem cell transfer. • In-vitro culture of oocytes and embryo Cell/embryo cryopreservation, • Measurement of cell death - Apoptosis,	**11**
Unit III	**Transgenic Animals and Cloning**	• Introduction to transgenic laboratory animals. • Principles and methods of development of transgenic animals • Animal cloning: Principle and methods with suitable example. • Transgenic domestic animals: traits affecting productivity, domestic animals as bioreactors • transgenic animals and biosafety • Economics aspects of transgenic animals	**11**

<table>
<tr><td>Unit IV</td><td>Human Healthcare Biotechnology</td><td>Genetic screening: methods of testing w.r.t. genetic disorders.
Molecular analysis of Huntington's disease, sickle cell anemia and cystic fibrosis
Prenatal diagnosis and its application
Gene Therapy: introduction, types of gene therapy
The mechanics and site of gene therapy
Applications of gene therapy: against cancer and molecular surgery</td><td>11</td></tr>
</table>

References

- Arora M.P. (2003), Biotechnology, Himalaya Publishing House, Mumbai.
- Freshney R. Ian (2006), Culture of Animal Cells: A Manual of Basic Techniques, John Wiley and Sons, Inc., New York.
- Gangal Sudha (2007), Principles and Practice of Animal Tissue Culture, Universities Press India Pvt. Ltd.
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- Purohit S.S. (2002), Agricultural Biotechnology, Agrobios India, Jodhpur.
- Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.

Discipline Specific Core (DSC) Course

BT-504: Bioengineering

Total Hours: 45 **Credits: 3**

Course objective

- This paper is introduced to acquire requisite skills for the design and development of bioreactors, media, sterilization, microbial growth etc.

Learning outcome

After successful completion of this course, students are expected to:

- Understand fundamental principles Bioprocess and bioengineering
- Understood Fermentation media, sterilization, as well as media optimization Understand concept of transgenesis, transgenic animals and their application as well as the human health care biotechnology
- Understood the basics of fermentation technology and learnt the concept of screening, optimization and maintenance of cultures.

Unit	Title	Topic Particular	Lectures
Unit I	**Basics of Bioengineering**	• Definition of Bioprocesses engineering. Introduction to simple engineering calculations, Mass & Energy Balances • Selection of mutants: producing improved level of primary metabolites with suitable example- - which do not produce feedback inhibitors or repressors. - which do not recognize presence of inhibitors or repressors.	**12**
Unit II	**Fermentation media and optimization**	• Carbon sources: Cane and Beet molasses, Malt, Corn, Starch, oils, hydrocarbons, alcohols. • Nitrogen sources: Corn steep liquor, Soybean meal, peanut meal, distillers soluble, • Antifoams: types, mode of action, advantages and disadvantages. • Inoculum media and Production media • Medium Optimization: Classical Approach, Plackett and Burman design	**12**
Unit III	**Air & Media sterilization**	• Air Sterilization Principles, Mechanisms of capture of particles in Air, Depth & Screen Filters, Sizing, Testing & validation of filters for air. • Principles of Media Sterilization- Decimal reduction, • Design of sterilization cycle using kinetics of thermal death of microbes, Equipment's used in sterilization.	**11**
Unit IV	**Microbial growth and culture system**	• Culture system- a. Batch culture system b. Fed batch culture system c. Semi continuous culture system	**10**

		d. Continuous culture system • Microbial growth kinetics in bioprocess	

References

- Dubey R.C (2006), A Text Book of Biotechnology, S. Chand and Co. Ltd, New Delhi.
- Kalaichelvan P.T; I Arul Pandi (2007), Bioprocess Technology, MJP Publishers, Chennai.
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- Satyanarayan, U., Biotechnology, (2009), Books and Allied Pvt. Ltd.

Skill Enhancement Course (SEC)

SEC: BT-505: Food Biotechnology

Total Hours: 45 **Credits: 3**

<table>
<tr><td colspan="4">Course objective
The course provides understanding of Microbial analysis of milk, Microbial production of fermented food viz. cheese, bread etc.
Causes of food spoilage, Spoilage of fruit, Vegetables, Dairy product
Food Preservation –Chemical Method, Physical method</td></tr>
<tr><td colspan="4">Learning outcome
After successful completion of this course, students are expected to:
Understand fundamental principles food and milk microbiology
Understood fermented products, and pasteurization of milk
Understood the basics of food spoilage, food preservation, and fermented food.</td></tr>
<tr><th>Unit</th><th>Title</th><th>Topic Particular</th><th>Lectures</th></tr>
<tr><td>Unit I</td><td>Milk</td><td>Milk - Definition, composition and types.
Fermented milk products - Yoghurt and cheese.
Preservation of milk by heat treatment (Pasteurization and ultra-high temperature).
Physicochemical characterization of milk.
Milk spoilage: MBRT and Resazurin test.</td><td>10</td></tr>
<tr><td>Unit II</td><td>Food Spoilage</td><td>Primary sources of microorganisms in food.
Food borne Bacteria/ Microbes in food – Bacteria, Molds and Yeasts.
Intrinsic and extrinsic factors affecting food micro flora.
Food Processing –Introduction, Objective, causes and effect.
Food Preservation- Chemical and Physical Method.
Food Additives: - Preservative, colour, and stability.
Food adulteration: - (Internal and Incidental).</td><td>12</td></tr>
<tr><td>Unit III</td><td>Food Preservation</td><td>Packaging & Labelling of foods.
HACCP system to prevent food borne illness.
Food pathogen, toxins and their detection in food.
Biosensors for food quality assessment.
ELISA assay for detection and quantitation of toxins in food.</td><td>11</td></tr>
<tr><td>Unit IV</td><td>Fermented Food</td><td>Fermented food- Idli and Bread.
Causes of food spoilage.
Spoilage of fruit, vegetables, meat, eggs, dairy product.
Fungal toxins: Afflation.
Bacterial Toxins: - Bacterium and staphylococcal toxins.</td><td>12</td></tr>
<tr><td colspan="4">References</td></tr>
</table>

- Adam M.R and Moss M.O (2003), Food Microbiology, New Age International Pub. New Delhi.
- Frazier W.C and Westhoff D.C (2005), Food Microbiology, 4th Edi. Tata Mc Graw Hill Pub Company Ltd. New Delhi.
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Discipline Specific Elective (DSE) Course

BT-506A: Environmental Biotechnology-I

Total Hours: 45 **Credits: 3**

Course objective

- An exposure to environmental perspectives.
- Insight into the management of wastewater, biodegradation techniques bioremediation and xenobiotics.

Learning outcome

After successful completion of this course, students are expected to:

- Domestic wastewater treatment, Classification of Wastewater treatment
- Biodegradation-Concept, Biodegradation of hydrocarbon, Measurement of biodegradation
- Bioremediation-Concept, Methods of Bioremediation (In-situ and Ex-situ Bioremediation)
- Understand Xenobiotic and recalcitrant, Metabolism of Xenobiotics

Unit	Title	Topic Particular	Lectures
Unit I	**Wastewater Treatment**	• Domestic wastewater treatments – i) Primary Treatment ii) Secondary Treatment iii) Tertiary Treatment • Aerobic Biological Treatment – Activated Sludge Process, Rotating Biological Contactors, Trickling Filters • Anaerobic Biological Treatment – Packed bed reactor, Air lift membrane bioreactor, Fluidized bed reactor • Important microorganisms and their role in wastewater treatment • Plasmid borne metabolic activities of microbes.	**12**
Unit II	**Xenobiotic**	• Introduction - Concept and Definition • Recalcitrancy • Xenobiotics degradation – i) Pesticide degradation (Principle with suitable example) ii) Herbicide degradation (Principle with suitable example) • Metabolism of xenobiotics - Cytochrome P450 system • Metabolic reactions - Phase I and Phase II	**11**
Unit III	**Bioremediation**	• Introduction –Definition and Concept • Methods of bioremediation (*In-situ* and *Ex-situ* Methods) • Bioremediation of soil – Bioremediation of saline and alkaline soil • Phytoremediation – Concept and Types • Applications of bioremediation	**11**
Unit IV	**Biodegradation Techniques**	• Concept and Definition • Types - Ready, ultimate and inherent	**11**

		biodegradation • Aerobic degradation pathways in microbes • Anaerobic degradation pathways in microbes • Biodegradation of hydrocarbon with suitable examples	

References

- Asthana D.K. and Asthana M. (2001), Environment: Problems and Solutions, S. Chand and Company Ltd, New Delhi
- Chatterji A.K. (2002), Introduction to Environmental Biotechnology, Prentice Hall of India Pvt. Ltd, New Delhi.
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Discipline Specific Elective (DSE) Course

BT-506(B): Bioinformatics

Total Hours: 45 **Credits: 3**

Course objective

- The primary goal of this course is to uncover how various tools and techniques of bioinformatics can be utilized in studies pertaining to macromolecules (DNA, RNA, protein).
- After completing this course students will be able to analyse, interpret and study fundamental biological data stored in databases.

Learning outcome

After successful completion of this course, students are expected to:

- Understand fundamentals of computer and internet and world wide web
- Understand the classification database used in bioinformatics Primary and secondary.
- BLAST, gene bank, EMBL, DDBJ, NCBI
- Principles and applications of evolutionary analysis of biological data

Unit	Title	Topic Particular	Lectures
Unit I	**Fundamentals of computer and internet**	• Introduction to Computer system – Hardware's and Software's, operating system (OS). • Concept of the World Wide Web (www), Browsers. • Introduction of the Internet – Definition, History, Basic Concept. • Introduction of Bioinformatics - Definition, history and scope of bioinformatics.	**12**
Unit II	**Biological Databases**	• Overview of Bioinformatics. • Different types of data retrieval and submission. • Introduction to Biological Databases • Sequence database – Primary and Secondary Databases • Nucleic acid sequence database -NCBI (GenBank), EMBL, DDBJ. • Protein / amino acid sequence database - PIR-PSD, SwissProt, TrEMBL	**12**
Unit III	**Online biological data analysis**	• Data analysis using bioinformatics tools. • Sequence comparisons and alignment • Scoring Matrices - • Introduction to FASTA • Introduction and application of BLAST– types of BLAST [BLASTn, BLASTp, BLASTx, t BLASTn, tBLASTx] • Pairwise Sequence Alignments - ▪ Global Alignments - Needleman Wunsch Algorithm ▪ Local Alignments - Smith Waterman Algorithm	**11**

Unit IV	**Evolutionary analysis of biological data**	• Introduction to concepts of phylogenetic tree analysis. • Parts of phylogenetic tree - Root, Branch, Nodes, Clade, Taxon (OUT), Ingroup and Outgroup. • Overview of submission, publication, retrieval of analysed data using bioinformatics tools.	**10**

References

- Baxevanis A.D and Ouellette B.F.F. (2002) Bioinformatics: a practical guide to the analysis of genes and proteins. 2nd Ed. John Wiley & Sons, Inc. Publications, New York.
- Baxevanis A.D, Davison D.B, and Petsko G.A. (2004) Current protocols in bioinformatics. John Wiley & Sons, Inc. Publications, New York.
- Orengo C, Jones D and Thornton J. (2003) Bioinformatics: genes, proteins and computers. Bios Scientific Publishers, Ltd. Oxford.
- Michael R, Barnes and Ian C. Gray. (2003) Bioinformatics for Geneticists. John Wiley & Sons, Ltd.
- Attwood T. K. et al (2007) Introduction To Bioinformatics, Pearson India
- Rastogi SC, Mendiritta N, Rastogi P. (2013) Bioinformatics: Methods and Applications, Prentice-Hall of India Pvt.Ltd
- https://www.ncbi.nlm.nih.gov/

<table>
<tr><th colspan="3">Discipline Specific Core (DSC) Course Practical</th></tr>
<tr><th colspan="3">BT 507 Practical Course: Industrial Biotechnology</th></tr>
<tr><th>Total hours: 60</th><th></th><th>Credits: 2</th></tr>
<tr><th>Sr. No</th><th>Topic</th><th>Lectures/ Hours</th></tr>
<tr><td colspan="3">Course Objectives:
• To acquaint with microbial fermentations
• Gain knowledge about upstream and downstream process.</td></tr>
<tr><td colspan="3">Learning outcomes
After successful completion of this course, students are expected to:
• Learn principles underlying fermentation processes.
• Know various stages in bioprocess that involve upstream and downstream process.
• Understand actual fermentation process of some metabolites</td></tr>
<tr><td>1.</td><td>Study of different parts of fermenter</td><td>04</td></tr>
<tr><td>2.</td><td>Fermentative production of antibiotics/ vitamins</td><td>04</td></tr>
<tr><td>3.</td><td>Determine thermal death time of given bacteria</td><td>04</td></tr>
<tr><td>4.</td><td>Fermentative production of enzyme – Amylase/lipase</td><td>04</td></tr>
<tr><td>5.</td><td>Fermentative production of alcohol using Sacharomyces cerevisiae</td><td>04</td></tr>
<tr><td>6.</td><td>Fermentative production of wine using fruit juice.</td><td>04</td></tr>
<tr><td>7.</td><td>Fermentative production of organic acid (Citric acid)</td><td>04</td></tr>
<tr><td>8.</td><td>Estimation of fermentative product (Acetic acid from vinegar)</td><td>04</td></tr>
<tr><td>9.</td><td>Estimation of ascorbic acid from given food sample/fermented broth by titrimetric method</td><td>04</td></tr>
<tr><td>10.</td><td>Estimation of penicillin/streptomycin by chemical assay</td><td>04</td></tr>
<tr><td>11.</td><td>Estimation of penicillin/streptomycin by biological assay</td><td>04</td></tr>
<tr><td>12.</td><td>Preparation of Sauerkraut by microorganisms</td><td>04</td></tr>
<tr><td>13.</td><td>Visit to any food /fermentation industry</td><td>04</td></tr>
<tr><td>Suggested Readings</td><td colspan="2">• Aneja K. R. (2003) Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan, New Delhi.
• Davis J and Freito F Physical and chemical methods of wastewater analaysis.
• Gaud R.S., Gupta G. D., Gokhale S.B. (2018) Practical Biotechnology. Nirali Prakashan, Pune
• Sadasivam S. & Manickam A (2005) Biochemical Methods, II edn. New Delhi.
• Schmauder H-P (2003) Methods in Biotechnology. Taylor & Francis Ltd
• Zito S and Gupta S K (2006) A Handbook of Practical and Clinical Immunology, Vol I & II, 2nd Edn. CBS Publishers.
• Zito S W Pharmaceutical Biotechnology (1997) A programmed Text. 2nd edn. Technomic publishing Lancaster.</td></tr>
</table>

Discipline Specific Core Course (DSC) Practical

BT-508: Practical Course: Animal Biotechnology and Immunology

Total hours: 60		**Credits: 2**

Course Objectives:
- To acquaint with Animal cell cultures
- Gain knowledge media and growth conditions require for animal cell culture.
- To train to different immunological techniques.

Learning outcomes

After successful completion of this course, students are expected to:
- achieve skill in animal cell culture techniques
- Learn principles underlying immunological techniques
- Know various immunological techniques and blood group detection.

Sr. No	Topic	Lectures/ Hours
1	Animal cell culture media preparation, sterilization, washing and packing	04
2	Staining of animal tissue by Haematoxylin / Periodate staining	04
3	Observation and identification of different cell types in peripheral blood	04
4	Survival curve of bacteria against UV radiations and chemical mutagens	04
5	Study of nucleic acid separation by Agarose Gel Electrophoresis	04
6	Study of Immuno-Diffusion by Ouchterlony Double Diffusion technique	04
7	Detection of antigen, antibody reaction by ELISA tests	04
8	Preparation of O and H antigen of *Salmonella.*	04
9	Study of agglutination reaction and its significance performing Widal test	04
10	Immobilization of whole cell (yeast) in calcium alginate	04
11	Study of ABO antigens by blood typing	04
12	Visit to Animal cell culture /Diagnostic laboratory	04

Suggested Readings

- Aneja K. R.(2003) Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan, New Delhi.
- Claverie J M and Notredame C (2003) Bioinformatics: A Beginner's Guide. John Wiley & Sons.
- Purohit S. S. (2006) A Laboratory Manual in Plant Biotechnology, India.
- Rashidi H. H. and Buehler L. K. (2005) Bioinformatics Basics: Applications in Biological Science and Medicine. CRS Press, USA.
- Sadasivam S. and Manickam (2005) A Biochemical Methods, 2nd edn. New Delhi.

- Schmauder Hans-Peter (2003) Methods in Biotechnology. Taylor & Francis Ltd
- Schuler M A and Zielinski R E (1989) Methods in Plant Molecular Biology. Academic Press, Inc. USA
- Talwar G P and Gupta S K (2006) A Handbook of Practical and Clinical Immunology, Vol I & II, 2nd Edn. CBS Publishers.
- Vyas S P ad Kohli D. V. (2010) Methods in Biotechnology and Bioengineering. CBS Publishers & Distributors.

Discipline Specific Core Course (DSC) Practical		
BT-509: Practical Course: Applied and Environmental Biotechnology		
Total hours: 60		**Credits: 2**
Sr. No	**Topic**	**Lectures/ Hours**

Course Objectives:

- To acquaint with microbial cell from fermented food.
- Gain knowledge different water analysis methods.
- To train to check different milk quality analysis techniques.

Learning outcomes

After successful completion of this course, students are expected to:

- Isolation and characterization of food fermenting organism,
- Understand various aspects of environmental biotechnology like BOD, COD
- Understand the soil contents.

1	Isolation and characterization of food fermenting organism from idli batter	04
2	Analysis of mycotoxin (Aflatoxin) in fungus contaminated food material	04
3	Microscopic examination of food/milk by breed method	04
4	Quality checking of milk - MBRT method	04
5	Evaluation of Pasteurization of milk - Phosphatase test	04
6	Determination of Total Viable Count from milk	04
7	Determination of Biological Oxygen Demand (BOD) of polluted water	04
8	Determination of Chemical Oxygen Demand (COD) of polluted water	04
9	Isolation of metal interacting bacteria from industrial effluent.	04
10	Determination of total carbohydrates and phosphorus of soil	04
11	Demonstration of total nitrogen estimation by Kjeldahl's method	04
12	Visit to wastewater treatment plant of any industry	04

Suggested Readings

- Plummer D T. (1992) An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
- Purohit S.S. (1995), A Laboratory Manual of Plant Biotechnology, Agrobotonica Pub. India. Pvt. Ltd., Bikaner
- Reddy M. G., Reddy M. N., Saigopal D. V. R. and Mallaiah K. V. (2008) Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai
- Sadashivam S. and Manickam A. (1996), Biochemical Methods, 2nd Edi. New Age International, New Delhi.
- Schmauder Hans Peter (1997), Methods in Biotechnology, Taylor and Francis, London.
- Schuler M. A. and Zielinski R. E. (1989), method in plant molecular biology.

T.Y.B.Sc (Biotechnology) Semester-VI

Discipline Specific Core (DSC) Course

BT-601: Recombinant DNA Technology

Total Hours: 45 **Credits: 3**

<table>
<tr><td colspan="4">Course objective
Provide Basic knowledge of principles of genetic engineering, enzymes, vector types, Methods of gene transfer
Provide an understanding on application of genetic engineering techniques in basic and applied experimental biology and conducting experiments</td></tr>
<tr><td colspan="4">Learning outcome
After successful completion of this course, students are expected to:
Basic principles of genetic engineering, enzymes, vector types, Methods of gene transfer
Gene cloning, indirect and direct screening
Expression strategies for heterologous genes, gene bank, animal farming
Techniques and application DNA sequencing</td></tr>
<tr><th>Unit</th><th>Title</th><th>Topic Particular</th><th>Lectures</th></tr>
<tr><td>Unit I</td><td>Basics of rDNA technology</td><td>Genetic engineering: concept, principle and applications.
Enzymes: Restriction endonucleases and its types, DNA methylases, DNA polymerase, DNA ligases, Kinases, Phosphatases, topoisomerases.
Cloning vectors: Choice and its properties,
Bacterial vectors: plasmid, Bacteriophage, Cosmids, Phagemids, BACs.
Eukaryotic vectors: YACs, Ti, SV40
Cloning hosts: Prokaryotic and eukaryotic hosts: properties
Applications of genetic engineering: Agriculture, Industry, Environment and Pharmaceutical (with one suitable example of each)</td><td>12</td></tr>
<tr><td>Unit II</td><td>Techniques in rDNA Technology</td><td>Techniques in r DNA technology: Agarose gel electrophoresis, Autoradiography
Gene transfer techniques: Transfection, Electroporation, Microinjection, Biolistic.
Blotting techniques – Southern, Northern, Western and Dot blotting</td><td>11</td></tr>
<tr><td>Unit III</td><td>Methods in molecular biology</td><td>DNA sequencing: Sangers method, Maxam and Gilbert method, Automated DNA sequencing
PCR – Principle and techniques, applications.
Types (Nested, Inverse, Anchored, Reverse, Real-time, Asymmetric)
Analysis of polymorphism: RFLP, RAPD, SNPs
DNA fingerprinting – Principle, Methodology and applications</td><td>11</td></tr>
<tr><td>Unit IV</td><td>rDNA technology:</td><td>Applications of r-DNA Technology in:</td><td>11</td></tr>
</table>

	Applications	Health and Medicine: Insulin, Interferon, Hepatitis vaccine, Agriculture: BT, Herbicide resistance • Gene mapping - Co-transformation and interrupted mating experiment	

References

- Arora M.P (2003), Biotechnology, Himalaya Publishing House, Mumbai
- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8th edition, W. H. Freemand and Company, New York.
- Brown T. A. (2016) Gene Cloning and DNA Analysis: An Introduction", 7th Edition, Wiley-Blackwell Publishers, UK ISBN: 978-1-119-07256-0.
- Bruce A. (2008), Molecular Biology of the Cell, 5th Edition. Publisher: Garland Science, New York.
- Clavene J.M and Notredame C (2003), Bioinformatics: A Beginner's Guide, Wiley-Dreamtech India Pvt.ltd., New Delhi.
- Dubey R.C (2006), A Text Book of Biotechnology, S. Chand and Co. Ltd, New Delhi.
- Jogdand S.N (2006), Gene Biotechnology, Himalaya Publishing House, Mumbai.
- Joshi P (2002), Genetic Engineering and its applications, Agrobios Pub, Jodhpur.
- Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning.
- Mitra Sandhya (2006), genetic Engineering, MacMillan India Ltd, Delhi.
- Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.
- Strickberger M.W. (2015), Genetics, 3rd edition, Pearson, India.

Discipline Specific Core (DSC) Course

BT-602: Plant Biotechnology

Total Hours: 45 **Credits: 3**

Course objective

- This course will provide knowledge about different techniques of plant biotechnology utilized for conservation and mass propagation of rare and endangered plant species to the students.
- The course will enlighten student about principles of plant tissue culture including *in vitro* culture of different plant parts.
- The course will provide detail pertaining to tools and processes involved in generation of transgenic plants.

Learning outcome

After successful completion of this course, students are expected to:

- Understand concept of totipotency, organization of plant tissue culture, aseptic technique of PTC, meristem culture, organ culture
- Principles and applications of phytohormones
- Transgenic plants- methods, analysis, applications
- Concept of transformation and role of Agrobacterium

Unit	Title	Topic Particular	Lectures
Unit I	**Introduction to Plant Tissue Culture**	• Totipotency- Definition and concept. • Laboratory organization of PTC. • Designing of culture media for PTC. • Phytohormones-Definition, Classification, Physiological effects and functions of Auxins, Cytokinins and Gibberellins • Aseptic techniques of PTC	10
Unit II	**Aseptic techniques of PTC**	• Callus and meristem culture. • Organ Culture • Root culture • Anther culture • Pollen culture and protoplast culture • Somatic embryogenesis	12
Unit III	**Transgenic plants**	• Transgenic plants - History and concept • Methods of developing transgenic plants - Electroporation, microinjection, particle bombardment, liposome mediated gene transfer • *Agrobacterium* mediated gene transfer (details of the Ti plasmid and its transfer into plant cells • Analysis of transgenic plant material – selectable marker and reporter gene	12
Unit IV	**Applications of transgenic Plants and IPR**	• Herbicide resistance (Glyphosphate and Atrazine) • Resistance against insects and pests (Bt endotoxin and protease inhibitor) • Plant cells as bio factories for the production of secondary metabolites (biopolymer and protein) • Ecological risk assessment of genetically modified crops	11

		• Intellectual property rights in plant varieties (Plant breeders' rights)	

References

- Gupta P. K. (2005), Elements of Biotechnology, Rastogi Publication Meerut.
- Ignacimuthu S. (1997), Applied plant biotechnology, Science Publishers, U.S.
- Ramavat K. G. (2008), Plant biotechnology, S. Chand and Co., New Delhi.
- Gupta P. K. (2005), Molecular biology and genetic engineering, 1st edition, Rastogi Publication Meerut.
- Verma S. K., Verma M. (1995), A Textbook of Plant Physiology, Biochemistry and Biotechnology, S. Chan and company ltd, New Delhi.
- Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata.
- Jain V. K. (1983), Fundamentals of Plant Physiology, 3rd edition, S. Chan and company ltd, New Delhi
- Chawla H.S. (2009), Introduction to Plant Biotechnology, 3rd edition, CRC press.
- Jogdand S.N. (2012), Advances in Biotechnology, Himalaya Publishing House, Mumbai.

Discipline Specific Core (DSC) Course

BT-603: Immunology

Total Hours: 45 **Credits: 3**

Course objective

- At the end of the course, students will be able to appreciate the strengths and weaknesses of our immune (defence) system.
- The course will provide sound knowledge of how immune system deals with various pathogens, different processes and cell types involved in prevention of disease along with the principle and applications of immune techniques.

Learning outcome

After successful completion of this course, students are expected to:

- Basic principles of Immune system, types of immunity, primary and secondary lymphoid organ.
- Antigen presentation, immune response lymph organs, complements system, immunological disorders.
- Ag-ab interactions, precipitation, agglutination, RIA, ELISA, monoclonal antibodies.

Unit	Title	Topic Particular	Lectures
Unit I	**Cells and Organs of Immune System**	• Blood cells: Morphology, formation and function, regulation of hematopoiesis • Primary lymphoid organs (Structure and function of Thymus and Bone marrow) • Secondary lymphoid organs (Structure and function of Spleen and Lymph node) • Primary and secondary immune response	**10**
Unit II	**Immune Mechanism**	• Antigen processing and presentation: Need of antigen presentation, APC's, Pathways • (Endogenous and Exogenous) • Inflammatory response: Role of lymphocytes in inflammation • Cell Mediated Immunity (T cell types, T cell activation, mechanism) • Humoral immunity (B- cell Proliferation, Differentiation) • Cytokines: Properties and role with examples • Complement system: Classical and Alternative pathway, Complement deficiency, • Biological activities of complement activation.	**12**
Unit III	**Immunological Disorders**	• Hypersensitivity: Types and mechanism in detail (Type I to IV) • Autoimmune diseases: a. Anemia b. Rheumatoid arthritis c. Diabetes • Myasthenia gravis	**11**
Unit IV	**Immunological Technique**	• Radio-Immuno Assay (RIA) • Enzyme Linked Immuno Sorbent Assay (ELISA): Direct and indirect ELISA	**12**

		• Immunofluorescence: Direct and indirect • Immunoelectrophoresis • Complement fixation • Western blot • Immunodiffusion	

References

- Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
- Ananthnarayan, P., Paniker, C. K.J., (1990), Textbook of Microbiology, Orient Longman, Madras.
- Banker, D (1980), Modern Practice in Immunization, 3rd Ed., Popular Prakashan Pvt. Ltd., Bombay.
- Glazier, A. M., Nikaido, H., (1995), Microbial Biotechnology, W. H. Freeman and Co., New York.
- Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

Discipline Specific Core (DSC) Course

BT-604: Bioprocess Technology

Total Hours: 45 **Credits: 3**

Course objective

- To understand the role of a bioprocess engineer in chemical, pharmaceutical and wine industry.
- The student would be able to understand the integrated bioprocess, design reactors, process economics, quality aspects, IPR and patenting,
- To develop concepts to scale-up bioprocesses for industry as well as research organizations.

Learning outcome

After successful completion of this course, students are expected to:

- Basic principles of upstream and downstream process of different commercially important products: enzymes, antibiotics, organic acids
- Understand Quality and economic aspects ion fermentation
- Understand the principles and role of biotechnologist in QC, QA, IPR and patenting.

Unit	Title	Topic Particular	Lectures
Unit I	**Fermentation products**	Fermentation processes with respect to - Microorganisms involved, inoculum preparation, medium used, fermentation process and recovery of: • Enzyme: Amylase • Organic acid: Citric acid • Antibiotic: Cephalosporin • Vitamin - Vitamin B_{12} • Beverages: Wine	12
Unit II	**Biotransformation and immobilization**	• Biotransformation: Concept and types of biotransformation reactions. • Biotransformation of steroids, Antibiotics, Arachidonic acid to prostaglandins with respect to their applications in pharmaceutical industry. • Immobilization of enzyme: solid support, Methods of immobilization. • Commercial applications of immobilized enzymes in food industry, pharma, dairy &other applications.	12
Unit III	**Quality and economic aspects of biological products**	• Sterility testing. • Pyrogen testing. • Carcinogenicity testing. • Toxicity testing • Good Laboratory Practices (GLP • Fermentation economics: Cost estimates, capital cost estimates, operating cost estimates. process design	10
Unit IV	**Intellectual Property Rights**	• Introduction to Patent, steps involved in filling, trade secret, • Copy rights and Trademark, Designs and Geographical Indication. • Introduction to - GATT (General Agreement of Tariff and Trades) and	11

		• TRIPS (Trade-Related Aspects of Intellectual Property Rights agreement) • Patenting of microorganisms, transgenic organisms, higher plants and higher animals.	

References

- Patel, A. H., Industrial Microbiology, 2nd edition, (2016), Laxmi Publications, New Delhi.
- Pauline Doran, Bioprocess Engineering Principles, 2nd Edition, (2012), Academic Press.
- Peter F. Stanbury. (2009) Principles of Fermentation Technology, 2E, Elsevier India Pvt. Limited.
- Satyanarayan, U., (2009) Biotechnology, Books and Allied Pvt. Ltd.
- Schuler, M. and Kargi, F. (2002) Bioprocess Engineering - Basic Concepts, 2nd edition, Prentice Hall.
- http://copyright.gov.in/frmContactUs.aspx
- www.ipindia.nic.in

Skill Enhancement Course (SEC)

SEC: BT-605: Pharmaceutical Biotechnology

Total Hours: 45 **Credits: 3**

Course objective

- To introduce undergraduate students the basic concepts of pharmaceutical biotechnology.
- The course will provide the basic information about various terms, concept, production and analytical techniques of pharmaceutical biotechnology.

Learning outcome

After successful completion of this course, students are expected to:

- Gain basic knowledge applications of biotechnology in the field of pharmaceuticals.
- Will understand the concept of drug discovery, drug designing.
- Will get knowledge of various medicinally important secondary metabolites as well as the role of recombinant DNA technology for the improvement of productivity and efficacy.

Unit	Title	Topic Particular	Lectures
Unit I	**Introduction to pharmaceutical biotechnology**	• Introduction of pharmaceutical biotechnology / Biopharmaceuticals. • Introduction to drug design and discovery • Stages in the drug discovery process. • Computer-Aided Drug Design (CADD) • Concept of Prodrug • Applications of pharmaceutical biotechnology.	11
Unit II	**Secondary metabolites of plant and microorganisms**	• Introduction of secondary metabolites. • metabolites of plant – Phenolics, Alkaloids, Saponins, Terpenes, Lipids and Carbohydrates • Secondary metabolites of microorganisms – Antibiotics, Antitumor agents, • Pharmacological and nutraceutical agents, Enzymes and enzyme inhibitors and agricultural and animal health products	11
Unit III	**Advances in pharmaceutical biotechnology**	• Recombinant DNA technology (RDT) • Techniques of gene manipulation, cloning strategies, cloning and expression vectors, recombinant selection and screening, expression in *E.coli* and yeast. • Applications of the RDT in the production of in the production of recombinant proteins (rProteins) a) Regulatory proteins interferon, interleukins etc. b) Blood products – Erythropoietin. c) Hormones: Insulin.	12
Unit IV	**Vaccines**	• Definition and Characteristics of ideal vaccine, • Types of vaccines with one example, • Modern vaccines:	11

		a) Recombinant vaccines: Hepatitis – B, b) Edible vaccines: concept with suitable example c) Subunit vaccines d) DNA vaccines.	

References

- Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
- Hussein, R. A., and El-Anssary, A. A. (2018). Plants secondary metabolites: the key drivers of the pharmacological actions of medicinal plants. Herbal Medicine.
- Liljefors, T., Krogsgaard-Larsen, P., & Madsen, U. (Eds.). (2002). Textbook of drug design and discovery. CRC Press.
- Schäfer, H., and Wink, M. (2009). Medicinally important secondary metabolites in recombinant microorganisms or plants: progress in alkaloid biosynthesis. *Biotechnology Journal: Healthcare Nutrition Technology*, 4(12), 1684-1703.
- Thirumurugan, D., Cholarajan, A., Raja, S. S., & Vijayakumar, R. (2018). An introductory chapter: secondary metabolites. Second metab—sources Appl, 1-21.
- Zaroff, S., and Tan, G. (2019). Hybridoma technology: the preferred method for monoclonal antibody generation for in vivo applications.

Discipline Specific Elective (DSE) Course

BT-606A: Environmental Biotechnology-II

Total Hours: 45 **Credits: 3**

Course objective

- This course will provide the students basic knowledge of Methods and applications of taxonomy.
- The course will enlighten student about principles of bioprospecting, biomonitoring of soil and air.
- The course will provide detail pertaining Principles of Toxicology and Biodiversity and its Conservations.

Learning outcome

After successful completion of this course, students are expected to:

- Understand basic knowledge of Methods and applications of taxonomy, nomenclature with respect to plants, animals and prokaryotes
- Principles and applications bioprospecting, biomonitoring of soil and air
- Detail understanding of pprinciples of toxicology and Biodiversity and its conservations

Unit	Title	Topic Particular	Lectures
Unit I	**Methods in taxonomy**	• Evolutionary classification, taxonomic hierarchy, concept of species • Numerical taxonomy, dendrogram and cladogram • Chemotaxonomy, nomenclature with respect to plants, animals and prokaryotes (suitable examples) • Application of taxonomical methods in biodiversity	**10**
Unit II	**Bioprospecting**	• Concept and examples of bioindicators (plants, algae, rotifers, earthworms, protozoa and microbes) and biomonitoring. • Biomonitoring of aquatic environment • Biomonitoring of soil environment. • Biomonitoring of air quality (pollen bioassay) • Principle and applications of biosensors in environmental analysis.	
Unit III	**Principles of Toxicology**	• Concept, classification, toxic effects, definition and estimation of LD_{50}. • Evaluation of toxicity: Acute, sub-acute and chronic toxicity testing, mutagenic assay (Ames assay), reproductive toxicity tests. • Metabolism of Xenobiotics: Cytochromes P_{450} system, Phase – I and Phase –II metabolic reactions. • Environmental toxicities with special reference to DDT, organophosphorous and organochlorine pesticides, heavy metals.	
Unit IV	**Biodiversity and its Conservations**	• Species concept, species diversity and ecostability (plant, animal and microbial),	

		Red Data Book, Endangered Species. • Hot spots of biodiversity, biodiversity at national level. • Causes and implications of loss of biodiversity • Conservation of biodiversity: *in-situ* and *Ex-situ* methods (principle and applications) • Convention on biodiversity (Earth Summit, Rio de Janeiro) • National Biodiversity Authority constitution and role.	

References

- Agrawal K. C. (1999) Biodiversity. Agro Botanica, Bikaner.
- Arora M. P.(2017) Biotechnology, Himalaya publishing house, Mumbai
- Asthana D. K. and Asthana M. (1998) Environment – Problems and solutions.
- Chatterji A. K.(2011) Introduction to Environmental Biotechnology
- Evans G. M and Furlong J. C. (2010) Environmental Biotechnology Theory and application.
- Gupta P. K. (2017) Biotechnology & Genomics in Crop Improvement Rastogi Publications. Meerut
- Ignacimuthu S (2007) Basic Biotechnology, Tata McGraw Hill Pub. Co. Ltd
- Kale V and Bhusari K (2010) Applied Microbiology Himalaya Publishing house.
- Purohit S.S.(1995) Agricultural Biotechnology Agro Botanica, Bikaner

Discipline Specific Elective (DSE) Course

BT-606B : Biostatistics

Total Hours: 45 **Credits: 3**

Unit	Title	Topic Particular	Lectures
Course objective • Provide detail knowledge about basic principles in biophysics, data collection and analysis • To enrich the students how to utilize various tools of biostatics in interpretation of biological data. • The course covers other core areas of biostatistics including probability, correlation and regression.			
Learning outcome After successful completion of this course, students are expected to: • Students will be able to characterize data and understand different sampling methods. • Use descriptive tools to summarize and display biological data • Identify appropriate statistical methods to be applied in each research setting, apply these methods, and acknowledge the limitations of those methods			
Unit I	**Introduction of biostatistics, sampling and probability**	• Introduction: Meaning, definition, Importance of the study of biostatistics, Biostatistics and its role in medical and agricultural biotechnology, Variables and their types, Measurement scales. • Defining population and selecting samples: Definition, Types- simple, random, stratified, cluster and double sampling. • Need for sampling - Criteria for good samples, Application of sampling • Probability and Standard Distributions: Meaning of probability of standard distribution, the binominal distribution, the normal distribution,	12
Unit II	**Systematic organization and Display of data**	• Tabulation of Data: Types of data- qualitative and quantitative, Frequency tables and histograms, frequency polygons, smooth frequency polygon, cumulative frequency curve, Normal probability curve, bar charts and pie charts • Importance and application of following: Testing of Hypotheses Level of significance, Degrees of freedom, Chi-square test, test of Goodness of fit & student t-test and p – value.	12
Unit III	**Measures of central tendency**	• Need for measures of central Tendency and Definition • The Arithmetic Mean • The Geometric Mean • The Harmonic Mean • The Median, The Mode	11
Unit IV	**Measures of Dispersion**	• Range, mean deviation, standard deviation and variance	10

		• Correlation and regression: Significance and correlation coefficient	

References

- Introduction to Biostatistics, (2004) Larry Winner, Department of statistics, University of Florida.
- Marc M. Triola and Mario F. Triola, (2006) Biostatistics for the biological and Health sciences.
- Michael Harris, Gordon Taylor (2003), Medical statistics made easy, an imprint of the Taylor & Francis group, UK.
- Michael R. Chernick, Robert H. Friis, (2003) Introductory biostatistics for health science, a John Wiley and son's publication.

Discipline Specific Core (DSC) Practical (Sem-VI)		
BT-607: Practical Course: Plant Biotechnology		
Total hours: 60		**Credits: 2**

Course Objectives:

- To acquaint with preparation of biofertilizer.
- Gain knowledge regarding plant tissue culture media formulations.
- To train to different techniques concerned to plant tissue culture.

Learning outcomes

After successful completion of this course, students are expected to:

- Isolate and characterization of: *Xanthomonas citri*, *Rhizobium* sp, preparation and efficiency testing of biofertilizer.
- Preparation of stock solutions, explant sterilization, media preparation and sterilization, callus culture, shoot tip culture.

Sr. No	Topic	Lectures/ Hours
1	Isolation and identification of *Xanthomonas citri* from infected citrus fruit or leaf.	04
2	Isolation of *Rhizobium* sp. from root nodule of leguminous plant.	04
3	Preparation and efficiency testing of biofertilizer-pot assay	04
4	Determination of IAA oxidase activity	04
5	Preparation of plant tissue culture explant and its sterilization	04
6	Preparation of stock solutions of plant tissue culture media	04
7	Preparation of plant tissue culture media	04
8	Callus culture using suitable explant of medicinal plant	04
9	Shoot tip culture in banana OR Any medicinal plant	04
10	Micropropagation of medicinal plant by meristem culture	04
11	Preparation of synthetic/ artificial seeds	04
12	Visit to plant tissue culture facilities / biofertilizer industry	04

Suggested Readings

- Gaud R.S. (2007) Practical Biotechnology Nirali Prakashan, Pune
- Parija S. C. (2007) Textbook of Practical Microbiology, Ahuja Publishing House New Delhi
- Plummer D T. (1992) An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
- Purohit S.S. (1995), A Laboratory Manual of Plant Biotechnology, Agrobotonica Pub. India. Pvt. Ltd., Bikaner
- Reddy M. G., Reddy M. N., Saigopal D. V. R. and Mallaiah K. V. (2008) Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai
- Schuler M A and Zielinski R E (2012) Methods in Plant Molecular Biology. Academic Press; 1 edition.
- Sharma P D (2018) Ecology and Environment. Rastogi Publications, Meerut.
- Smith R H (2012) Plant tissue culture: techniques and experiments Academic Press; 3rd Edn
- Vyas S P ad Kohli D. V. (2010) Methods in Biotechnology and Bioengineering. CBS Publishers & Distributors

Discipline Specific Core (DSC) Practical		
BT-608: Practical Course: Genetics and Bioinformatics		
Total hours: 60		**Credits: 2**

Course Objectives:

- To learn the laws in genetics
- To understand the principle and methods of genetics and bioinformatics.
- To acquaint the students with the different database in bioinformatics.

Learning outcomes

After successful completion of this course, students are expected to:

- Understand and verification of Mendel's laws using color beads
- Shall able to perform DNA isolation, perform transformation and conjugation in bacteria.
- Understand biological database and database search on web, shall access database Preparation of stock solutions, searching for gene and protein sequences.

Sr. No	Topic	Lectures/ Hours
1	Monohybrid and Dihybrid crosses in Pea/Drosophila demonstrating Mendel's law of	04
2	Inheritance.	04
3	Problems set in Mendelian inheritance, single point, two-point crosses and gene mapping in bacteria	04
4	Study of conjugation in bacteria	04
5	Development of competent cell system and study of transformation in bacteria	04
6	Isolation of DNA from Bacterial cell/ Plant cell	04
7	Demonstration of various domains (search engines) for bioinformatics through internet	04
8	Amplification of DNA fragment using PCR.	04
9	Concept of databases: Accessing database	04
10	Demonstration on Multiple sequence alignments.	04
11	Searching for gene and protein sequences and accessing information from web	04
12	Protein structure using RASMOL/ RASWIN	04

Suggested Readings

- Harley, J.P. and Prescott, L. M (1996) Lab. Exercises in Microbiology, 3rd Ed, WCB /McGraw Hill Inc.
- Jayararnan, I (1981) Lab.oratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
- Kalaichelvan P.T. and Dandiya P.C (2004), Microbiology and Biotechnology: A Laboratory Manual, MJP Publishers, Chennai.
- Parija S. C., Textbook of Practical Microbiology, Ahuja Publishing House New Delhi
- Plummer D T. (1992) An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
- Purohit S.S. (1995), A Laboratory Manual of Plant Biotechnology, Agrobotonica Pub.

India. Pvt. Ltd., Bikaner

- Reddy M. G., Reddy M. N., Saigopal D. V. R. and Mallaiah K. V. (2008)
- Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai
- Sadashivam S. and Manickam A. (1996), Biochemical Methods, 2nd Edi. New Age International, N. Delhi.

Discipline Specific Core (DSC) Practical		
BT-609: Practical Course: Pharmaceutical Biotechnology		
Total hours: 60		**Credits: 2**
Course Objectives: To acquaint with knowledge about Quality Control test in pharmaceutical industry.		
Learning outcomes After successful completion of this course, students are expected to: • Understand and perform sterility testing of pharmaceutical products, chemical and biological, MIC • Understand and perform MLT, validation of LAF, membrane filtration and sterility testing.		
Sr. No	**Topic**	**Lectures/ Hours**
1	Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry.	
2	Sterility testing of pharmaceutical products injectable/Ophthalmic solution	04
3	Chemical assay of antibiotic (Streptomycin/penicillin)	04
4	Determination MIC of antibiotics against test microorganism	04
5	Microbiological assay of Streptomycin or Penicillin by cup plate/ paper disc method	04
6	Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic	04
7	Microbial limit test (MLT) of pharmaceutical product	04
8	Validation of autoclave using biological indicator	04
9	Validation of laminar air flow cabinet	04
10	Isolation of antibiotic resistant bacterial population by gradient plate method	04
11	Sterility testing by membrane filter technique	04
12	Visit to pharmaceutical industry	04

Suggested Readings

- Davis J. and Freito F. (1970) Physical and chemical methods of wastewater analysis. FAO Bulletin, Rome, Italy.
- Gaud R.S.(2007) Practical Biotechnology Nirali Prakashan, Pune
- Sadasivam S. and Manickam A (2005) Biochemical Methods, 2nd edn. New Delhi.
- Schmauder Hans-Peter (2003) Methods in Biotechnology. Taylor & Francis Ltd
- Talwar G P and Gupta S K (2006) A Handbook of Practical and Clinical Immunology, Vol I & II, 2nd Edn. CBS Publishers.
- Zito S W (2006) Pharmaceutical Biotechnology: A programmed Text. 2nd Edn. Technomic Publishing Co., Inc., USA.

Skills acquired and Job prospects for the Biotechnology students

Biotechnology has aroused in past few decades owing to application of knowledge regarding the living systems for the betterment of the mankind. Degree program in Biotechnology teaches students how the living organisms including microbes, plants and animals could be used to produce something very useful for the human being at large. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunity in all biological sectors.

After successful completion of three years degree course in Biotechnology, student will be well versed with laboratory skills and transferable skills.

Laboratory Skills:

- Laboratory safety practices
- Skillful handling of microbial, animal and plant cell cultures and aseptic techniques
- Skillful handling of bioreactor and its use
- Molecular kit based and protocol-based analysis
- Handling of Bioinformatics software and results interpretation.
- Advanced techniques like- Chromatography, Electrophoresis, Spectrometry etc.
- Diagnostic techniques, microbial analysis of food, dairy, pharma products.
- Analysis and interpretation of results and logical thinking

Transferable Skills:

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas essential in food, pharma biotechnology-based industries and even for higher studies. These are:

- Analytical skill, Observational skill
- Planning and Time management
- Mathematical and IT skills
- Creative thinking, Problem solving
- Report writing skill, Presentation skill

Job Opportunities:

After successful completion of B.Sc. in Biotechnology, student may continue further studies like M.Sc. in Biotechnology and then Ph.D. in Biotechnology and make career in research field. Students have opportunities in private as well as public (Government) sectors.

Private Sector:

Biotechnologist can work in quality control, quality assurance and R & D divisions of companies like-Biotechnology based industries like Pharmaceutical companies, Chemical manufacturing companies, Food and Drink(includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sector:

Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Job profiles:

Biotechnologist, Biologist, Biomedical Scientist, Biotechnologist, plant or animal tissue culture scientist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Research Associates, Research Officers, Research Scientist etc.

Opportunities in higher studies

After successful completion of B.Sc. in Microbiology, student may continue further studies like M.Sc. in Biotechnology / Biochemistry and pursue higher studies. Even students can pursue other courses where graduation is essential.

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Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

Structure of syllabus for

B. Sc. [Biochemistry]

F. Y. B. Sc.

Choice Based Credit System (CBCS)

[2022 - 23]

F. Y. B. Sc. Biochemistry (CBCS Structure)

Prelude

The cumulative demand for trained and skilled manpower in the area of Biochemistry requires in depth functional knowledge of modern biology through hands-on training to the students.

The syllabus has been prepared anticipating the requirements of B.Sc. Biochemistry students under CBCS Program. The contents have been drawn to accommodate the widening horizons of the Biochemistry discipline and reflects the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

The degree of Bachelor of Science in Biochemistry (Choice Based Credit System) aims to introduce various aspects of Biochemistry and interdisciplinary subjects to the students. The program in Biochemistry as one of the core subject is designed to cultivate a scientific attitude and interest towards the modern areas of Biochemistry in particular and life science in general. This will help the students to become critical and curious in their outlook. The courses are designed to impart the essential basics in Biochemistry, Chemistry, Botany, Microbiology, Zoology and Biotechnology at the initial level of graduation. The basic courses are infused with application in modern life sciences, and awareness on Biochemistry and its influence in human life. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of Biochemistry and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about Biochemistry and contribution of Biochemistry among the society. At the end of the course, the students are expected to have good working knowledge in the field of Biochemistry and in addition knowledge gained from courses of interdisciplinary in nature. Students will surely have an urge to continue higher studies in Biochemistry and contribute significantly in the development.

The present syllabi is restructured anticipating the future needs of Biochemistry with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Biochemistry.

Hence, Board of Studies in Life Sciences in its meeting held on 23/06/2018 resolved to accept the revised syllabus for F. Y. B. Sc. (Biochemistry) based on Choice Based Credit System (CBCS) of UGC guidelines.

Scheme for B.Sc. program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		
1	**Core courses (16)**	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	(i) Theory	4	4	4	4	4	3	4	3					4 X 14=56
	(ii) Practical	2	4	2	4	2	3	2	3					2 X 14=28
2	**Ability enhancement compulsory course (AECC) (2)**	2	1	2	1									2 X 2 =04
3	**Skill Enhancement Course (SEC)** (4)					2	1	2	1	2	1	2	1	2 X 4 = 16
4	**Discipline Specific Elective DSE (6)**													
	(i) Theory									4	3	4	3	4 X 6 =24
	(ii) Practical									2	3	2	3	2 X 6 =12
	Total Credit value (Credit x No. of Courses)	**26**		**26**		**20**		**20**		**20**		**20**		**132**

Course Structure:

Duration: The duration of B.Sc. (Biochemistry) degree program shall be three years.

Medium of instruction: The medium of instruction for the course shall be English.

The present syllabus has been prepared to (i) accommodate the advanced topic on the Biochemistry discipline, (ii) build the basic science knowledge at the level of first year of Biochemistry and (iii) reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

At first year of under-graduation, students are given exposure to basic science to build the foundation of advance Biochemistry. For this purpose, more focus on relevant experimentation on the topics are included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of biotechnology like microbiology, biochemistry, human physiology. The relevant practicals are included to enrich their knowledge.

At third year under-graduation, six theory and three practical papers each for two semesters are included to uncover all applied areas of Biochemistry.

Scheme for F. Y. B. Sc. (Biochemistry)

Semester	**Core Course**				**Ability Enhancement Compulsory Course (AECC)**		
	DSC		Credits	Lectures		Credits	Lectures
I	DSC - 1 A: Core Course I: **Biochemistry**	Paper I Paper II Practical Paper	2 2 2	30 30 60	**AECC** 1: English/Marathi/ Communication	2	60
	DSC - 2 A: Core Course II	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC - 3 A: Core Course III	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC - 4 A: Core Course IV	Paper I Paper II Practical Paper	2 2 2	30 30 60			
II	DSC - 1 B Core Course I: **Biochemistry**	Paper I Paper II Practical Paper	2 2 2	30 30 60	**AECC** 2: Environmental Science	2	60
	DSC- 2 B Core Course II	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC- 3 B: Core Course III	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC- 4 B: Core Course IV	Paper I Paper II Practical Paper	2 2 2	30 30 60			

Student has choice to study three subsidiary subjects from **DSC 2, DSC 3 and DSE 4** among Chemistry/ Botany/ Zoology /Geography during I, II, III and IV semester; subject to availability of course at respective college.

Duration of Lecture: 30 Lectures of 60 minutes or 36 Lectures of 50 min. Each theory and practical course has to be completed in 30 and 60 lectures, respectively of 60 min duration

Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination.

- **Theory examination** (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
  - **Question 1** (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
  - **Question 2, 3 and 4** (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
  - **Question 5** (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.
- **Internal examination** (40 marks each semester): Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.
- **Practical Examination**: Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am -1pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practicals where incubation condition, allied aspect are essential. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination

Equivalence for F.Y. B.Sc. (Biochemistry) is furnished in the following table:

Old Syllabus (w.e.f. June 2018) (Semester pattern 60:40)	**New Syllabus (w.e.f. June 2022) CBCS pattern (Semester pattern 60:40)**
BC-101 Chemistry of Biomolecules	BC-101 Basic Biochemistry-I
BC-102 Cell Biology	BC-102 Cell Biology
BC-201 Basic Biochemistry	BC-201 Basic Biochemistry-II
BC-202 Basic Microbiology	BC-202 Basic Microbiology
BC-103 Basic techniques in Biochemistry – I	BC-103 Basic techniques in Biochemistry – I
BC-203 Basic techniques in Biochemistry – II	BC-203 Basic techniques in Biochemistry – II

F. Y. B. Sc. (Biochemistry) Semester – I

Semester	**CC -A and B**	**Paper code**	**Paper I**	**Paper code**	**Paper II**	**Paper code**	**Biochemistry Practical Paper**
I	CC A I	BC101	Basic Biochemistry-I	BC102	Cell Biology	BC103	Practical Paper I
II	CC A II	BC201	Basic Biochemistry-II	BC202	Basic Microbiology	BC203	Practical Paper II

CC A I: Paper I
BC101: Basic Biochemistry-I (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	**To acquaint students with basic concepts of biomolecule chemistry**		
Course outcome	**Students will be able to:** • **Learn the elements present in biomolecules** • **Differentiate between monomers and polymers.** • **Explain the role of water in synthesis and breakdown of polymers.** • **Compare and contrast the structure and function of the oligo and polysaccharides.** • **Summarize the functions of proteins and able to recognize the importance of the three dimensional shape of a protein on its function and the role of non-covalent bonds in maintaining the shape of a protein.** • **Compare and contrast saturated, mono-unsaturated, and poly-unsaturated fatty acids**		
I	**Carbohyd- -rates**	▪ Definition, scope of Biochemistry ▪ Biomolecules: Names of Biomolecules, their repeating units and their main function ▪ Definition and biological importance of Carbohydrate ▪ Classification of Carbohydrates: Monosaccharides, Oligosaccharides and Polysaccharides (definition, general formulae, and examples) ▪ D and L forms of carbohydrates, epimers of glucose ▪ Cyclic structure of monosaccharides: pyranose and furanose form (glucose and fructose) ▪ Mutarotation: definition, example & mechanism ▪ Derivatives of monosaccharides: sugar alcohols, sugar acids, sugar phosphates, deoxysugars, and amino sugars ▪ Reactions of glucose – oxidation with bromine water and nitric acid, reduction, acetylation, addition of HCN, NH2OH and phenyl hydrazine ▪ Diasaccharides: sucrose, lactose, maltose ▪ Homopolysaccharides: Starch, Glycogen, Cellulose ▪ Heteropolysaccharides: Mucopolysaccharides, Hyaluronic acid, Chondroitin sulphate	**10**
Unit II	**Lipids**	▪ Definition and functions of lipids	**10**

		▪ Classification of lipids: Simple lipids, Compound lipids and Derived lipids with examples ▪ Fatty acids: definition, nomenclature, Even & odd chain fatty acids, Saturated and unsaturated fatty acids ▪ Essential fatty acids: definition, examples, functions, deficiency ▪ Triacylglycerol: definition, occurrence, functions, structure (mono, di and tri-glycerols), simple and mixed triacylglycerol ▪ Properties of triacylglycerol: hydrolysis, saponification, rancidity, antioxidant, lipid peroxidation ▪ Purity evaluation of fats and oils: Iodine number, saponification number, Reichert-Meissl number, acid number ▪ Comparative account on animal and plant fat ▪ Functions of phospholipids ▪ Classification of phospholipids: Glycero-phospholipids; phosphatidic acid, lecithins, cephalins (structure and importance); Sphingo-phospholipids- structure and importance. ▪ Steroids: structure and function of cholesterol and progesterone	
Unit III	**Amino acids, peptides and proteins**	▪ Amino acids - definition, general structure, optical isomers, classification of amino acids based on structure, nutrition and metabolic fate. ▪ Chemical properties of amino acids – general reactions of amino acids with NaOH, alcohol, ammonia, ninhydrin, decarboxylation, transamination, oxidative deamination ▪ Peptides – definition and formation of peptide bonds, N- and C- terminals, representation of peptide chain, naming of peptide chain ▪ Protein - definition and levels of organization (primary, secondary, tertiary and quaternary). ▪ Bonds responsible for protein structure - covalent bonds (peptide and disulfide), non-covalent bonds (hydrogen, hydrophobic, and electrostatic bonds. Van der Waal’s forces). ▪ Classification of proteins based on shape, composition and solubility, biological functions and nutrition. ▪ Denaturation of protein - agents and characteristics of denaturation	**10**

	Suggested readings	1. Nelson, D. L. and Cox, M.M. (2007) Lehninger's Principles of Biochemistry 4th edition, W.H. Freeman and Company, New York, USA. 2. Conn, E. E., Stumpf, P. K., Bruening G., Doi R. H. (2007) Outlines of Biochemistry, Wiley India (P) Ltd., New Delhi. 3. Stryer, L., Tymcozko J. L., Berg J. M. (2012) Biochemistry, W. H. Freeman and Company, New York, USA. 4. Rastogi S.C. (2001) Biochemistry, 7th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi. 5. Satyanarayana, U. and Chakrapani U. (2010) Biochemistry, Books and Allied Pvt. Ltd., Kolkata, India. 6. Agarwal, G. R. Agarwal K., Agarwal O. P. (2005) Text Book of Biochemistry, 13th edition, Goel Publishing House, A unit of, Krishna Prakashan Media Pvt. Ltd., Meerut, India. 7. Jain, J.L., Jain,S. And Jain,N. (2005) Fundamentals of Biochemistry, 6th edition, S. Chand and Company Ltd., Delhi.	

CC A I: Paper II
BC-102: Cell Biology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	To complement the students with the basic understanding on the general aspects of animals and plants cell biology		
Course outcome	**Students will be able to:** • **Differentiate prokaryotic from eukaryotic cells and plant cells from animal cells** • **Discern structure and functions of cell organelles** • **Understand mitosis and meiosis processes.** • **Explain types of tissues and types of cell junctions**		
I	**Ultra structure of cell**	▪ Definition of cell and its elemental composition ▪ Characteristics of prokaryotic and eukaryotic cell ▪ Comparative account on plant and animal cell ▪ Structure and functions of - cell wall, cell membrane (Fluid Mosaic model), cytoplasm, mitochondria, golgi complex, endoplasmic reticulum (smooth and rough), chloroplast, nucleus, ribosomes, lysosomes	**10**
Unit II	**Cell division**	▪ Introduction to cell division ▪ Mitosis- interphase, different phases and significance of mitosis ▪ Meiosis- different phases of meiosis-I and II and its significance ▪ Comparative account on mitosis and meiosis ▪ Seed dormancy and seed germination, Photoperiodism, Vernalization, Flowering. Senescence	**10**

Unit III	**Tissues and cell junctions**	▪ Tissues- definition and types ▪ Epithelial tissues- general characteristics, functions and classification ▪ Simple and compound epithelial tissues- types, brief description, functions and locations ▪ Connective tissues- general characteristics and functions ▪ Types of connective tissues (cartilage, bone and blood)- brief overview, functions and locations ▪ Muscular tissues (skeletal, cardiac and smooth)- concise description, functions and locations ▪ Nervous tissues (neuron and neuroglia)- introductory description, functions and locations ▪ Cell junctions (complexes)- definition and types- tight junction, belt desmosome, spot desmosome and gap junction	**10**
	Suggested readings	1. Powar C.B. (2012) Cell Biology, 3rd edition, Himalaya Publishing House, Mumbai 2. Chatterjee C.C. (2004) Human physiology Vol. I, 11th edition, Medical allied Agency, Kolkata, India. 3. Nelson,D.L. and Cox, M.M. (2007) Lehninger's Principles of Biochemistry 4th edition, W.H. Freeman and Company, New York, USA. 4. Conn, E. E., Stumpf, P. K., Bruening G., Doi R. H. (2007) Outlines of Biochemistry, Wiley India (P) Ltd., New Delhi. 5. Stryer, L., Tymcozko J. L., Berg J. M. (2012) Biochemistry, W. H. Freeman and Company, New York, USA. 6. Rastogi S.C. (2001) Biochemistry, 7th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi. 7. Satyanarayana, U. and Chakrapani U. (2010) Biochemistry, Books and Allied Pvt. Ltd., Kolkata, India.	

CC A I: Biochemistry Practical Paper I
BC – 103: Basic Techniques in Biochemistry

Total Hours: 60 **Credits: 2**

Sr., no.	**Title of the Practical**	**Hours**
Course objective	**To acquaint with various techniques used in biochemistry**	
Course outcome	**Students will be able to:** • **Understand hazards and safety measure in laboratory.** • **Do normality, molarity, and percent solution based calculations.** • **Perform qualitative tests for carbohydrates, lipids and amino acids** • **Use, handling and care of compound microscope** • **Identify various phases of mitosis** • **Temporary mount available tissue**	

1	▪ First aid, Hazardous Chemicals, Antidotes to hazardous and toxic chemicals, Safety measures in laboratory	**4**
2	▪ Introduction of laboratory instruments - water bath, autoclave, hot-air oven, incubator, refrigerator, centrifuge, laminar air flow cabinet, pH meter, weighing balance, spectrophotometer	**4**
3	▪ Preparation of normal and molar, and percent solutions	**4**
4	▪ Preparation of buffers	**4**
5.	▪ Qualitative tests for carbohydrates- anthrone test, iodine test, Barfoed test, Seliwanoff's test, Fehling's test, Bial's test	**4**
6.	▪ Isolation of starch from potato	**4**
7.	▪ Qualitative tests for lipids- solubility test, acrolein test, presence of free fatty acids and unsaturated fatty acids	**4**
8.	▪ Qualitative tests for amino acids- Ninhydrin test, Xanthoproteic test, Ehrlich's test, Sodium nitroprusside test, Sullivan and McCarthy's test, Millon's test	**4**
9.	▪ Isolation of casein from milk	**4**
10	▪ Estimation of protein by Biuret method	**4**
11.	▪ Use, handling and care of compound microscope	**4**
12	▪ Study of various phases of mitosis using suitable sample	**4**
13	▪ Temporary mounting of available tissues	**4**
14	▪ Differential staining for DNA and RNA in human cheek epithelial cells	**4**
15	▪ Visualization of mitochondria by Janus green stain	**4**
Suggested readings	1. Cappuccino J. G. and Sherman N. (2014) Microbiology – a Laboratory Manual, 10th edition, Addison Wesley Publishing Company Inc., Boston, USA. 2. Wilson K. and Walker J. (2003) Practical Biochemistry: Principles and techniques, 5th edition, Cambridge University Press, UK. 3. Plummer D. T. (2005) An Introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill Publishing Company Ltd., New Delhi. 4. Baker F. J. (1967) Handbook of bacteriological techniques, 2nd edition, Butterworth & Co Publishers Ltd., UK. 5. Oser B. L. (ed.) (1965) Hawk's physiological chemistry, 14th edition, McGraw-Hill Book Company, New York, USA. 6. Jayaraman J. (2008) Laboratory Manual in Biochemistry, New Age International (P) Ltd. Publishers, New Delhi. 7. Sadashivam S. and Manikam A. (2008) Biochemical Methods, 3rd edition, New Age International (P) Ltd. Publishers, New Delhi. 8. Aneja K. R. (2007) Experiments in Microbiology, Plant Pathology, and Biotechnology, 4th edition, New Age International (P) Ltd. Publishers, New Delhi. 9. Gunasekaran P. (2005) Laboratory Manual in Microbiology, 1st edition, New Age International (P) Ltd. Publishers, New Delhi. 10. Rao B. S. and Deshpande V. (2005) Experimental Biochemistry: A student companion, I. K. International Pvt. Ltd., New Delhi. 11. Gunasekaran, P (2011) Laboratory Manual in Microbiology, New Age International Publishers,	

Note: Mandatory to perform at least 12 - 13 practicals

F. Y. B. Sc. (Biochemistry) Semester – II
CC A I: Paper I
BC- 201: Basic Biochemistry-II (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	To complement the students with the fundamental concepts of biochemistry		
Course outcome	**Students will be able to:** • **Recall DNA structure and functions** • **Discuss types and functions of RNA** • **Describe classification and properties of enzymes** • **Understand industrial applications of enzymes** • **Differentiate water soluble vitamins from fat soluble vitamins and Understand clinical significance of the vitamins**		
I	**Enzymes**	▪ Definition and historical background of enzyme. ▪ Terminologies: intracellular enzymes, extracellular enzymes, holoenzymes, apoenzymes, prosthetic group, cofactor, coenzymes, isoenzymes, katals, international unit, turnover number and active site. ▪ Nomenclature on the basis of – substrate acted upon by enzyme, type of reaction catalysed, substrate acted upon and type of reaction catalysed, substance (product) that is synthesized, over all chemical reaction taken into consideration (Enzyme commission number). ▪ Classification of enzymes - six major classes with description and examples each with EC number and reaction. ▪ Factors affecting enzyme activity - effect of substrate concentration, enzyme concentration, product concentration, pH, temperature, activators, time, and inhibitors. ▪ Specificity of enzyme action - absolute specificity, group specificity, optical specificity and geometrical specificity. ▪ Active site - definition and salient features of active site. ▪ Mechanism of enzyme action – lock and key model, induced fit model. ▪ Industrial applications of enzymes	**10**
Unit II	**Nucleic acids**	▪ Definition and types of nucleic acid-DNA and RNA. ▪ Structural components of DNA and RNA-phosphoric acid, pentose sugar, nitrogenous bases - purines and pyrimidine (numbering of purine and pyrimidine rings and chemical names). ▪ Nucleosides-deoxyribonucleosides, ribonucleosides and nomenclature of nucleosides.	**10**

		▪ Nucleotides-deoxyribonucleotides, ribonucleotides, nomenclature of nucleotides, mono-, di- and tri- ribo and deoxyribonucleotides, functions of nucleotides. ▪ DNA: formation of 3’5’-phosphodiester bond, Watson and Crick model of DNA, Chargaff’s rule. ▪ Forms of DNA: A-DNA, B-DNA, C-DNA and Z-DNA (condition, shape, helix diameter, rise per base pair, base pair per turn of helix, helix pitch, major and minor grooves). ▪ Denaturation of DNA: definition and its effect on UV absorption, viscosity, and specific optical rotation. ▪ Effect of pH and temperature on DNA denaturation, definition of renaturation of DNA. ▪ RNA: Structure, differences with DNA and types of RNA; rRNA: prokaryotic and eukaryotic rRNA and types; tRNA: cloverleaf structure. mRNA - hnRNA, exons, introns, splicing, 5’ capping, 3’ poly A tail	
Unit III	**Vitamins**	▪ Definition, history and nomenclature, Classification - fat-soluble and water soluble vitamins. ▪ Fat-soluble vitamins: chemistry, dietary sources, recommended dietary allowance, biochemical functions, deficiencies, hyper-vitaminosis of vitamin A, D, E and K. ▪ Water-soluble vitamins: chemistry, dietary sources, recommended dietary allowance, biochemical functions, deficiencies, hyper-vitaminosis of vitamin C, B1, B6, and B12	**10**
	Suggested readings	1. Nelson, D. L. and Cox, M.M. (2007) Lehninger's Principles of Biochemistry 4th edition, W.H. Freeman and Company, New York, USA. 2. Conn, E. E., Stumpf, P. K., Bruening G., Doi R. H. (2007) Outlines of Biochemistry, Wiley India (P) Ltd., New Delhi. 3. Stryer, L., Tymcozko J. L., Berg J. M. (2012) Biochemistry, W. H. Freeman and Company, New York 4. Rastogi S.C. (2001) Biochemistry, 7th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi. 5. Satyanarayana, U. and Chakrapani U. (2010) Biochemistry, Books and Allied Pvt. Ltd., Kolkata, India. 6. Agarwal, G. R. Agarwal K., Agarwal O. P. (2005) Text Book of Biochemistry, 13th edn., Goel Publishing House, Krishna Prakashan Media Pvt. Ltd., Meerut, India. 7. Jain, J.L., Jain,S. and Jain,N. (2005) Fundamentals of Biochemistry, 6th edn., S. Chand and Company Ltd., Delhi.	

CC A I: Paper II
BC - 202 Basic Microbiology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	**To complement the students with the various concepts about microorganisms**		
Course outcome	**Students will be able to:** • **Explain types, characteristics and significance of microorganisms** • **Describe the structure and functions of major components of microbial cells** • **Understand microbial growth, its measurement and bacterial growth curves** • **Classify microorganisms based on nutrition** • **Apply isolation techniques to screen bacteria on solid media** • **Acquainted with various methods of sterilization and disinfection**		
I	**Characteri-stics of microbes**	▪ Types of microorganisms. General characteristics and significance of bacteria, algae, fungi, virus and protozoa. Nutrition, classification and mode of reproduction. ▪ Major characteristics of microorganisms – morphological, chemical, metabolic, antigenic, and genetic characteristics. ▪ Role of microorganisms in infection, fermentation, environment and agriculture. ▪ Morphology and fine structure of bacteria - size, shape, arrangements, structure of bacterial cell, ▪ Structure and functions of flagella, Pilli, fimbriae, glycocalyx, capsule and cell wall of Gram positive and Gram negative bacteria	**10**
Unit II	**Growth, Nutrition and Isolation of microorga--nisms**	▪ Concept of growth. Growth curve: lag, logarithmic, stationary and death phase. ▪ Mathematical expression of growth – growth rate and generation time. ▪ Measurement of growth: Cell number, Cell mass, Cell activity ▪ Nutritional classification of microorganisms. Media – ingredients, types on the basis of physical state, composition and use. ▪ Methods of isolation of bacteria on solid media - streak plate method, pour plate method, roll tube method and spread plate method. ▪ Staining - concept of stains, acidic and basic stain, leuco compounds, intensifiers and mordant, aims of staining	**10**
Unit III	**Control of microorga--nisms**	▪ Definitions- sterilization, disinfection, antisepsis, sanitization, decontamination, pasteurization, preservation, germicidal and bactericides ▪ Sterilization	**10**

		• Heat- thermal death point, thermal death time, decimal reduction time
		  • Moist heat- mode of action, steam under pressure, Fractional sterilization, Boiling water, Pasteurization and canning
		  • Dry heat- mode of action, incineration, hot air oven
		• Radiation-ionizing and non-ionizing radiations
		• Chemical sterilization- ethylene oxide, formaldehyde
		• Filtration
		▪ Disinfection: characteristics of an ideal disinfectant, Disinfectants: phenol and phenolic compounds, alcohol, heavy metals, halogens, dyes, detergents, hydrogen peroxide	

	Suggested readings	1. Stanier R. Y., Ingraham J. L., Wheelis M. L. and Painter P. R. (1992) General Microbiology, 5th edition, Macmillan Press Ltd. UK. 2. Pelczar M. J. Jr, Chan E. C. S., Krieg N. R. (1985) Microbiology, 5th edition, Tata McGraw-Hill Education Pvt. Ltd, India 3. Madigan M. T., Martinko J. M., Dunlap P. V. and Clark D. P. (2008) Brock Biology of Microorganisms 12th edition, Pearson Benjamin-Cummings, USA. 4. Chincholkar S. B., Chaudhari A. B., and Patil U. K. (2006) Foundation of Microbiology, 4th edition, Nirali Prakashan, Pune, India. 5. Wiley J. M., Sherwood L. M. and Woolverton C. J. (2017) Prescott's Microbiology 10th edition, McGraw Hill International, USA. 6. Frobisher M. Hinsdill R., Crabtree K. T. and Goodheart C.R. (1974) Fundamentals of Microbiology, 9th edition, W. B. Saunder's Co. USA. 7. Powar C. B. And Daginawala H. F. (1995) General Microbiology Vol.I and II, 2nd edition, Himalaya Publishing House, Mumbai	

CC A I: Biochemistry Practical Paper II
BC – 203: Basic Techniques in Biochemistry – II

Total Hours: 60 **Credits: 2**

Sr. no.	**Title of the Practical**	**Hours**
Course objective	**To impart practical knowledge on basic techniques adopted in Biochemistry**	
Course outcome	**Students will be able to understand:** • **Working principle of spectrophotometer and able to handle spectrophotometer** • **Various staining techniques and Isolate bacteria by streak plate method** • **Familiarize with viable count of the micro-organisms.** • **Analysis quality of drinking water/potable water**	
1	▪ Qualitative test for amylase	**4**

2	▪ Effect of substrate concentration on enzyme activity	**4**
3	▪ Quantitative determination of DNA and RNA by spectrophotometric method	**4**
4	▪ Thermal denaturation of DNA	**4**
5.	▪ Estimation of ascorbic acid by volumetric method	
6.	▪ Monochrome staining	**4**
7.	▪ Negative staining	**4**
8.	▪ Gram staining	**4**
9.	▪ To study motility of bacteria by hanging drop method	**4**
10	▪ Preparation of culture media for bacterial cultivation (Nutrient broth and nutrient agar/ MacConkey's broth and MacConkey's agar)	
11.	▪ Isolation of bacteria by spread plate method from water/soil sample	**4**
12	▪ Isolation and culture characterization of bacteria by streak plate techniques	**4**
13	▪ Determination of viable count	**4**
14	▪ Demonstration of bacterial growth by spectrophotometer	**4**
15	▪ Demonstration of quality of drinking water	**4**
Suggested readings	1. Cappuccino J. G. and Sherman N. (2014) Microbiology – a Laboratory Manual, 10th edition, Addison Wesley Publishing Company Inc., Boston, USA. 2. Wilson K. and Walker J. (2003) Practical Biochemistry: Principles and techniques, 5th edition, Cambridge University Press, UK. 3. Plummer D. T. (2005) An Introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill Publishing Company Ltd., New Delhi. 4. Baker F. J. (1967) Handbook of bacteriological techniques, 2nd edition, Butterworth & Co Publishers Ltd., UK. 5. Oser B. L. (ed.) (1965) Hawk's physiological chemistry, 14th edition, McGraw-Hill Book Company, New York, USA. 6. Jayaraman J. (2008) Laboratory Manual in Biochemistry, New Age International (P) Ltd. Publishers, New Delhi. 7. Sadashivam S. and Manikam A. (2008) Biochemical Methods, 3rd edition, New Age International (P) Ltd. Publishers, New Delhi. 8. Aneja K. R. (2007) Experiments in Microbiology, Plant Pathology, and Biotechnology, 4th edition, New Age International (P) Ltd. Publishers, New Delhi. 9. Gunasekaran P. (2005) Laboratory Manual in Microbiology, 1st edition, New Age International (P) Ltd. Publishers, New Delhi. 10. Rao B. S. and Deshpande V. (2005) Experimental Biochemistry: A student companion, I. K. International Pvt. Ltd., New Delhi.	

Note: Mandatory to perform at least 12 - 13 practical during the semester

Skills acquired and Job prospectus for the Biochemistry students

Biochemistry is the molecular basis of life. Degree program in Biochemistry teaches students how inanimate, lifeless chemicals combine to produce a functional living organism. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunity in all sectors.

After successful completion of three years degree course in Biochemistry, student will be well versed with laboratory skills and transferable skills.

Laboratory Skills:

- Laboratory safety practices
- Accurate weighing and reagent preparation
- Skillful handling of basic and advanced instruments
- Calibration of basic instruments like pH meter, micropipettes etc
- Advanced techniques like-
    - Chromatography
    - Electrophoresis
    - Spectrometry
    - Polymerase Chain Reaction (PCR)
    - Plant Tissue Culture
    - Animal Tissue Culture
- Aseptic techniques
- Logical thinking
- Analysis and interpretation of results
- Collection, organization and presentation of data

Transferable Skills

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas. These are:

- Analytical skill
- Report writing skill
- Presentation skill
- Time management
- Creative thinking
- Problem solving
- IT skills
- Planning
- Observational skill

Job Opportunities:

After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biochemistry and then Ph.D. in Biochemistry and make career in research field. Students have opportunities in private as well as public (Government) sectors.

Private Sector:

Biochemist can work in quality control, quality assurance and R & D divisions of companies like-Biotech companies, Pharmaceutical companies, Chemical manufacturing companies, Food and Drink (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sectors:

Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Job profiles:

Biochemist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Microbiologist, Research Associates, Research Officers, Research Scientist etc.

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Structure of syllabus for

B. Sc. (Biochemistry)

S.Y. B.Sc.

Choice Based Credit System (CBCS)

(2019-20)

S. Y. B. Sc. Biochemistry (CBCS Structure) Semester III and IV

Prelude

The demand for trained and skilled manpower in Biochemistry requires in depth functional knowledge of modern biology through hands-on training to the students.

Bachelor of Science in Biochemistry (Choice Based Credit System) introduce Biochemistry and interdisciplinary subjects to the students. The program in Biochemistry as one of the core subjects is designed to cultivate a scientific attitude and interest towards the modern areas of Biochemistry in particular and life science in general to help the students to become critical and curious in their outlook. The program integrates the essential basics in Biochemistry, Chemistry, Botany, Microbiology, Zoology and Biotechnology at the initial level of graduation to develop proficiency in the theory as well as practical, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of Biochemistry and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about Biochemistry in the society. Students will surely have an urge to continue higher studies in Biochemistry and contribute significantly in the development.
The present syllabus is restructured anticipating the future needs of Biochemistry with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course will lead to impart skill-set essentials to further Biochemistry.
Hence, Board of Studies in Life Sciences in its meeting held on -------- resolved to accept the revised syllabus for S. Y. B. Sc. (Biochemistry) based on Choice Based Credit System (CBCS) of UGC guidelines.

Scheme for B.Sc. Program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		
1	Core courses(16)	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	(i) Theory	4	4	4	4	4	3	4	3					4X14=56
	(ii) Practical	2	4	2	4	2	3	2	3					2X14=28
2	Ability Enhancement Compulsory Course (AECC) (2)	2	1	2	1	2	1	2	1					2 x 2 x 2 x 2 = 08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	2	1	2	1	2X4=16
4	Discipline Specific Elective DSE(6)													
	(i) Theory									4	3	4	3	4X6=24
	(ii) Practical									2	3	2	3	2X6=12
	Total Credit value (Credit x No .of Courses)	26		26		22		22		20		20		136

Structure for S. Y. B. Sc. (Biochemistry)

Semester	Core Course				Ability Enhancement Compulsory Course			Skill Enhancement Courses		
	DSC	Paper	Credits	Lectures	AECC	Credits	Lectures	SEC	Credits	Lectures
III (Total Credits = 22)	DSC-1C:Core Course I: Biochemistry	Paper I	2	30	AECC I: English/Hindi/MIL Communication III (Advance)	2	30	SEC I: Microbial Isolation and Identification Techniques-I	2	30
		Paper II	2	30	AECC II: General knowledge paper	Non-credit				
		Practical Paper	2	60						
	DSC-2C: Core Course II	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
	DSC-3C: Core Course III	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
IV (Total Credits = 22)	DSC-1D:Core Course I: Biochemistry	Paper I	2	30	AECC I: English/Hindi/MIL Communication III (Advance)	2	30	SEC II: Microbial Isolation and Identification Techniques-II	2	30
		Paper II	2	30	AECC II: General knowledge paper	Non-credit				
		Practical Paper	2	60						
	DSC-2D: Core Course II	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
	DSC-3D: Core Course III	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						

Student has choice to study two subsidiary subjects from DSC 2 and DSC 3 among Chemistry/ Botany/ Zoology /Geography during semester III and IV; subject to availability of course at respective college.

Duration of Lecture: 30 Lectures of 60 minutes or 36 Lectures of 50 min.

Each theory and practical course has to be completed in 30 and 60 lectures, respectively of 60 min duration.

Each theory and practical course will be of 100 marks comprising of 40 marks internal and 60 marks external examination.

- **Theory examination** (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
    - **Question 1** (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
    - **Question 2, 3 and 4** (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
    - **Question 5** (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.

- **Internal examination** (40 marks each semester): Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.
- **Practical Examination:** Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on scheduled date or can be scheduled 10 am -1 pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practicals where incubation condition, allied aspect are essential. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination

Equivalence for S.Y. B.Sc. (Biochemistry) is furnished in the following table:

Old Syllabus (June 2015) (Semester pattern 60:40)	**New Syllabus (June 2018) CBCS pattern (Semester pattern 60:40)**
BC 231: Food Biochemistry	BC 301: Food Biochemistry
BC 232: Human Physiology-I	BC 302: Human Physiology-I
BC 233: Practical Course in Biochemistry - I	BC 303: Practical Course in Biochemistry - I
BC 241: Environmental Biochemistry	BC 401: Environmental Biochemistry
BC 242: Human Physiology-II	BC 402: Human Physiology-II
BC 243: Practical Course in Biochemistry - II	BC 403: Practical Course in Biochemistry - II

S. Y. B. Sc. (Biochemistry) Semester – III and IV

Semester	CC-A and B	Paper code	Paper-I	Paper Code	Paper-II	Practical Paper Code	Practical Paper	Skill Enhancement Courses (SEC)	Ability Enhancement Compulsory Courses (AECC)
III	CC A III	BC 301	Food Biochemistry	BC 302	Human Physiology I	BC 303	Practical Course in Biochemistry - I	SEC I: Microbial Isolation and Identification Techniques-I	AECC I: English/Hindi/MIL Communication III (Advance): Credit 2; AECC II: General knowledge paper (Noncredit)
IV	CC A IV	BC 401	Environmental Biochemistry	BC 402	Human Physiology II	BC 403	Practical Course in Biochemistry - II	SEC II: Microbial Isolation and Identification Techniques-II	AECC I: English/Hindi/MIL Communication III (Advance): Credit 2; AECC II: General knowledge paper (Noncredit)

Skill Enhancement Course: To increase the potentiality of Biochemistry students in industries and to make them more employable, Microbial Isolation and Identification Techniques course has been introduced. This course will improve skills of microbial isolation and identification of Biochemistry students which will help them to boost their industrial and research career.

CC A III: Paper I

BC 301: Food Biochemistry (Theory)

Total Hours: 30 **Credits: 2**

Course objective	To accustom students with basic concepts of Food Biochemistry	
Learning outcomes	Student will be able to- • Classify food based on functions • Calculate energy value of food and its measurement • Explain food adulteration and its types • Discuss food spoilage and various factors determining food spoilage • Discuss various methods of food preservation • Understand the concept of food allergy and food additives • Understand the significance of therapeutic diet	
Unit	**Topic Particular**	**Lectures**
Unit I: Energy value of food and its measurement	• Nutritive value of different foods: cereals and millets, pulses, nuts and oils, vegetables, fruits, milk and milk products, eggs, meat, fish and other animal foods, fats and oils, sugar and other carbohydrate food, condiments and spices • Classification of food based on function: energy yielding, body building and protective food • Five food group plan as per ICMR • Energy value of food: carbohydrate, protein, lipid • Energy unit: calorie, kilo calorie, Joule, mega Joule • Physiological energy value of food: loss in digestion and metabolism	08

	• Determination of energy value using Bomb calorimeter • Respiratory quotient: definition, RQ for carbohydrate, fat and protein • Relation between RQ and energy output • Specific dynamic action of food (SDA) • Basal Metabolic Rate: definition, determination, factors affecting BMR • Recommended dietary allowance: definition, factors affecting RDA, RDA for adult man	
Unit II Food adulterations	• Adulteration: Definition, types- Intentional and incidental (definition and one example) • Common adulterants in different foods: Milk and Milk product, vegetable oils, and fats, wheat products, pulses, honey, beverages, spices and condiments, miscellaneous. • Contamination of food with harmful microorganism: o Food intoxication: *Botulism*, *Clostridium perfringens*, *Bacillus cereus*, *Salmonella*, *Shigella dysenteriae*, *Listeria monocytogens*, *Yersinia enterocolitica* o Fungal contamination- *Fusarium* and *Cladosporium*, *Penicillium islandicum*, *Claviceps purpurea*, *Aspergillus flavus* • Parasitic infection, toxicants naturally occurring in some food, insect and rodent contamination of stored food. • Food laws and standards: Prevention of food adulteration act 1954; Bureau of Indian Standards, Agmark, Consumer protection act 1986, Hazard analysis critical control point (HACCP)	07
Unit III: Food spoilage and food preservation	• Food spoilage, factors determining food spoilage- intrinsic, extrinsic modes of processing and preservation, implicit parameters • Micro-organisms involved in food spoilage: bacteria, yeast and molds, Food spoilage by enzymes, and insect. • Chemical spoilage: lipid oxidation, enzymatic oxidation, lipolysis, discoloration • Food preservation: Concept and principle • Methods of food preservation: o Preservation by low temperature: freezing, chilling/cold storage / refrigeration o Preservation by high temperature: heating below 100°C (pasteurization), heating at 100°C, heating above 100°C o Preservation by drying: conventional air drying, microwave drying, osmotic dehydration, freeze drying, mechanical drying, spray drying, foam-mat drying, drying by smoking. o Irradiation: Types- radiation sterilization, radurization, radicidation, thermoradiation; ionizing radiation used for	07

	food irradiation- electron beam, x-rays, gamma rays and UV; uses of food irradiation, effect of ionizing radiation on nutrients of food o Chemicals: acids and their salts, nitrites, NaCl, sulphites, dimethyl dicarbonate, phenolic antioxidants, phosphate	
Unit IV: Food additives, food allergy and diet modification	• Food additives: Concept, importance of food additives, • Examples of food additives: antimicrobial agents, antioxidants, colour and adjuncts, emulsifiers, flavor enhancers, enzymes, sweeteners, non-nutritive and nutritive additives, propellants, aerating agents and gases. • Food allergy: Concept, classification immediate and delayed allergy. Clinical signs and symptoms. • Food as allergen: Animal origin - cow milk, goat milk, egg, fish, meat. Plant origin: cereals, soybean, peanut, other legumes, edible fungi, fats, oils, vegetables, fruits and beverages. • Detection of food allergy: history taking, diet diaries, elimination diet, provocative diet, pulse acceleration test, leukopenic index, x-ray, skin testing. • Therapeutic diet / diet modification in diseases: Definition and types of therapeutic diet. • Concept and significance of balanced diet. • Representative diets in: diabetes mellitus, cardio vascular diseases, anemia with brief rationale for each type of diet.	08
Suggested readings	**1.** Swaminathan M. (1998) Essentials of food and Nutrition. Vol I, II, 2nd edition, The Bangalore Printing and Publishing Co. Ltd. **2.** Srilakshmi B. (2006) Food Science 3rd edition, New Age International Pvt. Ltd Publishers. **3.** Vijaya Ramesh K. (2009) Food Microbiology MJP Publishers. **4.** Mirajkar Mridula and Menon Sreelata (2010) Food Science and Processing Technology, Vol.2 Commercial Processing and Packaging, Kanishka Publishers. **5.** Swaminathan M. (2018) Handbook of food & Nutrition, The Bangalore Printing and Publishing Co. Ltd. **6.** Satyanarayana U. (2006) Biochemistry, 3rd edition, Chakrapani. U. (ed.) Books and Allied (P) Ltd.	

CC A III: Paper II

BC 302: Human Physiology I (Theory)

Total Hours: 30 **Credits: 2**

Course objective	To accustom students with basic concepts of Human Physiology
Learning outcome	Student will be able to- • Understand histology and anatomy of various organs of digestive system • Discuss digestion and absorption of carbohydrates, proteins and lipids

	• Explain structure and functions of various parts of respiratory system • Understand mechanism of respiratory process • Learn various types of hematopoiesis • Understand mechanism of blood coagulation • Explain structure and functions of nephron. • Understand mechanism of urine formation	
Unit	**Topic Particular**	**Lectures**
Unit I: Digestive System	• Digestive system: Structure and functions. Histology of alimentary tract. • Structure and functions of different parts of digestive system: Esophagus, stomach, small intestine, large intestine. • Structure and functions of accessory digestive organs: Salivary glands, liver, Gall bladder, pancreas. • Composition and functions of digestive juices: Saliva, gastric juice, pancreatic juice, intestinal juice (succus entericus), bile. • Gastrointestinal hormones: Gastrin, Cholecystokinin pancreozymin, secretin and gastric inhibitory peptide, motilin. • Digestion and absorption of carbohydrate, protein and lipid. • Absorption of water and electrolytes.	08
Unit II: Respiratory System	• General structure of respiratory system. Structure and functions of trachea and lungs. • Physical properties of lungs: surface tension, elasticity, lung volume and lung capacity. • Respiration: Definition and functions. Mechanism of respiration/breathing: inspiration and expiration concerning diaphragm, intercostal muscle, sternum, ribs, accessory muscles. • Respiratory process: Oxygen transport: oxygen exchange in lungs and transport in tissue, dissociation curve for hemoglobin and factors affecting it - CO_2 concentration (Bohr's effect and significance), pH, temperature, 2,3-diphosphoglycerate. Carbon dioxide transport: chemical forms in which CO_2 transports, CO_2 transport in tissue (Chloride shift), in RBCs and as carbamino compounds. • Control of respiration: Nervous and chemical factors controlling respiration	07
Unit III Circulatory System	• Composition and functions of blood and plasma. Plasma proteins: specific plasma proteins (albumins, globulins, carrier proteins, acute phase proteins) and their functions. • Structure, functions and life span of RBCs, WBCs and platelets. • Hematopoiesis: Erythropoiesis, granulocytopoiesis, lymphocytopoiesis and Thrombocytopoiesis. • Hemoglobin: Structure, types (HbA, HbF, HbS) and functions. • Blood coagulation: Definition, blood clotting factors, extrinsic and intrinsic pathways. Blood coagulation tests: Bleeding	08

	time, clotting time, prothrombin time. Blood groups: A, B, O and Rh factor, cross matching, compatibility. Blood transfusion. • Lymphatics and lymph: Description, properties, formation and functions of lymph.	
Unit IV: Excretory System	• Organization of urinary tract. • Anatomy and functions of kidney. • Structure and functions of nephron. • Urine formation: glomerular filtration, tubular reabsorption and tubular secretion. Counter current multiplication theory of urine concentration. • Characteristics of urine: volume, colour, reaction, specific gravity, turbidity, odour, osmotic pressure. Normal and abnormal constituents of urine. • Role of kidney in fluid and acid-base balance.	07
Suggested readings	**1.** Chatterjee C.C. (2004) Human Physiology, Vol. I, II, 11th edition, Medical Allied Agency. **2.** Guyton A.C. and Hall J.E. (2001) Textbook of Medical physiology, 10th edition, Harcourt Publisher International Company. **3.** Talwar G.P. and Srivastava L. M. (2006) Text Book of Human Biochemistry, 3rd edition, Prentice Hall of India Pvt. Ltd. **4.** Marieb Elaine N. (1996) Essentials of Human Anatomy and Physiology, 9th edition, Pearson International Edition. **5.** Seeley R. R., Stephens T. D. and Philip Tate D.A. (1996) Essentials of Anatomy and Physiology, Second Edition, Mosby A Times Mirror Company, New York. **6.** Stuart Ira Fox (1996) Human Physiology, 5th edition, Wm C. Brown Publisher. **7.** Murray R.K., Granner D.K. and Rodwell V.W. (2006) Harper's Illustrated Biochemistry, 27th Edition, McGraw Hill Publisher. **8.** Suresh R. (2013), Essentials of Human Physiology, Books and Allied (P) Ltd, Kolkata. **9.** Chaudhari. S. K. (2014) Concise Medical Physiology, 6th editon, New Central Book Agency Pvt. Ltd. London. **10.** Das Asis (2006) Medical Physiology, 4th edition, Books and Allied (P) Ltd, Kolkata.	

CC A III: Biochemistry Practical Paper I

BC 303: Practical Course in Biochemistry (Practical)

Total Hours: 60 **Credits: 2**

Course objective	To acquaint students with various techniques used in biochemistry
Learning outcomes	Students will be able to: • Enumerate RBCs and WBCs and determine the health status • Determine blood groups, ESR and understand its clinical significance • Determine energy value of food stuff using bomb calorimeter • Identify adulterants present in food stuffs

	• Determine rancidity in edible oil and its applications • Determine moisture content in food sample • Examine food for microorganisms • Perform various staining techniques of micro-organisms	
Sr. No.	**Title of the Practical**	**Hours**
1.	Enumeration of RBCs for determining health status.	4
2.	Enumeration of WBCs for determining health status.	4
3.	Determination of ESR of the given blood sample.	4
4.	Determination of gastric juice acidity.	4
5.	Determination of blood groups (A, B, AB, O and Rh) and its significance.	4
6.	Determination of energy value of food stuff using bomb calorimeter	4
7.	Qualitative analysis of some common food adulterants: Pulses, oil, fats, milk and milk products, beverages, spices and condiments.	4
8.	Determination of rancidity in edible oil and its applications.	4
9.	Microbial examination of food.	4
10.	Determination of moisture content in food sample.	4
11.	Isolation and colony morphology study of microorganism	4
12.	Cell wall staining of micro-organisms	4
13.	Capsule staining of micro-organisms	4
14.	Morphological characterization of fungi by slide culture	4
15.	Determination of microorganism size by micrometry	4
Note: Mandatory to perform 13 practicals		
Suggested readings	**1.** Aneja K.R. (2007) Experiments in microbiology, plant pathology and biotechnology, New age international publishers. **2.** Kale V. and Bhusari K. (2010) Practical Microbiology: Principles and Techniques, Himalaya Publishing House. **3.** Godkar P.B. and Godkar D.P. (2003) Textbook of Medical Laboratory Technology, 2nd Edition, Bhalani Publishing House. **4.** Rajgopal G. and Toora B.D. (2005) Practical Biochemistry, 2nd edition, Ahuja Publishing House. **5.** Maheshwari D.K. (2002) Practical Microbiology, S. Chand Publishing, New Delhi **6.** Rajan S. and Christy Selvi R. (2015) Experimental Procedures in Life Sciences, CBS Publishers and Distributors Pvt. Ltd.	

A III: Paper III

BC SEC-I: Microbial Isolation and Identification Techniques - I (Theory)

Total Hours: 30 **Credits: 2**

Course objective	To accustom students with basic concepts of microbial isolation and morphological techniques.
Learning outcome	Students will be able to: • Understand various types of media used for microbial isolation • Measure microbial growth by various methods • Use Bergey's manual for identification of micro-organisms • Study microbial morphology by various staining techniques • Understand micrometry techniques used for microbial size measurement

Unit	Topic Particular	Lectures
Unit I: Microscopic techniques	• The light microscope: ○ Lenses and the bending of light ○ Microscopic resolution ○ Bright-field microscope ○ Dark-field microscope ○ Phase contrast microscope ○ Fluorescence microscope ○ Inverted microscope • Electron microscopy: ○ Transmission Electron Microscope (TEM) ○ Scanning Electron Microscope (SEM)	08
Unit II: Isolation of microorganisms	• Types of media: Culture Media- solid and broth, selective, differential and enrichment media. • Media used for isolation of microorganisms like bacteria, fungi, actinomycetes, yeasts and cyanobacteria. • Characteristic of bacteria, fungi, actinomycetes, yeasts and cyanobacteria. • Isolation techniques: Concept of isolation techniques: streak plate method, pour plate method, spread plate methods and anaerobic bacterial isolation by candle jar method and fungi isolation by slide culture technique.	07
Unit III: Microbial growth measurement	• Methods of measurement of Microbial Growth: a) Direct Counts: • Counting chambers • Electronic counters – flow cytometry on membrane filters. b) Viable Counting Methods: • Spread plate techniques • Pour plate techniques • Membrane filter technique • Turbidity • Most Probable Number (MPN). c) Measurement of cell mass: • Dry weight analysis, • Measurement of cell components	07
Unit IV: Morphological characteristics and Staining of microorganisms	• Bergey's Manual: Introduction • Morphological characteristic of microorganisms: Form, Size, Elevation, Margin/border, Surface, Opacity, Colour • Staining techniques: principles and procedures (Gram staining, acid fast staining, spore staining, capsule staining, Flagella staining, cell wall staining, metachromatic granules staining). Fungi: Lacto phenol cotton blue, arbuscular mycorrhizal staining. • Measure the size of microorganisms by micrometry by using Ocular micrometer and stage micrometer.	08

Suggested readings	1. Michael T Madigan, Kelly S Bender, Daniel H Buckely, W Matthew Sattley, David Allan Stahl (2018) Brock Biology of Microorganisms, NY Pearosn publisher. 2. Modi, H.A. (1995) Elementary Microbiology, Vol I, Ekta Prakashan, Nadiad 3. Aneja K.R. (2007) Experiments in microbiology, plant pathology and biotechnology, New age international publishers. 4. Kale V. and Bhusari K. (2010) Practical Microbiology: Principles and Techniques, Himalaya Publishing House. 5. Godkar P.B. and Godkar D.P. (2003) Textbook of Medical Laboratory Technology, Second Edition, Bhalani Publishing House. 6. Rajgopal G. and Toora B.D. (2005) Practical Biochemistry, 2nd edition, Ahuja Publishing House. 7. Maheshwari D.K. (2002) Practical Microbiology, S. Chand Publishing. 8. Rajan S. and Christy Selvi R. (2015) Experimental procedures in Life Sciences, CBS Publishers and Distributors Pvt Ltd.	

S.Y. B.Sc. Biochemistry Semester IV

CC A IV: Paper I

BC401: Environmental Biochemistry (Theory)

Total Hours: 30 **Credits: 2**

Course objective	To accustom students with basic concepts of Environmental Biochemistry	
Learning outcomes	Students will be able to: • Understand the concept of pollution and pollutants • Learn about greenhouse effect and global warming and measures to control greenhouse effect • Understand the concept of bioenergy • Explain biodegradation and bioremediation • Discuss concept and types of toxins • Understand mode of action of pesticides and its impact on environment	
Unit	**Topic Particular**	**Lectures**
Unit I: Pollution and environmental problems	• Pollution: Concept and introduction of pollution and pollutants. • Introduction, effect and control of; water pollution, land pollution, noise pollution and air pollution. • Greenhouse effect and global warming. Greenhouse gases. Measures to control greenhouse effect. • Ozone layer: Importance of ozone layer. Depletion of ozone, ozone hole, effects of ozone depletion. Measures to control ozone depletion. • Acid rain: Introduction, effects and measures to control acid rain.	08
Unit II: Bioenergy	• Bioenergy: Introduction. Biomass for energy production: Concept, chemical nature, sources, utilization.	07

	• Biogas: Introduction, substrates, process, microbial production of biogas, factors affecting biogas production, advantages. Limitations for large scale production. • Introduction to hydrogen as a biofuel. Production of bio-hydrogen by photosynthetic bacteria and fermentation. • Energy rich crops: Sugar and starch crops, wood rich plants and petroleum plants.	
Unit III: Biodegradation and bioremediation	• Biodegradation: Concept, microorganisms for biodegradation and bioremediation. Enzyme system for biodegradation. Factors affecting biodegradation. Xenobiotics. • Bioremediation: Concept, types, advantages and disadvantages. Types of reaction in bioremediation. • Bioremediation of contaminated soil, waste land and ground water	07
Unit IV: Environmental toxicology	• Toxins: Concept and types. Introduction, sources and remedies of metal toxins (arsenic, mercury). • Pesticides: Introduction, classification on the basis of mode of entry, mode of action and chemical nature. Application of pesticides. Environmental effects of pesticides. • Impact of pesticide on organisms. • Bio and chemical warfare agents: Anthrax, plague, small pox, sarin, chlorine, hydrogen cyanide, Sulphur mustard, lewisite and ricin	08
Suggested readings	1. Satyanarayana U. (2009) Biotechnology, Books and Allied (P) Ltd., Kolkata. 2. Santra S.C. (2010) Environmental Science, New Central Book Agency (P) Ltd, Kolkata. 3. De A. K. (2010) Environmental Chemistry, 7th edition, New Age International Publishers, New Delhi. 4. Jogdand S.N. (2005) Environmental Biotechnology, 2nd edition, Himalaya Publishing House, Mumbai. 5. Rana A.K. and Rana M.K. (2011) Environment and Ecology, Global Vision Publishing House, New Delhi. 6. Saha T.K. (2014) Ecology and Environmental Biology, Books and Allied (P) Ltd, Kolkata. 7. Satake M., Mido Y., Yasuhisa H., Taguchi S., Sethi M. S. and Iqbal S. A. (1997) Environmental Toxicology, Discovery Publishing House, New Delhi.	

CC A IV: Paper II

BC402: Human Physiology-II (Theory)

Total Hours: 30 **Credits: 2**

Course objective	To accustom students with basic concepts of Human Physiology
Learning	Students will be able to:

outcome	• Explain structure, functions and types of neurons • Discuss mechanism of synaptic transmission • Understand anatomy, histology and functions of male and female reproductive system • Learn molecular events during fertilization • Learn mechanism of hormone action • Explain various hormones secreted by endocrine glands and their functions • Understand mechanism of taste perception and olfaction	
Unit	**Topic Particular**	**Lectures**
Unit I : Nervous system	• Nervous system: Introduction to central and peripheral nervous system. • Peripheral nervous system: Cranial and spinal nerves. General structure of nerve. • Nervous tissue: Structure, functions and types of neurons (uni-, di- and multi-polar, myelinated and non-myelinated). • Synapse: Definition, classification, properties, types (structural basis: axo-dendritic, axoaxonic, axo-somatic; functional basis- chemical and electrical synapse). Mechanism of synaptic transmission. • Neurotransmitters: Definition. Structure and functions of excitatory and inhibitory neurotransmitters. • Reflex action: Definition, types (conditioned and unconditioned). • Reflex arc: Definition, components and types.	08
Unit II: Reproductive system	• Male reproductive system: Anatomy. Histology and functions of testis. Structure of sperm, spermatogenesis, hormonal control of spermatogenesis. Semen. Accessory glands: seminal vesicles, prostate, bulbourethral gland. • Female reproductive system: Anatomy and histology. Ovary: anatomy, histology and functions. Maturation of Graafian follicle and ovum. Menstrual cycle. Oogenesis and its hormonal regulation. • Hormones secreted by gonads: Chemistry and functions of androgen, testosterone, estrogen and progesterone. • Fertilization: Definition and molecular events during fertilization	08
Unit III : Endocrine system	• Endocrine system: Introduction to endocrine and exocrine glands. • Hormones: Concept and definition, • General characteristics of hormones: action in low concentration, storage, destruction and excretion, rate limiting action, dual control, multiple secretion, chemical nature, inter-relation of endocrines, inter-relation with vitamin, dysfunction of endocrine glands, therapeutic administration of hormones. • General properties of hormones: solubility, molecular weight, diffusion, cumulative action.	07

	• Mode of action of hormones: Endocrine, paracrine and autocrine. • Molecular mechanism of hormone action: protein, peptide, lipid/steroid hormones. • Pituitary gland: Anatomy: adenohypophysis and neurohypophysis. Functions of growth hormone, prolactin, FSH, LH, TSH, ACTH, MSH, vasopressin and oxytocin. • Thyroid gland: Anatomy and histology. Thyroid hormones and their functions (T3, T4 and thyroxine). Parathyroid gland: anatomy and histology. Functions of parathormone. • Endocrine pancreas: Anatomy and histology. Functions of insulin and glucagon. • Adrenal gland: Anatomy and histology. Functions of epinephrine, nor-epinephrine, gluco-corticoid, mineral-corticoid, sex hormones/sex steroid. • Pineal gland: Anatomy and histology. Functions of melatonin.	
Unit IV: Biochemistry of specialized tissue and receptors	• Taste (gustation): Histology of tongue, papillae, taste buds. Taste sensations and constitution related to taste: sweet, bitter, sour, salt. Mechanism of taste perception. Factors affecting taste sensation. • Smell (olfaction): Olfactory receptors, physiology of olfaction, pathways of olfactory impulses. • Skin: Structure and functions. Glands in skin: sweat, eccrine and sebaceous gland. Mechanism of secretion of sweat, types of sweating, pigmentation of skin. • Muscles: Structure and functions of striated and unstriated muscles. Mechanism of muscle contraction and relaxation. Role of actin, myosin, troponin, tropo-myosin, titin, nebulin, Ca^{2+} in muscle contraction and relaxation.	07
Suggested readings	1. Chatterjee C.C. (2004) Human Physiology Vol. I, II, 11th edition, Medical allied Agency. 2. Guyton A.C. and Hall J.E. (2001) Textbook of Medical Physiology, 10th edition, Harcourt publisher International Company. 3. Talwar G.P. and Srivastava L. M. (2006) Text Book of Human Biochemistry 3rd edition, Prentice Hall of India Pvt. Ltd. 4. Marieb Elaine N. (1996) Essentials of Human Anatomy and Physiology, 9th edition, Pearson International Edition. 5. Seeley R. R., Stephens T. D. and Philip Tate D.A. (1996) Essentials of Anatomy and Physiology, Second Edition Mosby A Times Mirror Company New York. 6. Stuart Ira Fox (1996) Human Physiology 5th edition, Wm C. Brown Publisher. 7. Murray R.K., Granner D.K. and Rodwell V.W. (2006) Harper's Illustrated Biochemistry, 27th Edition, McGraw Hill Publisher. 8. Suresh R. (2013) Essentials of Human Physiology, Books and	

	Allied (P) Ltd., Kolkata. 9. Chaudhari. S. K. (2014) Concise Medical Physiology, 6th edition, New Central Book Agency Pvt. Ltd., London. 10. Das Asis (2006) Medical Physiology, 4th edition, Books and Allied (P) Ltd., Kolkata	

CC A IV: Biochemistry Practical Paper II

BC 403: Practical Course in Biochemistry (Practical)

Total Hours: 60 **Credits: 2**

Course objective	To acquaint students with various techniques used in biochemistry	
Learning outcomes	Students will be able to: • Record blood pressure by sphygmomanometer and explain its significance • Determine bleeding time and clotting time and explain its significance • Determine sodium and potassium content in blood serum samples by flame photometer • Analyze wastewater for BOD/COD • Analyze soil and water for various parameters • Determine pH, conductivity and phosphate content of soil samples	
Sr. No.	**Title of the Practical**	**Hours**
1.	Recording of blood pressure by sphygmomanometer and its significance.	4
2.	Determination of in vitro protein digestibility.	4
3.	Determination of bleeding time and clotting time and its significance.	4
4.	Determination of sodium and potassium content in blood serum samples by flame photometer.	4
5.	Analysis of wastewater for BOD.	4
6.	Analysis of wastewater for COD.	4
7.	Estimation of chlorides in water.	4
8.	Determination of hardness of water.	4
9.	Soil analysis: pH, salt concentration by conductometry.	4
10.	Estimation of phosphate by Fisk-Subbarao method.	4
11.	IMViC test	4
12.	Sugar fermentation test	4
13.	Screening of organic acid/antibiotic/ enzyme producing microorganisms	4
14.	Isolation of yeast from sugarcane juice/sweet sample	4
15.	Preservation of industrially important microorganism by suitable method	4
Note: Mandatory to perform at least 13 Practicals		
Suggested readings	1. Plummer D. T. (2005) An Introduction to Practical Biochemistry, TATA McGraw-Hill. 2. Sadasivam S. and Manickam A. (2008) Biochemical Methods, 3rd edition, New Age International Publishers. 3. Rao B. S. and Deshpande V. (2005) Experimental Biochemistry: A Student Companion, I.K. International Pvt. Ltd., New Delhi.	

	4. Sawhney S.K. and Singh Randhir (2011) Introductory practical Biochemistry, Narosa Publication House Pvt. Ltd. 5. Jayaraman J. (1981) Laboratory Manual in Biochemistry, New Age International Publishers 6. Aneja K.R. (2007) Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Publishers. 7. Kale V. and Bhusari K. (2010) Practical Microbiology: Principles and Techniques, Himalaya Publishing House. 8. Godkar P.B. and Godkar D.P. (2003) Textbook of Medical Laboratory Technology, Second Edition, Bhalani Publishing House. 9. Rajgopal G. and Toora B.D. (2005) Practical Biochemistry, 2nd edition, Ahuja Publishing House. 10. Maheshwari D.K. (2002) Practical Microbiology, S. Chand Publishing. 11. Rajan S. and Christy Selvi R. (2015) Experimental Procedures in Life Sciences, CBS Publishers and Distributors Pvt. Ltd.	

CC A IV: Paper III

SEC-II: Microbial Isolation and Identification Techniques-II (Theory)

Total Hours: 30 **Credits: 2**

Course objective	To acquaint students with various biochemical techniques used for microbial identification	
Learning outcomes	Students will be able to: • Understand principle and procedure of various biochemical tests used for identification of microorganism • Use selective agar and differential media for isolation of microorganisms • Screen industrially economically important microorganisms • Understand microbial preservation techniques	
Unit	**Topic Particular**	**Lectures**
Unit I : Biochemical tests for Identification of microorganisms	• Concepts, principles and procedures: • Catalase Test • Starch hydrolysis test • Coagulase Test • Oxidase Test • Methyl Red / Voges-Proskauer (MR/VP), • Kliger's Iron Agar (KIA) • Nitrate Broth • Urease test • Casein hydrolysis • Tyrosine hydrolysis • Beta-galactosidase • Arginine dihydrolase • Lysine decarboxylase • Ornithine decarboxylase • Indole production • TSI test	08

	• Sugar fermentation acid and gas production test**.**	
Unit II: Microbial isolation on different media	• Selective agar test: Mannitol Salt Agar (MSA), Blood Agar Plates (BAP), Bile Esculin Agar, Nitrate Broth, Spirit Blue agar, MacConkey agar, Simon's Citrate Agar, Sulfur Indole Motility Media (SIM), Motility Agar • Selective and differential media: Eosin Methylene blue (*E. coli*), Xylose lysine deoxycholate agar (*Salmonella* and *Shigella*), Mannitol salt agar (*Staphylococcus* and *Micrococcus*), Cetrimide agar (*Pseudomonas*), Azide Dextrose Broth (*Streptococcus*), Ashby's Mannitol Agar (*Azatobacter*), Yeast extract mannitol agar (*Rhizobium*)	08
Unit III: Primary screening techniques	• Enzyme producing microorganisms: amylase, gelatinase, lipase • Organic acid producing microorganisms by using pH indicator dyes, Calcium carbonate test. • Antibiotic producing microorganisms by crowded plate technique • Probiotic producing microorganisms by MRS medium • Phosphate solubilizing microorganism by Pikovskaya's Agar	07
Unit IV Preservation of microorganisms	• A) Preservation in continuous metabolic active state: ○ Short-term preservation (Agar slants, Agar stabs), ○ Periodic transfer in fresh media ○ Long-term preservation (Glycerol stocks, Gelatin discs, Mineral oil, Storage in soil), • B) Suspended metabolic state: ○ Freeze drying (Lyophilization) ○ Drying in vacuum ○ Cryopreservation ○ Storage in silica gel • Quality control of preserved stock cultures	07
Suggested readings	1. Michael T Madigan, Kelly S Bender, Daniel H Buckely, W Matthew Sattley and David Allan Stahl (2018) Brock Biology of Microorganisms, Pearson publisher, New York. 2. Modi, H.A. (1995) Elementary Microbiology, Vol I, Ekta Prakashan, Nadiad 3. Aneja K.R. (2007) Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Publishers. 4. Kale V. and Bhusari K. (2010) Practical Microbiology: Principles and Techniques, Himalaya Publishing House. 5. Godkar P.B. and Godkar D.P. (2003) Textbook of Medical Laboratory Technology, 2nd Edition, Bhalani Publishing House. 6. Rajgopal G. and Toora B.D. (2005) Practical Biochemistry, 2nd edition, Ahuja Publishing house. 7. Maheshwari D.K. (2002) Practical Microbiology, S. Chand Publishing. 8. Rajan S. and Christy Selvi R. (2015) Experimental Procedures in Life Sciences, CBS Publishers and Distributors Pvt Ltd.	

Skills acquired and Job prospectus for the Biochemistry students

Biochemistry is the molecular basis of life. Degree program in Biochemistry teaches students how inanimate, lifeless chemicals combine to produce a functional living organism. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunity in all sectors.

After successful completion of three years degree course in Biochemistry, student will be well versed with laboratory skills and transferable skills.

Laboratory Skills:

- Laboratory safety practices
- Accurate weighing and reagent preparation
- Skillful handling of basic and advanced instruments
- Calibration of basic instruments like pH meter, micropipettes etc
- Advanced techniques like-
    - Chromatography
    - Electrophoresis
    - Spectrometry
    - Polymerase Chain Reaction (PCR)
    - Plant Tissue Culture
    - Animal Tissue Culture
- Aseptic techniques
- Logical thinking
- Analysis and interpretation of results
- Collection, organization and presentation of data

Transferable Skills:

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas. These are:

- Analytical skill
- Report writing skill
- Presentation skill
- Time management
- Creative thinking
- Problem solving
- IT skills
- Planning
- Observational skill

Job Opportunities:

After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biochemistry and then Ph.D. in Biochemistry and make career in research field. Students have opportunities in private as well as public (Government) sectors.

Private Sector:

Biochemist can work in quality control, quality assurance and R & D divisions of companies like- Biotech companies, Pharmaceutical companies, Chemical manufacturing companies, Food and Drink (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sectors:

Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Job profiles:

Biochemist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Microbiologist, Research Associates, Research Officers, Research Scientist etc.

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Structure of Syllabus

Program B.Sc.

T. Y. B. Sc. (Biochemistry)

Choice Based Credit System (CBCS)

2020-21

T.Y.B.Sc. Biochemistry

Preamble

The cumulative demand for trained and skilled manpower in the area of Biochemistry requires in depth functional knowledge of modern biology through hands-on training to the students.

The syllabus has been prepared anticipating the requirements of B.Sc. Biochemistry students under CBCS Program. The contents have been drawn to accommodate the widening horizons of the Biochemistry discipline and reflect the changing needs of the students. The detailed syllabus for each course is appended with a list of suggested readings.

The degree of Bachelor of Science in Biochemistry (Choice Based Credit System) aims to introduce various aspects of Biochemistry and interdisciplinary subjects to the students. The program in Biochemistry as one of the core subjects is designed to cultivate a scientific attitude and interest towards the modern areas of Biochemistry and life science in general. This will help the students to become critical and curious in their outlook. The courses are designed to impart the essential basics in Biochemistry, Chemistry, Botany, Microbiology, Zoology and Biotechnology at the initial level of graduation. The basic courses are infused with application in modern life sciences, and awareness on Biochemistry and its influence in human life. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of Biochemistry and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about Biochemistry and contribution of Biochemistry among the society. At the end of the course, the students are expected to have good working knowledge in the field of Biochemistry and in addition knowledge gained from courses of interdisciplinary in nature. Students will surely have an urge to continue higher studies in Biochemistry and contribute significantly in the development.

The present syllabus is restructured anticipating the future needs of Biochemistry with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Biochemistry.

Hence, Board of Studies in Life Sciences in its meeting accepted the revised syllabus for T. Y. B. Sc. (Biochemistry) based on Choice Based Credit System (CBCS) of UGC guidelines. The path for a bright future of Biochemistry has been emphasized to build up with a hope to achieve the goals in the form of fruitful program outcomes in the coming days.

There are 08 core courses which encompass all important aspects of the discipline of Biochemistry and are all compulsory courses. 04 choice-based Discipline Specific Elective (DSE) courses are designed which give the students a chance to apply their knowledge of Biochemistry to study societal problems. The students have a freedom to select the courses of their choice while Skill based Elective Courses (SEC) are also included to develop skills in areas which are related to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment.

Programme Outcome (PO)

As an outcome, the graduate students are expected to gain the following competencies upon completion of this program B.Sc.

- Students will understand the concepts and significance in the field of Biochemistry / Biotechnology / Microbiology that can be used for solving the real time problems.
- Students will acquire skills and ability in their field and find professional opportunities in industry, agriculture and higher studies.
- Students will have improved personal qualities and transferable skills to help them to groom as responsible citizens.

Program Specific Outcomes (PSO):

- T.Y. B.Sc. (Biochemistry) graduates will have basic and applied knowledge of Biochemistry.
- They can further continue their education as PG and then Ph.D.
- After successful completion of the program, students will acquire laboratory and transferable skills which will help them to boost their career.
- Students can apply their knowledge in public as well as private sector and build successful career.

Learning Objectives

- To acquaint the students with various disciplines of Biochemistry.
- To articulate foundation and pillar level knowledge of Biochemistry for the beneficiaries to apply them for advanced studies in the subject.
- To develop practical skills with a sound theoretical background.

- To apply the knowledge gained for higher education, research and profession of their choice.
- To analyse their interests among the various disciplines and implement them in their professional endeavours.

Programme Structure:

The programme includes 8 Discipline Specific Core Courses (DSC) of 3 credits each, 4 each for the two semesters (Semester V and VI). There shall be inclusion of 02 Skill Enhancement Course (SEC) of 3 credits each, one for each Semester. The course has incorporated 4 Discipline Specific Elective Courses of 3 credits each, two for each Semester. The student shall have liberty to choose one of the two courses. There shall be 6 Discipline specific Core Practical courses of 2 credits each; 3 courses for each semester.

Eligibility:

Students completing Second Year CBCS (Semester III and IV) of B.Sc. (44 credits) shall be eligible for admission to T.Y.B.Sc. CBCS Degree course. However, the candidate must pass all subjects of first year.

Course Fee: As per University norms

Duration: The duration of B.Sc. (Biochemistry) degree program shall consist of three years.

Medium of instruction: The medium of instruction for the program shall be English.

Credit to contact hour/Duration of Lecture: 45 Lectures of 60 minutes or 54 Lectures of 50 minutes shall be conducted for 08 Discipline Specific Core courses, 02 Skill Enhancement Courses and 02 Discipline Specific Elective courses of 3 credits each. Each theory and practical course must be completed in 45 and 60 lectures, respectively of 60 minutes duration. The score allotted for 06 Discipline Specific Core practical courses is 2 credits for each course.

Attendance:

The candidates appearing for the final year examinations of B.Sc. Biochemistry need to fulfill a regular attendance record in theory and practical of not less than 80 %. Failing to fulfill the criteria the student shall not be eligible for appearing for the T.Y.B.Sc. CBCS examination.

Exam Pattern

- Each theory and practical course will be of 100 marks comprising of 40 marks internal (College assessment) and 60 marks external examination (University assessment).
- Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each) while the tentative pattern of question papers shall be as follows;
- Question 1 (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
- Question 2, 3 and 4 (12 marks each): based from Unit I, II, III and IV, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
- Question 5 (12 marks): answer only 3 out of 5 in brief, based from all 4 units, Each 4 marks.

Internal examination (40 marks each semester):

Internal assessment (College assessment) of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.

Practical Examination:

Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule with some flexibility; if required. There shall be 10 marks for laboratory logbook and well written journal, 10 marks for *viva-voce* and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one/ two expert and two examiners (external and internal) per batch for the practical examination.

Scheme

Scheme for T. Y. B. Sc. program under the Faculty of Science and Technology includes in continuation with the First and Second Year's two semesters namely Semester V and VI. Each semester shall include four Core courses; one Skill based course, one Elective course, three Core practicals and one non-credit Elective Audit course.

Scheme for B.Sc. Program under Faculty of Science and Technology

Sr. No	Year → Course ↓	First Year				Second Year				Third Year				Total Credit Value
		Sem I		Sem II		Sem III		Sem IV		Sem V		Sem VI		
1	Core Courses (16)	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	i. Theory	4	4	4	4	4	3	4	3	3	4	3	4	4x14=56 3x8=24
	ii. Practical	2	4	2	4	2	3	2	3	2	3	2	3	2x14=28 2x6=12
2	Ability Enhancement Compulsory Course (AECC) (2)	2	1	2	1	2	1	2	1					2x2x2x2 =08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	3	1	3	1	2x2=04 3x2=06
4	Discipline Specific Elective (DSE) (6)									3	1	3	1	3x2=06
5	Elective Audit									No credit	Any 1	No credit	Any 1	--
6	Total Credit Value (Credit x No. of courses)	26		26		22		22		24		24		**144**

Structure of T.Y.B.Sc. (Biochemistry) Curriculum Semester V

<table>
<tr><th rowspan="2">Discipline</th><th rowspan="2">Course Type</th><th rowspan="2">Course Code</th><th rowspan="2">Course Title</th><th rowspan="2">Credits</th><th rowspan="2">Hours/ Week (Clock Hours)</th><th rowspan="2">Total Teaching hours</th><th colspan="2">Marks</th></tr>
<tr><th>CA</th><th>UA</th></tr>
<tr><td rowspan="4">DSC</td><td>Core I</td><td>BC-501</td><td>Genetics</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td>Core II</td><td>BC-502</td><td>Plant Biochemistry and Biofertilizers</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td>Core III</td><td>BC-503</td><td>Clinical Biochemistry</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td>Core IV</td><td>BC-504</td><td>Metabolism</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td>SEC</td><td>Skill Based</td><td>BC-505</td><td>Biophysical Chemistry</td><td>3</td><td>3</td><td>45</td><td>40</td><td>60</td></tr>
<tr><td rowspan="2">DSE</td><td rowspan="2">Elective Course (Anyone)</td><td>BC-506A</td><td>Fermentation Technology</td><td rowspan="2">3</td><td rowspan="2">3</td><td rowspan="2">45</td><td rowspan="2">40</td><td rowspan="2">60</td></tr>
<tr><td>BC-506B</td><td>Biomembranes-I</td></tr>
<tr><td rowspan="3">DSC</td><td rowspan="3">Core (Practical)</td><td>BC-507</td><td>Techniques in Plant Biotechnology and Molecular Biology-I</td><td>2</td><td>4 / batch</td><td>60</td><td>40</td><td>60</td></tr>
<tr><td>BC-508</td><td>Diagnostic Biochemistry</td><td>2</td><td>4 / batch</td><td>60</td><td>40</td><td>60</td></tr>
<tr><td>BC-509</td><td>Biophysical Chemistry</td><td>2</td><td>4 / batch</td><td>60</td><td>40</td><td>60</td></tr>
<tr><td rowspan="3">AU</td><td rowspan="3">Elective Audit Course (Anyone)</td><td>AC-501A</td><td>NCC</td><td rowspan="3">No credit</td><td rowspan="3">2</td><td rowspan="3">30</td><td rowspan="3">100</td><td rowspan="3">--</td></tr>
<tr><td>AC-501B</td><td>NSS</td></tr>
<tr><td>AC-501C</td><td>Sports</td></tr>
</table>

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

NCC: National Cadet Corps

NSS: National Service Scheme

Structure of T.Y.B.Sc. (Biochemistry) Curriculum Semester VI

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	BC-601	Genetic Engineering	3	3	45	40	60
	Core II	BC-602	Plant Biotechnology and Biomembranes	3	3	45	40	60
	Core III	BC-603	Immunology	3	3	45	40	60
	Core IV	BC-604	Enzymology	3	3	45	40	60
SEC	Skill Based	BC-605	Analytical Techniques	3	3	45	40	60
DSE	Elective Course (Anyone)	BC-606A	Toxicology	3	3	45	40	60
		BC-606B	Biomembranes-II					
DSC	Core (Practical)	BC-607	Techniques in Plant Biotechnology and Molecular Biology-II	2	4 / batch	60	40	60
		BC-608	Immunology and Toxicology	2	4 / batch	60	40	60
		BC-609	Analytical Biochemistry and Enzymology	2	4 / batch	60	40	60
AU	Elective Audit Course (Anyone)	AC-601A	Soft Skills	No credit	2	30	100	--
		AC-601B	Yoga					
		AC-601C	Practicing cleanliness					

DSC: Discipline Specific Core Courses/Core Practical

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Skill Enhancement Course (SEC):
To increase employability of Biochemistry students in industries courses like Biophysical Chemistry and Analytical Techniques have been introduced. These courses will improve common skills required in industry like preparation of solutions, sample isolation, purification and quantification by advanced techniques like chromatography, electrophoresis, spectrophotometry etc. This shall not only increase the potential of students' employability in industries, but also useful in higher studies and research career.

Discipline Specific Elective Course (DSE):

Elective course will give students choice to study the course of their interest. In the 5th semester, students can choose either Fermentation Technology or Biomembranes-I whereas in 6th semester they have choice between Toxicology and Biomembranes-II. Student who has selected Fermentation Technology for the 5th semester, compulsorily must take Toxicology in 6th semester which is same as in case of Biomembranes-I and II.

Audit Course (AU):
The syllabi for audit courses will be common for all courses and shall be available separately.

Equivalence for T.Y. B.Sc. (Biochemistry) is as follows in the table:

Old Syllabus (w.e.f. June 2017) (Semester pattern 60:40) courses	**Equivalent New Syllabus (w.e.f. June 2020) CBCS pattern (Semester pattern 60:40) courses**
BC- 351: Genetics	BC- 501: Genetics
BC- 352: Plant Biochemistry	BC- 502: Plant Biochemistry and Biofertilizers
BC- 353: Clinical Biochemistry-I	BC- 503: Clinical Biochemistry
BC- 354: Metabolism	BC- 504: Metabolism
BC- 355: Biophysical Chemistry	BC- 505: Biophysical Chemistry
BC- 356: Biotechnology	BC-506 A: Fermentation Technology
	BC-506 B: Biomembranes-I
BC- 357: Techniques in Molecular Biology-I	BC-507: Techniques in Plant Biotechnology and Molecular Biology-I
BC- 358: Diagnostic Biochemistry-I	BC- 508: Diagnostic Biochemistry
BC-359: Analytical Biochemistry and Enzymology-I	BC-509: Biophysical Chemistry
BC- 361: Genetic Engineering	BC- 601: Genetic Engineering
BC- 362: Plant and Agro Biotechnology	BC-602: Plant Biotechnology and Biomembranes
BC- 363: Clinical Biochemistry-II	BC- 603: Immunology
BC- 364: Enzymology	BC- 604: Enzymology
BC- 365: Analytical Techniques	BC- 605: Analytical Techniques
BC- 366: Biostatistics and Bioinformatics	BC- 606 A: Toxicology
	BC- 606 B: Biomembranes-II
BC- 367: Techniques in Molecular Biology-II	BC- 607: Techniques in Plant Biotechnology and Molecular Biology-II
BC- 368: Diagnostic Biochemistry-II	BC- 608: Immunology and Toxicology
BC-369: Analytical Biochemistry and Enzymology-II	BC-609: Analytical Biochemistry and Enzymology

Discipline Specific Core (DSC) Course

BC-501: Genetics (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basic concepts of Genetics.
- To study central dogma of genetics

Learning outcomes

After successful completion of this course, students are expected to:

- Understand the importance of Mendel's work.
- Understand structure of chromosome and DNA organization.
- Understand replication, transcription, translation processes.
- Understand fine structure of gene, gene regulation and mutations.

Unit	Title	Topic Particular	Hours

Unit I	**Basic Genetics**	• Mendel's law
		  o Law of dominance
		  o Law of segregation
		  o Law of independent assortment
		• Incomplete dominance
		• Test cross, back cross
		• Concept of multiple alleles
		  o Characters, symbolism e.g. ABO types
		• Lethal gene
			11

Unit II	**Chromosomes and structural organization of prokaryotic & eukaryotic DNA**	• Morphology, structure and types of chromosome • Chromosome number and variation in chromosome number • Structural organization of prokaryotic & eukaryotic DNA • Central dogma	11

Unit III	**DNA replication and transcription in bacteria**	• DNA replication in *E. coli*
		  o Replication origin, unwinding of the strand, Template DNA, RNA primer, polymerization, replication fork, leading strand, lagging strand, Okazaki fragment,
		• Transcription components
		  o Template, activated precursors, divalent metal ions, RNA polymerase, sigma factor
		  o Transcription process-initiation, elongation, termination
		• Fine structure of gene
		  o Cistron, muton, recon, intron, promotor, repressor, exon, regulator, operator etc
		• Gene regulation
			12

		◦ Operon concept, *lac* operon	

Unit IV	**Prokaryotic Translation and Mutations**	• Activation and transfer of amino acids to tRNA
		• Translation-initiation, elongation, termination
		• Post translational modification in eukaryotes
		• Mutations- definition
		• Gene mutations
		  ◦ Base pair substitutions- transition, transversion and inversion
		  ◦ Frameshift mutations- deletion and insertion
		  ◦ Missense mutation, nonsense mutations
		  ◦ Mutations in termination codons
		  ◦ Silent mutations
		• Mutagens: definition
		  ◦ Chemical-base analogues, agents modifying purines and pyrimidines
		  ◦ Physical radiations
			11

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- Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning.
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- Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata.
- Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut
- Powar C.B. (2010), Cell Biology, Himalaya Publishing House, Mumbai
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Discipline Specific Core (DSC) Course

BC-502: Plant Biochemistry and Bio-fertilizers (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basics of Plant Biochemistry.
- To study the life processes of plants
- To generate awareness about importance of biofertilizers.

Learning outcomes

After successful completion of this course, students are expected to:

- Learn life processes like photosynthesis, photorespiration and energy generation.
- Study various phytohormones, secondary metabolites and their mechanism.
- Understand importance of biofertilizers.

Unit	Title	Topic Particular	Hours

Unit I	**Photosynthesis, Photorespiration and ATP generation**	• Definition of photosynthesis, Ultra structure of chloroplast
		• Chemistry of Chlorophyll
		• Mechanism of Photosynthesis
		  o Photosystem I and II
		  o Light (Hill) reaction: Cyclic and non-cyclic photophosphorylation
		  o Dark reaction: C3 and C4 pathways
		  o Kranz anatomy
		  o Significance of photosynthesis
		  o Factors affecting photosynthesis-external and internal
		• Photorespiration:
		  o Definition
		  o Metabolism of Photorespiration
		  o Significance of photorespiration
		• Electron transport chain:
		  o Components of ETC
		  o Oxidative phosphorylation
		  o Redox potential and sites of ATP synthesis
			12

Unit II	**Phytohormones**	• Definition and types of phytohormones
		• Mechanism of action, physiological effect and applications of
		  o Auxins
		  o Cytokinins
		  o Gibberellins
		  o Abscisic acid
		  o Ethylene
		• Seed dormancy and seed germination
			11

Unit III	**Secondary Metabolites**	• Introduction and biosynthetic pathway of secondary metabolites	11

		• Classification of Isoprenoid /terpenoids: classification, chemistry, distribution and role of isoprenoids o Nitrogen containing secondary plant products: Classification ▪ Alkaloids: chemistry distribution classification and physiological role ▪ Cyanogenic glycosides and Glucosinolates: chemistry and functions ▪ Non-protein amino acids: chemistry and functions o Plant phenolics: chemistry, biological functions, classification ▪ Chemistry and functions of lignin, flavonoids and tannins	
Unit IV	**Biofertilizers**	• Biological nitrogen fixation o Nitrogen cycle o Symbiotic and asymbiotic nitrogen fixation o Mechanism of nitrogen fixation • Genetic engineering- nitrogenase and hydrogenase gene • Biofertilizers o Symbiotic nitrogen fixer o Asymbiotic nitrogen fixer o Phosphate solubilising bacteria o Organic fertilizers o Benefits and limitations of biofertilizers • Composting –mixed culture composting, vermicomposting	11

References

- Gupta N. K., Gupta S. (2005), Plant physiology, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
- Devlin R. M., Witham F. H. (1983), Plant Physiology, 4th edition, CBS Pub. New Delhi.
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- Chawla H.S. (2009), Introduction to Plant Biotechnology, 3rd edition, CRC press.

Discipline Specific Core (DSC) Course

BC-503: Clinical Biochemistry (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with Biochemistry of various diseases
- To understand inborn errors of metabolism

Learning outcomes

After successful completion of this course, students are expected to:

- Learn various disorders related to carbohydrate metabolism.
- Study different hemoglobinopathies.
- Understand clinical importance of various enzymes and isoenzymes.
- Learn concept of inborn errors of metabolism.

Unit	Title	Topic Particular	Hours
Unit I	**Disorders related to Carbohydrate metabolism**	• Regulation of blood glucose level o supply of glucose to the blood and removal glucose from blood o Post absorptive state o Postprandial state o Fundamental regulatory mechanism o Hormonal influence on carbohydrate metabolism • Blood sugar level and its clinical significance o Normal values of blood glucose level o Causes of hyperglycemia and hypoglycaemia • Glycosuria: mechanism, types-hyperglycemic glycosuria and renal glycosuria and their subtypes • Diabetes Mellitus: Definition, stages of diabetes mellitus, clinical types and causes, metabolic changes and complications, effect of insulin on carbohydrate, lipid and protein metabolism	12
Unit II	**Hemoglobinopathies**	• Structure and functions of hemoglobin • Abnormal hemoglobins: types based on mutation in structural gene and mutation in regulator gene o Sickle cell anaemia o Methemoglobinemia-Hb-M, Hb-Sabine o High O_2-affinity hemoglobins-Hb-Chesapeake, Hb-Rainier o Hemoglobin interfere in mRNA formation-Hb-Constant spring o Thalassemia	11
Unit III	**Enzymes and**	• General consideration	11

	isoenzymes of clinical importance	• Serum enzymes in heart diseases • Serum enzymes in liver diseases • Serum enzymes in GI tract diseases • Serum enzymes in muscle diseases • Serum enzymes in bone diseases • Isoenzymes: definition, clinical significance of LDH and CPK isoenzymes	
Unit IV	**Inborn Errors of Metabolism**	• Carbohydrate metabolism disorders o Lactose intolerance o Glycogen storage disease o Galactosemia • Protein metabolism disorders o Phenylketonuria o Alkaptonuria o Albinism o Maple syrup urine disease • Lipids metabolism disorders o Gaucher's disease o Nieman Pick's disease o Tay Sachs disease • Nucleic acid metabolism disorders o Lesch Nyhan syndrome o Gout	11

References

- Chatterjee M. N., Shinde R. (2012) Textbook of Medical Biochemistry, 8th edition, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi
- Dua A., Mahajan R. (2018) Clinical Biochemistry, Jnanda Prakashan, Delhi
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- Chatterjee C. C. (2018), Human Physiology Vol I and II, 12th edition, CBS.

Discipline Specific Core (DSC) Course

BC-504: Metabolism (Theory)

Total Hours: 45 **Credits: 3**

Course objectives
- To accustom students with basics of metabolism
- To comprehend catabolism and anabolism of various metabolites

Learning outcomes

After successful completion of this course, students are expected to:
- Learn various catabolic and anabolic reactions related to carbohydrate and amino acids.
- Study lipid and nucleotide metabolic reactions.
- Understand importance of metabolism in living things.

Unit	Title	Topic Particular	Hours
Unit I	**Carbohydrate metabolism**	• Glycolysis: steps; balance sheet; bioenergetics; fate of pyruvate • Tricarboxylic acid cycle: oxidation of pyruvate to acetyl Co-A; steps of TCA cycle; balance sheet; bioenergetics • Glyoxylate cycle • HMP pathway: functions of HMP pathway; steps • Glycogenolysis: steps of conversion of glycogen to glucose under the influence of epinephrine and glucagon • Gluconeogenesis: from pyruvate and amino acids • Glycogen biosynthesis	12
Unit II	**Amino acids metabolism**	• Proteolysis: digestion of proteins; enzymes involved in digestion of protein • Transamination: Transamination of L-aspartate, L-alanine, L-leucine, and L-tyrosine; mechanism of the reaction • Oxidative deamination: general reaction; oxidative deamination of glutamate • Transmethylation: mechanism of transmethylation involving methionine as methyl group donor • Decarboxylation: general reaction; decarboxylation of histidine, tryptophan and arginine • Nitrogen excretory products: o Synthetic pathway o Glutamine pathway o Direction excretion o Creatine and creatinine o Urea cycle	11

Unit III	**Lipid metabolism**	• Activation of fatty acids and transportation into mitochondria • β-oxidation of saturated even carbon fatty acids: steps, balance sheet, bioenergetics • β-oxidation of saturated odd carbon fatty acids: steps, fate of propionyl Co-A • β-oxidation of unsaturated fatty acids: fatty acids having one and two double bonds • Biosynthesis of fatty acids: formation of malonyl Co-A; enzymes and functions of fatty acid synthetase complex; steps of fatty acid biosynthesis • Elongation of saturated fatty acid and desaturation of fatty acids	11
Unit IV	**Nucleotides metabolism**	• Biosynthesis of purine ribonucleotides: steps of AMP and GMP biosynthesis • Regulation of purine nucleotide biosynthesis • Biosynthesis of pyrimidine ribonucleotide: steps of UMP and CMP biosynthesis • Regulation of pyrimidine biosynthesis • Biosynthesis of Deoxyribonucleotides: conversion of ribose sugar to 2'deoxyribose sugar • Formation of deoxythymidylic acid: steps • Regulation of deoxyribonucleotide biosynthesis • Degradation of purines • Salvage of purines • Purine nucleotide cycle • Pyrimidine degradation	11

References

- Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York.
- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L.(2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York.
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Skill Enhancement Course (SEC)

BC-505: Biophysical Chemistry (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To study various biophysical processes.
- To study laws of thermodynamics and bioenergetics.

Learning outcomes

After successful completion of this course, students are expected to:

- Understand the concept of acid-base and buffers.
- Study various biophysical processes like diffusion, osmosis, viscosity, etc.
- Learn energy rich compounds, bioenergetics and laws of thermodynamics.

Unit	Title	Topic Particular	Hours
Unit I	**Acids and Bases**	• Properties of water in relation to life process o Expansion on freezing o Uniquely high surface tension o Uniquely high heat capacity o High solvent power • Concept of Acid and Base o Arrhenius theory o Lewis acid and base o Lowry-Bronsted Theory • Acid-Base equilibria in water o Law of Mass Action o Ionisation of water o Equilibrium constant and Ionisation constant of water o Concept of pH • Buffers-Concept and definition o Henderson-Hasselbalch equation • Biological buffer systems o Phosphate buffer system o Bicarbonate buffer system	11
Unit II	**Diffusion, Osmosis and Colloidal phenomena**	• Diffusion-definition and types o Fick's laws of diffusion-first and second o Methods of determination of diffusion coefficient o Significance of diffusion coefficient • Osmosis-definition o Osmotic pressure- definition and its measurement o Tonicity-types o Significance of osmosis in biology • Colloids-concept o Classification of colloids-lyophilic and lyophobic colloids	12

<table>
<tr><td></td><td></td><td><li style="list-style-type:circle">Brownian movement
<li style="list-style-type:circle">Tyndall effect
<li style="list-style-type:circle">Donnan membrane equilibrium</td><td></td></tr>
<tr><td>Unit III</td><td>Viscosity, Surface tension and Adsorption</td><td>Viscosity-concept
Factors affecting viscosity
Measurement of viscosity
Capillary flow
Rotation of a cylinder immersed in solution
Rate of fall of a ball through solution
Applications of viscometry
Significance of viscosity in biological systems
Surface tension-concept
Factors affecting surface tension
Measurement of surface tension
Adsorption- concept
Kinds of adsorption interactions
Characteristics of adsorption
Importance of adsorption phenomena</td><td>11</td></tr>
<tr><td>Unit IV</td><td>Bioenergetics</td><td>Energy, Free energy and Energetic coupling
Energy rich compounds
ATP, causes of energy richness of ATP
Other energy rich compounds
Thermodynamics-definition
First and second law of thermodynamics
Enthalpy
Entropy
Standard free energy change
Exergonic and endergonic reactions
Redox potential and its measurement</td><td>11</td></tr>
</table>

References

- Frifielder D. (1983), Physical Biochemistry, W. H. Freeman and Co. New York.
- Holmes D. J., Peck H. (1983), Analytical biochemistry, academic press, New York.
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Discipline Specific Elective (DSE) Course

BC-506 A: Fermentation Technology (Theory)

Total Hours: 45 **Credits: 3**

Course objectives
- To accustom students with basics of Fermentation Technology.
- To explore industrial applications of fermentation.

Learning outcomes
After successful completion of this course, students are expected to:
- Learn screening of microbes, their preservation and inoculum development.
- Understand instrumentation, types and working of bioreactors.
- Study the basics of downstream processing.

Unit	Title	Topic Particular	Hours
Unit I	**Basics of Fermentation Technology**	• Fermentation: definition and concept • Characteristic of industrial strain • Screening of industrially important microbes: Primary & Secondary • Fermentation media: Composition, Raw materials, screening of media, antifoam, buffer. • Inoculum –stock, working culture • Inoculum development • Preservation methods for industrially important microbes	11
Unit II	**Bioreactors**	• History of Bioreactors • Parts of Bioreactors and their functions o Materials of construction o Valves o Agitators and its types o Sparger o Port feeders o Baffles • Controlling system • Types of bioreactors o Primary bioreactor o Tower o Air lift o Deep jet • Conventional Bioreactor-common features • Operation of conventional bioreactor	12
Unit III	**Types of fermentation and Downstream processing**	• Types of fermentation o Submerged o Solid state o Batch fermentation o Continuous fermentation: ▪ Chemostat ▪ Turbidostat	11

		• Synchronous culture and its applications.
		• Introduction to downstream processing
		    o Solid-liquid separation
		    o Release of intracellular products by cell disruption
		    o Concentration
		    o Purification by chromatography
		    o Formulation
		    o Drying	

Unit IV	**Industrial Biotechnology**	• Industrial sterilization process -
		    o Concept and need of sterilization
		    o History of sterilization
		    o Types of sterilization:
		        ▪ Batch
		        ▪ Continuous
		        ▪ Filtration
		• Industrial production of –
		    o Enzymes- amylase
		    o Acid- citric acid
		    o Alcohol- ethanol
		    o Antibiotic- penicillin
		• Microbial biomass production
		    o Introduction
		    o Yeast
		    o Economic aspect and Applications
		• Bioconversion
		    o Introduction
		    o Biomining and bioleaching- copper
			11

References

- Patel A. H. (1984), Industrial Microbiology, MacMillan India Ltd, New Delhi
- Verma S. K., Verma M. (1995), A Textbook of Plant Physiology, Biochemistry and Biotechnology, S. Chan and company ltd, New Delhi.
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Discipline Specific Elective (DSE) Course

BC-506 B: Biomembranes-I (Theory)

Total Hours: 45 **Credits: 3**

Course objectives • To accustom with basic concepts of Biomembrane. • To study various structures of biomembranes.			
Learning outcomes After successful completion of this course, students are expected to: • Explain the various structure of cell membranes. • Study the composition of various cell membranes, models of membranes • Learn specialized features and asymmetry of biomembranes			
Unit	**Title**	**Topic Particular**	**Hours**
Unit I	**Introduction to Biomembrane**	• Introduction, definition • A historical perspective of different models of membranes • Membrane characteristics with experimental basis of the model (Langmuir trough experiment, freeze fracture technique, X- ray diffraction) • Biomedical importance of membrane Compartmentalization of body's internal water by membranes • Ionic composition of intracellular and extracellular fluids • Factors affecting physical properties of membrane	11
Unit II	**Composition of Biomembranes**	• Lipids-introduction, types and role • Proteins • Integral • Peripheral& • Lipid anchored • Carbohydrates-types and functions. • Hydropathy plots & membrane Topology. • Composition variation between membranes (Prokaryotic / Eukaryotic / neuronal, Membranes / Sub cellular compartments). • Details of fluid mosaic model.	11

Unit III	**Model Membrane Systems**	• Synthesis and drug targeting tool
		  o Monolayers
		  o Planar bilayer
		  o Liposomes
		• Isolation & purification of membrane and membrane proteins-
		  o use of detergents,
			11

		o density gradient centrifugation etc. for purification of membrane proteins-role and its applications, • Criteria of membrane purification • Enzyme markers.	
Unit IV	**Membrane Structures and asymmetry**	• Polymorphic structures of amphiphilic molecules like soaps, detergents, lipids in aqueous solutions • Micelles & Bilayers-introduction, formation. • Thermodynamic forces and other factors affecting the formation of different structures. • Critical packing parameter. • Asymmetric nature of membrane • Macro and micro domains in membranes • Specialized features of plasma membrane: o Lipid rafts o Caveolae o Tight Junctions. • Membrane Skeleton o Role in maintaining cell structure o Membrane asymmetry. • RBC membrane- as a model.	12

References

- Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York.
- Murray R., Bender D., Botham K. (2012), Harper's Illustrated Biochemistry, 29th edition, McGraw Hill Education.
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- Darnell J., Lodish H., Baltimore D. (2008), Molecular Cell Biology, Scientific American Books.
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Discipline Specific Core (DSC) Course

BC-507: Techniques in Plant Biotechnology and Molecular Biology-I (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom with Techniques in Molecular Biology.
- To study techniques in Plant Biotechnology.

Learning outcomes

After successful completion of this course, students are expected to:

- Isolate DNA and estimate DNA, RNA, secondary metabolite and chlorophyll pigments.
- Produce alcohol, citric acid, amylase and vermicompost.
- Screen phosphate solubilizing bacteria**.**

Sr. No.	Topic Particular	Hours
1	Isolation of DNA from suitable sample	04
2	Estimation of DNA by DPA method	04
3	Estimation of RNA by orcinol method	04
4	Estimation of chlorophyll pigments by spectrophotometric method	04
5	Estimation of any one secondary metabolite	04
6	Production of alcohol	04
7	Production of citric acid	04
8	Production of amylase	04
9	Preparation of manure by vermicomposting process	04
10	Determination of activity of Phosphate solubilizing bacteria	04
11	Separation of plant pigments by chromatography.	04
12	Isolation of nitrogen fixing bacteria from root nodules.	04
13	Isolation of nitrogen fixing bacteria from soil sample.	04
14	Demonstration of working of fermenter.	04
15	Solve the problems based on Mendel’s experiments.	04

References

- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.
- Sawhney S.K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.
- Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd.

***Mandatory to perform any 10 practicals from above.**

Discipline Specific Core (DSC) Course

BC-508: Diagnostic Biochemistry (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom with various pathological tests.
- To generate awareness about clinical significance of the tests.

Learning outcomes

After successful completion of this course, students are expected to:

- Estimate various clinically important components with their clinical significance.
- Estimate various clinically important enzymes and their clinical significance.
- Correlate results obtained clinically.

Sr. No.	Topic Particular	Hours
1	Estimation of blood glucose in serum by GOD/POD method.	04
2	Estimation of reducing sugar in urine	04
3	Hb estimation by using haematometer its significance	04
4	Serum bilirubin estimation.	04
5	SGOT estimation by 2, 4 DNPH method.	04
6	SGPT estimation by 2, 4 DNPH method.	04
7	Serum alkaline phosphatase estimation by colorimetric method.	04
8	Serum acid phosphatase estimation by colorimetric method.	04
9	Estimation of cholesterol by colorimetric method.	04
10	Estimation of serum uric acid from the given sample.	04
11	Estimation of serum urea from the given sample.	04
12	Estimation of serum creatinine from the given sample.	04
13	Detection of abnormal constituents of urine: - Sugar, protein, ketone bodies and bile pigments	04
14	Estimation of proteins by Biuret method and albumins by Dumas method	04
15	Estimation of serum bilirubin.	04

References

- Sharma S., Sharma R. (2016), Practical manual of Biochemistry, Scientific International Publisher and Distributor, New Delhi.
- Maheshwari N. (2008), Clinical Biochemistry, Jaypee Brothers, Medical Publishers.
- Godkar P. B., Godkar D. P., Textbook of medical laboratory technology, 2nd edition, Bhalani Publishing House, Mumbai
- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.

***Mandatory to perform any 10 practicals from the above.**

BC-509 : Biophysical Chemistry (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom students with practical applications of biophysical chemistry.
- To give practical experience of biophysical processes.

Learning outcomes

After successful completion of this course, students are expected to:

- Prepare buffers of desirable pH and molarity.
- Determine viscosity and surface tension of the sample.
- Practical experience of the processes like diffusion and osmosis.

Sr. No.	Topic Particular	Hours
1	Preparation of phosphate buffer of suitable pH and molarity.	04
2	Determination of viscosity of suitable liquid by viscometer.	04
	Measurement of surface tension of the given sample.	04
3	Estimation of λ_{max} and extinction coefficient of a given chromophore.	04
4	Purification of protein by salt precipitation and solvent fractionation procedure.	04
5	Quantitative estimation of protein by Lowery's method.	04
6	Determination of diffusion of the sugar across a semipermeable membrane.	04
7	Study of osmosis by potato osmometer.	04
8	To study cell membrane permeability using beetroot.	04
9	To study the effect of temperature on permeability of beetroot membrane.	04
10	Preparation of RBC ghost cells and to study the effect of different solutes on permeability of RBC membrane.	04
11	To study the effect of pH on permeability of beetroot membrane.	04
12	Purification and estimation of casein from milk.	04
13	Demo calculation of the isoelectric point of a protein.	04
14	Separation of carbohydrates by paper chromatography.	04
15	Preparation of lactalbumin from milk.	04

References

- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
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- Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd.
- Giese Arthur C. (1975), Laboratory manual in cell physiology. Boxwood press, Pacific grove, CA.
- Von Blum Ruth (1981), Experimental studies of permeability in red blood cells. In tested studies for laboratory teaching (Glase, Jon C., Ed.) Kendall/Hunt Pub. Co. Dobuque.

***Mandatory to perform any 10 practicals from above.**

Discipline Specific Core (DSC) Course

BC-601: Genetic Engineering (Theory)

Total Hours: 45 **Credits: 3**

Course objectives • To introduce students to the genetic engineering field. • To make students aware about various genetic engineering techniques**.**			
Learning outcomes After successful completion of this course, students are expected to: • Learn role of enzymes and vectors involved in gene transfer. • Study various gene transfer methods. • Study gene library preparation. • Understand the basic principles of DNA sequencing and PCR.			
Unit	**Title**	**Topic Particular**	**Hours**
Unit I	**Introduction to Genetic Engineering**	• Concepts of Genetic engineering • Enzymes involved in genetic engineering- restriction endonucleases, DNA ligases, Alkaline phosphatases, DNA modifying enzymes • Prokaryotic and eukaryotic cells as hosts	11
Unit II	**Vectors and methods of gene transfer**	• Vectors- Plasmids, Bacteriophages, Cosmids, Artificial chromosome vectors, Shuttle vectors • Construction of rDNA- palindromes and staggered cleavage adding poly dA and poly dT tails, blunt end ligation • Methods of gene transfer- transformation, conjugation, Electroporation, Liposome mediated gene transfer, transduction, direct transfer of DNA, particle bombardment, microinjection, polyethylene glycol mediated gene transfer	12
Unit III	**Gene Libraries**	• Concept of gene libraries • Creation of human gene library, Use of long chain PCR for gene library construction • cDNA libraries- cDNA synthesis, construction of cDNA libraries, RT-PCR for cDNA libraries • Screening Strategies- screening by DNA hybridization, DNA probes, colony hybridization, PCR, immunological assay, protein function	11
Unit IV	**Techniques in Genetic Engineering**	• DNA Sequencing: Technique, applications, limitations of o Maxam Gilbert technique o Sanger’s Dideoxynucleotide method o Pyrosequencing o DNA chip • Polymerase Chain Reaction: principle, technique,	11

		applications of PCR in various fields	

References

- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8^{th} edition, W. H. Freeman and Company, New York.
- Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning.
- Gardner M., Simmons J., Snustad D. P. (2006), Principle of Genetics, 8^{th} edition, John Willey and Sons.
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- Gupta P.K. (2009), Genetics, Rastogi publication, Meerut.
- Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata.
- Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut
- Powar C.B. (2010), Cell Biology, Himalaya Publishing House, Mumbai
- Powar C.B. (2007), Genetics Vol. I, Himalaya Publishing House, Mumbai
- Powar C.B. (2009), Genetics Vol. II, Himalaya Publishing House, Mumbai

Discipline Specific Core (DSC) Course

BC-602: Plant Biotechnology and Biomembranes (Theory)

Total Hours: 45 **Credits: 3**

Course objective

- To accustom students with plant tissue culture techniques.
- To study the role of membranes in biological systems

Learning outcomes

After successful completion of this course, students are expected to:

- Learn various plant tissue culture techniques.
- Understand Agrobacterium mediated gene transfer.
- Explain mechanism of membrane transport and cell signaling.

Unit	Title	Topic Particular	Hours
Unit I	**Plant Tissue Culture**	• Introduction to PTC • Culture media composition • Terms used in PTC • Basic technique of plant tissue culture • Applications of PTC • Types of cultures-Callus culture, Cell culture • Protoplast isolation, fusion and culture	10
Unit II	**Micropropagation and Genetic Engineering of Plants**	• Micropropagation: o Definition and technique o Multiplication by axillary buds and apical shoots- meristem, shoot tip cultures and bud cultures o Organogenesis-direct and indirect o Somatic embryogenesis-direct and indirect o Factors affecting o Applications and disadvantages • Agrobacterium mediated gene transfer o Organisation of Ti plasmid o T-DNA transfer and integration o Ti plasmid derived vector systems o Plant transformation techniques using Agrobacterium o Advantages and limitation of Agrobacterium mediated gene transfer	12
Unit III	**Membrane transport and Special molecules of Transport**	• Principles and mechanism of o Osmo-regulation o Diffusion- types • Features of uniport, symport and antiport transport systems • Role of proteins in the process like exocytosis, endocytosis- phagocytosis and pinocytosis,	12

		receptor mediated endocytosis (cholesterol transport), and ATP, ADP- exchanger. **Special molecules of Transport:** • ATPases and its types (Sodium- Potassium pump, ABC, P type, V type ATPases). Sodium, proton Potassium and chloride dependent processes. • Phosphotransferase system • Group translocation	

Unit IV	**Membrane receptors and drug targets**	• Cell signaling definition and its types
		• Membrane receptors
		    o Structure and functions
		    o Types-enzyme linked; ion-channel linked, & G-protein linked receptors with example;
		    o Methods to study membrane receptors
		    o Purification of adrenergic and cholinergic receptors
		    o Second messengers-Introduction, definition, examples and their roles.
		• Penetrating the defenses:
		    o How antimicrobial agents reach their targets,
		    o cellular permeability barrier to drug penetration,
		    o some examples of modes of penetration of antimicrobial agents
			11

References

- Gupta P. K. (2005), Elements of Biotechnology, Rastogi Publication Meerut.
- Ignacimuthu S. (1997), Applied plant biotechnology, Science Publishers, U.S.
- Ramavat K. G. (2008), Plant biotechnology, S. Chand and Co., New Delhi.
- Gupta P. K. (2005), Molecular biology and genetic engineering, 1st edition, Rastogi Publication Meerut.
- Verma S. K., Verma M. (1995), A Textbook of Plant Physiology, Biochemistry and Biotechnology, S. Chan and company ltd, New Delhi.
- Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata.
- Jain V. K. (1983), Fundamentals of Plant Physiology, 3rd edition, S. Chan and company ltd, New Delhi
- Chawla H.S. (2009), Introduction to Plant Biotechnology, 3rd edition, CRC press.
- Jogdand S.N. (2012), Advances in Biotechnology, Himalaya Publishing House, Mumbai.

Discipline Specific Core (DSC) Course

BC-603: Immunology (Theory)

Total Hours: 45 **Credits: 3**

Course objectives
- To accustom students with basics of immunology
- To comprehend various immunochemical tests

Learning outcomes

After successful completion of this course, students are expected to:
- Explore cells and organs of immune system.
- Learn immunity and immune response.
- Study concept of antigen and antibody.
- Understand the importance of immunochemistry in diagnosis.

Unit	Title	Topic Particular	Hours
Unit I	**Cells and organs of immune system**	• Hematopoiesis • Cells of immune system o Lymphoid cells- T-cells, B-cells, Natural killer cells, dendritic cells o Granulocytes- Neutrophils, Eosinophils, Basophils, Monocytes, Macrophages, Mast cells • Organs of immune system o Primary lymphoid organs ▪ Thymus ▪ Bone marrow ▪ Lymphatic system o Secondary lymphoid organs ▪ Lymph nodes ▪ Spleen ▪ MALT and GALT	12
Unit II	**Immunity and Immune response**	• Immunity- definition and types • Innate immunity o Factors influencing innate immunity o Mechanism of innate immunity o Cellular factor in innate immunity • Adaptive/ acquired immunity o Active and passive immunity • Immune response o Humoral immune response ▪ Primary and secondary immune response ▪ Antibody production ▪ Factors affecting antibody production o Cell mediated immune response	11
Unit III	**Antigen and**	• Antigen-	11

	Antibody	o Definition o Basic terms- hapten, adjuvants, epitopes o Antigenicity and immunogenicity o Determinants of an antigenicity • Basic structure of antibody o Classes of antibodies ▪ IgG, IgA, IgM, IgD, IgE- structure and functions o Antigenic determinants on immunoglobulins ▪ Isotype, Allotype and Idiotype	
Unit IV	**Immunochemistry**	• General features of antigen-antibody reactions • Precipitation reaction- mechanism and applications o Flocculation reaction o Single diffusion o Double diffusion o Radial immunodiffusion o Immunoelectrophoresis o Crossover immunoelectrophoresis o Rocket immunoelectrophoresis • Agglutination reaction o Slide and tube agglutination o Coombs test and passive agglutination • Immunofluorescence • Radioimmunoassay • ELISA- types	11

References

- Shastri N.V. (2005), Principles of Immunology, Himalaya Publishing House, Mumbai
- Kindt T. J., Goldsby R. A., Osborne B. A. (2006), Kuby Immunology, 6th edition, W.H. Freeman and Company, New York
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- Tizard I. (2005), Immunology: An Introduction, Cengage Learning (RS).

Discipline Specific Core (DSC) Course

BC-604: Enzymology (Theory)

Total Hours: 45 **Credits: 3**

Course objectives • To accustom students with basics of enzymology. • To understand applications enzyme in various fields.			
Learning outcomes After successful completion of this course, students are expected to: • Understand classification and specificity of enzymes. • Learn mechanism of enzyme action and enzyme kinetics. • Study activation and deactivation of regulatory enzymes. • Explore various industrial applications of enzymes.			
Unit	**Title**	**Topic Particular**	**Hours**
Unit I	**Basic concepts in enzymology**	• Definition of enzyme • Terminologies - intracellular enzymes, extracellular enzymes, holoenzymes, apoenzymes, prosthetic group, cofactor, coenzymes, isoenzymes, katal, international unit, turnover number and active site. • Nomenclature and classification (IUB) of enzymes • Factors affecting enzyme activity - effect of substrate concentration, enzyme concentration, product concentration, pH, temperature, activators, time, light and radiation. • Specificity of enzyme action - absolute specificity, group specificity, optical specificity and geometrical specificity. • Active site - definition and salient features of active site.	11
Unit II	**Enzyme Kinetics and Inhibition**	• Mechanism of enzyme action – lowering of activation energy, lock and key model, induced fit model. • Michaelis Menten Equation: derivation, Km Vmax • Transformation of Michaelis –Menten equation: Lineweaver-Burk plot, Eadie-Hofstee plot • Inhibition: Reversible inhibition- competitive, non-competitive and uncompetitive inhibition with examples. • Factors contributing to the catalytic efficiency of enzymes: proximity and orientation of the substrate, covalent catalysis, acid-base catalysis, factor of strain in enzyme catalysis	12
Unit III	**Regulatory enzymes**	• Allosteric enzymes: definition, feedback inhibition, positive and negative modulator,	11

		heterotropic and homotropic control, mechanism of regulatory activity of allosteric enzymes-sequential and symmetry model, kinetics of allosteric enzymes, aspartate transcarbamoylase-kinetics and inhibition • Covalently modulated enzymes: definition, explanation with example of glycogen phosphorylase enzyme • Covalent activation of zymogen: pepsinogen, trypsinogen, chymotrypsinogen • Classes of proteolytic enzymes: serine, aspartate, cysteine and metalloproteases	
Unit IV	**Applications of enzymes**	• Enzyme Immobilization: methods • Applications of immobilized enzymes and cells o Manufacture of commercial products o Analytical applications o Therapeutic applications • Enzyme based biosensors and their applications • Other applications of enzymes	11

References

- Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York.
- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L.(2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York.
- Satynarayana U., Chakrapani U. (2017), Textbook of Biochemistry, 5thedition, Elsevier, India.
- Talwar G. P. (2002), Textbook of Human Biochemistry, 3rd edition, Prentice Hall India Learning Pvt. Ltd.
- Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut
- Powar C. B. (2010), Cell Biology, Himalaya Publishing House, Mumbai
- Powar C. B., Chatwal G. R. (2011), Biochemistry, Himalaya Publishing House, Mumbai

Skill Enhancement Course (SEC)

BC-605: Analytical Techniques (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basics of various analytical techniques.
- To explore applications of analytical techniques.

Learning outcomes

After successful completion of this course, students are expected to:

- Study concept, principle, and applications of various spectrophotometry.
- Learn principles and applications of various chromatography and electrophoretic techniques.
- Understand concept of centrifugation and radioactivity and its applications.

Unit	Title	Topic Particular	Hours
Unit I	**Spectrophotometry**	• Concept of electromagnetic radiations, electromagnetic spectrum • Laws of absorption- Lambert and Beer Law • Chromophore concept-auxochrome, various chromic shifts • Instrumentation for UV-Visible and infra-red spectrophotometry o Applications of UV-Vis spectrophotometry o Theory and applications of infra-red spectroscopy • Spectrofluorimetry o Fluorescence and phosphorescence o Theory and instrumentation of fluorimetry o Advantages, disadvantages and applications • Flame spectrophotometry-concept o Instrumentation for emission flame photometry and atomic absorption spectrophotometry o Applications of both	11
Unit II	**Chromatography**	• Concept of distribution coefficient • Modes of chromatography • Classification of chromatography • Principle and applications of- o Paper chromatography o Thin layer chromatography o Gel filtration chromatography o Ion exchange chromatography o Affinity chromatography o Gas liquid chromatography o Liquid-liquid chromatography	12

Unit III	**Electrophoresis**	• Principle of electrophoresis
		• Migration of an ion in an electric field
		• Factors affecting electrophoretic mobility
		• Principle and applications of-
		  o Paper electrophoresis
		  o Agarose gel electrophoresis
		  o Polyacrylamide gel electrophoresis
		  o SDS-Polyacrylamide gel electrophoresis
		  o Isoelectric focusing
		  o Capillary electrophoresis
		  o Immunoelectrophoresis
			11

Unit IV	**Centrifugation and Radioactivity**	• Basic principles of centrifugation • Instrumentation for centrifugation: low speed, high speed and ultracentrifuges • Applications of centrifugation: preparative techniques, analytical measurements • Radioactivity: introduction, isotopes in Biochemistry, units of radioactivity • Detection and measurement of radioactivity: Liquid Scintillation Counting, Geiger Muller Counting • Applications of radioisotopes • Radioisotopes and safety	11

References

- Frifielder D. (1983), Physical biochemistry, W. H. Freeman and Co. New York.
- Holmes D. J., Peck H. (1983), Analytical biochemistry, academic press, New York.
- Upadhyay A., Upadhyay K., Nath N. (2016), Biophysical chemistry: Principle and technique, Himalaya Pub. Nagpur.
- Wilson K,. Walker J. (2010), Principles and techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University press, UK
- Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata.
- Powar C.B., Chatwal G.R. (2011), Biochemistry, Himalaya Publishing House, Mumbai
- Boyer R. (2002), Modern Experimental Biochemistry, 3rd edition, Pearson Education, Inc.
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Discipline Specific Elective (DSE) Course

BC-606 A: Toxicology (Theory)

Total Hours: 45 **Credits: 3**

Course objectives

- To accustom students with basic concepts of toxicology.
- To study biotransformation of toxicants.

Learning outcomes

After successful completion of this course, students are expected to:

- Learn basic concepts of toxicants, toxicity and dose-response relationship.
- Study metabolism and mode of action of toxicants.
- Understand biotransformation and bioaccumulation of toxicants.

Unit	Title	Topic Particular	Hours
Unit I	**Basic Concepts of Toxicology**	• Toxicology: Definition, history, scope, basic divisions and goals of toxicology • Toxicants and toxicity: o Definition and concept o Factors that influence toxicity o Toxicity of chemical mixtures • Dose: o Definition o Selection of dose o Effect and response of dose • Dose-response relationship: o Graded/quantitative response o Quantal/quantum response • Statistical concept of toxicity: o Concentration-response relationship/ Threshold limits o Criteria for effects and LD_{50}	11
Unit II	**Absorption, Translocation and Excretion of Xenobiotics**	• Membrane permeability and mechanism of chemical transfer • Absorption of Xenobiotics: o Gastro-intestinal tract o Skin, Lungs o Parenteral administration • Translocation of Xenobiotics: o Membrane Barriers o Binding of xenobiotics to plasma proteins o Storage depots: Body fats, brain tissue, erythrocytes and other storage depots • Excretion of Xenobiotics: o Renal excretion, Biliary excretion o Gastro-intestinal tract o Expired air o Sweat, Saliva o Milk, Vaginal secretion	12
Unit III	**Mode of Action of**	• Effect of toxicants on structural proteins,	11

	Toxicants	enzymes, carriers, coenzymes, nucleic acids and lipids • Receptor Concept: o Definition, location and chemical nature o Categories of receptors o Mechanism of action of receptors o Factors affecting functions of receptors o Concept of agonism and antagonism o Role of receptors in toxicology • Mechanism of action of commonly used toxicants: o Metals o Pesticides o Environmental carcinogens o Teratogens o Ionizing and non-ionizing radiations	
Unit IV	**Biotransformation of Toxicants**	• Biotransformation: Definition, sites, principal objectives • Mechanism of biotransformation • Phase I reactions: o Oxidation o Reduction o Hydrolysis • Phase II reactions: conjugation reactions • Factors affecting biotransformation • Biotransformation of DDT • Bioactivation • Antidotes/antagonists: o Definition and classification o Mechanism of antidotal therapy o Antidotal procedures	11

References

- Klaassen C. D. (2008), Casarett and Doull’s Toxicology- The Basic Science of Poisons, 7th edition, The McGraw Hill Companies Inc.
- Hayes A. W. and Kruger C. L. (2014) Hayes’ Principles and Methods of Toxicology, 6th edition, CRC Press.
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- Lipmann M. (2009), Environmental toxicants – Human Exposure and Their Health Effects, 3rd edition, Wiley Interscience.
- Duffus J. H. and Worth H. (1996) Fundamental Toxicology for Chemists, Royal Soc. Chem.
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- Subramanian M. A. (2010), Toxicology, Principles and Methods, 2nd revised edition, MJP Publisher, Chennai.
- Sharma P. D. (2003), Toxicology, 2nd edition, Rastogi Publication, Meerut.

Discipline Specific Elective (DSE) Course

BC-606 B : Biomembranes-II (Theory)

Total Hours: 45 **Credits: 3**

<table>
<tr><td colspan="4">Course objective
To accustom with basic concepts of Biomembrane.
To study the role biomembranes in transport.</td></tr>
<tr><td colspan="4">Learning outcomes
After successful completion of this course, students are expected to:
Explain different transport system in cells
Understand drug transport and role of different cells in transport
Learn different techniques to study cell membranes</td></tr>
<tr><th>Unit</th><th>Title</th><th>Topic Particular</th><th>Hours</th></tr>
<tr><td>Unit I</td><td>Membrane Dynamics</td><td>Diffusion-Introduction
Lateral diffusion
Transverse / Flip Flop diffusion
Rotational motion of lipids and proteins
Techniques used to study different motion of molecules in membranes:
FRAP
FRET
Translational diffusion coefficient.
Phase Transition studies of lipid bilayer.
Transition temperature.
Membrane fluidity-concept, introduction.
Factors affecting membrane fluidity:
Composition, Temperature, salt /water stress,
Anesthetics, Age, pH, Nutrition etc.
Homeoviscous adaptation
Membrane fusion</td><td>11</td></tr>
<tr><td>Unit II</td><td>Membrane transport</td><td>Study of different transport systems-their structure, thermodynamics (free energy change involved, electro chemical potential, membrane potential, Nerst equation).
Diffusion: Simple diffusion, Facilitated diffusion
Transport systems:
Passive transport (Glucose, anion transporter)
Active transport (P type ATPases V type ATPases, F type ATPases, Na+ / H+ symport systems).
ABC family of transporters.
Transport processes driven by light (Bacteriorhodopsin, halorhodopsin)
Specialized membrane Pores:</td><td>12</td></tr>
</table>

		o Porins in Gram negative bacterial membranes (*E.coli* OmpF, OmpC, LamB) o Pore forming toxins (colicins, α hemolysin, anthrax toxin protective antigen) and Aquaporins. • Ion channels: Voltage gated ion channels (Na^+ / K^+ voltage gated ion channel), Ligand gated ion channels (Acetyl choline / IP3 / cGMP gated ion channel), Leaky channels. • Ionophores: Carriers and channel forming (valinomycin, gramicidin).	
Unit III	**Signal Transduction**	• Cell signaling-definition, Types: endocrine, paracrine and autocrine • Hormones-Introduction • Classification of hormones based on solubility & location of their receptors- o Lipophilic hormones hormones with intracellular receptors, o Lipophilic & o Hyrdophilic hormones with cell surface receptors; • Cell surface receptors-Introduction. • Types of receptors with examples o Enzyme linked o Ion-channel linked, & o G-protein linked receptors • Second messengers-Introduction, definition, examples and their roles.	11
Unit IV	**Penetrating the defenses**	• How antimicrobial agents reach their targets, • Cellular permeability barrier to drug penetration, • some examples of modes of penetration of antimicrobial agents, • The exploitation of transport systems in the design of new antimicrobial agents.	11
References	• Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York. • Murray R., Bender D., Botham K. (2012), Harper's Illustrated Biochemistry, 29th edition, McGraw Hill Education. • Voet D., Voet J.G. (2004), Biochemistry, John Wiley &Sons, Inc. • Darnell J., Lodish H., Baltimore D. (2008), Molecular Cell Biology, Scientific American Books. • Gupta M. L., Jangir M. L. (2002), Cell Biology – Fundamentals and Applications, Agrobios. • Alberts B., Johnson A., Lewis J. (2008), Molecular Biology of the Cell, 5th edition, Garland Publishing.		

Discipline Specific Core (DSC) Course

BC-607 : Techniques in Plant Biotechnology and Molecular Biology-II (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom students with Techniques in Molecular Biology.
- To study Techniques in Plant Biotechnology.

Learning outcomes

After successful completion of this course, students are expected to:

- Prepare MS media and will have knowledge about macro and micro elements.
- Perform various plant tissue culture techniques.
- Separate DNA fragments by agarose gel electrophoresis.
- Perform restriction digestion and PCR.

Sr. No.	Topic Particular	Hours
1	Preparation of MS media for PTC.	04
2	Development of somatic embryo from suitable tissue.	04
3	Development of seedling by aseptic germination of available seed.	04
4	Development of shoots by shoot tip culture method.	04
5	Development of callus from suitable tissue.	04
6	Isolation of protoplast.	04
7	DNA digestion using restriction endonucleases.	04
8	Separation of fragments produced by restriction endonucleases digestion by agarose gel electrophoresis	04
9	Amplification of DNA fragment using PCR.	04
10	Separation of fragments produced by PCR by agarose gel electrophoresis	04
11	Isolation of plasmid from micro-organism.	04
12	To study cell membrane permeability using potato.	04
13	Determine the DNA sequence using Sanger's Dideoxy method.	04
14	Perform BLAST of the given DNA sequence.	04
15	Demonstration of Southern blotting.	04

References

- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.
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***Mandatory to perform any 10 practicals from the above.**

Discipline Specific Core (DSC) Course

BC-608 : Immunology and Toxicology (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom students with immunological methods
- To make students aware about toxicological methods.

Learning outcomes

After successful completion of this course, students are expected to:

- Differentially count WBCs.
- Know the importance of cross matching of donor's and recipient's blood.
- Perform various immunological Ag-Ab tests.
- Determine LC_{50} value, effect of temperature and pH on toxicity of pollutant.

Sr. No.	Topic Particular	Hours
1	Differential counting of WBCs	04
2	Blood group detection and cross matching	04
3	Ag-Ab reaction by Ouchterlony double diffusion method	04
4	Radial immunodiffusion	04
5	Demonstration of ELISA and its significance.	04
6	Widal agglutination test (slide test method).	04
7	Determination of LC_{50} value of a pollutant by using suitable test animal.	04
8	Determination of the effect of temperature on the toxicity of a pollutant.	04
9	Determination of the effect of pH on the toxicity of a pollutant.	04
10	Qualitative evaluation of pesticide residues in vegetable samples.	04
11	Demonstration of immunoelectrophoresis.	04
12	Perform VDRL test.	04
13	Determine the relative amount of antigen/antibody in serum sample using precipitin ring test.	04
14	Determination of combined toxicity of pollutants on suitable organism.	04
15	Qualitative evaluation of pesticide residues in the fruit/food sample.	04

References

- Sharma S., Sharma R. (2016), Practical manual of Biochemistry, Scientific International Publisher and Distributor, New Delhi.
- Maheshwari N. (2008), Clinical Biochemistry, Jaypee Brothers, Medical Publishers.
- Godkar P. B., Godkar D. P., Textbook of medical laboratory technology, 2nd edition, Bhalani Publishing House, Mumbai
- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Plummer D. (2017), An Introduction to Practical Biochemistry, McGraw Hill Education.
- Subramanian M. A. (2010), Toxicology, Principles and Methods, 2nd revised edition, MJP Publisher, Chennai.

***Mandatory to perform any 10 practicals from above.**

Discipline Specific Core (DSC) Course

BC-609 : Analytical Biochemistry and Enzymology (Practical)

Total Hours: 60 **Credits: 2**

Course objectives

- To accustom students with various analytical techniques.
- To study enzyme kinetics practically.

Learning outcomes

After successful completion of this course, students are expected to:

- Perform enzymology related practical.
- Perform separation of mixture using chromatography and electrophoresis.
- Immobilize enzyme/yeast cell and can explore it.

Sr. No.	Topic Particular	Hours
1	Estimation of maltose by DNSA method.	04
2	To determine the effect of enzyme-amylase concentration on the rate of reaction.	04
3	To determine the effect of substrate concentration on the activity of amylase and determine Km and Vmax of the reaction.	04
4	To determine the effect of pH on activity of amylase.	04
5	To determine the effect of temperature on activity of amylase.	04
6	Immobilization of suitable enzyme/yeast cells.	04
7	Separation of amino acids using Paper layer chromatography.	04
8	Separation of amino acids using Thin layer chromatography.	04
9	Separation of amino acids using paper electrophoresis.	04
10	Separation of protein by SDS-PAGE.	04
11	Separation of proteins by native PAGE.	04
12	Partial purification of suitable enzyme.	04
13	Study the inhibition of suitable enzyme.	04
14	Estimation of suitable enzyme activity.	04
15	Demonstration of Ion exchange chromatography	04

References

- Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd.
- Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.
- Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai
- Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.
- Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd.

***Mandatory to perform any 10 practicals from the above.**

Skills acquired and Job prospects for the Biochemistry students

Biochemistry is the molecular basis of life. Degree program in Biochemistry teaches students the way several lifeless chemicals combine to produce a functional living organism. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunities in all sectors.

After successful completion of three years degree course in Biochemistry, student will be well versed with laboratory skills and transferable skills.

Laboratory Skills:

- Laboratory safety practices as well as aseptic techniques
- Accurate weighing and reagent preparation
- Skillful handling of basic and advanced instruments
- Calibration of basic instruments like pH meter, micropipettes etc
    - Advanced techniques like; Chromatography, Electrophoresis
    - Spectrometry, Polymerase Chain Reaction (PCR)
    - Plant Tissue Culture, Animal Tissue Culture
- Collection, organization and presentation of data
- Analysis, Logical thinking and, interpretation of results

Transferable Skills:

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas which include;

- Analytical skill, Observational skill
- Planning and Time management
- Mathematical and IT skills
- Creative thinking, Problem solving
- Report writing skill, Presentation skill

Job Opportunities:

After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biochemistry and then Ph.D. in Biochemistry and make career in research field. Students have opportunities in private as well as public (Government) sectors.

Private Sector:

Biochemist can work in quality control, quality assurance and R & D divisions of companies like-Biotech companies, Pharmaceutical companies, Chemical manufacturing companies, Food and Drink (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sector:

Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Job profiles:

Biochemist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Microbiologist, Research Associates, Research Officers, Research Scientist etc.

Opportunities in higher studies

After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biotechnology / Biochemistry and pursue higher studies. Even students can pursue other courses where graduation is essential.

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Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

Structure of syllabus

B. Sc. [Microbiology]

F. Y. B. Sc.

Choice Based Credit System (CBCS)

With effect from June

[2022 - 23]

C-1 A: Paper I (Section A)

MB 101: Microbial History, Diversity and Taxonomy (Theory)

Total Hours 30 Credits: 2

Unit	Title	Topic Particular	Lectures
Course Objective	To complement the students with the basic knowledge about microbial growth and microscopy		
Course Outcome (CO)	After successful completion of this course students are expected to: ▪ Understand the basic microbial structure and study the comparative characteristics of prokaryotes and eukaryotes and also Understand the structural similarities and differences among various physiological groups of bacteria/archaea ▪ Know general bacteriology and microbial aspects pertinent to bacteria, fungi and algae ▪ How the subject emerged as new branch of biology ▪ Learn ancient view about life continuity and concept of experiment ▪ Aware about historical developments and their applications as technology ▪ Cognizant about contribution of various pioneers of microbiology ▪ Aware about diversity of microorganism ▪ Study impact of microbes on earth atmosphere, health and technology development ▪ Recognize the scope of microbiology in all spheres of life and industrial sector ▪ Analyze the ways to classify the living system ▪ Understand the taxonomy (identification, binomial nomenclature, and Classification schemes/keys) and comprehend the various approaches of microbial taxonomy.		

UNIT-I	Historical developments and Scope of Microbiology -	▪ Spontaneous generation (abiogenesis) – Concept and experimental evidences to prove it ▪ Concept of Prokaryotic (Microorganisms) and Eukaryotic cells ▪ Discovery of Microscope ▪ Germ theory of Fermentation ▪ Germ theory of Disease: Koch's and Revere's postulate ▪ Development of pure culture methods and preparation of Decimal Dilution, solidifying agent (potato, gelatin, agar agar) ▪ Contribution(s) of the following scientists in the development of microbiology Antonie von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner ▪ Development and scope of microbiology in the following disciplines - ▪ Soil microbiology, Geomicrobiology, Microbial Ecology, Food and Agricultural Microbiology, Immunology, Medical Microbiology, Pharmaceutical Microbiology, Chemotherapy and Molecular Biology, Industrial Microbiology, Nano-technology and Bioinformatics, etc.	10
Unit-II	Microbial Diversity	▪ Concept of microbial diversity, ecology and its importance and ecological interactions ▪ General characteristics, Morphological features and Significance of - Viruses, Virion and Prions Bacteria (Eubacteria, Rickettsia, Mycoplasma, Actimomycetes), Archaebacteria, Cyanobacteria ▪ Algae, ▪ Fungi and ▪ Protozoa	10
Unit III	Microbial Taxonomy	▪ Whitakers' Five Kingdom system ▪ Carl Woese's three Domain system ▪ Binomial Nomenclature and basic rules ▪ Methods in microbial taxonomy: Cultural, Biochemical and molecular characteristics-Ribotyping, G=C ratio ▪ Numerical taxonomy and Chemotaxonomy ▪ Bergey's System of Bacterial Classification: structure, scheme and overview ▪ Introduction to classification of algae, fungi and	10

Suggested readings
1) Tortora GJ, Funke BR and Case CL (2008). Microbiology: An Introduction, 9th edition, Pearson Education, New Delhi 2) Talaro K and Chess B (2012) Foundations in Microbiology, 8th edition, The McGraw-Hill Companies, Inc., New York 3) Tortora, Funke, and Case (2010) Microbiology, 10th edition, Brenjamin Cummings Inc., California. 4) Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology, 9 th edition, Nirali Prakashan, Pune 5) Frobisher M. Hinsdill, Crabtree, and Goodheart, (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co., USA.

CC-1 A: Paper II (Section B)

MB 102: Microscopy and Basic Bacteriology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course Objectiv	To complement the students with the basic knowledge about microbial growth and microscopy		
Course Outcome (CO)	After successful completion of this course students are expected to - ▪ Demonstrate theory in microscopy and their handling techniques and staining procedures ▪ Know various culture media and their applications and also understand various physical and chemical means of sterilization ▪ Know general bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae ▪ Learn aseptic techniques and be able to perform routine culture handling tasks safely and effectively ▪ Comprehend the various methods for identification of unknown microorganisms ▪ Understand the modes of nutrition in microbial metabolism and able to classify the bacteria based on nutrition ▪ Know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement.		
UNIT-I	Microscopy and Staining	▪ Basics of Microscopy: Magnification, Resolution, Numerical Aperture ▪ Compound Microscope: Construction, Working Principle with Ray diagram ▪ Concept of Bright field and Dark filed Microscope ▪ Aberrations: Concept and types ▪ Oil immersion objective ▪ Concept of stain (Acidic and Basic) ▪ Smear preparation, Mordant and fixative ▪ Methods of staining: Simple (Monochrome and Negative) and Differential (Gram's and Acid fast)	10

Unit-II	Growth and Reproduction of Bacteria	▪ Concept of Growth and Reproduction, Mechanism of binary fission, Fragmentation, budding ▪ Mathematical expression for Growth, Growth rate and Generation time (Illustration with problem). ▪ Typical growth curve of bacterial population and its significance ▪ Batch culture, Diauxic growth ▪ Quantitative measurement of bacterial growth ▪ Synchronous and Continuous Growth Culture with applications in microbiology	10
Unit III	Cultivation of Bacteria	▪ Physical parameters: Effect of pH, temperature, water activity, Oxygen on growth and cultivation ▪ Types of bacteria, mode of their adaptations w.r.t. a) Temperature requirement (psychrophiles, b) mesophiles, thermophiles, thermodurics, psychrotrophs), c) pH requirement (acidophiles, alkaliphiles), d) Salt/solute and water activity (halophiles, xerophiles, osmophilic), e) Oxygen requirement (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), f) Pressure (barophile). ▪ Media ingredients (water, peptone, malt extract, meat extract, yeast extract, trace elements, growth factor) ▪ Types of media: complex, synthetic, selective, differential, enriched media ▪ Enrichment culture technique ▪ Concept Auxotroph and Prototroph ▪ Classification of bacteria based on nutrition: Phototroph (Phto-autotroph, Photo-heterotroph) and chemotroph (Chemo-autotroph, Chemo- heterotroph)	10

Suggested readings

1) Wiley, JM, Sherwood, LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International, New York
2) Frobisher M. Hinsdill, Crabtree and Goodheart (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co. USA.
3) Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms, 14th edition, Pearson International Edition, New Delhi
4) Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company, New York
5) Tortora, Funke and Case (2010). Microbiology, 10th edition, Brenjamin Cummings Inc, California.
6) Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology 9th edition, Nirali Prakashan, Pune
7) Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad

CC-1 A: Practical Paper I

MB 103: Microbiology Practical Paper - I (Practical)

Total Hours: 60 **Credits: 2**

Sr. No.	Title of the Practical	Hours
Course objectives	To introduce various microorganisms present in the ecosystem and acquaint with common equipment used in routine microbiology laboratory	
Course outcomes (CO)	After successful completion of this course students are expected to: Inculcate the ability to apply the process of science ▪ Demonstrate ability to formulate hypotheses and design experiments based on the scientific method. ▪ To analyse and interpret results from a variety of microbiological methods and apply these methods to analogous situations. ▪ Develop ability to use quantitative reasoning to solve problems in microbiology ▪ Communicate and collaborate with other disciplines ▪ To effectively communicate fundamental concepts of microbiology in written and oral format. ▪ To identify credible scientific sources and interpret and evaluate the information therein. ▪ Understand the relationship between science and society ▪ Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures ▪ Understand the basic microbial practices and study the comparative characteristics of prokaryotes and eukaryotes ▪ Comprehend the various methods for identification of microorganisms adopted in Bergey's Manual and able to classify the bacteria ▪ Know the various Physical growth requirements of bacteria ▪ Prepare and view specimens under bright field microscope. ▪ Aware and train in aseptic handling of microbial specimens. Practice safe microbiology, using appropriate protective and emergency procedures. ▪ Use appropriate microbiological and molecular lab equipment and methods. ▪ Document and report experimental protocols, results and conclusions	
1	Microbiology Good Laboratory practices and Biosafety	4
2	To study the principle, working and application of instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, pH meter, colorimeter) used in the microbiology laboratory	4
3	Acquainting basic microbiology tools: Cleaning and washing of Glassware, Wrapping the items prior to sterilization, Cotton Plugging, Aseptic handling (LAF/Bunsen burner), Inoculation of bacterial culture and inoculating needle, Microbial culture and biological waste Disposal	4
4	Use and Care of Compound Microscope with functions of each par	4
5	Study of fungi using temporary mounts and permanent slides (e.g. *Rhizopus*/ *Penicillium* /*Aspergillus*/ *Fusarium*)	4
6	Study of Algae/BGA temporary mounts and permanent slides (e,g. *Spirogyra* /*Anabaena* / *Nostoc*/ Cyanobacteria)	4
7	Study of the protozoans using temporary and permanent mounts (e.g. *Amoeba/Entamoeba/ Paramecium / Plasmodium*)	4
8	Preparation of culture media for bacterial cultivation.(Nutrient broth and nutrient agar/ MacConky's broth and MacConky's agar	4
9	Study of colony characteristics of different bacteria (e.g. *Escherichia coli*, *Staphylococcus aurous*, *Actinomycetes*)	4
10	Study of bacterial morphology using Monochrome staining	4

11	Study of morphological features of bacteria using Negative Staining	4
12	Study of Gram characteristics of bacteria using Gram's staining	4
13	Study of acid fast characteristics of bacteria using Acid fast staining (*Nocardia* spp./ Atypical mycobacteria)	4
14	Effect of pH and temperature on growth of bacteria	4
15	Demonstration of bacterial growth by spectrophotometer	4

CC 1 A: Paper II (Section A)

MB 201: Basic Biochemistry and Cytology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	To complement the students with cultivation and control of microbe with physical and chemical approach		
Course outcomes	After successful completion of this course students are expected to: ▪ Understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes and also Understand the structural architecture and differences among bacteria/archaea ▪ Know basic knowledge pertinent to cell biomolecules as such		
UNIT-I	**Biomolecules**	▪ **Proteins and amino acids -** Concept, general structure and properties of amino acids, Classification of amino acids, Classification of protein based on shape, composition, solubility and functions, Chemical bonds in protein structure (Covalent, hydrogen, hydrophobic, electrostatic, van der Waal's forces), Structural levels of protein organization: Primary, secondary, tertiary and quartnary, Protein denaturation ▪ **Carbohydrates -** Concept and properties, Classification of carbohydrates, Structure of common carbohydrates (Glucose, lactose, starch and peptidoglycan) and biological significance ▪ **Lipids -** Concept, function and classification of lipids, Fatty acids (Definition, nomenclature, saturated and unsaturated), Structure and biological significance of phospholipids and sterols ▪ **Nucleic acids -** Concept and structural constituents of Nucleic acids (nucleoside, nucleotide, polynucleotide, purines and pyrimidines. DNA: Structure (Watson and Crick Model), Chargaff's Rule, RNA: Structure and significance of: mRNA, tRNA and rRNA, hnRNA, Forms of DNA: A, B and Z (structure and differences) and unusual structures of DNA	10

Unit II	**Anatomy of Prokaryotic cell**	▪ Ultra-structure of bacterial cell. Cell size, shape and arrangement ▪ Structure, Function and Chemical Composition of the following Glycocalyx/capsule, Flagella, endoflagella, Pilli, Cell wall, sphaeroplasts, protoplasts, and L-forms ▪ Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell ▪ Nucleolus, Nucleoid Mesosomes, Plasmid, phasmid, Ribosome, ▪ Cytoplasmic inclusions (volutin granules, PHB granule, glycogen, carbohydrates, Magnetosomes, gas vesicles, carboxysomes, chlorosome and sulphur granules) and Endospore structure and formation	10
Unit III	**Anatomy of Eukaryotic cell**	▪ Ultra-structure of Fungal, Algal and Protozoal Cell ▪ Structure, Function and Chemical Composition of the following Flagella, Cell wall, Nucleus, Mitochondria, Chloroplast, Golgi bodies, Ribosome, Lysosome	10

Suggested readings

1) Black, JG. (2008) Microbiology: Principles and Explorations, 7th edition, Prentice Hall, New Jersey.

2) Madigan, MT and Martinko, JM. (2014). Brock Biology of Micro-organisms, 14th edition, Parker J. Prentice Hall International, Inc., New Jersey.

3) Stanier, RY, Ingraham, JL, Wheelis, ML and Painter, PR. (2005) General Microbiology, 5th edition, McMillan, London

4) Salle, S.J. (1974) Fundamental Principals of Bacteriology, 2nd edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

5) Willey, JM, Sherwood, LM, and Woolverton, CJ. (2013) Prescott's Microbiology, 9^{th} edition, McGraw Hill Higher Education, New Delhi.

6) Patil, UK., Kulkarni, JS., Chaudhari, AB. and Chincholkar, SB. (2016) Foundation in Microbiology, 9^{th} edition, Nirali Prakashan, Pune

CC 1 B: Paper II (Section B)

MB 202: Microbiological Techniques (Theory)

Total Hours: 3 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	To complement the students with cultivation and control of microbe with physical and chemical approach		
Course outcomes	After successful completion of this course students are expected to: ▪ Know general bacteriology and introduce microbial techniques for isolation of pure cultures of bacteria, fungi, algae and virus ▪ Demonstrate theory and practical skills in handling microbial culture ▪ Know various bacteria based on nutritional needs and also understand various physical and chemical means of sterilization ▪ Discern knowledge about sterility assessment of sterilizing agents		
UNIT-I	Isolation and Cultivation of Microbes	▪ Pure culture technique for bacteria - Streak, Pour plate, Spread plate ▪ Cultivation of anaerobes: Roll tube method, anaerobic jar and anaerobic cabinet/chamber ▪ Cultivation of fungi, Blue green algae, algae ▪ Cultivation of animal and plant viruses (living animals, embryonated eggs and cell line cultures) , ▪ Cultivation of bacteriophage	10
Unit II	Control of Microbes-I	▪ Aseptic condition - necessity and application ▪ Concept of - Antiseptic, Sanitizer, Germicide, Antibiotics, Microbiocide, Microbiostasis ▪ Disinfection: Concept of disinfectant and characters of an ideal disinfectant ▪ Mode of action and applications of Phenol and Phenolic compounds, Alcohols, Halogens, Heavy metals and their compounds, Dyes, Detergents, Quaternary ammonium compounds, H_2O_2. ▪ Pasteurization - Concept and Methods - LTH, HTST, and UHT	10
Unit III	Control of microbes-II	▪ Concept of sterilization and parameters, TDT, TDR ▪ Physical methods: Dry heat (Hot air oven, Incineration), Moist heat (Autoclave, Tyndallisation) and Radiation- (X-rays, Gamma rays and UV rays) ▪ Sterilization by Filtration: Membrane filter, LAF (HEPA), Nucleopore filters ▪ Chemical methods - Ethylene oxide and Formaldehyde ▪ Chemical and Biological Indicators of Sterilization ▪ Validation of sterility in autoclave and LAF ▪ Control of microbes by Low Temperature, Desiccation, Osmotic pressure, Surface tension etc.	10

Suggested readings

1. Pawar, CB, & Daginawala HF. (1998) General Microbiology, Vol. I & II, Himalaya Publ., House, Mumbai.
2. Black, JG. (2008) Microbiology: Principles and Explorations, 7th edition, Prentice Hall, New Jersey.
3. Madigan, MT and Martinko, JM. (2014) Brock Biology of Micro-organisms, 14th edition, Parker J. Prentice Hall International, Inc., New Jersey.
4. Frobisher, M. Hinsdill, R., Crabtree, KT., and Goodheart, CR. (1974) Fundamentals of Microbiology, 9th edition, WB Saunder's Co., Many, USA.
5. Pelczar MJ, Chan, ECS and Krieg, NR. (1993) Microbiology. 5th edition. McGraw Hill Book Company, Penguin, USA
6. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016) Foundations in Microbiology, 9th edition, Nirali Prakashan, Pune.
7. Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad

CC-1 A: Practical Paper I

MB 203: Microbiology Practical Paper - II (Practical)

Total Hours: 60 **Credits: 2**

Sr. No.	Title of the Practical	Hours
Course objectives	To instil practical skills about methods of isolation, characterization, control of microbes and familiarize with fundamental aspects of cellular chemistry	
Course outcomes (CO)	After successful completion of this course students are expected to: ▪ Inculcate scientific thinking: a. Student can adapt the ability to apply the process of science, demonstrate an ability to formulate hypotheses and design experiments based on the scientific method b. Analyze and interpret results from a variety of microbiological methods and apply these methods to analogous situations c. Adapt quantitative reasoning and graphing skills to solve problems in microbiology. ▪ Introduce microbiology Laboratory Skills, Perform advanced staining methods ▪ Use pure culture and selective techniques to isolate, enumerate, enrich and isolate microorganisms and to use appropriate methods to identify microorganisms (media-based) ▪ Become conversant in basic biochemical methods in microbiology ▪ Demonstrate practical skills in microscopy and their handling techniques and staining procedures ▪ Practice aseptic techniques and be able to perform routine culture handling tasks safely and effectively ▪ Understand preparation of standard solutions required in various assays.	
1	Demonstration of motility by hanging drop and swarming growth	4
2	Capsule staining	4
3	Endospore staining	4
4	Isolation of bacteria by Streak Plate technique	4
5	Isolation of bacteria by spread plate technique from water sample	4
6	Determination of Colony Forming Unit (cfu) by pour plate method from soil/water sample	4
7	Effect of heavy metal(s) on growth of bacteria and demonstration of oligodynamic action	4
8	Sterilization of heat sensitive material by membrane filtration	4

9	Evaluation of skin disinfectant (alcohol/soap/Dettol)for disinfection	
10	Study micro-flora of the air and water on nutrient agar plates	4
11	Qualitative tests for carbohydrate and lipids	4
12	Qualitative tests for amino acids and proteins	4
13	Qualitative tests for nucleic acid	
14	Slide culture technique for fungi	4
15	Preparation of standard solutions (Normal/ Molar/ Percentage)	4

Skills acquired and job prospects for the microbiology students: Microbiologists study the world of tiny entities that are too small to be seen with the naked eye. This includes bacteria, viruses, algae, fungi, and parasites. Few microbes cause infection to humans, animals, or plants, but many more contribute to beneficial nutrient cycling process in their ecological niches. Hence, microbiologists study the interaction of microorganisms with other living and nonliving world and how they affect our lives, as well as their role in the biome. Initially, more focus was given on the biology of microorganisms at both the cellular and molecular level, as well as their ecology. Now, microbiology is pervaded in all areas of life sciences, such as molecular biology, immunology and biochemistry as well as backbone of basic research, medicine, healthcare and food. Several microbiologists work in hospitals, universities, medical schools, government laboratories, and almost every industry, and array of fields from agriculture to the space industry. Accordingly, few job prospectus in microbiology are furnished below: Research assistant/fellow provides technical support to conduct research working in a team with leading scientists and work in an industrial, government, university, or medical laboratory as food, industrial or environmental microbiologists and quality assurance technologists. In industry & hospitals, microbiologists assist in quality and safety of vitamins, vaccines, antibiotics, antiseptics and identify harmful microorganisms in water, food, dairy, pharmaceutical and environmental products. Technical representatives provide information about pharmaceuticals and other medical or scientific products to prospective customers. Clinical and veterinary microbiologists, medical technologists generally work in veterinary clinics or hospitals to identify disease causing microorganisms in humans and animals. In addition, several career paths take the graduates in microbiology to a wider range of career options such as teaching in College, scientific area, science writing for the general public, public relations, or regulatory affairs. Bachelor’s degree in microbiology also provides the necessary foundation to continue an education in the medical, veterinary, dental or legal fields. During the graduation in microbiology, the students acquire few skills to:

- demonstrate ability to handle a bright field light microscope to view and interpret slides
- prepare slides for microbiological examination
- transfer and handle microorganisms using aseptic techniques and instruments
- prepare microbiological media and test systems for cultivation and identification of microbes
- calibrate laboratory equipment
- acquaint with analytical and result communication with knowledge to interpret the data
- acquire laboratory safety skills and emergency procedures

  Reference: ASM's curriculum recommendations: Microbiology Majors Program, www.asm.org)

Equivalence for FYBSc (Microbiology) Syllabus 2022-23:

Old Syllabus (w. e. f. June 2018-19) CBCS (Pattern 60:40)	**New Syllabus (w. e. f. June 2022-23) CBCS (Pattern 60:40)**
MB-101 : Microbial Diversity	MB-101: Microbial History, Diversity and Taxonomy
MB-102 : Microscopy and Basic Bacteriology	MB-102: Microscopy and Basic Bacteriology
MB-201 : Basic Biochemistry and Cytology	MB-201: Basic Biochemistry and Cytology
MB-202 : Microbial Techniques	MB-202: Microbiological Techniques

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Structure of Syllabus for

Program: B. Sc. (Microbiology)

S. Y. B. Sc.

Choice Based Credit System (CBCS)

2019-2020

S. Y. B. Sc. Microbiology (CBCS Structure) Semester III and IV

Preface

Bachelor of Science (Choice Based Credit System) with Microbiology as one of the core subjects is designed to cultivate a scientific challenge and help the students to become critical, curious in their outlook. The courses are designed to introduce the essential basics in Biochemistry, Chemistry, and Microbiology at the initial level of graduation. The basic courses are integrated with current application in modern life sciences to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of Microbiology and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, etc. This will create zeal and zest about Microbiology which will pave a newer path for the development of society. At the end of the course, the students are expected to have good working knowledge in the field of Microbiology. Students will surely have an urge to continue higher studies in Microbiology and contribute significantly in the development.

The syllabus in microbiology is restructured anticipating the future needs of Microbiology in research, industry sector with more emphasis on imparting hands-on skills. The core thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further microbiology.

Hence, Board of Studies in Life Sciences in its meeting held on 23/06/2018 resolved to accept the revised syllabus for S. Y. B. Sc. (Microbiology) based on Choice Based Credit System (CBCS) of UGC guidelines.

Scheme for B.Sc. Program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		
1	Core courses(16)	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	(i)Theory	4	4	4	4	4	3	4	3					4X14=56
	(ii)Practical	2	4	2	4	2	3	2	3					2X14=28
2	Ability enhancement compulsory course (AECC)(2)	2	1	2	1	2	1	2	1					2 x 2 x 2 x 2 = 08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	2	1	2	1	2X4=16
4	Discipline Specific Elective DSE(6)													
	(i)Theory									4	3	4	3	4X6=24
	(ii)Practical									2	3	2	3	2X6=12
	Total Credit value (Credit x No .of Courses)	26		26		22		22		20		20		136

Course Structure:

Duration: The duration of B.Sc. (Microbiology) degree program shall consists of three years.

Medium of instruction: The medium of instruction for the course shall be English.

The present syllabus has been prepared to (i) accommodate the advanced topic on the Microbiology discipline, (ii) build the basic science knowledge at the level of first year of Microbiology and (iii) reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of microbiology like genetics, immunology, enzymology, and bioprocess biotechnology. The relevant practicals are included to enrich their knowledge.

Structure for S. Y. B. Sc. (Microbiology)

Semester	Core Course				Ability Enhancement Compulsory Course			Skill Enhancement Courses		
	DSC	Paper	Credits	Lectures	AECC	Credits	Lectures	SEC	Credits	Lectures
III (Total Credits = 22)	DSC-1C:Core Course I: Microbiology	Paper I	2	30	AECC I: English/Hindi/MIL Communication III (Advance)	2	30	SEC I: Microbiological Analysis of Air, Water and Soil	2	30
		Paper II	2	30	AECC II: General knowledge paper	Non-credit				
		Practical Paper	2	60						
	DSC-2C: Core Course II	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
	DSC-3C: Core Course III	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
IV (Total Credits = 22)	DSC-1D:Core Course I: Microbiology	Paper I	2	30	AECC I: English/Hindi/MIL Communication III (Advance)	2	30	SEC II: Biofertilizers and Biopesticides	2	30
		Paper II	2	30	AECC II: General knowledge paper	Non-credit				
		Practical Paper	2	60						
	DSC-2D: Core Course II	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
	DSC-3D: Core Course III	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						

Student has choice to study two subsidiary subjects from DSC 2, DSC 3 among Chemistry/ Botany/ Zoology /Geography during III and IV semester; subject to availability of course at respective college.

- **Duration of Lecture:** 30 Lectures of 60 minutes or 36 Lectures of 50 min. Each theory and practical course has to be completed in 30 and 60 lectures, respectively of 60 min duration
- Each theory and practical course will be of 100 marks comprising of 40 marks internal and 60 marks external examination.
- Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
- **Question 1 (12 marks):** 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
- **Question 2, 3 and 4 (12 marks each):** based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.

- **Question 5 (12 marks):** answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.
- **Internal examination (40 marks each semester):** Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.
- **Practical Examination:** Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am -1pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practicals where incubation condition, allied aspect are essential. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination.

Equivalence for S.Y. B.Sc. (Microbiology) is furnished in the following table:

Old Syllabus (June 2016) (Semester pattern 60:40)	**New Syllabus (June 2019) CBCS pattern (Semester pattern 60:40)**
MB 231: Fundamental Biochemistry	MB 301: Basic Microbial Enzyme and Metabolism
MB 232: Microscopy and Microbial Ecology	MB 302: Microscopy and Microbial Ecology
MB 233: Practical Course in Microbiology- I	MB 303: Practical Paper III
MB 241: Genetics and Immunology	MB 401: Genetics and Immunology
MB 242: Basic Microbial Biotechnology	MB 402: Basic Industrial Microbiology
MB 243: Practical Course in Microbiology II	MB 403: Practical Paper IV

S. Y. B. Sc. (Microbiology) Semester – III and IV

Semester	CC-A and B	Paper code	Paper-I	Paper Code	Paper-II	Practical Paper Code	Practical Paper	Skill Enhancement Courses (SEC)	Ability Enhancement Compulsory Courses (AECC)
III	CC A III	MB 301	Basic Microbial Enzyme and Metabolism	MB 302	Microscopy and Microbial Ecology	MB 303	Practical Paper III	SEC I: Microbiological Analysis of Air, Water and Soil	AECC I: English/Hindi/MIL Communication III (Advance): Credit 2; AECC II: General knowledge paper (Noncredit)
IV	CC A IV	MB 401	Genetics and Immunology	MB 402	Basic Industrial Microbiology	MB 403	Practical Paper IV	SEC II: Biofertilizers and Biopesticides	AECC I: English/Hindi/MIL Communication III (Advance): Credit 2; AECC II: General knowledge paper (Noncredit)

MB - 301: Basic Microbial Enzyme and Metabolism

Total Hours: 30 **Credits: 2**

Unit	Topics	Lectures
Course objective	To acquaint students with basic concepts of enzymology and microbial metabolism.	
Learning outcomes	After successful completion of this course, students are expected to: • understand the basic of microbial enzymology, nature of enzyme, their nomenclature, working mechanism, classification based on their action etc. • know how about different parameters affecting the activity of enzyme. • learn about nutrient uptake by microbes, various mechanism used to transport ions and molecules in microbial cells. • aware about concept of metabolism and its basic types. • cognizant about various pathways used by microbes to break down molecule and generate ATP as a source of energy. • aware about the regulations and energetics of various pathways. • understand aerobic, anaerobic respiration and fermentation.	
UNIT-1:	**Microbial Enzymes**	**10**
	• Introduction to enzymes and its nature (Protein and non-protein)	
	• General properties of enzymes, Units of enzyme activity, Isoenzyme, oligomeric enzymes, Multiple enzyme complex	
	• Cofactors, prosthetic groups, apoenzyme, holoenzyme, active site	
	• Enzyme nomenclature and classification (IUBMB), Significance of numbering system	
	• Features of enzymes catalysis:	
	➢ Collision theory, activation energy, transition state theory, catalysis	
	➢ Lowering of activation energy	
	➢ Fischer's Lock and key hypothesis	
	➢ Koshland's Induced fit hypothesis	
	➢ Thermodynamics of enzymatic reaction	
	• Enzyme kinetics	
	➢ Effect of Substrate concentration, temperature, pH, activators and inhibitor on the enzyme activity	
	➢ Relationship between initial velocity and substrate concentration	
	➢ Steady state and equilibrium theory	

	➢ Michaelis-Menten equation, *Km, Vmax*, and *Kcat* concept	
	• Applications of various microbial enzymes in different fields	
UNIT-2:	**Nutrient uptake and Transport**	**10**
	• Nutritional categories of microbes	
	• Bacterial cellular membrane structure and functions	
	• Bacterial cell transport	
	➢ Passive diffusion: water, gases, Glucose transporter, porins	
	➢ Facilitated diffusion: Glycerol transport	
	• Primary active transport: P-, V- and F- type ATPase ➢ Sodium potassium pump, Calcium pump and Proton pump	
	• Secondary active transporters: Lactose permease, Na^+ glucose symport	
	• Concept of uniport, symport and antiport	
	• Group translocation: PEP, ABC family transporters (MDR, CFTR)	
	• Ionophores, Bacteriorhodopsin, ion channels, iron uptake	
UNIT-3:	**Microbial metabolism**	**10**
	• Cellular metabolism: Anabolic and Catabolic reactions	
	• Aerobic respiration, Anaerobic respiration, and Fermentation	
	• Bacterial metabolic pathways: reaction sequence, energetics and regulation: ➢ Carbohydrate catabolism: Glycolytic pathways (EMP, ED, PP), PDH complex, TCA cycle and reverse TCA cycle, Glyoxylate cycle ➢ Carbon dioxide fixation: Carl-Bensen's and Hatch-Slack pathway ➢ Lactate and alcohol fermentation ➢ Methane formation (Methanogenesis)	
Suggested Readings	1. Lehninger, A I. (2013) Principles of Biochemistry, 6th edn., Nelson, D L and Cox, M. M. (eds.) WH Freeman and Co., New York. 2. Moat, A. and Foster, J. (2002) Microbial Physiology, 4th edn., Wiley Interscience Publications, New York. 3. Gottschalk, G. (1986) Bacterial Metabolism, 2nd edn., Springer- Verlag 4. Stryer, L. (2001) Biochemistry, 5th edn., WH Freeman and Co., New York. 5. Stanier RY, Ingraham JL, Wheelis ML, Painter PR (1995) General Microbiology, 5th Edition, MacMillan Press Ltd., London. 6. Prescott, L. M., Hartley, J. P. and Klein, D. A. (1993) Microbiology, 2nd Ed., W. M. C. Brown Publ., England 7. Tortora, G. J., Funke, B. R. and Case, C. L. (2004) Microbiology, 8th Edn., Person Education, New Delhi 8. Nicholas, C.P. and Lewis, S. (1999) Fundamentals of Enzymology, 3rd edn., oxford University Press Inc. New York 9. Caldwell, D.R. (1995) Microbial Physiology and Metabolism, Brown Publishers, London 10. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. (2013) Prescott's Microbiology, 9th edn., MacGraw Hill Higher Education	

MB - 302: Microscopy and Microbial Ecology

Total Hours: 30 **Credits: 2**

Unit	Topics	Lectures
Course objective	To complement the students with the basic knowledge about microscopy and microbial ecology.	
Learning outcomes	After successful completion of this course, the students are expected to: • demonstrate theory in microscopy and acquaint with advanced microscopy. • know the basic concepts of microbial ecology such as biotic and abiotic factors, microbial interactions etc. • learn the establishment of symbiosis, some positive and negative interactions. • comprehend the various symbiotic interactions of microbes with plants, animals and other microbes. • understand the microbial interactions in extreme habitats. • know the detail concept of biotopes.	
UNIT-1:	**Microscopy**	**10**
	• Principle, image formation, working, ray diagram and applications: ➢ PCM ➢ Fluorescence Microscope, FISH, FRET ➢ TEM, SEM and Scanning Tunneling Microscopy (STM)	
	• Specimen preparation, Freeze Etching, Shadow casting technique	
UNIT-2:	**Microbial Ecology**	**10**
	• Concept of microbial ecology and biotic and abiotic factors	
	• Types of microbial interactions	
	➢ Positive: Mutualism, Commensalism, Syntropy, Neutral association, Symbiosis	
	➢ Negative: Prey, Amensalism, Antibiosis, Competition, Parasitism, Predation	
	• Establishment of symbiosis: Direct and Reinfection with examples	
	• Microbial Interactions (Rhizosphere, phyllo-sphere) • Interactions with plants ➢ Legume-Rhizobium Root and Stem, Leaf nodulation ➢ Mycorrhiza: Ecto, Endo, VAM, Orchid ➢ Lichen ➢ PGPR • Interactions in Animals ➢ Ruminant symbiosis • Interactions of Bacteria ➢ Bacterial Bioluminescence. ➢ Microbial Kappa particles	
UNIT-3:	**Microbial interactions in extreme habitats**	**10**
	• Extremophiles: Archaebacteria and their characteristic features and types Acidophiles, Psychrophiles, Thermophiles, Barophiles, Alkalophiles, Halophiles, Methanogens (Acetotrophic, Hydrogenotrophic, Methylotrophic) with examples	
	• Biotopes	
	• Adaptation strategies and their physiology	
	• Evolutionary significance and applications of extremophiles	

Suggested Readings	1. Kathy Talaro and Barry Chess (2012) Foundations in Microbiology, The McGraw-Hill Companies, Inc., New York. 2. Tortora, Funke and Case (2010) Microbiology, Brenjamin Cummings Inc., California 3. Stanier, R.Y., Ingraham, J.L., Wheelis M.L., Painter R.K. (1995) General Microbiology, MacMillan Press Ltd. London. 4. Frobisher M. (1974) Fundamentals of Microbiology, Hinsdill, Crabtree and Goodheart Ed., WB Saunder's Co. USA. 5. Pelczar MJ, Chan ECS, Krieg NR (1998) Microbiology Tata McGraw Hill Publishing Co. Ltd. New Delhi. 6. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2011) Foundations in Microbiology Nirali Prakashan, Pune. 7. Modi H. A. (1995) Elementary Microbiology 1 and 2, Ekta Prakashan, Ahmedabad 8. Stolp, H. (1988) Microbial Ecology; Organism's habitat activities, Cambridge University Press, Cambridge 9. Barton, L.L. and Northrup, D.E. (2011) Microbial Ecology, 1st edn., Wilet Blackwell, USA 10. Atlas, R.M. and Bartha, R. (2000) Microbial Ecology: Fundamental's and Application, 4th edn., Benjamin/Cummings Science Publ., USA 11. Campbell R.E. (1983) Microbial Ecology, Blackwell Scientific Publ., Oxford 12. Adam Schikora (2018) Plant-Microbe Interactions in the Rhizosphere, Caister Academic Press, Germany, ISBN: 978-1-912530-00-7 13. Anitori, R.P. (2012) Extremophiles: Microbiology and Biotechnology, Caister Academic Press, Germany, ISBN: 978-1-904455-98-1	

MB - 303: Practical Paper-III

Total Hours: 30 **Credits: 2**

Sr. No.	Title of practical	Hours
Course objective	To introduce the students to various structural, biochemical, environmental and microscopic aspects of microorganisms along with study of extremophiles	
Learning outcomes	After successful completion of this course, students are expected to: • learn proper handling of micropipette, pH meter, graduated pipette and volumetric flask along with their calibrations. • perform specific staining techniques and acquired skill of handling microscope while observing stained preparations. • able to demonstrate basic biochemical characteristics of bacteria. • able to check potability of water. • know characteristics and significance of extremophiles. • different environmental aspects of microorganisms.	
1.	Handling and calibration of pipette, volumetric flask, micropipette, and pH meter	04
2.	Cell wall staining by any suitable method.	04
3.	Flagella staining by any suitable method.	04
4.	Biochemical Test: IMViC test and TSI test.	04
5.	Sugar Fermentation: Glucose, Lactose, Sucrose and Fructose.	04
6.	Presumptive Coliform test for checking potability of water (MPN).	04
7.	Confirmed and Completed Coliform test for assessing potability of water.	04
8.	Determination of microflora of soil/food	04
9.	Screening of *Actinomycetes* and fungi from soil	04

10.	Detection of microbial enzymes from microbes: Amylase, Lipase, Coagulase, Nitrate reductase, Catalase, Gelatinase, Protease, Urease	04
11.	Enzyme activity assay (amylase/ protease)	04
12.	Preparation of Buffers (0.1 M Phosphate Buffer – 6.8 to 7.4) and check the buffering capacity of same prepared buffer	04
13.	Microscopic observation of Rhizobia from root nodules/ Mycorrhizal spores from soil.	04
14.	Isolation of Halophiles / Alkalophiles / Acidophiles/ Thermophiles	04
NOTE: Mandatory to perform at least 12-13 practicals		
Suggested Readings	1. Alcamo, I.E. (2001) Laboratory Fundamentals of Microbiology, Jones and Bartlett, 2. Aneja, K.R (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi. 3. Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York. 4. Dubey, R.C. and Maheshwari D.K (2004) Practical Microbiology, S. Chand and Co., New Delhi. 5. Harley, J.P. and Prescott, L.M (1996) Laboratory Exercise in Microbiology, 3rd edition, WCB/McGraw Hill. 6. Jayaraman, I. (1981) Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi. 7. Norris, J.R. (1969) Methods in Microbiology Vol. I, 1st Edn. Academic Press Inc., London. 8. Parija, S.C. (2007) Textbook of Practical Microbiology, Ahuja Publishing House, New Delhi. 9. Plummer, D.T. (1992) An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi. 10. Sharma, K. (2007) Manual of Microbiology Tools and Techniques, Anne's Book India, New Delhi.	

S. Y. B. Sc. Semester III: Skill Enhancement Course (SEC)

MB SEC- I: Microbiological Analysis of Air, Water and Soil

Total Hours: 30 **Credits: 2**

Unit	Topics	Lectures
Course objective	• To highlight the number and range of pathogens that may be found in air, water and soil. • To describe some of the key preventative and monitoring actions which maintain and improve microbiological quality of water, air and soil. • To introduce the concept and use of indicator bacteria specially in water quality monitoring. • To describe the principal indicator bacteria used and their key characteristics which make them suitable for use as indicators. • To emphasize the value of *E. coli* and thermotolerant fecal coliforms as routine indicators	
Learning outcomes	After successful completion of this course, the students are expected to: • competently explain various aspects of environmental microbiology • aware about the pollution, Water and air-borne diseases and their transmission, methods of determination of sanitary quality of water and sewage treatment methods employed in waste water treatment. • appreciate the diversity of microorganisms and learn the abundance, distribution and significance of microorganism in the environment such as bioremediation and plant microbe interactions	

	• understand various biogeochemical cycles - microbes involved and biochemical mechanisms of Carbon, Nitrogen, Phosphorus cycles etc.	
UNIT-1:	**Microbiological analysis of air and soil**	**20**
	• Concept of air and soil microbiology	
	• Aero-microbiology: ➢ Bio-aerosols, droplet nuclei, Air borne microbes, impact on human health and environmental, Significance in food, pharma industries, allergens, surgical operation theatres ➢ Techniques for microbial sampling of air from various sources, Aerosol sampling, fate of aerosols, inactivation by UV light and HEPA filter ➢ Assessment of air quality by solid, liquid impingement, Enumeration of microflora by different techniques, ➢ Air borne transmission of microbes, their diseases and preventive control measures	**10**
	• Soil microbiology: ➢ Biogeochemical cycles: C, P, N, S ➢ Soil horizons, classification of soils ➢ Microflora of various soil types and salt affected soils ➢ Rhizosphere microflora ➢ Preparation of Winogradsky's column to study soil microflora Enumeration of soil microflora by different techniques,	**10**
UNIT-2:	**Water microbiology**	**10**
	• Water ecosystem: Fresh water (Ponds, Lakes, Stream); Marine water (Estuaries, mangroves, deep sea, hydrothermal vents, saltpans, Coral reef)	
	• Microflora of water	
	• Bacterial assessment of water and potability of water	
	• Indicator bacteria: *E. coli*, *Staphylococcus aureus*, *Clostridium perfringens*, MPN (Black, White), MPN index, IMViC test	
	• Physiochemical characteristics of water: TSS, TDS, DO, BOD and COD	
	• Brief account of water borne diseases and their control measures	
Suggested Readings	1. Clesceri L S., Greenberg, A. E, and Eaton A. D. (1998) Standard Methods for Examination of Water and Wastewater, 18th Edition, American Public Health Association, Washington. 2. Maier R.M., pepper, I.L. and Gerba, C.P. (2009) Environmental Microbiology, 2nd edn., Academic Press, NY 3. Salle, S.J. (1974) Fundamental Principals of Bacteriology, 2nd edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi. 4. SubbaRao, N.S. (1999) Soil Microbiology, 4th edn., Oxford and IBH Publ. Co., New Delhi 5. Coyne, M.S. (2001) Soil Microbiology: An Exploratory Approach, Delmar Thomson Learning 6. Alexander, M. (1977) Introduction to Soil Microbiology, John Wiley and sons Inc. New York 7. Burns, R.G. and Slater, J.H. (1982) Experimental Microbial Ecology, Blackwell Scientific Publ., Oxford 8. Atlas, R.M. and Bartha, R. (2000) Microbial Ecology, 4th edn., Benjamin/Cumming Science Publ., USA 9. Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York. 10. Dubey, R.C. and Maheshwari D.K (2004) Practical Microbiology, S.	

	Chand and Co. New Delhi. 11. Harley, J.P. and Prescott, L.M (1996) Laboratory Exercise in Microbiology, 3rd edition, WCB/McGraw Hill, London	

S. Y. B. Sc. Semester IV: Microbiology

MB - 401: Genetics and Immunology

Total Hours: 30 **Credits: 2**

Unit	Topics	Lectures
Course objective	To acquaint students with basic concepts of microbial Genetics and Immunology	
Learning outcomes	After successful completion of this course, the students are expected to: • understand the basic of microbial enzymology, nature of enzyme, their nomenclature, working mechanism, classification based on their action etc. • understand the concepts like gene, chromosome, Structural organization of chromosome, extra chromosome: plasmid and its types • know general terms used in genetics • aware about genetic code • learn mutation, type, agent causing mutation and their mechanism, test to detect mutation etc. • learn about infection: mode and source. • understand antigen, antibody and their role in immunity and immune response. • know about antibody diversity. • understand blood grouping system. • cognizant about vaccine, anti-sera and toxoid	
UNIT-1:	**Genes and chromosomes**	**10**
	• Concept of gene, genome, allele, genotype, phenotype, recon, muton, cistron, intron, exon, haploid, diploid, lethal gene, partially diploid, homologous, heterologous etc.	
	• Typical structure of prokaryotic and eukaryotic chromosome	
	• Structural organization of prokaryotic and eukaryotic chromosome	
	• Concept of Chromosome variation (Euploidy, Aneuploidy and Polyploidy and Mitotic Non-disjunction), giant chromosome.	
	• Plasmid: Concept, types, structure and properties, incompatibility	
	• Genetic code and its properties	
UNIT-2:	**Mutations**	**10**
	• Concept and significance of mutations	
	• Types of mutation: Base pair substitutions, frame shift, deletion, inversion, insertions, Tandem duplications, missense, nonsense, neutral, silent, pleiotropic and suppressor mutations Useful phenotypes: Auxotrophic, Conditional, Lethal, Resistant	
	• Spontaneous and induced types of mutation	
	• Mechanism of Spontaneous mutations	
	• Mechanism of induced mutations: Physical (UV, Gamma, and X-rays), Chemical (Base analogues, deaminating agents, alkylating agent, intercalating agent)	
	• Methods to study mutations: ➢ Fluctuation test ➢ Replica plate technique ➢ Ame's test	
	• DNA repair and types of repair systems	
UNIT-3:	**Infection and Immunity**	**10**
	• Infection: Types, Mode and sources of transmissions	

	• Immunity: concept, types (Innate, Acquired) and components of immune system and properties of immune system • Immune Cells (stem cell, T cell, B cell, NK cell, Macrophages, Dendric cell) and organs (Bone marrow, thymus, lymph node, spleen, GALT, CALT) involved in immune response	
	• Non-specific immune response	
	• Specific immune response: Primary and secondary	
	• Type of immune response: Humoral and cell mediated, T and B cells characteristics	
	• Antigen: Concept of hapten, adjuvants, immunogen, epitope and paratope, T- dependent and T-independent antigens	
	• Types and properties of antigen	
	• Blood group: ABO antigen, Bombay blood group antigen, D-antigen and its variants, blood transfusion and rh incompatibilities	
	• Antibody: Types, structure and properties of each antibody, antigenic determinants on antibodies (isotypic, allotypic, ideotypic)	
	• Concept of Antibody diversity	
	• Vaccine, immune sera and toxoid	
Suggested Readings	1. Wiley, JM, Sherwood, LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International, New York. 2. Frobisher M. Hinsdill, Crabtree and Goodheart (1974) Fundamentals of Microbiology, 9th edition, WB Saunder's Co., USA. 3. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014) Brock Biology of Microorganisms, 14th edition, Pearson International Edition, New Delhi 4. Pelczar MJ, Chan ECS and Krieg NR. (1993) Microbiology. 5th edition. McGraw Hill Book Company, New York 5. Tortora, Funke and Case (2010) Microbiology, 10th edition, Brenjamin Cummings Inc, California. 6. Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad. 7. Stanier, RY, Ingraham, JL, Wheelis, ML and Painter, PR. (2005) General Microbiology, 5th edition, McMillan, London 8. Salle, S.J. (1974) Fundamental Principals of Bacteriology, 2nd edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi. 9. Pawar, CB, and Daginawala, HF. (1998) General Microbiology, Vol. I and II, 1st edition, Himalaya Publishing House, Mumbai. 10. Ananthanarayan, P., Paniker, C. K. J. (1990) Textbook of Microbiology, Orient Longman, Madras. 11. Kimball, J. W. (1990) Introduction to Immunology, MacMillan Publishing Company, New York. 12. Kuby, J. W. H. (1994) Immunology, W.H. Freeman and Company, New York. 13. Riott, I.M. (1998) Essential Immunology, ELBS Blackwell Scientific Publications, Oxford 14. Maloy, S.R., Freifelder, D. and Cronan, J.E. (1994) Microbial Genetics, 2nd edn., Jones and Bartlett Publishers 15. Keya Chaudhari (2014) Microbial Genetics, TERI Press, New Delhi ISBN: 9788179933237 16. Abbas AK, Lichtman AH, Pillai S. (2007) Cellular and Molecular Immunology, 6th edition, Saunders Publication, Philadelphia	

MB - 402: Basic Industrial Microbiology

Total Hours: 30 **Credits: 2**

Unit	Topics	Lectures
Course objective	To acquaint students with basic concepts of industrial microbiology.	
Learning outcomes	After successful completion of this course, the students are expected to: • understand the basics of fermentation technology, screening techniques, microbial culture preservation techniques etc. • know the concepts of inoculum development and media sterilization for fermentation process. • learn about the typical structure of fermenter and its parts, types of fermentation processes and synchronous growth. • aware about the detail downstream process of fermentation of important microbial products.	
UNIT-1:	**Basics of fermentation technology**	**10**
	• Characteristics of industrial strains	
	➢ Screening of industrially important microorganisms ➢ Primary and Secondary Screening with examples ➢ Screening for Amino acid / vitamin producers ➢ Screening for Antibiotic Producers ➢ Strain improvements ➢ Culture collection centers: National (NCIM, MCC) International (ATCC) and their role ➢ Preservation of microbial culture: Soil culture, Oil overlay, Liquid nitrogen Freezing, drying, Lyophilization ➢ Working and stock culture	
	• Inoculum ➢ Inoculum source and Characteristics ➢ Acclimatization ➢ Inoculum development and Characteristics features	
	• Fermentation media ➢ Raw materials used in media production, Screening and Selection of raw materials, typical composition and criteria for selection ➢ Synthetic media, Complex media and Natural media ➢ Sterilization: Batch Sterilization, Continuous Sterilization	
UNIT-2:	**Fermentation**	**10**
	• Criteria for fermenter design and construction	
	• Fermenter types and parts (Impeller, baffles, sparger, stuffing box)	
	• Measurement and control of fermentation parameters: pH, temperature, dissolved oxygen, foaming and aeration	
	• Fermentation process: Submerged (Batch, Fed batch, Dual/ Multiple) Solid state fermentation, concept, characteristics and applications	
	• Continuous Cell growth: Chemostat and Turbidostatic	
	• Synchronous cell growth: Physical and Chemical methods ➢ Applications of synchronous culture	
UNIT-3:	**Downstream processing**	**10**
	• Product isolation methods ➢ Cell removal ➢ Cell disruption: Chemical methods, Ultra sonication and Enzymatic methods	
	• Recovery of fermentation products	

	• Filtration: Theory, Filter bids, (Examples: Pressure leaf filters, Rotatory vacuum filters)	
	• Centrifugation: Theory, Types: Basket centrifuge, Tubular bowl, Multi-chamber centrifuge	
	• Solvent recovery: Two phase aqueous extraction, superficial fluid extraction, countercurrent extraction	
	• Chromatography: Ion exchange, Adsorption, Affinity chromatography, GC and HPLC	
	• Membrane process: Ultrafiltration, Reverse Osmosis, Drying, Crystallography	
Suggested Readings	1. Casida, L.E (1998) Industrial Microbiology New Age International Publishers, New Delhi 2. Crueger, W. and Crueger, A. (2000) Biotechnology: A Textbook of Industrial Microbiology, Panima Publ Co., New Delhi 3. Stanbury, P.F., Whitaker, A. and Halt G. (1995) Principles of Fermentation Technology, Pergamon Press, New York. 4. Whitaker, A. and Stanbury, P.F. (1995) Principles of Fermentation Technology, Butterworth-Heinemann 5. Patel A. H. (1996); Industrial Microbiology McMillan Publication, New Delhi. 6. Prescott S.C and Dunn C.G. (1983) Industrial Microbiology, McGraw Hill Book Co. Inc., New York. 7. Tortora, Funke and Case (2010) Microbiology, Brenjamin Cummings Inc., California 8. Stanier, R.Y., Ingraham, J.L., Wheelis M.L., Painter R.K. (1995) General Microbiology, MacMillan Press Ltd., London. 9. Frobisher M. (1974); Fundamentals of Microbiology, Hinsdill, Crabtree and Goodheart Edition, WB Saunder's Co., USA. 10. Pelczar MJ, Chan ECS, Krieg NR (1998) Microbiology Tata McGraw Hill Publishing Co. Ltd., New Delhi.	

MB - 403: Practical Paper - IV

Total Hours: 30 **Credits: 2**

Sr. No.	Title of practical	Hours
Course objective	To enhance practical skills of students in concern with Genetics, Industrial microbiology and enzymology.	
Learning outcomes	After successful completion of this course students are expected to: 1. Structure and functions of nucleus and volutin granules. 2. Able to carry out titrations skillfully. 3. Understand structure, working principle and significance of each and every part of fermenter. 4. Know chromatography techniques. 5. Students can be able to detect blood groups and perform cross-matching. 6. Understand concept of stock solutions and can prepare required stock concentration by proper dilutions. 7. Get knowledge about enzymes; successfully detect various enzymes produced by microorganisms.	
1	Nucleus staining by any suitable method	04
2	Volutine granules staining by any suitable method.	04
3	Isolation of antibiotic resistant mutants.	04
4	Isolation of UV induced auxotrophic mutants.	04
5	Estimation of acetic acid from vinegar by titrimetric method.	04
6	Screening of antibiotic producing microbes by Crowded plate technique and Organic acid producing microbes by Indicator dye method.	04

7	Recovery of organic acid from fermentation broth and detection using Paper chromatography and Thin Layer chromatography	04
8	Determination of ABO and Rh blood group and cross matching of blood	04
9	Separation of lymphocytes from whole blood and count using hemocytometer	04
10	Preparation of different dilutions from given stock solutions of antibiotic.	04
11	Growth curve of bacteria by cell number measurement using absorbance	04
12	Preservation of fungal spore culture using soil culture method and validating its viability	04
13	Fermentative production of alcohol and recovery of alcohol using distillation	04
14	Demonstration of a typical fermenter	04
NOTE: Mandatory to perform at least 12-13 practical		
Suggested Readings	1. Aneja, K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi. 2. Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York. 3. Dubey, R.C. and Maheshwari D.K. (2004) Practical Microbiology, S. Chand and Co., New Delhi. 4. Harley, J.P. and Prescott, L.M. (1996) Laboratory Exercise in Microbiology, 3rd edn., WCB/McGraw Hill Publ. Co., London 5. Jayaraman, I (1981) Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi. 6. Norris, J.R. (1969) Methods in Microbiology Vol. I, 1st edition, Academic Press Inc., London. 7. Parija, S.C. (2007) Textbook of Practical Microbiology, Ahuja Publishing House, New Delhi. 8. Plummer, D.T. (1992) an Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi. 9. Sharma, K. (2007) Manual of Microbiology Tools and Techniques, Ane's Book India, New Delhi.	

S. Y. B. Sc. Semester IV: Skill Enhancement Courses (SEC)

SEC-II: Biofertilizers and Biopesticides

Total Hours: 30 **Credits: 2**

Unit	Topics	Lectures
Course objectives	• To aware the students to the adverse effects of plant production and protection of chemicals on the biotic and abiotic components of environment. • To familiarize students with the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.	
Learning outcomes	After successful completion of this course students are expected to: 1. Completion of the course will give an overview of relevant use of microbial biofertilizers and biopesticides. 2. The students will become familiar with the vast reserves of available microbial biodiversity that provide abundant opportunities to harness the ability of micro - organisms and their chemical constituents 3. To sustainably minimize damage from pests or increase agricultural productivity and production.	
UNIT-1:	**Biofertilizers**	18
	General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers	
	Screening and isolation of symbiotic and non-symbiotic nitrogen fixing bacteria for production of biofertilizer	

	Rhizobium: Isolation, characteristics, types, inoculum production and field application, legume/pulses plants	
	Frankia: Isolation, characteristics, *Alder*, *Casurina* plants, non-leguminous crop symbiosis	
	Cyanobacteria, *Azolla*: Isolation, characterization and role in crop cultivation	
	Non-symbiotic nitrogen fixing bacteria: *Azospirillum, Azotobacter*: isolation, characteristics, mass inoculum production and field application	
	PGPR, phosphate solubilizing bacteria and Mycorrhizal biofertilizers: isolation, characteristics, mass inoculum production and field application	
	Application of biofertilizers: Liquid, and preparation of carrier-based formulation, Seed bacterization, soil broadcasting	
	Bio-efficacy and quality parameters	
UNIT-2:	**Biopesticides**	12
	General account of microbes used as biopesticides / bioinsecticides and their advantages over synthetic pesticides	
	Screening and isolation of bioagents	
	Bacillus thuringiensis, *Pseudomonas fluorescence*, *Trichoderma viridae:* Mode of action, mass production, formulation, Field applications NPV and *Beauveria bassiana: A*ction, Cultivation and field applications	
	Advantages and disadvantages of biopesticides	
	Bio-efficacy and quality parameters assessment	
Suggested Readings	1. Kannaiyan, S. (2003) Biotechnology of Biofertilizers, CHIPS, Texas. 2. Rai M. K. (2005) Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York. 3. Reddy, S.M. et. al. (2002) Bioinoculants for sustainable Agriculture and Forestry, Scientific Publishers, New Delhi 4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH Publishing co. Pvt. Ltd., New Delhi. 5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG 6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH Publication, New Delhi	

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Structure of Syllabus

Program B.Sc.

T. Y. B. Sc. (Microbiology)

Choice Based Credit System (CBCS)

2020-21

T.Y.B.Sc. Microbiology

Preamble

The degree course of Bachelor of Science (Choice Based Credit System) in Microbiology has been designed with a multi-faceted approach so as to meet the ever-growing challenges in the field of Pathology, Immunology, Genetics, Biochemistry, Pharmaceuticals, Food and Dairy industry, Agriculture and Nanotechnology. The beneficiaries of this course are entitled to get enriched with a wide range of theoretical and practical knowledge in the above fields. The aim is to inculcate interest in the subject and apply the knowledge gained for society, employment, business, as well as research. The subjects incorporated shall be updated with the novel technologies and innovative methods to go hand in hand with the developing demands of Life Sciences. The course is empowered with skills focussed to gain proficiency in handling equipment and learning the norms and precautions essential in a Microbiology Laboratory. The B.Sc. course shall build graduates that shall apply the knowledge gained for collection and interpretation of data in research. They shall also be acquainted with skills for presentation of data in a standard scientific style. The course has the greatest asset to envisage the beneficiaries with the practical and theoretical skills needed in the subject once they qualify the degree and face the open challenges of Microbiology in the world. The upcoming global challenges have been taken into consideration with priority during the designing of the course. This shall attract students to opt the subject so as foresee a sound knowledge in the subject and satisfy their curiosities. The motive is to lay a strong foundation for the student in the subject that shall help him grow and reach his targets in the global educational hub.

The candidates opting for the course shall get enough opportunities to select courses of his/her choice. This will bestow full justice to their interests. Restructuring of the syllabus has been done to suffice the needs of a choice-based credit system that shall strengthen the student's intellectual status at large.

Board of Studies in Life Science has taken efforts to fulfil the components of Teaching-Learning-Evaluation process to a maximum extent during the compilation of the syllabi. The syllabus is vividly endowed with course objectives and learning outcomes for every subject. The guidelines laid down by University Grants Commission (UGC), New Delhi for the CBCS have been given due justice during the restructuring of the syllabi.

Hence, Board of Studies in Life Sciences in its meeting accepted the revised syllabus for T. Y. B. Sc. (Microbiology) based on Choice Based Credit System (CBCS) of UGC guidelines.The path for a bright future of Microbiology has been emphasized to build up with a hope to achieve the goals in the form of fruitful program outcomes in the coming days.

There are 08 core courses which encompass all important aspects of the discipline of Microbiology and are all compulsory courses. 04 choice-based Discipline Specific Elective (DSE) courses are designed which give the students a chance to apply their knowledge of Microbiology to study societal problems. The students have a freedom to select the courses of their choice while Skill based Elective Courses (SEC) are also included to develop skills in areas which are related to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment.

Programme Outcome (PO):

As an outcome, the graduate students are expected to gain the following competencies upon completion of this program B. Sc.

- Students will understand the concepts and significance in the field of Biochemistry / Biotechnology / Microbiology that can be used for solving the real time problems.
- Students will acquire skills and ability in their field and find professional opportunities in industry, agriculture and higher studies.
- Students will have improved personal qualities and transferable skills to help them to groom as responsible citizens.

Program Specific Objectives (PSO):

- Microbiology graduates will apply their knowledge and skills gained through the program to achieve success in their academic and/or professional development.
- Our graduates can apply this knowledge for pursuing postgraduate education.
- The program shall promote them to choose varied career paths in various disciplines of the subject.
- Our candidates will develop a sense of societal and ethical responsibility pertaining to health, agriculture, dairy, genetic engineering, and fermentation industry.
- The knowledge shall promote our graduates to stand independently amidst the growing technological innovations in the subject.
- Students will have an expertise in isolation techniques and diagnostic tests.
- Students will have a wide perspective on fermentation technology, GMP, GLP and IPR.
- Students will have familiarity with metabolism functional in bacteria.
- Students will understand contemporary environmental issues and shall be motivated to provide solutions for solving them.

Learning Objectives (LO):

- To acquaint the students with various disciplines of Microbiology.

- To articulate foundation and pillar level knowledge of Microbiology for the beneficiaries to apply them for advanced studies in the subject.
- To develop practical skills with a sound theoretical background.
- To apply the knowledge gained for higher education, research and profession of their choice.
- To analyse their interests among the various disciplines and implement them in their professional endeavours.

Programme Structure:

The programme includes 8 Discipline Specific Core Courses (DSC) of 3 credits each, 4 each for the two semesters (Semester V and VI). There shall be inclusion of 02 Skill Enhancement Course (SEC) of 3 credits each, one for each Semester. The course has incorporated 4 Discipline Specific Elective Course (DSE) of 3 credits each, two for each Semester. The student shall have liberty to choose one of the two courses. There shall be 6 Discipline specific Core Practical courses of 2 credits each; 3 courses for each semester.

Eligibility:

Students completing Second Year CBCS (Semester III and IV) of B.Sc. (44 credits) in Microbiology shall be eligible for admission to T. Y. B. Sc. degree course having CBCS pattern. However, the candidate must pass all subjects of first year.

Course Fee: As per University norms.

Duration: The duration of B. Sc. (Microbiology) degree program shall consist of three years.

Medium of instruction: The medium of instruction for the course shall be English.

Credit to contact hour/Duration of Lecture: 45 Lectures of 60 minutes or 54 Lectures of 50 minutes shall be conducted for 08 Discipline Specific Core courses, 02 Skill Enhancement Courses and 02 Discipline Specific Elective courses of 3 credits each. Each theory and practical course must be completed in 45 and 60 lectures, respectively of 60 minutes duration. The score allotted for 06 Discipline Specific Core practical courses is 2 credits for each course.

Attendance:

The candidates appearing for the final year examinations of B.Sc. Microbiology need to fulfill a regular attendance record in theory and practical of not less than 80 %. Failing to fulfill the criteria the student shall not be eligible for appearing for the T. Y. B. Sc. (CBCS) examination.

Exam Pattern

- Each theory and practical course will be of 100 marks comprising of 40 marks internal (College assessment) and 60 marks external examination (University assessment).
- Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each) while the tentative pattern of question papers shall be as follows;
- Question 1 (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
- Question 2, 3 and 4 (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
- Question 5 (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.

Internal examination (40 marks each semester):

Internal assessment (College assessment) of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.

Practical Examination:

Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5-6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am -1 pm / 2 – 5 pm for 2 consecutive days) in case of microbiology practical where incubation condition, allied aspect is essential. There shall be 5 marks for laboratory logbook and well written journal, 10 marks for *viva-voce* and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination.

Scheme

Scheme for T. Y. B. Sc. program under the Faculty of Science and Technology includes in continuation with the First and Second Year's two semesters namely Semester V and VI. Each semester shall include four Core courses; one Skill based course, one Elective course, three Core practicals and one non-credit Elective Audit course.

Scheme for B.Sc. Program under Faculty of Science and Technology

Sr. No.	Year → Course ↓	**First Year**				**Second Year**				**Third Year**				**Total Credit Value**
		Sem I		Sem II		Sem III		Sem IV		Sem V		Sem VI		
1	Core Courses (16)	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	
	i. Theory	4	4	4	4	4	3	4	3	3	4	3	4	4x14=56 3x8=24
	ii. Practical	2	4	2	4	2	3	2	3	2	3	2	3	2x4=28 2x6=12
2	Ability Enhancement Compulsory Course (AECC) (2)	2	1	2	1	2	1	2	1					2x2x2x2 =08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	3	1	3	1	2x2=04 3x2=06
4	Discipline Specific Elective (DSE) (6)									3	1	3	1	3x2=06
5	Elective Audit									No credit	Any 1	No credit	Any 1	--
6	Total Credit Value	26		26		22		22		24		24		**144**

	(Credit x No. of courses)							

Structure of Curriculum of T. Y. B. Sc. (Microbiology) Semester V

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	MB-501	Microbial Genetics	3	3	45	40	60
	Core II	MB-502	Bioprocess Technology	3	3	45	40	60
	Core III	MB-503	Metabolism	3	3	45	40	60
	Core IV	MB-504	Basic Immunology	3	3	45	40	60
SEC	Skill Based	MB-505	Medical Microbiology I	3	3	45	40	60
DSE	Elective Course (Anyone)	MB-506A	Food Microbiology	3	3	45	40	60
		MB-506B	Pharmaceutical Quality Control and Quality Assurance					
DSC	Core (Practical)	MB-507	Methods in Medical Microbiology-I	2	4 (per batch)	60	40	60
		MB-508	Methods in Industrial Microbiology-I	2	4 (per batch)	60	40	60
		MB-509	Methods in Applied Microbiology-I	2	4 (per batch)	60	40	60
AU	Elective Audit Course (Anyone)	AC-501A	NCC	No credit	2	30	100	--
		AC-501B	NSS					
		AC-501C	Sports					

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

NCC: National Cadet Corps

NSS: National Service Scheme

Structure of Curriculum of T.Y.B.Sc. (Microbiology) Semester VI

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	MB-601	Molecular Biology	3	3	45	40	60
	Core II	MB-602	Fermentations	3	3	45	40	60
	Core III	MB-603	Enzymology	3	3	45	40	60
	Core IV	MB-604	Advanced Immunology	3	3	45	40	60
SEC	Skill Based	MB-605	Medical Microbiology-II	3	3	45	40	60
DSE	Elective Course (Anyone)	MB-606A	Agricultural Microbiology	3	3	45	40	60
		MB-606B	Regulatory Practices & IPR					
DSC	Core (Practical)	MB-607	Methods in Medical Microbiology-II	2	4 (per batch)	60	40	60
		MB-608	Methods in Industrial Microbiology-II	2	4 (per batch)	60	40	60
		MB-609	Methods in Applied Microbiology-II	2	4 (per batch)	60	40	60
AU	Elective Audit Course (Anyone)	AC-601A	Soft Skill	No credit	2	30	100	--
		AC-601B	Yoga					
		AC-601C	Practising cleanliness					

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

Skill Enhancement Course (SEC):

To increase the potentiality of Microbiology students in industries and to make them more employable in pharmaceutical industries or medical Microbiology fields and go for higher studies. This course will improve skills of required for them to boost their industrial and research career.

Discipline Specific Elective Course (DSE)

Elective course will give students choice to study the course of their interest that include the food, pharmaceutical and agricultural microbiology. This shall give them a real choice in selecting the course of their interest. In the 5^{th} semester, student can choose either Food Microbiology or Pharmaceutical Quality Control and Quality Assurance. Whereas in the 6^{th} semester they have choice between Agricultural Microbiology or Regulatory Practices & IPR. Student who has selected Food Microbiology for the 5^{th} semester, compulsorily must take Agricultural Microbiology in 6^{th} semester while one who has selected Pharmaceutical Quality Control and Quality Assurance shall opt for Regulatory Practices & IPR in the 6^{th} semester.

Audit Course (AU):
The syllabi for audit courses will be common for all courses and shall be available separately.

Equivalence of the courses for T. Y. B. Sc. (Microbiology)

Old Syllabus (June 2016) (Semester pattern 60:40) courses		**Equivalent New Syllabus (June 2020) CBCS pattern (Semester pattern 60:40) courses**	
Course Code	**Paper**	**Course Code**	**Paper**
Semester V			
MB-351	Microbial Genetics	**MB-501**	Microbial Genetics
MB-352	Fermentation Technology	**MB-502**	Bioprocess Technology
MB-353	Microbial Metabolism	**MB-503**	Metabolism
MB-354	Medical Microbiology	**MB-505**	Medical Microbiology-I
MB-355	Immunology	**MB-504**	Basic Immunology
MB-356	Applied Microbiology	**MB-506 (A)**	Food Microbiology
MB-357	Techniques in Diagnostic Microbiology-I	**MB-507**	Methods in Medical Microbiology-I

MB-358	Techniques in Industrial Microbiology-I	**MB-508**	Methods in Industrial Microbiology-I
MB-359	Techniques in Applied Microbiology-I	**MB-509**	Methods in Applied Microbiology-I
Semester VI			
MB-361	Molecular Biology	**MB-601**	Molecular Biology
MB-362	Pharmaceutical Microbiology	**MB-602**	Fermentations
MB-363	Enzymology	**MB-603**	Enzymology
MB-364	Clinical Microbiology	**MB-605**	Medical Microbiology-II
MB-365	Diagnostic Immunology	**MB-604**	Advanced Immunology
MB-366	Environmental Microbiology	**MB-606 (A)**	Agricultural Microbiology
MB-367	Techniques in Diagnostic Microbiology-II	**MB-607**	Methods in Medical Microbiology-II
MB-368	Techniques in Industrial Microbiology-II	**MB-608**	Methods in Industrial Microbiology-II
MB-369	Techniques in Applied Microbiology-I	**MB-609**	Methods in Applied Microbiology-II

T.Y.B.Sc. (CBCS) Syllabus Semester - V

Discipline Specific Core (DSC) Course		
MB 501- Microbial Genetics		
Total Hours:45		**Credits:3**
Course Objectives • To introduce the concepts in Microbial Genetics. • To acquaint with molecular techniques. • To update applied knowledge in the field of microbial genetics.		
Learning Outcomes After successful completion of this course, students are expected to: • Acquaint with the concepts of Gene transfer and its Central Dogma. • Able to learn the principles and applications of various molecular techniques. • Students shall have the basic knowledge of operon and r-DNA technology.		
Unit	**Topics**	**Lectures**
UNIT-1	**Central Dogma**	**15**
➢	Introduction to the concept of Central Dogma of molecular biology	
	Primary and Secondary structure of DNA	
	Denaturation and Renaturation of DNA, Cot Curve	
➢	Replication of DNA	
	Modes of Replication: Conservative, Semiconservative, Dispersive	
	Meselson and Stahl Experiment	
	Mechanism of Bacterial DNA Replication: • Initiation: Unwinding, Primer • Elongation: DNA Polymerase I and III, Replication fork • Termination	
	Models of Replication: Theta, Rolling Circle, Linear Eukaryotic	
	The fidelity of DNA Replication.	
➢	Transcription in Bacteria	
	Components of Transcription: Template, Transcription Unit, Substrate for Transcription, Transcription apparatus, Bacterial RNA polymerase	
	• Initiation: Bacterial Promoters • Elongation • Termination: Rho dependent and Rho independent	
➢	Translation in Bacteria	
	Binding of Amino Acids to Transfer RNA (Activation of Amino acid and Charging of t-RNA)	
	• Initiation: Initiation factors, Shine-Dalgarno Consensus Sequence, Subunits of ribosomes	

	• Elongation: A. P. E sites • Termination: Release factors	
UNIT 2	**Viral Genetics**	**15**
➢	Classification of viruses based on genome	
➢	Salient features of viral genome • Unusual bases: TMV and T4 • Overlapping genes: Hepatitis B virus • Alternate Splicing: Retrovirus • Terminal redundancy: T4 • Terminal Cohesive ends: Lambda • Segmented Genome: Influenza Virus • Non-segmented Genome: Picorna virus	
➢	Structure of Double Stranded DNA phages: T4 and Lambda.	
➢	Lytic Cycle	
	Lysogenic Cycle	
➢	Bacteriophage mutants: • Plaque morphology • Conditional lethal (Ts and Am) mutants • Deletion Mutants	
UNIT 3	**Gene Transfer and Repair Mechanisms**	**15**
➢	Gene Transfer by Transformation: • Development of Competence (Gram Positive & Gram Negative) • Mechanism in Gram Positive and Gram Negative bacteria	
➢	Gene Transfer by Conjugation: • F^+, Hfr and F^1 strains • F plasmid • Conjugation in F^+ and Hfr cells	
➢	Gene Transfer by Transduction: • Generalised Transduction • Specialised Transduction • Abortive Transduction	
➢	Transposition: • Transposable elements that move via DNA intermediates: IS Composite & TnA family of transposons • Mechanism of DNA mediated transposition	
➢	• Transposable elements that move via RNA intermediates: Retrotransposons • Mechanism of retro-	

	transposition	
➢	DNA Repair mechanisms: • DNA damage • Direct Reversal of DNA damage • Base Excision Repair by base flipping • Nucleotide Excision Repair • Recombination repair • Translesion DNA synthesis (TLS) • SOS Repair	

Suggested Reading:

1. Gunther S. Stent, (1978), Molecular Genetics: An Introductory Narrative, 2nd Edn. W.H. Freeman & Co.
2. Hayes, W. (1964), The Genetics of Bacteria and their Viruses, CBS Pub. New Delhi.
3. Gardner, Simmons, Snustad. (2006), Principles of Genetics, 8th Ed. John Wiley & Sons. Inc. New York.
4. Primrose, S. B. (2002). Principles of Gene Manipulation 6th Edn Oxford: Blackwell Scientific Publications.
5. Strickberger, M.W. (1985), Genetics, 3rd Edition Macmillan Pub. Co. NY.
6. Uldis N. Streips, Ronald E. Yashbin (2002) Modern Microbial Genetics, 2nd Edition, Wiley-Liss, Inc.
7. Watson et al., (2004) Molecular Biology of Genes, International Edition, Benjamin Cummings Publishers.
8. Jeremy W. Dale and Simon F. Park (2004) Molecular Genetics of Bacteria, 4th Edition, John Wiley and Sons, Ltd.
9. David Freifelder, (1987) Molecular Biology, 2nd Edition. Jones & Bartlett Publication.

Websites

- https://www.biointeractive.org/classroom-resources/central-dogma-and-genetic-medicine
- https://courses.lumenlearning.com/microbiology/chapter/the-viral-life-cycle/

Discipline Specific Core (DSC) Course		
MB 502- Bioprocess Technology		
Total Hours:45		**Credits:3**

Course Objectives

- To introduce with concepts related to bioreactors and their types.
- To acquaint with concepts strain improvement and scale up.
- To understand the processes involved in fermentation.

Learning Outcomes

After successful completion of this course, students are expected to:

- Know a bioreactor, its parts, types and working.
- Get knowledge about the significant processes in a bioreactor like strain improvement, inoculum development sterilization and scale-up.

Unit	Topics	Lectures
UNIT-1	**Bioreactor Engineering**	**15**
➢	Types of bioreactor (Air-lift fermenter and Bubble column bioreactor.	
➢	Types of - Impeller, Sparger and Baffle arrangements.	
➢	Probes (O_2 and pH), Control of Temperature and Foam.	
➢	On-line, In-situ, Measurements within fermenter.	
UNIT-2--	**Industrial Sterilization, Strain Improvement and Scale Up**	**15**
➢	Need of aseptic conditions in fermentation process.	
➢	Fermentation media sterilization – Batch and Continuous.	
➢	Sterilization of air by Filtration.	
➢	Methods of strain improvement based on: • Modification of permeability • Mutation • r-DNA technology	
➢	Criteria for scale-up, Scale-up of industrial process.	
UNIT-3	**The Development of Inoculum for Industrial Fermentations**	**15**
➢	Introduction and criteria for the transfer of inoculum	
➢	The development of inoculum for yeast processes: • Brewing • Bakers' yeast	
➢	The development of Inoculum for bacterial processes.	
➢	The development of Inoculum for mycelial processes: • Sporulation on solidified media • Sporulation on solid media • Sporulation in submerged culture • The use of the spore inoculum. • Inoculum development for vegetative fungi.	
➢	The effect of inoculum on the morphology of filamentous organisms in submerged culture.	

➢	The aseptic inoculation of fermenters: • Inoculation from a laboratory fermenter or a spore suspension vessel. • Inoculation from a fermenter.	

Suggested Reading

1. Stanbury, P. F., Whitaker, A., Hall, S. J, (1997), Principles of fermentation Technology, Aditya Book Pvt. Ltd., New Delhi.
2. Demanin Arnold L. and Davies Julian E., (1999) Manual of Industrial Microbiology and Biotechnology, 2nd ed. Panima, ASM Press.
3. Bu'lock, J. and Kristiansen, B, (1987), Basic Biotechnology, Academic Press, London.
4. Rehm, Ii J. and Reed, G, (1983), Biotechnology vol.111, Verlag Chenue, Florida.
5. Casida, L. E., (1991), Industrial Microbiology, Wiley Eastern, New Delhi.
6. Peppler, H. J., Perlman, D., (1979), Microbial Technology, vol. I & II, Academic Press.
7. Prescott, S. C. And Dunn, C. G, (1987), Industrial Microbiology, 3rd Ed., McGraw Hill, New York.
8. Ratledge, C. and Kristiansen, B., (2001), Basic Biotechnology, Cambridge University Press.
9. Patel, A. H., (1984), Industrial Microbiology, MacMillan India Ltd., New Delhi.
10. Doelle, H. W., Mitchell, D. V. and Rolz, C E., (1992), Solid Substrate Cultivation, Elsevier Science Publishers Ltd.. England.
11. Crueger W and Crueger A., (2000) Biotechnology: A textbook of Industrial Microbiology, 2nd ed. Panima Publishing corporation, New Delhi.
12. Jogdand S. N. (2006) Industrial Biotechnology, Himalaya Publishing House, Mumbai.

Discipline Specific Core (DSC) Course		
MB 503- Metabolism		
Total Hours:45		**Credits:3**

Course Objectives

- To acquaint with the principles of Bioenergetics.
- To understand the concept of thermodynamics and Electron Transport Chain.
- To define the types of anabolic and catabolic pathways and the mechanisms involved therein.

Learning Outcomes

After successful completion of this course, students are expected to:

- Get well versed with the catabolic and anabolic pathways.
- Understand the concept of ETC and principles of thermodynamics.
- Apply the principles of metabolism in various bacteria.

Unit	Topics	Lectures
UNIT-1	**Bioenergetics and Biological oxidation**	**15**
➢	Laws of thermodynamics	
➢	Concept of free energy, entropy and enthalpy	
➢	High energy compounds	
➢	ATP-ADP Cycle	
➢	Redox potential	
➢	Electron transport chain (ETC)	
➢	Inhibitors of electron transport chain	
➢	Oxidative Phosphorylation: Concept and Mechanism	
➢	Inhibitors and Uncouplers of oxidative phosphorylation	
➢	Mitochondrial ATP synthase complex	
➢	Shuttle pathways (Malate aspartate and Glycerol phosphate shuttles)	
➢	Reverse electron transport chain (RETC)	
UNIT 2	**Anabolic pathways**	**15**
➢	Gluconeogenesis	
➢	Cori cycle	
➢	Polysaccharides: Glycogen and Peptidoglycan biosynthesis	
➢	Fatty acid biosynthesis	
➢	FAS Complex: Structure and Significance	
➢	Ketone bodies: Concept and Synthesis	
➢	Purine and Pyrimidine nucleotide biosynthesis (de Novo and Salvage pathway)	
UNIT 3	**Catabolic Pathways**	**15**
➢	Transamination	
➢	Concept of anaplerosis	
➢	HMP Shunt	

➢	Uronic acid Pathway	
➢	Catabolism of Polysaccharides: Starch and glycogen	
➢	Fatty acid oxidation	
➢	PDH Complex: Reactions and Regulation	
➢	Overview of catabolism of proteins	
➢	Deamination (Oxidative and Non-oxidative)	
➢	Urea cycle	

Suggested Reading:

1. Nelson, D. L., and Cox, M. M. (2009), Lehninger's Principles of Biochemistry. New York: WH Freeman.
2. Moat, A., and Foster, J., (1988), Microbial Physiology. Wiley Interscience Publications, New York.
3. Stamen R. Y., Ingraham, J. L., Wheelis, M. L., and Painter, P. R., (1990), General Microbiology, MacMillan Edu. Ltd., London.
4. Berg, J. M., Tymoczko, J. L., and Stryer, L. (2008), Biochemistry (Loose-Leaf). Macmillan.
5. Satyanarayana U., and Chakrapani U., (2006), Biochemistry, Books and Allied (P) Ltd. Kolkata.
6. Zubay, G. L., Parson, W. W., and Vance, D. E. (1995), Principles of Biochemistry. WCB Publishers, Oxford, England.

Discipline Specific Core (DSC) Course		
MB 504 - Basic Immunology		
Total Hours:45		**Credits:3**
Course Objectives • To study the concepts related to antigen and antibody. • To study the various immune cells and organs functional in a body. • To get knowledge about MHC and Antigen Presentation.		
Learning Outcomes After successful completion of this course, students are expected to: • Get acquainted with Antigenicity and Immunogenicity. • Know the role of immune cells and organs and the functional mechanisms of each. • Understand the structure and role of MHC and APC.		
Unit	**Topics**	**Lectures**
UNIT-1	**History of Immunology**	**20**
➢	Historical developments in the field of immunology	
➢	Contributions of: Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa	
➢	Antigen and Antibodies.	
➢	Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity)	
➢	Antigenicity versus Immunogenicity	
➢	Haptens, Epitopes (T & B cell epitopes)	
➢	T-dependent and T-independent antigens	
➢	Adjuvants, Carriers, Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic)	
➢	Genetic basis of antibody formation (organization of heavy and light chain genes) VDJ rearrangements	
➢	Theories of antibody formation (Burnet's clonal selection theory)	
➢	Monoclonal and Chimeric antibodies	
UNIT-2	**Immune Cells and Organs**	**10**
➢	Hematopoesis: Concept of Stem cells.	
➢	Structure, functions and properties of: T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell& dendritic cell	
➢	Organs of immune system: Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT and CALT	
UNIT-3	**Major Histocompatibility Complex and antigen presentation**	**15**
➢	Definition of MHC	
➢	Organization of MHC locus (Mice & Human)	
➢	Structure and Functions of MHC Class I & II molecules	

➢	Antigen processing and presentation: need and significance	
➢	Antigen presentation pathways (Cytosolic and Endocytic pathways) & Cross presentation	

Suggested Reading:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Ananthnarayan, P., Paniker, C. K. J., (1990). Textbook of Microbiology, Orient Longma n, Madras.
3. Banker, D (1980), Modern Practice in Immunization, 3rd Ed., Popular Prakashan Pvt. Ltd., Bombay.
4. Coleman, R. M, Lombard M F, Sicard, R. E., (1989). Fundamental Immunology, 2nd E d., W. C. Brown Publishers, USA.
5. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11^{th} Edn Wiley-Blackwell Scientific Publication, Oxford.
6. Glazier, A. M., Nikaido, H., (1995), Microbial Biotechnology, W. H. Freeman and Co., New York.
7. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6^{th}* edition W.H. Freeman and Company, New York.
8. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
9. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
10. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Skill Enhancement Course (SEC)		
MB 505- Medical Microbiology-I		
Total Hours:45		**Credits:3**
Course Objectives • To introduce the concepts in Medical Microbiology. • To enrich knowledge about various diseases with respect to diagnosis, prevention, control and role of chemotherapy. • To understand the human anatomy with functions.		
Learning Outcomes After successful completion of this course, students are expected to: ➢ Get a clear vision about various aspects of infectious diseases. ➢ Understand the principles of immunological phenomena associated with the infectious diseases. ➢ Carry out fundamental or applied research in the field of Medical Microbiology.		
Unit	**Topics**	**Lectures**
UNIT-1	**Basic concepts in Medical Microbiology**	**15**
➢	Commensal and Pathogenic Human Microflora and microbiome - normal microflora of the human body, dual nature of normal flora with respect to disease, normal flora of major human body systems (respiratory tract, gastrointestinal tract, genitourinary system, skin) and Concept of human microbiome	
➢	Classification of disease – infectious, communicable, contagious, nosocomial, iatrogenic& zoonotic diseases	
➢	Chain of infection -Portal of entry and exit of pathogen	
➢	Stages of infectious diseases and virulence factors	
➢	Transmission of disease – Modes of transmission	
➢	Collection of clinical samples and Laboratory diagnosis: precautions required for sample collection (oral cavity, throat, skin, blood, urine, faeces)	
➢	Prophylaxis of disease	
➢	Treatment, Prevention and Control of disease	
➢	Epidemiology of disease	
➢	General concept and applications of public health microbiology.	
UNIT-2	**Anatomy and functions of Human System**	**15**
➢	Respiratory System	
➢	Gastrointestinal System	
➢	Excretion system	
➢	Central Nervous System – CNS and PNS	
➢	Reproductive system	
➢	Special Senses - Eye and ear (in brief)	
➢	Skin	

UNIT-3	**Chemotherapeutic agents- General characteristics and mode of action**	**15**
➢	Classes of antimicrobial agents, spectrum of activity and Criteria for evaluation of chemotherapeutic agents.	
➢	Antibacterial agents: Five modes of action with one example each: • Inhibitor of nucleic acid synthesis: Quinolones. • Inhibitor of cell wall synthesis: β-lactams (Penicillin) and polypeptides (Bacitracin). • Inhibitor of cell membrane function: Polymyxins. • Inhibitor of protein synthesis: Tetracyclines, Chloramphenicol. • Inhibitor of metabolism: Sulfonamides.	
➢	Antifungal agents: inhibition of plasma membrane- Amphotericin B, Griseofulvin.	
➢	Antiviral agents: inhibition of viral replication – Amantadine	
➢	Antiprotozoal drug - hydroxychloroquine	
➢	Antitoxin and Interferon as therapeutic drugs	
➢	Antibiotic resistance and its mechanism of resistance- MDR, XDR, MRSA & NDM-1.	

Suggested Reading:

1. Ananthnarayan, P., Paniker, C. K. J., (2009), Textbook of Microbiology 8^{th} Edn, Universities Press, Hyderabad.
2. Atlas, R. M. (1995), Microorganisms in our world, Mosby Yearbook Inc.
3. Chakraborty P (2013), A textbook of Microbiology, New Central Book Agency, Delhi.
4. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S., (1990), Microbiology, 4^{th} Ed., Harper and Row Publishers, Singapore.
5. Dey, N. C. and Dey, T. K., (1999) Medical Bacteriology and Microbiology, 16^{th} Edn, Allied Agency, Calcutta.
6. Prescott, L. M., Hartley, J. P. and Klein, D. A., (1993), Microbiology, 2nd Ed., W. M. C. Brown Publ, England.
7. Tortora, G. J., Funke, B. R. and Case, C. L., (2004), Microbiology, 8^{th} Edn., Person Education (Low Price edition), Delhi.
8. Nagoba BS and Pichare Asha (2012), Medical Microbiology: Prep Manual for Under Graduates, Elsevier.

Web sites

- http://www.who.ch.- World Health Organization
- http://www.ncbi.nlm.nih.gov/PubMed- PubMed -Medline on the Web.
- http://www.cdc.gov- US Centers for Disease Control (Atlanta)
- http://www.who.int/emc/-WHO Communicable Disease Surveillance and Response

<table>
<tr><td colspan="3" align="center">Discipline Specific Elective (DSE) Course</td></tr>
<tr><td colspan="3" align="center">MB 506 (A) - Food Microbiology</td></tr>
<tr><td>Total Hours:45</td><td></td><td>Credits:3</td></tr>
<tr><td colspan="3">Course Objectives
To understand concepts in milk microbiology.
To complement the students with the basic knowledge of food microbiology.
To acquaint the students with food preservation techniques.</td></tr>
<tr><td colspan="3">Learning Outcomes
After successful completion of this course, students are expected to:
Know the concepts related to popular milk products, milk examination and spoilage.
Comprehend knowledge regarding fermented food products, food spoilage and infection.
Understand diverse strategies for food preservation.</td></tr>
<tr><td>Unit</td><td>Topics</td><td>Lectures</td></tr>
<tr><td>UNIT-1</td><td>Food and Milk Microbiology</td><td>15</td></tr>
<tr><td>➢</td><td>Milk - Definition, composition and types.</td><td></td></tr>
<tr><td>➢</td><td>Microbiological examination of food and milk:
Standard plate count, Breed count, Test for mastitis, MBRT test Resazurin test & Brucella ring test.</td><td></td></tr>
<tr><td>➢</td><td>Milk products:
Fermented milk: Advantage
Examples: Dahi / Yoghurt, buttermilk</td><td></td></tr>
<tr><td>➢</td><td>Cheese: Types, general production process, microbiological changes during ripening, defects and spoilage.</td><td></td></tr>
<tr><td>➢</td><td>Microbial quality of milk
Milk microorganisms: acid/ gas producers, proteolytic, lipolytic, pathogenic etc.
Defects: Colour and Flavour, Sweet curdling, Stormy fermentation& Ropiness.</td><td></td></tr>
<tr><td>UNIT-2</td><td>Fermented products and food spoilage</td><td>15</td></tr>
<tr><td>➢</td><td>Fermented foods: Bread and Idli.</td><td></td></tr>
<tr><td>➢</td><td>Food infection: sources, mechanism of infection and prevention.</td><td></td></tr>
<tr><td>➢</td><td>Microbial food poisoning with respect to toxins, their effects, properties of toxins and treatment:
Staphylococcus aureus, Bacillus cereus, Clostridium botulinum Salmonella and Vibrio parahaemolyticus.</td><td></td></tr>
<tr><td>➢</td><td>Aflatoxins: Structure, detection, mode of action and detoxification.</td><td></td></tr>
<tr><td>➢</td><td>Fermented vegetables: Sauerkraut and Soy Sauce</td><td></td></tr>
<tr><td>➢</td><td>Concept of prebiotics and probiotics and their significance.</td><td></td></tr>
<tr><td>UNIT 3</td><td>Food Preservation Techniques</td><td>15</td></tr>
<tr><td>➢</td><td>Factors influencing on food preservation.</td><td></td></tr>
<tr><td>➢</td><td>Temperature dependent control:</td><td></td></tr>
</table>

	• Low temperature: Chilling and freezing • High temperature • Pasteurization: Principle and Types	
➢	Chemical preservatives: Sulphur dioxide, Nitrites and nitrates& Organic acids (Acetic and Lactic acids)	
➢	Antibiotics (Natamycin)	
➢	Canning: Concept and Method.	
➢	Control of Water activity: Dehydration	
➢	Use of radiations: Microwave, UV and Ionizing.	

Suggested Reading:

1. Adams, M. R., Moss, M. O, (1995), Food Microbiology, New Age International, New Delhi.
2. Singh B. D. (2014), Biotechnology: exploring horizons, Kalyani publishers, Ludhiana.
3. Banwart, G. J., (1987), Basic Food Microbiology, CBS Publ., New Delhi.
4. Bilgrami, K. S, Dube, H. G., (1994), Textbook of Modern Plant pathology, Vikas Publ., New Delhi.
5. Frazier, W. C, Westhoff, D C., (1988), Food Microbiology, Tata McGraw Hill, New Delhi.
6. James M. Jay, Martin J. Loessner, David A. (2012), Modern Food Microbiology, 7th Edition(Food Science Texts Series).
7. Winton, A. L, Winton, K. B, (1998), Milk and Milk Products, Agro-botanical Publ, Bikaner.
8. Ray B (2005), Fundamental Food Microbiology, CRC press, London.

<table>
<tr><td colspan="3">Discipline Specific Elective (DSE) Course</td></tr>
<tr><td colspan="3">MB 506 (B)- Pharmaceutical Quality Control & Quality Assurance</td></tr>
<tr><td>Total Hours:45</td><td></td><td>Credits:3</td></tr>
<tr><td colspan="3">Course Objectives
• To develop practical skills involved in interpretation of biological materials and data.
• To promote development of entrepreneurship and build up Professionals in Pharmaceutical Analysis, teaching and R&D work.
• Develop a scientific attitude to make students open minded, critical and curious about scope, functioning and the future of pharmaceutical Microbiology.</td></tr>
<tr><td colspan="3">Learning Outcomes
After successful completion of this course, students are expected to:
• Understand microbial spoilage and preservation of pharmaceutical formulations during production and in products.
• Get hands-on knowledge of various methods / processes required in pharmaceutical quality control and assurance.
• Acquire knowledge of GMP practice, CGMP, FDA, GLP and Pharmacopeia.</td></tr>
<tr><td>Unit</td><td>Topics</td><td>Lectures</td></tr>
<tr><td>UNIT-1</td><td>Microbial production and Spoilage of pharmaceutical products</td><td>15</td></tr>
<tr><td>➢</td><td>Designing of Microbiology laboratory – Guidelines, Layout
Design and layout of sterile product manufacturing unit.</td><td></td></tr>
<tr><td>➢</td><td>Microbial contamination and spoilage of pharmaceutical products (sterile injectables, non-injectables, ophthalmic preparations and implants) and their sterilization.</td><td></td></tr>
<tr><td>➢</td><td>Other pharmaceuticals produced by microbial fermentations
Biopharmaceuticals viz. streptokinase& streptodornase.</td><td></td></tr>
<tr><td>UNIT-2</td><td>Quality control of pharmaceuticals</td><td>15</td></tr>
<tr><td>➢</td><td>Importance and functions of quality control.</td><td></td></tr>
<tr><td>➢</td><td>Methods for quality assessment, Sterilization control and sterility testing:
• Heat sterilization
• D value, Z value
• Survival curve
• Radiation
• Gaseous sterilization
• Filter Sterilization
• Ames test
• Sterility test
• Toxicity test</td><td></td></tr>
<tr><td>UNIT 3</td><td>GMP, GLP and Quality Assurance</td><td>15</td></tr>
<tr><td>➢</td><td>Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry.</td><td></td></tr>
<tr><td>➢</td><td>Regulatory aspects of Quality control, Quality assurance and Quality.</td><td></td></tr>
</table>

	Management in Pharmaceuticals.	
➢	A comparison of Quality Control and Quality Assurance.	
➢	Sampling and specification of raw materials and finished Products.	
➢	Validation: Sterile manufacturing unit and Biosafety levels.	
➢	Validation and calibration of Laminar Air Flow, Autoclave, Balance, pH meter and Centrifuge.	
➢	Chemical and biological indicators.	

Suggested Reading:

1. Hugo W. B. & Russell A. D. (2009), Pharmaceutical Microbiology –6th Edn. Blackwell scientific Publications.
2. Analytical Microbiology–Edt by Frederick Kavanagh Volume I & II. (1972), Academic Press New York.
3. Quinolone antimicrobial agents – Edt. Hooper, David C; Rubinstein, Ethan (2003), ASM Press, 3rd edition
4. Quality control in the Pharmaceutical Industry - Murray S. Cooper Vol.2. (1979), Academic Press Washington DC. New York.
5. Biotechnology – Edt. By H. J. Rehm & G. Reed, Vol 4 (1983), VCH Publications, Federal Republic of Germany.
6. Vyas S. P. & Dixit V.K. (2010), Pharmaceutical Biotechnology by CBS Publishers, New Delhi.
7. Willig Sydney H., Tuckerman Murray M., Hitchings IV William S. (1982), Good Manufacturing Practices for Pharmaceuticals II Edition, Mercel Dekker NC New York.
8. Handbook of Pharmaceutical Analysis Edt. Lena Ohannesian and Antony J. Streeter (2002), Marcel Dekker, Inc. New York

Discipline Specific Core (DSC) Practical Course		
MB 507 - Methods in Medical Microbiology – I		
Total hours: 60		**Credits: 2**

Course Objectives:

- To acquaint with microbial isolation techniques from various clinical samples.
- Gain knowledge about diagnostic tests for diseases.
- To train to determine potency of antibiotics using various standard methods.

Learning outcomes

After successful completion of this course, students are expected to:

- Achieve skill in pure culture techniques.
- Learn principles underlying diagnostic tests and handle kits for diagnosis of diseases.
- Know various stages involved in malarial and diarrhoeal infections.

Sr. No	Topic	Lectures/ Hours
1.	Isolation and identification of *Proteus* sp. from urine sample.	04
2.	Isolation and identification of *E. coli* from stool sample.	04
3.	Isolation and identification of *Salmonella* from blood sample.	04
4.	Preparation of O and H antigen of *Salmonella.*	04
5.	Widal Test.	04
6.	Determination of Minimum Inhibitory Concentration (MIC) of an antibiotic.	04
7.	Antimicrobial Sensitivity Test: Stoke’s method.	04
8.	Antimicrobial Sensitivity Test: Kirby-Bauer method.	04
9.	Detection of Malarial parasite by a suitable test.	04
10.	Determine the influence of various sugar/nitrogen concentrations on growth of bacteria.	04
11.	Study of various stages of malarial parasite in RBCs using permanent slides.	04
12.	Demonstration of Universal Precautions for handling blood and other body fluids.	04

Suggested Reading:

1. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
2. Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
3. Mackie TJ and McCartney JE (1989), Practical Medical Microbiology, 13th Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchill Livingstone International Student Ed.
4. Parija Subhash Chandra (2008), Textbook of Microbiology, Ahuja Publishing House, New Delhi, ISBN: 81 89443-06-2
5. Willey JM, Sherwood LM, and Woolverton CJ. (2013), Prescott, Harley and Klein’s

Microbiology. 9th edition. McGraw Hill Higher Education
6. Deshmukh A.M. (1997), 1st Ed., Handbook of Media, Stains and reagents in Microbiology Pama Publications.
7. Reddy M. G., Reddy M. N., Saigopal D. V. R. And Mallaiah K. V. (2008), Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai

Discipline Specific Core (DSC) Practical Course		
MB-508: Methods in Industrial Microbiology-I		
Total hours: 60		**Credits: 02**

Course Objectives

- To acquaint the learner with various fermentation processes.
- To apply the concept of these processes for commercially valuable products.
- To correlate this knowledge with the industrial fermentation process.

Learning Outcomes

After successful completion of this course students are expected to:

- Understand the operations in fermentation processes
- Inculcate the salient features of quality management and regulatory processes.
- Use computer for data generation and maintenance.

Sr.No.	Topic	Lectures/ Hours
1.	Production and estimation of alcoholic beverages from fruit juice.	04
2.	Screening and Isolation of lipase producing organisms from soil/compost.	04
3.	Sterility testing of injectables by membrane filter technique	04
4.	Isolation of probiotics/ lactic acid bacteria.	04
5.	Determine Thermal Death Time (TDT) of given bacteria.	04
6.	Determine Thermal Death Point (TDP) of given bacteria.	04
7.	Separation and identification of amino acid/ sugar by Thin Layer Chromatography/paper chromatography.	04
8.	Measurement of fungal growth by biomass (mycelia dry weight) method.	04
9.	Total fungal spore count using Neubauer's chamber.	04
10.	Design and use of typical fermentation medium using raw material-Molasses / agro waste.	04
11.	Bio-burden estimation of pharmaceutical finished product.	04
12.	Presentation of data in an appropriate form (graphs/ tables using MS Excel).	04

Suggested Reading:

1. Aneja, K. R. (1996), Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 2nd Ed., Wishwa Prakashan, New Delhi (New Age International, Pvt. Ltd.).
2. Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S. Chand and Co. Delhi.
3. Gunashekharan P, Introduction to Microbial Techniques
4. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
5. Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.

6. Mackie TJ and McCartney JE (1989), Practical Medical Microbiology, 13rd Edn Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchy Livingstone International Student Ed.
7. Parija S. C., (2007), Textbook of Practical Microbiology, Ahuja Publishing House New Delhi.
8. Plummer, D. T. (1992), An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
9. Sharma Kanika, Manual of Microbiology Tools and techniques, 2nd Ed. (2007), Ane's Book India, New Delhi

Discipline Specific Core (DSC) Practical Course		
MB-509: Methods in Applied Microbiology-I		
Total hours: 60		**Credits: 02**

Course Objectives

- To learn the isolation of agriculturally important microorganisms causing food poisoning & microbes responsible for food fermentation.
- To understand the principle and methods of microbiological examination of milk and sewage.
- To acquaint the students with the concept of BOD and nanoparticles.

Learning Outcomes

After completion of this course, students will be able to:

- Isolate and identify agriculturally important microbes like *Azotobacter* and cellulolytic microbes.
- Detect food poisoning causing microbes and perform the tests to determine quality control of dairy product (milk).
- Synthesize nanoparticles by biological method/s and characterize them using UV-Visible Spectrophotometry.

S.N.	Topic	Lectures/Hours
1.	Isolation and identification of *Azotobacter* from rhizosphere sample.	04
2.	Isolation of cellulose degrading bacteria from decaying wood sample.	04
3.	Isolation of lignin degrading bacteria.	04
4.	Isolation of bacteriophage from sewage (Plaque assay).	04
5.	Determination of Dissolved oxygen and Biological Oxygen Demand (BOD) of sewage water effluent.	04
6.	Isolation and identification of food poisoning causing *S. aureus/ Bacillus cereus/ Clostridium botulinum* from spoiled food sample.	04
7.	Study of stormy fermentation.	04
8.	Analysis of milk sample by MBRT test	04
9.	Analysis of milk sample by Resazurin test.	04
10.	Isolation and characterization of food fermenting microorganisms from idli batter/Curd.	04
11.	Demonstration of mushroom cultivation.	04
12.	Synthesis of silver nanoparticles by using Fungi / BGA / Bacteria and determination of $\lambda_{max.}$	04

Suggested Reading:

1. Aneja, K. R. (1996), Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 2nd Ed., Wishwa Prakashan, New Delhi (New Age International, Pvt. Ltd.).
2. Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S. Chand and Co. Delhi.

3. Gunasekaran P, Introduction to Microbial Techniques
4. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
5. Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
6. Mackie TJ and McCartney JE (1989), Practical Medical Microbiology, 13rd Edn Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchy Livingstone International Student Ed.
7. Parija S. C., (2007), Textbook of Practical Microbiology, Ahuja Publishing House New Delhi.
8. Plummer, D. T. (1992), An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi. Sharma Kanika, Manual of Microbiology Tools and techniques, 2nd Ed. (2007), Ane's Book India, New Delhi

T.Y.B.Sc. (CBCS) Syllabus Semester - VI

Discipline Specific Core (DSC) Course		
MB 601- Molecular Biology		
Total Hours:45		**Credits:3**

Course Objectives

- To get acquainted with the molecular regulatory mechanisms in bacteria.
- To understand the principles underlying techniques used in molecular Biology.
- To study the principle and applications of recombinant DNA technology.

Learning Outcomes

After successful completion of this course, students are expected to:

- Get well versed with the regulatory mechanisms of Lactose and Tryptophan operon.
- Understand the principles and applications of advanced molecular techniques.
- Know the methodology involved in engineering of genes and its practical applications.

Unit	Topics	Lectures
UNIT-1	**Gene Regulation**	**15**
	Diauxic Growth Phenomenon	
	Modes of Regulation	
	Mechanism of Regulation: Induction and Repression	
	Concept of Operon	
	Lactose Operon: Positive and Negative Regulation	
	Lac Mutants	
	Tryptophan Operon: Repressible System& Attenuation	
UNIT -2	**Techniques in Molecular Biology**	**15**
	Principle and Applications of:	
➢	• Blotting techniques: Dot and Slot blotting, Southern, Northern & Western Blotting.	
	• Autoradiography	
	• Gene Sequencing: Sanger's method, Maxam-Gilbert method, Ribotyping, Automated DNA sequencing & Shotgun Sequencing	
	• DNA Fingerprinting	
	• Polymerase Chain Reaction (PCR)	
➢	Construction of Genome Library& c-DNA Library	
➢	Gene Mapping: Co-transformation & Interrupted Mating Experiment.	
UNIT-3	**r-DNA Technology**	**15**
➢	Restriction Enzymes: Type I, II, III; Role of Type II Enzymes in genetic engineering	
➢	DNA Polymerases, Terminal deoxynucleotidyl transferases, Kinases, Phosphatases & DNA Ligase	
➢	Cloning Vectors: Definition and Properties	

	• Plasmid Vectors: pBR322, pUC • Lambda Vector • Cosmids, BACs & YACs	
➢	Use of Linkers and Adaptors	
➢	Generation of recombinant DNA molecule: • Cutting and joining the DNA molecules • Methods to transfer recombinant DNA into host cells • Methods of screening the cells containing the recombinant DNA • Identification of clones using probes	
➢	Applications of r-DNA technology in • Health and Medicine: Production of insulin, interferon & Hepatitis vaccine • Agriculture: Herbicide Resistant crops & Bt cotton. • Environment: Bioremediation of pollutants.	

Suggested Reading:

1. Bruce A. (2008), Molecular Biology of the Cell, 5th Edition. Publisher: Garland Science, New York.
2. Gunther S. Stent, (1978), Molecular Genetics: An Introductory Narrative, 2nd Edn. W.H. Freeman & Co.
3. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, (2013), Molecular Biology of the Gene, 7th Edn. Pearson Publishers.
4. Jeremy Dale and Malcom von Schantz (2002) From Genes to Genomes, John Wiley and Sons Ltd.
5. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, (2012) Lewin's GENES XI, 11th Edition. Jones & Bartlett Learning.
6. Lodish H. et al. (2012), Molecular Cell Biology, 7th Edn W. H. Freeman & Company. New York.
7. Streips Uldis N.and Yashbin Ronald E. (2002), Modern Microbial Genetics, 2nd Edition, Wiley-Liss, Inc.
8. Watson *et al.*, (2004), Molecular Biology of Genes, International Edition, Benjamin Cummings Publishers.
9. Jeremy W. Dale and Simon F. Park (2004), Molecular Genetics of Bacteria, 4th Edition, John Wiley and Sons, Ltd.

Websites

- https://www2.le.ac.uk/projects/vgec/highereducation/topics/recombinanttechniques
- https://www.mybiosource.com/learn/recombinant-DNA-Technology/
- http://www2.csudh.edu/nsturm/CHEMXL153/RegulationofGeneExpression.htmhttp://www2.csudh.edu/nsturm/CHEMXL153/RegulationofGeneExpression.htm

Discipline Specific Core (DSC) Course		
MB 602- Fermentations		
Total Hours:45		**Credits:3**

Course Objectives

- To introduce fermentation processes and their types.
- To provide knowledge about the chronological development in fermentation.
- To acquire knowledge about large scale production of commercially valuable products.

Learning Outcomes

After successful completion of this course, students are expected to:

- Understand fermentation processes involved in the production of various products.
- Get acquainted with the needs of a fermentation industry.
- Know about the large-scale production of various valuable products.

Unit	Topics	Lectures
UNIT-1	**An Introduction to Fermentation Process**	**15**
➢	History and Introduction to fermentation process.	
➢	Overview few fermentation processes and products: • Microbial cells (biomass) • Microbial enzymes • Microbial metabolites • Recombinant products	
➢	The chronological development in the fermentation industry	
➢	The component parts of fermenter and fermentation parameters (Typical fermentation process)	
UNIT-2	**Large-Scale Production of the following with respect to organisms involved, inoculums preparation, fermentation media, fermentation process, flow chart andrecovery**	**15**
➢	Antibiotics: Streptomycin and Penicillin	
➢	Amino acids: L- Lysine and L- Glutamic acid	
➢	Enzyme: Amylase	
➢	Vitamin: Cyanocobalamin	
➢	Production of vaccine & Immune sera.	
UNIT-3	**Large-Scale Production of the following with respect to organisms involved, inoculums preparation, fermentation media, fermentation process, flow chart and recovery**	**15**
➢	Organic acids: Citric acid, Vinegar and Lactic acid	
➢	Organic solvent: Ethanol	
➢	Beverage: Beer & Wine	

Suggested Reading:

1. Bu'lock, J. and Kristiansen, B, (1987), Basic Biotechnology, Academic Press, London.
2. Casida, L. E., (1991), Industrial Microbiology, Wiley Eastern, New Delhi.
3. Crueger W and Crueger A., (2000), Biotechnology: A textbook of Industrial microbiology, 2nd ed. Panima Publishing Corporation, New Delhi.
4. Demanin Arnold L. and Davies Julian E., (1999), Manual of Industrial Microbiology and

Biotechnology, 2nd ed. Panima, ASM Press.
5. Doelle, H. W., Mitchell, D. V. and Rolz, C E., (1992), Solid Substrate Cultivation, Elsevier Science Publishers Ltd.. England.
6. Jogdand S. N. (2006), Industrial Biotechnology, Himalaya Publishing House, Mumbai
7. Patel, A. H., (1984), Industrial Microbiology, MacMillan India Ltd., New Delhi.
8. Peppler, H. J., Perlman, D., (1979), Microbial Technology, vol. I & II, Academic Press.
9. Prescott, S. C. And Dunn, C. G, (1987), Industrial Microbiology, 3rd Ed., McGraw Hill, New York.
10. Ratledge, C. and Kristiansen, B., (2001), Basic Biotechnology, Cambridge University Press.
11. Rehm, Ii J. and Reed, G, (1983), Biotechnology vol.111, Verlag Chenue, Florida.
12. Stanbury, P. F., Whitaker, A., Hall, S. J, (1997), Principles of fermentation Technology, Aditya Book Pvt. Ltd., New Delhi.
13. Vyas, S. P. and Dixit, V. K., (1998), Pharmaceutical Biotechnology, CBS Publisher, New Delhi.

Discipline Specific Core (DSC) Course		
MB 603- Enzymology		
Total Hours:45		**Credits:3**
Course Objectives • To understand regulation of enzyme action. • To get acquainted with enzyme technology. • To get knowledge about techniques involved in enzyme purification**.**		
Learning Outcomes After successful completion of this course, students are expected to: • Know the role of coenzymes in enzyme action. • Understand the regulation of enzymatic reactions pertaining to allosteric proteins and covalent modification. • Acquire knowledge about purification of enzymes by various methods, immobilization of enzymes and enzyme engineering techniques.		
Unit	**Topics**	**Lectures**
UNIT-1	**Enzymes and Cofactors**	**15**
➢	Role of Cofactors in metabolism	
➢	Occurrence, Structure and Biochemical functions of the following: • Nicotinic acid: NAD and NADP • Riboflavin: FMN and FAD • Thiamine: TPP • Pantothenic acid: Coenzyme A • Biotin: Biocytin • Folic acid: THF • Pyridoxine: Pyridoxal Phosphate	
UNIT -2	**Enzyme Regulation**	**15**
➢	Allosteric enzyme: Concept, Properties, Positive and Negative Cooperativity, Example-ATCase	
➢	Isoenzyme: Concept and example -LDH	
➢	Enzyme Inhibition: • Reversible Inhibition: Competitive. Uncompetitive, Non-competitive with examples • Irreversible Inhibition	
➢	Covalent modification: Glycogen Phosphorylase	
➢	Proteolytic modification of Zymogens	
UNIT-3	**Enzyme Technology**	**15**
➢	Methods of Enzyme Purification based on various properties:	
➢	Molecular size: Molecular Exclusion Chromatography	
➢	Solubility: Isoelectric Precipitation& Salt precipitation	
➢	Electric Charge: SDS-PAGE electrophoresis	

➢	Adsorption: Affinity chromatography	
➢	Enzyme assay: Spectrophotometric Assay	
➢	Immobilization of Enzyme: Concept, Methods and Applications	
➢	Enzyme Engineering: Objectives, Principle, Methodology & Applications	

Suggested Reading:

1. Lehninger, A I., (1982), Principles of Biochemistry, Butterworth Publishers, New York.
2. Microbiology, 5th Ed., MacMillan Edu. Ltd., London
3. Moat, A., Foster, J., (1988), Microbial Physiology, 2nd Ed., Wiley Interscience Publications, New York.
4. Palmer T., (1985). Understanding Enzymes. 2nd Ed., Ellis Horwood Ltd., Chichester. Price, N. C, Stevens, L, (1989), Fundamentals of Enzymology, 2nd Ed., Oxford Sci. Publ., Oxford.
5. Rose, A. H., (1983), Chemical Microbiology, 3rd Ed., Butterworth Publishers.
6. Satyanarayana U., (1999), Biochemistry, Books and Allied (P) Ltd. Calcutta
7. Stamen R. Y., Ingraham, J. L., Wheelis, M. L., Painter, P. R., (1990),
8. Stryer, L., (1988), Biochemistry, W H Freeman and Co., New York.
9. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers.

Discipline Specific Core (DSC) Course		
MB 604: Advanced Immunology		
Total Hours:45		**Credits:3**
Course Objectives • To understand various protective mechanisms underlying the human immune system, immunological disorders and tumours. • To study the principles underlying various immunological techniques. • To debate the immuno-prophylactic measures against various novel viral infections.		
Learning Outcomes After successful completion of this course, students are expected to: • Be well versed with protective immunity and tolerance in the body. • Gain knowledge about the serological tests and their applications. • Know the path that may help to overcome the challenges in the synthesis of novel vaccines.		
Unit	**Topics**	**Lectures**
UNIT-1	**Protective Mechanisms**	**15**
➢	• B-cell activation: Proliferation, Differentiation, Memory B cells& Plasma cells • T cells: Effector T cell activation, Differentiation& Memory T cells • Killing Mechanisms by CTL and NK cells • Introduction to tolerance • Interaction between immune cells • Role of lymphokines	
➢	Other protective mechanisms: • Inflammation • Complement: Classical and Alternative cascade • Biological consequences of complement Activation	
➢	Interferon: • Introduction, Mechanism and Significance • Tumor Necrosis Factor (TNF) • Phagocytosis	
UNIT -2	**Immunological Disorders and Tumour Immunity**	**10**
➢	Types of Autoimmunity	
➢	Hypersensitivity with examples	
➢	Immunodeficiencies - Animal models (Nude and SCID mice), SCID & DiGeorge syndrome	
➢	Types of tumors Tumor Antigens: TSTA & TATA	
➢	Causes and therapy for cancers (generalized)	
UNIT-3	**Immunological Techniques**	**10**
➢	Basics of antigen-antibody interaction: affinity, avidity & interaction forces	

➢	Principles of Precipitation, Agglutination, Immunodiffusion& precipitation curve	
➢	Immunoelectrophoresis	
➢	ELISA: Direct and Indirect& ELISPOT assay	
➢	Western blotting	
➢	Immunofluorescence	
➢	Flow cytometry	
UNIT-4	**Immunoprophylaxis**	**10**
➢	Vaccines: • Historical developments • Characteristics of ideal vaccine • Types of vaccines with one example	
➢	Vaccine development against emerging infectious agents: • SARS • HIV • Novel Corona virus (COVID-19)	
➢	Quality control of vaccines and sera	
➢	Immunization schedule in India	

Suggested Reading:

1. Abbas AK, Lichtman AH, Pillai S. (2007), Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Ananthnarayan, P., Paniker, C. K. J., (1990), Textbook of Micro-biology, Orient Longman, Madras.
3. Banker, D (1980), Modern Practice in Immunization, 3rd Ed., Popular Prakashan Pvt. Ltd., Bombay.
4. Coleman, R. M, Lombard M F, Sicard, R. E., (1989), Fundamental Immunology, 2nd Ed., W. C. Brown Publishers, USA.
5. Delves P, Martin S, Burton D, Roitt IM. (2006), Roitt's Essential Immunol.11thEd. Wiley-Blackwell Scientific Publication, Oxford.
6. Glazier, A. M., Nikaido, H., (1995), Microbial Biotechnology, W. H. Freeman and Co., New York.
7. Goldsby RA, Kindt TJ, Osborne BA. (2007), Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
8. Murphy K, Travers P, Walport M. (2008), Janeway's Immunobiology. 7th Ed., Garland Science Publishers, New York.
9. Peakman M, and Vergani D. (2009), Basic and Clinical Immunology. 2nd Ed., Churchill Livingstone Publishers, Edinberg.
10. Richard C and Geiffrey S. (2009), Immunology. 6th edition. Wiley Blackwell Publication

<table>
<tr><td colspan="3">Skilled Enhancement Course (SEC)</td></tr>
<tr><td colspan="3">MB 605-Medical Microbiology - II</td></tr>
<tr><td>Total Hours:45</td><td></td><td>Credits:3</td></tr>
<tr><td colspan="3">Course Objectives
• To create awareness about the infectious diseases.
• To create theoretical base for practical approaches.
• To study prognosis of bacterial, viral and other diseases.</td></tr>
<tr><td colspan="3">Learning Outcomes
After successful completion of this course, students are expected to:
• Become aware about the various types of diseases and their sources.
• Justify the variation between viral, bacterial and other diseases.
• Explain prognosis of diseases and understand the role of medical microbiology in public health.</td></tr>
<tr><td>Unit</td><td>Topics</td><td>Lectures</td></tr>
<tr><td>UNIT-1</td><td>Viral infections and diseases</td><td>15</td></tr>
<tr><td>➢</td><td>Study of diseases with respect to causative agent, infectious dose, portal of entry, pathogenicity, epidemiology, laboratory diagnosis, prophylaxis, treatment, prevention and control of the following:
• AIDS
• Picornavirus disease –Poliomyelitis
• Rhabdovirus disease – Rabies
• Hepadnavirus diseases –Hepatitis A, B and C
• Corona virus disease</td><td></td></tr>
<tr><td>UNIT -2</td><td>Bacterial Infections and diseases</td><td>15</td></tr>
<tr><td>➢</td><td>Study of diseases with respect to - causative agent, infectious dose, portal of entry, pathogenicity, epidemiology, laboratory diagnosis, prophylaxis, treatment prevention and control of the following:
• Respiratory disease: Tuberculosis
• Gastrointestinal diseases: Typhoid & Cholera
• Bacterial disease affecting the brain and nervous system: Tetanus
• Sexually transmitted bacterial disease: Syphilis</td><td></td></tr>
<tr><td>UNIT-3</td><td>Fungal and Protozoal diseases</td><td>15</td></tr>
<tr><td>➢</td><td>Study of diseases with respect to causative agent, portal of entry, pathogenicity, laboratory diagnosis, prophylaxis, treatment, prevention and control of the following:
Cutaneous mycoses: Dermatophytosis, Tinea Pedis (Athlete’s foot)
Systemic mycoses: Histoplasmosis
Opportunistic mycoses: Candidiasis</td><td></td></tr>
<tr><td>➢</td><td>Protozoal diseases: Malaria & Amoebic dysentery</td><td></td></tr>
<tr><td colspan="3"></td></tr>
</table>

Suggested Reading:

1. Ananthnarayan, P., Paniker, C. K. J., (2009), Ed 8th Textbook of Microbiology, Universities press, Hyderabad.
2. Atlas, R. M. (1995), Microorganisms in our world, Mosby Year Book Inc.
3. Chakraborty P (2013), A text book of Microbiology, New Central Book Agency, Delhi.
4. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S., (1990), Microbiology, 4th Ed., Harper and Row Publishers, Singapore.
5. Dey, N. C. and Dey, T. K., (1999), Medical Bacteriology and Microbiology, 16th Ed, Allied Agency, Calcutta.
6. Nagoba BS and Pichare Asha (2012), Medical Microbiology: Prep Manual for Under Graduates, Elsevier
7. Prescott, L. M., Hartley, J. P. and Klein, D. A., (1993), Microbiology, 2nd Ed., W. M. C. Brown Publishers, England.
8. Tortora, G. J., Funke, B. R. and Case, C. L., (2004), Microbiology, 8th Ed., Person Education (Low Price edition), Delhi.

Web sites

- http://www.who.ch.: World Health Organization
- http://www.ncbi.nlm.nih.gov/PubMed:PubMed -Medline on the Web.
- http://www.cdc.gov: US Centre for Disease Control (Atlanta)
- http://www.who.int/emc/ : WHO Communicable Disease Surveillance and Response

Discipline Specific Elective (DSE) Course		
MB 606 (A) - Agricultural Microbiology		
Total Hours:45		**Credits:3**

Course Objectives

- To understand concepts in plant pathology.
- To acquaint the students with basic knowledge of plant disease control.
- To complement the students with the concepts in Agricultural Microbiology.

Learning Outcomes

After successful completion of this course, students are expected to:

- Understand classification of plant pathology with regional plant diseases.
- Know the concepts related to methods of plant disease control.
- Comprehend knowledge regarding Agricultural Microbiology.

Unit	Topics	Lectures
UNIT-1	**Plant Microbe Interactions**	**15**
➢	Rhizosphere: concept, microorganisms, significance and Rhizosphere engineering	
➢	Classification of plant diseases based on symptoms, crop and parts affected	
➢	Terminology: Host, Alternate and Collateral host, Resistance, Susceptibility and Tolerance	
➢	Disease Triangle (Host, environment and pathogen), concept of Disease cycle	
➢	Study of plant diseases with respect to causative agent, host, symptoms and control: • Wilt of cotton • Citrus canker • Downy mildew of grapes • Whip smut of sugarcane • Tikka disease of groundnut • Banana Bunchy Top Viral disease (BBTV)	
UNIT -2	**Methods of plant disease control**	
➢	Mechanism: Exclusion, Eradication, Reduction of inoculum, Protection and Resistant varieties	
➢	Chemical control: fungicides, bactericides etc.	
➢	Biological control: microbial herbicides& insecticides	
➢	Cultural methods: Tillage, Deep ploughing and Spacing	
➢	Integrated pest management: Inspection, Identification, Threshold, Employment control and Evaluation	
➢	Modern approaches • Application of viral proteins in controlling plant viral diseases • Antisense RNA technology in plant disease control	

	• RNA interference (RNAi) in controlling plant pathogens • Mycoviruses for controlling fungal pathogens	
UNIT-3	**Agricultural and environmental microbiology**	**15**
➢	Transgenic plants: • Method: Gene construction, vector (Ti/Ri plasmid), mechanism& importance • Example: Development of insect resistant plants (Bt cotton), Biochemical production of Hirudin-A polypeptide& Phytase enzyme	
➢	Waste: source, types and management • Liquid waste: primary, secondary and tertiary treatments. • Solid waste: Composting: necessity, microbiology, methods, advantages and disadvantages	
➢	Biogas: feedstock, process (hydrolysis, acidogenesis, Methanogenesis), factors affecting biogas production	
➢	Bioremediation: importance, types, methods, example of xenobiotic degradation	

Suggested Reading:

1. Dubey R. C. and Maheshwari D. K. (2006), A textbook of microbiology, S Chand, New Delhi.
2. Das H. K. (2005), Textbook of biotechnology, Wiley Dream tech India Pvt. Ltd.
3. Kuderia, V. P., (1998), Water Pollution, Pragati Prakashan, Meerut.
4. Martin Alexander (1977), Introduction to Soil Microbiology, 2nd Ed., John Wiley & Sons.
5. Mitchell, R. (1974), Introduction to Environmental MicrobiologyPrentice Hall, New Je rsey.
6. Pathak, V. N, Khatri, N.K., Pathak, M., (1996), Fundamentals of Plant Pathology, Agro - botanical Publ., Bikaner.
7. Powar, C. B., Daginwalla, H. F., (1990), General MicrobiologyVol. I & II, Himalaya P ublishing House, Mumbai.
8. Rao, M. N. and Rao, H. V N, (1989), Air Pollution, Tata McGraw Hill Publ, Company, Ltd., New Delhi.
9. Salle, A. J., (1990), Fundamentals of Microbiology, Tata McGraw Hill, New Delhi.
10. Satyanarayana U. (2005), Biotechnology, Books and Allied (P) Ltd. Kolkata.
11. Thakur I S (2011), Environmental Biotechnology: Basic concepts and applications, IK International, New Delhi.

Discipline Specific Elective (DSE) Course

MB 606 (B)- Regulatory Practices and IPR

Total Hours:45		**Credits:3**

Course Objectives

- To promote development of entrepreneurship and know the importance and scope of the IPR in Microbiology.
- To get acquainted with regulatory practices undertaken at commercial level.
- Develop a scientific attitude to make students open minded, critical and curious about scope, functioning and the future of Commercial Microbiology.

Learning Outcomes

After successful completion of this course, students are expected to:

- Understand role of regulatory practices in Pharmaceutical Industry and become aware of the patents norms.
- Have knowledge pertaining to Intellectual Property Rights and their protection.
- Be endowed with the legislature to be followed during the generation of genetically modified plant and animals.

Unit	Topics	Lectures
UNIT-1	**Regulatory practices in pharmaceutical industry**	**15**
➢	General organization of pharmaceutical industry	
➢	Regulatory agencies: ISO, WHO and US certification. IP, BP and USP	
➢	Government regulatory practices and policies, role and functioning of FDA, legislative perspective	
UNIT-2	**Intellectual Property Rights and Protection**	**20**
➢	Concept of Patents	
➢	GATT and TRIP, Concept of Patents, Copyrights, Trademarks; Patenting – need for patents	
➢	Patenting of Biological materials, Regulatory issues and Challenges to food product	
➢	Patent process, protection of knowledge, knowledge consortia and databases	
➢	Plant Variety Protection Act	
➢	Procedure for patent application, International harmonization of patent laws	
➢	Patenting of life forms - plant, animals, microbes, gene, process and products	
➢	Plant Breeders Rights - International conventions on biological diversity	
UNIT 4	**Biosafety and Society**	**10**
➢	Transgenic plants, Commercial status and public acceptance	
➢	Bio-safety guidelines for research involving GMO’s	
➢	Benefits and risks, Socio-economic impact and ecological considerations of GMO’s	

➢	Gene flow	

Suggested Reading:

1. Anant Padmanabhan (2012), Intellectual Property Rights: Infringement and Remedies, LexisNexis-Butterworths.
2. Gasser, C.C. and Eraley, R.T. (1989), Genetically engineering plants for crops improvements Science 1293-1296.
3. Gupta P.K. (2003), Biotechnology and Genomics, Rastogi Publications Meerut.
4. Karmach, C.L. (eds) (1991), Biotechnology Regulations Handbook, Centre for energy and environmental management, Fanifac Stn. Vingnia. 68.
5. Kshitij Kumar Singh (2015), Biotechnology and IPR, DOI https://doi.org/10.1007/978-81-322-2059-6ISBN 978-81-322-2058-9.
6. Monney, H.A.and Bernandi, G (ed) 1993 Introduction of genetically modified organisms into the environment, Wiley, New York.
7. Stewant-tull, D.E.S. & Sussman, M (Eds.) (1994), The release of Genetically Modified Microorganisms, REGEM 2, Plenum Press, New York.
8. Bills, D. and Kind, Shain-Daw (Ed.) (1990), Biotechnology and Food safety Butterworth-Heinemann Boston, London.

   Sussman, M., Collmi, C.H., Shimnen, A.A. and Stewart-tull D.E. (1994).

Websites:

- https://ipr.icegate.gov.in/IPR
- https://www.wipo.int/about-ip/en/
- http://library.jgu.edu.in/content/intellectual-property-rights
- https://www.hilarispublisher.com/open-access/regulatory-practice-in-pharmaceutical-industry

Discipline Specific Core (DSC) Practical Course		
MB 607 - Methods Medical Microbiology – II		
Total Hours: 60		**Credits: 2**

Course Objective:

- To study pure culture techniques involved in the isolation of pathogens from clinical samples.
- To investigate the normal flora of skin and mouth.
- To handle diagnostic tests involved in detection of STDs.

Learning Outcomes

After successful completion of course, students are expected to:

- Perform pure culture techniques and apply them for pathogenic bacteria.
- Inculcate the technique involved in collection of mouth and skin samples using swabs for diagnostic purpose.

Perform diagnostic tests for Syphilis and AIDS.

Sr. No	Topic	Lectures/ Hours
1.	Isolation and identification of *Staphylococcus* from pus sample.	04
2.	Isolation and identification of *Pseudomonas* from pus sample.	04
3.	Isolation and identification of *Candida* from skin/mouth.	04
4.	Isolation of Normal Microbial Flora of Skin.	04
5.	Potassium hydroxide wet mount preparation for presumptive diagnosis of fungal infection.	04
6.	Isolation of Normal Microbial Flora of Mouth.	04
7.	Cultivation of Anaerobic bacteria by suitable method.	04
8.	Enzyme-linked immunosorbent assay (ELISA)	04
9.	Venereal disease research laboratory (VDRL)	04
10.	Demonstration of precipitation reaction based on immunodiffusion.	04
11.	Study of various stages of *Entamoeba histolytica* using permanent slides.	04
12.	Visit to Pathology Laboratory/Blood Bank.	04

Suggested Reading:

1. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
2. Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
3. Mackie TJ and McCartney JE (1989), Practical Medical Microbiology, 13rd Edn Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchy Livingstone International Student Ed.
4. Parija Subhash Chandra (2008), Text Book of Microbiology, Ahuja Publishing

	House, New Delhi, ISBN:: 81 89443-06-2 5. Willey JM, Sherwood LM, and Woolverton CJ. (2013), Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education 6. Deshmukh A.M. (1997), 1st Edn., Handbook of Media, Stains and reag ents in Microbiology Pama Publications. 7. Reddy M. G., Reddy M. N., Saigopal D. V. R. And Mallaiah K. V. (2008), Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai

DSC Discipline Specific Core Practical		
MB-608: Methods Industrial Microbiology-II		
Total hours: 60		**Credits: 02**

Course Objectives

- To analyse the potency of an antibiotic by suitable bioassay.
- To study the stoichiometric evaluation of enzyme activity.
- To handle the techniques involved in enzyme immobilization.

Learning Outcomes

After successful completion of this course, students are expected to:

- Design bioprocesses for commercially valuable products.
- Learn techniques for validation of instruments used in fermentation industry.
- Investigate the role of immobilization in enzyme activity and apply it for various purposes.

Sr.No.	Topic	Lectures/ Hours
1.	Production and estimation of citric acid by fermentation.	04
2.	Microbiological assay of Penicillin / Streptomycin by paper disc or agar -well plate method.	04
3.	U.V. Survival curve.	04
4.	Isolation of antibiotic resistant bacteria by gradient plate technique.	04
5.	Screening of amylase producing organism from rhizosphere.	04
6.	Production of amylase at shake flask level in laboratory.	04
7.	Determination of protein content of crude amylase enzyme.	04
8.	Determination of enzyme activity and specific activity of crude enzyme amylase.	04
9.	Immobilization of yeast cells/enzyme and detection of immobilization activity.	04
10.	Validation of autoclave / laminar air flow system.	04
11.	Microbiological assay of commercial vitamin.	04
12.	**Activity:** Visit to Food / Milk Processing/ Pharmaceutical / Fermentation Industry / Research organization.	04

Suggested Reading:

1. Aneja, K. R. (1996), Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 2nd Ed., Wishwa Prakashan, New Delhi (New Age International, Pvt. Ltd.).
2. Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S.Chand and Co. Delhi.
3. Gunashekharan P, Introduction to Microbial Techniques___________
4. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
5. Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.

6. Mackie and McCartney (1989), Practical Medical Microbiology, 13rd \ Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchy Livingstone International Student Ed.
7. Parija S. C., (2007), Textbook of Practical Microbiology, Ahuja Publishing House New Delhi.
8. Plummer, D. T. (1992), An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
9. Sharma Kanika, Manual of Microbiology Tools and techniques, 2nd Ed. (2007), Ane's Book India, New Delhi

DSC Discipline Specific Core Practical		
MB-609: Methods in Applied Microbiology-II		
Total hours: 60		**Credits: 02**

Course Objectives

- To isolate and screen microbes involved in bioremediation processes
- To analyse the wastewater / liquid effluent and emphasize on safety handling of hazardous materials.
- To aware the students about bioenergy, bio fertilizers, biocontrol agents etc**.**

Learning Outcomes

After successful completion of this course, students are expected to:

- Isolate and screen microbes involved in bioremediation processes like dyes and lignin degradation.
- Isolate and identify rhizospheric microbes which are important for crops
- Analyse the quality of wastewater / liquid effluent and make charts of safety handling of hazardous materials and MSDS.

Sr.No.	Topic	Lectures/ Hours
1.	Isolation of azo/aryl dye degrading bacteria from polluted soil sample by solid phase decolourization method.	04
2.	Isolation of phosphate solubilizing microorganism from rhizosphere soil.	04
3.	Demonstration of Koch's postulates in plants.	04
4.	Analysis of wastewater of distillery/dairy/Pharma. industry-Determination of TS, TDS and COD.	04
5.	Isolation and primary screening of bacteria/fungi from soil sample for lignin dephenolization activity.	04
6.	Isolation and identification of *Rhizobium* sp. from root nodules.	04
7.	Isolation and identification of *Azotobacter* sp. from root nodules.	04
8.	Demonstration safety handling of hazards chemicals and awareness of Material Safety Data Sheet (MSDS).	04
9.	Demonstration of biogas production.	04
10.	Evaluation of efficacy of biofertilizer (*Azotobacter/ Rhizobium/ Trichoderma* sp.) by pot assay.	04
11.	Dilution methods for liquid/solid/semisolid food samples.	04
12.	Evaluation of antifungal activity of bacterial biocontrol agent.	04

Suggested Reading

1. Anuradha De (2014), Practical and Applied Microbiology, 5th Edition, National Book Depot, Mumbai.
2. Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S.Chand and Co. Delhi.
3. Dubey Akhilesh, Mishra Neeraj, Singh, Deb Neha, Abhinav and Verma, Shivendra. (2010), Isolation of dye degrading microorganism. Electronic Journal of Environmental, Agricultural and Food Chemistry.
4. Parija S. C., (2007), Textbook of Practical Microbiology, Ahuja Publishing House New Delhi.

5. Reddy M. G., Reddy M. N., Saigopal D. V. R. and Mallaiah K. V. (2008), Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai.
6. Roy D C et al, (2018), Biodegradation of Crystal Violet dye by bacteria isolated from textile industry effluents, PeerJ.; Vol. 6, doi: 10.7717/peerj.5015.
7. Sharma Kanika, Manual of Microbiology Tools and techniques, 2nd Ed. (2007), Ane's Book India, New Delhi.

Skills acquired and Job prospects for the Microbiology students

Microbiology is one of the most significant subjects exhibiting its impact in human health, industrial production of antibiotics, vaccines, enzymes, fine chemicals, energy sector and social sector like waste treatment etc. Degree program in Microbiology teaches students how microorganisms are part of human life and how they are useful in various applications. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunity in all sectors.

After successful completion of three years degree course in Microbiology, student will be well versed with laboratory skills and transferable skills essential for working in industrial sector, working in laboratories and higher studies.

Laboratory Skills:

- Laboratory safety practices
- Skillful handling of microbial cultures and aseptic techniques
- Skillful handling of fermenters and its parts
- Molecular kit based and protocol-based analysis
- Advanced techniques like- Chromatography, Electrophoresis, Spectrometry
- Some medical diagnostic techniques like Widal test, microbial analysis of food and dairy products.
- Analysis and interpretation of results and logical thinking

Transferable Skills:

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas. These are:

- Analytical skill, Observational skill
- Planning and Time management
- Mathematical and IT skills
- Creative thinking, Problem solving
- Report writing skill, Presentation skill

Job Opportunities:

Private Sector:

Microbiology can work in quality control, quality assurance and R & D divisions of companies like-Biotech companies, Pharmaceutical companies, Chemical manufacturing companies, Food and Beverages (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sector:

Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Job profiles:

Microbiologist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Biochemist, Research Associates, Research Officers, Research Scientist etc. wherever microbiology is dealt with.

Opportunities in higher studies

After successful completion of B.Sc. in Microbiology, student may continue further studies like M.Sc. in Microbiology / Biotechnology / Biochemistry and pursue higher studies. Even students can pursue other courses where graduation is essential.

--x--

KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY, JALGAON

॥अंतरी पेटवू ज्ञानज्योत॥

1990
'A' Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS STRUCTURE OF

F.Y.B.Sc.

[Environmental Science]

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

Semester-I & II

[w.e.f. June 2022]

KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY, JALGAON

Faculty of Science & Technology

Syllabus for Core Subject
Environmental Science

As per the UGC Guidelines based on
Choice Base Credit System (CBCS)

At
F.Y.B.Sc.
Semester wise Syllabus
Theory and Practicals

Semester-I

Envi-101: Introduction to Environment -I
Envi-102: Natural Resources-I
Envi-103: Laboratory Course based on Theory Papers

Semester-II

Envi-201: Paper-I Introduction to Environment -II
Envi-202: Natural Resources-II
Envi-203: Laboratory Course based on Theory Papers

[w.e.f. June 2022]

- **Objectives:**
  1. To acquire the deep knowledge in Environmental Science subject at undergraduate level.
  2. To impart the ability to understand and analyze the environmental issues related toenvironmental components.
  3. To develop responsibility among students for protection, preservation, and conservation ofenvironment.
  4. To create conscious regarding rational utilization of Natural resources.
  5. To develop practical skills on environment and Natural Resources analysis for their better management.

Structure of F. Y. B. Sc. (Environmental Sciences) under CBCS

w. e. f. June 2022

Sem	Core Course	Structure	Code & Title of Paper	Marks		Credits	No. of Hours
				Ext.	Int.		
I	CC A-I	Theory	Envi-101: Introduction to Environment –I	60	40	02	30
			Envi-102: Natural Resources-I	60	40	02	30
		Practical	Envi-103: Laboratory Course based on Theory Papers	60	40	02	60
II	CC A-II	Theory	Envi-201: Introduction to Environment –II	60	40	02	30
			Envi-202: Natural Resources-II	60	40	02	30
		Practical	Envi-203: Laboratory Course based on Theory Papers	60	40	02	60
Total Credits Sem. I & Sem. II = 12							

.SEMESTER –I

CC A-1: Paper I

Envi-101: Introduction to Environment-I (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Hours
Course Objective	To acquaint students with basic concepts of Environment & their components		
Learning outcome	On completion of the course, students are able to: • Understand about the concept of environment, their structure & types, different components and their functions. • Understand about the different components of Environment. • Aware about social environment, understanding the relation between man & environment. • Aware about global environmental issues and possible solution associated for the same.		
I	**Basic Concept of Environment**	• Meaning of Environment: Concept, Definition, Scope, Importance • Structure of Environment : Lithosphere, Hydrosphere, Atmosphere and Biosphere • Types of Environments: Physical Environment, Biological Environment, Social or Cultural Environment. • Global Environmental Problems and their effects (Acid Rain, Green House Effects, Global Warming, Ozone Layer Depletion, Ozone Hole etc.)	**8**
II	**Environmental Components**	• Introduction • Lithosphere: Concept, Definition, Interior Structure of earth, Importance • Atmosphere: Concept, Structure, Importance, Reaction involved in atmosphere associated with gaseous pollutants. • Hydrosphere: Concept, structure of water, properties ofwater, types of water-Ground Water, Surface Water • Biosphere: Concept, Definition, Importance	**10**

III	**Basic concept of Ecology**	• Introduction • Ecology: Concept, Definition, Scope of Ecology, Subdivisions of Ecology • Ecosystem: Concept, Definition, Types of Ecosystems, Forest Ecosystem, Grassland Ecosystem, Deserts Ecosystem • Structure and functioning of Ecosystem	**8**
IV	**Social Environment**	• Man and Environment Interaction • Environment and Human Health • Environmental Ethics • Environmental Crisis	**4**

CC A I: Paper II

Envi-102: Natural Resources-I (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Hours
Course Objective	To acquaint students with basic concepts of Natural resources & their importance		
Learning outcome	On completion of the course, students are able to: • Understand the concepts of natural resources, their types and importance • Understand the detailed information about biogeochemical cycles, their role & function in the environment with a-biotic and biotic components. • Aware about mining activity and their impact on environment through some case studies. • Understand the concepts of lithosphere, soil, soil formation, soil profile, ecosystems. • Aware about importance of soil formation and conservation, food chain, food web and productivity.		
I	**Introduction to Natural resources**	• Introduction, Definition, Concept of Natural Resources • Classification of Natural Resources • Exhaustible & Non-exhaustible Natural Resources • Renewable resources • Non-renewable resources	**4**
II	**Mineral resources & Bio-geochemical Cycle**	• Mineral resources: Introduction, Importance • Use and exploitation of Mineral resource • Environmental effects of extracting and using Mineral resources • Bio-geochemical Cycle: Definition and concept of biogeochemical cycles • Carbon cycle • Nitrogen cycle • Sulphur cycle • Oxygen cycle • Phosphorous cycle	**10**
III	**Soil Resources**	• Introduction • Composition of Soil, • Soil Formation • Soil type in India • Soil profile • Soil Conservation	**8**

IV	**FoodEnergy**	• Energy • Productivity in an ecosystem:- 1) Primary Production. 2) Secondary Production. • Food chain and its types • Food webs • Trophic Levels • Energy Flow • Energy pyramids • Types of animals based on food habits • First & Second law of thermodynamics	**8**

CC A-1 : Practical Paper - I

Envi-103: Laboratory Course based on Theory Papers

TOTAL HOURS: 60 **CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: • Understand the concepts of water sampling with preservation techniques • Understand the physical, chemical and biological properties of water samples with water quality standards. • To determine the pH, electrical conductivity of water as well as soil which help to understand the nature of particular water and soil. • Estimate the solids from water to evaluate their effects on humans. • To determine Dissolved oxygen from water body which help to understand the function of water body	
1	To study the Safety Measures with in the Laboratory	4
2	Collection of Water Sample	4
3	Preservation of Water Sample	4
4	To study the physical properties of water sample.	4
5	Study of Water Quality Standards	4
6	To study the methods of Sterilization	4
7	To study the principle, working operation and application of pH & EC Meter	4
8	To study the principle, working operation and application of Turbidity Meter	4
9	To determine pH of given water sample	4
10	To determine the pH of given soil sample	4
11	To determine the electrical conductivity of given water sample	4
12	To determine the electrical conductivity of given soil sample	4
13	To determine the total solids from provided water sample	4
14	To determine the total dissolved solids from water sample	4
15	Estimation of dissolved oxygen present in water sample by Winkler's Method	4

SEMESTER –II

CC A II: Paper I

Envi-201: Introduction to Environment-II (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Hours
Course Objective	To acquaint students with concepts of Earth formation & Environmental issues.		
Learning outcome	On completion of the course, students are able to: • Understand the concepts Earth Process, classification and formation of rocks, their movements beneath the earth with tectonic plates and their effects on lithosphere. • Understand the concepts of environmental pollution, their sources and effects on biotic and abiotic community. • Aware about environmental issues and their monitoring for minimizing the environmental pollution • Understand the concept of environmental education, its need and importance. • Aware about objectives and principles of environmental education.		
I	**Earth Process**	• Rock: Introduction, Definition • Classification of rocks • Formation of rocks- Igneous, Sedimentary and Metamorphic rocks • Weathering of rocks • Erosion of rocks • Plate tectonics, Sea floor spreading • Mountain building and rock deformation	**8**
II	**Environmental Pollution**	• Introduction. • Concepts and Definition of Environmental Pollution • Pollutants: Definition, Sources, Nature and Types of Pollutants • Types of Environmental Pollution: Air pollution, Water pollution, Soil pollution, Noise pollution, Solid Waste pollution, Thermal Pollution, Plastic pollution.	**8**

III	**Current Environmental Issues**	• Introduction to Global Environmental Problems • Green House gases and its impacts • Climate Changes • Green Houses Gases • Global Warming & Sea Level rise • Ozone Depletion & Ozone Hole • Deforestation • Desertification	**8**
IV	**Environment Education & Awareness**	• Introduction • Need of Environmental Education & Awareness • Goals of Environmental Education • Objectives Environmental Education • Principles of Environmental Education • Environmental Education in India	**6**

CC A II: Paper II

Envi-202: Natural Resources-II (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Hours
Course Objective	To acquaint students with basic concepts of Renewable & Non-renewable resources		
Learning outcome	On completion of the course, students are able to: • Understand the concepts of Water, Land forest and Energy resources. • Aware about over utilization of surface & ground water, benefit and problem associated with water availability, conflicts over water. • Understand about the use and over exploitation of forest, causes and effects of forest, timber extraction and mining. • Aware about importance of natural resource through some case studies like "Chipko Movements" and "Sardar Sarovar Project". • Understand the concept of equitable use of natural resources for sustainable lifestyle.		
I	**Water Resources**	• Use and over utilization of surface and ground water • Floods and droughts • Conflict over water • Significance of Water • Water problems • Sardar Sarovar Dam – Case Study	**6**
II	**Land Resources**	• Land as resource • Soil Erosion • Land Degradation • Landslides • Desertification	**6**
III	**Forest Resources**	• Use & over exploitation • Deforestation • Chipko Movement – Case Study • Timber extraction and mining • Dams & their effects on forest & tribal people • Equitable use of natural resources for sustainable lifestyles • Role of an individual in conservation of natural resources	**10**

IV	**Energy Resources**	• Growing energy needs • Renewable and non-renewable energy resources • Natural resources and associated problems • Use of alternate energy sources • Solar energy, Wind Energy, Hydro energy, Tidal Energy, Geothermal Energy, Biomass energy, Biogas and Bio-fuels	**8**

CC A II: Paper II

Envi-203: Laboratory Course based on Theory Papers

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science for water & soil analysis	
Learning Outcome	On completion of the course, students are able to: • To determine the chemical properties of water like acidity, alkalinity, turbidity, hardness to evaluate their impacts on biotic community. • Understand the physical, chemical and biological properties of water samples with water quality standards. • To determine the pH, electrical conductivity of water as well as soil which help to understand the nature of particular water and soil. • Estimate the solids from water to evaluate their effects on humans.	
1	Study of quality criteria of Air and Noise pollutions	4
2	To determine the Acidity of given water sample	4
3	To determine the Alkalinity of given water sample	4
4	Determination of Total Hardness of given water sample	4
5	Determination of Ca & Mg Hardness of given water sample	4
6	To determine the Turbidity by Turbidometry method	4
7	To determine soil temperature by soil thermometer	4
8	Determination of soil bulk density	4
9	To determine Organic Matter from soil (Ignition method)	4
10	To determine the water holding capacity of the soil sample.	4
11	Study of Microscope	4
12	Study of phytoplankton	4
13	Study of Zooplanktons	4
14	To examine the organisms present in the water sample by hanging Drop technique	4
15	Classification of Rocks	4

Reference Books for Semester I & II (F. Y. B. Sc. – Environmental Sciences)

❖ Envi-101 & 201 - Introduction to environment-I & II

1. P.D. Sharma (2006) : Ecology and Environment – Rastogi Publications, Meerut
2. S.T. Ingle et al. (2005) Environment Studies – Prashant Publication House, Pune
3. N. Arumugam et.al. (2005) Environment Studies –Saras Publication, Kanyakumari
4. P.S.Verma and V.K. Agrawal (1998) Environmental Biology (Principles of ecology), S.Chand and company Ltd, New Delhi
5. H.V. Jadhav (1994): Principles of Environmental Sciences, Himalaya Publishing House
6. Savindra Singh (2002): Environmental Geography, Prayag Pustak Bhavan, Allahabad
7. Erach Bharucha(2005): Textbook of Environmental Studies for Undergraduate Courses,Universities Press, Hyderabad.

❖ Envi- 102 & 202 - Natural Resources – I & II

1. P.D. Sharma (2006): Ecology and Environment – Rastogi Publications, Meerut
2. S.T. Ingle et al. (2005) Environment Studies – Prashant Publication House, Pune
3. P.S. Verma and V.K. Agrawal (1998) Environmental Biology (Principles of ecology), S.Chand and company ltd, New Delhi
4. H.V. Jadhav (1994): Principles of Environmental Sciences, Himalaya Publishing House
5. Dr. A. M. Deshmukh (1996): Outlines of Microbiology, Krishnai Publication, Karad
6. P.C. Dubey, D.K. Maheshwari (1993): A Textbook of biotechnology, S. Chand andCo. Ltd, New Delhi
7. S.C. Santra (2001): Environmental Sciences, New Central Book Agency (P) Ltd, Kolkata

❖ Envi-103 & 203 – Laboratory Course based on Theory Papers

1. Wastewater Engineering: Metcalf & Eddy, Tata Mc-Graw Hill Publishers, III Edition (1995)
2. Water Supply and Sanitary Engineering: S. C. Rangwala, Charotar publishing house, Anand (1992)
3. Water and Wastewater Technology: Mark J Hammer & Mark J Hammer Jr., Prentice Hall of India, IV Edition (2002)
4. Environmental Pollution Control Engineering: C.S. Rao, New Age International (P) Ltd.(1991)
5. Sewage Disposal and Air pollution engineering: S. K. Garg, Khanna publishers, New Delhi (1998)
6. Air Pollution and Control: Mowli and Subbayya, Divyajyoti Prakashan, Jodhpur (1989)
7. Air Pollution: V.P. Kudesia, Pragati Prakashan, New Delhi (1997)
8. Noise Pollution and Management: G. Gaur, Sarup and Sons, New Delhi (1997)

Table of Equivalence for F.Y.B.Sc. CBCS (Environmental Science)

Semester	Old Syllabus w.e.f. June 2018	New Syllabus w.e.f. June 2022
I	Envi-101: Introduction to Environment -I	Envi-101: Introduction to Environment -I
	Envi-102: Natural Resources-I	Envi-102: Natural Resources-I
	Envi-103: Laboratory Course based on Theory Papers	Envi-103: Laboratory Course based on Theory Papers
II	Envi-201: Paper-I Introduction to Environment -II	Envi-201: Paper-I Introduction to Environment -II
	Envi-202: Natural Resources-II	Envi-202: Natural Resources-II
	Envi-203: Laboratory Course based on Theory Papers	Envi-203: Laboratory Course based on Theory Papers

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS STRUCTURE OF

B. Sc. [Environment Science]

S. Y. B. Sc.

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

[2019-20]

PREAMBLE

The syllabus has been prepared anticipating the requirements of B.Sc. Environment Science students under Choice Based Credit System (CBCS) Program. The contents have been drawn to accommodate the widening horizons of the Environment Science discipline and reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

The course curriculum outlined here is designed in an inclusive and interdisciplinary manner and draws content from various allied disciplines. Ideally, an undergraduate programme in environmental science should focus equally on theory and practice so that students are able to pick up necessary skills enabling them to find gainful employment at the job market. Therefore, a number of skill-based courses have been identified and made a part of the curriculum. Attention was also paid to structuring various core courses so as to make them appealing from a practitioner's point of view. It is hoped that a student with a B.Sc. Environmental Science (Hons.) degree, after having read the courses outlined here, should feel adequately equipped to meet the challenges of career development. At the same time, there is sufficient content for those who wish to continue academic life at the university beyond undergraduate level. That said, due care has been taken to maintain necessary academic rigor and depth in the course content so that the learning outcomes from these courses will lead to intellectual growth of a student.

The present syllabus is restructured anticipating the future needs of Environment Science with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Environment Science.

Hence, the committee constituted for preparation of structure of B. Sc. in Environmental Science in its meeting held on 16/05/2019 resolved to accept the revised syllabus for S. Y. B. Sc. (Environmental Science) based on Choice Based Credit System (CBCS) of UGC guidelines.

Scheme of B. Sc. program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		
1	**Core courses (16)**	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	(i) Theory	4	4	4	4	**4**	**3**	**4**	**3**					4 X14=56
	(ii) Practical	2	4	2	4	**2**	**3**	**2**	**3**					2X14=28
2	**Ability enhancement compulsory course(AECC) (2)**	2	1	2	1									2X2=04
3	**Skill Enhancement Course (SEC)** (4)					**2**	**1**	**2**	**1**	2	1	2	1	2 X8= 16
4	**Discipline Specific Elective DSE (6)**													
	(i) Theory									4	3	4	3	4X6=24
	(ii) Practical									2	3	2	3	2X6 =12
	Total Credit value (Credit x No. of Courses)	**26**		**26**		**20**		**20**		**20**		**20**		**132**

- **Course Structure:**

Duration: The duration of B.Sc. (Environment Science) degree program shall be three years.
Medium of instruction: The medium of instruction for the course shall be **English**.
The present syllabus has been prepared to:

i. Accommodate the advanced topic on the Environment Science discipline
ii. Build the basic science knowledge at the level of first year of Environment Science
iii. Reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

At first year of under-graduation, students are given exposure to basic science to build the foundation of advance Environment Science. For this purpose, more focus on relevant experimentation on the topics is included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of Environmental Microbiology. The relevant practical are included to enrich their knowledge. At third year under-graduation, six theory and three practical papers each for two semesters are included to uncover all applied areas of Environment Science.

The courses codes and titles for the courses are as given below: **S. Y. B. Sc. Envi-Environment Science**,

Core Courses [DSC] (12 Courses)

- **Core Courses [DSC] (12 Courses, 4 Environment Science + 8 subsidiary subjects)**

Sem	CC A & B	Paper Code	Paper Name	Paper Code	Paper Name	Practical Paper Code	Practical Paper Name
III	CC A III	Envi-301	Ecology & Environmental	Envi-302	Basics in Environmental Microbiology	Envi-303	Laboratory Course based on Theory Paper-III
IV	CC A IV	Envi-401	Ecosystem & Biodiversity	Envi-402	Applied & Industrial Microbiology	Envi-403	Laboratory Course based on Theory Paper-IV

- **Skill enhancement courses (SEC) (any Four):**

Student has choice to study any four courses from respective semester subject to the availability of particular course at respective college

Semester	SEC	Course Title	SEC	Course Title
III	SEC I	Fundamental of Sample & Solution preparation	SEC II	Microbial Isolation & Identification Techniques
IV	SEC III	Air Quality Monitoring Techniques	SEC IV	Industrial Safety
V	SEC V	Environment Management System	SEC VI	Water Monitoring Techniques
VI	SEC VII	Noise & Illumination Monitoring Techniques	SEC VIII	Fire Safety Management

Scheme of S. Y. B. Sc. (Environment Science)

Semester	CORE COURSE				Skill Enhancement Course (SEC)		
	DSC		Credits	Lectures		Credits	Lectures
III	DSC- 1 A: Core Course I: **Environment Science (Sp)**	Paper I Paper II Practical Paper	2 2 2	30 30 60	**SEC 1**	2	30
	DSC- 2 A: Core Course II	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC- 3 A: Core Course III	Paper I Paper II Practical Paper	2 2 2	30 30 60			
IV	DSC- 1 B Core Course I :**Environment Science (Sp)**	Paper I Paper II Practical Paper	2 2 2	30 30 60	**SEC 2**	2	30
	DSC- 2 B Core Course II	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC- 3 B: Core Course III	Paper I Paper II Practical Paper	2 2 2	30 30 60			

Student has choice to study two subsidiary subjects from **DSC 2, and DSC 3** among Chemistry/ Botany/ Zoology /Geography/Geo-informatics/Information Technology/Mathematics during III and IV semester; subject to availability of course at respective college.

- **Duration of lecture:** 30 Lectures of 60 minutes or 36 Lectures of 50 min.
- **Examination Pattern**

Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination.

- **External Examination:** Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
- Question 1 (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.

- Question 2, 3 and 4 (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
- Question 5 (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.
- **Internal examination (40 marks each semester):** Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.
- **Practical Examination:** Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule (10 am to 1 pm or 2 pm to 5 pm) on schedule date. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination.

➢ **Equivalence for S.Y. B.Sc. (Environment Science) is furnished in the following table:**

Old Syllabus (W. E. F. June 2016) (Semester Pattern 60:40)	**New Syllabus (W. E. F. June 2019) CBCS Pattern (Semester Pattern 60:40)**	**Remark, If Any**
Envi - 211: Ecology	Envi-301: Ecology & Environmental	Code And Title Of The Paper Change
Envi - 212: Environmental Microbiology	Envi-302: Basics In Environmental Microbiology	Code And Title Of The Paper Change
Envi - 213: Laboratory Course Based On Theory Papers - I	Envi-303: Laboratory Course Based On Theory Papers (301 & 302)	Code And Title Of The Paper Change
Envi - 221: Social Environment And Their Conservation	Envi-401: Ecosystem & Biodiversity	Code And Title Of The Paper Change
Envi - 222: Applied And Industrial Microbiology	Envi-402: Applied & Industrial Microbiology	Code Of The Paper Change
Envi - 223: Laboratory Course Based On Theory Papers - II	Envi-403: Laboratory Course Based On Theory Papers (401 & 402)	Code And Title Of The Paper Change

S. Y. B. Sc. (Environment Science) Semester – III

Sem	CC A & B	Paper Code	Paper Name	Paper Code	Paper Name	Practical Paper Code	Practical Paper Name
III	CC A III	Envi-301	Ecology & Environmental	Envi-302	Basics in Environmental Microbiology	Envi-303	Laboratory Course based on Theory Paper-III
IV	CC A IV	Envi-401	Ecosystem & Biodiversity	Envi-402	Applied & Industrial Microbiology	Envi-403	Laboratory Course based on Theory Paper-IV

SEMESTER –III

CC A-III: Paper I

Envi-301: Ecology and Environment (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of Ecology & Environment.		
Learning outcome	On completion of the course, students are able to: • Understand about the concept of ecology, their structure & types, different components and their functions. • Understand about the a-biotic, biotic factors & their relation to each other. • Aware about ecosystem, function & components of ecosystem and their stability. • Aware about human population and population ecology.		
I	**Introduction to Ecology**	• Definition of Ecology • Historic Background • Ecology in India • Terminology of ecology	**6**
II	**A-biotic & Biotic Factors**	• Climatic Factors (Light, Temperature, Precipitation, Humidity) • Topographic Factors • Edaphic Factors- Definition and Importance of Soil, Composition of Soil. • Relationship among Organisms	**8**

		• Positive Interactions- Commensalism, Proto cooperation and Mutualism, Negative Interactions- Competition, Predation, Parasitism and Antibiosis.	
III	**Ecosystem**	• Meaning of Ecosystem • Types of Ecosystem • Components of Ecosystem • Functioning of Ecosystem • Ecosystem Productivity • Stability of Ecosystem.	**10**
IV	**Human Population & Population Ecology**	• Introduction, Definition and Types of Population • Population Characteristics- Population Size and Density, Dispersion, Age Structure, Natality, Mortality and Life Tables • Population Explosion in India • Population Growth when resources not limited, Population interactions (Competition, predation and mutualism) • Age Structure	**6**

References:

1. Savindra Singh (2002): Environmental Geography – Prayag Pustak Bhavan, Allahabad
2. P. D. Sharma(2010): Ecology and Environment – Rastogi Publications, Meerut
3. S.T.Ingle et. al. (2005): Environmental Studies – Prashant Publication House, Pune
4. P.S. Verma and V. K. Agrawal (1998): Environmental Biology (Principles Of Ecology), S. Chand and Company Ltd., New Delhi.

CC A III: Paper II

Envi-302: BASICS IN ENVIRONMENTAL MICROBIOLOGY (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of environmental microbiology		
Learning outcome	On completion of the course, students are able to: • Understand the concepts of environmental microbiology, their types and importance • Understand the detailed information about microscopy and their application. • Acquired the skill of staining techniques for isolation and identification of microorganism. • Understand the Physical, Chemical and Biological Methods of isolating pure culture		
I	**History and Introduction of Microbiology**	• History of microbiology • Contribution in Microscopy • Important Contribution in Development of Microbiology • Definition of Microbiology • Types of Microbiology • Introduction to Applied Branches in Microbiology	**4**
II	**Microscopy**	• General principles of Microscopy • Applications and Importance of Microscope • Parts of Microscope – Mechanical & Optical Parts • Working Distance, Abbreviation, Resolving Power, Numerical Aperture, Ray Diagram, Applications • Comparative Study of Following Microscope – Compound and Electron Microscope, Principles and Applications of Phase Contrast Microscope, Fluorescent Microscope, Dark Field Microscope	**6**
III	**Stains and Staining Techniques**	• Definition of Dye and Stain • Classification of Stain- Acidic, Basic and Neutral • Procedures and Mechanism of Simple Staining, Gram Staining, Acid – Fast Staining, Negative Staining, Special Staining • Control of Micro Organisms.	**10**
IV	**Cell Structure & Pure Culture Techniques**	• Nuclear Organization • Chromosomes	**10**

		• Nuclear Division • Cell Membrane • Cell Wall, Respiration • Method of Selection • Physical, Chemical and Biological Methods of isolating pure culture- Streak Plate, Spread Plate and Enrichment Culture Technique	

References:

1. Dr.A.M.Deshmukh (1996): Outlines of Microbiology, Krishnai publication, Karad.
2. R.C. Dubey, D.K.Maheshwari (1993): A Textbook of Microbiology, S.Chand and company Ltd. New Delhi.
3. R.C. Dubey, D.K.Maheshwari (1993): A Textbook of Biotechnology, S.Chand and company Ltd. New Delhi.

CC A-III : Practical Paper (Paper III)

Envi-303: Laboratory Course based on Theory Papers (301 & 302)

TOTAL HOURS: 60 **CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: • Understand the concepts of microscopy, aware about microbiological equipments. • Prepare microbial media with different proportion. • To prepare the slide using different staining techniques to identify microorganism from soil and curd • Aware about Ecological adaptations in Wetland plants & Mesophytes. • To determine temperature, wind profile & light intensity using environmental instruments. • To determine physical & chemical parameters of solid waste.	
1	Study of microscopy	4
2	To study the microbiological equipments.	4
3	Preparation of microbial media and sterilization	4
4	Study of staining techniques – Simple or Monochrome staining	4
5	Study of staining techniques - Negative Staining	4
6	Study of staining techniques- Gram Positive & Gram Negative staining	4
7	Isolation of Bacteria from curd and its Gram Staining	4
8	Isolation, purification and identification of fungi from air	4
9	To study the Ecological adaptations in Wetland plants & Mesophytes (any 2 each)	4
10	Demonstration of Lux Meter (Light Intensity Meter)	4
11	To study of wind profile and temperature of the given locations.	4
12	To examine the organisms present in the water sample by Hanging Drop Technique.	4
13	To study and analyze the Physical parameters of solid waste	4
14	To study and analyze the Chemical parameters of solid waste	4
15	To determine the soil temperature and moisture.	4

Note: Mandatory to perform at least 12 practicals

References:

1. Waste Water Engineering: Metcalf & Eddy, Tata Mc-Graw Hill Publishers, III Edition (1995)

2. Water Supply and Sanitary Engineering: S. C. Rangwala, Charotar publishing house, Anand (1992)
3. Water and Wastewater Technology: Mark J Hammer & Mark J Hammer Jr., Prentice Hall of India, IV Edition (2002)
4. Environmental Pollution Control Engineering: C.S.Rao,New Age International (P) Ltd. (1991)
5. Sewage Disposal and Air pollution engineering: S. K. Garg, Khanna publishers, New Delhi (1998)
6. Air Pollution and Control: Mowli and Subbayya, Divyajyoti Prakashan, Jodhpur (1989)
7. Air Pollution: V.P. Kudesia, Pragati Prakashan, New Delhi (1997)
   Noise Pollution and Management: G. Gaur, Sarup and Sons, New Delhi (1997)

SEMESTER –IV

CC A IV: Paper I

Envi-401: SOCIAL ENVIRONMENT AND THEIR CONSERVATION (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

<table>
<tr><th>Unit No.</th><th>Title</th><th>Topics</th><th>Lectures</th></tr>
<tr><td>Course Objective</td><td colspan="3">To acquaint students with social environment & their conservation</td></tr>
<tr><td>Learning outcome</td><td colspan="3">On completion of the course, students are able to:
• Understand the concepts of social environment & their importance.
• Aware about environmental impact assessment process & its importance.
• Understand about the forest resource and its conservation for sustainable development.
• Aware about importance wild life conservation and its importance.
• Understand the concept of environmental lawas.</td></tr>
<tr><td>I</td><td>Social Environment & EIA</td><td>• Meaning of Social Environment and their conservation
• Urban problems related to energy
• Resettlement and Rehabilitation of people – its problems and concern, Development,
• Gaya Hypothesis
• Sustainability, Sustainable Development, Environmentally Sensitive Development
• Environmental Monitoring and Impact Assessment: Ecological Indicators (Bioindicators)
• Biological Monitoring Programme
• Environmental Impact Assessment – Concept, Objectives, and Projects covered, Procedure, Environmental Appraisal Committee, Environmental management Plan.</td><td>6</td></tr>
<tr><td>II</td><td>Forest Resources and Conservation</td><td>• Concept and meaning
• Sources
• Forest Cover, Deforestation, Desertification
• Demand and supply of wood,
• Afforestation, Strategies to demands and conservation
• Protection forestry.</td><td>6</td></tr>
</table>

III	**Wildlife Resource and Conservation**	• Concept and meaning Wild life conservation • Endangered, Rare, Vulnerable species • Reason for extinction of Wildlife • Need for wildlife conservation • Protection of endangered species and wildlife management in India *w.r.t* Sanctuaries, National Parks and Project Tiger.	**10**
IV	**Introduction to Environmental Laws**	• Indian Environmental Laws • General laws, Special Laws • Forest Conservation Act (1980) • Wildlife Protection Act (1972) • The Water (Conservation and Prevention of Pollution) Act (1974) • The Air (Conservation and Prevention of Pollution) Act (1981)	**8**

References:

1. Savindra Singh (2002): Environmental Geography – Prayag Pustak Bhavan, Allahabad
2. P. D. Sharma(2010): Ecology and Environment – Rastogi Publications, Meerut
3. S.T.Ingle et. al. (2005): Environmental Studies – Prashant Publication House, Pune
4. P.S. Verma and V. K. Agrawal (1998): Environmental Biology (Principles Of Ecology), S. Chand and Company Ltd., New Delhi.

CC A IV: Paper II

Envi-402: APPLIED AND INDUSTRIAL MICROBIOLOGY

(Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of Applied & Industrial Microbiology.		
Learning outcome	On completion of the course, students are able to: • Understand the concepts of air and water microbiology. • Aware about food microbiology associated with food contamination, food infection and food poisoning. • Understand about the sewage waste water microbiology. • Aware about importance medical microbiology.		

I	**Microbiology of Air and Water**	• Microbiology of Air
		  • Techniques for Microbial examinations
		  • Solid -liquid impingement,
		  • Droplet infectious dust
		• Microbiology of Water
		  • Water bacterial flora
		  • Determination of sanitary quality Faecal pollution Indicators Bacterial techniques
		  • Standard plate counts test for coli-forms
		  • Membrane filter techniques Presumptive completed confirmed test, MPN, IMVIC test,
		  • Purification of drinking water & its significance.
			6

II	**Microbiology of Food**	• Meaning and Concept • Microbial spoilage of bread, Meat, Eggs, Pickles • General principals and methods of food preservation, Filtration and centrifugation, sun drying, High and low temperature, Irradiation, Unaerobiosis, • Food infection -Salmonellosis, • Food poisoning-Clostridial, Staphylococcal.	**6**
III	**Microbiology of Sewage**	• Physical, Chemical, Microbial characteristics • Sewage types-chemical and Microbial,BOD and COD • Treatment and disposal-septic tank Imhoff tank • Physical and biological treatment.	**10**
IV	**Medical Microbiology**	• Basic concept of infection • Pathogenesis and virulence of micro-organisms	**8**

		• Type of diseases, Morbidity and Mortality rate, Transmission of diseases • General principals of prevention and control • Study of diseases-dysentery, Bacillary, Tetanus, Amoebic and cholera.	

References:

1. Dr.A.M.Deshmukh (1996): Outlines of Microbiology, Krishnai publication, Karad.
2. R.C. Dubey, D.K.Maheshwari (1993): A Textbook of Microbiology, S.Chand and company Ltd. New Delhi.
3. R.C. Dubey, D.K.Maheshwari (1993): A Textbook of Biotechnology, S.Chand and company Ltd. New Delhi.

CC A IV: Practical Paper (Paper III)

Envi-403: Laboratory Course based on Theory Papers (401 & 402)

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science for water & soil analysis	
Learning Outcome	On completion of the course, students are able to: • To determine the chemical properties of water like acidity, alkalinity, turbidity, hardness to evaluate their impacts on biotic community. • Understand the physical, chemical and biological properties of water samples with water quality standards. • To determine the pH, electrical conductivity of water as well as soil which help to understand the nature of particular water and soil. • Estimate the solids from water to evaluate their effects on humans.	
1	Determination of dissolved organic matter from the soil by Walkey and Black method	4
2	Determination WHC of soil	
3	Determination of chlorides from soil sample	
4	To measure the light intensity through Lux Meter	4
5	To find out the Leaf Area Index (LAI) of given plant leaves	4
6	To compare Biomass and Net Primary Production of Grazed and Un grazed Area	4
7	To study the Biotic Components of Pond Ecosystem	4
8	To study Primary Productivity of Water Body.	4
9	To determine the minimum size of Quadrant by 'Species Area Curve Method'	4
10	Study of Quality criteria of Water for Drinking Purpose	4
11	To study the Presumptive, Confirmed and Completed tests (MPN) for drinking water.	4
12	Determination of BOD of given sewage water sample	4
13	To study the construction and working of Effluent Treatment Plant	4
14	Assessment of Atmospheric Fungi using Petri plate method	4
15	To study the classification of Fire & Fire Extinguisher	4

Note: Mandatory to perform at least 12 practical

References:

1. Waste Water Engineering: Metcalf & Eddy, Tata Mc-Graw Hill Publishers, III Edition (1995)
2. Water Supply and Sanitary Engineering: S. C. Rangwala, Charotar publishing house, Anand (1992)
3. Water and Wastewater Technology: Mark J Hammer & Mark J Hammer Jr., Prentice Hall of India, IV Edition (2002)

4. Environmental Pollution Control Engineering: C.S.Rao,New Age International (P) Ltd. (1991)
5. Sewage Disposal and Air pollution engineering: S. K. Garg, Khanna publishers, New Delhi (1998)
6. Air Pollution and Control: Mowli and Subbayya, Divyajyoti Prakashan, Jodhpur (1989)
7. Air Pollution: V.P. Kudesia, Pragati Prakashan, New Delhi (1997)
   Noise Pollution and Management: G. Gaur, Sarup and Sons, New Delhi (1997)

Skill enhancement courses (SEC) (any Four):

Student has choice to study any four courses from respective semester subject to the availability of particular course at respective college

Semester	SEC	Course Title	SEC	Course Title
III	SEC I	Fundamental of Sample & Solution preparation	SEC II	Microbial Isolation & Identification Techniques
IV	SEC III	Air Quality Monitoring Techniques	SEC IV	Industrial Safety
V	SEC V	Environment Management System	SEC VI	Water Monitoring Techniques
VI	SEC VII	Noise & Illumination Monitoring Techniques	SEC VIII	Fire Safety Management

SEMESTER –III & IV

SEC- I

SEC- I: Fundamental of Sample & Solution preparation (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
I	**Basic in Sampling**	• Meaning of Sample/Solution, definition • Basis of sampling • Importance of sampling	**4**
II	**Sampling Process**	• Types of sampling • Sampling procedures • Sampling statistics • Hazards in sampling	**10**
III	**Preparation of Solution-I**	• Standard solutions • Equivalents & Normality • oxidation numbers • Preparation of standards solutions	**10**
IV	**Preparation of Solution-I**	• EDTA Solution • $NA_2S_2O_3$ Solution • FAS Solution	**6**

SEC- II

SEC- II: Microbial Isolation & Identification Techniques (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
I	**Microbial Media**	• Meaning of media/broth, definition • Basis of media • Sterilization: Meaning/ Definition/ Importance	4
II	**Preparation of Media**	• Types of Media • Procedures of media preparation • Dilutions • Hazards in sampling	10
III	**Identification Techniques-I**	• Stain and Dye • Types of stain • Monochrome Staining • Gram + & - Staining	10
IV	**Identification Techniques-II**	• Streak Plate Method • Spread Plate Method • Enrichment Culture Method	6

SEC- III

SEC- III: Air Quality Monitoring Techniques (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
I	**Air Quality**	• Meaning of air quality, definition • Ambient and workplace air quality • Primary and secondary air pollutants	4
II	**Air pollutants**	• Gaseous air pollutants: SOx & NOx • Dust air pollutants: SPM & RSPM • Health effects of SOx & NOx • Health effects of SPM & RSPM	10
III	**Identification Techniques-I**	• Stain and Dye • Types of stain • Monochrome Staining • Gram + & - Staining	10
IV	**Identification Techniques-II**	• Streak Plate Method • Spread Plate Method • Enrichment Culture Method	6

SEC- IV

SEC- IV: Fundamental of Industrial Safety (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
I	**Basics in IS**	• Concept • History & development of safety • Health Vs Wealth • Industrialization and Accidents • Need of Industrial Safety.	4
II	**Introduction to Industrial Accidents**	• Introduction, Definition, Types of accidents • Causes of accident, Need of accident control • accident protection and control techniques	10
III	**Personal Protective Equipments**	• Concept, Definition, Need Of PPE, Statutory Provision • Non-Respiratory Equipments • Respiratory Equipments	10
IV	**Safety Management**	• Concept and Definition Need Of Safety Management, • Safety Standards, Safety Codes • Safety Policy, Safety Signs	6

SEC- V

SEC- V: Environment Management System (EMS) (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
I	**Basics in EMS**	• Concept • History & development of EMS • Need of EMS • ISO 14000 series • Principles of ISO 14000 series	4
II	**Environment audit**	• Concept of EMS standards • Environmental audit and review cycle • Need of Environment audit • Types of Environment audit	10
III	**EMS process**	• Environmental labeling • Life cycle assessment • Life cycle inventory • Life cycle impact assessment	10
IV	**Environmental Laws and Case**	• Concept, need of the laws • Water (Prevention and Control of Pollution) Act 1974	6

	Studies	• Environment Protection Act 1986 • Case Studies - Bhopal Gas Disaster, Chernobyl Nuclear Disaster	

SEC- VI

SEC- VI: Water Quality Monitoring Techniques (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
I	**Basics in Water Quality**	• Concept • Types of water quality • Physical, chemical and biological properties of water	**4**
II	**Sampling of water**	• Concept • Types of sampling • Requirement for sampling • Preservation of sampling	**10**
III	**Water Quality Standard**	• Concept • Drinking Water Quality Standards • Sewage Waste Water Quality Standards • Industrial Waste Water Quality Standard	**10**
IV	**Analysis of water quality**	• Physical, chemical and biological analysis • Analysis of Colour, Turbidity, Total Solids • Analysis of pH, Hardness, Chlorides • MPN Test	**6**

SEC- VII

SEC- VII: Noise & Illumination Monitoring Techniques (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
I	**Basics in Noise Pollution**	• Definition of Sound and Noise • Sources of noise pollution • Noise pollution level in India • Effects of noise pollution	**4**
II	**Noise Quality Monitoring**	• Concept • Noise Quality Standards • Ambient Noise Quality Monitoring • Workplace Noise Quality Monitoring	**10**
III	**Basics in Illumination**	• Concept • Light intensity at workplace • Standards for Illuminations	**10**

		• Monitoring of Illumination Level	
IV	**Instrumentation**	• Noise Level Meter – Principle and working process • Noise Dose Meter – Principle and working process • Lux Meter – Principle and working process	**6**

SEC- VIII
SEC- VIII: Fire Safety Management (Theory)

TOTAL HOURS: 30 **CREDITS: 2**

Unit No.	Title	Topics	Lectures
I	**Basics in Fire**	• Concept of fire • Fire phenomena • Fire load, factor contributing to fire • Sources of fire	**4**
II	**Heat & Combustion**	• Concept of heat and combustion • Pyrometers & its types • Diffusion flames & Its types	**10**
III	**Fire Extinguisher**	• Concept • Classification of fire • Need of fire safety • Fire extinguisher & its Types	**10**
IV	**Fire Protection Management**	• Fire prevention and detection system, • Inspections, maintenance of ancillary equipments • Training and Mock drill	**6**

Reference Books for SEC I to SEC VIII

1. P. D. Sharma (2006) : Ecology and Environment – Rastogi Publications, Meerut
2. S. T. Ingle et al. (2005) Environment Studies – Prashant Publication House, Pune
3. P. S. Verma and V. K. Agrawal (1998) Environmental Biology (Principles of ecology), S. Chand and company ltd, New Delhi
4. H. V. Jadhav (1994): Principles of Environment Science, Himalaya Publishing House
5. Savindra Singh (2002): Environmental Geography, Prayag Pustak Bhavan, Allahabad
6. Erach Bharucha (2005): Textbook of Environmental Studies for Undergraduate Courses, Universities Press, Hyderabad.
7. P. D. Sharma (2006) : Ecology and Environment – Rastogi Publications, Meerut
8. S. T. ngle et al. (2005) Environment Studies – Prashant Publication House, Pune
9. P. S. Verma and V. K. Agrawal (1998) Environmental Biology (Principles of ecology), S. Chand and company ltd, New Delhi
10. H. V. Jadhav (1994): Principles of Environment Science, Himalaya Publishing House

11. Dr. A. M. Deshmukh (1996): Outlines of Microbiology, Krishnai Publication, Karad
12. P.C. Dubey, D.K. Maheshwari (1993): A Textbook of biotechnology, S.Chand and Co.Ltd, New Delhi.
13. S. C. Santra (2001) : Environment Science, New Central Book Agency (P) Ltd, Kolkata

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

'A' Grade
NAAC Re-accredited
(3rd Cycle)

SYLLABUS STRUCTURE OF

B. Sc. [Environment Science]

T. Y. B. Sc.

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

[2020-21]

PREAMBLE

The syllabus has been prepared anticipating the requirements of B.Sc. Environment Science students under Choice Based Credit System (CBCS) Program. The contents have been drawn to accommodate the widening horizons of the Environment Science discipline and reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

The course curriculum outlined here is designed in an inclusive and interdisciplinary manner and draws content from various allied disciplines. Ideally, an undergraduate programme in environmental science should focus equally on theory and practice so that students are able to pick up necessary skills enabling them to find gainful employment at the job market. Therefore, a number of skill-based courses have been identified and made a part of the curriculum. Attention was also paid to structuring various core courses so as to make them appealing from a practitioner's point of view. It is hoped that a student with a B.Sc. Environmental Science (Hons.) degree, after having read the courses outlined here, should feel adequately equipped to meet the challenges of career development. At the same time, there is sufficient content for those who wish to continue academic life at the university beyond undergraduate level. That said, due care has been taken to maintain necessary academic rigor and depth in the course content so that the learning outcomes from these courses will lead to intellectual growth of a student.

The present syllabus is restructured anticipating the future needs of Environment Science with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Environment Science.

Hence, Board of Studies in Environmental Science in its meeting held on ………….. resolved to accept the revised syllabus for T. Y. B. Sc. (Environmental Science) based on Choice Based Credit System (CBCS) of UGC guidelines.

Scheme of B. Sc. program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		
1	**Core courses (16)**	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	(i) Theory	4	4	4	4	4	3	4	3					4 X14=56
	(ii) Practical	2	4	2	4	2	3	2	3					2X14=28
2	**Ability enhancement compulsory course(AECC) (2)**	2	1	2	1									2X4=08
3	**Skill Enhancement Course (SEC)** (4)					2	1	2	1					2 X2= 04
4	**Discipline Specific Elective DSE (6)**													
	(i) Theory									3	4	3	4	3X8=24
	(ii) Practical									2	3	2	3	2X6 =12
5	**Skill Enhancement Course (SEC):** Skill Based course									3	1	3	1	3X2 =6
6	**Elective Course** (any one)									3	1	3	1	3X2 =6
7	**Elective Audit Course** (out of 3)									NC	Any one	NC	Any one	
	Total Credit value (Credit x No. of Courses)	**26**		**26**		**22**		**22**		**24**		**24**		**144**

NC= None credit

- **Course Structure:**

Duration: The duration of B.Sc. (Environment Science) degree program shall be three years.
Medium of instruction: The medium of instruction for the course shall be **English**.
The present syllabus has been prepared to:

i. Accommodate the advanced topic on the Environment Science discipline
ii. Build the basic science knowledge at the level of first year of Environment Science
iii. Reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

At first year of under-graduation, students are given exposure to basic science to build the foundation of advance Environment Science. For this purpose, more focus on relevant experimentation on the topics is included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of Environmental Microbiology. The relevant practical are included to enrich their knowledge.

At third year under-graduation, six theory and three practical papers each for two semesters are included to uncover all applied areas of Environment Science.

- **Equivalence for T.Y. B.Sc. (Environment Science) is furnished in the following table:**

Old Syllabus (w. e. f. June 2017) (Semester pattern 60:40)	**New Syllabus (w. e. f. June 2020) CBCS pattern (Semester pattern 60:40)**	**Remark, If any**
Envi- 311: Environmental Pollution – I	Envi- 501: Environmental Pollution – I	Code of the Paper change
Envi- 312: Biodiversity and its Conservation – I	Envi- 502: Biodiversity and its Conservation – I	Code of the Paper change
Envi-313: Basic Concept in Environmental Toxicology – I	Envi-503: Basic Concept in Environmental Toxicology – I	Code of the Paper change
Envi-314: Remote Sensing & GIS – I	Envi-504: Remote Sensing & GIS – I	Code of the Paper change
Envi-315: Instrumental Techniques in Environmental Analysis –I	Envi-505 A: Instrumental Techniques in Environmental Analysis –I	Code of the Paper change
Envi-316: Environmental Biotechnology – I	Envi-506 B: Environmental Biotechnology – I	Code of the Paper change
Envi- 317: Practical Course Based On Theory Papers	Envi- 507: Practical Course Based On Theory Papers	Code of the Paper change
Envi- 318: Practical Course Based On Theory Papers	Envi- 508: Practical Course Based On Theory Papers	Code of the Paper change
Envi- 319: Practical Course Based On Theory Papers	Envi- 509: Practical Course Based On Theory Papers	Code of the Paper change
Envi- 321: Environmental Pollution – II	Envi- 601: Environmental Pollution – II	Code of the Paper change
Envi- 322: Biodiversity and its Conservation – II	Envi- 602: Biodiversity and its Conservation – II	Code of the Paper change
Envi-323: Basic Concept in Environmental Toxicology – II	Envi-603: Basic Concept in Environmental Toxicology – II	Code of the Paper change
Envi-324: Remote Sensing & GIS – II	Envi-604: Remote Sensing & GIS – II	Code of the Paper change
Envi-325: Instrumental Techniques in Environmental Analysis –II	Envi-605 A: Instrumental Techniques in Environmental Analysis –II	Code of the Paper change
Envi-326: Environmental Biotechnology – II	Envi-606 B: Environmental Biotechnology – II	Code of the Paper change
Envi- 327: Practical Course Based On Theory Papers	Envi- 607: Practical Course Based On Theory Papers	Code of the Paper change
Envi- 328: Practical Course Based On Theory Papers	Envi- 608: Practical Course Based On Theory Papers	Code of the Paper change
Envi- 329: Practical Course Based On Theory Papers	Envi- 609: Practical Course Based On Theory Papers	Code of the Paper change

The courses codes and titles for the courses are as given below: **T. Y. B. Sc. Envi-Environment Science**.

Semester	Core Course	Paper code	Skill Enhancement Course	Paper code	Elective Course	Paper code
V	Environmental Pollution	**Envi-501**	Air Monitoring Techniques	**Envi-505**	A) Instrumental Techniques in Environmental Analysis –I	**Envi-506A**
	Biodiversity and its Conservation	**Envi-502**			B) Environmental Biotechnology – I	**Envi-506B**
	Basic Concept in Environmental Toxicology – I	**Envi-503**				
	Remote Sensing & GIS – I	**Envi-504**				
	Practical course: Laboratory Course based on Theory Paper-Envi-501	**Envi-507**				
	Practical course: Laboratory Course based on Theory Paper- Envi-502	**Envi-508**				
	Practical course: Laboratory Course based on Theory Paper- Envi-503 & 504	**Envi-509**				
VI	Environmental Pollution-II	**Envi-601**	Water Monitoring Techniques	**Envi-605**	A) Instrumental Techniques in Environmental Analysis –II	**Envi-606A**
	Biodiversity and its Conservation-II	**Envi-602**			B) Environmental Biotechnology – II	**Envi-606B**
	Basic Concept in Environmental Toxicology – II	**Envi-603**				
	Remote Sensing & GIS – II	**Envi-604**				

	Practical course: Laboratory Course based on Theory Paper-Envi-601	**Envi-607**				
	Practical course: Laboratory Course based on Theory Paper- Envi-602	**Envi-608**				
	Practical course: Laboratory Course based on Theory Paper- Envi-603 & 604	**Envi-609**				

Skill Enhancement Course: To increase the potentiality of Environment Science students in industries and to make them more employable, Air Monitoring Techniques and Water Monitoring Techniques, these two courses have been introduced. This course will improve the skills of ambient and workplace air quality monitoring to assess the gaseous and dust pollutants, as well as qualitative analysis of waste water, drinking water, sewage water using standard methods and instruments of Environment Science students which will help them to boost their industrial and research career.

Elective Course: Elective course will give students choice to study the course of their interest. In 5^{th} semester, student can choose either Environmental Biotechnology – I or Instrumental Techniques in Environmental Analysis –I. Whereas in 6^{th} semester they have choice between Environmental Biotechnology – II or Instrumental Techniques in Environmental Analysis – II. Student who has selected Environmental Biotechnology – I for 5^{th} semester, compulsorily has to take Environmental Biotechnology – II in 6^{th} semester. Same is the case for Instrumental Techniques in Environmental Analysis –I and II.

- **Duration of lecture:** 30 Lectures of 60 minutes or 36 Lectures of 50 min or 60 Lectures of 60 minutes or 72 Lectures of 50 min.

- **Examination Pattern**

  Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination.

  - **External Examination:** Theory examination (60 marks) will be of two hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
  - Question 1 (12 marks): 2 sub-questions (a & b), each of 6 marks; (a) MCQ's 6 out of 8 each carry one mark, (b) definition 3 out of 5 each carry 2 marks.
  - Question 2, 3 and 4 (12 marks each): based from Unit I, II, and III, respectively. Question 2 for one sentence answer, 6 out of 8 each question carry 2 marks, Question 3 for short answer, 4 out of 6 each question carry 3 marks, Question 4 for shore note answer, 3 out of 5 each question carry 4 marks.
  - Question 5 (12 marks): answer only 2 out of 4 in brief, based from all 3 units, Each 6 marks.
  - **Internal examination (40 marks each semester):** Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.
  - **Practical Examination:** Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination.

SEMESTER –V
Core Courses

Envi- 501: Environmental Pollution – I (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of pollution, pollutants, also about air, water and marine pollution		
Learning outcome	On completion of the course, students are able to: • Understand the basic concept in pollution, pollutants, their types and effects. • Understand air pollution with sources, causes and effects on biotic community. • Understand water pollution with sources, causes and effects on biotic community. • Understand Marine pollution with sources, causes and effects on biotic community • Aware about their control strategies of different types of pollutions.		
I	**Introduction to Environmental Pollution**	• Definition of pollution • Pollutants • Factors of pollution, Types of pollutants • Levels and Movement of pollutants, Effects of pollution.	**11**
II	**Air pollution**	• Meaning and definition of air pollution • Sources and Types of air pollutants • Air pollution in India • Adverse effects of air pollution • Smog and Acid rains, Control of air pollution.	**11**
III	**Water pollution**	• Definition of water pollution • Sources and Types of water pollutants • Nature and types of water pollution • Surface water pollution, Ground water pollution • Ganga pollution and its control measures • Waste water treatment technology in industries • Primary, Secondary and Tertiary treatment of Sewage Treatment Plants.	**12**
IV	**Marine pollution**	• Introduction, Sources and nature of pollutants sea water pollution • Industrial waste and sewage sludge • Disposal of plastic litters, Oil pollution and Marine biota, • Petrochemicals in the sea, Coral reefs and pollution. •	**11**

Envi- 502: Biodiversity and its Conservation - I (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

<table>
<tr><th>Unit No.</th><th>Title</th><th>Topics</th><th>Lectures</th></tr>
<tr><td>Course Objective</td><td colspan="3">To acquaint students with basic concepts of bioethics and importance of biodiversity, information about different species and environmental movements</td></tr>
<tr><td>Learning outcome</td><td colspan="3">On completion of the course, students are able to:
• Understand the concept of biodiversity, their types, classification and their social, ethical and optional values.
• Aware about bioethics, habitat destruction, fragmentation, degradation and pollution.
• Aware about endangered and endemic species in the world and in the India.
• Aware for the conservation of biodiversity through In-situ and Ex-situ.
• Study of major environmental movements (case study) associated with environment and biodiversity conservation.</td></tr>
<tr><td>I</td><td>Introduction to Biodiversity</td><td>• Introduction, Definition, Genetic, Species and Ecosystem diversity
• Bio-geographical classification of India
• India as Mega-diversity Nation, Value of biodiversity
• Consumptive and Productive use
• Social, Ethical and Optional values</td><td>10</td></tr>
<tr><td>II</td><td>Bioethics and Conservation</td><td>• Key ethical arguments, Causes of extinction
• Habitat destruction, Habitat fragmentation, Habitat degradation & Pollution
• Introduction of exotic species, diseases, over exploitation, shifting and jhum cultivation.</td><td>10</td></tr>
<tr><td>III</td><td>Endangered and Endemic species</td><td>• In India and in World countries
• Conservation of biodiversity
• In-situ and Ex-situ conservation
• Hotspot biodiversity.</td><td>13</td></tr>
<tr><td>IV</td><td>Major Environmental movements</td><td>• Chipko movement
• Silent Valley Movement
• Appiko movement
• Narmada Bachao Andolan,
• Tehri Dam conflicts and ideological trends in Indian environmentalists</td><td>12</td></tr>
</table>

Envi- 503: Basic Concepts in Environmental Toxicology – I (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

<table>
<tr><th>Unit No.</th><th>Title</th><th>Topics</th><th>Lectures</th></tr>
<tr><td>Course Objective</td><td colspan="3">To acquaint students with basic concepts of basics in environmental toxicology</td></tr>
<tr><td>Learning outcome</td><td colspan="3">On completion of the course, students are able to:
• Understands the concept of toxicology, toxicants, their exposure with time and dose, concept of carcinogen and mutagen.
• Study the mechanism of bioaccumulation, biomagnifications, acute and chronic toxicity.
• Understand the factors affecting the toxicity
• Study the toxicity of gaseous pollutants like CO, NOx, SOx and petroleum solvents.</td></tr>
<tr><td>I</td><td>Basic Principles of Toxicology</td><td>• Pollutants, Responses to toxic exposure
• Duration and frequency of exposure
• Dose response relationship
• Carcinogens
• Mutagens
• Natural defense mechanism</td><td>12</td></tr>
<tr><td>II</td><td>Toxic substances</td><td>• Environmental toxicant
• Bioaccumulation
• Bio magnification
• Toxic residues</td><td>12</td></tr>
<tr><td>III</td><td>Toxicity</td><td>• Factors affecting toxicity of chemicals
• Evaluation of toxicity
• Bio assay test, Acute and Chronic toxicity</td><td>11</td></tr>
<tr><td>IV</td><td>Toxicology of gaseous pollutants</td><td>• Carbon monoxide
• Oxides of Nitrogen
• Sulphur dioxides
• Petroleum and Solvents</td><td>10</td></tr>
</table>

Envi- 504: Remote Sensing and GIS – I (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

<table>
<tr><th>Unit No.</th><th>Title</th><th>Topics</th><th>Lectures</th></tr>
<tr><td>Course Objective</td><td colspan="3">To acquaint students with basic concepts of fundamental of RS, sensors, satellite and GIS</td></tr>
<tr><td>Learning outcome</td><td colspan="3">On completion of the course, students are able to:
• Understand the fundamental of remote sensing and their use in environment segments.
• Study of different sensors with their principles and working.
• Understand the construction and working of satellites with different resolution.
• Interpreted the image using different visual and digital recognition elements.
• Understand the concept of GIS, data using in GIS, scanning, digitization and use of GPS.</td></tr>
<tr><td>I</td><td>Fundamentals of Remote Sensing</td><td>• Definition, concept and history of remote sensing
• Electro-magnetic radiation, Energy interaction with atmosphere, interaction with Earth's surface materials
• Spectral reflectance curve, Spectral signatures
• Concept of atmospheric window</td><td>10</td></tr>
<tr><td>II</td><td>Sensors</td><td>• Introduction and types-active and passive sensors
• Along track and across track scanners
• Optical sensor, Microwave sensor
• Thermal sensor and hyper spectral sensor
• Sensor resolution- spectral, spatial, radiometric, temporal
• Platforms: Introduction and types -Ground based, air borne and space borne platforms</td><td>11</td></tr>
<tr><td>III</td><td>Satellites</td><td>• Satellites types, satellite orbit: geosynchronous and sun synchronous satellites
• Indian remote sensing program Characteristics of IRS-P6
• High resolution satellites: IKONOS and Quick Bird.
• Image analysis: visual and digital, Recognition elements: Tone, Texture, Pattern, Shape, Size, Shadow and Association</td><td>12</td></tr>
<tr><td>IV</td><td>Introduction to Geographic Information Systems</td><td>• Definition, components of GIS
• Concept of map, Map scale and Types of Maps
• Data: spatial and non-spatial data, raster and vector data, GIS file formats:, Shapefile and GRID File
• Scanning, Digitization, Geometric transformation
• Topology: introduction, relationships and topological errors, attribute data query, spatial data query
• Global Positioning system (GPS) – Introduction</td><td>12</td></tr>
</table>

Skill Enhance Courses (Any One)

Envi- 505: Air Quality Monitoring Techniques (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of Air quality and its monitoring techniques.		
Learning outcome	On completion of the course, students are able to: • Understand the fundamental of air quality monitoring. • Sound knowledge of air pollutants and its adverse effects on biotic community. • Preparation of chemicals and reagent for the analysis of NOx and SOx. • Knowledge about instruments used in air quality monitoring.		
I	**Air Quality**	• Meaning of air quality, definition • Ambient and workplace air quality • Primary and secondary air pollutants	**10**
II	**Air pollutants**	• Gaseous air pollutants: SOx & NOx • Dust air pollutants: SPM & RSPM • Health effects of SOx & NOx • Health effects of SPM & RSPM	**11**
III	**Air Quality Index**	• History of AQI • Standards of AQI • Importance of AQI • Monitoring of AQI	**12**
IV	**Analytical & Instrumentation Techniques**	• Chemical Reagent use for NOx and SOx determination with their preparation techniques • Principle and working of RDS • Applications of RDS • Principle and working of UV-spectrophotometer • Applications of UV-spectrophotometer	**12**

Elective Courses (Any One)

Envi- 506-A: Instrumental Techniques in Environmental Analysis - I (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of instrumental methods, elementary electronics, EMR and sampling techniques		
Learning outcome	On completion of the course, students are able to: • Understand the use of instruments for environmental analysis, classification of instruments, detection limits and errors associated with instruments techniques. • Study of basic of elementary electronics of instrumentations. • Study of EMR and its interactions with property of wave, particles. • Understand the concept of polarization absorption and emission. • Understanding the process of sampling, concept of standard solution, normalities, and oxidation numbers.		
I	**Instrumental methods of Analysis**	• Introduction, Classification of instrumental methods • Components of instruments • Confidence intervals, Detection limit • Precision and accuracy • Constant errors and proportionate errors	**10**
II	**Elementary Electronics**	• Semiconductors • Properties of Silicon and Germanium Semiconductor • Semiconductor diodes • Transistors, bipolar, Amplifiers, Filters • Voltage regulators, Readout devices	**11**
III	**Electromagnetic Radiation and its Interaction**	• Properties of electromagnetic radiation • Wave properties, Particle properties of radiation, • Energyunits, Electromagnetic spectrum • Polarization of radiation, Absorption of radiation • atomic absorption and molecular absorption • Emission radiation	**12**
IV	**Sampling and Basic Concepts in Chemical Analysis**	• Basis of sampling, Sampling procedures • Sampling statistics, Hazards in sampling • Standard solutions, Preparation of standards • Equivalents • Normality and oxidation numbers • Titrimetric Analysis, Gravimetric analysis	**12**

Envi- 506-B: Environmental Biotechnology - I (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of environmental biotechnology, biomass, biomass energy and bioremediation		
Learning outcome	On completion of the course, students are able to: • Understanding the concept of environmental biotechnology and its global impacts on different field like agriculture, health care and environment. • Study the composition of biomass and its types. • Study the biomass energy gain from petroleum plants, hydrocarbon, liquid fuel and biogas. • Understand the concept of bioremediation with different micro-organisms.		
I	**Introduction of Environmental Biotechnology**	• Scope and importance • Global impact of biotechnology Healthcare, Agriculture • Environment, Biotechnology in India • Need for future development • Ban on genetic food • Gene bank and Plant conservation.	**10**
II	**Biomass**	• Biomass as an energy source • Composition of biomass • Terrestrial biomass, Aquatic biomass • Saline water hyacinth • Waste as a renewable source of energy, • enzymatic digestion.	**11**
III	**Biomass energy**	• Petroleum plants • Hydrocarbon from higher plants • Alcohol the liquid fuel • Biogas	**12**
IV	**Bioremediation**	• In situ bioremediation • Intrinsic bioremediation • Ex-situ bio remediation • Bioremediation of hydrocarbons – use of mixture of bacteria • Use of genetically engineered bacterial strains	**12**

•

Practical Courses

Envi- 507: Practical Course Based On Theory Papers (Practical)

TOTAL HOURS: 60 **CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: • Understanding the concept of sampling and its preservations • Demonstrate on pH and EC meter for monitoring the pH and electrical conductivity of water and soil samples. • Analyse the water with different parameters like solids, available & residual chlorine, and phosphate for determining its quality. • Understand and study of water quality criteria for drinking as well as for waste water.	
1	Study of Safety Instructions	4
2	Collection & Preservation of Water Sample	4
3	Determination of Colour of Industrial effluents	4
4	To study principles, component & working operation of pH & EC Meter	4
5	To study principles, component & working operation of Turbidity Meter	4
6	To study principles, component & working operation of of DO Meter	4
7	Determination of pH & Conductivity of water sample	4
8	Determination of Volatile Solids from soil sample	4
9	Determination of Phosphate from the water	4
10	Determination of Dissolved oxygen by DO meter	4
11	Determination of Residual chlorine from water sample	4
12	Determination of Available chlorine from water sample	4
13	Determination of the total solids from water sample	4
14	Study of Quality criteria of Water for Drinking Purpose	4
15	Study of Quality criteria of Water for Industrial and other Purpose	4

Note: Mandatory to perform at least 12 practicals

Envi- 508: Practical Course Based On Theory Papers (Practical)

TOTAL HOURS: 60 **CREDITS: 2**

Sr. No.	**Title of the Practical**	**Hours**
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: • Understand and study of Air and Noise quality criteria for determining the pollution level. • Demonstrate on RDS sampler for monitoring of oxides of nitrogen, oxides of sulphur, SPM and RSPM. • Analyse the chlorophyll contents for estimation of pollution load. • Understand and study of adaptations of some plants as a pollution resistant.	
1	Study of quality criteria of Air and Noise pollutions	4
2	To study principle, components and working operation of respirable dust sampler	4
3	Determination of NOx from ambient air	4
4	Determination of SOx from ambient air	4
5	Determination of SPM from ambient air	4
6	Determination of RSPM from ambient air	
7	Study of effect of Sulphur dioxide on plants	4
8	Study of effect of Hydrogen sulphide on plants	4
9	Determination of Noise level	4
10	Ecological adaptations of Xerophytes	4
11	Determination of Leaf extract pH of a given plant leaf.	4
12	Determination of Chlorophyll-*a* content of a given sample.	4
13	Determination of Relative Water Contents (RWC) of a given plant leaf.	4
14	Determination of Density, Abundance and Frequency of component species in a Grassland community.	4
15	Determination of requisite size and number of quadrants to be laid down for studying vegetation.	4

Note: Mandatory to perform at least 12 practicals

Envi- 509: Practical Course Based On Theory Papers (Practical)

TOTAL HOURS: 60 **CREDITS: 2**

Sr. No.	**Title of the Practical**	**Hours**
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: • Understand and study of metal digestion and analysis. • Demonstrate on instruments which are used in environmental analysis like Spectrophotometer, flame photometer, gas chromatography. • Analyse the selected metal for estimation of pollution load. • Understand and study of construction and working of ETP for waste water treatment.	
1	Nitric acid digestion for metal analysis	4
2	Nitric acid and Hydrochloric acid digestion for metal analysis	4
3	Nitric acid perchloric acid digestion for fluoride analysis	4
4	Nitric acid sulphuric acid digestion for metal analysis	4
5	Study and demonstration of Atomic Absorption Spectrophotometer	4
6	Study and Demonstration of UV-visible spectrophotometer	4
7	Study and demonstration of Flame Photometer	4
8	Estimation of Sodium by Flame Photometer from the provided sample.	4
9	Estimation of Potassium by Flame Photometer from the provided sample.	4
10	Study on morality, normality and buffers	4
11	Determination of Chlorides from water sample	4
12	To study the construction and working of Effluent Treatment Plant	4
13	Estimation of chromium in water.	4
14	Estimation of Zinc from the provided sample	4
15	Estimation of Mercury from the provided sample	4

Note: Mandatory to perform at least 12 practicals

SEMESTER –VI

Core Courses

Envi- 601: Environmental Pollution – II (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of noise, solid waste, thermal and radioactive pollution		
Learning outcome	On completion of the course, students are able to: • Understand Noise pollution with sources, causes and effects on biotic community. • Understand Solid waste pollution with sources, causes and effects on biotic community. • Understand Thermal pollution with sources, causes and effects on biotic community. • Understand Radioactive pollution with sources, causes and effects on biotic community. • Aware about their control strategies of different types of pollutions.		
I	**Noise Pollution**	• Definition of Sound and Noise • Measurement of noise level, Sources of noise pollution • Noise pollution level in India • Effects of noise pollution, Concept of sound, Noise and hearing problems, Measurement of noise pollution • Noise mapping	**10**
II	**Solid Waste**	• Introduction, History and origin of solid waste • Methods of solid waste collection • Classification of solid waste • Solid waste treatment methods- Pyrolysis, Incineration, Microbial treatment	**11**
III	**Thermal Pollution**	• Introduction, Source and effects of thermal pollution on ecosystem • Hazardous effects, Long term impacts • Process of mixing heated effluents with receiving water • Thermal effects on marine life and bacteria • Effect on water quality, man and its environment	**12**
IV	**Radioactive Pollution**	• Radioactivity, Natural radioactivity • Characteristics of alpha, beta and gamma rays • Radiochemistry, Types of radiochemistry • Radioactive substances • Classification of radioactive isotopes • Case study of radioactive pollution, Chernobyl and Three mile island	**12**

Envi- 602: Biodiversity and its Conservation - II (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of importance of biodiversity conservation through forest and wild life protection		
Learning outcome	On completion of the course, students are able to: • Understand the international agreements associated with environmental awareness. • Understand and study of forest and their types, relation between forest and global warming, carbon sink, nature pollution indicators. • Understand and study the forest conservation through laws. • Concept of forest fire, forest population heavy loss of green beelt and forest research in India. • Understand the strategies for wildlife conservation through study of depletion of wildlife and their effects.		
I	**Environmental Movement**	• Genesis of globalenvironmental movement • environmental resolution- Public Participation • Politics of green movements.	**10**
II	**International Agreements and Environmental Awareness**	• Earth Summit • Convention of Biodiversity • United Nations Convention on Climate Change • Biodiversity Act (2002)	**11**
III	**Protection of Forest**	• Introduction, Importance of forest • Forest and Global warming, Forest are carbon sink and sources of carbon • Natures pollution indicators -Forest • India's forests, Types of forest, National Forest Policy • Forest conservation through laws, Preservation or Conservation strategies • Forest fire, Forest and Indian population • Heavy loss of green belt, Forest research in India	**12**
IV	**Strategies for Wild life**	• Introduction, Importance of wild life to man • Reasons for depletion of wildlife • Effects of wildlife depletion, Reasons for wildlife conservation • Categories of Indian wild life, Endangered species, Protected wild life of India • Biosphere research program • Wild life research in India • Wild life education and training	**12**

Envi- 603: Basic Concepts in Environmental Toxicology – II (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of soil , air, water toxicology with bio-transformation		
Learning outcome	On completion of the course, students are able to: • Understand the basics of soil toxicology. • Study of toxic elements of air and water like Lead, Mercury, Arsenic, Chromium, Cadmium, Nickel, Bismuth, Zinc, Copper, Manganese, etc. • Aware about toxicity of pesticides and their effects. • Understand the concept of eco-toxicology, public health, animals in relation to human health.		
I	**Soil toxicology**	• Organic chemicals in the soil environment • Inorganic chemicals in the soil environment	**10**
II	**Effect of Toxic elements for Air and Water**	• Lead • Mercury • Arsenic • Chromium • Cadmium • Nickel • Bismuth • Thallium, Vanadium • Zinc • Copper • Manganese	**11**
III	**Toxicity of Pesticides**	• Introduction • Classification of pesticides • Pesticide and human health	**12**
IV	**Bio transformation Phase I and Phase II**	• Chemical toxicants • Industrial and Agricultural wastes • Eco-toxicology • Public health, Animals in relation to human health • Ecological change and diseases • Water relation to human health • Urbanization stress and health	**12**

Envi- 604: Remote Sensing and GIS – II (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

<table>
<tr><th>Unit No.</th><th>Title</th><th>Topics</th><th>Lectures</th></tr>
<tr><td>Course Objective</td><td colspan="3">To acquaint students with basic concepts of Vector and raster data use in RS & GIS, applications of RS & GIS in different field</td></tr>
<tr><td>Learning outcome</td><td colspan="3">On completion of the course, students are able to:
• Understand the analysis of vector data using buffering.
• Study the analysis of raster data using overlay features.
• Understand and study of applications of RS and GIS in agriculture field.
• Understand and study of applications of RS and GIS in social science & Geo- disaster management field.
• Understand and study of applications of RS and GIS in forestry, ecology, and watershed & water resource management.</td></tr>
<tr><td>I</td><td>Vector Data Analysis</td><td>• Buffering – Variations in Buffering
• Overlay- Feature Type and overlay
• concept of Distance measurement
• concept of Pattern analysis</td><td>10</td></tr>
<tr><td>II</td><td>Raster Data Analysis</td><td>• Data Analysis Environment
• Concept of Local Operations
• Concept of Physical distance Measurement Operations
• Comparison of Vector- and Raster- Based Data Analysis</td><td>11</td></tr>
<tr><td>III</td><td>Applications of RS and GIS in Agriculture, Soil Sciences and Drought Management</td><td>• Agriculture: Introduction – Agriculture Ecosystems, Yield parameters, identification of crops and acreage estimation, disease identification
• Soil Sciences: Introduction –Soil classification, Spectral response curve of soils, soil mapping, mapping and monitoring of degraded land
• Drought Management: Introduction, Types of drought, consequences, drought management</td><td>12</td></tr>
<tr><td>IV</td><td>Applications of RS and GIS in Forestry and Ecology and Watershed and Water Resource Management</td><td>• Forestry and Ecology: Introduction - forest density, Forest type mapping, inventory of forests, delineation of degraded forests, damage assessment, Landscape characterization, Biomass assessment
• Watershed and Water Resource Management: Sustainable watershed management, Spectral response of pure water, Water pollution detection, Salinity and waterlogged area mapping</td><td>12</td></tr>
</table>

Skill Enhance Courses (Any One)

Envi- 505: Water Quality Monitoring Techniques (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of Water quality and its monitoring techniques.		
Learning outcome	On completion of the course, students are able to: • Understand the fundamental of water quality monitoring. • Sound knowledge of water pollutants and its adverse effects on biotic community. • Knowledge and skill about water quality standards. • Knowledge about standard methods used in water quality monitoring.		
I	**Basics in Water Quality**	• Concept • Types of water quality • Physical, chemical and biological properties of water	**10**
II	**Sampling of water**	• Concept • Types of sampling • Requirement for sampling • Preservation of sampling	**11**
III	**Water Quality Standard**	• Concept • Drinking Water Quality Standards • Sewage Waste Water Quality Standards • Industrial Waste Water Quality Standard	**12**
IV	**Analysis of water quality**	• Physical, chemical and biological analysis • Analysis of Colour, Turbidity, Total Solids • Analysis of pH, Hardness, Chlorides • MPN Test	**12**

Elective Courses (Any one)

Envi- 606 - A: Instrumental Techniques in Environmental Analysis -II (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of principles and working operation of different environmental instruments, chromatography, spectro-photometry and environmental statistics		
Learning outcome	On completion of the course, students are able to: • Understand the use of different instruments like pH meter, EC meter, Turbidity meter, Flame photo meter, Bomb Calorimeter, etc. • Study of spectrophotometer using UV-visible and Atomic Absorption Spectrophotometer. • Study of chromatography techniques using column chromatography, Ion exchange chromatography, Thin layer chromatography, Gas chromatography and HPLC. • Understand the concept of environmental statistics through mean, mode, median and variance.		
I	**Principle and Applications of Instruments**	• pH meter, • Potentiometry • Conductometry • Turbidimetry • Flame Photometry • Bomb Calorimeter • Neutron Activation Analysis • Isotope Dilution Analysis.	**11**
II	**Spectrophotometry**	• Introduction - UV-visible spectrophotometer • Single beam/Double beam, Radiation sources, Wavelength selection, Sample containers, Detectors • Atomic absorption spectrophotometer-Introduction, Radiation sources, Wavelength selection, Sample containers, Detectors • Introduction to Inductively Coupled Plasma Optical Emission Spectroscopy (ICPOES).	**10**
III	**Chromatography**	• An introduction of chromatography • Classification of separation methods • Classification of chromatography • Qualitative and quantitative analysis • Column chromatography • Liquid-liquid Partition chromatography • Ion exchange, Thin layer, Paper, Gas Chromatography • HPLC, Electrophoresis	**12**

IV	**Environmental Statistics**	• Fundamental of Statistics • Mean • Mode • Median • Variance	12

Envi- 606 - B: Environmental Biotechnology - II (Theory)

TOTAL HOURS: 45 **CREDITS: 3**

Unit No.	Title	Topics	Lectures
Course Objective	To acquaint students with basic concepts of bioremediation, bioleaching and hazards of environmental engineering		
Learning outcome	On completion of the course, students are able to: • Understanding the concept of toxicity of bioremediation through metal and dyes. • Study the concepts of xenobiotics. • Study the process of bioleaching using different micro-organisms • Understand the hazards in environmental engineering through growth inhibition and replacement of natural strains.		
I	**Bioremediation Toxicity**	• Bioremediation of heavy metals, Bioremediation of dyes • Genetic modification in industrial effluents • Wastewater treatment technology • Role of microbes in effluents	10
II	**Bioremediation**	• Xenobiotics • Gene manipulation of pesticides regarding microorganisms	11
III	**Bioleaching**	• Introduction, Definition • Types of leaching- Direct & Indirect leaching • Microorganism used in leaching • Leaching of Copper • Leaching of Uranium • Leaching of Gold and Silver	12
IV	**Hazards of Environmental engineering**	• Survival of gene modified microorganisms in the environment • Adaptive mutagenesis • Effect of environmental factors on gene transfer • Ecological impacts of gene modified microorganisms released in the environment • Growth inhibition of natural strains • Replacement of natural strains	12

Practical Courses

Envi- 607: Practical Course Based On Theory Papers (Practical)

TOTAL HOURS: 60 **CREDITS: 2**

Sr. No.	**Title of the Practical**	**Hours**
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: • Determine different parameters like ammonia, nitrates and sulphate from water samples to describe its quality. • Demonstrate on turbidity meter to determine the water turbidity. • Analyse the soil for measuring the chlorides for determining its quality. • Understand and study of water quality criteria for drinking as well as for sewage waste water through BOD and COD.	
1	Determination of pH & Conductivity of sewage water sample	4
2	Determination of pH & Conductivity of soil sample	
3	Determination of Nitrate from the water.	4
4	Determination of Sulphate from the water.	4
5	Determination of Ammonia from the water	4
6	Estimation of coliform bacteria from water by MPN test (2 days required)	4
7	Determination of Turbidity by Turbidity meter	4
8	Determination of Ca & Mg Hardness of given water sample	4
9	Determination of Calcium & Magnesium ions from given water sample	4
10	Determination of soil moisture	4
11	Determination of chlorides from soil sample	4
12	Determination of DO of sewage water sample	
13	Determination of BOD of sewage water sample	4
14	Determination of COD of sewage water sample	4

Note: Mandatory to perform at least 12 practicals

Envi- 608: Practical Course Based On Theory Papers (Practical)

TOTAL HOURS: 60 **CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: • Understand and study of physical characteristics of soil like bulk density, water holding capacity, organic carbon, organic matter etc. • Study and determining the atmospheric fungi for its effects on human • Analyse the chlorophyll contents for estimation of pollution load. • Understand and study of adaptations of different plant and animal species for survival in the environment.	
1	Estimation of Primary productivity	4
2	Determination of soil bulk density	4
3	Determination WHC of soil	4
4	Estimation of Organic carbon	4
5	Demonstration of Spirometer for use in occupational health	4
6	Assessment of Atmospheric Fungi using Petri plate method (2 days required)	4
7	Ecological adaptations of Mesophytes	4
8	Ecological adaptations of Hydrophytes	4
9	Determination of Sludge Volume Index	4
10	Determination of Oil & grease from given water sample	4
11	To study and analyze the Physical parameters of solid waste	4
12	To study and analyze the Chemical parameters of solid waste	4
13	Study on noise pollution in flourmills	4
14	Study on dust pollution in flourmills	

Note: Mandatory to perform at least 12 practicals

Envi- 609: Practical Course Based On Theory Papers (Practical)

TOTAL HOURS: 60 **CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: • Understand and study of satellite images using different characteristic like tone, texture, pattern, shape and size. • Demonstrate on instruments which are used in environmental analysis like Bomb calorimeter and HPLC. • Computation of environmental statistics through mean, mode, median and variance. • Understand and study of determination of selected metal for their toxicological effects.	
1	Study and Demonstration of Bomb calorimeter	4
2	Estimation of Chlorophyll content by TLC method	4
3	Study and Demonstration of Gas Chromatography	4
4	Computation of Mean, Median, Mode and Variance of the given environmental data set	4
5	Use of excel program for calculating mean, standard deviation.	4
6	Use of excel program for preparation of chart and graphs.	4
7	Use of MS-Word for creating document, tables and graphs.	4
8	Study of Satellite Image	4
9	Study of Thematic Map	4
10	Demonstration on the use of GPS	4
11	Marked the latitude and longitude and preparation of location map using GPS	4
12	Use of GIS software for environment studies	4
13	Estimation of Iron from the provided sample	4
14	Estimation of Lead from the provided sample	4
15	Estimation of Cadmium from the provided sample	4

Note: Mandatory to perform at least 12 practicals

Reference Books for Semester V & VI (T. Y. B. Sc. – Environment Science)

❖ Envi-501 & 601 - Environmental Pollution - I & II

1. Environmental chemistry by B. K. Sharma, Goel publication house, Meerut, Sixth revised edition – 2001.
2. Environmental geography by Savindra Singh, Prayag Pustak Bhavan, Allahabad. Revised edition – 2002.
3. Ecology and environment by P. D. Sharma, Rastogi publications, Meerut. Seventh edition – 2004.
4. Environmental studies by S. T. Ingle and S. R. Thorat, Prashant publications, Pune, First edition – 2005.

❖ Envi- 502 & 602 - Biodiversity and its Conservation – I & II

1. Environmental chemistry by B. K. Sharma, Goel publication house, Meerut, Sixth revised edition – 2001.
2. Environmental geography by Savindra Singh, Prayag Pustak Bhavan, Allahabad. Revised edition – 2002.
3. Ecology and environment by P. D. Sharma, Rastogi publications, Meerut.Seventh edition – 2004.
4. Environmental studies by S. T. Ingle and S. R. Thorat, Prashant publications, Pune, First edition – 2005.

❖ Envi-503 & 603 – Basic Concepts in Environmental Toxicology – I & II

1. Environmental Toxicology and Chemistry by Donald D Crossby. First edition– 2001.
2. Toxicology principle and methods, M. A. Subramaniam, MJP publishers, Chennai. First edition – 2003.
3. Environmental toxicology – Satake and Mido Discovery publishing home.New Delhi, Second edition – 2005.
4. Toxicology by Sumitro Ghosh, Dominant publishers, New Delhi. First edition– 2005.

❖ Envi-504 & 604 – Remote Sensing and GIS – I & II

1. Textbook of Remote sensing and geographical information systems, M. Anji Reddy (2006), B.S. Publications, Hyderabad.
2. Remote sensing Principles and applications, Dr. B. C. Panda (2005), Viva books Private New Delhi.
3. Elements of Photogrammetry, Paul R. Wolf, McGraw-Hill, 2000.
4. Remote sensing and Image interpretation, Lillesand and Keifer, John Wiley and Sons,1987.
5. Introduction to Geographical Information System, Kang- Tsung – Chang, 2002, McGrawHill.
6. Geographic Information System- an introduction, 3rd edition, Tor Bernhardsen, Wiley Pub.

7. Geographic Information Systems and Science (2nd ed.), 2005, Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind, John Wiley & Sons, Ltd.
8. Concepts and techniques of Geographic Information System, C.P.Lo & Albert K.W.Yeung, 2002, Prentice Hall, India.
9. Introduction of Geographic Information Systems and Science, Paul A. Lonfley, Michel Goodchild, D.J.Maguire & D.W. Rhind, 2002, John Wiley & Sons Ltd.

❖ **Envi-505 & 605 – Air Quality Monitoring Techniques and Water Quality Monitoring Techniques**

1. Environmental Pollution Control Engineering: C.S.Rao,New Age International (P) Ltd. (1991).
2. Air Pollution and Control: Mowli and Subbayya, Divyajyoti Prakashan, Jodhpur (1989)
3. Air Pollution: V.P. Kudesia, Pragati Prakashan, New Delhi (1997).
4. Waste Water Engineering: Metcalf & Eddy, Tata Mc-Graw Hill Publishers, III Edition (1995).
5. Water Supply and Sanitary Engineering: S. C. Rangwala, Charotar publishing house, Anand (1992).
6. Water and Wastewater Technology: Mark J Hammer & Mark J Hammer Jr., Prentice Hall of India, IV Edition (2002)
7. Environmental Pollution Control Engineering: C.S.Rao,New Age International (P) Ltd. (1991)

❖ **Envi-506 A & 606 A – Instrumental Techniques in Environmental Analysis – I & II**

1. Environmental Science by S. C. Santra, Central Publishing, New Delhi. First edition 2000.
2. Environmental Toxicology and Chemistry by Donald D Crossby. First edition – 2001.
3. Toxicology principle and methods, M. A. Subramaniam, MJP publishers, Chennai. First edition – 2003.
4. Toxicology by Sumitro Ghosh, Dominant publishers, New Delhi. First edition – 2005.
5. Vogel’s Textbook of Chemical Analysis, ElBS publisher, Third edition –2005.
6. Instrumental Methods of Chemical Analysis – Willard and Merritt, CBS publisher. Second edition – 2001.

❖ **Envi-506 B & 606 B – Environmental Biotechnology – I & II**

1. Fundamentals of Biotechnology by Purohit, Discovery Publishing House. First edition – 2003.
2. Biotechnology by RC Dubey S. Chand Publications, New Delhi. Second edition – 2003.
3. Advance in Biotechnology by S. N., Jogdand. Himalaya Publishing, India. First edition – 2001.
4. Biotechnology fundamentals and applications - Agrobotanical Publishers, India. First edition – 2005.
5. Environmental Science by S. C. Santra, Central Publishing, New Delhi. First edition – 2000.

❖ **Envi-507, 508, 509 & 607, 608, 609 –** Practical Course Based On Theory Papers

1. Waste Water Engineering: Metcalf & Eddy, Tata Mc-Graw Hill Publishers, III Edition (1995)
2. Water Supply and Sanitary Engineering: S. C. Rangwala, Charotar publishing house, Anand (1992)
3. Water and Wastewater Technology: Mark J Hammer & Mark J Hammer Jr., Prentice Hall of India, IV Edition (2002)
4. Environmental Pollution Control Engineering: C.S.Rao,New Age International (P) Ltd. (1991)
5. Sewage Disposal and Air pollution engineering: S. K. Garg, Khanna publishers, New Delhi (1998)
6. Air Pollution and Control: Mowli and Subbayya, Divyajyoti Prakashan, Jodhpur (1989)
7. Air Pollution: V.P. Kudesia, Pragati Prakashan, New Delhi (1997)
8. Noise Pollution and Management: G. Gaur, Sarup and Sons, New Delhi (1997)

KAVAYITRI BAHINABAI CHAUDHARI

NORTH MAHARASHTRA UNIVERSITY JALGAON

||अंतरी पेटवू ज्ञानज्योत||

1990

'A' Grade

NAAC Re Accredited

(3rd Cycle)

SYLLABUS of

F.Y. B. Sc. (MATHEMATICS)

(Semester System 60+40 Pattern)

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

Effective from June 2022

Scheme for B. Sc. (Mathematics) under Choice Based Credit System pattern with

F.Y. B. Sc. Syllabus

Effective from June 2022

Sem.	Course	Paper	Course Code with Title	Credit	No. Periods in Hour /week	No. Periods of 45 min.
I	MTHCC- A	Paper - 1	MTH 101: Matrix Algebra	2	2	3
		Paper - 2	MTH 102: Calculus of Single Variable	2	2	3
		Paper - 3	MTH 103 (A): Co-ordinate Geometry **or** MTH 103 (B): Discrete Mathematics	2	2	3
II	MTHCC- B	Paper-1	MTH 201: Ordinary Differential Equations	2	2	3
		Paper- 2	MTH 202: Theory of Equations	2	2	3
		Paper - 3	MTH 203 (A): Laplace Transforms **or** MTH 203 (B): Numerical Methods	2	2	3

SEMESTER - I

MTHCC- A
MTH 101: Matrix Algebra

Course Description:

This course provides an elementary level knowledge of Rank and adjoint of matrix, Applications of matrices to system of linear equations, Eigen values and Eigen vectors of matrices and also the transformation of matrices.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective:

A primary need for the establishment of this course is to understand the basic knowledge and applications of matrices in various fields. So, the main objective is to teach mathematical approaches and models to grow mathematical skill, to improve mathematical thinking and to improve choice making power of the students.

Learning Outcomes:

Upon successful completion of this course the student will be able to:

a) understand concepts on matrix operations and rank of the matrix.
b) understand use of matrix for solving the system of linear equations.
c) understand basic knowledge of the eigen values and eigen vectors.
d) apply Cayley-Hamilton theorem to find the inverse of the matrix.
e) know the matrix transformation and its applications in rotation, reflection, translation.

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Unit 1: Adjoint and Inverse of a Matrix. (Marks 15, 08 hours)

Elementary operations on matrices, Adjoint of a matrix, Inverse of matrix, Existence, uniqueness and properties of inverse of a matrix.

Unit 2: Rank of a Matrix. (Marks 15, 08 hours)

Elementary matrix, Rank and Normal form of a matrix. Reduction of matrix to its normal form. Rank of product of two matrices.

Unit 3: System of Linear Equations and Eigen Values. (Marks 15, 07 hours)

A homogeneous and non-homogeneous system of linear equations. Consistency of system of linear equations. Application of matrices to solve the system of linear equations. Eigen values, Eigen vectors, Characteristic equation of a matrix, Cayley Hamilton theorem, (Statement only) and its use to find the inverse of a matrix.

Unit IV: Orthogonal Matrices and Quadratic Forms. (Marks 15, 07 hours)

Orthogonal matrices. Properties of orthogonal matrices. Quadratic forms: matrix representation. Elementary congruent transformations. Diagonal form of a quadratic form. Canonical forms.

REFERENCE BOOKS:

1. Matrix and Linear Algebra, by K. B. Datta, Prentice Hall of India Pvt. Ltd. New Delhi,2000.
2. A Text Book of Matrices, by Shanti Narayan, S. Chand Limited, 2010.
3. Schaum's Outline of Theory and Problems of MATRICES, by Richord Bronson, McGraw-Hill, New York, 1989.

MTH 102 –Calculus of Single Variable

Course Description: This course provides fundamental knowledge of limits and continuity, Differentiations, Mean value theorem, Rolle's theorem, Cauchy's Mean value theorem and Geometrical interpretations.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective: Use the fact that the derivative is the slope of the tangent line to the curve at a given point to help determine the derivatives of simple linear functions. The basic need of this course is to understand the concepts Limits, Derivative and applications of calculus. Use the Intermediate Value Theorem to identify an interval where a continuous function has a root. Use the fact that the derivative is the slope of the tangent line to the curve at a given point to help determine the derivatives of simple linear functions. Also, this course will improve problem solving and logical thinking abilities of the students. By learn this course students can use the concepts of calculus to develop different mathematical models.

Learning Outcomes: Upon successful completion of this course the student will be able to:

a) understand basic concepts on limits and continuity.
b) understand use of differentiations in various theorems.
c) know the Mean value theorems and its applications.
d) make the applications of Taylor's, Maclaurin's theorem.
e) know the applications of calculus.
f) Determine the derivative of a function using the limit definition.
g) Interpret the derivative as the slope of a tangent line to a graph, the slope of a graph at a point, and the rate of change of a dependent variable with respect to an independent variable
h) Use the first and second derivatives to analyze and sketch the graph of a function, intervals on which the graph is increasing, decreasing.

Unit-1 Limit and Continuity (Marks 15, 08hours)

Epsilon-delta definition of limit of a function, Basic properties of limit, Indeterminate form, L-Hospitals rule, Examples of limit, Continuous function.

Properties of continuous function on closed and bounded interval.

i. Boundedness.
ii. Attains its bounds
iii. Indeterminate mean value theorem.
iv. Uniform continuity.

Unit-2 Mean Value Theorems (Marks 15, 08 hours)

Differentiability, Definition of derivative ,Theorem on continuity and examples, Roll's theorem, Langrage's Mean value theorem, Cauchy's mean value theorem, Examples on Roll's theorem, Langrage's Mean value theorem & Cauchy's mean value theorem, Geometrical interpretation and application, Increasing and Decreasing function.

Unit-3. Successive Differentiation **(Marks 15, 07 hours)**

The nth derivative of some standard functions:

$$e^{ax+b}, x^m, (ax+b)^m, \frac{1}{ax+b}, \log(ax+b), \sin(ax+b), \cos(ax+b),$$
$$e^{ax}\sin(ax+b), e^{ax}\cos(ax+b)$$

Leibnitz's Theorem and examples on it.

Unit-4. Application of differential Calculus. **(Marks 15, 07 hours)**

Taylor's theorem with Lagrange's form of remainder and related examples.

Maclaurin' theorem with Lagrange's form of remainder and related examples.

Reduction formulae

i. $\int_0^{\pi/2} (\sin x)^n \, dx$

ii. $\int_0^{\pi/2} (\cos x)^n \, dx$

iii. $\int_0^{\pi/2} (\sin x)^m (\cos x)^n dx$

iv. $\int \left(\frac{\sin nx}{\sin x}\right) dx$ and examples on it.

REFERENCE BOOKS:

1. Theory and Problems of Advanced Calculus, by Robert Wrede and Murray R. Spiegel, McGraw-Hill Company, New York, Second Edition, 2002.
2. Text Book on Differential calculus, by Gorakh Prasad, Pothishala Private Ltd., Allahabad, 1959.
3. Integral calculus, by Gorakh Prasad, Pothishala Private Ltd., Allahabad
4. Problems in Calculus of One Variable, by I. A. Maron CBS Publishers & Distributors

MTH 103(A): Coordinate Geometry

Course Description: This course provides an elementary level knowledge of two- and three dimensional geometries especially sphere, cone and cylinders.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective: General objectives are to study two-dimensional geometry, translation and rotation of axes and its use to convert in standard 2-d forms. Also, to study three-dimensional geometry, Sphere, Cone and Cylinder along with their properties and interpretations.

Learning Outcomes:

Students can visualize geometrical concepts and draw two dimensional figures and can find their standard forms by shifting and rotation of axes. Students also can draw three dimensional figures and their equations particularly Sphere, Cone and Cylinder.

Unit-I Analytical Geometry **(Marks 15, 08 hours)**

Change of axes, Translation and Rotation,Invariant, Conic section, General equation of second degree in two variables and its reduction to standard form.

Unit-II Sphere **(Marks 15 , 08 hours)**

Equation of sphere in different forms, Plane section of sphere, Tangent line and Tangent plane to sphere,

Condition of tangency and point of contact, Interpretation of $S + \lambda S' = 0$, and $S + \lambda U = 0$ with usual notations.

Unit-III Cone **(Marks 15, 07 hours)**

Equation of cone with vertex at origin, Equation of cone with vertex at (α, β, γ), Right circular cone, Enveloping cone of sphere.

Unit-IV Cylinder **(Marks 15, 07 hours)**

Definition of cylinder, Equation of cylinder, Right circular cylinder, Enveloping cylinder.

REFERENCE BOOKS:

1. The Elements of Coordinate Geometry, By S. L. Loney, Mc-Millan and Company, London, 1895.
2. Text Book of Coordinate Geometry, By Gorakh Prasad and H. C. Gupta, Pothishala Pvt. Ltd. Allahabad,2000.
3. Analytical Solid Geometry, By Shanti Narayan, S. Chand and Co., 1959.

MTH 103(B): Discrete Mathematics

Course Description: This course provides fundamental knowledge of discrete mathematics.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective: To study

- Partition and Relations
- Coding Theory
- Mathematical logic
- Boolean Circuit and Algebra

Learning Outcomes:

Students are able to understand the concepts of relations, coding and decoding, mathematical logic, Boolean algebra.

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Unit-1. Relation **(Marks 15, 08 hours)**

1.1 Partition of sets

1.2 Cartesian product of two sets

1.3 Relation: Domain and range of relation

1.4 Inverse relation

1.5 Reflexive, Symmetric, Anti-Symmetric, Transitive relations, equivalences relation

1.6 Equivalence Classes

Unit-2. Coding Theory **(Marks 15, 08 hours)**

2.1 Weight of word, Hamming Distance, Message

2.2 Encoding Function, Detection of k or Fewer Errors, Parity Check Code

2.3 Minimum Distance of Encoding Function

2.4 Parity Check Matrix

2.5 Decoding Function, Maximum Likelyhood Decoding Function (Only Theory)

Unit-3. Mathematical Logic **(Marks 15, 07 hours)**

3.1 Statement

3.2 Logical Connectives: Conditional, Bi-conditional, Converse, Inverse, Contrapositive

3.3 Tautology, Contradiction, Satisfiable

3.4 Duality Law

3.5 Algebra of Proposition

3.6 Exclusive OR, NAND, NOR

Unit-4. Boolean Algebra **(Marks 15, 07 hours)**

4.1 Gates: NOT, AND, OR, NOR, NAND, XOR, XNOR

4.2 Combinatorial Circuit

4.3 Boolean Expression

4.4 Equivalence Combinatorial Circuits

4.5 Boolean Algebra

REFERENCE BOOKS:

1. Fundamental Approach to Discrete Mathematics by D. P. Achariya Sreekumar, New Age International Publishers, New Delhi.
2. Discrete Mathematical Structures by Bernard Kolman, Robert C Busby and Ross, Prentice Hall of India New Delhi, Eastern Economy Edition.

SEMESTER - II

MTH 201: Ordinary Differential Equations

Course Description: This course provides fundamental knowledge of Ordinary Differential Equations and their applications.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective: The basic need of this course is to understand the different methods of solving differential equations and their applications to solve problems arrives in engineering and technology.

Learning Outcomes: After successful completion of this course the student will be able to:

a) understand basic concepts in differential equations.

b) understand method of solving differential equations

c) understand use of differential equations in various fields.

Unit-I Differential Equations of First Order and First Degree (Marks 15, 08 hours)

a) Partial derivatives of first order.

b) Exact differential equations. Condition for exactness.

c) Integrating factor.

d) Rules for finding integrating factors.

e) Linear differential equations.

f) Bernoulli's Equation. Equation reducible to linear form.

Unit-II Differential Equations of First Order and Higher Degree (Marks 15, 07 hours)

a) Differential equations of first order and higher degree.

b) Equation solvable for p.

c) Equation solvable for y.

d) Equation solvable for x.

e) Clairaut's form.

Unit-III Linear Differential Equations with Constant Coefficients (Marks 15, 08 hours)

a) Linear differential equations with constant coefficients.

b) Complementary functions.

c) Particular integrals of $f(D)y = X$, where $X = e^{ax}$, $cos(ax)$, $sin(ax)$, x^n, $e^{ax}V$ & xV with usual notations.

Unit-IV Homogeneous Linear Differential Equations (Marks15, 07hours)

a) Homogeneous linear differential equations (Cauchy's differential equations).

b) Example of Homogeneous linear differential equations.
c) Equations reducible to homogeneous linear differential equations (Legendre's equations)
d) Example of Equations reducible to homogeneous linear differential equations

REFERENCE BOOKS:

1. Introductory Course in Differential Equations, by D. A. Murray, Orient Congman (India) 1967.
2. Differential Equations, by G. F. Simmons, Tata McGraw Hill, 1972.

MTH 202: Theory of Equations

Course Description: This course provides fundamental knowledge of Theory equations.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective: To study

- Divisibility of numbers and Roots of polynomial equations.
- Relations between roots and coefficients of polynomials.
- Roots of cubic equations by using Cardon's method, biquadratic equations by Descarte's method and roots of polynomial equation s by Newton's method.

Learning Outcomes:

Students can find out roots of any equation of degree less than or equal to five. Theory of equations is highly useful in various subjects like algebra, linear algebra, calculus, ordinary and partial differential equations etc.

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Unit-1. Divisibility of Integers **(Marks15, 08 hours)**

Number Systems. Well ordering principle (statement only). Principle of Mathematical Induction. Divisibility of integers and theorems. Division algorithm. GCD and LCM. Euclidean algorithm. Unique factorization

Unit-2. Polynomials **(Marks15, 08 hours)**

Revision of Polynomials, Horner's method of synthetic division, Existence and uniqueness of GCD of two polynomials, Polynomial equations, Factor theorem and generalized factor theorem for polynomials, Fundamental theorem of algebra (Statement only), Methods to find common roots of polynomial equation, Descarte's rule of signs, Newton's method of divisors for the integral roots.

Unit-3. Theory of Equations-I **(Marks15, 07 hours)**

Relation between roots and coefficient of general polynomial equation in one variable. Relation between roots and coefficient of quadratic, cubic and biquadratic equations. Symmetric functions of roots.

Unit-4. Theory of Equations–II **(Marks15, 07 hours)**

Transformation of equations. Cardon's method of solving cubic equations. Biquadratic equations. Descarte's method of solving biquadratic equations.

REFERENCE BOOKS:

1. Elementary Number Theory, by David M. Burton, W. C. Brown publishers, Dubuquolowa, 1989.
2. Higher Algebra, by H. S. Hall and S. R. Knight, H. M. Publications, 1994.
3. Matrix and Linear Algebra, by K. B. Datta, Prentice Hall of India Pvt. Ltd. New Delhi, 2000.
4. Theory of Equations, by D. R. Sharma, Sharma Publications, Jalandar, 2003.

MTH 203(A): Laplace Transforms

Course Description: This course offers an introduction to the concepts of Laplace transforms, Inverse Laplace transforms along with some important properties, and solution of an ordinary differential equations using Laplace transform.

Prerequisite Course: 11 and 12 standard Mathematics.

General Objective: The basic need of this course is to understand the concepts and applications of Laplace transforms. The concepts and methods are useful for solving Differential Equations.

Course Outcomes:

Upon successful completion of this course the student will be able to:

- Know about piecewise continuous functions, Dirac delta function, Laplace transform and its properties.
- Know about Unit step, Periodic, Error, Gamma and Null functions.
- Understand Laplace and Inverse Laplace transforms.
- Know the basic properties of Laplace and inverse Laplace transforms.
- Calculate the Laplace transform of basic functions using the definition.
- Find the Laplace transform of derivatives of functions.
- Compute inverse Laplace transforms.
- Solve ordinary differential equations using Laplace transforms.

UNIT-I: Laplace Transform and Their Basic Properties **(Marks15, 08 hours)**

1. Basic concept & Definition of Integral Transform.
2. Definition of the Laplace transform, Kernel of Laplace Transform
3. Definition of Sectional or piecewise continuity& Functions of exponential order
4. Sufficient conditions for existence of Laplace transform.
5. Laplace transforms of elementary functions
6. Some important properties of Laplace transforms: Linearity property, First translation or shifting property, Second translation or shifting property, Change of scale property, Laplace transform of derivatives, Laplace transform of integrals, Multiplication by t^n, Division by t.

UNIT-II: Laplace Transform of Some special functions (Marks15, 08 hours)

1. Periodic functions.
2. The Gamma function.
3. The Error &Complementary Error function.
4. Unit step function.
5. Unit impulse or Dirac delta function.
6. Null functions.
7. Evaluation of integrals by Laplace transform.

UNIT-III: Inverse Laplace Transform (Marks15, 07 hours)

1. Definition of inverse Laplace transform, Uniqueness of inverse Laplace transform.
2. Inverse Laplace transform of some functions.
3. Some important properties of inverse Laplace transforms: Linearity property, First translation or shifting property, Second translation or shifting property, Change of scale property, Inverse Laplace transform of derivatives, Inverse Laplace transform of integrals, Multiplication by s^n, Division by s.
4. Convolution Theorem(Without Proof)
5. Partial fraction Method.

UNIT-IV: Applications to Differential Equations (Marks15, 07 hours)

1. Ordinary differential equations with constant coefficients.
2. Ordinary differential equations with variable coefficients.
3. Simultaneous ordinary differential equations of first order.

REFERENCE BOOKS:

1. Murray R. Spiegel, Schaum's Outline Series,Theory and Problems of Laplace Transforms, Mc Graw Hill Ltd, New York, 1965.
2. Lokenath Debnath and Dambaru Bhatta,Integral Transforms and Their Applications, Second Edition, C. R. C. Press, London, 2007.

3. Phil Dyke, An Introduction to Laplace Transforms and Fourier Series, Second Edition, Springer-Verlag London, 2014.

MTH-203(B) Numerical Methods

Course Description: This course provides fundamental knowledge of different methods of solution of equations, basics of interpolation and curve fitting for set of dada Also it provides methods for solving differential equations.

Prerequisite Course(s):11th and 12thstandard Mathematics.

General Objective: The students will be able to understand the basic numerical analysis which is applicable to problems like finding of zeroes of algebraic equations, interpolation, curve fitting and solution of first order differential equations. Students will also understand that when exact solutions are difficult to obtain, then approximate solutions can be obtained by using numerical methods.

Learning Outcomes: Students will be able to

- Understand basic concepts of methods of solutions of equations viz. bisection, iteration, Newton-Raphson methods and method of false position.
- Understand methods of curve fitting viz. Gauss's forward and backward difference formulae and Lagrange's interpolation formula.
- Use of curve fitting such as least square, polynomials and exponential fittings for set of given dada.
- Use Taylor's series, Euler's method, Modified Euler's methods, RangeKutta methods for solving ordinary differential equations.

Unit-1: Solutions of Algebraic and Transcendental Equations (15 marks, 08 hours)

1.1: Errors and their computation: Algebraic equations, transcendental equations, root of equations, Exact and Approximate numbers, significant digits or significant figures, rounding off Numbers, Type of errors: Inherent errors, Truncation errors.

1.2: Absolute error, Relative error and percentage error, Absolute accuracy, Relative accuracy.

1.3: The bisection method.

1.4: The iteration method.

1.5: The method of false position.

1.6: Newton-Rapson method.

Unit-2: Interpolation (15 marks, 08 hours)

2.1: Finite Differences: forward differences, backward differences,central differences.

2.2: Symbolic relations and separation of symbols: Forward difference operator, Backward difference operator, Central difference operator, Averaging (Mean) operator, Shift operator.

2.3: Gauss's forward central difference formula.(without proof)

2.4:Gauss's backward central difference formula.(without proof)

2.5: Interpolation with unevenly spaced point, Lagrange's interpolation formula.

Unit-3: Curve fitting (15 marks, 07 hours)

3.1: Least squares curve fitting procedures.

3.2: Fitting of straight line $y = a + bx$.

3.3: Nonlinear curve fitting: Power function $y = ax + c$

3.4: Fitting of polynomial of degree two $y = a + bx + cx^2$

3.5: Fitting of exponential function $y = ae^{bx}$

Unit-4: Numerical solutions of ordinary differential equations: (15 marks, 07 hours)

Solution by

4.1: Taylor's series

4.2: Euler's method

4.3: Modified Euler's method

4.4: RungeKutta second order formula

4.5: RungeKutta fourth order formula.

REFERENCE BOOKS:

1. Numerical Methods by V.N.Vedamurty and N.Ch.S.N.Iyehgar, Vikas Publishing House, India.
2. Introductory Methods of Numerical Analysis by S. S. Sastry, Prentice Hall India Learning Private Limited, Fifth edition, 2012.

Equivalences for F. Y. B. Sc. (Mathematics)

Effective from June 2022

New Paper				Old Paper	
Sem.	**Course**	**Paper**	**Course Code with Title**	**Paper**	**Course Code with Title**
I	MTHCC- A	Paper - 1	MTH 101: Matrix Algebra	Paper - 1	MTH 101: Matrix Algebra
		Paper – 2	MTH 102: Calculus of Single Variable	Paper – 2	MTH 102: Calculus
		Paper – 3	MTH 103 (A): Co-ordinate Geometry	Paper – 3	MTH 103 (A): Co-ordinate Geometry
			MTH 103 (B): Graph Theory	Paper – 3	MTH 103 (B): Discrete Mathematics
II	MTHCC- B	Paper-1	MTH 201: Ordinary Differential Equations	Paper-1	MTH 201: Ordinary Differential Equations
		Paper- 2	MTH 202: Theory of Equations	Paper- 2	MTH 202: Theory of Equations
		Paper – 3	MTH 203 (A): Laplace Transforms	Paper – 3	MTH 203 (A): Laplace Transform
			MTH 203 (B): Numerical Methods		MTH 203 (B): Numerical Analysis

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

STRUCTURE AND SYLLABUS OF

S.Y. B. Sc. (MATHEMATICS)

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

Effective from June 2019

KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY, JALGAON

Syllabus for S. Y. B. Sc. (Mathematics)
Under Choice Based Credit System (CBCS)
Effective from June 2019

The examination pattern is semester system for both the theory and practical papers. Each theory paper is of 100 marks (60 marks for external examination and 40 marks for internal examination) and practical paper is of 100 marks (60 marks for external examination and 40 marks for internal examination). The examination will be conducted at the end of each semester. Period of teaching for each theory paper is 30 clock hours and for practical paper is 60 clock hours.

COURSE STRUCTURE

Sem.	Course	Paper	Course Code with Title	Credits	No. Periods in Hour /week
III	MTHCC- C	Paper - 1	MTH 301: Calculus of Several Variables	2	2
		Paper - 2	MTH 302(A): Group Theory Or MTH -302(B): Theory of Groups and Codes	2	2
		Paper - 3	MTH 303: Practical paper based on MTH 301 and MTH 302	2	4
	SEC-1	SEC-1	MTH 304: Set Theory and Logic	2	2
IV	MTHCC- D	Paper - 1	MTH 401: Complex Variables	2	2
		Paper - 2	MTH 402(A): Differential Equations Or MTH-402 (B): Differential Equations and Numerical Methods	2	2
		Paper - 3	MTH 403: Practical paper based on MTH 401 and MTH 402	2	4
	SEC-2	SEC-2	MTH 404: Vector Calculus	2	2

Syllabus for S.Y. B.Sc. (Mathematics)

SEMESTER – III

MTH -301: Calculus of Several Variables (Period: 30 Clock hours)

Course Description:

This course provides an elementary level knowledge of functions of several variables, their limit continuity, Taylors expansion, differentiation and integration of functions of two or more variables.

Prerequisite Course(s): Preliminary knowledge of real analysis, functions of one variables and calculus.

General Objective:

This is the second course in the calculus series after a course of Calculus in F. Y. B. Sc. for science students. In this course we discuss functions of two and more variables along with their series expansions and extreme values. We also discuss integration techniques as well as applications of integrals.

Learning Outcomes:

Upon successful completion of this course the student will be able to understand:

a) limit and continuity of functions of several variables
b) fundamental concepts of multivariable Calculus.
c) series expansion of functions.
d) extreme points of function and their maximum, minimum values at those points.
e) meaning of definite integral as limit as sums.
f) how to solve double and triple integration and use them to find area by double integration and volume by triple integration.

Unit- 1: Functions of Two and Three Variables **Marks-15**

1.1 Explicit and Implicit Functions
1.2 Continuity
1.3 Partial Derivatives
1.4 Differentiability
1.5 Necessary and Sufficient Conditions for Differentiability
1.6 Partial Derivatives of Higher Order
1.7 Schwarz's Theorem
1.8 Young's Theorem.

Unit-2: Jacobian, Composite Functions and Mean Value Theorems **Marks-15**

2.1 Jacobian (Only for Two and Three Variable)
2.2 Composite Functions (Chain Rule)

2.3 Homogeneous Functions.
2.4 Euler's Theorem on Homogeneous Functions.
2.5 Mean Value Theorem for Function of Two Variables.

Unit -3: Taylor's Theorem and Extreme Values **Marks-15**

3.1 Taylor's Theorem for Function of Two Variables.
3.2 Maclaurin's Theorem for Function of Two Variables.
3.3 Absolute and Relative Maxima & Minima.
3.4 Necessary Condition for Extrema.
3.5 Critical Point, Saddle Point.
3.6 Sufficient Condition for Extrema.

Unit -4: Double and Triple Integrals **Marks-15**

4.1 Double Integrals by Using Cartesian and Polar Coordinates.
4.2 Change of Order of Integration.
4.3 Area by Double Integral.
4.4 Evaluation of Triple Integral as Repeated Integral.
4.5 Volume by Triple Integral.

Recommended Book:

Mathematical Analysis: S.C. Malik and Savita Arora. Wiley Eastern Ltd, New Delhi. 1992 (Chapter 15: Functions of several variables 1, 1.1, 1.2, 1.3, 1.4, 1.6,2, 3, 3.1, 3.2, 4, 4.1, 5, 5.2, 6, 7.2, 9, 9.1, 10, 10.1, 10.2)

Reference Books –

1. Calculus of Several Variables by Schaum's Outline Series.
2. Mathematical Analysis by T. M. Apostol, Narosa Publishing House, New Delhi, 1985

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MTH -302(A): Group Theory (Period: 30 Clock hours)

Course Description:

This course provides an elementary level knowledge of algebraic structure like groups and rings.

Prerequisite Course(s): Preliminary knowledge of sets, functions and binary operations and number systems like Set of integers, rationals, reals and complex.

General Objective:

A primary objective of this course is to understand algebraic structures and their properties. Doing this one can use these structures to solve problems arises in many branches of Mathematics such as theory of equations, theory of numbers, Geometry etc. This enable students to grow their mathematical skill and used them to apply in many branches of science. So, the main objective is to develop and maintain problem-solving skills of the students.

Learning Outcomes:

Upon successful completion of this course the student will be able to:

a) understand group and their types which is one of the building blocks of pure and applied mathematics.
b) understand Lagarnge, Euler and Fermat theorem
c) understand concept of automorphism of groups
d) understand concepts of homomorphism and isomorphism
e) understand basic properties of rings and their types such as integral domain and field.

Unit-1: Groups **Marks-15**

1.1 Definition and Examples of a group.
1.2 Simple Properties of Group.
1.3 Abelian Group.
1.4 Finite and Infinite Groups.
1.5 Order of a Group.
1.6 Order of an Element and Its Properties.

Unit-2: Subgroups **Marks-15**

2.1 Definition and Examples of Subgroups.
2.2 Simple Properties of Subgroup.
2.3 Criteria for a Subset to be a Subgroup.
2.4 Cyclic Groups
2.5 Normal subgroups and Coset Decomposition.
2.6 Lagrange's Theorem for Finite Group.
2.7 Euler's Theorem and Fermat's Theorem.

Unit-3: Homomorphism and Isomorphism of Groups **Marks-15**

4.1 Definition and Examples of Group Homomorphism.
4.2 Properties of Group Homomorphism.
4.3 Kernel of a Group Homomorphism and it's Properties.
4.4 Definition and Examples of Isomorphism.
4.5 Definition and Examples of Automorphism of Groups.
4.6 Properties of Isomorphism of Groups.

Unit -4: Rings **Marks-15**

4.1 Definition and Simple Properties of a Ring.
4.2 Commutative Ring, Ring with unity, Boolean Ring.
4.3 Ring with zero divisors and without zero Divisors.
4.4 Integral Domain, Division Ring and Field. Simple Properties.

Recommended Book: -

1. University Algebra: N. S. Gopalakrishnan, New age international publishers, 2018. (Chapter 1: 1.3, 1.4, 1.5, 1.6,1.7, 1.8, 1.9)

Reference Books: -

1. Topics in Algebra: I. N. Herstein (John Wiley and Sons).
2. A first Course in Abstract Algebra: J. B. Fraleigh (Pearson).
3. A course in Abstract Algebra: Vijay K. Khanna and S. K. Bhambri, Vikas Publishing House Pvt. Ltd., Noida.

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MTH -302(B): Theory of Groups and Codes (Period: 30 Clock hours)

Course Description:

This course provides an elementary level knowledge of algebraic structure like groups and codes.

Prerequisite Course(s): Preliminary knowledge of Sets, functions and binary operations and number systems like Set of integers, rationals, reals and complex.

General Objective:

A primary need for the establishment of this course is to understand algebraic structures and their properties. Upon studying this one can use these sutures to solve problems arises in many branches of Mathematics and computer science such as theory of equations, theory of numbers, Geometry, theory of computations, cryptography etc. This enable students to grow their mathematical skill and used them to apply in many other branches of science and technology.

Learning Outcomes:

Upon successful completion of this course the student will be able to:

a) understand group structures which is useful to understanding ideas of modern mathematics.
b) understand solutions to polynomial equations
c) understand permutation groups
d) understand concepts of homomorphisms and isomorphisms
e) Students will understand basic concepts in codding theory.

Unit-1: Groups **Marks-15**

1.1 Definition and Examples of a group.
1.2 Simple Properties of Group.
1.3 Abelian Group.
1.4 Finite and Infinite Groups.
1.5 Order of a Group.
1.6 Order of an Element and Its Properties.

Unit-2: Subgroups **Marks-15**

2.1 Definition and Examples of Subgroups.
2.2 Simple Properties of Subgroup.
2.3 Criteria for a Subset to be a Subgroup.

2.4 Cyclic Groups
2.5 Normal subgroups and Coset Decomposition.
2.6 Lagrange's Theorem for Finite Group.
2.7 Euler's Theorem and Fermat's Theorem.

Unit-3: Homomorphism and Isomorphism of Groups **Marks-15**

3.1 Definition and Examples of Group Homomorphism.
3.2 Properties of Group Homomorphism.
3.3 Kernel of a Group Homomorphism and it's Properties.
3.4 Definition and Examples of Isomorphism.
3.5 Definition and Examples of Automorphism of Groups.
3.6 Properties of Isomorphism of Groups.

Unit -4: Group Codes **Marks 15**

4.1 Message, Word, (m, n)- Encoding Function, Code Words.
4.2 Detection of k or fewer errors, Weight, Parity Check Code
4.3 Hamming Distance, Properties of the Distance Function, Minimum Distance of an encoding function.
4.4 Group Codes.
4.5 (n, m)- Decoding function, Maximum Likelihood Decoding Function.
4.6 Decoding procedure for a Group Code given by a Parity Check Matrix.

Recommended Book: -

1. University Algebra: N. S. Gopalakrishnan, New age international publishers, 2018. (Chapter 1: 1.3, 1.4, 1.5, 1.6,1.7, 1.8, 1.9)
2. Discrete Mathematical Structures: Bernard Kolman, Robert C. Busby and Ross (Prentice Hall of India New Delhi, Eastern Economy Edition).

Reference Books: -

1. Topics in Algebra: I. N. Herstein (John Wiley and Sons).
2. A first Course in Abstract Algebra: J. B. Fraleigh (Pearson).

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MTH-303: Practical Course Based on MTH-301 and MTH-302

(Period: 60 Clock hours)

Practical No	Title of the Practical
1	Functions of two and three Variables
2	Jacobian, Composite Functions and Mean Value Theorems
3	Taylor's Theorem and Extreme Values
4	Double and Triple Integrals
5	Groups
6	Subgroups
7	Homomorphism and Isomorphism of Groups
8(A)	Rings
8(B)	Group Codes

List of Practical Problems

Practical 1: Functions of Two and Three Variables

1. Evaluate the limit, if it exists, for the following function

$$f(x,y)=\begin{cases}\dfrac{x^2y}{x^4+y^2} & ,if\ x^4+y^2\neq 0\\ 0 & ,if\ x=y=0.\end{cases}$$

2. Let $f(x,y)=x\sin\frac{1}{x}+\ y\sin\frac{1}{y}\ ,\ xy\neq 0$. Show that $\lim\limits_{(x,y)\to(0,0)} f(x,y)=0$.

3. Let $f(x,y)=\frac{x^2y^2}{x^4+y^4-x^2y^2}$, $(x,y)\neq(0,0)$. Verify that both the repeated limits exist and are equal, but simultaneous limit does not exist.

4. Show that the function

$$f(x,y)=\begin{cases}\dfrac{xy}{\sqrt{x^2+y^2}} & ,if\ (x,y)\neq(0,0)\\ 0 & ,if\ (x,y)=(0,0)\end{cases}$$

is continuous at the origin.

5. Let $f(x,y)=\begin{cases}\frac{xy}{x^2+y^2} & ,if\ (x,y)\neq(0,0)\\ 0 & ,\ if\ (x,y)=(0,0)\end{cases}$

Show that both the first order partial derivatives exist at $(0,\,0)$, but the function is not continuous thereat.

6. Discuss the continuity and differentiability at the origin of the function

$$f(x,y)=\begin{cases}\frac{xy}{x^2+y^2} & ,if\ (x,y)\neq(0,0)\\ 0 & ,if\ (x,y)=(0,0)\end{cases}$$

7. Let$f(x,y)=\begin{cases}x^2\tan^{-1}\left(\frac{y}{x}\right)-y^2\tan^{-1}\left(\frac{x}{y}\right) & ,if\ (x,y)\neq(0,0)\\ 0 & ,if\ (x,y)\neq(0,0)\end{cases}$

Show that $f_{xy}(0,0)\neq f_{yx}(0,0)$.

8. Show that for the function

$$f(x,y)=\begin{cases}\dfrac{xy}{x^2+y^2} & ,if\ (x,y)\neq(0,0)\\ 0, & ,\quad if\ (x,y)=(0,0)\end{cases}$$

$f_{xy}(0,0)=f_{yx}(0,0)$, even though the conditions of Schwarz's theorem and Young's theorem are not satisfied.

9. Using differentials find approximate value of $\sqrt{(1.02)^2+(1.97)^3}$.
10. Using differentials find approximate value of $(3.9)^2(2.05)+(2.05)^3$.

Practical 2: Jacobian, Composite functions and Mean value theorem

1. If $u = \cos x$, $v = \sin x \cos y$, $w = \sin x \sin y \cos z$, then show that
$$\frac{\partial(u,v,w)}{\partial(x,y,z)} = (-1)^3 sin^3x\, sin^2y \sin z$$
2. If $z = f(x,y) = \tan^{-1}\left(\frac{x}{y}\right)$, $x = u + v$, $y = u - v$, then show that $\frac{\partial z}{\partial u} + \frac{\partial z}{\partial v} = \frac{u-v}{u^2+v^2}$.
3. If $u = f(e^{y-z}, e^{z-x}, e^{x-y})$, then prove that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = 0$
4. If z is function of x and y and if $x = e^u + e^{-v}$, $y = e^{-u} - e^v$, then prove that $\frac{\partial z}{\partial u} - \frac{\partial z}{\partial v} = x\frac{\partial z}{\partial x} - y\frac{\partial z}{\partial y}$.
5. If $z = f(u,v)$, where $u = 2x - 3y$ and $v = x + 2y$, then prove that $\frac{\partial z}{\partial x} + \frac{\partial z}{\partial y} = 3\frac{\partial z}{\partial v} - \frac{\partial z}{\partial u}$.
6. If $u = \tan^{-1}\left(\frac{x^3+y^3}{x-y}\right)$, then show that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = \sin 2u$. Hence, deduce that $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2} = (1 - 4sin^2u)sin2u$.
7. If $u = \sin^{-1}\left(\frac{x^2+2xy}{\sqrt{x-y}}\right)^{\frac{1}{5}}$, then find the value of $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$ and $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2}$.
8. If $u = \tan^{-1}\left(\frac{\sqrt{x^2+y^2}}{x-y}\right)$, then find the value of $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2}$.
9. Let $f(x,y) = x^2y + 2xy^2$. Find the quadratic equation in θ by applying the mean value theorem applied to the line segment joining the points (1,2) to (3,3).
10. Let $f(x,y) = x^3 - xy^2$. Show that θ used in the mean value theorem applied to the points (2,1) and (4,1) satisfies the quadratic equation $3\theta^2 + 6\theta - 4 = 0$.

Practical 3: Taylor's theorem and Extreme values

1. Use Taylor's theorem of suitable order to expand $\sin x \sin y$ in the form $xy - \frac{1}{6}\{(x^3 + 3xy^2)\cos\theta x \sin\theta y + (y^3 + 3x^2y)\sin\theta x \cos\theta y\}$,$0 < \theta < 1$.
2. Show that the expansion of $\sin(xy)$ in powers of $(x-1)$ and $\left(y - \frac{\pi}{2}\right)$ upto and including second degree terms is
$$1 - \frac{1}{8}\pi^2(x-1)^2 - \frac{1}{2}\pi(x-1)\left(y - \frac{\pi}{2}\right) - \frac{1}{2}\left(y - \frac{\pi}{2}\right)^2.$$

3. Using Maclaurin's expansion, prove that $e^{ax}\cos by = 1 + ax + \frac{a^2x^2 - b^2y^2}{2!} + \frac{a^3x^3 - 3ab^2xy^2}{3!}$.

4. Expand $e^x tan^{-1}y$ about $(1\ ,1)$ up to the second degree in powers of $(x-1)$and $(y-1)$.

5. Find maxima and minima of the function $f(x,y) = x^3 + y^3 - 3x - 12y + 20$.

6. Discuss the extreme values of the function $f(x,y) = 2(x^2 - y^2) - x^4 + y^4$.

7. Investigate maximum and minimum values of $f(x,y) = (x + y - 1)(x^2 + y^2)$.

8. Find the extreme values of $f(x,y) = xy(a - x - y)$.

9. Find the least value of the function $f(x,y) = xy + \frac{50}{x} + \frac{50}{y}$.

Practical –4: Double and Triple Integrals

1. Using double integration, find the area between the parabola $y^2 = 4ax$ and $x^2 = 4ay$.
2. Find the area of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, using double integral.
3. Evaluate $\int_0^a \int_0^x \int_0^{x+y} e^{x+y+z}\, dxdydz$.
4. Using triple integration, find the volume of the sphere of radius a.
5. Evaluate $\int_0^1 \int_0^2 \int_0^3 (x + y + z)\, dxdydz$.
6. Change the order of integration in $\int_0^4 \int_0^{\sqrt{4x-x^2}} f(x,y)dxdy$.
7. Draw a sketch of the region of integration
   i) $\int_0^4 \int_0^{\sqrt{25-x^2}} f(x,y)dxdy$.
   ii) $\int_{-1}^3 \int_{x^2}^{x+3} f(x,y)dxdy$.
8. Evaluate $\int\int ydxdy$ over the area bounded by $y = x^2$ and $x + y = 2$.

Practical - 5: Groups

1. Let $\mathbb{Q}^+$ denotes the set of all positive rational numbers and for any $a\ ,b \in \mathbb{Q}^+$, define $a * b = \frac{ab}{3}$. Show that $(\mathbb{Q}^+\ ,\ *)$ is an abelian group.
2. Let $G = \{(a\ ,b): a\ ,b \in \mathbb{R},\ a \neq 0\}$. Show that $(G\ ,\odot)$ is a non-abelian group, where $(a\ ,b)\odot(c\ ,d) = (ac\ ,ad + b)$.
3. Let G be a group and $a \in G\ ,n \in \mathbb{N}$. Show that $a^n = e$ if and only if $o(a) | n$.
4. Show that a group G is abelian if and only if $(ab)^2 = a^2b^2\ \forall\ a\ ,b \in G$.

5. In the group $(\mathbb{Z}_7, \times_7)$, find (i) $(\bar{3})^2$ ii) $(\bar{4})^{-3}$ iii) $o(\bar{3})$ iv) $o(\bar{4})$
6. In the group $(\mathbb{Z}_{11}, \times_{11})$, find (i) $(\bar{4})^3$ ii) $\left(\bar{5}\right)^2$ iii) $o(\bar{9})$ iv) $o(\bar{7})$
7. Show that $G = \mathbb{R} - \{1\}$ is an abelian group under the binary operation $a * b = a + b - ab, \forall\, a, b \in G$
8. Prove that $G = \{\begin{bmatrix} x & x \\ x & x \end{bmatrix}$: x is a non-zero real number$\}$ is a group under matrix multiplication.
9. If G is a group such that $a^2 = e, \forall\, a, b \in G$, then show that G is abelian.
10. If in a group G, $a^5 = e$ and $aba^{-1} = b^2, \forall\, a, b\ G$, then find order of an element b.

Practical - 6: Subgroups

1. If G is a group, then show that the center of $G, Z(G)$, is a subgroup of G, where $Z(G) = \{x \in G : xa = ax,\ \forall a \in G\}$.
2. Show that $(\mathbb{Z}_7, \times_7)$is a cyclic group. Find all its generators, all its proper subgroups and order of every element.
3. Let $G = \{1, -1, i, -i, j, -j, k, -k\}$ be a group under multiplication and $H = \{1, -1, i, -i\}$ be its subgroup. Find all the left and right cosets of H in G.
4. Let A and B be two subgroups of a finite group G whose orders are relatively prime. Show that $A \cap B = \{e\}$.
5. Show that every proper subgroup of a group of order 77 is cyclic.
6. Find the remainder obtained when 15^{27} is divided by 8.
7. Find the remainder obtained when 33^{19} is divided by 7.
8. Let G be a group of all non-zero complex numbers under multiplication. Show that $H = \{a + ib : a^2 + b^2 = 1\}$ is a subgroup of G.
9. If H is subgroup of a group G and if the normalizer of H, $N(H) = \{g \in G : gHg^{-1} = H\}$, then prove that (a) $N(H)$ is a subgroup of G and (b) H is a normal subgroup of $N(H)$.
10. If G is a group and H is a subgroup of index 2 in G, then prove that H is a normal subgroup of G.

Practical – 7: Homomorphism and Isomorphism of Groups

1. Let $G = \{A : A$ is $n \times n$ matrix over $\mathbb{R}$ and $|A| \neq 0\}$, the group of non-singular matrices of order n over $\mathbb{R}$ under matrix multiplication and let $\mathbb{R}^* = \mathbb{R} - \{0\}$, be the group of nonzero real numbers under multiplication. Define $f : G \to \mathbb{R}^*$ by $f(A) = |A|$, for all $A \in G$. Show that f is an onto group homomorphism and find its kernel.
2. If $G_1 = \{1, -1, i, -i\}$ is a group under multiplication and $G_2 = \{2, 4, 6, 8\}$ is a group under multiplication modulo 10, then show that G_1 and G_2 are isomorphic.
3. Let G be a group and $a \in G$. Show that $f_a : G \to G$ defined by $f_a(x) = axa^{-1}$, for all $x \in G$ is an automorphism.

4. Let G be a group and $f : G \rightarrow G$ be a map defined by $f(x) = x^{-1}$, for all $x \in G$. Prove that
(a) If G is abelian, then f is an isomorphism.
(b) If f is a group homomorphism, then G is abelian.

5. Let $G = \{a, a^2, a^3, \ldots, a^{11}, a^{12} = e\}$ be a cyclic group of order 12 generated by a. Show that $f : G \rightarrow G$ defined by $f(x) = x^4, \forall\, x \in G$ is a group homomorphism. Find the kernel of f.

6. Let f and g be group homomorphisms from the group G into G. Show that $H = \{x \in G : f(x) = g(x)\}$ is a subgroup of G.

7. Prove that the mapping $f : C \rightarrow C_0$ such that $f(z) = e^z$ is a homomorphism of the additive group of complex numbers onto the multiplicative group of non-zero complex numbers. What is the kernel of f?

8. Let G be a group of all matrices of the type $\left\{\begin{bmatrix} a & b \\ -b & a \end{bmatrix} : a, b \in G \text{ and } a^2 + b^2 = 1\right\}$ under matrix multiplication and G' be a group of non-zero complex numbers under multiplication. Show that $f : G \rightarrow G'$ defined by $f\left(\begin{bmatrix} a & b \\ -b & a \end{bmatrix}\right) = a + ib$, is an isomorphism.

Practical – 8(A): Rings

1. (a) Show that $\mathbb{Z}_7 = \{\overline{0}, \overline{1}, \overline{2}, \overline{3}, \overline{4}, \overline{5}, \overline{6}\}$ forms a ring under addition and multiplication modulo 7.
(b) In the ring $(\mathbb{Z}_{10}, +_{10}, \times_{10})$, find all divisors of zero.

2. Show that $\mathbb{Z}[i] = \{a + ib : a, b \in \mathbb{Z}\}$, the set of Gaussian integers, forms an integral domain under usual addition and multiplication of complex numbers.

3. Show that $R = \{a + b\sqrt{2} : a, b \in \mathbb{Z}\}$ is an integral domain under usual addition and multiplication.

4. In the ring $(\mathbb{Z}_7, +_7, \times_7)$, find (i) $-(\overline{4} \times_7 \overline{6})$; (ii) $\overline{3} \times_7 (\overline{-6})$; (iii) $(\overline{-5}) \times_7 (\overline{-5})$ (iv) Units in $\mathbb{Z}_7$; (v) additive inverse of $\overline{6}$; (vi) zero divisors. Is $\mathbb{Z}_7$ a field or an integral domain? Justify.

5. Let $\mathbb{R}$ be the set of all real numbers. Show that $\mathbb{R} \times \mathbb{R}$ forms a field under addition and multiplication defined by $(a, b) + (c, d) = (a + c, b + d)$ & $(a, b) . (c, d) = (ac - bd, ad + bc)$.

6. If p is a prime number, then show that $\mathbb{Z}_p$ is an integral domain.

7. Which of the following rings are integral domains? (i) $\mathbb{Z}_{187}$; (ii) $\mathbb{Z}_{61}$; (iii) $\mathbb{Z}_{2\times 2}$. (iv) $(\mathbb{Z}, +, \cdot)$.

Practical – 8(B): Group Codes

1. Consider the (3,8) encoding function $e : B^3 \rightarrow B^8$ defined by $e(000) = 00000000$, $e(001) = 10111000$, $e(010) = 00101101$, $e(011) = 10010101$, $e(100) = 10100100$, $e(101) = 10001001$, $e(110) = 00011100$, $e(111) = 00110001$.
   (a) Find the minimum distance of e.
   (b) How many errors will e detect?
2. Show that the (3,6) encoding function $e : B^3 \rightarrow B^6$ defined by $e(000) = 000000$, $e(001) = 001100$, $e(010) = 010011$, $e(011) = 011111$, $e(100) = 100101$, $e(101) = 101001$, $e(110) = 110110$, $e(111) = 111010$is a group code. Also find the minimum distance of e.
3. Compute: (a) $\begin{bmatrix} 1 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix} \oplus \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 0 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} * \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$
4. Let H $= \begin{bmatrix} 0 & 1 & 1 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ be a parity check matrix. Determine the $(2\,,5)$ group code $eH : B^2 \rightarrow B^5$.
5. Consider the parity check matrix: H $= \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$. Decode the following words relative to a maximum likelihood decoding function associated with eH : $a)$ 10100 $b)$ 01101 $c)$ 11011
6. Consider the parity check matrix: H $= \begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$. Determine the coset leaders for $N = eH(B^3)$. Also compute the Syndrome for each coset leader and decode the code 001110 relative to maximum likelihood decoding function.
7. Let the $(9, 3)$ decoding function $d : B^9 \rightarrow B^3$ be defined by $d(y) = Z1Z2Z3$, where $Z_i = 1$, if $\{yi, yi + 3, yi + 6\}$ has at least two 1's
   $= 0$, if $\{yi, yi + 3, yi + 6\}$ has less than two 1's, i = 1, 2, 3.
8. If $y \in B^9$, then determine $d(y)$, where (i) $y = 101111101$ (ii) $y = 100111100$.

Note: Practical problems based on each unit are not limited to the given ones, but any other related challenging and application-oriented problems may also be evaluated in the practical sessions.

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SEC -1

MTH 304: Set Theory and logic (Period: 30 Clock hours)

Course Description:

This course is an elementary skill development course for S. Y. B.Sc. students.

Prerequisite Course(s): Secondary school level knowledge of elementary mathematics.

General Objective: The general objectives are to acquire concepts of sets, relations, countable and uncountable sets; statements and truth values; concept of tautology, contradiction and quantifiers.

Learning Outcomes:

a) Uses of the language of set theory, designining issues in different subjects of mathematics
b) understand the issues associated with different types of finite and infinite sets via countable uncountable sets
c) knowledge of the concepts and methods of mathematical logic, set theory, relation calculus, and concepts concerning functions which are included in the fundamentals of various disciplines of mathematics
d) understanding the role of propositional and predicate calculus
e) able to provide the logical mathematical reasoning, formulate theorems and definitions

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Unit-1: Sets and Subsets **Marks-15**

1.1 Finite Set and Infinite set

1.2 Equality of two Sets,

1.3 Null Set, Subset, Proper subset, Symmetric difference of two sets

1.4 Universal set, Power set, Disjoint sets,

1.5 Operation on sets: Union and Intersection

1.6 Venn diagram

1.7 Equivalent sets

1.8 Countable and uncountable sets

Unit-2: Relations and Functions **Marks-15**

1.1 Product of sets

1.2 Relations, Types of relations, Reflexive, Symmetric, Transitive relations and Equivalence relations
1.3 Function, Types of functions, One-one, Onto, Even, Odd and Inverse function
1.4 Composite functions

Unit-3: Algebra of Propositions **Marks-15**

2.1 Statements, Conjunction, Disjunction.
2.2 Negation, Conditional and Bi-Conditional statements, Propositions.
2.3 Truth table, Tautology and Contradiction.
2.4 Logical equivalence, Logical equivalent statements.

Unit-4: Quantifiers **Marks-15**

3.1 Propositional functions and Truth sets.
3.2 Universal quantifier, Existential quantifier.
3.3 Negation of proposition which contain quantifiers, Counter examples.

Recommended book:

1. Set Theory and Related Topics by Schaum's outline Series (Chapter1, chapter 4, chapter 6: 6.2, 6.3, chapter 10)

Reference Books:

1. R.R.Halmons, Naïve Set Theory, Springer, 1974
2. E. Kamke, Theory of Sets, Dover Publishers,1950

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SEMESTER – IV

MTH -401: Complex Variables (Period: 30 Clock hours)

Course Description:

This course will improve basic and intermediate level knowledge of a special type of number system namely complex numbers and also discusses complex valued function with their integrations.

Prerequisite Course(s): Basic knowledge of Sets, functions, real valued functions, their limits and continuity and integrations.

General Objective:

A primary objective of this course is to make students aware of generalization of real number system and calculus. Analyticity and complex integrations are useful for applications. This course improves mathematical skill and ability to solve various integrations.

Learning Outcomes:

a) The course is aimed to introduce the theory for functions of complex variables
b) Students will understand the concept of analytic function
c) Students will understand the Cauchy Riemann Equations
d) Students will understand harmonic functions
e) Students will understand complex integrations
f) Students will understand calculus of residues.
g) Students will acquire the skill of contour integrations.

Unit-1: Complex numbers **Marks-15**

1.1 Complex numbers, modulus and amplitude, polar form
1.2 Triangle inequality and Argand's diagram
1.3 DeMoivre's theorem for rational indices and applications
1.4 n^{th} roots of a complex number
1.5 Elementary functions: Trigonometric functions, Hyperbolic functions of a complex variables (definitions only).

Unit-2: Functions of complex variables **Marks-15**

2.1 Limits, Continuity and Derivative.
2.2 Analytic functions, A Necessary and sufficient conditions for analytic functions.
2.3 Cauchy Riemann equations.
2.4 Laplace equations and Harmonic functions
2.5 Construction of analytic functions

Unit-3: Complex integrations **Marks-15**

3.1 Line integral and theorems on it.

3.2 Statement and verification of Cauchy-Gaursat's Theorem.
3.3 Cauchy's integral formulae for $f(a), f'(a)$ and $f^n(a)$
3.4 Taylor's and Laurent's series.

Unit-4: Calculus of Residues **Marks-15**

4.1 Zeros and poles of a function.
4.2 Residue of a function
4.3 Cauchy's residue theorem
4.4 Evaluation of integrals by using Cauchy's residue theorem
4.5 Contour integrations of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ and $\int_{-\infty}^{\infty} f(x)dx$

Recommended book:

1. Complex Variables and Applications; J. W. Brownand, R. V. Churchill. 7th Edition. (McGraw-Hill) (Capter1, chapter 2, chapter 3, chapter 4, chapter 6)

Reference Books:

1. Theory of Functions of Complex Variables: Shanti Narayan, S. Chand and Company New Delhi.
2. Complex variables: Schaum's Outline Series.

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MTH-402(A): Differential Equations (Period: 30 Clock hours)

Course Description:

This course is of primary nature and here we introduce the students how the Differential Equations are formed and how to solve them using various methods.

Prerequisite Course(s): Basic knowledge of Real and complex valued functions, differentiations and integrations.

General Objective:

The main objective of this program is to cultivate mathematical aptitude among the students and nurture their interest towards problem solving aptitude by introducing various methods of solution of differential equations.

Learning Outcomes:

a) Students will aware of formation of differential equations and their solutions
b) Students will understand the concept of Lipschitz condition
c) Students will understand method of variation of parameters for second order L.D.E.
d) Students will understand simultaneous linear differential equations and method of their solutions
e) Students will understand Pfaffian differential equations and method of their solutions
f) Students will understand difference equations and their solutions

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Unit-1: Theory of ordinary differential equations **Marks-15**

1.1 Lipschitz condition
1.2 Existence and uniqueness theorem
1.3 Linearly dependent and independent solutions
1.4 Wronskian definition
1.5 Linear combination of solutions
1.6 Theorems on i) Linear combination of solutions ii) Linearly independent solutions iii) Wronskian is zero iv) Wronskian is non-zero
1.7 Method of variation of parameters for second order L.D.E.

Unit-2: Simultaneous Differential Equations **Marks-15**

2.1 Simultaneous linear differential equations of first order
2.2 Simultaneous D.E. of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$.
2.3 Rule I: Method of combinations
2.4 Rule II: Method of multipliers
2.5 Rule III: Properties of ratios
2.6 Rule IV: Miscellaneous

Unit-3: Total Differential or Pfaffian Differential Equations **Marks-15**

3.1 Pfaffian differential equations
3.2 Necessary and sufficient conditions for the integrability
3.3 Conditions for exactness
3.4 Method of solution by inspection
3.5 Solution of homogenous equation

Unit-4: Difference Equations **Marks-15**

4.1 Introduction, Order of difference equation, degree of difference equations
4.2 Solution to difference equation and formation of difference equations
4.3 Linear difference equations, Linear homogeneous difference equations with constant coefficients
4.4 Non-homogenous linear difference equation with constant coefficients

Recommended books:

1. Ordinary and Partial Differential Equation by M. D. Rai Singhania, S. Chand & Co. 18th Edition. (Chapter 1 and Chapter 2)
2. Numerical Methods by V. N. Vedamurthy and N. Ch. S. N. Iyengar, Vikas Publishing House, New Delhi. (Chapter 10).

Reference Book:

1. Introductory course in Differential Equations by D. A. Murray, Longmans Green and co. London and Mumbai, 5th Edition 1997.

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MTH-402 (B): Differential Equations and Numerical Methods (Period: 30 Clock hours)

Unit-1 : Theory of ordinary differential equations **Marks-15**

1.1 Lipschitz condition
1.2 Existence and uniqueness theorem
1.3 Linearly dependent and independent solutions
1.4 Wronskian definition
1.5 Linear combination of solutions
1.6 Theorems on i) Linear combination of solutions ii) Linearly independent solutions iii) Wronskian is zero iv) Wronskian is non-zero
1.7 Method of variation of parameters for second order L.D.E.

Unit-2 : Simultaneous Differential Equations **Marks-15**

2.1 Simultaneous linear differential equations of first order
2.2 Simultaneous D.E. of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$.
2.3 Rule I: Method of combinations
2.4 Rule II: Method of multipliers
2.5 Rule III: Properties of ratios
2.6 Rule IV: Miscellaneous

Unit-3 : Total Differential or Pfaffian Differential Equations **Marks-15**

3.1 Pfaffian differential equations
3.2 Necessary and sufficient condition for integrability
3.3 Conditions for exactness
3.4 Method of solution by inspection
3.5 Solution of homogenous equation

Unit-4 : Numerical differentiation **Marks-15**

4.1 Numerical Differentiation
4.2 Derivatives using Newtons forward interpolation formula
4.3 Derivatives using Newtons backward interpolation formula
4.4 Derivatives using Stirling's interpolation formula
4.5 Maxima and minima

Recommended books: -

1. Ordinary and Partial Differential Equation by M. D. Rai Singhania, S. Chand & Co. 18th Edition. (Chapter 1 and Chapter 2)
2. Numerical Methods by Dr. V. N. Vedamurthy and Dr. N. Ch. S. N. Iyengar, Vikas Publishing (Chapter 9)

Reference Books:

1. Introductory methods of Numerical Analysis, S.S. Sastry, Prentice Hall India, 12 th edition, New Delhi.
2. Differential equations, G.F. Simmons, Tata Mcgrawhill, 1972.

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MT-403: Practical course based on MTH-401, MTH-402
(Period: 60 Clock hours)

Practical No	Title of the Practical
1	Complex Numbers
2	Function of Complex Variable
3	Complex Integration
4	Calculus of Residues
5	Theory of ordinary differential equations
6	Simultaneous Differential Equations
7	Total (Pfaffian) Differential Equations
8(A)	Difference Equations
8(B)	Numerical Differentiation

List of Practicals

Practical-1: Complex Numbers

1. Find the Modulus and principle value of the argument of $\frac{(1+i\sqrt{3})^{13}}{(\sqrt{3}-i)^{11}}$.
2. If z_1, z_2, z_3 represents the vertices of an equilateral triangle, then prove that $z_1^2 + z_2^2 + z_3^2 = z_1z_2 + z_2z_3 + z_3z_1$.
3. If $cos\alpha + cos\beta + cos\gamma = 0$ and $sin\alpha + sin\beta + sin\gamma = 0$, then show that
   i. $cos3\alpha + cos3\beta + cos3\gamma = 3\cos(\alpha + \beta + \gamma)$ and
      $sin3\alpha + sin3\beta + sin3\gamma = 3\sin(\alpha + \beta + \gamma)$
   ii. $cos2\alpha + cos2\beta + cos2\gamma = 0$ and
      $sin2\alpha + sin2\beta + sin2\gamma = 0$
4. Find all the values of $(1 + i)^{\frac{1}{5}}$. Show that their continued product is $1 + i$.
5. Solve the equation $x^8 - x^4 + 1 = 0$.
6. Determine the region in the Z-plane represented by $|z - 3| + |z + 3| = 10$.
7. Using De Moivre's theorem express $\cos^6 \theta$ in terms of cosines of multiple angles.
8. If $|z_1| = |z_2| = |z_3| = 5$ and $\overline{z_1} + \overline{z_2} + \overline{z_3} = 0$, then prove that $\frac{1}{z_1} + \frac{1}{z_2} + \frac{1}{z_3} = 0$.

Practical-2: Functions of Complex Variable

1. Evaluate: $\lim_{z \to (1+i)} \frac{z^4+4}{z-1-i}$.
2. If $f(z) = \frac{3z^4-2z^3+8z^2-2z+5}{z-i}$, $z \neq i$ is continuous at $z = i$, then find the value of $f(i)$.
3. Find an analytic function $f(z) = u + iv$ and express it in terms of z, if $u = x^3 - 3xy^2 + 3x^2 - 3y^2 + 1$

4. Find an analytic function $f(z) = u + iv$ whose imaginary part is $v = e^x(xsiny + ycosy)$ using Milne Thomson Method.
5. Show that the real and imaginary parts of the function e^z satisfy C-R equations and they are harmonic.
6. Show that $u = \frac{1}{2}\log(x^2 + y^2)$ satisfies Laplace Equation. Find its harmonic conjugate.
7. If $f(z)$ is an analytic function with constant modulus, then show that $f(z)$ is a constant function.
8. Evaluate $\lim_{z \to e^{\frac{i\pi}{3}}} \frac{(z-e^{\frac{i\pi}{3}})z}{Z^3+1}$.

Practical-3: Complex Integration

1. Evaluate $\int_C (y - x - 3x^2 i)dz$, where C is :
   i. The straight-line joining $z = 0$ to $z = 1 + i$
   ii. The straight-line joining $z = 0$ to $z = i$ first and then from $z = i$ to $z = 1 + i$.
2. Use the Cauchy Goursat theorem to obtain the value of $\int_C e^z \, dz$, where C is the circle $|z| = 1$ and hence deduce the following:
   i. $\int_0^{2\pi} e^{cos\theta} \sin(\theta + sin\theta)\, d\theta = 0$
   ii. $\int_0^{2\pi} e^{cos\theta} \cos(\theta + sin\theta)\, d\theta = 0$
3. Using Cauchy's Integral formula, evaluate $\int_C \frac{dz}{z^3(z+4)}$, where C is the circle $|z| = 2$.
4. Obtain the expansion of $f(z) = \frac{z^2-1}{(z+2)(z+3)}$, in the powers of z in the region
   (i) $|z| < 2$ (ii) $2 < |z| < 3$ (iii) $|z| > 3$.
5. Prove that $\frac{1}{4z-z^2} = \sum_{n=0}^{\infty} \frac{z^{n-1}}{4^{n+1}}$, where $0 < |z| < 4$.
6. Verify Cauchy's integral theorem for $f(z) = z^2$ around the circle $|z| = 1$.
7. Evaluate $\int_{|z|=2} \frac{e^{2z}}{(z-1)^4} dz$ using Cauchy's integral formula.
8. Find the expansion of $f(z) = \frac{1}{(z^2+1)(z^2+2)}$ in powers of z, when $|z| < 1$.

Practical-4: Calculus of Residues

1. Find the residue of $f(z) = \frac{z^2+2z}{(z+1)^2(z+4)}$ at its poles.
2. Evaluate $\int_{|z|=3} \frac{e^z}{z(z-1)^2} dz$ by Cauchy's residue theorem.

3. Evaluate $\int_C \frac{3z^2+2}{(z-1)(z^2+9)} dz$ by Cauchy's residue theorem, where C is (i) The circle $|z-2| = 2$ (ii) The circle $|z| = 4$
4. Use the Contour integration to evaluate $\int_0^{2\pi} \frac{d\theta}{5+3cos\theta}$.
5. Evaluate by Contour integration $\int_{-\infty}^{\infty} \frac{1}{x^4+13x^2+36} dx$.
6. Find the sum of residues of $f(z) = \frac{e^z}{z^2+a^2}$ at its poles.
7. Evaluate $\int_{|z|=2} \frac{dz}{z^3(z+4)}$ by Cauchy's residue theorem.
8. Evaluate $\int_0^{\infty} \frac{x^2dx}{(x^2+1)(x^2+4)}$ by contour integration.

Practical 5: Theory of ordinary differential equations

1. Show that $f(x,y) = xy^2$ satisfies the Lipschitz condition on the rectangle R: $|x| \le 1, |y| \le 1$, but does not satisfy the Lipschitz condition on the strip S : $|x| \le 1, |y| \le \infty$.
2. Prove that sin$2x$ and cos$2x$ are solutions of $y'' + 4y = 0$ and these solutions are linearly independent.
3. Prove that $1, x, x^2$ are linearly independent. Hence, form the differential equation whose solutions are 1, x and x^2.
4. Examine whether the set of functions 1 , x^2, x^3 are linearly independent or not.
5. Solve by method of variation of parameters $y'' + a^2y = cosec(ax)$
6. Solve by method of variation of parameters $y'' + y - x = 0$
7. Show that functions $1 + x$, $x^2, 1 + 2x$ are linearly independent.
8. Examine whether e^{2x} and e^{3x} are linearly independent solution of differential equation $y'' - 5y' + 6y = 0$ or not?
9. Solve by method of variation of parameters, $y'' + 3y = sec3x$.

Practical 6 –Simultaneous Differential Equations

1. Solve : (i) $\frac{dx}{x^2z} = \frac{dy}{0} = \frac{dz}{-x^2}$ and (ii) $\frac{dx}{\tan x} = \frac{dy}{\tan y} = \frac{dz}{\tan z}$
2. Solve : (i) $\frac{dx}{xy} = \frac{dy}{y^2} = \frac{dz}{xyz-zx^2}$ and (ii) $\frac{dx}{y} = \frac{dy}{x} = \frac{dz}{xyz^2(x^2-y^2)}$
3. Solve : $\frac{dx}{y+z} = \frac{dy}{z+x} = \frac{dz}{x+y}$
4. Solve : $\frac{adx}{yz(b-c)} = \frac{bdy}{zx(c-a)} = \frac{cdz}{xy(a-b)}$
5. Solve : $\frac{dx}{x^2-y^2-z^2} = \frac{dy}{2xy} = \frac{dz}{2xz}$
6. Solve : $\frac{dx}{z(x+y)} = \frac{dy}{z(x-y)} = \frac{dz}{x^2+y^2}$

7. Solve : $\frac{dx}{\sin(x+y)} = \frac{dy}{\cos(x+y)} = \frac{dz}{z}$

8. Solve : $\frac{dx}{z^2} = \frac{ydy}{xz^2} = \frac{dz}{xy}$

9. Solve : $\frac{dx}{y^2(x-y)} = \frac{dy}{-x^2(x-y)} = \frac{dz}{z(x^2+y^2)}$.

Practical - 7 :Total (Pfaffian) Differential Equations

1. Show that the following differential equations are integrable. Hence solve them
   (i) $(y^2 + z^2 + x^2)dx - 2xydy - 2xzdz = 0$
   (ii) $2yzdx + zxdy - xy(1 + z)dz = 0$
2. Solve : $yz^2(x^2 - yz)dx + zx^2(y^2 - xz)dy + xy^2(z^2 - xy)dz = 0$
3. Solve : $\frac{yz}{x^2+y^2}dx - \frac{xz}{x^2+y^2}dy - tan^{-1}\frac{y}{x}dz = 0$
4. Solve : $zydx = zxdy + y^2dz = 0$
5. Solve : $(x^2 - yz)dx + (y^2 - xz)dy + (z^2 - xy)dz = 0$
6. Solve : $(2x^2 + 2xy + xz^2 + 1)dx + dy + 2zdz = 0$
7. Solve : $(y + z)dx + dy + dz = 0$
8. Show that the equation $yz^2(x^2 - yz)dx + zx^2(y^2 - xz)dy + xy^2(z^2 - xy)dz = 0$ is integrable. Is it exact? Verify.

Practical 8(A) : Difference Equations

1. Form the difference equation corresponding to the following general solution:
   (a) $y = c_1x^2 + c_2x + c_3$
   (b) $y = (c_1 + c_2n)(-2)^n$
2. Show that $y_x = c_1 + c_2.2^x - x$ is a solution of difference equation $y_{x+2} - 3y_{x+1} + 2y_x = 1$.
3. Formulate the Fibonnaci difference equation and solve it.
4. Solve the following difference equations:
   (a) $y_{x+1} - 3y_x = 1$
   (b) y_{x+1}-$3y_x = 0,\ y_0 = 2$
5. Solve the following non-homogeneous linear difference equations:
   (i) $y_{x+2} - 4y_x = 9x^2$
   (ii) $\Delta y_x + \Delta^2 y_x = sinx$
6. Solve: $y_{x+2} - 4y_{x+1} + 3y_x = 3^x + 1$.
7. Solve: $y_{x+2} - 4y_{x+1} + 4y_x = 3x + 2^x$.
8. Solve: $u_{x+2} - 5u_{x+1} + 6u_x = 36$.

Practical – 8 (B): Numerical differentiation

1. Find the first and second derivatives of the function tabulated below at $x = 1.9$

x	1.0	1.2	1.4	1.6	1.8	2.0
$f(x)$	0	0.128	.544	1.296	2.432	4.0

2. Find first and second derivatives at $x = 0$ from the following table:

x	0	1	2	3	4	5
$f(x)$	4	8	15	7	6	2

3. Find the value of $sec(310)$ from the following table:

x	31	32	33	34
$sec(x)$	0.6008	0.6249	0.6494	0.6745

4. Find first derivative using Stirling's formula at $x = 0.5$:

x	0.35	0.4	0.45	0.5	0.55	0.6	0.65
$f(x)$	1.521	1.506	1.488	1.467	1.444	1.418	1.389

5. Find the maximum value of $f(x)$ from the following table:

x	3	4	5	6	7	8
$f(x)$	0.205	0.240	0.259	0.262	0.250	0.224

6. Find the maximum value of y from the following table:

x	0	2	3	4	7	9
$f(x)$	4	26	58	112	466	922

7. Find the first derivative at $x = 4$ by using Stirling's formula:

x	1	2	3	4	5	6
$f(x)$	1	3	7	13	21	31

8. Find the maximum and minimum values of $f(x)$:

x	0	1	2	3	4	5
$f(x)$	0	0.25	0	2.25	16.0	56.25

Note: Practical problems based on each unit are not limited to the given ones, but any other related challenging and application-oriented problems may also be evaluated in the practical sessions.

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SEC- 2

MTH 404: Vector Calculus (Period: 30 Clock hours)

Course Description:

This is a skill development course of vector algebra and its calculus for S. Y. B.Sc. students

Prerequisite Course(s): Secondary school level knowledge of elementary physics and mathematics.

General Objective: The general objectives are to acquire skills of vectors algebra, vector valued functions, operators like del and curl and line and surface integrals.

Learning Outcomes:

a) understand scalar and vector products
b) understand vector valued functions and their limits and continuity and use them to estimate velocity and acceleration of partials.
c) Calculate the curl and divergence of a vector field.
d) Set up and evaluate line integrals of functions along curves.

Unit -1: Product of Vectors **Marks-15**

1.1 Scalar Product
1.2 Vector Product
1.3 Scalar Triple Product
1.4 Vector Product of Three Vectors
1.5 Reciprocal Vector

Unit-2: Vector functions **Marks-15**

1.1 Vector functions of a single variable.
1.2 Limits and continuity.
1.3 Differentiability, Algebra of differentiation.
1.4 Curves in space, Velocity and acceleration.
1.5 Vector function of two or three variables.
1.6 Limits, Continuity, Partial Differentiation

Unit-3: The Vector Operator Del **Marks-15**

2.1 The vector differentiation operator del.
2.2 Gradient.
2.3 Divergence and curl.
2.4 Formulae involving del. Invariance.

Unit-4: Vector Integration **Marks-15**

3.1 Ordinary integrals of vectors.
3.2 Line integrals.
3.3 Surface integrals.

Recommended Book:

1. Vector Analysis by Murray R Spiegel, Schaum's Series, McGraw Hill Book Company.

Reference Book:

1. Vector Calculus by Shanti Narayan and P.K. Mittal, S. Chand & Co., New Delhi

KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY, JALGAON

Equivalence courses for S. Y. B. Sc. (Mathematics)

Effective from 2019

Semester	Old course (June 2016)	New course (June 2019)
Sem-I	MTH 231 : Calculus of Several Variables	MTH 301 : Calculus of Several Variables
	MTH 232(A): Algebra	MTH 302(A) : Group Theory
	MTH 232(B): Theory of Groups	MTH -302(B): Theory of Groups and Codes
	MTH 233 : Practical Course based on MTH-232 & MTH-232	MTH 303 : Practical paper based on MTH 301 & MTH 302
Sem-II	MTH 241 : Complex Variables	MTH 401 : Complex Variables
	MTH 242(A): Differential Equations	MTH 402 : Differential Equations
	MTH 242(B): Differential and Difference Equations	MTH-402 (B): Differential Equations and Numerical Methods
	MTH 243 : Practical Course based on MTH-241 & MTH-242	MTH 403 : Practical paper based on MTH 401 & MTH 402

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

SYLLABUS FOR

T.Y. B. Sc. (MATHEMATICS)

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

Effective from June 2020-2021

KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY, JALGAON

Syllabus for T. Y. B. Sc. (Mathematics)
Under Choice Based Credit System (CBCS)
Effective from June 2020

Course Structure: Six semester course with continuous evaluation of external and internal examinations in 60:40 pattern.

Discipline	Course Type	Course code	credits	Hours per week	Total Teaching Hours
Semester-V					
DSC	Core I	MTH – 501	3	3	45
	Core II	MTH – 502	3	3	45
	Core III	MTH – 503	3	3	45
	Core IV	MTH – 504	3	3	45
DSC Skill Enhancement course (SEC)	Skill based	MTH – 505	3	3	45
DSC Elective course	Elective course (Any one)	MTH – 506(A)	3	3	45
		MTH – 506(B)	3	3	45
DSC	DSC Practical	MTH – 507	2	4 (Per batch)	60
		MTH – 508	2	4 (Per batch)	60
		MTH – 509	2	4 (Per batch)	60
Non-Credit Course	Elective Audit Course (Any one)	AC-601(A)	Non-credit	2	30
		AC-601(B)	Non-credit	2	30
		AC-601(C)	Non-credit	2	30
Semester-VI					
DSC	Core I	MTH – 601	3	3	45
	Core II	MTH – 602	3	3	45
	Core III	MTH – 603	3	3	45
	Core IV	MTH – 604	3	3	45
DSC Skill Enhancement course (SEC)	Skill based	MTH – 605	3	3	45
DSC Elective course	Elective course(Any one)	MTH – 606(A)	3	3	45
		MTH – 606(B)	3	3	45
DSC	DSC Practical	MTH – 607	2	4 (Per batch)	60
		MTH – 608	2	4 (Per batch)	60
		MTH – 609	2	4 (Per batch)	60

Medium of instruction: The medium of instruction for the courses shall be English.

Credit to contact hour: 1 credit = 15 teaching hour

Attendance: At least 75% per semester

Examination pattern

- Each theory and practical course will be of 100 marks comprising of 40 marks internal and 60 marks external examinations.
- Theory examination (60 marks) will be of two hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:

Question Pattern	Q.1	Q.2	Q.3	Q.4	Q.5	Total Questions
Question Type	Any 6 out of 9	Any 4 out of 6	Any 3 out of 4	Any 2 out of 3	Any 1 out of 2	16 out of 24
Marks	2 marks each	3 marks each	4 marks each	6 marks each	12 marks	--
Maximum Total Marks	18	18	16	18	24	94 marks

Semester-V

<table>
<tr><td colspan="3">DSC Core Course</td></tr>
<tr><td colspan="3">MTH - 501: Metric Spaces.</td></tr>
<tr><td>Total Hours: 45</td><td></td><td>Credits: 3</td></tr>
<tr><td></td><td colspan="2">Course objectives
1. Introduction of metric as a generalization of distance function and basic concepts in metric spaces.
2. To explain the concept of sequence and complete metric space with their properties.
3. To discuss compactness, and sequential compact spaces and their properties along with continuity.</td></tr>
<tr><td></td><td colspan="2">Learning outcomes
After studying this course, student should be able to:
1. Understand the Euclidean distance function on $\mathbb{R}^n$ and appreciate its properties, and state and use the Triangle and Reverse Triangle Inequalities for the Euclidean distance function on $\mathbb{R}^n$
2. Explain the definition of continuity for functions from $\mathbb{R}^n$ to $\mathbb{R}^m$ and determine whether a given function from $\mathbb{R}^n$ to $\mathbb{R}^m$ is continuous
3. Explain the geometric meaning of each of the metric space properties (M1) – (M3) and be able to verify whether a given distance function is a metric
4. Distinguish between open and closed balls in a metric space and be able to determine them for given metric spaces
5. Define convergence for sequences in a metric space and determine whether a given sequence in a metric space converges
6. State the definition of continuity of a function between two metric spaces.</td></tr>
<tr><td>Unit</td><td>Topics</td><td>Lectures</td></tr>
<tr><td>UNIT-1</td><td>Metric Spaces.
1.1 Equivalence and Countability
1.2 Metric Spaces
1.3 Limits in Metric Spaces</td><td>09</td></tr>
<tr><td>UNIT-2</td><td>Continuous functions on Metric Spaces.
2.1 Reformulation of definition of continuity in Metric Spaces.
2.2 Continuous function on Metric Spaces.
2.3 Open Sets
2.4 Closed Sets
2.4 Homeomorphisms.</td><td>09</td></tr>
<tr><td>UNIT-3</td><td>Connected Metric Spaces
3.1 More about Sets
3.2 Connected Set
3.3 Bounded and Totally bounded sets</td><td>09</td></tr>
<tr><td>UNIT-4</td><td>Complete of Metric Spaces
4.1 Complete Metric Spaces
4.2 Properties of Complete Metric Spaces
4.3 Contraction Mapping on Metric Spaces.</td><td>09</td></tr>
</table>

UNIT-5	**Compactness of Metric Spaces** 4.1 Compact Metric Spaces. 4.2 Continuous function on compact Metric Spaces . 4.3 Continuity of inverse function 4.4 Uniform Continuity	09
Recommended Book (s):		
1	R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Co. PVT. LTD, 2nd Edition, 1976 Chapter I : 1.5 ,1.6 , Chapter IV : 4.2, 4.3, Chapter V : 5.2,5.3, 5.4, 5.5 Chapter VI : 6.1,6.2,6.3.6.4,6.5,6.6,6.7,6.8	
Reference Book (s):		
1	S. C. Malik and Savita Arora, Mathematical Analysis, Second Edition, New Age International Pvt. Ltd., New Delhi , 2010.	
2	A First Course in Mathematical Analysis by D. Somsundaram and B. Chaudhari, Narosa Publishing House, New Delhi. 2018	

DSC Core Course		
MTH - 502: Real Analysis –I		
Total Hours: 45		**Credits: 3**
	Course objectives 1. To study the Riemann Integration. 2. To study the Mean value theorems of integral calculus 3. To study Improper integrals with finite limit and infinite limit 4. To study the concept of Riemann integration and its properties. 5. To study Beta and Gamma Integrals	
	Learning outcomes After successful completion of this course, students are expected to: 1. Understand the structure of Riemann Integration 2. Represent lattice in diagrammatic form. 3. Understand the Improper integrals with finite limit and infinite limit their properties. 4. Learn the concepts of Beta and Gamma Integrals.	
Unit	**Topics**	**Lectures**
UNIT-1	**Riemann Integration** 1.1 Definition and Existence of the Integral, The meaning of $\int_a^b f dx$ when $a \leq b$, Inequalities for integrals 1.2 Refinement of partitions 1.3 Darboux's Theorem (without proof) 1.4 Conditions of integrability 1.5 Integrability of the sum and difference of integrable functions. 1.6 The integral as a limit of sum (Riemann Sums) and the limit of sum as the integral and its applications 1.7 Some Integrable functions.	**09**
UNIT-2	**Mean value theorems of integral calculus** 2.1 The First mean value theorem 2.2 The generalized First mean value theorem 2.3 Abel's lemma (without proof) 2.4 Second mean value theorem. Bonnets form and Karl Weierstrass form	**09**
UNIT-3	**Improper integrals with finite limit** 3.1 Integration of unbounded functions with finite limits of Integral 3.2 Comparison Test for convergence at a of $\int_a^b f dx$ 3.3 Convergence of the improper integrals $\int_a^b \frac{dx}{(x-a)^n}$ 3.4 Cauchy's general test for convergence at the point a of $\int_a^b f dx$ 3.5 Absolute convergence of the improper integrals	**09**

	$\int_a^b f dx$	
UNIT-4	**Improper integrals with infinite limit** 4.1 Convergence of the integral with infinite range of Integration 4.2 Comparison Test for convergence at ∞ 4.3 Convergence at a of $\int_a^\infty \frac{dx}{x^n}$, $(a > 0)$ 4.4 Cauchy's General Test for convergence at ∞ 4.5 Absolute convergence of $\int_a^\infty f dx$ 4.6 Test for absolute convergence of $\int_a^\infty f dx$ 4.7 Abel's Test and Dirichlet's Test for convergence of $\int_a^\infty f dx$	09
UNIT-5	**Beta and Gamma Integrals** 5.1 Convergence of Beta and Gamma Integrals 5.2 Properties of Beta and Gamma Functions 5.3 Relation between Beta and Gamma Functions 5.5 Duplication Formula 5.6 Evaluation of integrals using Beta and Gamma Integrals	09
Recommended Book (s):		
1	S. C. Malik and Savita Arora, Mathematical Analysis, second Edition New Age International Pvt. Ltd., New Delhi, 2000. Chapter 9: 1 to 13, Chapter 11: 1 to 5.	
Reference Book (s):		
1	R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Co. PVT. LTD, 2nd Edition, 1976.	

DSC Core Course		
MTH - 503: Algebra		
Total Hours: 45		**Credits: 3**
	Course objectives 1) To gain the basic concepts of groups like subgroups, normal, isomorphism of groups. 2) To understand basic concepts of rings like ideals, isomorphism of rings and polynomial rings.	
	Learning outcomes After successful completion of this course, students are expected to: 1) know the use Permutation Groups 2) know normal Subgroups and group isomorphisms 3) Know Ideals in rings, Quotient Rings and Isomorphism of Rings 4) Know polynomial Rings and irreducibility of polynomials	
Unit	**Topics**	**Lectures**
UNIT-1	**Permutation Groups** 1.1 Definitions: Permutation, Cycle, Transposition 1.2 Permutations as a product of disjoint cycles and transpositions 1.3 Even and odd permutations 1.4 Permutation Groups, Alternating Groups	**09**
UNIT-2	**Normal Subgroups** 2.1 Normal Subgroup 2.2 Criterions for a subgroup to be a normal subgroup 2.3 Union and Intersection of normal subgroups 2.4 Quotient Group 2.5 Simple Group 2.6 Cyclic group 2.7 Commutator subgroup 2.8 Group homomorphism	**09**
UNIT-3	**Isomorphism Theorems for Groups** 3.1 Revision of Homomorphism and Isomorphism of Groups. 3.2 Isomorphism theorems for groups and examples 3.3 Cayley's theorem, Theorem: $o(A_n) = \frac{o(S_n)}{2}$ 3.4 Automorphism and inner Automorphism	**09**
UNIT-4	**Ideals, Quotient Rings and Isomorphism of Rings** 4.1 Revision of Ring, integral domain, field and basic properties 4.2 Characteristics of a ring 4.3 Subrings, ideals, left ideals, right ideals, principal ideals, prime and maximal ideals. 4.4 Quotient rings 4.5 Quotient Field (Definition & Examples only) 4.6 Homomorphism and isomorphism of rings	**09**

UNIT-5	**Polynomial Rings** 5.1 Definition and Properties of polynomial rings 5.2 Roots of Polynomials 5.3 Factorization of Polynomials 5.4 Division Algorithm for Polynomials 5.5 Eisenstein's Criterion 5.6 Other irreducibility criterion	**09**
Recommended Book(s):		
1	N.S. Gopalakrishnan, University Algebra, 2nd Revised Edition, New Age International Publishers, 2003. Chapter-1 : Art.-1.7, 1.8, 1.9, 1.11; Chapter-2 : Art.- 2.2, 2.3,2.4,2.5, 2.6, 2.7,2.8,2.9,2.14,2.15	
2	J.B. Fraleigh, A First Course in Abstract Algebra , 3rd Edition, Narosa Publishing House, Tenth Reprint 2003. Chapter-30: Art.-30.1, 30.2, 30.3; Chapter-31: Art.-31.1, 31.2.	
Reference Book(s):		
1	I.N. Herstein, *Topics in Algebra* ,2^{nd} Edition, Vikas Publishing House Pvt. Ltd. New Delhi. 2018.	
2	V. K. Khanna and S. K. Bhambri, *A course in Abstract Algebra* (3^{rd} Edition), Vikas Publishing House Pvt. Ltd. New Delhi, 2008.	
3	P.B. Bhattacharya, S. K. Jain and S. R. Nagpaul, *Basic Abstract Algebra* (2^{nd} Edition), Cambridge University Press, 2003.	

<table>
<tr><td colspan="3" align="center">DSC Core Course</td></tr>
<tr><td colspan="3" align="center">MTH - 504: Lattice Theory</td></tr>
<tr><td>Total Hours: 45</td><td></td><td>Credits: 3</td></tr>
<tr><td></td><td colspan="2">Course objectives
1) To study the structure of poset and lattice.
2) To study the diagrammatic representation of lattice.
3) To study the terms Maximal element, Minimal element, Greatest element, Least elements.
4) To study the concept of ideals and its properties.
5) To study homomorphism of lattices.
6) To study modular and distributive lattice and their inter-relation.
7) To study complemented and relatively complemented lattice.</td></tr>
<tr><td></td><td colspan="2">Learning outcomes
After completing this syllabus students will able to
1) Understand the structure of poset and lattice.
2) Represent lattice in diagrammatic form.
3) Understand the terms Maximal element, Minimal element, Greatest element, Least elements.
4) Learn the concepts of ideals and their properties.
5) Learn the concepts of homomorphism.
6) Understand modular and distributive lattice and their inter-relation.
7) Understand complemented and relatively complemented lattice</td></tr>
<tr><td align="center">Unit</td><td align="center">Topics</td><td align="center">Lectures</td></tr>
<tr><td align="center">UNIT-1</td><td>Posets
1.1. Posets and Chains
1.2. Diagrammatical Representation of posets
1.3. Maximal and Minimal elements of subset of a poset, Zorn’s Lemma (Statement only)
1.4. Supremum and infimum
1.5. Poset isomorphism
1.6. Duality Principle.</td><td align="center">09</td></tr>
<tr><td align="center">UNIT-2</td><td>Lattices
2.1. Two definitions of lattice and equivalence of two definitions
2.2. Modular and Distributive inequalities in a lattice.
2.3. Sublattice and Semilattice
2.4. Complete lattice</td><td align="center">09</td></tr>
<tr><td align="center">UNIT-3</td><td>Ideals
3.1. Ideals ,Union and intersection of Ideals
3.2. Prime Ideals
3.3. Principal Ideals
3.4. Dual Ideals
3.5. Principal dual Ideals
3.6. Complements , Relative Complements</td><td align="center">09</td></tr>
</table>

UNIT-4	**Homomorphisms and Modular Lattices** 4.1. Homomorphisms, Join and meet homomorphism 4.2. Definition of Kernel 4.3. Properties of Kernels 4.4. Modular lattice 4.5. Sublattice of Modular lattice 4.6. Homomorphic image of Modular lattice	**09**
UNIT-5	**Distributive lattices and Boolean Lattice** 5.1. Distributive lattice 5.2. Relation between Modular and Distributive Lattices 5.3. Sublattice of distributive lattice 5.4. Homomorphic image of distributive lattice 5.5. Complemented and Relatively complemented lattice 5.6. Definition Boolean Lattice 5.7. Properties of Boolean lattice	**09**
Recommended Book(s):		
1	Vijay K. Khanna, Lattices and Boolean Algebra, Vikas Publ. Pvt. Ltd , 2nd edition 2004, Chapter -2,3,4,	
Reference Book(s):		
1	George Gratzer, General Lattice Theory, Birkhauser, 2nd Editon, 2013.	

DSC Skill Enhancement Course (SEC) SEC-III: Skill Based DSC Elective Course		
MTH - 505: Integral Transforms		
Total Hours: 45		**Credits: 3**
	Course objective The goals for the course are 1. To gain a facility with using the transform, both specific techniques and general principles, and learning to recognize when, why, and how it is used. 2. Together with a great variety, the subject also has a great coherence, and the hope is students come to appreciate both.	
	Learning outcomes After successful completion of this course, students are expected to: 1. Know the use of Fourier transform in Wave equation, 2. Solve Boundary Value Problems, also problem on Heat-flow in semi-infinite bar. 3. Use Fourier transform in communication theory and signal analysis, image processing and filters, data processing and analysis, solving partial differential equations for problems on gravity. 4. Students will be able to use Z-transform in the characterization of Linear Time-Invariant system (LTI), in development of scientific simulation algorithms	
Unit	**Topics**	**Lectures**
UNIT-1	**Fourier Transforms :** 1.1 Complex and exponential form of Fourier series 1.2 Fourier Integrals 1.3 Equivalent form of Fourier integral 1.4 Sine and cosine integrals 1.5 Fourier transforms 1.6 Fourier cosine transforms 1.7 Fourier sine transforms	**09**
UNIT-2	**Inverse Fourier Transforms** 2.1 Useful result for evaluating the integral in Fourier transforms 2.2 Inverse Fourier transforms 2.3 Inverse sine transforms 2.4 Inverse cosine transforms	**09**
UNIT-3	**Theorems of Fourier Transforms** 3.1 Modulation theorem 3.2 Convolution theorem 3.3 Finite Fourier transforms 3.4 Finite Fourier cosine transforms 3.5 Finite Fourier sine transforms 3.6 Fourier transform of the derivatives of a function. 3.7 Application of Fourier transform to boundary value problem.	**09**

UNIT-4	**Z – Transforms** 4.1 Basic preliminary Z-transforms 4.2 Inverse Z-transform 4.3 Z-transform pair 4.4 Uniqueness of inverse Z-transform 4.5 Properties of Z-transforms	**09**
UNIT-5	**Inverse Z-transforms** 5.1 Power series method 5.2 Partial fraction method 5.3 Inverse integral method. 5.4 Solution of difference equations with constant coefficients using Z-transform	**09**
Recommended Book(s):		
1	Lokenath Debnath, Dambaru Bhatta, Integral Transforms and Their Applications, Third Edition, CRC Press, 2014. Chapter 2 : 2.1 to 2.19 Chapter 12 : 12.1 to 12.8	
Reference Book(s):		
1	Davies, Brian, Integral Transforms and Their Applications, 3rd edition, Springer Verlag, New York, 2002. Chapter 7 : 7.1 to 7.4.	

DSC Elective Course (Any one)		
MTH – 506(A): C Programming		
Total Hours: 45		**Credits: 3**
	Course objectives The course is oriented to those who want to advance structured and procedural programming understating and to improve C programming skills. The major objective is to provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.	
	Learning outcomes After successful completion of this course, students are expected to: • Understanding a functional hierarchical code organization. • Ability to define and manage data structures based on problem subject domain. • Ability to work with textual information, characters. • Ability to work with arrays of complex objects. • Understanding a concept of object thinking within the framework of functional model. • Understanding a defensive programming concept. Ability to handle possible errors during program execution.	
Unit	**Topics**	**Lectures**
UNIT-1	**Basic concepts** 1.1 Introduction 1.2 Character set 1.3 C tokens, keywords 1.4 Constants 1.5 Variables, data types 1.6 Variables, symbolic constants 1.7 Over flow, under flow 1.8 Operators of arithmetic, relational, logical, assignment, increment and decrement, conditional and special type.	**09**
UNIT-2	**Expressions and conditional statements** 2.1 Arithmetic expression and its evaluation precedence of arithmetic operators type 2.2 Conversion, operator precedence, mathematical functions 2.3 Reading and writing a character 2.4 Formatted input and out put 2.5 Decision making, if, is-else, else-if, switch and go to statements.	**09**

UNIT-3	**Loops: Decision making and Looping:** 3.1 Sentinel loops. While loop, do-while loop and for statements. 3.2 Jump in loops, continue, break and exit statements.	09
UNIT-4	**Arrays** 4.1 One dimensional array 4.2 Two dimensional and multidimensional arrays. 4.3 Declaration and initialization of arrays.	09
UNIT-5	**Functions** 5.1 Need for user defined functions, multi-function program 5.2 Elements of function, definition of functions, return values and their types 5.3 Function calls, function declaration, category of functions. 5.4 Functions that return multiple values. Recursion.	09
Recommended Book (s):		
1	Programming in ANSI C , E. Balagurusamy, Mcgraw-Hill company, New York, 2012. Chapter 1 to chapter 9 all points.	
Reference Book (s):		
1	LET Us C, Yashwant Kanitkar, B.P.B. Publication, 14TH Edition, 2016 Chapter 1 to 8, Chapter 13 and 14.	

MTH – 506(B): Number Theory		
Total Hours: 45		**Credits: 3**
	Course objectives: To study prime numbers and Diophantine equations, Theory of congruence's, Perfect numbers, Fibonacci sequence and finite continued fractions.	
	Learning outcomes After successful completion of this course, students are expected to: 1) solve Diophantine equations 2) use Fermat's theorem, Euler's theorem and Wilson's theorem for finding remainders 3) understand perfect, Mersenne and Fermat's numbers. 4) understand Fibonacci sequence 5) solve Diophantine equations by using finite continued fractions.	
Unit	**Topics**	**Lectures**
UNIT-1	**Prime numbers and Diophantine Equations** 1.1 The Fundamental Theorem of Arithmetic 1.1 The Sieve of Eratosthenes 1.3 The Goldbach Conjecture 1.4 The Diophantine Equation $ax + by = c$	**09**
UNIT-2	**The theory of congruence** 2.1 Basic Properties of Congruence 2.2 Binary and decimal representations of integers. 2.3 Linear Congruences and the Chinese Remainder Theorem.	**09**
UNIT-3	**Fermats Theorem** 3.1 Fermat's Factorization Method 3.2 The Little Theorem and pseudoprimes 3.3 Wilson's Theorem	**09**
UNIT-4	**Perfect Numbers** 4.1 Perfect Numbers 4.2 Mersenne Numbers 4.3 Farmat's Numbers	**09**
UNIT-5	**Fibonacci sequence and finite continued fractions** 5.1 The Fibonacci sequence 5.2 Certain Identities Involving Fibonacci Numbers. 5.3 Finite continued fractions	**09**
Recommended Book (s):		
1.	Elementary Number Theory , David M. Burton, Sixth Edition, Tata McGraw-Hill Edition, New Delhi, 1998. Ch.3 : 3.1 to 3.3, Ch . 2 : 2.5, Ch.4 : 4.2 to 4.4, Ch.5 : 5.2 to 5.4, Ch.11 : 11.2 to 11.4, Ch 14 : 14.2 to 14.3, Ch 15: 15.2	
Reference Book (s):		
1.	Introduction to Analytic Number Theory ,T. M. Apostol, Springer International student Edition, 1972.	
2.	Number Theory, Hari Kishan, Krishna Prakashan Media (p) Ltd, Meerat,, 2014.	

DSC Core (Practical)		
MTH – 507: Practical Course based on (MTH-501& MTH-502)		
Total Hours: 60		**Credits: 2**
	Course objectives • To develop analytical and computational skills • To get hands on training for solving problems of Metric spaces and Riemann integrals.	
	Learning outcomes After successful completion of this course, students are expected to: • Students will develop problem solving problems on metric spaces and Riemann integrations.	
Unit	**Topics**	**Lectures**
UNIT-1	Examples on unit -1 of (MTH-501 & MTH-502)	**12**
UNIT-2	Examples on unit -2 of (MTH-501 & MTH-502)	**12**
UNIT-3	Examples on unit -3 of (MTH-501 & MTH-502)	**12**
UNIT-4	Examples on unit -4 of (MTH-501 & MTH-502)	**12**
UNIT-5	Examples on unit -5 of (MTH-501 & MTH-502)	**12**

List of Practical's:

MTH-507	Practical Course based on MTH-501 & MTH-502

MTH-501 : Metric Spaces

Practical No. 1 - Metric spaces

1. If A_1 , A_2 , $\cdots$, A_n are countable sets, then show that $\bigcup_{n=1}^{\infty} A_n$ is countable.
2. Show that the intervals $(0, 1)$ and $[0, 1]$ are equivalent.
3. Show that the intervals $\left[-\frac{\pi}{2}\ ,\ \frac{\pi}{2}\right]$ and $(-\infty\ ,\ \infty)$ are equivalent.
4. Let $x = (x_1 , x_2)$, $y = (y_1 , y_2)$ be any two points in $\mathbb{R}^2$. Define $\rho :\ \mathbb{R}^2 \times \mathbb{R}^2 \to \mathbb{R}$ by $\rho(x, y) =\ \max\{|x_1 - y_1|, |x_2 - y_2|\}$. Show that ρ is a metric on $\mathbb{R}^2$.
5. Let $d :\ \mathbb{R} \times \mathbb{R} \to \mathbb{R}$ be defined by $d(x , y) = \frac{|x-y|}{1+|x-y|}\ \forall\, x, y \in \mathbb{R}$. Show that d is a metric on $\mathbb{R}$.

Practical No. 2 –Continuous Functions on Metric Spaces

1. Which of the following subsets of $\mathbb{R}^2$ are open? Justify.
   a) $A\ =\ \{(x, y) \in \mathbb{R}^2 \mid x\ and\ y\ are\ rationals\}$
   b) $B\ =\ \{(x, y) \in \mathbb{R}^2 \mid x\ and\ y\ are\ both\ irrationals\}$
2. If A and B are open subsets of $\mathbb{R}$ then show that $A \times B$ is an open subset of $\mathbb{R}^2$.
3. Let f and g be two real valued continuous functions on metric space M and $B = \{x \in M : f(x) \geq g(x)\}$. Prove that B is closed.
4. Give an example of a sequence $A_1, A_2 , A_3 \cdots$ of non empty closed subsets of $\mathbb{R}$ such that both of the following conditions hold :
   a) $A_1 \supset\ A_2\ \supset\ A_3 \supset \cdots$
   b) $\bigcap_{n=1}^{\infty} A_n = \phi$
5. Show that $\mathbb{R}$ and $\mathbb{R}_d$ are not homeomorphic to each other.

Practical No. 3 – Connected Metric Spaces

1. If A is a connected subset of a metric space M and if $A \subset B \subset \bar{A}$ then prove that B is connected.
2. Show that $(0, 1)$ is not complete but connected subset of the usual metric space $\mathbb{R}$.
3. Let $A = [\,0, 1]$ be a metric space with absolute value metric d. Which of the following subsets of A are open subsets of A ?

   i) (½, 1]　　　　ii) (½, 1)
4. Prove that the interval $[0, 1]$ is not connected subset of $\mathbb{R}_d$.
5. Let A be a subset of l^2 space consisting of the points $e_1 = (1\,,0\,,0\,,\cdots), e_2 = (0\,,1\,,0\,,\cdots), e_3 = (0\,,0\,,1\,,\cdots)$, then show that A is a bounded subset of l^2 but it is not totally bounded.

Practical No. 4 – Complete Metric Spaces

1. Let $(M\,,\rho)$ be a metric space If $T\colon M \to M$ is a contraction on M then prove that T is continuous on M.
2. Prove that any discrete metric space is complete .
3. If $T\colon X \to X$ is define as $Tx = x^2$, where $x = \left[0, \frac{1}{3}\right]$, Then T is a contraction on $\left[0, \frac{1}{3}\right]$.
4. If $T\colon [0,1] \to [01]$ and there is a real number α with $0 < \alpha < 1$ such that $|f'(x)| < \alpha$, where f' is the derivative of f , then f is contraction on [0,1]
5. Show that any set with discrete metric space forms a complete metric space.

Practical No. 5 – Compact Metric Spaces

1. Let $f\,:\,\mathbb{R} \to \mathbb{R}$ be defined by $f(x) = sinx$, for all $x \in \mathbb{R}$ $f(x)$. Examine whether $f(x)$ is uniformly continuous or not.
2. Show that $f(x) = x^2$, for all $x \in [0\,,1]$ is uniformly continuous on [0,1] using definition of uniformly continuous function.
3. Show that every finite subset E of any metric space $(M\,,\rho)$ is compact.
4. Give example of

   a) Complete, compact and connected metric space.

   b) Complete, compact but not connected metric space.
5. Let f be a continuous function from the compact metric space M_1 into the metric space M_2. Then prove that range $f(M_1)$ of f is bounded subset of M_2.

MTH-502: Real Analysis

Practical No. 06 -

1. Let $f(x) = x^2$ defined on $[0, k]$. Find $a)$ $U(p, f)$, b) $L(p, f)$ and show that $f \in [0, k]$ and $\int_0^k f(x)dx = \frac{k^3}{3}$
2. Find the upper and lower integral for the function defined on $[0, 1]$ as
$$f(x) = \begin{cases} \sqrt{1 - x^2} & , when\ x\ is\ rational \\ 1 - x & , when\ x\ is\ irrational \end{cases}$$
3. The function $f(x)$ defined on $\left[0, \frac{\pi}{4}\right]$ as $f(x) = \begin{cases} cosx, & when\ x\ is\ rational \\ sinx\,, & when\ x\ is\ irrational \end{cases}$

   Show that $f(x) \notin R\left[0, \frac{\pi}{4}\right]$
4. Show that the function defined as $f(x) = \frac{1}{2^n}$, where $\frac{1}{2^{n+1}} < x \le \frac{1}{2^n}$, $n = 0, 1, 2, \cdots$ $f(x) = 0$ is integrable on [0, 1] and evaluate $\int_0^1 f(x)dx$
5. A function defined on [0, 1] as $f(x) = \frac{1}{a^{r-1}}$, if $\frac{1}{a^r} < x \le \frac{1}{a^{r-1}}$, where a is an integer greater than 2, and $r = 1, 2, 3, \cdots$ Show that

   $a)$ $\int_0^1 f(x)dx\ exists$,　　　$b)$ $\int_0^1 f(x)dx = \frac{a}{a+1}$

Practical No. 07 : Mean Value Theorem

1. Using Mean Value Theorem. Prove that $\frac{\pi^3}{24} \leq \int_0^{\pi} \frac{x^2}{5+3cosx} dx \leq \frac{\pi^3}{3}$
2. Show that $\frac{1}{2} \leq \int_0^1 \frac{dx}{\sqrt{4-x^2+x^3}} \leq \frac{\pi}{6}$
3. If $a > 0, show$ that $ae^{-a^2} < \int_0^{-a^2} e^{-x^2} dx < tan^{-1}a$
4. Show that $\lim_{n\to\infty} \int_0^1 \frac{nf(x)}{1+n^2x^2} dx = \frac{\pi}{2} f(0)$
5. Verify second Mean Value Theorem for the function $f(x) = x$ and $g(x) = e^x$

Practical No. 08 : Improper integral for finite limit

1. Show that $\int_0^2 \frac{\text{logx}}{\sqrt{2-\text{x}}} \text{dx}$ is convergent.
2. Discuss the convergence of $\int_1^2 \frac{\sqrt{x}}{logx} dx$.
3. Test the convergence of $\int_0^1 \frac{dx}{x^{1/2}(1-x)^{1/2}}$.
4. Show that the integral $\int_0^{\pi/2} logsinx\ dx$ is convergent and hence evaluate it.
5. Show that $\int_0^1 x^{m-1}(1-x)^{n-1}dx$ exists if and only if $m, n \geq 0$

Practical No. 09 : Improper integral for infinite limit

1. Examine the convergence of $\int_0^{\infty} \frac{x^2}{\sqrt{x^5+1}} dx$.
2. Show that $\int_0^{\infty} \frac{sin^2 x}{x^2} dx$ is convergent.
3. Test the convergence of the integral $\int_0^{\infty} \frac{xtan^{-1}x}{(1+x^4)^{1/3}} dx$.
4. Show that the integral $\int_0^{\infty} x^{m-1}e^{-x} dx$ is convergent if and only if $m > 0$.
5. Using $\text{Cauchy's Test, show that}$ $\int_0^{\infty} \frac{sinx}{x} dx$ is convergent.

Practical No. 10 : Beta and Gamma Integrals

1. Show that $\int_0^{\infty} e^{-ax}x^{n-1} dx = \frac{n!}{a^n}$, $a > 0$
2. Show that $\Gamma(\text{n}) = \int_0^1 \frac{\left(log\frac{1}{y}\right)^{n-1}}{x^2} dy$.
3. Prove that $\int_0^{\infty} \frac{x^{m-1}}{(1+x)^{m+n}} dx = \beta(m, n)$.
4. Prove that $\int_0^1 \frac{x^{m-1}+x^{n-1}}{(1+x)^{m+n}} dx = \beta(m, n)$.
5. Show that $m > 0, n > 0, \int_a^b (x-a)^{m-1}(b-x)^{n-1}dx = (b-a)^{m+n-1}\beta(m, n)$.

DSC Core (Practical)		
MTH – 508 :Practical Course based on (MTH-503 & MTH-504)		
Total Hours: 60		**Credits: 2**
	Course objectives • To develop analytical and computational skills • To get hands on training in solving problems of groups, rings and Lattice Theory.	
	Learning outcomes After successful completion of this course, students are expected to: • develop problem solving skills	
Unit	**Topics**	**Lectures**
UNIT-1	Examples on unit -1 of (MTH-503 & MTH-504)	**12**
UNIT-2	Examples on unit -2 of (MTH-503 & MTH-504)	**12**
UNIT-3	Examples on unit -3 of (MTH-503 & MTH-504)	**12**
UNIT-4	Examples on unit -4 of (MTH-503 & MTH-504)	**12**
UNIT-5	Examples on unit -5 of (MTH-503 & MTH-504)	**12**

List of Practical's:

MTH-508	Practical Course based on MTH-503 & MTH-504

MTH-503 : Algebra

Practical No. 1 - Permutations

1) Prepare a multiplication table of the permutations on set $A = \{1, 2, 3\}$ and show that S_3 is a group under the operation of permutation multiplication.
2) Find all even permutations in the permutation group S_4.
3) If $\sigma = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 5 & 4 & 1 & 6 & 3 & 2 \end{pmatrix}$ and $\mu = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 2 & 3 & 4 & 1 & 6 & 5 \end{pmatrix}$ in S_6, then find
   i) σ^2 ii) μ^2 iii) $\sigma\mu$ iv) $\mu\sigma$ v) σ^{-1} vi) μ^{-1}.
4) If $\sigma = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 6 & 4 & 7 & 5 & 2 & 3 & 1 \end{pmatrix}$ in S_7, then express σ as a product of transpositions. Is it an even permutation? Also find order of σ.
5) If $\mu = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ 4 & 6 & 2 & 5 & 8 & 9 & 3 & 1 & 7 \end{pmatrix}$ in S_9, then find order of μ^{-1}.

Practical No.-2 Normal Subgroups

1) Show by an example that union of two normal subgroups of a group G need not be a normal subgroup.
2) Find all normal subgroups of the group of quaternions $Q = \{\pm 1, \pm i, \pm j, \pm k\}$.
3) Show that A_n is a normal subgroup of the permutation group S_n.
4) Give an example of subgroups H, K of G such that H is normal in K and K normal in G but H is not normal in G.

5) Let $G = \mathrm{GL}(2,\mathbb{R}) = \{A : A \text{ is non-singular } 2\times 2 \text{ matrix over } \mathbb{R}\}$, a group under usual matrix multiplication and $H = \mathrm{SL}(2,\mathbb{R}) = \{A \in G : |A| = 1\}$ a subgroup of G. Show that H is normal in G.

Practical No.-3 Isomorphism Theorems for Groups

1) Let $\mathbb{R}^*$ be the multiplicative group of non-zero reals. Show that $\frac{\mathrm{GL}(2,\mathbb{R})}{\mathrm{SL}(2,\mathbb{R})} \cong \mathbb{R}^*$.
2) If G, H, K are groups such that $G \cong H$ and $H \cong K$, then prove that $G \cong K$.
3) Let $G = \{1, -1\}$ be the group under multiplication. Show that the function $f: S_n \to G$ defined by $f(\sigma) = \begin{cases} 1 & \text{if } \sigma \text{ is even} \\ -1 & \text{if } \sigma \text{ is odd} \end{cases}$, is an onto group homomorphism. Find its kernel.
4) Show that $\mathbb{Z}_9$ is not a homomorphic image of $\mathbb{Z}_{16}$.
5) Show that the group $(\mathbb{Q}, +)$ is not isomorphic to $(\mathbb{Q}^+, \cdot)$.

Practical No.-4 Ideals, Quotient Rings and Isomorphism of Rings

1) Show that characteristics of a Boolean ring is two.
2) Find the characteristics for the rings i) $(\mathbb{Z}_n, +_n, \times_n)$ ii) $(\mathbb{Z}, +, \cdot)$.
3) Let R be a ring and $Z(R) = \{x \in R : xy = yx \ \forall y \in R\}$. Show that
   (a) $Z(R)$ is a subring of R.
   (b) If R is a division ring, then $Z(R)$ is a field.
4) Give an example of a right ideal in a ring which is not a left ideal.
5) Find all ideals in the ring $(\mathbb{Z}_{12}, +_{12}, \times_{12})$.

Practical No.-5 Polynomial Rings

1) Let $f(x) = 2x^3 + 4x^2 + 3x + 2$ and $g(x) = 3x^4 + 2x + 4$ in $\mathbb{Z}_5[x]$. Find
   a) $f(x) + g(x)$ b) $f(x) \cdot g(x)$ c) $\deg(f(x) \cdot g(x))$.
2) Let $f(x) = x^6 + 3x^5 + 4x^2 - 3x + 2$ and $g(x) = x^2 + 2x - 3$ be polynomials in $\mathbb{Z}_7[x]$.
   a) Find $q(x), r(x) \in \mathbb{Z}_7[x]$ such that $f(x) = g(x).q(x) + r(x)$ with $\deg(r(x)) < 2$.
   b) Find all zeros of $f(x) = x^5 + 3x^3 + x^2 + 2x$ in $\mathbb{Z}_5$.
3) Examine whether the polynomial $x^3 + 3x^2 + x - 4$ is irreducible over the field $(\mathbb{Z}_7, +_7, \times_7)$.
4) Express the polynomial $x^4 + 4$ as a product of linear factors in $\mathbb{Z}_5[x]$.
5) Give an example of polynomials $f(x)$ and $g(x)$ in a ring $\mathbb{Z}_6[x]$ such that $\deg(f(x) \cdot g(x)) < \deg(f(x)) + \deg(g(x))$.

MTH -504: Lattice Theory

Practical 6: Posets

1) Show that set of natural numbers N under usual $\leq$ forms a poset.
2) Show that in a poset $a < a$ for no a and $a < a, b < c \Rightarrow a < c$.
3) Prove that a mapping $f: P \to Q$ is an isomorphism iff f is isotone and has an isotone inverse.
4) Show that two chains $S = \left\{0, \dots, \frac{1}{n}, \dots, \frac{1}{3}, \frac{1}{2}, 1\right\}, \leq$ and $T = \left\{0, \frac{1}{2}, \frac{2}{3}, \dots, \frac{1}{3}, \frac{1}{2}, 1\right\}, \leq$ are dually isomorphic.
5) Let A and B be two posets. Show that $A \times B = \{(a, b) = a \in A, b \in B\}$ forms a poset under the relation defined by $(a_1, b_1) \leq (a_2, b_2) \Leftrightarrow a_1 \leq a_2 \text{in} A$ and $b_1 \leq b_2$ in B.

Practical 7:Lattices

1) Show that a lattice L is a chain iff every non-empty subset of it is a sublattice.
2) Let S be any set and L be a lattice. Let T =set of all functions from $S \to L$. Define relation$\leq$ on T by $f \leq g \Rightarrow f(x) \leq g(x) \forall x \in S, f, g \in \mathrm{T}$. Show that $(\mathrm{T}, \leq)$ forms a lattice.

3) Draw the diagram of the lattice of factors of 20, under divisibility and show that it is same as that of the product of two chains with three and two elements.
4) Prove that a finite lattice has least and greatest elements.
5) Show that a lattice of factors of 12 under divisibility is a sublattice of the lattice N of natural numbers under divisibility.

Practical 8: Ideals

1) Prove that an ideal is a sublattice. Is converse true? Justify.
2) Prove that, union of two ideals is an ideal iff one of them is contained in other.
3) Let N be the lattice of all natural numbers under divisibility.

Show that $A = \{1, p, p^2, \dots, \}$, where p is a prime, forms an ideal of N.

4) Show that an ideal of a lattice L which is also a dual ideal is the lattice itself.
5) Prove that, a lattice L is a chain iff all ideals in L are prime.

Practical 9: Homomorphisms and Modular Lattices

1) Let L, M be lattices. If $\theta: L \to M$ is onto homomorphism and L has least element then prove that M has least element.
2) Prove that homomorphic image of a relatively complemented lattice is relatively complemented.
3) If $\theta: L \to M$ is onto homomorphism, where L, M are lattices and o' is least elemtnt of M, then $Ker\theta$ is an ideal of L.
4) If $\theta: L \to L$ is a homomorphism, where L is a complete lattice then $\exists$ some $a \in L$, such that $\theta(a) = a$.
5) Prove that homomorphic image of modular lattice is modular.

Practical 10: Distributive Lattices Boolean Lattice

1) Prove that, every distributive lattice is always modular, but converse need not true.
2) A lattice L is distributive iff $a \wedge (b \vee c) = (a \vee b) \wedge (a \wedge c), \forall a, b, c \in L$.
3) Prove that homomorphic image of distributive lattice is distributive.
4) Prove that a sublattice of a distributive lattice is distributive.
5) Prove that, a lattice is distributive iff $a \vee (b \wedge c) = (a \vee b) \wedge (a \vee c), \forall\ a, b, c \in L$.

DSC Core (Practical)		
MTH – 509: Practical Course based on (MTH-505,MTH-506(A) or MTH- 506(B))		
Total Hours: 60		**Credits: 2**
	Course objectives • To develop analytical and computational skills • To get hands on training in solving problems of Integral Transforms and either in C Programming or Number Theory.	
	Learning outcomes After successful completion of this course, students are expected to: • develop problem solving skills • develop computer programs for problems of number theoretic problems.	
Unit	**Topics**	**Lectures**
UNIT-1	Examples on unit -1 of (MTH-505 & MTH-506(A or B)	**12**
UNIT-2	Examples on unit -2 of (MTH-505 & MTH-506(A or B)	**12**
UNIT-3	Examples on unit -3 of (MTH-505 & MTH-506 (A or B)	**12**
UNIT-4	Examples on unit -4 of (MTH-505 & MTH-506 (A or B)	**12**
UNIT-5	Examples on unit -5 of (MTH-505 & MTH-506 (A or B)	**12**

List of Practical's:

MTH-509	Practical Course based on MTH-505 & MTH-506 (A or B)

MTH-505 Integral Transforms
Practical 1 Fourier Transforms

1) Find the Fourier integral for the function $f(x) = \begin{cases} 0, & if\ x < 0 \\ e^{-x}, & if\ x > 0 \\ \frac{1}{2}, & if\ x = 0 \end{cases}$

2) By considering Fourier sine and cosine integrals of e^{-mx} $(m > 0)$, prove that
$(a) \int_0^\infty \frac{\lambda \sin \lambda x}{\lambda^2 + m^2}\, d\lambda = \frac{\pi}{2} e^{-mx}$, $m > 0$, $x > 0$ and
$$(b) \int_0^\infty \frac{\cos \lambda x}{\lambda^2 + m^2}\, d\lambda = \frac{\pi}{2m} e^{-mx} \ ,\ m > 0\ , x > 0$$

3) Find the Fourier cosine integral representation for the function
$$f(x) = \begin{cases} x^2, & if\ 0 < x < a \\ 0, & if\ x > a \end{cases}$$

4) Using Fourier integral representation, show that

$$\int_0^{\infty} \frac{\cos\left(\frac{\pi\lambda}{2}\right)\cos(\lambda x)}{1-\lambda^2}\, d\lambda = \begin{cases} \frac{\pi}{2}\cos x, & if\ |x| \le \frac{\pi}{2} \\ 0, & if\ |x| > \frac{\pi}{2} \end{cases}$$

5) Find the Fourier transform of $f(x) = \begin{cases} 1 - x^2, & if\ |x| \le 1 \\ 0, & if\ |x| > 1 \end{cases}$

and hence evaluate $\int_0^{\infty} \left(\frac{x\cos x - \sin x}{x^3}\right)\cos\left(\frac{x}{2}\right) dx$.

Practical 2 Inverse Fourier Transforms

1) Using inverse sine transform, find $f(x)$, if $F_s(\lambda) = \frac{1}{\lambda} e^{-a\lambda}$
2) What is the function f(x), whose Fourier cosine transform is $\frac{\sin a\lambda}{\lambda}$?
3) Solve the integral equation $\int_0^{\infty} f(x)\sin\lambda x\ dx = \begin{cases} 1-\lambda, & if\ 0 \le \lambda < 1 \\ 0, & if\ \lambda \ge 1 \end{cases}$
4) Solve the integral equation $\int_0^{\infty} f(x)\sin\lambda x\, dx = \begin{cases} 1, & if\ 0 \le \lambda < 1 \\ 2, & if\ 1 \le \lambda < 2 \\ 0, & if\ \lambda \ge 2 \end{cases}$
5) Solve the integral equation $\int_0^{\infty} f(x)\cos\lambda x\ dx = e^{-\lambda},\ \lambda > 0$

Practical 3 Theorems of Fourier Transforms

1) Find the finite sine and cosine transforms of $f(x) = 2x,\ \ 0 \le x \le 4$
2) If $f(x) = \sin kx$, where $0 \le x \le \pi$ and k is an positive integer, then show that

$$F_s[f(n)] = \begin{cases} 0, & if\ n \ne k \\ \frac{\pi}{2}, & if\ n = k \end{cases}$$

3) Find$f(x)$ if $F_c[f(n)] = -\frac{l^3}{n^2\pi^2}(1+\cos n\pi)$ and $F_c(0) = \frac{l^3}{6}$, where $0 \le x \le l$
4) Find $f(x)$ if $F_c[f(n)] = \frac{2l^3}{n^3\pi^3}(1-\cos n\pi)$, where $0 \le x \le l$
5) Find $f(x)$ if $F_c[f(n)] = \frac{\cos\frac{2n\pi}{3}}{(2n+1)^2}$, where $0 \le x \le 1$

Practical 4 Z – Transform

1) Find $Z\{f(k)\}$ if $f(k) = \{8,\ 6,\ 4,\ 2, -1,\ 0,\ 1,\ 2,\ 3\}$
2) Find $Z\{f(k)\}$ if $f(k) = 2^k\cos(3k+2),\ k \ge 0$
3) Find $Z\{f(k)\}$ if $f(k) = 3^k\sinh(\alpha k),\ k \ge 0$
4) Find $Z\{f(k)\}$ if $f(k) = \sin\left(\frac{k\pi}{4} + \alpha\right),\ k \ge 0$
5) Find $Z\{f(k)\}$ if $f(k) = e^{-ak}\sin(bk),\ k \ge 0$

Practical 5 Inverse Z-transform

1) Find $Z^{-1}\left[\frac{z}{\left(z-\frac{1}{4}\right)\left(z-\frac{1}{5}\right)}\right]$, if $|z| > \frac{1}{4}$ by partial fraction method
2) Show that $Z^{-1}\left[\frac{z^2}{\left(z-\frac{1}{4}\right)\left(z-\frac{1}{5}\right)}\right] = \{x_k\}for|z| < \frac{1}{5}$, where $x_k = 4\left(\frac{1}{5}\right)^k - 5\left(\frac{1}{4}\right)^k$, $k < 0$
3) Show that $Z^{-1}\left[\frac{z^3}{\left(z-\frac{1}{4}\right)^2(z-1)}\right] = \{x_k\}\ for\ |z| > 1$, where $x_k = \frac{16}{9} - \frac{4}{9}\left(\frac{1}{4}\right)^k - \frac{1}{3}(k+1)\left(\frac{1}{4}\right)^k, k \ge 0$
4) Find $Z^{-1}\left[\frac{10z}{(z-2)(z-1)}\right]$ by using inversion integral method.
5) Find $Z^{-1}\left[\frac{z^3}{(z-1)\left(z-\frac{1}{2}\right)^2}\right]$ by using inversion integral method.

MTH -506(A) C Programming

Practical No : 6(A) - Basic concept

1) Write a C program that will obtain the area and perimeter of a square when the length of side is given.
2) Write a C program that will obtain the area and perimeter of a rectangle when the length of width of rectangle is given.
3) Write a C program to calculate area and circumference of the circle, whose radius is given.
4) Write a C program to multiply two floating point numbers.
5) Write a C program to find the average of five given numbers.

Practical No : 7(A) - Expressions and conditional statements

1) Write a C program that determines whether a given integer is odd or even and displays the number and description on the same line.
2) Write a C program that determines whether a given integer is divisible by 3 or not and displays the number and description on the same line.
3) Write a C program that determines the roots of the quadratic equation $ax^2 + bx + c = 0,\ a \neq 0$.
4) Write a C program to print the largest of the three numbers using nested if . . .else statement.
5) Write a program to check whether given year is leap or not.

Practical No : 8(A) - Looping

1) Write a C program to find the sum of odd natural numbers from 100 to 500.
2) Write a C program that determines whether a given integer is prime or not.
3) Write a program of triangular number.
4) Write a C program to prepare multiplication table from 21 to 30.
5) Write a C program to generate and print first n Fibonacci numbers.

Practical No : 9(A) - Arrays

1) Write a C program to sort N numbers in ascending order.
2) Write a C program to sort N numbers in descending order.
3) Write a C program to read two matrices and perform addition of these matrices.
4) Write a C program to read two matrices and perform subtraction of these matrices.
5) Write a C program to find transpose of given matrix.

Practical No : 10(A)- Functions

1) Write a C-program to find GCD of two numbers by using function.
2) Write a C program of addition of two numbers by user defined function
3) Write a C program to display all prime numbers between two integer.
4) Write a C program to check integer as a sum of two prime numbers.
5) Write a program to check whether a number is prime or not, by using function

MTH-506 (B) Number Theory

Practical No : 6(B) -

1) Prove that:
   a) Any prime of the form $3n + 1$ is also of the form $6m + 1$.
   b) The only prime p for which $3p + 1$ is a perfect square is $p = 5$.
2) Find all prime divisors of 50!
3) Obtain all prime numbers between 100 and 200 by using Sieve of Eratosthenes method.

4) a) Find all pairs of prime numbers p and q satisfying $p - q = 3$
b) Three integers $p, p+2, p+6$ which are all primes is called a prime-triplet.
c) Find five prime-triplets.
5) Prove that $n^4 + 4^n$ is composite for all integers $n > 1$

Practical No : 7(B) -

1) a) Determine the last three digits of 7^{999}
b) Find the remainder when $1^5 + 2^5 + 3^5 + \cdots + 100^5$ is divided by 4.
2) Solve the following linear congruences:
a) $25x \equiv 15 \pmod{29}$,
b) $140x \equiv 133 \pmod{301}$
3) Find all solutions of the linear congruence: $3x - 7y \equiv 11 \pmod{23}$
4) 4 By using CRT, solve the following system of congruences: $x \equiv 1 \pmod 3$, $x \equiv 2 \pmod 5$, $x \equiv 3 \pmod 7$.
5) a) Show that the number 5117247 is divisible by 9.
b) Test whether the number 67058902 is divisible by 7

Practical No : 8(B) -

1) a) Factorize 2047 by Fermat's Factorization method.
b) Use Fermat's method to factor 23449
2) a) Find the remainder when 5^{38} is divided by 11.
b)Find the unit digit of 3^{100}
3) a) If $7 \nmid a$, prove that either $a^3 + 1$ or $a^3 - 1$ is divisible by 7.
b) If $gcd(a, 133) = gcd\ (b, 133) = 1$, show that $133\ |(a)^{18} - b^{18})$.
4) If p and q are distinct primes, prove that $p^{q-1} + q^{p-1} \equiv 1\ (mod\ pq)$.
5) Show that 341 is pseudoprime.

Practical No : 9(B) -

1) a) Show that 496 and 8128 are perfect numbers.
b) Show that the integer $n = 2^7\ (2^8 - 1)$ is not a perfect number.
2) Show that if $a^k - 1$ is a prime $(a > 0, k \geq 2)$ then $a = 2$ and k is a prime.
3) Show that every even perfect number has last digit either 6 or 8.
4) Show that every even perfect number $n = 2^{k-1}\ (2^k - 1)$ is the sum of first $2^{\frac{k-1}{2}}$ odd cubes.
5) Show that the Mersenne number M_{17} is prime. Hence show that $n = 2^{16}\ (2^{17} - 1)$ is perfect.

Practical No : 10(B) -

1) a)Represent the following numbers as a sum of distinct Fibonacci numbers:
i) 27 ii) 75 iii) 110 iv) 128 v) 150
b) Evaluate the following:
i) $gcd\ (u_8, u_{16})$ ii) $gcd\ (u_{15}\ ,\ u_{27})$ iii) $gcd(u_{12}, u_{37})$.
2) For primes $p = 7{,}11{,}13{,}17$ verify that either $u_{p-1}\ or\ u_{p+1}$ is divisible by p.
3) For $n = 1, 2 \cdots\ , 10$ verify that $5u_n^2\ + 4(-1)^n$ is always a perfect square.
4) a) Show that the sum of first n Fibonacci numbers with odd indices is given by formula $u_1 + u_3 + u_5 + \cdots + u_{2n-1} = u_{2n}$.
b) Show that the sum of first n Fibonacci numbers with even indices is given by formula $u_2 + u_4 + u_6 + \cdots + u_{2n} = u_{2n+1} - 1$.
5) a) Use induction to show that $u_{2n} \equiv n(-1)^{n+1}\ \ (mod\ 5),\ \ for\ \ n \geq 1$.
b) Derive the identity $u_{n+3} = 3u_{n+1} - u_{n-1}$.

- Syllabus of the Non-Credit Elective audit courses AC-601(A): Soft skill AC-601 (B): Yoga and AC-601(C): Practicing Cleanliness will be supplied by the university separately. Students have to opt any one of them. There are 2 credits for this course and has 30 clock hours teaching. For this course there will be internal examination of 100 Marks only.

Semester VI

DSC Core Courses		
MTH - 601: Measure Theory		
Total Hours: 45		**Credits: 3**
	Course objectives The aim of this course is to learn the basic elements of Measure Theory. It is useful as it provides a foundation for many branches of mathematics such as harmonic analysis, theory of partial differential equations and probability theory.	
	Learning outcomes 1) Learn measurable sets. Learn the concept of Sets of measure zero. 2) Understand why a more sophisticated theory of integration and measure is needed. 3) Show that certain functions are measurable. 4) Understand properties of the Lebesgue integrals.	
Unit	**Topics**	**Lectures**
UNIT-1	**Measurable Sets** 1.1 Length of open and closed sets 1.2 Inner and outer measure of a set 1.3 Measurable sets and Properties of measurable sets 1.4 Symmetric difference of two measurable sets 1.5 Cantor's ternary sets	**09**
UNIT-2	**Measurable functions** 2.1 Real valued measurable functions 2.2 Sequence of measurable functions 2.3 Supremum and infimum of measurable functions 2.4 Almost everywhere concept	**09**
UNIT-3	**Lebesgue integral for bounded functions** 3.1 Measurable partition, Refinement, Lower and Upper Lebesgue sum and Lebesgue integrals 3.2 Existence of Lebesgue integral for bounded function. 3.3 Properties of Lebesgue integral for bounded measurable functions 3.4 Lebesgue integral for bounded function over a set of finite measure	**09**
UNIT-4	**Lebesgue integral for unbounded functions** 4.1 Non-negative valued function 4.2 Positive and negative part of a function 4.3 Definition and properties of $\int_E f$ where f is non-negative valued function in $L[a,b]$.	**09**
UNIT-5	**Some fundamental theorems and metric space $\boldsymbol{L^2[a,b]}$** 5.1 Lebesgue dominated convergence theorem 5.2 Fatou's Lemma 5.3 Square integrable function 5.4 Schwartz inequality, Minkowski inequality.	**09**

Recommended Book(s):	
1	R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Co. PVT. LTD, 2nd Edition, 1976 **Chapter 11** : 11.1,11.2,11.3, 11.4,11.5,11.6,11.7, 11.8, 11.9
Reference Book(s):	
1	Measure Theory and Integration, G. D. Barra, Woodhead Publishing; 2 Edition, 2003.
2	Lebesgue Measure and integration, P. K. Jain and V. P. Gupta, New Age International Publishers; Third edition, 2019.

<table>
<tr><td colspan="3" align="center">DSC Core Courses</td></tr>
<tr><td colspan="3" align="center">MTH - 602: Real Analysis – II</td></tr>
<tr><td>Total Hours: 45</td><td></td><td>Credits: 3</td></tr>
<tr><td></td><td colspan="2">Course objectives
1. To study Sequence of real numbers, series function.
2. To study of Fourier series. Theory of Uniform convergence of sequence of functions and Cauchy’s criteria for uniform con. of sequence of function.</td></tr>
<tr><td></td><td colspan="2">Learning outcomes
After successful completion of this course, students are expected to:
1. solve Convergence and divergence
2. use Test for absolute convergence,
3. understand Fourier series for even and odd functions t,
4. understand Sine and cosine series in half range</td></tr>
<tr><td align="center">Unit</td><td align="center">Topics</td><td align="center">Lectures</td></tr>
<tr><td align="center">UNIT-1</td><td>Sequence of real numbers
1.1 Definition of sequence and subsequence of real numbers.
1.2 Convergent Sequence.
1.3 Divergent Sequences.
1.4 Monotone sequence.
1.5 Operation on Convergent Sequences.
1.6 Cauchy Sequences.</td><td align="center">09</td></tr>
<tr><td align="center">UNIT-2</td><td>Series of real numbers
2.1 Convergence and divergence
2.2 Series with non-negative terms
2.3 Alternating series
2.4 Conditional convergence and absolute convergence
2.5 Test for absolute convergence
2.6 Series whose terms form non-increasing sequence</td><td align="center">09</td></tr>
<tr><td align="center">UNIT-3</td><td>Sequence of functions
3.1 Pointwise convergence of sequence of functions
3.2 Uniform convergence of sequence of functions
3.3 Cauchy’s criteria for uniform con. of seq. of fun.
3.4 Consequences of uniform convergence</td><td align="center">09</td></tr>
<tr><td align="center">UNIT-4</td><td>Series of functions
4.1 Pointwise convergence of series of functions
4.2 Uniform convergence of series of functions
4.3 Integration and differentiation of series of functions
4.4 Abel’s sum ability.</td><td align="center">09</td></tr>
<tr><td align="center">UNIT-5</td><td>Fourier series in the range (-π , π)
5.1 Fourier series and Fourier coefficients
5.2 Dirichlet’s condition of convergence (Statement only)
5.3 Fourier series for even and odd functions
5.4 Sine and cosine series in half range</td><td align="center">09</td></tr>
</table>

Recommended Book(s):	
1	R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Co. PVT. LTD, 2nd Edition, 1976: Unit 1:- 2.1, 2.3, 2.4, 2.6, 9.1, 9.2 Unit 2:- 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7 Unit 3 and 4:- 9.4, 9.5, 9.6
2	Laplace Transform and Fourier series, M. R. Spigel ,Schaum series, Mc Graw Hill, 1965, Unit – 4
Reference Book(s):	
1	Mathematical Analysis by S.C. Malik and Savita Arora.
2	Mathematical Analysis by S.K. Chatterjee

DSC Core Courses		
MTH - 603: Linear Algebra		
Total Hours: 45		**Credits: 3**
	Course objectives 1) To study vector spaces, basis and dimensions. 2) To study Linear transformation also Eigen value and eigen values 3) To study diagonalization of matrices, congruences, Perfect numbers,	
	Learning outcomes After successful completion of this course, students are expected to: 1) solve Rank and nullity theorem 2) use Cayley Hamilton theorem, Euler's theorem and finding Eigen values and Eigen vectors of linear transformation. 3) understand Kernel and image of linear transformations. 4) understand Singular and non-singular linear transformations	
Unit	**Topics**	**Lectures**
UNIT-1	**Vector Spaces** 1,1 Vector spaces, Subspaces, Examples. 1.2 Necessary and sufficient conditions for a subspace. 1.3 Addition, Intersection and union of subspaces. 1.4 Quotient space. 1.5 Linear Combinations. 1.6 Linear span and properties.	09
UNIT-2	**Basis and Dimensions** 2.1 Linear dependence and independence. 2.2 Basis and dimension of finite dimensional vector spaces. 2.3 Co-ordinates of a vector. 2.4 Existence theorem and its applications, Extension theorem. 2.5 Theorems on basis and dimensions.	09
UNIT-3	**Linear Transformations** 3.1 Introduction 3.2 Linear transformation, 3.3 Kernel and image of linear transformations 3.4 Range space and null space of linear transformations. 3.5 Rank and nullity theorem. 3.6 Algebra of linear transformations. 3.7 Invertible linear transformations. 3.8 Singular and non-singular linear transformations.	09
UNIT-4	**Eigen values and Eigen vectors** 4.1 Matrix polynomial. 4.2 Eigen values and Eigen vectors of linear transformation. 4.3 Diagonalization and Eigen vectors 4.4 Cayley Hamilton theorem.	09

	4.5 Characteristics polynomial and minimum polynomial.	
UNIT-5	**Matrices and Linear Transformation** 5.1 Matrix representation of linear operator. 5.2 Matrix representation of linear transformation. 5.3 Change of basis 5.4 Similarity 5.5 Diagonalisation of Matrix	**09**
Recommended Book(s):		
1	Linear Algebra, S. Lipschutz and Marc Lars Lipson, 4th Edition, Schaum's outline series, McGraw Hill Book Company, New York, 2009. Cha. -4 4.1 to 4.14 cha.-5 5.1 io 5.6 Cha. -6 6.1 to 6.5 Cha- 9, 9.1 to 9.4 9.7 9.8.	
Reference Book(s):		
1	N. S. Gopalkrishnan, University Algebra(2015), New Age Int. Pvt.Ltd	
2	A. R. Vasishtha and J.N. Sharma, Linear Algebra (2014), Krishna Publication, Meerut.	
3	K. P. Gupta J. K. Goyal, Advanced Course in Modern Algebra	
4	V. K. Khanna and S. K. Bhambri, Course in Abstract Algebra (2013),Vikas Publishing House Pvt. Ltd. New Delhi.	

<table>
<tr><th colspan="3">DSC Core Courses</th></tr>
<tr><th colspan="3">MTH - 604: Ordinary and Partial Differential Equations</th></tr>
<tr><td>Total Hours: 45</td><td></td><td>Credits: 3</td></tr>
<tr><td></td><td colspan="2">Course objectives.
The main objective of this course is to provide the student with an understanding of the solutions and applications of ordinary differential equations. By using this theory and models students can apply their knowledge in real world.
Prerequisite: F.Y.B.Sc. and S.Y.B.Sc. Mathematics.</td></tr>
<tr><td></td><td colspan="2">Learning outcomes
1) Know the exact differential equation and its solution.
2) Solve the exact differential equations by using integrating factor.
3) Solve the linear differential equation of second order by using various methods.</td></tr>
<tr><th>Unit</th><th>Topics</th><th>Lectures</th></tr>
<tr><td>UNIT-1</td><td>Exact Differential Equation
1.1 Definition, condition of exactness of a linear differential equation of order n, examples of type-1
1.2 Integrating factor, examples of type-2
1.3 Exactness of non-linear equation by inspection, examples of type-3
1.4 Equation of the form $\frac{d^2y}{dx^2} = f(y)$</td><td>09</td></tr>
<tr><td>UNIT-2</td><td>Linear Differential Equation of Second Order
2.1 The standard form of linear differential equation of second order
2.2 Complete solution in terms of one known integral belonging to C.F.
2.3 Rules for getting an integral belong to C.F., working rule for finding complete solution when an integral of C.F. is known
2.4 Removal of first derivative (reduction to normal form) working rule for solving problem by using normal form
2.5 Transformation of the equation by changing the independent variable, working rule.</td><td>09</td></tr>
<tr><td>UNIT-3</td><td>Linear Partial Differential Equations of the First Order
3.1 Definition of partial differential equation, order and degree of partial differential Equation
3.2 Derivation of partial differential equation by elimination of arbitrary constants and arbitrary functions.
3.3 Lagrange's equations and Lagrange's method of solving $Pp + Qq = R$
3.4 Integral surface passing through a given curve</td><td>09</td></tr>
</table>

UNIT-4	**Compatible System** 4.1 Surfaces orthogonal to a given system of surfaces and examples 4.2 Compatible system of first order equations 4.3 Condition for system of two first order partial differential equation to be compatible and examples 4.4 Particular case and examples	09
UNIT-5	**Non-Linear partial Differential Equation of order one** 5.1 Charpit's method and examples 5.2 Special type (a)Involving only p and q (b)Equation not containing the independent variable (c) Separable equation, 5.3 Examples on (a), (b) and(c) 5.4 Jacobi's method and examples	09

Recommended Book (s):

1	Advanced Differential Equations, M D Raisinghania, S. Chand and Company Pvt Ltd. , 1988. Part-I: 3.1, 3.2, 3.4, 3.5, 3.6, 3.7, 3.8, 3.11, and 3.12. Part-I: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, and 4.12. Part-II: 1.1, 1.2, 1.3, 1.4, 1.5, and 1.6.
2	Ordinary and partial differential equations, M D Raisinghania, S. Chand and Company Pvt Ltd, 2017. Part-III: 2.16, 2.17, 3.4, 3.5, and 3.6. Part-III: 3.7, 3.8, 3.9, 3.10, 3.11, 3.14, 3.15, 3.16, 3.17, 3.18, 3.19, and 3.21.

Reference Book (s):

1	Elements of Partial Differential Equations, Ian Naismith Sneddon, McGraw Hill Publication Company Ltd., 1957
2	Differential Equations, Richard Bronson, Schaum's Outline Series. McGraw Hill Education; 3 edition, 2017.

DSC Skill Enhancement Course (SEC) SEC-III: Skill Based DSC Elective Course		
MTH - 605: Graph Theory		
Total Hours: 45		**Credits: 3**
	Course objective 1. The course is oriented to those who want to advance structured and procedural programming understating and to improve operation on graphs. 2. The major objective is to provide students with understanding of graph, Trees. Matrix representation of graphs.	
	Learning outcomes After successful completion of this course, students are expected to: 1. Understanding a functional hierarchical code organization. Ability to define and manage graphs, connected graphs. 2. Understanding a concept of Cut set and cut vertices.	
Unit	**Topics**	**Lectures**
UNIT-1	**Graphs** 1.1 Definition, Handshaking lemma 1.2 Type s of graph 1.3 Subgraphs 1.4 Operations on graphs 1.5 Isomorphism of graphs	**09**
UNIT-2	**Connected graphs** 2.1 Walk path cycles, (circuit) 2.2 Connected and disconnected graphs 2.3 Eulerian graphs ,Konigsberg seven bridge problem 2.4 Hamiltonian graph 2.5 Traveling salesman problem	**09**
UNIT-3	**Trees** 3.1 Definition and properties of a tree 3.2 Distance and center in a tree 3.3 Rooted and binary trees 3.4 Spanning tree	**09**
UNIT-4	**Cut set and Cut vertices** 4.1 Cut sets ,edge connectivity ,vertex connectivity 4.2 Fundamental Cut set, fundamental circuits 4.3 Planar graph, Eulers formula for planar graph 4.4 Geometrical dual 4.5 Coloring of a graph	**09**
UNIT-5	**Matrix representation of graphs** 5.1 Incidence matrix 5.2 Adjacency matrix 5.3 Types of diagraph 5.4 Incidence matrix of a diagraph 5.5Adjacency matrix of a diagraph	**09**

Recommended Book(s):	
1	Discrete mathematics by S. Lipschutz and M. L. Lipson, Schaum's Outline Series ,McGraw Hill, New York, 2007. Unit 1: (Chapter 8) 8.1, to 8.13, (Chapter 9) 9.1 to 9.6,
Reference Book(s):	
1	Graph Theory with Applications to Engineering and Computer Science, Narsingh Deo , Prentice Hall Pvt, Ltd. 1976.
2	Graph Theory , F. Harary, Narosa Publishing House, 2001.

DSC Elective Course (Any one)		
MTH – 606(A): Introduction to SciLab		
Total Hours: 45		**Credits: 3**
	Course Objective: 1) Understand the fundamentals of SciLab and its utilization. 2) Familiarization of the syntax of numerical computing language-SciLab. 3) Application of SciLab for implementation/simulation and visualization of basic mathematical computations	
	Course Outcomes : After successful completion of this course students are expected to 1) Understand the main features/tools of SciLab. 2) Implement and determine simple mathematical computations in SciLab. 3) Interpret and visualize simple mathematical functions using SciLab tools. 4) Analyze the mathematical problem with simulation environment in SciLab. 5) Understand the need for simulation/implementation for the verification of mathematical functions.	
Unit	**Topics**	**Lectures**
UNIT-1	**Introduction to SciLab** 1.1 Introduction to SciLab 1.2 What is SciLab, Downloading & Installing SciLab, A quick taste of SciLab. 1.3 The SciLab environment – manipulating the command line, working directory, comments 1.4 Variables in memory, recording sessions, the SciLab menu bar, demos	**09**
UNIT-2	**Elementary Mathematics Through SciLab** 2.1 Scalars & Vectors–introduction, initializing vectors in SciLab 2.2 Mathematical operations on vectors, relational operations on vectors, logical operations on vectors, built-in logical functions 2.3 Elementary mathematical functions, mathematical functions on scalars, complex numbers, trigonometric functions, inverse trigonometric functions, hyperbolic functions.	**09**
UNIT-3	**Matrices and Polynomials Through SciLab** 3.1 Matrices – introduction, arithmetic operators for matrices, basic matrix processing 3.2 Polynomials–introduction, creating polynomials,	**09**

	basic polynomial commands, finding roots of polynomial, polynomial arithmetic, miscellaneous polynomial handling.	
UNIT-4	**Programming in SciLab** 4.1 Variables and variables names, assignment statements and arithmetic, relational and logical operators, 4.2 Branching: Conditional (if, if-else, nested and ladder if-else, switch constructs), Unconditional (break and continue statements) 4.3 Looping: Entry controlled (for and while) 4.4 Handling matrices with loops, scripts, functions.	**09**
UNIT-5	**Graphics and Applications in SciLab** 5.1 Graphic Output – Introduction, 2d plotting, 3d plotting, other graphic primitives. 5.2 Applications: Linear Algebra-Solving linear equations, Eigen values etc. 5.3 Numerical Analysis–Iterative methods ODE-Plotting solution curves	**09**
Recommended Book(s):		
1	Computer SCILAB–A Free Software to MATLAB, Er. Hema Ramachandran, Dr. Achuthsankar S. Nair, S Chand & Company, 2011. Chapter 1 to 8.	
2		
Reference Book(s):		
1	Programming in Scilab, Rajan Goyal, Mansi Dhingra, Narosa Publishing House, New Delhi, 2019.	

DSC Elective Course (Any one)		
MTH – 606(B): Operations Research		
Total Hours: 45		**Credits: 3**
	Course objectives 1. To study linear programming problem (LPP). 2. To study the simplex method to solve linear programming problem. 3. To study the simplex method for unbounded, alternative and infeasible solutions of LPP. 4. To study the initial basic feasible solution of transportation problem (TP). 5. To study the saddle point, maximin-minimax principal, two person zero sum game. 6. To study 2×2 games without saddle point. 7. To study graphical method to solve $m \times 2$ and $2 \times n$ games. 8. To study dominance property.	
	Learning outcomes After successful completion of this course, students are expected to: 1. solve the linear programming problem by graphical method and simplex method. 2. learn the unbounded, alternative and infeasible solutions of LPP by graphical and simplex method. 3. understand the standard and canonical form of LPP. 4. find the optimal solution of TP by MODI method. 5. solve the solution of assignment problems by Hungerian Method. 6. Understand the unbalanced, balanced, maximization, restricted AP and alternative solution of AP. 7. understand the saddle point, maximin-minimax principal, two person zero sum game. 8. use of dominance property to find the solution games	
Unit	**Topics**	**Lectures**
UNIT-1	**Linear Programming Problem (LPP)** 1.1 Formation of LPP 1.2 Solution of LPP by graphical method 1.3 Special cases in LPP: a) Unbounded solution b) Alternative solution c) Infeasible solution 1.4 Standard and Canonical forms of LPP	**09**
UNIT-2	**Simplex Methods** 2.1 Simplex Algorithm 2.2 Solution of LPP by simplex method 2.3 Artificial variable technique (Big M method) 2.4 Special cases in LPP: (a) Unbounded solution (b) Alternate solution (c) Infeasible solution	**09**

UNIT-3	**Transportation Problem (TP)** 3.3 General Transportation Problem 3.4 Transportation Table. Methods for finding IBFS: (a) North –West corner rule (b) Matrix minima method (Least cost method) (c) Vogel's approximation method (VAM) 3.5 Optimality test and optimization of solution to TP by U-V method (MODI). Special cases in TP: (a) Alternate solution (b) Maximization TP (c) Unbalanced TP (d) Restricted TP 3.6 Degeneracy in TP	**09**
UNIT-4	**Assignment Problem (AP)** 4.1 Mathematical Formulation of Assignment problem 4.2 Hungerian method for solving AP 4.3 Special cases in AP: (a) Alternate solution (b) Maximization AP (c) Unbalanced AP (d) Restricted AP.	**09**
UNIT-5	**Game Theory** 5.1 Two person-zero sum games 5.2 Pure and mixed strategies, value of a game 5.3 Maxmin and Minimax principles and saddle point 5.4 Solution of 2×2 game by algebraic method and oddment method 5.5 Game without saddle points-mixed strategies Graphical solution of $m \times 2$ and $2 \times n$ games 5.6 Dominance Property	**09**
Recommended Book(s):		
1	Operations Research, Kanti Swarup, P. K. Gupta, Man Mohan, S. Chand and Sons, Educational Publishers, New Delhi. Twelfth Edition,2004 Chapter No. 3, 4, 10, 11.	
Reference Book(s):		
1	Operation Research by S. D. Sharma and K.Ramnath, Meerut Publication, 2012.	
2	Operation Research by Prem Kumar Gupta,S. Chand and Company pvt Ltd. New Delhi 7th Edition-2014.	

DSC Core (Practical)		
MTH – 607: Practical Course based on (MTH-601, MTH-602)		
Total Hours: 60		**Credits: 2**
	Course objectives • To develop analytical and computational skills • To get hands on training for solving problems of measure theory and sequences and series of functions in Real analysis.	
	Learning outcomes After successful completion of this course, students are expected to: • Students will develop problem solving skills	
Unit	**Topics**	**Lectures**
UNIT-1	Examples on unit -1 of (MTH-601 & MTH-602)	12
UNIT-2	Examples on unit -2 of (MTH-601 & MTH-602)	12
UNIT-3	Examples on unit -3 of (MTH-601 & MTH-602)	12
UNIT-4	Examples on unit -4 of (MTH-601 & MTH-602)	12
UNIT-5	Examples on unit -5 of (MTH-601 & MTH-602)	12

List of Practical's:

MTH-607	Practical Course based on MTH-601 & MTH-602

MTH-601 : Measure Theory

Practical No. 1 - Measurable Sets

1. If $I_1, I_2 \cdots, I_k$ are open subintervals of $[a, b]$ .Show that
   $|I_1 + I_2 + \cdots + I_k| \leq |I_1| + |I_2| + \cdots + |I_k|$
2. Show that for any set A, $\overline{m}(A) = \overline{m}(A + x)$ where $A + x = \{y + x : x \in A\}$
3. If $E \subseteq [a, b]$, show that $\overline{m}(E) + \underline{m}(E') = (b - a)$.
4. a) If E_1 is a measurable subset of $[a, b]$ and if $mE_2 = 0$, then prove that $E_1 \cup E_2$ is measurable.
   b) If E_1 and E_2 are measurable subsets of $[0,1]$ and if $mE_1 = 1$, then show that $m(E_1 \cap E_2) = mE_2$.
5. If If E_1 and E_2 are measurable subsets of $[0,1]$, prove that the symmetric difference of E_1 and E_2 is also measurable.

Practical No. 2 Measurable Functions.

1. If $f(x) = \begin{cases} \frac{1}{x}, & for < 0 < x < 1 \\ 5, & x = 0 \\ 7, & x = 1 \end{cases}$, then
   Show that f is measurable on $[0,1]$.
2. Show that the subset E of $[a, b]$ is measurable if and only if the characteristic function χ_E is measurable.

3. If $F'(x)$ exists for every x in $[a,b]$ and $f(x) = F'(x) \quad (a \leq x \leq b)$. Prove that f is a measurable function.
4. If $f = g$ almost everywhere and f is measurable function then show that g is also measurable.
5. Show that the function f defined on $\mathbb{R}$ by

$$f(x) = \begin{cases} x+5\,, & x < -1 \\ 2, & -1 \leq x \leq 0 \\ x^2\,, & x > 0 \end{cases}$$

is measurable function.

Practical No. 3 Lebesgue Integral for Bounded Functions.

1. The Dirichilet function $f: [0,1] \rightarrow \mathbb{R}$ defined by

$$f(x) = \begin{cases} 1, & if\ x\ is\ rational \\ 0, & if\ x\ is\ irrational \end{cases}$$

Show that $f(x)$ is Lebesgue integrable but not Riemann integrable.
2. Let f be a bounded function on $[a,b]$. Let P and Q are any two measurable partitions of $[a,b]$. Show that $L[f\,; Q] \leq U[f;\, P]$.
3. If E_1 and E_2 are disjoint measurable subsets of $[a,b]$ and f is bounded function in $L[a,b]$ then prove that $\int_{E_1 \cup E_2} f = \int_{E_1} f + \int_{E_2} f$.
4. Let χ be the characteristic function of the irrational number in $[0,1]$. Show that $\chi \in L[0,1]$ and $\int_0^1 \chi = 1$.
5. a) If E is measurable subset of $[a,b]$, then show that $\int_E k = k.m(E)$ where k is a positive constant.
   b) Let $E_1,\ E_2,\ \cdots, E_n$ be measurable subsets of $[0,1]$. If each point of $[0,1]$ belongs to at least three of these sets. Show that at least one of the sets has measure $\geq \frac{3}{n}$.

Practical No. 4 Lebesgue Integral for Unbounded Functions

1. Let $f(x) = \begin{cases} \frac{1}{x^{2/3}}, & if\ \ 0 < x \leq 1 \\ 0, & if\ \ x = 0 \end{cases}$

   Calculate ${}^{n}f$, also prove that f is L-integrable on $[0,1]$ and $\int_0^1 f dx = 3$.

2.a) If $f(x) = log\frac{1}{x}$ for $0 < x \leq 1$ find ${}^{3}f$.

b) If $f(x) = (\frac{1}{x})^{1/3}$ for $0 < x \leq 1$ find ${}^{4}f$.

3. If $f(x) = \begin{cases} 1/x\,, & if\ \ 0 < x \leq 1 \\ 19, & if\ x = 0 \end{cases}$ then prove that f is not L-integrable on $[0,1]$.
4. If $f(x) = \frac{1}{x^p}$ for $0 < x \leq 1$, then prove that $f \in L[0,1]$, if $p < 1$ and $L\int_0^1 f = \frac{1}{1-p}$.
5. Let $f(x) = 0$ for every x in the Cantor set K and $f(x) = n$, for x in each of the interval of length $\frac{1}{3^n}$ in K'. Prove that f is L-integrable on $[0,1]$ and that $\int_0^1 f = 3$.

Practical No. 5 Some Fundamental Theorems

1. Let $f \in L[0,1]$ and $F(x) = \int_a^x f(t)dt$, for $a \leq x \leq b$. Prove that F is continuous on $[0,1]$.
2. Using Lebesgue dominated convergence theorem evaluate $\lim_{n\to\infty} \int_0^1 f_n(x)dx$, where

   $f_n(x) = \frac{n^{\frac{3}{2}}.x^{\frac{3}{2}}}{1+n^2+x^2},\ \ 0 \leq x \leq 1,\ \ n = 1, 2, 3, \cdots ....$

3. For $n \in I$, let $f_n(x) = \begin{cases} 2n, & \frac{1}{2n} \leq x \leq \frac{1}{n} \\ 0\,, & x \in (0, \frac{1}{2n}) \cup (\frac{1}{n}, 1) \end{cases}$

calculate $\int_0^1 \lim_{n\to\infty} f_n(x)dx$ & $\lim_{n\to\infty} \int_0^1 f_n(x)dx$. Show that Fatou's lemma applies but that Lebesgue dominated convergence theorem does not.

4. For each positive integer n and $x \in [0,2]$ define $f_n(x)$ to be,

$$f_n(x) = \begin{cases} \sqrt{n}\,, & \frac{1}{n} \le x \le \frac{2}{n} \\ 0\,, & x \in [0,\frac{1}{n}) \cup (\frac{2}{n},1] \end{cases}$$

then show that $\lim_{n\to\infty} \int_0^2 f_n(x) = 0$.

5. Let $g(x) = \begin{cases} 0, & 0 \le x \le \frac{1}{2} \\ 1, & \frac{1}{2} \le x \le 1 \end{cases}$, $f_{2k}(x) = g(x),\ f_{2k+1}(x) = g(1-x), 0 \le x \le 1$. Then show that $\lim_{n\to\infty} \inf \int_0^1 f_n(x)dx > \int_0^1 \lim_{n\to\infty} \inf f_n(x)dx$

MTH-602 Real Analysis-II

Practical No. 06 : Sequence of real numbers

1. Prove that a sequence of real numbers is Cauchy if and only if it is convergent.
2. Discuss the convergence of sequence whose n^{th} term is $a_n = \left(1+\frac{1}{n}\right)^n$.
3. If $\{S_n\}_{n=1}^{\infty}$ is Cauchy's sequence of real numbers which has a subsequence converges to L, then show that $\{S_n\}_{n=1}^{\infty}$ itself converges to L.
4. If $\{S_n\}_{n=1}^{\infty}$ is sequence of real numbers which converges to L, then show that $\{S_n\}_{n=1}^{\infty}$ converges to L^2.
5. If $\{a_n\}_{n=1}^{\infty}$ is Cauchy's sequence of real numbers, then show that $\{a_n\}_{n=1}^{\infty}$ is also Cauchy.

Practical No. 07 : Series of real numbers

1. Discuss the convergence of series $\sum_{n=1}^{\infty} \frac{n+1}{n+2}$, does the $\sum_{n=1}^{\infty} \frac{n+1}{10^{10}(n+2)}$ converges or diverges?
2. Examine the convergence of the series $1 + x + x^2 + x^3 + -$
3. Discuss the convergence of series $\sum_{n=1}^{\infty} \frac{1}{(2n-1)!}$
4. Test the convergence of series
$$(1-2) - (1-2^{1/2}) + (1-2^{1/3}) - (1-2^{1/4}) + \cdots$$
5. Examine the convergence of the series $a)\ \sum_{n=1}^{\infty} \frac{5^n}{2^n+5}$ $b)\ \sum_{n=1}^{\infty} \frac{n!}{n^n}$

Practical No. 08 : Sequence of functions

1. Let $f_n(x) = \frac{x^n}{1+x^n}, 0 \le x \le 1$. Show that $\{f_n\}_{n=1}^{\infty}$ converges pointwise on [0, 1]. If $\lim_{n\to\infty} f_n(x) = f(x)$. Does there $N \in x$ such that $|f_n(x) - f(x)| < \frac{1}{4}, \forall n \in N$, for all $x \in [0,1]$.
2. If $f_n(x) = \frac{n}{n+x}, n \ge x$, then show that $\{f_n(x)\}_{n=1}^{\infty}$ is uniformly convergent in any finite interval.
3. Let $f_n(x) = \frac{\sin nx}{n}, 0 \le x \le 1$. Show that $\{f_n\}_{n=1}^{\infty}$ converges uniformly to 0 but that $\{f_n\}_{n=1}^{\infty}$ does not converges even pointwise to 0 on [0, 1].
4. Let $f_n(x) = \frac{nx}{1+n^2x^2}$, $x \in R$. Show that $\{f_n\}_{n=1}^{\infty}$ is not uniformly convergent in [0, 1] although it converges pointwise to 0.
5. Let $f_n(x) = \frac{x}{1+nx}, 0 \le x \le 1$. Then show that $\{f_n\}_{n=1}^{\infty}$ converges uniformly to 0.

Practical No. 09 : Series of functions

1. Show that the series $\sum_{n=1}^{\infty} \frac{sin(x^2+n^2x)}{n(n+2)}$ is uniformly convergent for all values of x.
2. Using Weierstress M-test, show that the series $\sum_{n=1}^{\infty} \frac{cos(x^2+n^2x)}{n(n^2+2)}$ is uniformly convergent.
3. Test the uniform convergence of the series $\sum_{n=0}^{\infty} xe^{-nx}$ on [0, 1].
4. Show that $\sum_{n=1}^{\infty} \frac{1}{n^p+n^q x^2}$ is uniformly convergent for all values of x if p>1.
5. Show that $\sum_{n=1}^{\infty} \frac{x}{n^p+n^q x^2}$ is uniformly convergent for all values of x if p+q>2.

Practical No. 10 : Fourier Series in range $[-\pi, \pi]$

1. If f is bounded and integrable on $[-\pi, \pi]$ and if $a_n,\ b_n$ are its fourier coefficients then prove that $\sum_{n=1}^{\infty}({a_n}^2 + {b_n}^2)$ converges.
2. Obtain the Fourier series for $f(x) = \begin{cases} 0 & for -\pi \le x \le 0 \\ x & for \quad 0 \le x \le \pi \end{cases}$
3. Let $\frac{1}{2}a_0 + \sum_{n=1}^{\infty}(a_n cosnx + b_n sinnx)$ be Fourier series which converges uniformly to f(x) on $[-\pi, \pi]$. Show that $\frac{1}{2}{a_0}^2 + \sum_{n=1}^{\infty}({a_n}^2 + {b_n}^2) = \frac{1}{\pi}\int_{-\pi}^{\pi}\{f(x)\}^2 dx$
4. Obtain the Fourier series of the function $f(x) = nsinx$ in $[-\pi, \pi]$. Hence deduce that $\frac{\pi}{4} = \frac{1}{2} + \frac{1}{1.2} + \frac{1}{3.5} + \frac{1}{5.7} + \cdots$
5. Expand $f(x) = |x|$ in Fourier series in $[-\pi, \pi]$ and hence deduce that $\frac{\pi^2}{9} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \cdots$

DSC Core (Practical)		
MTH – 608: Practical Course based on (MTH-603 & MTH-604)		
Total Hours: 60		**Credits: 2**
	Course objectives • To develop analytical and computational skills • To get hands on training in solving problems of linear spaces and ordinary as well as partial differential equations.	
	Learning outcomes After successful completion of this course, students are expected to: • Understand basics of vector spaces and method of solving differential equations.	
Unit	**Topics**	**Lectures**
UNIT-1	Examples on unit -1 of (MTH-603 & MTH-604)	**12**
UNIT-2	Examples on unit -2 of (MTH-603 & MTH-604)	**12**
UNIT-3	Examples on unit -3 of (MTH-603 & MTH-604)	**12**
UNIT-4	Examples on unit -4 of (MTH-603 & MTH-604)	**12**
UNIT-5	Examples on unit -5 of (MTH-603 & MTH-604)	**12**

List of Practical's:

MTH-608	**Practical Course based on MTH-603 & MTH-604**

MTH-603 : Linear Algebra

Practical No. 1 - Vector Spaces

1. Let V be the set of all ordered pair (p,q) of real numbers. Examine whether V is a vector space over $\mathbb{R}$ or not with respect to the addition and scalar multiplication defined below:
   (i) $(p,q)+(p',q')=(0,q+q'),\ \alpha(p,q)=(\alpha p,\alpha q)$.
   (ii) $(p,q)+(p',q')=(p+p',q+q'),\ \alpha(p,q)=(0,\alpha q)$.
   (iii) $(p,q)+(p',q')=(p+p',q+q'),\ \alpha(p,q)=(\alpha^2 p,\alpha^2 q)$.
2. If $V_3(\mathbb{R})$ be a vector space of all ordered triads (x,y,z). Determine which of the following subsets of $V_3(\mathbb{R})$ are subspaces
   (i) $W=\{(x,y,z)\mid x,y,z\in\mathbb{R}\ and\ x-3y+4z=0\}$
   (ii) $W=\{(x,y,z)\mid x,y,z\in\mathbb{Q}\}$
   (iii) $W=\{(x,y,z)\mid x\geq 0\}$
3. (a) Write the vector $v=(1,-2,5)$ as linear combination of the vectors
   $e_1=(1,1,1),\ e_2=(1,2,3),\ e_3=(2,-1,1)$
   (b) For which value of k will the vector $u=(1,-2,k)$in $\mathbb{R}^3$ be a linear combinations of the vectors $v=(3,0,-2)$ and $w=(2,-1,-5)$?

4. Show that the vectors $u = (1, 2, 3)$, $v = (0, 1, 2)$ and $w = (0, 0, 1)$ generates $\mathbb{R}^3$.
5. Find the condition on a, b and c so that $(a, b, c) \in \mathbb{R}^3$ belongs to the space generated by $u = (2, 1, 0)$, $v = (0, 1, 2)$ and $w = (0, 3, -4)$.

Practical No. 2 Basis and Dimension

1. If x, y, z are linearly independent vectors over the field $\mathbb{C}$ of complex numbers then prove that (i) $x + y,\ y + z,\ z + x$ are also linearly independent over $\mathbb{C}$.
   (ii) $x + y,\ y - yz,\ x - 2y + z$ are linearly independent.
2. Find the co-ordinate vector of $v = (3, 5, -2)$ relative to the basis
   $e_1 = (1, 1, 1),\ e_2 = (0, 2, 3),\ e_3 = (0, 2, -1)$
3. Find the basis and dimension of solution space W of the following system of equations
   $x + 2y - 4z + 3s - t = 0,\ \ x + 2y - 2z + 2s + t = 0,\ \ 2x + 4y - 2z + 3s + 4t = 0.$
4. Show that the vectors $(0, 1, -1), (1, 1, 0) and\ (1, 0, 2)$ is basis of a vector space $\mathbb{R}^3(\mathbb{R})$.
5. Let W_1 and W_2 be two subspaces of $\mathbb{R}^4$ given by $W_1 = \{(a, b, c, d) \mid b + d = 2c\}$, $W_2 = \{(a, b, c, d) \mid a = b, b = 2c\}$. Find the basis and dimension of $(i)\ W_1,\ \ (ii)\ W_2,\ \ (iii)\ W_1 + W_2,\ \ (iv)\ W_1 \cap W_2$.

Practical No. 3 Linear Transformations

1. Let $T: \mathbb{R}^3 \to \mathbb{R}^3$ be the linear map defined by $T(x, y, z) = (x + 2y - z,\ y + z,\ x + y - 2z)$. Find the basis and dimension of the image of T.
2. Find the linear map $T: \mathbb{R}^3 \to \mathbb{R}^4$ whose image is generated by $(1, 2, 0, -4)$ and $(2, 0, -1, -3)$.
3. Show that the linear operator on $\mathbb{R}^3$ defined by $T(a, b, c) = (a + b + c,\ b + c,\ c)$ is non singular and find its inverse.
4. Let $T: \mathbb{R}^3 \to \mathbb{R}^3$ be the linear transformation defined by $T(x, y, z) = (3x,\ x - y,\ 2x + y + z)$. Prove that T is invertible and find the formula for T^{-1}.
5. Let $T: \mathbb{R}^4 \to \mathbb{R}^3$ be the linear mapping defined by $T(x, y, s, t) = (x - y + s + t,\ x + 2s - t,\ x + y + 3s - 3t)$. Find the basis and dimension of the kernel of T.

Practical No. 4 Eigen Values and Eigen Vectors

1. Find the eigen values and corresponding eigen vectors of the matrix $A = \begin{bmatrix} 1 & 2 \\ 3 & 2 \end{bmatrix}$.
2. Find the characteristics roots, their corresponding vectors and the basis for the vector space of the matrix $A = \begin{bmatrix} 2 & 1 & 0 \\ 0 & 1 & -1 \\ 0 & 2 & 4 \end{bmatrix}$.
3. Verify Cayley-Hamilton theorem for the matrix $A = \begin{bmatrix} 1 & 3 & 7 \\ 4 & 2 & 3 \\ 1 & 2 & 1 \end{bmatrix}$.
4. Find all eigen values and basis of each eigen space of linear operator $T: R^3 \to R^3$ defined by $T(x, y, z) = (2x + y,\ y - z,\ 4y + 4z)$.
5. Verify Cayley-Hamilton theorem for the matrix $A = \begin{bmatrix} 1 & 2 & 0 \\ 2 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$ and hence obtain A^{-1}.

Practical No. 5 Matrices and Linear Transformations

1. Let T be linear operator on $\mathbb{R}^3$ defined by $T(x, y, z) = (x - y,\ y - x,\ x - z)$. Find the matrix of T with respect to basis $Q = \{(1, 0, 0),\ (0, 1, 1),\ (1, 1, 0)\}$.
2. Let T be linear operator on $\mathbb{R}^2$ defined by $T(x, y) = (x + y,\ -2x + 4y)$. Compute the matrix of T relative to basis $\{(1,1),\ (1, 2)\}$.

3. Let $T: \mathbb{R}^2 \to \mathbb{R}^3$ be a linear transformation defined by $T(x, y) = (y,\ 5x - 13y,\ 7x + 16y)$. Obtain the matrix of T in the following basis of $\mathbb{R}^2$ and $\mathbb{R}^3$ where $B_1 = \{(3,1),\ (5,2)\}$ and $B_2 = \{(1,0,-1),\ (-1,2,2),\ (0,1,2)\}$ respectively.

4. Show that the matrix $A = \begin{bmatrix} 1 & -1 & 4 \\ -3 & 2 & 1 \\ 2 & 1 & -1 \end{bmatrix}$ is diagonalizable.

5. Find the matrix P if exists which diagonalize matrix $A = \begin{bmatrix} 3 & 2 & 4 \\ 2 & 0 & 2 \\ 4 & 1 & 3 \end{bmatrix}$.

MTH-604: Ordinary and Partial Differential Equation

Practical No. 6 - Exact Differential Equation

1. Solve $(x^3 - 2x)\frac{d^3y}{dx^3} + 3(3x^2 - 2)\frac{d^2y}{dx^2} + 18x\frac{dy}{dx} + 6y = 24x$
2. Show that $\frac{d^3y}{dx^3} + cosx\frac{d^2y}{dx^2} - 2sinx\frac{dy}{dx} - ycosx = sin(2x)$ is exact and find its first integral.
3. Find m , if x^m is an integrating factor of the differential equation
$x^2\frac{d^3y}{dx^3} + 4x\frac{d^2y}{dx^2} + (x^2 + 2)\frac{dy}{dx} + 3xy = 1$ and obtain its first integral.
4. Show that the equation $y + 3x\frac{dy}{dx} + 2y\left(\frac{dy}{dx}\right)^3 + \left(x^2 + 2y^2\frac{dy}{dx}\right)\frac{d^2y}{dx^2} = 0$ is exact and find its first integral.
5. Solve i) $\frac{d^2y}{dx^2} = a^2y$ ii) $\frac{d^2y}{dx^2} = \frac{a}{y^3}$

Practical No. 7 - Linear Differential Equation of Second Order

1. Find the general solution of $sin^2x\frac{d^2y}{dx^2} = 2y$ given that $y = cotx$ is a one integral.
2. Solve $(sinx - xcosx)y'' - xsinxy' + ysinx = 0$ if $y = sinx$ is solution of it.
3. Solve by using normal form $\frac{d^2y}{dx^2} - 2tanx\frac{dy}{dx} + 5y = 0$
4. Solve by removing the first derivative $x\frac{d}{dx}\left(x\frac{dy}{dx} - y\right) - 2x\frac{dy}{dx} + 2y + x^2y = 0$
5. Solve by changing the independent variable $x\frac{d^2y}{dx^2} + (4x^2 - 1)\frac{dy}{dx} + 4x^3y = 2x^3$

Practical No. 8 - Linear Partial Differential Equations of First Order

1. Form a partial differential equation by eliminating the arbitrary function f from $f(x + y + z, x^2 + y^2 - z^2) = 0$
2. Find partial differential equation by eliminating the constants
   i) $x^2 + y^2 - (z - 1)^2 = a^2$ ii) $ax^2 + by^2 + z^2 = 1$
3. Find the general integral of
   i) $\left(\frac{y^2z}{x}\right)p + xzq = y^2$
   ii) $z(xp - yq) = y^2 - x^2$
4. Find the integral surface of the linear partial differential equation $x(y^2 + z)p - y(x^2 + z)q = (x^2 - y^2)z$ which contains the straight line $x + y = 0,\ z = 1$
5. Find the surface which is orthogonal to one parameter surface $z = cxy(x^2 + y^2)$ and which passes through the hyperbola $x^2 - y^2 = a^2$ and $z = 0$

Practical No. 9 - Non-Linear Partial Differential Equations of Order one

1. Show that the equations $xp - yq = x$ and $x^2p + q = xz$ are compatible.
2. Show that equations $xp = yq$ and $z(xp + yq) = 2xy$ are compatible and solve them.
3. Using Charpit's method find the complete integral if
   i) $(p^2 + q^2)y = qz$
   ii) $p^2x + q^2y = z$

4. Find the complete integral of the equations
   i) $p+q=pq$ ii) $zpq=p+q$ iii) $p^2y(1+x^2)=qx^2$
5. Find the complete integral of the equations by using Jacobi's method
   i) $p^2x+q^2y=z$ ii) $z^2=pqxy$

Practical No. 10 - Non-linear Partial differential equation of order One

1. Using Charpit's method find the complete integral of $(p^2+q^2)y=qz$.
2. Find the complete integral of the equations
   i) $p+q=pq$ ii) $zpq=p+q$ iii) $p^2y(1+x^2)=qx^2$
3. Find the complete integral of $p^2x+q^2y=z$ by using Charpit's method .
4. Using Jacobi's method find complete integral of $p^2x+q^2y=z$

5. Find complete integral of $z^2=pqxy$ by using Jacobi's method.

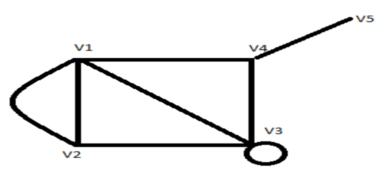
DSC Core (Practical)		
MTH – 609: Practical Course based on (MTH-605, MTH-606(A) or MTH- 606(B))		
Total Hours: 60		Credits: 2
	Course objectives • To develop analytical and computational skills • To get hands on training in solving problems of graph theory and either of SciLab or operations research.	
	Learning outcomes After successful completion of this course, students are expected to: • Students will develop problem solving analytical and computational skills.	
Unit	**Topics**	**Lectures**
UNIT-1	Examples on unit -1 of (MTH-605, MTH-606(A orB)	**12**
UNIT-2	Examples on unit -2 of (MTH-605, MTH-606(A orB)	**12**
UNIT-3	Examples on unit -3 of (MTH-605, MTH-606(A orB)	**12**
UNIT-4	Examples on unit -4 of (MTH-605, MTH-606(A orB)	**12**
UNIT-5	Examples on unit -5 of (MTH-605, MTH-606(A orB)	**12**

List of Practical's:

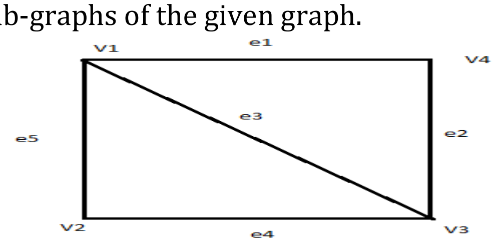
MTH-609	Practical Course based on (MTH-605, MTH-606(A) or MTH- 606(B))

MTH-605 : Graph Theory
Practical no. 1 - Graph

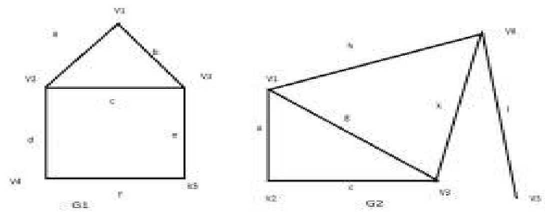
1. Verify Handshaking lemma for the following graph G. And also Find order and size of G.



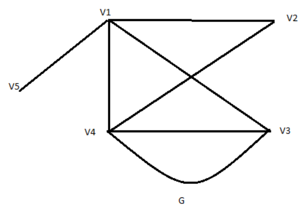
2. Find ten different sub-graphs of the given graph.



3. Find the Union, Intersection and ring sum for the graphs G_1 and G_2.

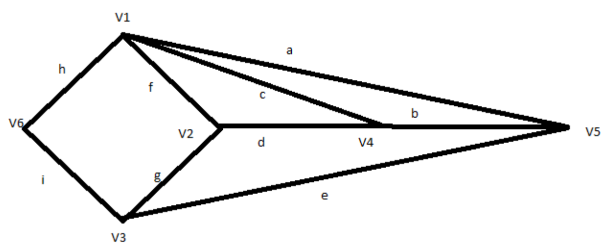


4. If G1 and G2 are regular graphs, is G1 + G2 regular? Justify.
5. Find six spanning sub graphs of following graph G.

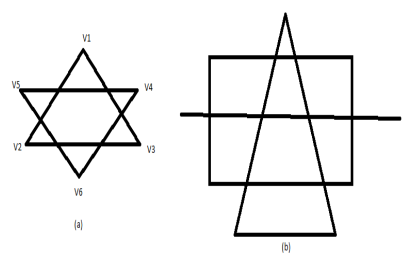


Practical No. 2 - Connected Graph.

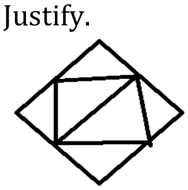
1. Find six different paths between vertices V_5 and V_6 in the following graph. Also give the length of these paths.



2. Which of the following graphs are connected? If not, then find components of the graphs.



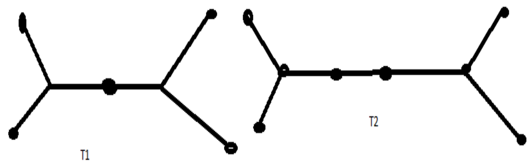
3. Is the following graph Eulerian? Justify.



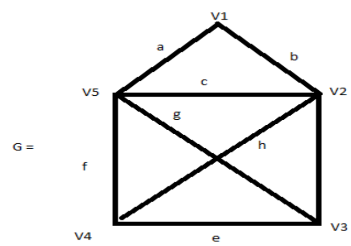
4. Draw two graphs in each case.
   i) Which is Hamiltonian but not Eulerian.
   ii) Which is Eulerian but not Hamiltonian.
4. Draw graph which is neither Eulerian nor Hamiltonian.

Practical No. 3 - Trees

1. Construct the tree on six vertices such that
   a) Which has minimum number of pendent vertices.
   b) Which has maximum number of pendent vertices.
2. Draw five non-isomorphic trees on six vertices.
3. construct a tree whose diameter is not equal to twice its radius.
4. Find eccentricity of each vertex. Also find centre, radius and diameter of the following graph.

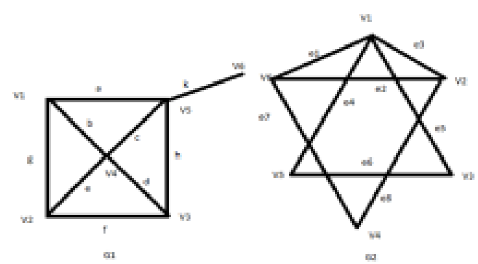


5. Draw six distinct spanning tree of the given graph G,

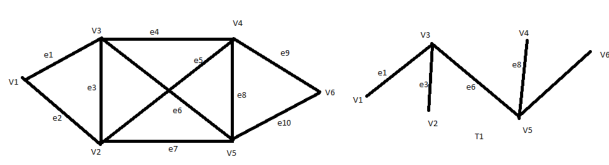


Practical No. 4 - Cut Sets and Cut Vertices.

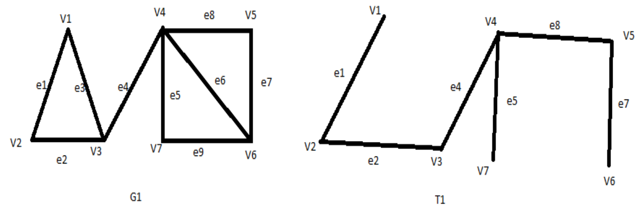
1. Find six different cut-set of the following graphs.



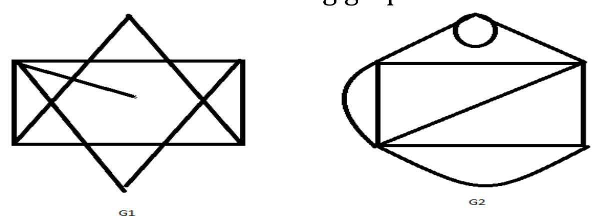
2. Construct a graph on 8 vertices, 16 edges and of vertex connectivity four.
3. With usual notations , construct a graph
   a) $K(G) = \lambda(G) = \delta(G)$
   b) $K(G) < \lambda(G) < \delta(G)$
4. Find fundamental cut-set and fundamental circuit for given graph and its given spanning tree.
   a)



b)

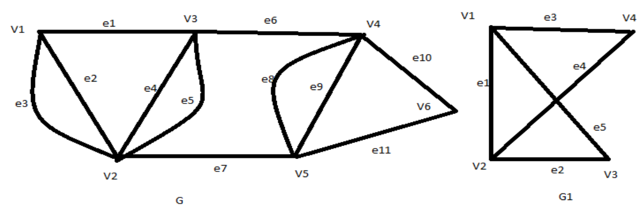


5.Construct the geometrical dual of the following graphs



Practical No. 5 - Matrix Representation of a Graph.

1. Find the incidence matrix of the following graphs.



2. For the given incidence matrix, draw the graph.

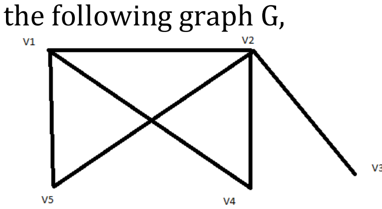
a)

	e1	e2	e3	e4	e5	e6	e7
V1	1	1	0	1	0	1	0
V2	1	0	1	0	1	0	0
V3	0	1	1	0	1	0	1
V4	0	0	0	0	0	0	0
V5	0	0	0	1	0	1	1

b)

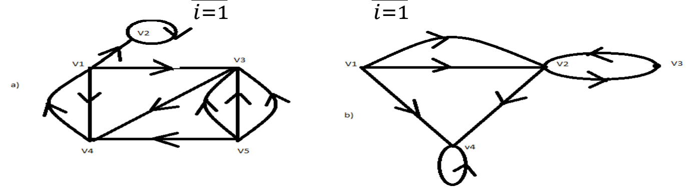
	e1	e2	e3	e4	e5	e6	e7	e8
V1	1	0	0	1	0	0	0	1
V2	1	1	0	0	1	0	0	0
V3	0	0	0	0	1	1	1	0
V4	0	1	1	0	0	1	1	0
V5	0	0	1	1	0	0	0	1

3. Find the adjancy matrix of the following graph G,

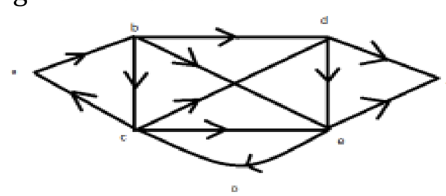


4. Find the indegree and outdegree of each vertex in the following digraphs and also verify handshaking Dilemma.

$$\sum_{i=1}^{n} d^{-}(Vi) = \sum_{i=1}^{n} d^{+}(Vi)$$



5. In digraph D given below , find five directed paths from vertex a to f and two directed circuits starting from vertex d.



MTH: 365(A) Introduction to SciLab

Practical No. 6(A) - Introduction to SciLab

1. Answer the following questions.
   a. What is the command to clear the screen?
   b. What is the short cut key to clear the screen?
   c. What is command history? What are the shortcut keys to use the command history?
   d. Is there a command to record all commands that you type and save them to a file so that you can see them later?
2. What are the rules for choosing names for variables in Scilab? Can you use a numeric character as the first character? Can you use underscore (_) as the first character? Can you use special characters, such as -, +, /, ? in a variable name?
3. Write a SciLab program for the following.
   a. Display your country name, university name, college name etc.
   b. Factorial of a single digit number.
   c. Absolute value of a number.
4. Write a SciLab program for the following problems
   a. Compute the area and circumference of a circle given the radius.
   b. Largest of three numbers.
   c. Logarithm of a number.
5. Write a SciLab program for the following problems
   a. Compute simple interest given the interest rate, principal and duration.
   b. Compute compound interest given the interest rate, principal, compounding nature and duration.

Practical No. 7(A) -Elementary Mathematics through SciLab

1. Define the complex numbers z_1 and z_2 in Scilab and perform the following mathematical operations on it. Also, try to plot the result in the Re-Im plane.
   a. Extract the real part and imaginary part of complex numbers.
   b. Define conjugate of complex number.
   c. Define addition of complex numbers.

2. Define the complex numbers z_1 and z_2 in Scilab and perform the following mathematical operations on it. Also, try to plot the result in the Re-Im plane.
   a. Define subtraction of complex numbers.
   b. Define multiplication of two complex numbers.
   c. Define division of two complex numbers.
3. Define the complex numbers z_1 and z_2 (Cartesian form) in Scilab and convert them into polar form.
4. Plot the following function in Scilab in the range of $-2\pi \leq x \leq 2\pi$
   a. $y = \sin(x)$
   b. $y = \cos(x)$
   c. $y = \tan(x)$
5. Plot the following function in Scilab in the range of $-2\pi \leq x \leq 2\pi$
   a. $y = \sinh(x)$
   b. $y = \cosh(x)$
   c. $y = \tanh(x)$

Practical No. 8(A) -Matrices and Polynomials through SciLab

1. Answer the following questions in Scilab.
   a. Create a 2×3 matrix of real values.
   b. Describe the addition of two matrices.
   c. Describe the multiplication of two matrices.
   d. Describe the scalar multiplication of matrix.
   e. Describe the power of a matrix.
   f. Describe the transpose of a matrix.
2. Discuss the following functions which generate matrices.

eye	identity matrix
linspace	linearly spaced vector
Ones	matrix made of ones
Zeros	matrix made of zeros

3. Discuss the solution of the system of linear equations in Scilab.
4. Write a Scilab program for the following.
   a. Define the polynomial $p_1(x)$ which has the following roots: $x_1 = -1, x_2 = 2$
   b. Define the polynomial which has the following coefficients: $a_1 = 3$, $a_2 = -3, a_3 = -8, a_4 = 7$.
5. Write a Scilab program for the addition, subtraction, multiplication, and division of the above two polynomials. (Refer the previous example)

Practical no. 9(A) - Programming in SciLab

1. List the rules to define variables in SciLab program.
2. Explain conditional statements: if, if-else, nested and ladder if-else, switch constructs
3. Write a note on break and continue statements
4. Explain in detail loops in SciLab
5. Describe the concept of functions and user defined functions in SciLab

Practical No. 10(A) - Graphics and Applications in SciLab

1. a. Write a Scilab program to plot 2d graph for a given set of data.
   b. Write a Scilab program to plot 3d graph for a given set of data.

2. Write a Scilab program to find an approximate solution of given transcendental equation using Bisection/Regula-Falsi/Newton Raphson method. Also plot its solution curve.
3. a. Write a Scilab program to find the solution of given system of linear equations.
   b. Write a Scilab program to find an eigen values of a given matrix.
4. Write a Scilab program to solve the given ODE using suitable method and plots its solution.
5. Write a Scilab program to solve the given definite integral using suitable method.

MTH 606 (B): Operations Research

Practical No. 6(B): Linear Programming Problem (LPP)

1. Use graphical method to solve the LPP
   Min $Z = x_1 + 0.5x_2$ subject to the constraints
   $3x_1 + 2x_2 \leq 12,\ 5x_1 \leq 10,\ x_1 + x_2 \geq 8, -x_1 + x_2 \geq 4,\ x_1, x_2 \geq 0.$
2. Use graphical method to solve the LPP
   Max. $Z = 2x_1 + 4x_2$subject to the constraints $x_1 + 2x_2 \leq 5,\ x_1 + x_2 \leq 4,\ x_1, x_2 \geq 0$. Is this LPP has alternative solution? If yes, find it.
3. Using graphical method show that the following LPP has unbounded solution.
   Max. $Z = 6x_1 + x_2$subject to the constraints $2x_1 + x_2 \geq 3,\ x_2 - x_1 \geq 0,\ x_1, x_2 \geq 0.$
4. Using graphical method show that the following LPP has infeasible solution.
   Max. $Z = x_1 + x_2$subject to the constraints $x_1 + x_2 \leq 1,\ -3x_1 + x_2 \geq 3,\ x_1, x_2 \geq 0.$
5. Reduce the following LPP to its standard form:
   Max $Z = x_1 + x_2 + 4x_3$ subject to the constraints
   $-2x_1 + 4x_2 \leq 4,\ x_1 + 2x_2 + x_3 \geq 5,\ 2x_1 + 3x_2 \leq 2andx_1, x_2, x_3 \geq 0.$

Practical No. 7(B): Simplex Methods

1. Use simplex method to solve the LPP
   Max $Z = 4x_1 + 10x_2$ subject to the constraints $2x_1 + x_2 \leq 50,\ 2x_1 + 5x_2 \leq 100,$ $2x_1 + 3x_2 \leq 90\ and\ x_1 \geq 0,\ x_2 \geq 0.$
2. Using Big-M method show that the following LPP does not possess any feasible solution.
   Max $Z = 3x_1 + 2x_2$ subject to the constraints $2x_1 + x_2 \leq 2,\ 3x_1 + 4x_2 \geq 12,$ $and\ x_1 \geq 0,\ x_2 \geq 0.$
3. Using Big-M method show that the following LPP has alternative solution.
   Max $Z = 6x_1 + 4x_2$ subject to the constraints $2x_1 + 3x_2 \leq 30,\ 3x_1 + 2x_2 \leq 24,$ $x_1 + x_2 \geq 3\ and\ x_1 \geq 0,\ x_2 \geq 0.$
4. Using simplex method solve the LPP
   Max $Z = 3x_1 + 4x_2$ subject to the constraints $x_1 + x_2 \leq 4,\ 2x_1 + x_2 \leq 5,$ $and\ x_1 \geq 0,\ x_2 \geq 0.$
5. Use simplex method to solve the LPP, Max$Z = 3x_1 + 2x_2$ subject to the constraints $x_1 + x_2 \leq 4,\ x_1 - x_2 \leq 2\ and\ x_1 \geq 0,\ x_2 \geq 0.$

Practical No. 8 (B): Transportation Problem (TP)

1. Obtain IBFS of TP by using North-West Corner rule

	D	E	F	G	Available
A	11	13	17	14	250
B	16	18	14	10	300
C	21	24	13	10	400
Requirements	200	225	275	250	

2. Obtain IBFS of TP by using Matrix Minima Method

	D_1	D_2	D_3	D_4	Capacity
O_1	1	2	3	4	6
O_2	4	3	2	0	8
O_3	0	2	2	1	10
Demand	4	6	8	6	

3. Obtain IBFS of TP by using Vogel's Approximation Method

	D	*E*	*F*	*G*	Available
A	11	13	17	14	250
B	16	18	14	10	300
C	21	24	13	10	400
Demand	200	225	275	250	

4. Convert the following unbalanced TP into balanced TP.

	Destinations						
		I	II	III	IV	V	**Supply**
Sources	A	4	3	26	38	30	160
	B	3	2	34	34	198	280
	C	3	3	24	28	30	240
	Demand	1	1	200	120	240	

5. Obtain IBFS by VAM and solve the transportation problem for minimum cost.

	D_1	D_2	D_3	Supply
S_1	2	7	4	5
S_2	3	3	1	8
S_3	5	4	7	7
S_4	1	6	2	14
Demand	7	9	18	

Practical No. 9 (B): Assignment Problem (AP)

1. Solve following AP.

	I	II	III	IV
A	2	3	4	5
B	4	5	6	7
C	7	8	9	8
D	3	5	8	4

Is there exist alternative solution? If Yes, Find it.

2. A departmental head has four subordinates and four tasks to be performed. The subordinates differs in efficiency and the tasks differ in their intrinsic difficulty. His estimate, of the time each man would take to perform each task, is given in the matrix below:

Tasks	Men			
	E	F	G	H
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

How should the tasks be allocated, one to a man, so as to minimize total man-hours?

3. Solve the following assignment problem for maximum profit.

	1	2	3	4
A	16	10	14	11
B	14	11	15	15
C	15	15	13	12
D	13	12	14	15

4. The following is the cost matrix of assigning 4 clerks to 4 key punching jobs. Find the optimal assignment if clerk I cannot be assigned to job 1:

Clerk	Job			
	I	II	III	IV
1	---	5	2	0
2	4	7	5	6
3	5	8	4	3
4	3	6	6	2

What is the minimum total cost?

5. Convert the following unbalanced AP into balanced AP and solve it for minimization.

	A	B	C
W	9	26	15
X	13	27	6
Y	35	20	15
Z	18	30	20

Practical No. 10 (B): Game Theory

1. Find the best strategy of each player and the value of game.

	Player B					
Player A		A	B	C	D	E
	I	9	3	1	8	0
	II	6	5	4	6	7
	III	2	4	3	3	8
	IV	5	6	2	2	1

2. A and B play a game in which each has three coins 5p ,10p and 20p each player selects the point without the knowledge of coin, if the sum of coin is an odd amount, A wins B's coin and if the sum of coin is even then B wins A's coin. Find the best strategy for player A &B and the value of game.
3. Find the ranges of values of p &q which will render the entry $(2, 2)$a saddle point for the game

	Player B			
Player A		I	II	III
	I	2	4	5
	II	10	7	Q
	III	4	P	6

4. Solve the following 2×4 game by graphical method.

Player B					
Player B		I	II	III	IV
	I	3	3	4	0
	II	5	4	3	7

5. Solve the following game by graphical method.

	Player B				
Player A		I	II	III	IV
	I	19	6	7	5
	II	7	3	14	6
	III	12	8	18	4
	IV	8	7	13	-1

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Equivalence for T. Y. B. Sc. (Mathematics) Courses

Old Syllabus (June 2017) (Semester pattern 60:40)		New Syllabus (June 2020) CBCS pattern (Semester pattern 60:40)	
Course code	**Paper**	**Course code**	**Paper**
Semester-V			
MTH-351	Topics in Metric Spaces	MTH-501	Metric Spaces
MTH-352	Integral Calculus	MTH-502	Real Analysis- I
MTH-353	Modern Algebra	MTH-503	Algebra
MTH-354	Lattice Theory	MTH-504	Lattice Theory
MTH-355(A)	C-Programming	MTH-506(A)	C-Programming
MTH-355(B)	Elementary Number Theory	MTH-506(B)	Number Theory
MTH-356(A)	Vector Analysis	MTH-505	Integral Transforms
MTH-356(B)	Integral Transforms	MTH-505	Integral Transforms
MTH-357	Practical Course based on MTH-351 & MTH-352	MTH-507	Practical Course based on MTH-501 & MTH-502
MTH-358	Practical Course based on MTH-353 & MTH-354	MTH-508	Practical Course based on MTH-503 & MTH-504
MTH-359	Practical Course based on MTH-355 & MTH-356	MTH-509	Practical Course based on MTH-505 & MTH-506
Semester-VI			
MTH-361	Measure and Integration Theory	MTH-601	Measure Theory
MTH-362	Method of Real Analysis	MTH-602	Real Analysis- II
MTH-363	Linear Algebra	MTH-603	Linear Algebra
MTH-364	Ordinary and Partial Differential Equations	MTH-604	Ordinary and Partial Differential Equations
MTH-365(A)	Optimization Techniques	MTH-606(B)	Operations Research
MTH-365(B)	Dynamics	MTH-606(A)	Introduction to SciLab
MTH-366(A)	Applied Numerical Methods	MTH-605	Graph Theory
MTH-366(B)	Differential Geometry	MTH-605	Graph Theory
MTH-367	Practical Course based on MTH-361 & MTH-362	MTH-607	Practical Course based on MTH-601 & MTH-602
MTH-368	Practical Course based on MTH-363 & MTH-364	MTH-608	Practical Course based on MTH-603 & MTH-604
MTH-369	Practical Course based on MTH-365 & MTH-366	MTH-609	Practical Course based on MTH-605 & MTH-606

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||अंतरी पेटवू ज्ञानज्योत||

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS

For

F. Y. B. Sc- (Sem. Ist and IInd)

Subject: Geography

Under

Choice Based Credit System

(With Effect from June - 2022)

Semester-wise Course Structure of F. Y. B. Sc Geography

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
GG. -101	DSC Theory	INTRODUCTION TO LITHOSPHERE	3	--	3	40	--	60	--	2
GG.-102	DSC Theory	MORPHOLOGY OF LANDSCAPE	3	--	3	40	--	60	--	2
GG.103	DSC Practical	PRACTICAL GEOGRAPHY- CARTOGRAPHIC TECHNIQUES	-	4	4	40	-	60	-	2

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
GG. -201	DSC Theory	ATMOSPHERE	3	--	3	40	--	60	--	2
GG.-202	DSC Theory	HYDROSPHERE	3	--	3	40	--	60	--	2
GG.203	DSC Practical	PRACTICAL GEOGRAPHY- MAP PROJECTION	-	4	4	40	-	60	-	2

Equivalences for old courses of F. Y. B. Sc Geography (Semester I and II)

Semester – I st

Old Courses (June 2017)		New Courses (June 2021)	
Code of Courses	**Title of the courses**	**Code of Course**	**Title of the courses**
Gg.101	PHYSICAL GEOGRAPHPY – I (LITHOSPHERE PART - I)	GG. 101	INTRODUCTION TO LITHOSPHERE
Gg.102	PHYSICAL GEOGRAPHPY – II (ATMOSPHERE)	GG.102	MORPHOLOGY OF LANDSCAPE
Gg.103	PRACTICAL GEOGRAPHY- CARTOGRAPHIC TECHNIQUES	GG.103	PRACTICAL GEOGRAPHY- CARTOGRAPHIC TECHNIQUES

Semester – II nd

Old Courses (June 2017)		New Courses (June 2021)	
Code of Courses	**Title of the courses**	**Code of Courses**	**Title of the courses**
Gg.201	PHYSICAL GEOGRAPHPY (LITHOSPHERE PART - II)	GG. 201	ATMOSPHERE
Gg.202	PHYSICAL GEOGRAPHPY – II (HYDROSPHERE)	GG.202	HYDROSPHERE
Gg.203	PRACTICAL GEOGRAPHY- MAP PROJECTION	GG.203	PRACTICAL GEOGRAPHY- MAP PROJECTION

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FACULTY OF SCIENCE AND TECHNOLOGY

New Syllabus F.Y.B.Sc. Semester- I (CBCS Pattern)
With effect from June- 2022

Gg.- 101: INTRODUCTION TO LITHOSPHERE

Total Credits: 02 **Teaching Hours: 30**

LEARNING OBJECTIVES:

1. To study the basic concept of lithosphere.
2. To study the processes involve in the formation of various landforms.

LEARNING OUTCOMES:

After completion of this course, the students will be able…

1. To understand the geographical phenomena.
2. To understand the formation, types and importance of rocks and minerals.
3. To understand the landforms and their origin.
4. To know the external and internal forces that acting on the earth surface.

Unit No.	Topic Name	Sub-Topic	Teaching Hours
I	**Introduction to Physical Geography**	a) Definition, Nature and Scope of Physical Geography b) Branches of Physical Geography c) Meaning and Concept of Lithosphere d) First and Second order landforms	**06**
II	**Distribution of land and water**	a) Present distribution of land and water. b) The interior structure and composition of the Earth c) Theories regarding the present distribution of land and water – i) Wegner's continental drift theory with criticism. ii) Theory of plate tectonics with criticisms.	**09**
III	**Rocks and Minerals**	a) Definitions of Rocks and Minerals b) Classification of rocks c) Characteristics of Igneous, Sedimentary & Metamorphic rocks. d) Distribution of Igneous, Sedimentary and Metamorphic rocks in India	**08**
IV	**Earth Movements**	a) Endogenetic and Exogenetic forces b) Classification of Diastrophic forces – Epeirogenic and orogenic forces. c) Nature, Definitions and types of folds	**07**

		and Faults. d) Sudden movements:- Earthquake and volcanic eruption (Definitions, causes, effects) e) Mass movement: Meaning, factors and types.	

Weightage

Unit No.	Marks
I	12
II	18
III	15
IV	15
Internal Assessment (CA)	**40**
External Assessment (UA)	**60**
Total Marks	**100**

Suggested Reading:

1. Ahirrao.W.R. ,Alizad.S.S and Dhapte.C.S (1998) Morphology and landscape, Nirali prakashan Pune.
2. Bloom.A.L (1998) Geomorphology. A systemetic analysis of late cenozoic landforms, Pearsonn education (Singapore) Pvt.Ltd.
3. Chaudhary S.R., Patil V.J., and Badgujar A.A (2014) Physical geography Prashant publication, Jalgaon.
4. Bharmbe S.N., Dhake S.V, Patil. V.J.: Physical geography-Part-I (Lithosphere) Prashant Publication.
5. Suryawanshi D.S and Others. (2011) Geography (Lithosphere and Hydrosphere) Vrinda publication, Jalgaon
6. Trivartha G.T. Elements of Physical geography (Mc. Graw hill)
7. Singh Savindra Physical geography (Eng. & Hindi)
8. Monkhouse F.J (1996) Principles of Physical Geography, Hodder and Stoughton, London.

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FACULTY OF SCIENCE AND TECHNOLOGY

New Syllabus F.Y.B.Sc. Semester- I (CBCS Pattern)
With effect from June- 2022

Gg. - 102: MORPHOLOGY OF LANDSCAPE

Total Credits: 02 **Teaching Hours: 30**

LEARNING OBJECTIVES:

1. To understand the processes that shapes the landforms around us.
2. To understand the denudation processes.
3. To understand the work of external forces.

LEARNING OUTCOMES:

After completion of this course, the students will be able …

1. To know the temporal changes in landforms.
2. To understand the geomorphological processes in detail.
3. To understand the role of geomorphic agents in sculpturing of the earth surface.

Unit No.	Topic Name	Sub-Topic	Teaching Hours
I	**Introduction to Morphology of Landscape and Work of Wind**	**A.** Introduction: Morphology and Landscape • Landscape: Meaning & Definitions. • Types of Landscape **B.** Mechanism of Wind Erosion and Deposition **I.** Erosional Landforms: • Blowout • Mushroom Rock • Yardangs • Zeugen • Inselbergs **II.** Depositional Landforms: • Ripplemarks • Sand Dunes • Barkhans • Shifting Dune • Loess	**09**

II	**Work of River**	**A.** Mechanism of river erosion and deposition **I.** Erosional Landforms: • Gorge • 'V' Shaped Valley • Rapids • Waterfall • Pot Holes **II.** Depositional Landforms: • Meander • Ox-bow Lake • Flood Plain • Levee • Delta	**07**
III	**Work of Sea Waves**	**A.** Mechanism of Marine Erosion and Deposition I. Erosional Landforms: • Sea Cliff • Wave Cut Platform • Sea Caves • Sea Arch • Sea Stack II. Depositional Landforms: • Sea Beach • Spits • Lagoon • Barrier island	**07**
IV	**Work of Glacier**	**A.** Mechanism of Glacial Erosion and Deposition I. Erosional Landforms: • Circque • U-shaped valley • Hanging Valley • Roche Montano • Horn and Aerect II. Depositional Landforms: • Moraines • Drumlin • Esker • Parched Block • Verve • Kames	**07**

Weightage

Unit No.	Marks
I	18
II	14
III	14
IV	14
Internal Assessment (CA)	**40**
External Assessment (UA)	**60**
Total Marks	**100**

Suggested Reading:

1. Ahirrao, W.R., Alizad, S.S. and Dhapte, C.S., (1998): Morphology and Landscape, Nirali Prakashan, Pune.
2. A. Guyot (2017): Physical Geography, Andesite Press, London.
3. Chaudhari S.R., V.J.Patil & Arvind Badgujar (2014): Physical Geography Prashant Publication, Jalgaon.
4. Husain, M., (2001): Fundamentals of Physical Geography, Rawat Publication, Jaipur.
5. Kale, V.S. and Gupta, A., (2001): Introduction to Geomorphology, Orient Longman, Calcutta.
6. Majid Husain (2016):Physical Geography, Rawat Publication, Jaipur.
7. Monkhouse, F.J., (1996): Principles of Physical Geography, Hodder and Stoughton, London.
8. Savindra Singh (2006):Physical Geography, Pravalika Publication, Allahabad.
9. Savindra Singh (2017): Physical Geography
10. S. N. Bharambe, S. V. Dhake, V. J. Patil, Physical Geography - Part 1(Lithosphere), Prashant Publication, Jalgaon
11. Strahler A. H., (2008): Modern Physical Geography(4thEdition), Wile
12. Suryawanshi D.S., & Others, (2011): Geography (Lithosphere & Hydrosphere), Vrinda publication, Jalgaon
13. Trewartha, G.T: Elements of Physical Geography) McGraw Hill

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FACULTY OF SCIENCE AND TECHNOLOGY

New Syllabus F.Y.B.Sc. Semester- I (CBCS Pattern)
With effect from June- 2022

Gg.- 103: PRACTICAL GEOGRAPHY- CARTOGRAPHIC TECHNIQUES

(Each batch of 15 students with four teaching hours per week)

Total Credits: 02 **Teaching Hours: 60**

LEARNING OBJECTIVES:

1. To acquaint the students with basic knowledge of cartography and maps.
2. To familiar students with types of map scales.
3. To understand the techniques of drawing graphs, diagrams and distributional maps showing physical, climatic, economic and social attributes of a region.
4. To enable the students to analyse the geographical data and understand the relationship between different geographical factors.

LEARNING OUTCOMES:

After completion of this course, the students will be able …

1. To understand various cartographic techniques used in geographical study.
2. To adopt the knowledge of drawing graphs, diagrams and distributional maps.
3. To analyse geographical data with the help of cartographic techniques.

Unit No.	Topic Name	Sub-Topic	Teaching Hours
I	**Introduction to Cartography**	**A.** Cartography i. Meaning and Concept ii. Importance of Cartography **B.** Maps i. Definition ii. Types- Physical and Cultural Maps **C.** Map Scale i. Definition. ii. Methods of Representing scales a) Verbal scale b) Numerical scale c) Graphical scale i. Conversion of scale: British and Metric system ii. Construction of following scales a) Simple Graphical Scale b) Time and Distance Scale (Only Metric System)	15
II	**Graphs**	**A.** Definition and types of graphs **B.** Construction, uses, merits and demerits of the following Graphs i. Simple Line Graph	15

		ii. Bar Graph iii. Combine Graph (Line & Bar Graph) iv. Climograph	
III	**Statistical Diagrams**	**A.** Concept and uses of Statistical Diagrams **B.** Construction, uses, merits and demerits of the following Diagrams i. Wind Rose/Star Diagram ii. Divided Circle iii. Proportional Circle	**15**
IV	**Distributional Maps**	Meaning and Types of Distributional Maps Construction, uses, merits and demerits offollowing Distributional Maps i. Dot Map ii. Choropleth Map iii. Isopleth Map	**15**

Weightage

Unit No.	Marks
I	15
II	15
III	15
IV	15
Internal Assessment (CA)	**40**
External Assessment (UA)	**60**
Total Marks	**100**

Suggested Reading:

1. Balbir Singh Negi: Practical Geography, Kedarnath Ramnath Publishers, Meerut Delhi.
2. Gopal Singh: Map Work and Practical Geography, Vikas Publishing House Pvt. Ltd.,
3. Mishra R. P. & Ramesh A.: Fundamental of Cartography, McMillan Co., New Delhi.
4. Monkhouse F. J. & Wilkinson H. R.: Maps and Diagram, Methuen & Co. Ltd. London. New Delhi.
5. Pal, S.K.: Statistics for Geoscientists — Techniques and Applications, Concept, New
6. Robert H. & Patrick M.: Quantitative Techniques in Geography, Oxford University Press.
7. Robinson, A.H. et al.: Elements of Cartography, John Wiley & Sons, U.S.A.
8. Sarkar A.K Practical Geography: A Systematic Approach, Oriental Longman, Calcutta.
9. Singh, R.L. and Dutt, P.K.: Elements of Practical Geography, Kalyani Publishers, New Delhi.
10. Singh L. R.: Fundamentals of Practical Geography, Sharda Pustak Bhavan, Allahabad.

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FACULTY OF SCIENCE AND TECHNOLOGY

New Syllabus F.Y.B.Sc. Semester- II (CBCS Pattern)
With effect from June- 2022

Gg. - 201: ATMOSPHERE

Total Credits: 02 **Teaching Hours: 30**

LEARNING OBJECTIVES:

1. To acquaint the students with basic knowledge of atmosphere, weather, climate and climatic elements.
2. To acquire the knowledge of applications of Climatology in the different field.
3. To understand the impact of atmosphere on agricultural, human settlements, health and commerce.

LEARNING OUTCOMES:

After completion of this course, the students will be able …

1. Identify the layers of earth's atmosphere.
2. Describe key features of each layer of the atmosphere
3. To interpret global energy budgets.
4. To understand the application of the climatology.

Unit No.	Topic Name	Sub-Topic	Teaching Hours
I	**Atmosphere : Introduction, Structure and Composition**	A) Meaning and Definition of Atmosphere, weather and climate B) Composition of Atmosphere i. The Gases ii. Water Vapor iii. Dust Particles C) Structure of Atmosphere i. Troposphere, ii. Stratosphere iii. Mesosphere iv. Thermosphere a) Ionosphere b) Exosphere	**07**
II	**Insolation and Temperature**	A) Meaning and Definition: Insolation, Isotherm,Solar Constant and Albedo of the Earth B) Distribution of Insolation: Factors affecting the distribution of Insolation C) Heat Budget of the Earth and Atmosphere D) Temperature: I. Factors affecting on distribution of temperature. II. Horizontal Distribution III. Vertical Distribution	**07**

III	**Atmospheric Pressure & Winds**	A) Atmospheric Pressure i. Isobars ii. Formation of Pressure Belts iii. Shifting of Pressure Belts and their Effects B) Winds I. Meaning & Definition II. Factors affecting Winds a. Pressure Gradient b. Coriolis Force c. Friction Force III. Classification of Winds a. Planetary Winds - Definition & Types b. Monsoon Winds – Concept and Characteristics c. Periodical Winds - Land and Sea Breezes, Mountains & Valley Breezes	**08**
IV	**Humidity & Applications of Climatology**	A) Definition & Types of Humidity i. Absolute ii. Specific iii. Relative B) Forms of Condensation: Fog, Dew, Frost,Clouds & Precipitation C) Forms of Precipitation: Rain, Drizzle, Snow, Sleet D) Types of Rainfall: i. Convectional ii. Orographic / Relief iii. Cyclonic or Frontal E) Applications of Climatology in the field of agriculture , health, trade & transport	**08**

Weightage

Unit No.	Marks
I	14
II	14
III	16
IV	16
Internal Assessment (CA)	**40**
External Assessment (UA)	**60**
Total Marks	**100**

Suggested Reading:

1. Aguado, E. and Burt, J.E. (2001): Understanding Weather and Climate, Printice Hall, Upper Saddal River, New Jersey.
2. Barry, R.G. &Chorly, R.J.(1995) : Atmosphere, Weather and Climate, Routledge, LondonAnd New York.
3. Critchfield, H. J.(2002) : General Climatology, Prentice Hall, New Delhi, India.
4. Das, P.K.(1968): Monsoon, National Book Trust, New Delhi.
5. Lal, D.S. (1986): Climatology, Chaitany Book Trust, New Delhi.
6. Lal, D.S. (2009): Climatology and Oceanography, Sharda Pustak Bhavan, Allahabad
7. Lutgents, F.K. & Tarbuck E.J. (2001): The Atmosphere, Prentice Hall, Upper Saddal RiverNew Jersey.
8. Majid Hussain: Climatology
9. Millar A. et.al. (1983): Elements of Meteorology, Merrill, Columbus
10. Siddharth, K. (2001): Atmosphere, Weather and Climate, Kisaliya Publications Pvt. Ltd.New Delhi.
11. Singh Savindra (2005): Climatology, PrayagPustak Bhawan, Allahabad.
12. Strahler, A.N. (1965): Introduction to Physical Geography, Willey, New York.
13. Stringer E.T.(1982) : Foundation of Climatology, Surjeet publications, Delhi.
14. Trewartha, G.T. (1980): An Introduction to Weather and Climate, McGraw Hill, NewYork.

KAVAYITRI BAHINABAI CHAUDHARY
NORTH MAHARASHTRA UNIVERSITY, JALGAON

FACULTY OF SCIENCE AND TECHNOLOGY

New Syllabus F.Y.B.Sc. Semester- II (CBCS Pattern)
With effect from June- 2022

Gg. - 202: HYDROSPHERE

Total Credits: 02 **Teaching Hours: 30**

LEARNING OBJECTIVES:

1. To introduce the students to the basic concepts of Oceanography.
2. To introduce the origin and effects of Tsunami.
3. To give the knowledge of properties & movements of ocean water.
4. To know the nature & types of ocean coast.

LEARNING OUTCOMES:

After completion of this course, the students will be able …

1. To understand the basic concepts of Hydrosphere.
2. To explain the properties of different oceans.
3. To understand the concept of movement of ocean water.

Unit No.	Topic Name	Sub-Topic	Teaching Hours
I	**Introduction to Hydrosphere and Submarine Relief**	**A.** Meaning and Concept of Hydrosphere **B.** Importance of the Study of Hydrosphere in Modern Time **C.** Surface Configuration of Ocean Floor **D.** Submarine Relief of Indian and Atlantic Oceans:	08
II	**Properties of Ocean Water**	**A. Salinity:** Definitions & Meaning i. Composition of Salinity of Ocean Water ii. Factors Affecting the Distribution of Salinity of Ocean Water iii. Distribution of Salinity- Open Ocean, Partially Enclosed Sea, Inland Sea and Lakes **B. Temperature** i. Distribution of Ocean Water Temperature: a) Horizontal b) Vertical **C. Density** i. Definitions and Characteristics of Density of Ocean Water ii. Factors Controlling the Density of Ocean Water	08

III	**Movement of Ocean Water**	**A. Oceanic Waves** i. Definitions, Nature and Characteristics of Waves. ii. Breaking of Waves iii. Tsunami waves: Definitions, Characteristics and Effects of Tsunami **B. Ocean Currents** i. Definition and Types of Ocean currents ii. Characteristics of Ocean currents iii. Causes of Origin of Ocean currents iv. Ocean Currents in the Atlantic and Indian Oceans. v. Effects of Ocean Currents **C. Ocean Tides** i. Definition and Meaning ii. Types: Spring and Neap Tides iii. Importance of Tides iv. Effects of Tides	**09**
IV	**Ocean Coast**	**A. Ocean Coast** i. Definition and Nature of Ocean Coast ii. Types of Ocean Coast a. Submergence Coast b. Emergence Coast	**05**

Weightage

Unit No.	Marks
I	12
II	16
III	20
IV	12
Internal Assessment (CA)	**40**
External Assessment (UA)	**60**
Total Marks	**100**

Suggested Reading:

1. Ahirao, Alizad and Dhapate (2002): Climatology and Oceanography
2. Bharambe, Dhake and Patil, Physical Geography Part-II, Atmosphere and Hydrosphere.
3. Bhardwaj K, Physical Geography-Oceanography, Discovery publishing house New Delhi.
4. Davis Richard J.A., (1987): Oceanography- An introduction to the marine Environment, W.M.C.,Brooth Flow.
5. Garison T. (1998): Oceanography, Wards worth Company, USA
6. Khan Nizamuddin (2001): An Introduction to Physical Geography, Concept Publication Padma, Apartment New Delhi.
7. Majid Husain (2001): Fundamental of Physical Geography, Ravat Publication, Jaipur

8. Negi B.S., Climatology and oceanography, Kedarnath and Ramnath Publishing , Meerut.
9. Padey, P.N. (2002): Physical Geography, NiraliPrakashan, Pune
10. Ross D.A.(1988): Introduction to Oceanography, Prentice Hall, New Jersey.
11. Savindar Sing, Physical Geography, Prayagpustakbhavan, Alahabad.
12. Sharma R.C. and Vatal,(1970): Oceanography for Geographers, Chaitanya Delhi.
13. Siddhartha K. (2001): Oceanography A Brief Introduction, Kisalaya Publication Pvt. Ltd.
14. Tikha R.N., Physical Geography, Kedarnath and Ramnath and Co. Merrut.
15. Trewartha Robinson, Physical Elements of Geography, McGraw Hill Books Company, New Delhi.
16. Ummerkutty A. N. P. (1999), Science of the Oceans, National Book Trust, New

KAVAYITRI BAHINABAI CHAUDHARY
NORTH MAHARASHTRA UNIVERSITY, JALGAON

FACULTY OF SCIENCE AND TECHNOLOGY

New Syllabus F.Y.B.Sc. Semester- II (CBCS Pattern)
With effect from June- 2022

Gg.- 203: PRACTICAL GEOGRAPHY- MAP PROJECTION

(Each batch of 15 students with four teaching hours per week)

Total Credits: 02 **Teaching Hours: 60**

LEARNING OBJECTIVES:

1. Acquaint the students with basic Projection and preparation of maps.
2. To enable the students with importance of various map projections.
3. To acquaint the students with the principles of Graticules
4. Basics of choice of map projections

LEARNING OUTCOMES:

After completion of this course, the students will be …

1. Benefited with different kind of map projections & their importance.
2. Expert in drawing projections according to requirement.
3. Identify & choose map projections for different regions.
4. Enhance basics of latitudes, longitude & great circle among students.

Unit No.	Topic Name	Sub-Topic	Teaching Hours
I	**Introduction to Map Projections**	**A.** Introduction to Map and Globe i. Definitions of Map & Globe ii. Parallels of Latitudes iii. Meridians of Longitudes iv. Great Circle **B.** Introduction to Map Projection i. Definitions of Map Projection ii. Necessity of Map projection	**15**
II	**Classification of Map Projection**	**A.** Classification of Map Projection on the basis of their development i. Perspective Projections ii. Non-Perspective Projections iii. Conventional map Projections	**08**
III	**Construction of Map Projections**	**A. Construction of Map Projections by Graphical Methods** **a. Zenithal Projection:** i. Zenithal Polar Gnomonic projection. ii. Zenithal Polar Stereographic projection **b. Conical Projections**: i. Conical projection with one standard parallels. ii. Conical projection with two standard parallels iii.Bonne'sprojection.	**27**

		c. Cylindrical Projections i. Cylindrical Equal Area Projection ii. Mercator'sProjection **d. Conventional map projections**. i. Sinusoidal projection. ii. Mollweide projection	
IV	**Choice & Use of Map projections**	**A.** Choice of Map projections for different Purposes and regions **B.** Problems with the choice of map projection **C.** Distortion (shape, size, direction, area.)	**10**

Weightage

Unit No.	Marks
I	15
II	12
III	25
IV	08
Internal Assessment (CA)	**40**
External Assessment (UA)	**60**
Total Marks	**100**

Suggested Reading:

1. Gopal Singh: Mapwork and Practical Geography
2. R.P.Mishra & A.Ramesh Fundamental of Cartography.
3. R.C.Sing & Dutta: Elements of Practical Geography
4. James Alfred Steers, An Introduction to the Study of Map Projections, University of London Press,
5. Erwin Raisz Elements of Cartography: 12. Elements of Practical Geography: Robbinson A.H.&Sleep R.D.
6. Kellaway,G.P.,(1979):Map Projections, B.I.Publications,NewDelhi
7. Monkhouse,F.J. and Wilkinson,H.R.1980:Maps and Diagrams
8. Singh,R.L. and Singh,R.P.B.(1992):Elements of practical Geography.
9. Steers,J.A. (1954):An Introduction to the Study of Map Projections,University of ,NewYork.
10. R.Sing & Kanaujia Map work and Practical Geography
11. F.J. Mankhouse & H.R. Wilkinson: Map & Diagrams
12. George Kallawy Map Projection: London Press, London.

Kavayitri Bahinabai Chaudhari

North Maharashtra University,

Jalgaon

S. Y. B. Sc

(Semester III & IV)

Syllabus of Geography

(Under the Faculty of Science)

Choice Based Credit System (CBCS)

With effect from June 2019

Equivalence courses for S.Y.B.Sc. Geography Students

S.Y.B.Sc Geography (Old Courses)	New Syllabus of S.Y.B.Sc. Geography W.E.F. June 2019
Gg: 231 Sem. III Paper I- Environmental Geography - I	Gg: 301 (DSC) Sem. III Paper I - Environmental Geography
Gg: 232 Sem. III Paper II- Physical Geography of India	Gg: 302 (DSC) Sem. III Paper II –Physical Geography of Maharashtra
Gg: 233 Sem. III Paper III- Practical Geography (Topographical Maps, Weather Instrument, Maps and Images)	Gg: 303(DSC) Sem. III (LAB-III) Paper III - Interpretation of Topographical, Weather Maps and Weather Data Analysis
--	Gg: 304 Sem. III SEC I - Regional Planning and Development
Gg: 241 Sem. IV Paper I-Environmental Geography II	Gg: 401(DSC) Sem. IV Paper I - Human Geography
Gg: 242 Sem. IV Paper II-Economic Geography of India	Gg: 402 (DSC) Sem. IV Paper II - Socio – Economic Geography of Maharashtra
Gg: 243 Sem. IV Paper III -Practical Geography (Surveying, Leveling and Excursion/Village Survey Report)	Gg: 403 (DSC) Sem. IV (LAB-IV) Paper III - Surveying and Area Measurement by GPS
--	Gg: 404 Sem. IV SEC II - Field Techniques and Survey based Project Report

Details about the course for S.Y.B. Sc. Geography under CBCS Pattern

<table>
<tr><th rowspan="2">Semester</th><th rowspan="2">Courses as per UGC</th><th colspan="2">Core Courses</th><th rowspan="2">Number of credits</th><th rowspan="2">Hours per semester</th><th colspan="2">Marks</th></tr>
<tr><th>Course Code</th><th>Course Title</th><th>Int.</th><th>Ext.</th></tr>
<tr><td rowspan="4">III</td><td rowspan="2">Geography-DSC 3A</td><td>Gg. 301 Paper-I</td><td>Environmental Geography</td><td>02</td><td>30</td><td>40</td><td>60</td></tr>
<tr><td>Gg.302 Paper- II</td><td>Physical Geography of Maharashtra</td><td>02</td><td>30</td><td>40</td><td>60</td></tr>
<tr><td>Geography LAB-DSC3A LAB</td><td>Gg. 303 Paper-III</td><td>LAB III Interpretation of Topographical, Weather Maps and Weather Data Analysis</td><td>02</td><td>60</td><td>40</td><td>60</td></tr>
<tr><td>Skill Enhancement Course I (SEC I)</td><td>Gg.304</td><td>Regional Planning and Development</td><td>02</td><td>30</td><td>40</td><td>60</td></tr>
</table>

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<tr><th rowspan="2">Semester</th><th rowspan="2">Courses as per UGC</th><th colspan="2">Core Courses</th><th rowspan="2">Number of credits</th><th rowspan="2">Hours per semester</th><th colspan="2">Marks</th></tr>
<tr><th>Course Code</th><th>Course Title</th><th>Int.</th><th>Ext.</th></tr>
<tr><td rowspan="4">IV</td><td rowspan="2">Geography-DSC 4A</td><td>Gg. 401 Paper-I</td><td>Human Geography</td><td>02</td><td>30</td><td>40</td><td>60</td></tr>
<tr><td>Gg.402 Paper- II</td><td>Socio- Economic Geography of Maharashtra</td><td>02</td><td>30</td><td>40</td><td>60</td></tr>
<tr><td>Geography LAB-DSC4A LAB</td><td>Gg. 403 Paper-III</td><td>LAB IV Surveying and Area Measurement by GPS</td><td>02</td><td>60</td><td>40</td><td>60</td></tr>
<tr><td>Skill Enhancement Course II (SEC II)</td><td>Gg.404</td><td>Field Techniques and Survey based Project Report</td><td>02</td><td>30</td><td>40</td><td>60</td></tr>
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Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Under faculty of Science and Technology

S.Y.B.Sc. SEMESTER- III

New Syllabus (CBCS Pattern)

(with effect from: June 2019)

Gg. 301 (DSC) Paper – I: Environmental Geography

Total Credits – 2. **Internal Marks - 40**
Total Hours – 30 **External Marks – 60**

Objectives:-

1. To create the environmental awareness amongst the students.
2. To acquaint the students with fundamental concepts of Environmental Geography.
3. To aware the students about the processes and patterns in the natural environment.
4. To acquaint the students with past, present and future utility and potentials of Environmental Geography at regional, national and global levels.
5. To make aware the students about the judicious use of resources.

Unit No.	Topic	Sub-topics	Hours
I	**Introduction to Environmental Geography**	I) Introduction to Environment- Meaning, Concept a) Types of Environment: i) Natural(Physical) ii) Biotic II) Environmental approaches a) Deterministic b) Possibilistic c) Ecological III) Ecosystem- a) Meaning and Concept b) Structure - Components i) Abiotic ii) Biotic c) Function i) Nutrient Cycling a)Carbon Cycle b)Nitrogen Cycle ii)Energy Flow a)Food Chain b)Food Web	8

II	**Man and Environment Relation ship**	A) Major environmental Dilemmas i) EL-NINO Imbalance ii) pollution concept **B)** Human environment relationship i) Human life in- Equatorial region -Mountainous Region -Desert Region - Coastal Region	6
III	**Environmental Problems And Management**	**A)** Pollutants and pollution: i) Air pollution- causes ,effect and control ii) water pollution-cause effect and control B) Biodiversity- Definition And Type I) Types of Biodiversity a)Genetic Diversity b) Species Diversity c) Ecosystem Diversity C) Threats To Biodiversity I) Pouching Of Wildlife II)Man-Wildlife Conflicts D) Environmental Management- A)Priority Sectors i)Pollution control ii) Power and mineral resources iii) Environmental education	8
IV	**National Environmental Policy And Movement**	A) National Environmental Policy (NEP)- Introduction, Objective, And Principal B) Initiatives or actions regarding i) Land Degradation ii) Forest And Wildlife Conservation iii) Fresh Water Iv) Climate Change. C) Major environmental movements i) The Chipko Andolan ii) Tehri-High Dam Project iii) Sardar Sarover Project	8

Unit No.	**Weightage of Marks**
I	15
II	15
III	20
IV	10
Total Marks (University Level)	60
Internal Marks (College Level)	40

Reference Books:

- Benny Josheph (2005): Environmental Studies, Tata McGraw-Hill Publishing Company, New Delhi.
- Cunningham W.P. and Cunningham M.A. (2003): Principles of Environmental Science: Inquiry and Applications, Tata McGraw Hill Publications, New Delhi.
- Miller, G.T. (2002): Living in the Environment, Books Cole Thomas Learning Inc. U.S.A.
- Nagor, A.P. (1996): Biological Diversity and International Environmental Law, A.P.H Publication, New Delhi.
- Purohit, Shammi and Agrawal (2012):A Text Book Of Environmental Science, Student Edition, Chopasani Road, Jodhpur
- Saxena, H.M.(2004): Environmental Studies, Rawat Publications, Jaipur.
- Santra S.C (2013): Environmental Science, New Central Book Agency (P) Ltd. Kolkata, West Bengal
- Sharma, P.D. (2004): Ecology and Environment, Rastogi Publications, Shivaji Road, Meerut.
- Singh, Savindra (2001): Environmental Geography, Prayag Pustak Bhavan, Alahabad- 110002.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Under faculty of Science and Technology

S.Y.B.Sc. SEMESTER- III

New Syllabus (CBCS Pattern)

(with effect from: June 2019)

Gg. 302 (DSC) Paper – II : Physical Geography of Maharashtra

Total Credits – 2. **Internal Marks - 40**
Total Hours – 30 **External Marks – 60**

Unit No.	Unit Sub	Sub Unit	Hours
1	**Geographical Personality of Maharashtra**	**1.1** Introduction to Maharashtra: Natural, Historical and Political **1.2** Location, Extent and Geographical Area **1.3** Administrative Divisions **1. 4** Adjoining or Adjacent States	**08**
2	**Physiography and Drainage**	**2.1** Physiography: a) Konkan Region b) Western Ghat c) Maharashtra Plateau **2.2** Major Rivers in Maharashtra a) Godavari b) Krishna c) Tapi **2.3** Water Resources in Maharashtra - Major Dams or Water reservoirs in Maharashtra a) Koyna b) Jayakwadi e) Hatnur **2.4** Importance and need of conservation of water in Maharashtra	**08**
3	**Climate**	**3.1** Characteristics of Climate **3.2** Seasons **3.3** Regional variations in temperature and rainfall distribution	**07**
4	**Soils and Natural Vegetation**	**4.1** Soil: a) Types of Soil b) Spatial Distribution of soil c) Characteristics of Soil d) Erosion and Conservation of Soil in Maharashtra **4.2** Natural Vegetation: a) Types of Forest b) Spatial Distribution of Forest c) Importance conservation of Forest	**07**
		Total Hours	**30**

Sr. No.	Unit No.	Weightage of Marks
1	1	15
2	2	15
3	3	15
4	4	15
University Assessment (U.A.)		60
College Assessment (C.A.)		40

References: -

1) C. D. Deshpande : Geography of Maharashtra
2) Dr. S. M. Bhamare (2013) : Geography of Maharashtra, Prashant Publication, Jalgaon.
3) Jaymala Diddee, S. R. Jog, V. S. Kale, V. S. Datye : Geography of Maharashtra
4) K. R. Dixit : Maharashtra in Maps
5) Savadi and Keche : Maharashtra
6) R. L. Sing (2012): India: A Regional Geography, National Geographical Society of India
7) Santosh Dasthane : Maharashtra. (Marathi Medium)
8) Subhashchandra Sarang: Maharashtra Bhugol, Vidya Prakashan, Nagpur. (Marathi Medium)
9) Dr. Jaykumar Magar Maharashtracha Bhugol. (Marathi Medium)
10) Dr. S. D. Bhaise, Dr. D. A. Mhaski : Maharashtracha Prakrutik Bhugol, Atharva Publication, Jalgaon (Marathi Medium)

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Under faculty of Science and Technology

S.Y.B.Sc. SEMESTER- III

New Syllabus (CBCS Pattern)

(with effect from: June 2019)

Gg. 303 (DSC) [LAB-III] Paper – III: Interpretation of Topographical, Weather Maps and Weather Data Analysis

Total Credits – 2	**Internal Marks - 40**
Total Hours – 60	**External Marks – 60**

Objectives:

1. To develop the interpretation skill among the students.
2. To introduce the students about the information recorded on topographical and weather maps.
3. To acquire various information from the maps.

Unit No.	Topic	Sub Topic	Hours
1	**Topographical Maps**	1.Introduction to topographical maps 2. Indexing of toposheet. 3.Grid reference (Four and Six figures) 4.Methods of representation of relief featurs a) Qualitative method – Hachures, Hill Shading, Layer tinting, b) Quantitative methods – Spot height, Bench mark, Triangulation, Contour, Form line. 5. Representation of relief features by contours a) Slope b) Relief features 6. Conventional signs and symbols of toposheet. 7. Profiles: a) Cross profile b) Longitudinal profile 8. Interpretation of toposheet. (At least 3 Plain, Plateau, Mountain, Desert & Coastal)	**30**
2	**Weather Maps and Weather Data Analysis**	1. Introduction to weather maps 2. Signs and symbols. 3. Isobaric patterns. 4.Interpretation of weather maps (Summer, Winter, Rainy) 5. Weather Data Analysis with the help of a) Temperature Data b) Rainfall Data c) Wind Direction and Wind Speed	**30**

		6. Structure, Function and Use of following weather instruments: a) Maximum and Minimum Thermometer. b) Aneriod Barometer. c) Rainguage. d) Barograph. e) Thermograph.	
		Total Periods	**60**

Sr. No.	**Unit No.**	**Weightage of Marks**
1	1	30
2	2	30
University Assessment (U. A.)		60
College Assessment (C. A.)		40

Reference Books:

1. Vaidyanadhan, R. (1968): Index to a Set of Sixty Topographic Maps: Illustrating
2. Ramamurthy, K. (1982): Map Interpretation, Rex Printer, Madras
3. Specified Physiographic Features From India, Council of Scientific and Industrial
4. Research, Ministry of Education, Government of India
5. Gupta, K. K. and Tyagi, V. C. (1992): Working with Maps, Survey of India Publication
6. Tamaskar, B. G. and Deshmukh, V. M. (1974): Geographical Interpretation of Indian
7. Topographical maps, Orient Longman, Kolkata
8. Dury, G. H. (1972): Map Interpretation, Pritman and Sons, London
9. Singh, G. (1996): Map Work and Practical Geography, Vikas Publication, New Delhi

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Under faculty of Science and Technology

S.Y.B.Sc. SEMESTER- III

New Syllabus (CBCS Pattern)

(with effect from: June 2019)

Gg. 304 SEC 1: Regional Planning and Development

Total Credits – 2 **Internal Marks - 40**
Total Hours – 30 **External Marks – 60**

Objectives:-

1) To introduce general problems of regional development and their application to rural areas.
2) To introduce basic methods of elaboration regional development studies
3) The student is able to explain the role of regional policy and desire the tools used to regional development support
4) To understanding of social and regional relation of the rural development

Unit No.	Topic	Sub Topic	Hours
1	**Introduction**	A) Regional Planning: i) Definition of region ii) The concept, need & objectives of Regional Planning. iii) Role of Geography in Regional Planning. iv) Role of regional planning in development v) Types of Regional Planning: Short Term, Long Term, Physical and Economic, Developmental & Imperative. B) Types of region:- i. Homogeneous, ii. Nodal, iii. Functional, iv. Programming, v. Administrative, vi. Urban areas. C) Characteristics of Planning Regions	08
II	**Choice of Region**	A) Characteristics of an ideal planning region B) Delineation of planning region (Variables for delineation, land use characteristics, demographic, transport infrastructure, social services and public utilities, socio-economic structures, methods) C) Regionalization of India for planning D) Agro-ecological Zones	07
III	**Theories and Models for Regional Planning**	**1.** Rostows Model of Economic Development **2.** Growth Pole Theory in Indian Context.	05

IV	**Measuring of development**	**A)** Economic Planning: Introduction to 12th five year plan, Role NITI Aayog in development, Damodhar Valley Corporation- the success story **B)** Backward regions and regional planning **C)** Environment:- Environmental laws and their implementation, Policy instruments for controlling water and air pollution, the Environmental Protection Act, Social Forestry in India,- rationale and benefits	**10**
Total			**30**

Sr. No.	**Unit No.**	**Weightage of Marks**
1	1	15
2	2	15
3	3	15
4	4	15
University Assessment (U.A.)		60
College Assessment (C.A.)		40

Reference Books:

1. Bhattacyarya S.: Corporate Planning.
2. Blij H. J. De, 1971: Geography: Regions and Concepts, John Wiley and Sons.
3. Claval P.l, 1998: An Introduction to Regional Geography, Blackwell Publishers, Oxford and Massachusetts.
4. Friedmann J. and Alonso W. (1975): Regional Policy - Readings in Theory and Applications, MIT Press, Massachusetts.
5. Gore C. G., 1984: Regions in Question: Space, Development Theory and Regional Policy, Methuen, London.
6. Gore C. G., Köhler G., Reich U-P. and Ziesemer T., 1996: Questioning Development; Essays on the Theory, Policies and Practice of Development Intervention, Metropolis-Verlag, Marburg.
7. Haynes J., 2008: Development Studies, Polity Short Introduction Series.
8. Johnson E. A. J., 1970: The Organization of Space in Developing Countries, MIT Press, Massachusetts.
9. Kulkarni A.R. : Contributions to regional Planning and Development.
10. Mahesh Chand & Puri V.K. : Regional Planning in India.
11. Mishra R.P.: Regional Planning
12. Peet R., 1999: Theories of Development, The Guilford Press, New York.Peter Self: Planning and the Urban Region.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Under faculty of Science and Technology

S.Y.B.Sc. SEMESTER- IV

New Syllabus (CBCS Pattern)

(with effect from: June 2019)

Gg. 401 (DSC) Paper I : Human Geography

Total Credits – 2 **Internal Marks - 40**
Total Hours – 30 **External Marks – 60**

Objectives:

1. This course is to acquaint the students with the nature of man-environment relationship and human capability.
2. To adopt and modify the environment under its varied conditions from primitive life style to the modern living;
3. To identify and understand environment and population in terms of their quality and spatial distribution pattern.
4. To comprehend the contemporary issues facing the global community.

Unit No	Topic	Sub -topic	Hours
1	**Introduction to Human geography**	**A)** A Definition, Nature and Scope **B)** Branches of Human Geography **C)** Relationship between Man and Environment **D)** Approaches of Human Geography	5
2	**Human Races and Religion**	**A)** Definition of Human Race **B)** Physical basis of racial groups **C)** Classification of world Races – Caucasoid, Mongoloid, Negroid and Australoid **D)** Definition of Religion and Major Religious system – Judaism, Islam, Christianity, Buddhism and Hinduism	10
3	**Population**	**A)** Factors affecting on the distribution of Population – Physical, Socio – Cultural and Demographic. **B)** Worlds population distribution **C)** Malthusian theory of Population growth **D)** Demographic transition theory	5
4	**Settlements**	**A)** Definition and types of rural settlements - Compact, Semi Compact and Dispersed. **B)** Patterns of rural settlements – Circular , Radial , Elongated , Square and Amorphous **C)** Definition and functional classification of Urban settlements – Administrative, Defence, Culture, Production and Communication. **D)** Recent Trends and Patterns of Urbanization in India.	10
		Total	**30**

Sr. No.	Unit No.	Weightage of Marks
1	1	12
2	2	16
3	3	16
4	4	16
University Assessment (U.A.)		60
College Assessment (C.A.)		40

References –

1. Majid Husain - Human Geography, Rawat publication, Jaipur.
2. Maurya S.D. – Manav Bhugol , Sharad pustak bhavan , Allahabad
3. S.K.Shelar – Human Geography, Chandralok prakashan , Kanpur.
4. Mohammad I. Hassan – Population Geography, Rawat publication.
5. R.C.Chandana – Geography of Population, Kalyani publishers, New Dehli.
6. Sumita Ghosh – Introduction to Settlement Geography, Orient black swan, Kolkata.
7. Patil S.B. and Patil Y.V. - Geomorphology and Settlements in Dhule District, Research express ,Latur.
8. Manvi Bhugol- Dr. Namdev N. Gajre, Prashant Publication, Jalgaon.
9. Dr. S. D. Bhaise, Dr. D. A. Mhaski : Loksankhya Bhugol, Atharva Publication, Jalgaon (Marathi Medium)

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Under faculty of Science and Technology

S.Y.B.Sc. SEMESTER- IV

New Syllabus (CBCS Pattern)

(with effect from: June 2019)

Gg. 402 (DSC) Paper II : Socio-Economic Geography of Maharashtra

Total Credits – 2 **Internal Marks - 40**
Total Hours – 30 **External Marks – 60**

Objectives:

- To accustom the students with utility and applications knowledge got from the study of Socio-Economic Geography in different walks of the life.
- To acquaint the student with basic knowledge of Maharashtra state.
- To acquaint the student with prospects and problems of agriculture, industries, trade and transport of Maharashtra.

Unit	Topic	Sub-topics	Hours
I	**Population**	**1.1** Introduction and Population Growth in Maharashtra **1.2** Population distribution in Maharashtra a) High population density regions b) Medium population density regions c) Low population density regions **1.3** Factors affecting on distribution of population in Maharashtra. a) Physical b) Economic c) Social Factors **1.4** Demographic features in Maharashtra (Sex Ratio)	6
II	**Agriculture**	**2.1** Introduction to Agriculture of Maharashtra. **2.2** Role of agriculture in the Economy of Maharashtra **2.3** Agro – climatic zones in Maharashtra **2.4** Types of agriculture in Maharashtra (Plantation agriculture, Dairy farming, Horticulture, Subsistence Farming, Organic Farming.) **2.5** Recent trends in agriculture – Introduction to Polyhouse and Shade net house **2.6** Problems of agriculture and its remedial measures	6
III	**Minerals, Energy Resources and Industries**	**3.1 Major minerals** and their production and distribution a) Iron ore b) Bauxite **3.2 Energy resources**: production and distribution a) Nuclear Power Station b) Thermal power projects c) Hydel power projects **3.3 Industries**: a) Cotton Textile Industries: i. Factors governing the location of cotton textile	9

		industries. ii. Distribution and problems faced by cotton textile industries. b) The sugar industries – Distribution and problems of sugar industries.	
IV	**Trade and Transport**	**A) Trade:** i) Introduction and types of trades a) International b) National ii) Factors affecting on trade in Maharashtra **B) Transportation:** i) Meaning and different modes of transportation in Maharashtra. ii) Classification of roads a) National highways b) State highways iii) Railways a) General information about length, distribution and types of gauges. b) Main railway lines passing through Maharashtra.	9

Sr. No.	Unit No.	Weightage of Marks
1	1	15
2	2	15
3	3	15
4	4	15
University Assessment (U.A.)		60
College Assessment (C.A.)		40

Reference Books:

1) Government of India. : The Gazetteer of India, Vol. I & II, Publication Division, New Delhi, 1965.
2) Government of India: Census of India 2011.
3) Despande, C.D.: India: A Regional Interpretation, Northern Book Centre, New Delhi, 1992.
4) Sharma, and Coutihno,: Economic and Commercial Geography of India. Vikas Publishing House, India, 1998.
5) Memoria, C. B.: Geography of India, Shivlal Agrawal and Co., Agra, 1986.
6) Negi, B. S.: Economic and Commercial Geography of India, Kedarnath Ram nath, New Delhi.
7) Tirtha, Ranjit.(2002) : Geography of India, Rawat, Jaipur.
8) Tata McGraw Atlas: Socio Economic Atlas of India.
9) Majid Hussain (2014): Geography of India ,McGraw Hill Education (India) Private education, New Delhi.
10) Dr. S. M. Bhamare (2013) : Geography of Maharashtra, Prashant Publication, Jalgaon.
11) C. D. Deshpande : Geography of Maharashtra.
12) K. R. Dixit : Maharashtra in Maps.

13) S. H. Deshpande : Economy of Maharashtra.
14) Jaymala Diddee, S. R. Jog, V. S. Kale, V. S. Datye : Geography of Maharashtra.
15) Savadi and Keche : Maharashtra.
16) R. L. Sing (2012): India: A Regional Geography, National Geographical Society of India, Varanasi -5.
17) Santosh Dashtane : Maharashtracha. (Marathi Medium)
18) Subhaschandra Sarang : Maharashtra Bhugol, Vidya Prakashan, Nagpur. (Marathi Medium)
19) Dr. Jaykumar Magar Maharashtracha Bhugol. (Marathi Medium)
20) Dr. S. D.Bhaise: Maharashtracha Prakrutik Bhugol, Atharva Publication, Jalgaon(Marathi Medium)
21) Dr. Lalit Sandanshiv : Krushi Bhugol, Atharva Publication, Jalgoan (Marathi Medium)

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Under faculty of Science and Technology

S.Y.B.Sc. SEMESTER- IV

New Syllabus (CBCS Pattern)

(with effect from: June 2019)

Gg. 403 (DSC) [LAB-IV] Paper III: Surveying and Area Measurement by GPS

Total Credits – 2 **Internal Marks - 40**
Total Hours – 30 **External Marks – 60**

Objectives:

1. To develop the surveying skill among the students.
2. To introduce the students about working and practical utility of GPS.
3. To acquaint the students about the field survey.

Unit No.	Unit	Sub Unit	Hours
1	**Surveying**	A) Meaning and Definition of Surveying B) Need of Surveying in Geography C) Types of Surveying 1) Plane Surveying 2) Geodetic Surveying D) Methods of Surveying 1) Trigonometric Survey 2) Traverse Survey: Open and Close Traverse	08
2	**Plane Table Survey**	A) Introduction B) Instruments Used in Plane Table Survey C) Procedure in Plane Table Survey D) Methods of Plane Table Survey 1) Radiation Method 2) Intersection Method F) Conversion of Area in Different Units- (Hectare and Acre to Sq. Feet and Sq. Meters)	22
3	**GPS Survey**	A) Introduction and Components of GPS B) Applications of GPS C) Procedure of GPS Survey D) Survey Using GPS 1) Survey of Given Area 2) Preparation of Layout 3) Measurement of Surveyed Area	18
4	**Excursion or Village Survey**	Visit to a Place of Geographical Interest or Village Survey Students Should Submit a Field Report at the Time of Semester Examination.	12

Weightage of Marks

Unit No.	Unit	Weightage of Marks
1	Surveying	05
2	Plane Table Survey	20
3	GPS Survey	15
4	Excursion or Village Survey	10
Viva –voce		10
Total (University Level)		60
Total (College Level)		40

Note: *The educational tour or village survey should be conduct and organized by the directions of Maharashtra Govt. rules and regulations.*

Reference Books:-

1) Kanetkar T.P. and Kulkarni S.V. (1983), Surveying and Levelling (Part I and II), Pune Vidyarthi Gruha Prakashan, Pune.
2) Monkhouse, F.X.J. & Wilkinson, H.R.(1989): Maps & Diagrams, B.I Publications, Bombay.
3) Mishra, R.P and Ramesh A. (2000): Fundamental of Cartography, Concept Publishing Company, New Delhi.
4) Robinson, A.H. & Sleep, R.D.(1969): Elements of Practical Geography, New York, John Wiely
5) Singh Gopal (1996): Map Work and Practical Geography, Vikas Publishing House Pvt. Ltd., New Delhi.
6) Singh, R.C. and Dutta (1993): Elements of Practical Geography, Kalyani Publications, New Delhi.
7) Singh, Lekhraj & Singh Raghunandan (1973): Map work and Practical, Central Book Deopt. Allahabad.
8) Singh, R.L. and Singh, R.P.B. (1997): Elements of Practical Geography,Kalyani Publishers, New Delhi.
9) Sing, R.L. and Kanaujia L.R.S.(1963): Map Work and Practical Geography, Allahabad Central Book Depot.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Under faculty of Science and Technology

S.Y.B.Sc. SEMESTER- IV

New Syllabus (CBCS Pattern)

(with effect from: June 2019)

Gg. 404 SEC II: Field Techniques and Survey Base Project Report

Total Credits – 2 **Internal Marks - 40**
Total Hours – 30 **External Marks – 60**

Objectives:

1) To inculcate in students the analytical approach towards their geographical environment through field study/work of a selected area.
2) To aware students that how does a field work form an important part of geographical learning?
3) To develop the skill of selection of appropriate technique for field study.
4) To enable the student to frame different types of questionnaires to conduct a field study.
5) To develop the ability of analysis, interpretation and report writing based upon the data collected during a field study.

Unit	Topic	Sub Topic	Hours
01	**Introduction to Field Study Report**	A. Definition of Field and field work B. Role and Objective of Field-Work C. Values and Ethics of Field-Work D. Identifying the Case Study (Rural / Urban / Physical / Human / Environmental)	05
02	**Concepts in Field Work**	A. Kinds of Question (One sentence Answer) 1. Generic 2. Genetic 3. Theoretical 4. Remedial 5. Methodological B. Merits, Demerits of the Field Techniques. C. Selection of the Appropriate Technique; Observation (Participant / Non Participant). D. Types of Sampling 1. Simple random sampling 2. Stratified random sampling 3. Systematic random sampling	05
03	**Data Collection and Analysis**	A. Types of Hypothesis - Null Hypothesis - H_1 and H_0 Hypothesis - Importance of Hypothesis - Testing and Hypothesis B. Questionnaires (Open/ Closed / Structured / Non-Structured); Interview with Special Focus	05

		C. Analysis of data D. Use of Supporting Techniques for data representation E. Types of Hypothesis	
04	**Report Writing**	Designing the Field Report A. Title Page B. Acknowledgment C. Content D. Research Problem E. Review of Literature F. Abstract G. Introduction H. Objective I. Hypothesis J. Methodology K. Result or Findings L. Discussion / Subject Explanation M. Conclusion N. References / Bibliography O. Appendices P. Binding	15

Sr. No.	**Unit No.**	**Weightage of Marks**
1	1	10
2	2	15
3	3	15
4	4	20
University Assessment (U.A.)		60
College Assessment (C.A.)		40

Reading List:

1. Creswell J., 1994: Research Design: Qualitative and Quantitative Approaches Sage Publications.
2. Dikshit, R. D., 2003. The Art and Science of Geography: Integrated Readings. Prentice-Hall of India, New Delhi.
3. Evans M., 1988: “Participant Observation: The Researcher as Research Tool” in Qualitative Methods in Human Geography, eds. J. Eyles and D. Smith, Polity.
4. Mukherjee, Neela, 1993. Participatory Rural Appraisal: Methodology and Application. Concept Publs. Co., New Delhi.
5. Mukherjee, Neela, 2002. Participatory Learning and Action: with 100 Field Methods. Concept Publs. Co., New Delhi
6. Robinson A., 1998: "Thinking Straight and Writing That Way", in Writing Empirical Research Reports: A Basic Guide for Students of the Social and Behavioural Sciences, eds. by F. Pryczak and R. Bruce Pryczak, Publishing: Los Angeles.
7. Special Issue on “Doing Fieldwork” The Geographical Review 91:1-2 (2001).
8. Stoddard R. H., 1982: Field Techniques and Research Methods in Geography, Kendall/Hunt. 9. Wolcott, H. 1995. The Art of Fieldwork.Alta Mira Press, Walnut Creek, CA.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

1990

'A' Grade
NAAC Re-accredited
(3rd Cycle)

Choice Based Credit System (CBCS)

Syllabus for T.Y.B. Sc (Geography)

(Under the Faculty of Science and Technology)

(Since 2020-2021)

T.Y.B.Sc CBCS Structure(Since 2020-21)

Sr. No	Courses	Semester V		Semester VI		Total Credit value
01	Discipline Specific Core DSC	Credits Each	Courses	Credits Each	Courses	
	(i) Core I to IV	03	04	03	04	3X8=24
	(ii)Core (Practical)	02	03	02	03	2X6=12
02	Skill Enhancement Course (SEC): Skill Based course	03	01	03	01	3 X 2 = 06
03	Elective Course (any one)	03	01	03	01	3X2=06
04	Elective Audit Course (out of 3)	None Credit	Any one	None Credit	Any one	------
Total Credit Value (Credit X No. of Courses)		24		24		48

JOB OPPORTUNITY
FOR
T.Y.B.Sc STUDENTS

Board of Study of Geography is attempting to introduce new advance courses in the syllabus such as Geomorphology , Climatology , Oceanography ,Global Positioning System , Disaster Management, Economic Geography, Biogeography, Agriculture Geography, Remote Sensing & GIS, Water Resource Management and Geography of India. It is welcoming to note that practical courses are closely related to above courses. When the students do their practical with the help of remote sensing data by using GIS software. They should have the knowledge of spatial distribution of plants and forests, soils, water resource and populations.

When students complete their graduation with geography they have an Opportunity of job as below:

1. The syllabus is designed by considering competitive examination- MPSC, UPSC, NET/SET and GIS etc. Obviously there is an opportunity to overcome vent of job.
2. Good hands of students with remote sensing data analysis using GIS software create several opportunities of jobs in government as well as private sectors.
3. Digital data analysis IT companies: Every year IT companies require number of candidates those are trained in GIS.
4. GPS and DGPS trained students could get the job in survey companies, such as Pvt. Ltd. Civil builders, road surveyors, town planner, etc.

Urban Planner or Community Development: –

Geography is a natural tie-in with urban or city planning. City planner's work on zoning, land use, new developments, from a gas station renovation to the development of whole new sections of urban area. You'll work with individual property owners, developers and other officials. If you are interested in this area, be sure to take Urban Geography and Urban Planning classes. An internship with a city planning agency is essential experience for this type of work.

Cartographer: – For those with cartography courses backgrounds may enjoy work as a cartographer. The news media, book publishers, atlas publishers, government agencies and others are looking for cartographers to help produce maps. This would likely require relocation.

GIS Specialist: – City Governments, Country Agencies and other Government and Private Agencies or Groups are often in need of experienced GIS professionals. Coursework and internship in GIS are especially important. Computer programming or engineering skills are very helpful in this arena- the more about computers and languages you know, the better off you are.

Climatologist: – Agencies like National Weather Services, News Media, the Weather Forecasting Channels, and other Government Entities occasionally need Climatologist. Admittedly, these Jobs usually go to those with Meteorology Degrees, a Geographer with experience and vast coursework in Meteorology and Climatology would definitely be an asset.

Transportation Management: – Like Urban and City Planning, there are opportunities in local Government but regional transit authorities or shipping, logistics, and transportation companies look kindly to someone with transportation Geography in their background and good computer and analytical skills.

Environmental Management: – A plethora of Environmental Assessment, clean up , and management companies exist throughout the world today. A Geographer brings excellent skills for project management and the development of reports like Environmental impact reports. It's often a wide-open field with tremendous growth opportunities.

Writer/Researcher: – Undoubtedly during your college years you have spent time developing your writing skills and certainly as Geography major you know how to research? How about a career as a writer – you could be a science writer or a travel writer for a magazine or newspaper. The About.comFreelanceWriting site provides information to help you get started.

Reference: - http://geography.about.com/od/careersingeography/a/jobsgeography.htm

Details of CBCS Structure for T.Y.B.Sc Geography
(With Effect from June 2020)

Subject Code	Semester	Title of Subject	CBCS Structure Code	Credit Point	Total Teaching Hours
Gg.501	V	Geomorphology	DSC Core I	03	45
Gg .601	VI	Soil Geography.	DSC Core I	03	45
Gg. 502	V	Climatology	DSC Core II	03	45
Gg. 602	VI	Biogeography.	DSC Core II	03	45
Gg. 503	V	Oceanography	DSC Core III	03	45
Gg. 603	VI	Population Geography.	DSC Core III	03	45
Gg. 504	V	Water Resource Management	DSC Core IV	03	45
Gg. 604	VI	Agricultural Geography.	DSC Core IV	03	45
Gg. 505	V	Remote Sensing and GPS	DSC SEC	03	45
Gg.605	VI	Geographical Information System	DSC SEC	03	45
Gg.506 A Gg.506 B (*Any One)*	V	Disaster Management. *OR* Geography Of Tourism*(Any One*	DSC Elective	03	45
Gg .606 A Gg .606 B (Any One)	VI	Geography of India *OR* Economic Geography (*Any One)*	DSC Elective	03	45
Gg. 507	V	Practical in Aerial Photography.	DSC Core-Practical	02	60
Gg. 607	VI	Practical in Satellite Imaginaries, GIS and GPS.	DSC Core-Practical	02	60
Gg. 508	V	Practical in Morphometric Analysis.	DSC Core-Practical	02	60
Gg. 608	VI	Practical in Water and Soil Analysis.	DSC Core-Practical	02	60
Gg. 509	V	Practical in Statistical Techniques.	DSC Core-Practical	02	60
Gg. 609	VI	Advanced Statistical Methods With the Help of Computer and Project Work .	DSC Core-Practical	02	60

Only Equivalence Courses

T.Y.B.Sc Geography (Old Courses) (W.E.F June 2017)	T. Y. B. Sc. Geography New Syllabus (CBCS Pattern) (With Effect from June- 2020)
Semester-V	Semester-V
Gg.311: Geomorphology	GG.501 (DSC Core I) : Geomorphology
Gg.312: Climatology	GG.502 (DSC Core II): Climatology
Gg.313: Oceanography	GG.503 (DSC Core III): Oceanography
Gg.314: Water Resource Management	GG.504 (DSC Core IV): Water Resource Management
Gg.315: Disaster Management	GG.506 A (DSC Elective): Disaster Management.
Gg.316: Remote Sensing and GIS	Gg.505 (DSC SEC): Remote Sensing and GPS
Semester-VI	Semester-VI
Gg. 321: Soil Geography	GG.601 (DSC Core-I): Soil Geography
Gg.322: Biogeography	GG.602 (DSC Core-II): Biogeography
Gg.323: Economic Geography	GG.606 B (DSC Elective): Economic Geography
Gg.324: Agriculture Geography	GG 604 (DSC Core IV) : Agriculture Geography
Gg.325 ; Population Geography	GG.603 (DSC Core-III) : Population Geography
Gg.326: Regional Geography of Maharashtra	GG 606 A (DSC Elective) : Geography of India
Semester-V (Practical)	Semester-V (Practical)
Gg.301: Practical in Aerial Photography	GG.507 (DSC Practical Core): Practical in Aerial Photography
Gg.302: Practical in Morphometric Analysis	GG.508 (DSC): Practical of Morphometric Techniques
Gg.303: Practical in Statistical Techniques	Gg.509 (DSC); Practical in Statistical Techniques
Semester-VI (Practical)	Semester-VI (Practical)
Gg.304: Practical in Satellite Imageries, GIS And GPS	GG 607 (DSC) : Practical In Satellite Imageries, GIS And GPS
Gg.305: Practical in Water and Soil Analysis	GG 608 (DSC) : Practical In Water And Soil Analysis
Gg.306: Advanced Statistical Method with the help of computer, Project work & Excursion	GG 609 (DSC) : Advanced Statistical Methods With Help Of Computer Project Work And Excursion

SEMESTER-V

SEMESTER : V

T.Y.B.Sc Geography(CBCS Pattern)

Subject Code	Title of Subject	CBCS Structure Code	Credit Point	Total Teaching Hours
Gg.501	Geomorphology	DSC Core I	03	45
Gg. 502	Climatology	DSC Core II	03	45
Gg. 503	Oceanography	DSC Core III	03	45
Gg. 504	Water Resource Management	DSC Core IV	03	45
Gg. 505	Remote Sensing and GPS	DSC SEC	03	45
Gg.506 A OR Gg.506 B *(Any One)*	Gg.506 A Disaster Management. *OR* Gg.506 B Geography Of Tourism *(Any One)*	DSC Elective	03	45
Gg. 507	Practical in Aerial Photography.	DSC Core-Practical	02	60
Gg. 508	Practical in Morphometric Analysis.	DSC Core-Practical	02	60
Gg. 509	Practical in Statistical Techniques.	DSC Core-Practical	02	60
AC-501 A AC-501B AC-501 C (Any One)	NSS NCC Sports (Any One) (02Hours/Week) Total Marks: CA : 100	Elective Audit Course (Non Credit)	No Credit	30

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: V

Gg. 501 (DSC Core I) – Geomorphology

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

- To understand the origin of various landforms.
- To study the processes of landforms development.
- To help the students for preparation of competitive examinations.

Unit No.	Topic	Sub Topic	Teaching Clock Hours
1	Introduction to Geomorphology	A) Definitions , Nature & Scope of Geomorphology. B) Fundamental Concepts i. Uniformitarianism ii. Geological Time Scale	08
2	Origin of Primary relief of the Earth	A) Plate Tectonic Theory B) Sea Floor Spreading theory C) Paleomagnetism	10
3	Exogenous Processes	A) Properties of Rocks (Structure, Texture, Hardness, Porosity) B) Weathering: i. Definition ii. Factors iii. Types iv. Products	08
4	Slopes	A) Elements of slopes: i. Convex Slope ii. Free Face Slope iii. Constant or Talus Slope iv. Concave Slope B) Development of Slope Profile: i. W. Penck's views ii. L C King's views	10
5	Davisian Cycle of Erosion	A) Davisian Cycle of Erosion i. Basic Assumptions ii. Theory iii. Concepts iv. Criticism B) Concept of Rejuvenation i. Causes ii. Features	09

<table>
<tr><th colspan="4">Weightages of Marks</th></tr>
<tr><th>Units</th><th>Teaching Clock Hours</th><th>Marks</th><th>Credits</th></tr>
<tr><td>1</td><td>08</td><td>12</td><td rowspan="5">03</td></tr>
<tr><td>2</td><td>10</td><td>12</td></tr>
<tr><td>3</td><td>08</td><td>12</td></tr>
<tr><td>4</td><td>10</td><td>12</td></tr>
<tr><td>5</td><td>09</td><td>12</td></tr>
<tr><td>Total</td><td>45</td><td>60</td><td>03</td></tr>
<tr><td colspan="2">University Assessment</td><td>60</td><td rowspan="3"></td></tr>
<tr><td colspan="2">College Assessment</td><td>40</td></tr>
<tr><td colspan="2">Total Marks</td><td>100</td></tr>
</table>

References:

1. A Test book of Geomorphology: Dayal P., Shukala book Depot, Patana (1996)
2. Principals of Physical Geography: Monkhouse F.J., Hodder and Stoughton,London.
3. Chorley R.J, Schumm, S.A. and Sugden D.E. (1984): Geomorphology, Methuen, London.
4. Geomorphology: Sarvindar Singh, PrayagPustakBhavan; Allahabad (2002).
5. Geomorphology: Wooldridge, Longman; New York.
6. Geomorphology: Sparks B.W., Longmans, New York (1972).
7. Kale V.S and Gupta, a (2001): Introduction to Geomorphology, Orient Longman Calcutta.
8. Morphology and Landscape: Harry Robinson, University Tutorial Press(1977).
9. Physical Geography: Tikka, KedarnathRamnath& Co.(1995).
10. Principals of Physical Geomorphology: Thournbury W.D. & Wiley Eastern (1960).
11. Savindra Singh (2002): Geomorphology, PrayagPustakBhawan, Allahabad.
12. The Earth’s Dynamic Surface: K. Siddharth, Kisalaya Publication Pvt. Ltd.(2001).
13. Thornbury, W.D. (1960) Principles of Geomorphology”, John Wiley and Sons, NewYork.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: V

Gg. 502 (DSC Core II) – Climatology

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

1. To acquaint the students with basic knowledge of atmosphere, weather andclimate.
2. To know the fundamental concepts of climatology.
3. To understand various weather phenomena.
4. To identify climatic differentiation on the earth.
5. To acquire the knowledge of weather forecasting.

Unit No.	Topic	Sub Topic	Teaching Clock Hours
1	Introduction	A) Meaning, Definitions of Climatology. B) Concept of Climatology C) Nature & Scope of Climatology D) Sub-divisions of Climatology E) Climate &Human Activities	08
2	The Atmosphere	A) Origin of the Atmosphere B) Composition of the Atmosphere C) Structure of the Atmosphere D) Modern views Regarding the Structure of Atmosphere i) Homosphere ii) Heterosphere	08
3	Insolation & Heat Budget	A) Meaning, Definition of Insolation Solar Constant &Albedo of the Earth B) Factors Affecting Distribution of Insolation C) Effects of Atmosphere (Scattering Diffusion ,Reflecting& Absorption) D) Heat Budget of the Earth & Atmosphere	09
4	Climatic Changes	A) Meaning & Concept B) Indicators Of Climatic changes C) Causes of Climatic Changes D) Theories Of Climatic Changes i) Carbon Dioxide Theory ii) Volcanic Dust Theory	10
5	Classification of Climate & Application of Climatology	A) Koppen's Classification of Climate B) Applications in the field of i) Agriculture ii) Health iii) Urban Planning iv) Trade & Transportation	10

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	08	12	03
2	08	12	
3	09	12	
4	10	12	
5	10	12	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References:

1) SavindraSing(2005) : Climatology ‘Prayag Publication, Allahabad.
2) A.K.Barua(2005) : Climatology ‘ Dominant Publishers & Distributor, New Delhi’
3) K.Siddharth(2011):Atmosphere,Weather&climate – A text book of climatology, Kisalaya Publication Pvt. Ltd. New Delhi
4) D.S.Lal(2011) : Climatology, ShardaPustakBhavan , Allahabad.
5) Majid Husain (2003) :Climatology, Anmol Publications Pvt Ltd. New Delhi
6) Prof.S.A.Quzi(2009) : Principal of Physical Geography ,APH Publishing corporation, New Delhi

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: V

Gg. 503 (DSC Core III) – Oceanography

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

- To introduce students to basic concepts of Oceanography.
- To understanding the chemical, physical, geological and biological processes which act on the ocean's surface and to recognize the submarine forms, the seawater composition and properties.

Unit No.	Topic	Sub Topic	Teaching Clock Hours
1	Introduction	A) Meaning and Definitions. B) Boundaries and Basic Information of the Oceans. C) Importance of the Oceans. D) The Nature and Scope of Oceanography E) Major Branches of Oceanography.	09
2	Oceanic Waves	A) Wave Characteristics. A) Wave Generating factors. B) Wave Refraction and Wave Diffraction. C) Wave Types.	09
3	Tides	A) Definitions. B) Tide Generating Forces. C) Equilibrium Theory of Tides. D) Types of Tides i. Diurnal, Semidiurnal ii. Spring and Neap Tides	09
4	Marine Deposits	A) Definitions of Marine Deposits. B) Classification of Marine Sediments. i. Lithogenous Sediments. ii. Hydrogenous Sediments. iii. Biogenous Sediments. iv. Cosmogenous Sediments. C) Sources of Marine deposits. i. Terrigenous deposits. ii. Volcanic Deposits. iii. Pelagic Deposits.	09
5	Man and Marine Resources	A) Oceans and Climate. B) Marine Environment. C) Ocean and Food Resources. D) Ocean and Ecosystem. E) Marine Pollution.	09

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	09	13	03
2	09	12	
3	09	15	
4	09	10	
5	09	10	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References:

1. Oceanography for Geographers: King C.A.M. Anado, London (1970).
2. Principles of Oceanography: Sharma Vithal M. Chetana Publication House Allahabad (1970).
3. Principles of Oceanography: Sharma Vithal M. Chetana Publication House Allahabad (1970).
4. Oceanography – Introduction to Marine Environment: Davis Richard J.A., C. Brown, lowa.
5. Science of oceans and Human life: Vmmarkutty A.N.P. (1985) NBT, New Delhi.
6. Introduction to world ocean: Duxbury C.A. and Duxbury B,C, Brown lawa(1996).
7. Introduction to Oceanography: Sharma Vithal M. ChetanaPubliction House Allahbad (1977).
8. Oceanography-Introduction to Marine Science: Garrison T., Book Cole Pacific Grove U.S.A. (2001).
9. Oceanography for Geographer- R.C. Sharma, M. Vatal Published by C.S.Jain for Chaitanya Publishing House Allahabad.

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New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: V

Gg. 504 (DSC Core IV) – Water Resource Management

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

- To Judge surface & Ground water resources.
- To understand significance of water resource for human development.
- To generalize the concept of water resource management and planning.
- To conclude the water resource management through scientific planning.

Unit No.	Topics	Sub topics	Teaching Clock Hours
1	Introduction to Water Resource	A) Earth and Hydrosphere. B) Hydrological cycle. C) Classification of water resources- i. Oceans. ii. Rivers. iii. Lakes. iv. Wetlands. v. Ice caps and glaciers.	8
2	Water Resources in India	A) Demand For Water i. Agriculture. ii. Industrial. iii. Domestic. B) Role of State in Water Resources Management.	8
3	Water Resources Problems and Conflicts	A) Problems of Water Resources- i. Floods ii. Droughts iii. Drinking Water Scarcity in India B) Multipurpose River Valley Projects in India and Their Environmental and Social Impacts: Case Studies of - Narmada and Tehri Dam C) National River Linking Plan: Ecological and Economic Impacts.	10
4	Conservations of Water Resources	A) Methods of Water Conservations- i. Physical ii. Biological. iii. Significance of Shirpur Pattern. iv. Baripada Pattern of Water Conservation. B) Water Pollution Control measures.	10

5	Water Resource Management & Planning	A) Modern Techniques of irrigation i. Drip irrigation ii. Sprinkler irrigation iii. Micro irrigation B) Application of Remote Sensing in water resource Management	9

Weightage of Marks

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	08	10	03
2	08	12	
3	10	14	
4	10	14	
5	09	10	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References:

1. Global Hydrology: Processes, Resources and Environment Management, John, J. A. (1997):
2. Longman Publishers
3. Mountains and Rivers of India, Law, B. C. (Ed. 1968) :, IGU National Committee for
4. Geography, Calcutta.
5. Water Resources Distribution, Use and Management, Matter, J. R. (1984) : John Wiley,
6. Maryland.
7. Land, Water and Development, River Basin Systems and their Sustainable
8. Management, Newson, M. (1992) :Rowfledge, London.
9. India’s Water Wealth, Rao, K. L. (1979) : Orient Longman, New Delhi
10. Water Management Principles and Practices, Singh, R. A. and Singh, S. R. (1979) : Tara
11. Publication, Varanasi.
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14. CEA. 2011. Water Resources and Power Maps of India. Central Board of Irrigation & Power.
15. Grumbine, R.E. &Pandit, M.K. 2013. Threats from India's Himalaya dams. Science 339:
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17. Loucks, D.P., Stedinger, J.R. &Haith, D. A. 1981. Water Resource Systems Planning and
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Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: V

Gg. 505 (DSC SEC) –Remote Sensing and GPS

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

- To introduce the fundamentals of Remote Sensing.
- To provide details of Satellite Remote Sensing.
- To aware about the application of Remote Sensing in various fields.
- To develop GPS usage skill in students.
- To aware basics and geometry of Aerial photographs.

Unit	Topic	Sub-topics	Teaching Clock Hours
1	Introduction to Remote Sensing	A) Introduction and Definition of Remote Sensing B) Development of Remote Sensing C) Applications of Remote Sensing D) Platforms of Remote Sensing: E) Types of Remote Sensing: i) Based on Source of Energy a. Active Remote Sensing b. Passive Remote Sensing ii) Based on Range of Electromagnetic Spectrum a. Thermal Remote Sensing b. Microwave Remote Sensing	9
2	Aerial Photographs	A) Introduction and Principles B) Types of Aerial Photographs i. Vertical ii. Low Oblique iii. High Oblique C) Geometry of Aerial Photographs i. Scale of Aerial photograph	09
3	Satellite Remote Sensing	A) Principles of Satellite B) EMR (Electromagnetic Radiation) C) EMS (Electromagnetic Spectrum) D) EMR Interaction with the Atmosphere i. Scattering ii. Absorption iii. Reflection E) EMR Interaction with the Earth Surface i. Reflection ii. Absorption	10

		iii. Emission iv. Transmission F) Satellites: i. Landsat Satellite Program ii. IRS Program (Indian Remote Sensing Satellite) G) Sensors: Classification of Sensors i. Passive Sensor ii. Active Sensor	
4	GPS (Global Positioning System)	A) 5.1 GPS: Introduction B) 5.2 Principles of GPS C) 5.3 Uses of GPS i. Navigation ii. Surveying iii. Cartography iv. Transportation v. Disaster / Hazard Management	7
5	Introduction to GPS Project Report	A) GPS based Project Report i. Preparing GPS for data collection ii. Input in GPS (Way points and Routes) iii. Getting data from GPS to GIS Output as map or layout (Surfer, Easy GPS etc. software's)	10

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	09	10	03
2	09	10	
3	10	15	
4	07	15	
5	10	10	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References:

English Medium

1. Campbell J. B., (2007): *Introduction to Remote Sensing*, Guildford Press.
2. Michael N. Demers (2009): *Fundamentals of Geographical Information System*, John Wiley & Sons, Inc.
3. Kang-tsung Chang (2008) : *Introduction to Geographical Information Systems*, McGraw Hill Education (India) Private Limited, Chennai
4. Jensen, J.R. (2000): *Remote Sensing of the Environment: An Earth resource Perspective*. Prentice Hall.
5. Jensen, J.R. (2004): *Introductory Digital Image Processing : ARemote Sensing Perspective*. Prentice Hall.
6. Joseph George (2005): *Fundamentals of remote sensing*. Universities Press

7. Lillesand, T.M. and Kiefer, R.W.andChipman J. W.(2004) : *Remote Sensing and Image Interpretation*, John Wiley. (Wiley Student Edition).
8. Sabbins, F.F. (1985):*Remote sensing Principles and interpretation*. W. H. Freeman & company.
9. Wolf P. R. And Dewitt B. A., (2000): Elements of Photogrammetry: With Application in GIS. McGraw-Hill.

Marathi Medium:

1. Dr. ShrikantKarlekar (2007): *BhougolicMahitiPranali*, Diamond Publication, Pune.
2. Dr. ShrikantKarlekar (2007): *Dursavedan*, Diamond Publication Pune.
3. Dr. D. S. Suryawanshi (2018): *Geo-informatics*,Prashant Publications, Jalgaon.

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New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: V

Gg. 506 A (DSC Elective) –Disaster Management.

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

- To acquaint the students with basic knowledge of natural and manmade disasters.
- To understand impacts of disasters.
- To create awareness among students about disasters.
- To know the fundamental concepts of disaster management.
- To acquire the knowledge of preparedness and mitigation.
- To understand manifesting the mitigation.

Unit No.	Topic	Sub Topics	Teaching Clock Hours
1	**Introduction to Disaster**	A. Concept and Definitions of Disaster, Hazards, Risk and Vulnerability B. Classification of Disaster C. Importance of the Study of Disaster - Management D. Difference between Disaster and Hazards	08
2	**Geo – Physical Disaster**	Causes, Impact, Management, Distribution and Mapping in India A. Earthquake B. Landslide C. Tsunami	12
3	**Atmospheric Disaster**	Causes, Impact, Management, Distribution and Mapping in India A. Flood B. Droughts C. Cyclone	08
4	**Manmade Disaster**	Causes, Impact, Management, Distribution and Mapping of following Disaster in India A. Terrorism B. Fire C. Accidents D. Chemical Disaster	08

5	**Disaster Risk Reduction**	Causes, Impact, Management, Distribution and Mapping in India A. Mitigation and Preparedness: Survival Kit, Medicinal Kit, Warning and Alarm System B. Community Based Disaster Management: Do's and Don'ts during and Post Disaster C. NDMA and NIDM D. Role and Responsibilities of GO's and NGO's	09

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	08	12	03
2	12	16	
3	08	10	
4	08	10	
5	09	12	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References:

1. Disaster Management; Future challenges and opportunities, Editor: Jagbir Singh
2. K. International Publishing House Pvt. Ltd., New Delhi, Mumbai, Bangalore.
3. Concept and Practices in Disaster Management, Colonel (Retd.) P.P. Marathe,Diamond Publications,1691, SadashivPeth , Near Grahakpeth, Pune 411030
4. Hand Book of Effective Disaster: Recovery, Planning, Mc Grow Hill Publ.,London.
5. The Book of Natural Disaster: Alladin Books Ltd., London.
6. Disaster Management : Ed. Vinod Sharma, National Center for Disaster
7. Management, Indian Institute of Public Administration, Indraprastha Estate,
8. Ring Road New Delhi 110002.
9. Earthquake: A.K.R. Hemmody, NBT of India.
10. Disaster Preparedness, Council for Advancement of Peoples Action and Rural
11. Technology, D- Block, Ponkha Road Janakpuri, New Delhi, 110075.
12. Disaster in India studies of grim Reality, AnuKapur and Neeta Meena
13. Deeplima, Roshani, Debhanjal, Rawat Publication, Jaipur.
14. Environmental Geography and Natural Hazards, A.A. PiraziziConceptPublication Co., New Delhi, 110059.
15. Disaster in India: Studies of grim Reality, AnuKapur and Neeta Meena
16. Deeplima ,Roshani, Debhanjal, Rawat Publication, Jaipur.
17. 11. Practical Disaster Management: Col. P. P. Marathe; Diamond Publication, Pune.
18. 12. Natural Disaster: Ahmad Husain; Sumit Enterprises, New Delhi.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: V

Gg. 506 B (DSC Elective) –Geography of Tourism.

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

- To enable students to acquire knowledge of Tourism Geography.
- To understand basic concepts of Tourism Geography.
- To understand various Geo Tourism.
- To know the importance of the sustainable tourism.

Unit No.	Topic	Sub Topics	Teaching Clock Hours
1	Nature and Scope of Tourism Geography	A) Definition and Concept of Tourism B) Nature and Scope of Tourism Geography C) Issues in Tourism D) Role of Geography in tourism	08
2	Types of Tourism	A) Natural Tourism B) Cultural tourism C) Medical Tourism D) Pilgrimage	12
3	Recent Trends in Tourism	A) Eco – Tourism – i. Sanctuaries – Corbett National Park and Wildlife Sanctuaries ii. National Park – Bandipur National Park , Karnataka iii. Heritage – Ellora Caves B) Sustainable Tourism – i. Agro Tourism ii. Heritage Tourism C) E- Tourism: i. ERS ii. EBS iii. DBMS	08
4	Impact of Tourism	A) Economical Impact - Employment, Increased Trade, Inflation of Land Values, Increased Revenue and Effect on Foreign Exchange.	08

		B) Social Impact–Cultural Change, Crime And Gambling, Establishment of New Colonies C) Environmental Impact – Land, Water, Noise, Air	
5	Tourism in India	A) Tourism infrastructure B) Case study of Himalaya –Darjeeling C) Desert– Jaiselmer D) Coastal – Goa E) National Tourism Policy in India	09

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	08	**12**	03
2	12	**12**	
3	08	**12**	
4	08	**12**	
5	09	**12**	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References:

1. Bhatia, A.K. (1991) : International Tourism Fundamentals and Practices, Sterling Publishers Pvt. Ltd., New Delhi-110016
2. Bhatia, A.K. : Tourism Development, Sterling Publishers Pvt. Ltd., New Delhi-110016
3. Burkart and Medlik -Tourism, Past, Present and Future Heinemann, ELBS. (1981)
4. Cooper, Fletcher, Tourism, Principles and practices, Pitman. Publishing ,1993
5. Geetanjali (2010) : Tourism Policy and Planning, ABD Publishers, Jaipur
6. Kaul: Dynamics of Tourism, Sterling Publishers Pvt. Ltd., New Delhi-110016
7. Mill and Morrison (1992) : The Tourism system an Introductory Text , Prentice Hall
8. P.S. Gill: Dynamics of Tourism (4 Vols) Anmol Publication. New Delhi,
9. Wagh S.A. &Sonawane S.B. (2016) : ParyatanBhugol, AtharvaPrakashan, Jalgaon

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New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: V

Gg. 507 (DSC Core-Practical) Practical in Aerial Photography.

(04 Clock Hours Per Batch Per Week)

Total Marks:100

(CA:40 and UA:60) **Credit Points: 02** **Total Clock Hours: 60**

Objectives:

1. To introduce basics and concepts of photogrammetric, aerial photography
2. Introduction to the principles and practices of aerial photograph and photo interpretation
3. Students will learn basic theories of aerial photography and common applications for remote sensing using vertical aerial photography.
4. Students will be able to demonstrate the understanding of properties and characteristics of aerial photographs.

Unit. No.	Topic	Sub Topics	Teaching Clock Hours
1	Introduction of Aerial Photographs	A) Definition, significance of Aerial Photographs B) Brief history or Development of Aerial Photographs C) Tools and Equipments used in Aerial Survey- Aeroplane, Camera, Altimeter, Filter D) Term Associate with Aerial Photographs and Survey	10
2	Aerial Photographs	A) Types- Vertical, Tilted, Oblique, Convergent and Trimetrogon B) Terminology of Vertical Photography C) Camera Calibration- Fiducial Marks, Flying Height, Photo base, Nadir Principal Point	10
3	Scale and Photographic Information	A) Side Information recorded on Aerial Photograph B) Calculation of Scale and Area C) Calculation of Flying height	14
4	Overlaps	A) Overlap of Aerial Photographs B) Orientation of Aerial Photographs C) Calculation of Overlap	12
5	Map Preparation and Integration of Aerial Photographs	A) Identification of Features B) Preparation of Sketch or Map of Overlapped Area C) Elements of Photo Interpretation D) Interpretation of Aerial Photographs	14

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	10	12	02
2	10	12	
3	14	12	
4	12	10	
5	14	14	
Total	**60**	**60**	**02**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References:

1. P. Saha and P. Basu (2006): Advanced Practical Geography, Books and Allied Publication, Kolkata, India
2. . 2. Khullar, Essentials of Practical Geography, New Academic Publishing Co, India.
3. P. Nag and S. Sengupta (2008): Introduction to Geographical Information System, Concept Publishing Company, New Delh.
4. G. Joseph (2007): Fundamentals of Remote Sensing, Universities Press, Hyderabad.
5. R. A. Schowengerdt (2009): Remote Sensing Models and Methods for Image Processing, Academic Press, An Imprint of Elsevier, Burlington.
6. S. Mehtani and A. Sinha (2010): Remote Sensing Geography, Commonwealth Publishers Pvt. Ltd., New Delhi.
7. W. K. Pratt (2006): Digital Image Processing, A Wiley-Interscience Publication, New York.
8. P. Nag and M. Kudrat (1998): Digital Remote Sensing, Concept Publishing Company, New Delh.
9. Remote Sensing & Photogrammetric: M.L.Jhanwar, T.S.Chouhan; VigyanPrakashan, Jodhpur.
10. Applied Remote Sensing & Photo-Interpretation :T.S.Chouhan, K.N.JoshiVigyanPrakashan, Jodhpur.
11. Door savendananipraklapahawal(Marathi) Dr. san jay Bhaise, Prof. D. A. Prashant Publication Jalgaon.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon
New Syllabus (CBCS Pattern) W.E.F June 2020
T.Y.B.Sc Sem.: V
Gg. 508 (DSC Core-Practical) Practical in Morphometric Analysis.
(04 Clock Hours Per Batch Per Week)

Total Marks:100

(CA:40 and UA:60) **Credit Points: 02** **Total Clock Hours: 60**

Objectives:

1. To understand the concept of drainage system and its morphology practically.
2. To generalize thenature of drainage system and its aspects.
3. To conclude the morphometric analysis by scientific methods.
4. To provide the vision for job opportunities are available for the students of geography in the field of GIS, RSand watershed planning department through the practical work.
5. To encourage the students for morphometric research.

Unit No.	Topic	Sub Topic	Teaching Clock Hours
01	Morphometric Analysis of Drainage : **Linear Aspects**	i) Drainage hierarchy a) Horton`s Stream Ordering Method b) Strahler's Stream Ordering Method ii) Bifurcation ratio iii) Sinuosity index iv) Length ratio	15
02	Morphometric Analysis of Drainage : **Areal Aspects**	i) Stream frequency ii) Drainage Density iii) Form factor iv) Elongation ratio v)Texture ratio	15
03	Morphometric Analysis of Drainage : **Relief Aspects**	i) Hypsometric integral ii) Relative relief iii) Absolute Relief	10
04	Profile Analysis	A) Construction of profiles i) Cross Profile ii) Longitudinal profile	10
05	Slope Analysis	A) Slope map- Smith's Method B) Slope map- Wenthworth's Method	10

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	15	12	02
2	15	12	
3	10	12	
4	10	12	
5	10	12	
Total	**60**	**60**	**02**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References :

1. Gregary K.G. and Walling D. (1973); Drainage Basin Forms and Processes, Edward Arnold
2. Khan Za (1998): Text Book of Practical Geography
3. Khullar, Essentials of Practical Geography, New Academic Publishing Co, India.
4. Morrisawa (1985) : Stream
5. P. Saha and P. Basu (2006): Advanced Practical Geography, Books and Allied Publication, Kolkata, India.
6. Richards K. (1982) River; form and processes in alluvial channels Matheu London
7. Robinson Rep. (2010): Elements of Cartography 6/e
8. Savindra Singh (2005): Geomorphology, PrayagPustakBhawan, Allahabad, India.
9. Schumm S.A. (1977) Fluvial system John Wiley & Co.
10. Singh Gopal (Rep. 2010): Map Work and Practical Geography
11. Singh L R (2011): Fundamentals of Practical Geography
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New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: V

Gg. 509 (DSC Core-Practical) Practical in Statistical Techniques.

(04 Clock Hours Per Batch Per Week)

Total Marks:100

(CA:40 and UA:60) **Credit Points: 02** **Total Clock Hours: 60**

Objectives:

1. To familiarize the students with statistical analysis and its applications in Geography.

Unit No	Topic	Sub Topics	Teaching Clock Hours
1	Geographical Data	A) Nature of Scales & Measurement i. Spatial and Temporal ii. Discrete and Continuous Data iii. Grouped and Ungrouped Data iv. Nominal, Ordinal, Interval and Ratio of scales	10
2	Statistical Data	B) Frequency Distribution i. Tally Marks and Frequency Table ii. Frequency Histogram, Frequency Polygon iii. Cumulative Frequency Curve or Ogive curve	10
3	Measures of Central Tendency	A) Measures of Central Tendency i Meaning and Description of Central Tendency.- Mean, Median, Mode and Quartile ii Calculation of Mean, Median, Mode and Quartile for Ungrouped and Grouped data (2 Examples each)	12
4	Measures of Dispersion	A) Measures of Dispersion i Mean Deviation ii Standard Deviation iii Quartile Deviation	13
4	Bivariate analysis	A) Application of following tests: i. Chi Squared Test (One Way Only) ii. Student's t Test (comparison of Sample Means) iii. Concept of Bivariate Correlation and Regression. iv. Meaning of Coefficient of Correlation. v. Calculation of Karl Pearson's Product Moment Coefficient of Correlation	15

		vi. Spearman's Coefficient of Correlation (Two Examples) vii. Simple Regression Equation(Two Examples).	

<table>
<tr><th colspan="4">Weightages of Marks</th></tr>
<tr><th>Units</th><th>Teaching Clock Hours</th><th>Marks</th><th>Credits</th></tr>
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<tr><td>2</td><td>10</td><td>10</td></tr>
<tr><td>3</td><td>12</td><td>13</td></tr>
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<tr><td colspan="2">College Assessment</td><td>40</td></tr>
<tr><td colspan="2">Total Marks</td><td>100</td></tr>
</table>

References :

1. Ebdon David, (1989) Statistics for Geographers
2. P. Saha and P. Basu (2006): Advanced Practical Geography, Books and Allied
3. Publication, Kolkata, India.
4. S. N. Karlekar and M. Kale (2006): Statistical analysis of geographical data,
5. Diamond Publication, Pune
6. King, (1975) Statistical Geography
7. Norcliffe G.B. (1977). Inferential statistics for Geographers (Hutchinson, London)
8. Rogerson P.A. (2001). Statistical methods for Geography (SAGE pub., London,
9. New Delhi)
10. Shaw G. &Wheller D. (1985). Statistical Techniques in Geographical Analysis,
11. John Wiley & Sons, New York. approach to economic geography.Harper and
12. Row, New York
13. P. Saha and P. Basu (2006): Advanced Practical Geography, Books and Allied
14. Publication, Kolkata, India.
15. Singh G. (1996) Map work and practical geography, Vikas publ. New Delhi
16. Singh R.L., (1979) Elements of practical Geography, Kalyani publ., New Delhi

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SEMESTER-VI

SEMESTER : VI

T.Y.B.Sc Geography(CBCS Pattern)

Subject Code	Title of Subject	CBCS Structure Code	Credit Point	Total Teaching Hours
Gg .601	Soil Geography.	DSC Core I	03	45
Gg. 602	Biogeography.	DSC Core II	03	45
Gg. 603	Population Geography.	DSC Core III	03	45
Gg. 604	Agricultural Geography.	DSC Core IV	03	45
Gg.605	Geographical Information System	DSC SEC	03	45
Gg .606 A Gg .606 B (Any One)	Geography of India *OR* Economic Geography (*Any One)*	DSC Elective	03	45
Gg. 607	Practical in Satellite Imaginaries, GIS and GPS.	DSC Core-Practical	02	60
Gg. 608	Practical in Water and Soil Analysis.	DSC Core-Practical	02	60
Gg. 609	Advanced Statistical Methods With the Help of Computer and Project Work .	DSC Core-Practical	02	60
AC-601 A AC-601B AC-601 C (Any One)	Soft Skill Yoga Practicing Cleanliness (Any One) (02 Clock Hours/Week) Total Marks: CA : 100	Elective Audit Course (Non Credit)	No Credit	30

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New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: VI

Gg. 601 (DSC Core I) –Soil Geography.

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

- To know the relationship between physical factors and soil.
- To study the various soil forming processes.
- To learn the measures of soil conservation.

Unit No.	Topic	Sub Topics	Teaching Clock Hours
1	Introduction to Soil Geography	A) Definition of Soil Geography B) Nature & Scope of Soil Geography C) Approaches to The Study of Soil Geography i. Pedagogical Approach ii. Edapological Approach	08
2	Soil Formation & Soil Profile	A) Processes of Soil Formation i. Weathering &Pedogenesis Processes ii. Carbonation iii. Humification iv. Laterisation v. Calcification vi. Podzolisation B) Factors Responsible For Soil Formation i. Parent Rock ii. Precipitation iii. Temperature iv. Biological Factors: Plants, Animals & Micro Organisms C) Soil Profile: Meaning & Concept.	12
3	Soil Properties	A) Soil Physical Properties i. Soil Structure ii. Soil Texture iii. Soil Colour iv. Soil Moisture v. Soil Temperature B) Chemical Properties of Soil i. Soil pH ii. Soil Solution	09

4	Soil Classification	A) Soil Classification i. Zonal Soil ii. Azonal Soil iii. Intra Zonal Soil B) Major Soil Types In India	08
5	Soil Degradation & Conservation	A) Soil Erosion: Meaning, Causes and Effects B) Soil Degradation: Soil Salinization C) Soil Conservation: Meaning & Methods Of Soil Conservation.	08

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	08	12	03
2	12	12	
3	09	12	
4	08	12	
5	08	12	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

Reference Books:

1. Fundamentals of Soil Science: Miller A.A., Turk L.M. & Forth
2. Soil Geography: SarkarHimanshu ; (Nikhil) K.D. Kolkatta
3. A Text Book of Soil Science: Daji J.A. ; Tata Mc Grow Hill, Mumbai
4. A text book of Soil Science: Biswas T.D.&Mukharji ; Tata Mc Grow Hill Mumbai
5. Soil Geography : James G. Cruikshant ; Newtone Abbot Devon
6. Soil Geography: Buntice B.T
7. Bunting: Geography of Soils, Hutchinson, London
8. Rode A. A. : Soil science
9. Briggs David. : Soils, Butterworth, London
10. Birkland P. Weathering Pedology and Geo-morphological Research.

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New Syllabus (CBCS Pattern) W.E.F June 2020

T.Y.B.Sc Sem.: VI

Gg. 602 (DSC Core II) –Biogeography.

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**
(03 Clock Hours / Week)

Objectives:

- To aware biogeographical issue among the student.
- To acquaint the students with fundamental concept of biogeography.
- To aware the student about the processes and development of plant and animals.
- To make aware the student about use of resources with prudence.

Unit No.	Topic	Sub Topics	Teaching Clock Hours
1	Introduction	**A)**Definitions , Nature and Scope **B)**Branches of Biogeography I) Phytogeography II) Zoogeography **C)**Approaches to The Study of Biogeography I) Evolutionary or Historical Approach II)Ecological Approach	08
2	Evolution , Dispersal and Distribution of Plant	**A)** Evolutionary History of The World Plant Cover : Evolution of Heterotrophs, Autotrophs and Land Plants **B)** Dispersal of Plants : I) Definition of Dispersal of Plants II) Factors of Dispersal : Properties of Seeds, Agents of Seed Transportation,Role of Man and Limiting Factors of Seed Dispersal **C)** Affecting and Controlling Factors of Distribution of Plant	12
3	Plant Community	**A)** Meaning of Vegetation and Plant Community **B)** Vertical Stratification of Plant Communities **C)** Classification of Plants : Morphological , Hierarchical Classification of Plants , Classification of Plants Based on Climate	09
4	Animal Community	**A)** Origin and Evolution of Animals in Pre- Cambrian, Cambrian and Carboniferous Periods.	08

		B) Classification of Animals I) On the Basis of Habitats (Aquatic and Terrestrial Animals) II) On the Basis of Feeding Habits (Herbivores , Carnivores and Omnivores) **C)** Dispersal of Animals : Definition and Types of Dispersal **D)** Factors of Dispersal : Land and Water, Topographic Factors , Climatic and Biological Factors	
5	Bio Geographical Regions	A) Meaning B) Major Floral Region C) Major Faunal Region	08

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	08	10	03
2	12	14	
3	09	12	
4	08	12	
5	08	12	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References:

1. H. S. Mathur (2003): Essentials of Biogeography, Pointer Publishers, Jaipur,
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3. Savindra Singh (1991): Environmental Geography, Prayag Pustak Bhawan,Allahabad, India.
4. Singh Rb ed. (2009): Biogeography and Biodiversity
5. Singh Savindra (2009): Biogeography
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T.Y.B.Sc Sem.: VI

Gg. 603 (DSC Core III) –Population Geography.

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

- To know the problems of population
- To learn the population policies in India resource.
- To understand the recent problems of population in the world as well as nation.
- To study the demographic structure of population in India.
- To know the methods in present the population data.

Unit No.	Topic	Sub Topics	Teaching Clock Hours
1	Introduction	A) Definitions, Nature And Scope of Population Geography B) Definition of Population Data C) Source of Population Data With Special Reference To India i. Primary Sources: Personal Interview , Questionnaires ii. Secondary Sources: Census Reports, Vital Registrations, Sample Survey, International Publications, Internet.	10
2	Density and Distribution of Population	A) Definition And Types of Density of Population i. Arithmetic Density ii. Agriculture Density iii. Economic Density iv. Critical Density B) Density and Distribution of Population in India (According to Census 2011)	10
3	Population Growth and Theories of Population	A) Growth of Population in India (Since 1901) B) Determinants of Population Growth : (Meaning , Measures and Affecting Factors) i. Fertility ii. Mortality and iii) Migration	10

		C) Determinants of Population Growth : (Meaning , Measures and Affecting Factors) i)Fertility ii) Mortality iii) Migration C) Theories of Population i) Karl Mark's Theory on Population Growth ii)The Optimum Theory of Population	
4	Population Composition	Composition of Population i. Rural and Urban Composition ii. Age-Sex Composition	08
5	Population Contemporary Issues	A) Declining Sex Ratio in India B) HIV/ AIDS	07

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	10	16	03
2	10	12	
3	10	12	
4	08	10	
5	07	10	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References :

1. Barrett H.R., 1995: Population Geography, Oliver and Boyd.
2. Bhende A. and Kanitkar T., 2000: Principles of Population Studies, Himalaya Publishing House.
3. Chanda R.C. and Sidhu M.S., 1980: An Introduction to Population Geography, Kalyani Publishers
4. Clerke J.I., 1965: Population Geography, Pergamon Press, Oxford.
5. Jones H.R., 2000: Population Geography, 3rd ed. Paul Chapman, London.
6. Lutz W., Warren C.S. and Scherbov S., 2004: The End of the World Population Growth in the 21st Century, Earthscan
7. Newbold K.B., 2009: Population Geography: Tools and Issues, Rowman and Littlefield Publishers
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T.Y.B.Sc Sem.: VI

Gg. 604 (DSC Core IV) –Agricultural Geography.

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

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objectives:

- To introduce Agricultural systems.
- To make able the student to understand an influence of different physical and manmade factors on agriculture.
- To introduce Agricultural region and agro-climatic regions of India.
- To provide information about the worlds agricultural types.
- To make students aware about the importance of agricultural revolutions in Indian context.
- To know place of agriculture in economy of India.

Unit No.	Topic	Sub-Topics	Teaching Clock Hours
1	Introduction	A. Definition , Nature And Scope of Agricultural Geography B. Development of Agricultural Geography C. Approaches To The Study of Agricultural Geography i. Commodity Approach ii. Systematic Approach iii. Regional Approach iv. Deterministic Approach	10
2	Determinants of Agriculture	Determinants of Agriculture A. Physical Determinants - Relief, Climate & Soils B. Economic Determinants - Irrigation, Capital & Market C. Social Determinants – Density of Population , Land Ownership, Land Fragmentation And Labour D. Technological Determinants - Mechanization, Bio-Chemical Inputs, Chemical Fertilizers & High Yielding Seeds	10
3	Land Use and Agricultural System of the World	A) Land Use i. Definition ii. Classification of Land-Use iii. Von Thunen's Theory of Agricultural Land-Use B) Study of Following Major Agricultural Types: i. Intensive Subsistence Agriculture ii. Extensive Farming iii. Plantation Agriculture iv. Commercial Crop And Livestock Farming	12

4	Agricultural Regions of India	A) Meaning, Definitions of Agricultural Region and Characteristics of Agricultural Regions of India. B) Criterion's of Agricultural Region. i. Crop Combination – Meaning And Definition ii. Weavers Minimum Positive Deviation Method iii. Crop Combination Regions Of India C) Agro-Climatic Regions of India	8
5	Agriculture Revolution in India	A) Agricultural Revolution B) Need, Importance, Problem& Prospects i. Green Revolution ii. White Revolution iii. Blue Revolution iv. Pink Revolution v. Organic framing	5

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	10	14	03
2	10	14	
3	12	12	
4	08	10	
5	05	10	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References :

1. Anderson, R.H. (1936): Grain Drills through 39 Centuries. Agricultural History

2. Buchanan, R.O. (1959): Some Reflections on Agricultural Geography

3. Carrier & Lyman, H. (1968): Beginning of Agriculture in America Johnson. New York

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8. Mitchel, P. (1979): Agro-ecosystem, Inter India Publication,New Delhi

9. Randhawa, M.S. (1980): An History of Agriculture in India Vols. I, II, III,IV, New Delhi.

10. Shafi, M. (1984): Agricultural productivity and regional imbalance, concept, New Delhi.
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13. Singh, J. (1974): Agricultural Atlas of India: A Geographical perspective, Vishal Publications, Kurukshetra.
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T.Y.B.Sc Sem.: VI

Gg. 605 (DSC SEC) –Geographical Information System.

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

- To introduce the students about new advanced field in Geography.
- To develop the skill of new technique in the field GIS.
- To acquaint the students to components of GIS.
- To familiarize with the tools and application of GIS

Unit No.	Topic	Sub Topics	Teaching Clock Hours
1	Introduction to Geographical Information System (GIS)	*A)* Introduction, Definition and Meaning *B)* Components of GIS i. Hardware ii. Software iii. Data iv. Users – People *C)* GIS Tasks: Input Manipulation, Management, Query &Analysis, Visualization	**10**
2	GIS Data Structures	A) Geospatial Data Types i. Spatial Data ii. Non-Spatial Data B) Raster Data Structure i. Cells, Pixels, Grid ii. Resolution: Spatial, Spectral , Radiometric, Temporal C) Vector Data Structure i. Point entities ii. Line entities iii. Area entities D) Sources of Raster & Vector data E) Comparison between Raster & Vector	**10**
3	GIS Data Analysis	A) GIS Data Inputs i. Keyboard Entry ii. Manual digitizing iii. Scanning & Automatic Digitizing iv. GPS Data Inputs B) Geo-Referencing	**08**

		C) Editing D) Output and Query E) Overlays	
4	Map Projections	A) Introduction B) Properties of Map projections i) Conformal, ii) Equal Area, iii) Equidistant C) Projection Types i) UTM, ii) Cylindrical, iii) Conical	**08**
5	Application of GIS	A) Land Use/Land Cover Mapping B) Urban Sprawl C) Forests Monitoring D) Watershed Planning	**09**

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	10	14	03
2	10	14	
3	08	12	
4	08	08	
5	09	12	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References :

1. Bhatta, B. (2010) Analysis of Urban Growth and Sprawl from Remote Sensing,Springer, BerlinHeidelberg.41
2. Burrough, P.A., and McDonnell, R.A. (2000) Principles of Geographical Information System-Spatial Information System and Geo-statistics. Oxford University Press

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4. Heywoods, I., Cornelius, S and Carver, S. (2006) An Introduction to Geographical Information system. Prentice Hall.
5. Jha, M.M. and Singh, R.B. (2008) Land Use: Reflection on Spatial Informatics Agriculture and Development, New Delhi: Concept.
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8. Singh, R.B. and Murai, S. (1998) Space Informatics for Sustainable Development, Oxford and IBH, New Delhi
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T.Y.B.Sc Sem.: VI

Gg. 606 (A)- (DSC Elective) – Geography of India

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives:

1. To acquaint the students with basic knowledge of our country.
2. To aware the students about physiography, drainage, climate, soils and natural vegetation of India.
3. To aware the students with natural resources available in the country and need of conservation and protection of them.
4. To acquaint the students with prospects and problems of agriculture, industries, trade and transport in India.
5. To aware the students with natural resources available in the country and need of conservation and protection
6. To make the students ready for NET, SET and competitive examinations.

Unit No.	Topic	Sub-topics	Teaching Clock Hours
1	Geographical Personality of India	A) Location (Site and Situation), Extent and Geographical Area B) State and Union Territories wise Geographical Area C) Physiographic Divisions of India (Salient features of following divisions) i. Himalayan Mountainous Region ii. Northern Plain Region iii. Peninsular Plateau iv. Coastal Plains v. Islands D) Drainage i. Himalayan Rivers ii. Peninsular Rivers	12
2	Mineral & Energy Resources	A. Mineral Resources i) Iron Ore ii) Bauxite B. Energy Resources i)Coal ii)Hydel Power iii) Wind Power	08
3	Climate	A. Role of Various Controlling Factors on Climate of India B. Characteristics of Indian Climate ,Various Seasons and Weather Associated with them C. Monsoon: Origin and Mechanism	08

4	Agriculture and Industries	A. Role of Agriculture in Indian Economy Crops - Distribution in India i. Food Crops - Rice and Wheat ii. Cash Crops - Cotton and Sugar cane B Industries i. Iron and Steel Industries ii. Sugar Industries	09
5	Transportation Modes	Transportation Modes a) Roads i)Express Highways ii)Asian Highways iii)Golden Quadrilateral b) Railways i)General Features ii)Divisions	08

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	12	15	03
2	08	10	
3	08	10	
4	09	15	
5	08	10	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References :

1. Das, P.K.: *Monsoon.*
2. Deshpande, C.D.: *India: A Regional Interpretation.*
3. Khatib, K.A. (2008): *Geography of India,*K'Sagar Publications, Pune.
4. Majid Husain (2014): *Geography of India*, McGraw Hill Education (India) Private Education, New Delhi.
5. Mamoria, C.B.: *Geography of India*
6. Nag P. and S. Sengupta: *Geography of India.*
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10. Singh, Jasbir: *Agricultural Atlas of India.*
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T.Y.B.Sc Sem.: VI

Gg. 606 (B)- (DSC Elective) – Economic Geography

Total Marks:100

(CA:40 and UA:60) **Credit Points: 03** **Total Clock Hours: 45**

(03 Clock Hours / Week)

Objectives :

1) To meet the requirements of the under graduate students as well as those preparing themselves for competitive examinations.
2) Recognize problems and state them in a manner
3) To study the economic life of man with relation to environment
4) To Study the spatial variation on the earth's surface of activities related to producing, exchanging and consuming goods and services.

Tries to evaluate the effects that differences of physical environment have upon the utilization of those resources.

Unit No	Topic	Sub-topics	Teaching Clock Hours
1	Introduction to Economic Geography	A. Introduction, Meaning and Definition B. Nature and Scope of Economic Geography C. Approaches to the study of Economic Geography- i. Regional/Spatial Approach. ii. Systematic Approach iii. Principle Approach iv. Resource Utilisation Approach v. System analysis Approach	9
2	Location of Industries	A. The Factors of Industrial Location. I) Geographical Factors: a) Land b) Raw Material c) Climate d) Water Resources II) Socio-Economic Factors : a) Capital b) Labour c) Transport d) Demand e) Market	9

		B. The Location Theory : The Least Cost Location Theory of Alfred Weber :	
3	Primary Economic Activities of Man	A) Economic Importance of Agriculture B) Types of Agricultural Practices : i. Commercial Fishing. ii. Commercial Grain Farming. iii. Commercial Dairy Farming.	9
4	Secondary Economic Activities of Man	A) The Cotton Textile Industry : i. Process of Cotton textile Manufacturing ii. Factors of Location of Cotton Textile Industry : a) Raw Material b) Industrial Power c) Water Supply d) Humidity e) Labour B) Petro-Chemical Industry; Factors of Location of Petro-Chemical Industry	9
5	Tertiary and quaternary Economic Activities of Man	A) Transport : i. Importance ii. Factors of Development of Transport B) Transportation : i. Waterways ii. Airways C) International Trade : Role of World Trade Organization D) Information and Communication Technology Industry.	9

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	9	12	03
2	9	13	
3	9	14	
4	9	11	
5	9	10	
Total	**45**	**60**	**03**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References:

1) Human and Economic Geography :Goh Cheng Leong and Gillanc.Morgan

2) Economic Geography (A Study of Resources) Prithwish Roy

3) Economic Geography: AlkaGautamAndSonalRastogi

4) Agricultural Geography : Jasbir Singh and S.S.Dhillon

5) Agricultural Geography : Mohammad Shafi.

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T.Y.B.Sc Sem.: VI

Gg. 607 (DSC Core-Practical) Practical in Satellite Imaginaries, GIS and GPS.

(04 Clock Hours Per Batch Per Week)

Total Marks:100

(CA:40 and UA:60) **Credit Points: 02** **Total Clock Hours: 60**

Objectives:

- To introduce practical technique in GIS and GPS
- To learn actuate GIS Processing using Satellite data
- To know the application of GIS& GPS in various fields.

Unit No.	Topic	Sub-Topics	Teaching Clock Hours
1	Introduction to Satellite Imageries	A. Introduction to Satellite Imageries B. Types of Satellite Imageries C. Browsing of Satellite Data from Online Sources (NRSC, GLCF, GLOVIS, BHUVAN (any two)) D. Identifying features on Satellite Images	10
2	Introduction to GIS Software's	A. Introduction to GIS Software's B. Exploring Properties And Tools of Software C. Geo Referencing D. Digitization- Map Making-Point, Line And Polygon Map	14
3	Satellite Image Processing	A. Interpretation of Satellite Imageries (At least 2) B. Grid Reference C. Area Calculation D. Annotation strip E. Scale calculation	10
4	GIS Processing	A. Image Rectification B. Image Enhancement Technique- Contrast, Histogram Equalization, NDVI, Filters C. Supervised and Unsupervised Classification D. Web GIS- Google Map-Earth, Being Maps, Openstreet Map, GIS Cloud, Bhuvan etc.	14
5	Introduction to GPS	A. Introduction to GPS B. GPS Survey- Taking Geo-Points And Area Calculation C. GPS Applications	12

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	10	12	02
2	14	12	
3	10	12	
4	14	12	
5	12	12	
Total	**60**	**60**	**02**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References Book:

1. R. A. Schowengerdt (2009): Remote Sensing Models and Methods for Image Processing, Academic Press, An Imprint of Elsevier, Burlington.
2. G. Joseph (2007): Fundamentals of Remote Sensing, Universities Press, Hyderabad.
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5. W. K. Pratt (2006): Digital Image Processing, A Wiley-Interscience Publication, New York.
6. P. Nag and M. Kudrat (1998): Digital Remote Sensing, Concept Publishing, Company, New Delh.
7. Remote Sensing &Photogrammetry :M.L.Jhanwar, T.S.Chouhan; VigyanPrakashan, Jodhpur.
8. Applied Remote Sensing & Photo-Interpretation :T.S.Chouhan, K.N.JoshiVigyanPrakashan, Jodhpur.
9. Mishra R P (2002): Fundamentals of Cartography Revised and Enlarged 2/e
10. Sarkar (Ashish) 2011): Practical Geography: A Systematic Approach 2/e (Rep.
11. Husain Majid) (Rep. 2011): Understanding Geographical Map Entries
12. Rampal K K (Rep. 2009): Mapping and Compilation :Methods and Techniques
13. Harvey Francis (2009): A Primer of GIS:Fundamental Geographic and Cartographic Concepts

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T.Y.B.Sc Sem.: VI

Gg. 608 (DSC Core-Practical) Practical in Water and Soil Analysis.

(04 Clock Hours Per Batch Per Week)

Total Marks:100

(CA:40 and UA:60) **Credit Points: 02** **Total Clock Hours: 60**

Objectives:

1. To acquaint the students with deferent techniques of soil and water analysis in geography.
2. To aware the students with importance of water and soil n the era of increasing population.

Unit No.	Topic	Sub-Topics	Teaching Clock Hours
1	**Concept of Soil Sampling**	A. Methods of Soil Sampling B. Various Methods of Soil Sampling And At Least One Field Sampling (By Using Soil Augur or Core Tubes)	10
2	**Study of Physical Properties of Soil**	A) Collection and Processing of Soil Sample for Determination of i. Soil Texture ii. Soil Moisture iii. Bulk Density and Specific Gravity iv. Percentage Porosity **(Any Two of the Above)**	10
3	**Study of Chemical Properties of Soils**	A) Collection and Processing of Soil Sample for Determination of i. Soil Ph ii. Chloride Estimation iii. Soil EC iv. Organic Matter by Ignition Method **(Any Two of the Above)**	12
4	**Water Analysis**	A) Methods of Collection of Water Samples i. Ruttener Water Sampler ii. Van Dorn Water Sampler iii. Dussart Water Sampler B) Handling & Preservation Of Water Samples	12
5	**Study of Water Analysis Properties**	A) Physical Properties: Determination of Following Properties i. Color ii. Temperature –Measurement of Surface and Subsurface Temperature. a) Reversing Thermometer Method iii. Transparency iv. Turbidity B) Chemical Properties i. Ph – Determination of Ph With Ph Meter ii. Electric Conductivity (Soluble Salts Concentration) iii. Total Hardness	16

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<tr><td colspan="2">College Assessment</td><td>40</td></tr>
<tr><td colspan="2">Total Marks</td><td>100</td></tr>
</table>

References :

1. Backman, H.O and Brady, N.C.: The Nature and Properties of Soils, McMillan New York, 1960.
2. Bennet, Hugh H.: Soil Conservation, McGraw Hill, New York .
3. Bunting, B.T.: The Geography of Soils, Hutchinson, London, 1973.
4. Clarke G.R.: Study of the Soil in the Field, Oxford University Press, Oxford, 1957.
5. Foth H.D. and Turk, L.M.: Fundamentals of Soil science, John Wiley, New York,1972.
6. GovindaRajan, S.V. and GopalaRao, H.G.: Studies on Soils of India Vikas, New Delhi, 1978.
7. Ghosh R. K. and Swain S.: Practical Agricultural Engineering Vol. I &II.,NayaPrakash, Calcutta 1993.
8. Raychoudhuri, S.P.: Soils of India, ICAR, New Delhi,1958.
9. Russell, Sir Edward J.: Soil Conditions and Plant Growth, Wiley, New York, 1961
10. Suresh R: Soil & Water Conservation Engineering Standard Publishers & Distributors, 1997.

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T.Y.B.Sc Sem.: VI
Gg. 609 (DSC Core-Practical) Advanced Statistical Methods With the Help of Computer and Project Work .

(04 Clock Hours Per Batch Per Week)

Total Marks:100

(CA:40 and UA:60) **Credit Points: 02** **Total Clock Hours: 60**

Objectives:

- To familiarize the students with statistical methods use in geographic data analysis.
- To aware varies computer application software use in statistic

Unit No.	Topic	Sub Topics	Teaching Clock Hours
1	**Measures of Central Tendency**	A. Measures of Central Tendency – i. Mean ii. Medium iii. Mode	10
2	**Measures of Dispersion**	A. Standard Deviation B. Average Deviation C. Quartile Deviation.	10
3	**Correlation**	A. Correlation i. Karl Pearson Method ii. Spearman's Method iii. Multiple Correlation B. Chi- square Test	12
4	**Geographical data Analysis Techniques**	A. Simple Regression Analysis. B. Factor Analysis C. Time Series. D. Least Square analysis.	13
5	**Project Work**	Select a small region- Tahsil, Circle, or a Village for which students would like to prepare a project report. Students should submit their projects atleast in 10 pages. **OR** Excursion Report : Prepare a report of excursion using maps, diagrams & photographs. Students should submit the report at the time of examination	15

Note : The educational tour / Village Survey /visit to any place should be conduct and organize by the direction of Maharashtra Govt. rules and regulations and prior permission of college authority.

Weightages of Marks			
Units	**Teaching Clock Hours**	**Marks**	**Credits**
1	10	10	02
2	10	12	
3	12	13	
4	13	15	
5	15	10	
Total	**60**	**60**	**02**
University Assessment		60	
College Assessment		40	
Total Marks		**100**	

References :

1. Statistical Geography : Dr. B. S. Negi, Gdamath, Ramnath
2. Statistical Geography : Saroj K. Poul
3. Statistics for Geography : Ebdon David
4. Statistical Techniques : Saroj K. Poul
5. Quantitative Techniques in Geography: Robret H. and Patrick M. , Oxford University Press; (1974)
6. Statistical Methods in Geography Studies : AslamMahmood& Prof. Moonis
7. Raza; Rajes Publication New Delhi (1971)
8. Statistical Mapping and Presentation of Statistical Data : Dickinson G.C., London (1963)

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

||अंतरी पेटवू ज्ञानज्योत||

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS

For

Master of Science (M. Sc.)
[Botany]

M.Sc. Part-Ist (Sem-I & II)

Choice Based Credit System
(Outcome Based Curriculum)

2021 - 2022

Program at a Glance

Name of the program (Degree)	:	M. Sc. Botany
Faculty	:	Science and Technology
Duration of the Program	:	Two years (four semesters)
Medium of Instruction and Examination	:	English
Exam Pattern	:	60: 40 (60 marks University exam and 40 marks continuous internal assessment)
Passing standards	:	40% in each exam separately (separate head of passing)
Evaluation mode	:	CGPA
Total Credits of the program	:	88 (68 core credits including 4 credits of project/dissertation, 04 skill enhancement credits, 08 subject elective credits and 08 audit credits)

Summary of Distribution of Credits under CBCS Scheme for M.Sc. BOTANY

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV
01	Core	**16**	**20**	**16**	**12**
02	Skill based	**04**	**--**	**-**	**-**
03	Elective	**-**	**-**	**04**	**04**
04	Project	**-**	**-**	**-**	**04**
05	Audit	**02**	**02**	**02**	**02**
06	Total Credits	**22**	**22**	**22**	**22**

Subject Type	Core	Skill based	School Elective	Project	Audit	Total
Credits	**64**	**04**	**08**	**04**	**08**	**88**
						Total Credits = 88

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

M. Sc. Botany

Choice Based Credit System (Outcome Based Curriculum) with effect from 2021 -2022

Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Practical)	Total Credits	
I	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
II	4	12 + 8	**20**	1	0 + 0	--	1	2	2	**22**
III	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
IV	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
Total Credits	**68**			**12**			**8**			**88**

(T, Theory; P, Practical)

Structure of Curriculum

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
	Prerequisite and Core Courses									
(A)	Theory	4	2	4	3	4	2	4	2	36
	Practical	4	2	4	2	4	2	4	2	28
(B)	**Skill Based / Subject Elective Courses**									
1	Theory /Practical	4	1	--	--	4	1	4	1	16
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course			2	1					2
3	Technology Related + Value Added Course					2	1			
4	Professional and Social + Value Added Course							2	1	2
	Total Credit Value	14	6	14	6	14	6	14	6	88

List of Audit Courses (Select any ONE course of Choice from Semester II; Semester III and Semester IV)							
Semester I (Compulsory)		**Semester II** (Choose One)		**Semester III** (Choose One)		**Semester IV** (Choose One)	
		Personality and Cultural Development		**Technology + Value Added Course**		**Professional and Social + Value Added Course**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Sport Activities	AC-301B	Cyber Security	AC-401B	Current Affairs
		AC-201C	Yoga	AC-301C	Seminar + Review Writing	AC-401C	Banana Fruit Processing
		AC-201D	Music	AC-301D	Biodiversity & Conservation	AC-401D	Intellectual Property Rights (IPR)

Semester-wise Course Structure of M.Sc. Botany

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BOT-101	Core	Plant Systematics-I (Algae, Fungi & Bryophytes)	4	--	4	40	--	60	--	4
BOT-102	Core	Taxonomy of Angiosperms	4	--	4	40	--	60	--	4
BOT-103	Core	Practical Based on Bot. 101	--	4+4	8	--	40	--	60	4
BOT-104	Core	Practical Based on Bot. 102	--	4+4	8	--	40	--	60	4
BOT-105	Skill Based	Applied Plant Biotechnology	4	--	4	40	--	60	--	4
AC-101	Audit Course	Practicing Cleanliness		2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BOT-201	Core	Plant Systematics-II (Pteridophytes, Gymnosperm & Palaeobotany)	4	--	4	40	--	60	--	4
BOT-202	Core	Plant Physiology and Biochemistry	4	--	4	40	--	60	--	4
BOT-203	Core	Cytogenetics and Molecular Biology	4	--	4	40	--	60	--	4
BOT-204	Core	Practical based on BOT 201 & BOT 202	--	4+4	8	--	40	--	60	4
BOT-205	Core	Practical based on BOT 203	--	4+4	8	--	40	--	60	4
AC-201 A/B/C/D	Audit Course **(Select any one)**	AC-201 A: Soft Skills AC-201 B: Sport Activities AC-201 C: Yoga AC-201 D: Music	--	2	2	--	100	--	--	2
Total Credit for Semester II: 22 (T = Theory: 12; P = Practical:8; Skill Based:00; Audit course:2)										

Semester III

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BOT-301	Core	Plant Development & Reproduction	4	--	4	40	--	60	--	4
BOT-302	Core: Special Paper	BOT-302 A: Phycology Special Paper-I BOT-302 B: Mycology Special Paper-I BOT-302 C: Angiosperm Special Paper-I	4	--	4	40	--	60	--	4
BOT-303	Core	Practical Based on BOT 301	4		4	40	--	60	--	4
BOT-304	Core	Practical Based on BOT 302 (Special Paper)	--	4+4	8	--	40	--	60	4
BOT-305	Elective **(Select any one)**	BOT 305 A: Biostatistics and Bioinformatics BOT 305 B: Techniques in plant Sciences	4	--	4	40	--	60	--	4
AC-301 A/B/C/D	Audit Course **(Select any one)**	AC-301 A: Computer Skills AC-301 B: Cyber Security AC-301 C: Seminar and Review Writing AC-301 D: Biodiversity and Conservation		2	2		100	--	--	2
Total Credit for Semester III: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Semester IV

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BOT-401	Core: Special Paper	BOT-401 A: Phycology Special Paper-II BOT-401 B: Mycology Special Paper-II BOT-401 C: Angiosperm Special Paper-II	4	--	4	40	--	60	--	4
BOT-402	Core: Special Paper	BOT-402 A: Phycology Special Paper-III BOT-402 B: Mycology Special Paper-III BOT-402 C: Angiosperm Special Paper-III	4	--	4	40	--	60	--	4
BOT-403	Core	Practical based on BOT 401 & BOT 402		4+4	8	--	40	--	60	4
BOT-404	Core	Practical: Project Dissertation	--	4+4	8	--	40	--	60	4
BOT-405	Elective **(Select any one)**	BOT-405 A: Plant Ecology & Phytogeography BOT-405 B: Industrial Botany	4	--	4	40	--	60	--	4
AC-401 A/B/C/D	Audit Course **(Select any one)**	AC-401 A: Human Right AC-401 B: Currant Affairs AC-401 C: Banana Fruit Processing AC-401 D: Intellectual Property right (IPR)		2	2		100	--	--	2
Total Credit for Semester IV: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Distribution of Course papers for M. Sc. Part I (Botany)

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part I					
Semester I : Theory Courses					
BOT-101	Plant Systematics-I (Algae, Fungi & Bryophytes)	Core course	04	100	03
BOT -102	Taxonomy of Angiosperms	Core course	04	100	03
BOT-105	Applied Plant Biotechnology	Skill based	04	100	03
Semester I : Practical Courses					
BOT-103	Practical Based on Bot. 101	Core course	**04+04**	**100**	**06**
BOT-104	Practical Based on Bot. 102	Core course	**04+04**	**100**	**06**
AC-101	Practicing Cleanliness	Audit Course	**02**	**100**	
Semester II : Theory Courses					
BOT-201	Plant Systematics-II (Pteridophytes, Gymnosperm & Palaeobotany)	Core course	**04**	**100**	**03**
BOT-202	Plant Physiology and Biochemistry	Core course	**04**	**100**	**03**
BOT-203	Cytogenetics and Molecular Biology	Core course	**04**	**100**	**03**
Semester II : Practical Courses					
BOT-204	Practical based on BOT 201 & BOT 202	Core course	**04+04**	**100**	**06**
BOT-205	Practical based on BOT 203	Core course	**04+04**	**100**	**06**
AC- 201 A/B/C/D (Select any one)	AC- 201 A: Soft Skills AC- 201 B: Sport Activities AC- 201 C: Yoga AC- 201 D: Music	Audit Course	**02**	**100**	

M. Sc. I (Botany) Equivalence of Papers			
Semester-I			
Code	**Tittle (Old)**	**Code**	**Tittle (New)**
BOT 101	Angiosperm Taxonomy	BOT 102	Taxonomy of Angiosperms
BOT 102	Environmental Botany and Biostatistics	BOT-101	Plant Systematics-I
BOT 103	Cytogenetics, and Molecular Biology	BOT-105	Applied Plant Biotechnology
BOT 104	Practical –I (Based on BOT.101)	BOT-103	Practical Based on Bot. 101
BOT 105	Practical –II (Based on BOT.102 and BOT.103)	BOT-104	Practical Based on Bot. 102
Semester-I			
Code	**Tittle (Old)**	**Code**	**Tittle (New)**
BOT 201	Diversity of Lower Cryptogams	BOT-203	Cytogenetics and Molecular Biology
BOT 202	Diversity of Higher Cryptogams	BOT-201	Plant Systematics-II
BOT 203	Plant Physiology and Biochemistry	BOT-202	Plant Physiology and Biochemistry
BOT 204	Practical –I (Based on BOT.201)	BOT-205	Practical based on BOT 203
BOT 205	Practical –II (Based on BOT.202 and BOT.203)	BOT-204	Practical based on BOT 201 & BOT 202

<table>
<tr><th>Core Course</th><th>BOT - 101:
Plant Systematics-I
(Algae, Fungi and Bryophytes)</th><th>Lecture 60</th></tr>
<tr><td colspan="3">Course Objectives:
1. To study salient features of Algae, Fungi and Bryophytes
2. To know the diversity of Cryptogamic plants in nature.
3. To study the life cycle patterns in cryptogams.
Course Outcomes:
1. Able to differentiate cryptogamic plants
2. Able to describe life cycle patterns in cryptogams
3. Higher cognitive skills will develop</td></tr>
<tr><td>Unit 1</td><td>Introduction to Algae
1. Introduction: Definition, Occurrence and Habitat General characters, and similarities and differences with Fungi and Bryophyte
2. Reproduction; Life cycle and Alternation of generation
3. Algae in human welfare</td><td>03 L</td></tr>
<tr><td>Unit 2</td><td>Classification of algae
1. Basis of algal classification and nomenclature; Classification of algae According to F. E. Fritsch (1945) and Parker (1982) up to class and subclass:
2. Comparative account of the algal classes, with respect to pigments, reserve food, cell wall, chloroplast and eyespot, flagella</td><td>03 L</td></tr>
<tr><td>Unit 3</td><td>Study of importance classes of algae
A. Cyanophyceae
i) Introduction, Ecology of Blue Green Alga,
ii) Thallus organization, Ultra cell structure & Heterocyst, Heterocyst function
iii) Reproduction and Economic role
B. Chlorophyceae
i) General characters, Range of thallus structure, Structure of Cell
ii) Method of reproduction.
C. Phaeophyceae
i) General characters, Range of thallus structure
ii) Method of reproduction
D. Rhodophyceae
i) General characters, Range of thallus structure
ii) Method of reproduction
E. Introduction and General Characters of following Class
i. Bacillariophyceae
ii. Euglenophyceae</td><td>14L</td></tr>
</table>

	iii. Xanthophyceae	
Unit 4	**Fungi – Introduction:** 1. Distinguishing characters, Thallus structure, Hyphal modifications 2. Nutrition 3. Classification of fungi up to classes as per- Ainsworth et al., system (1973). 4. Economic importance- Fungi in biotechnology, fungi as food	**03 L**
Unit 5	**A) Myxomycota:** i) Distinguishing characters ii) Structure of thallus and reproductive bodies iii) Life cycle pattern with reference to Pysarum. **B) Mastigomycotina:** i) Distinguishing characters ii) Thallus structure and reproduction (Asexual and sexual) iii) Life cycle pattern with reference to Plasmopara. **C) Zygomycotina:** i) Distinguishing characters ii) Thallus structure, Heterothallism and reproduction iii) Life cycle pattern with reference to Mucor	**09 L**
Unit 6	**A) Ascomycotina:** i) Distinguishing characters ii) Thallus structure, structure of asci, Types of ascocarps iii) Life cycle pattern with reference to Eurotium **B) Basidiomycotina:** i) Distinguishing characters ii) Thallus structure, Types and Structure of basidia and basidiocarps iii) Life cycle pattern with reference to Teliomycetes **D) Deuteromycotina:** i) Distinguishing characters ii) Thallus structure, fructifications, Types of conidia	**08 L**
Unit 7	**Introduction to Bryophytes** **A) Introduction: -** General characteristics, habitat, reproduction, structure of gametophyte & sporophyte **B) Classification: -** Classification of Bryophytes up to orders by G.M. Smith 1955) **C) Economic importance of Bryophytes** **D) Evolution of gametophytes & sporophytes in Bryophytes**	**05 L**
Unit 8	Distinguishing features, phylogeny & evolutionary tendencies of the following orders with their affinities	**15 L**

	Hepaticae :(Marchantiales, Jungermannias, Metzeriales and Calobryales **Anthocerotae: Anthocerotales** **Musci:** Polytrichales	

Suggested readings:

1. Bold, H and Wynne M.J. (1978) Algal structure and reproduction. Prentice Hall of India Pri.Ltd.New Delhi, India.
2. Bony, A.D. (1978) Phytoplankton.Edward Arnold Pub.Ltd. London, U.K.
3. Chapman, V.J. and Chapman D.J. (1979) The Algae. English Language Book Society and Mc.millan,Co, London, U.K.
4. C.van den Hoek; D.G.Mann; H.M.Jahns (1988) Algae An introduction to Phycology. Cambridge University Press, UK.
5. Daws, C. J. (1981) Marine Botany. Wiley Publication Com. New York, USA.
6. F.E.Fritsh (1965) The Structure and reproduction of Algae Vol. I and II. The syndics of the Cambridge University press,London.
7. Gupta J.S (1981) A Text Book of Algae, Oxford & IBH Publishing Co. Mumbai, India.
8. Khan M. (1970) Fundamentals of Phycology Bishan Singh Mahendra Pal Singh, Dehra Dun, India.
9. Lee, R.E. (1989) Phycology. Cambridge University Press, Cambridge, U.K
10. Mahendra Perumal G and N. Anand(2009) Mannual of Freshwater Algae of Tamil Nadu, Bishen Singh Mahendr Pal Singh, Dehra Dun, India
11. Morris, I (1967) An Introduction To The Algae, Hutchinson University Press, U.K.
12. Prescot, G.W. (1969). The Algae.Thomas Nelson and Sons Ltd, Nashville, USA
13. Robin G.South and Alan Whittick (1996).Phycology .Blackwell science. Oxford London Edinburg, U.K.
14. Round, F.E. (1973)The Biology of the Algae. Edward Arnold, London, U.K.
15. Sharma, O.P.(1950)A text book of Algae.TataMcGraw Hill, New Delhi, India.
16. Smith, G.M. (1950). Fresh water Algae of United States.McGrawHill Book Company, New York, USA.
17. Sambamurty A.V.S.S. (2005) A Text Book of Algae. I.K.International Mumbai, India.
18. Vashishta B.R. (2010) Botany Part- I Algae S.Chand& Company Ltd.New Delhi, India.
19. Vijayaraghavan M.R. and Sunita kumara (1995) Chlorophyta Structure Ultrastructure & Reproduction, Bishen Singh Mahendr Pal Singh, Dehra Dun, India
20. O. P.Sharma (2011) Algae. Tata Mc Graw Hill Education Private Limited, New Delhi.
21. Vashishta B.R. (2010) Botany Pa rt- I Algae S.Chand& Company Ltd.New Delhi, India.
22. Ainsworth, Sussman and Sparrow (1973) The fungi. Vol IV A & IV B. Academic Press. London, U.K. 21.
23. Alexopolous C.J., Minms C.W. and Blackwell M. (1999) (4th edn) Introductory Mycology. Willey, New York, USA.
24. Deacon J.W. (2006) Fungal Biology (4th Ed.) Blackwell Publishing, Oxford, U.K.

25. Dube H.C. (2004) An Introduction To Fungi. Vikas Publishers.New Delhi, India.
26. Kendrick B. (1994) The Fifth Kingdom (paperback), North America, New York Publisher:
27. Kirk et al. (2001) Dictionary of fungi, 9th edn, Wallingford: CABI.
28. Mehrotra R.S. and Aneja K.R. (1990) An Introduction To Mycology. New Age Publishers, New Delhi, India
29. Miguel U., Richard H., and Samuel A. (2000) Illustrated Dictionary of the Mycology. Elvira Aguirre Acosta, Publisher: St. Paul, Minn: APS press.
30. Sharma O.P. (2010) A Text Book of Fungi. S.Chand's Publication,New Delhi, India
31. Sharma, P.D. (1998) The Fungi. Rastogi Publications, Merrut, India.
32. Vashista, B.R. and Sinha A.K. (2008) Botany for Degree Students –Fungi. S.Chand and company Ltd., New Delhi, India.
33. Webster J. and Rpland W. (2007) Introduction To Fungi (3rd Edn) Cambridge University, Press, U.K.
34. Cavers F. (1976) Interrelationships of Bryophytes S.R. Technic, Ashok Rajpath, Patana.
35. Chopra R.N. & Kumar P.K. (1988) Biology of Bryophytes John Wiley & Sons, New York
36. Kashyap S.R. (1929) Liverworts of the Western Himalayas and the Punjab Plains Part 1, Chronica Botanica, New Delhi.
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39. Parihar N.S. (1980).Bryophytes : An Introduction to Embryophyta Vol-I, Central Book Depot, Allahabad.
40. Prem Puri (1981) Bryophytes: Morphology, Growth and Differentiation. Atma Ram and Sons , New Delhi
41. Rashid A. (1996) An Introduction to Bryophytes Vikas Publication House Pvt. Ltd. New Delhi
42. Sambamurty A.V.S.S. (2020) A textbook of Bryophytes, pteridophyes gymnosperms & paleobotany, Dreamtech Press.
43. Smith G.M. (2019) Cryptogamic Botany, Bryphytes & Pteridophytes Vol-II 2nd Edition, Surjeet Publications
44. Udar R. (1975) Bryology in India. Chronica Botanica, New Delhi
45. Udar R. (1970) Introduction to Bryophytes, Shashidhar Malaviya Prakashan, Lucknow
46. Watson E.V. (1971) Structure and life of Bryophytes 3rd Edn. Hutchinson University Library London.
47. Vashishta B.R., Sinha A.K., Kumar A. (2008) Botany for degree students Bryophyta, S.Chands Publication

Core Course	BOT-102 Taxonomy of Angiosperms	Lecture 60

Course Objectives:

1. To study aims, principles and methods in taxonomy.
2. To study taxonomic structure of Angiosperms.
3. To study Cronquist system of classification.
4. To study recent APG system of classification and evolutionary trends.
5. To study morphological peculiarities and biological importance of plants

Course outcomes:

1. Student provide with importance of classification in Angiosperms.
2. They will get the knowledge of recent system of classification in Angiosperms.
3. This course helps to make them aware of wild plants their habit and habitat from field tour.
4. Student will know biological adaption and evolutionary trends of angiosperm.

Unit 1	**Taxonomy.** 1. Aim, principles and methods in taxonomy. 2. Basic Concepts of Biosystematics and Taxonomy, Trends in biosystematics- Chemotaxonomy, Cytotaxonomy. 3. Taxonomic Tools – Floras, monographs, Herbaria, Botanical survey of India (Regional & zonal centre, activity)	**12**
Unit 2	**System of classification.** 1. Review of Pre- Darwinian and Post Darwinian classification 2. Cronquist system of classification: Introduction, principles, Outline, Merits and demerits.	**12**
Unit 3	**Angiosperm phylogeny group.** 1. Principles of APG – I (1998), APG- II (2003), APG- III (2009) and APG- IV (2016) system of classification. 2. APG-III (2003) system of classification: Introduction, APG III vs Bentham and Hookers classification, Outline classification.	**12**
Unit 4	**Families of Angiosperm.** With respect to characteristic features, interrelationships, classification (APG) and economic importance of families: **ANITA grade**: Nymphaeaceae, **MAGNOLIIDS**: Magnoliaceae, **MONOCOTS:** Araceae, **COMMELINOIDS**: Arecaceae, **EUDICOTS**: Papaveraceae, **CORE EUDICOTS**: Amaranthaceae, **EUROSIDS-I:**Malpighiaceae, **EUROSID- II**: Malvaceae, **ASTERIDS:**Sapotaceae, **EUASTERIDS-I**:Gentianaceae **EUASTERID-II**: Apiaceae, Asteraceae.	**12**
Unit 5	**a) Biological importance and morphological peculiarities of the families**. Nepenthaceae, Orobanchaceae, Balanophoraceae, Refflesiaceae, Podostemnaceae, Orchidaceae **b) Study of evolutionary trends in taxonomy** i) Evolution of Inflorescence ii) Evolution of floral nectaries iii) Evolution of Androecium iv) Evolution of Gynoecium	**12**

Suggested readings:

1. Agashe SN (1995) Paleobotany, Oxford and IBH Publ. Co. Pvt. Ltd, New Delhi.
2. **Briggs David 2009.** *Plant microevolution and Conservation in Human-influenced Ecosystems*.Cambridge University Press.
3. **Cook T (1903).** The Flora of Presidency of Bombay, Vol. I (Indian Reprint) Bishen Singh, Mahendra Pal Singh, Dehradun
4. **Cronquist, A. 1981.***An Integrated System of Classification of Flowering Plants* Columbia University Press, New York.

5. **Cronquist, A. 1988.***The Evolution and Classification of Flowering Plants* (2nd ed.) Allen Press, U.S.A.
6. **Davis, P. H. and V. H. Heywood 1991**.*Principles of Angiosperm Taxonomy***.**Today and Tomorrow Publications, New Delhi.
7. **Eames A J (1961).** Morphology of Angiosperms, McGraw Hill Book Co.
8. **Erdtman G (1966).** Pollen Morphology and Plant Taxonomy of Angiosperms (An introduction to Palynology I), Hafner Pub. Co. London.
9. **Hickey M and King C (2000).** The Cambridge Illustrated Glossary of Botanical Terms. Cambridge University Press, UK.
10. **Jain S. K. and Rao R. R.** Handbook of Field and Herbarium Methods, Today and Tomorrow Publishers, New Delhi.
11. **Jones S B and Luchinger A E (1986).** Plant Systematics 2nd edn, McGraw Hill Book Co.
12. **Judd et al. (2007)** Plant Systematics – A phylogenetic approach. Sinauer Pub. 3rd edition
13. **Judd W. S., Campbell, C. S., Kellogg, E. A., Stevens P. F. and M. J. Donoghue 2008.***Plant Systematics: A phylogenetic Approach.*Sunderland, Massachusetts, USA.
14. **Kubitzki K (1977).** Flowering Plants Evolution and Classification of Higher Categories. Plant Systematics – Evolution Supplement I.
15. **Kuijt J. (1969).** The biology of parasitic flowering plants. California University Press.
16. **Lawrence George H. M. 195.1** *Taxonomy of Vascular Plants.*Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi.
17. **Leadlay E. and S. Jury (ed.) 2006.***Taxonomy and Plant conservation.*Cambridge University Press.
18. **Manilal, K. S. and M. S. Muktesh Kumar [ed.] 1998.***A Handbook of Taxonomic Training.* DST, New Delhi.
19. **Naik, V. N. 1984.***Taxonomy of Angiosperms*. Tata McGraw-Hill Publication Com. Ltd. New Delhi
20. **Quicke, Donald, L. J. 1993.***Principles and Techniques of Contemporary Taxonomy.* Blakie Academic & Professional, London
21. **Radford A E (1986).** Fundamentals of Plant Systematics, Harper and Row N Y.
22. **Simpson M.** Plant Systematics, Academic Press, 2nd edition.
23. **Singh G (2004).** Plant Systematics, 2nd edn, Oxford and IBH, New Delhi.
24. **Sivrajan V V (1984).** Introduction to Principles of Plant Taxonomy, Oxford and IBH, New Delhi.
25. **Smith P M (1976).** The Chemotaxonomy of Plants, Edward Arnold Pub. Ltd.
26. **Sporne K R (1974).** Morphology of Angiosperms, Hutchinson University Library, London.
27. **Stace C A (1989).** Plant Taxonomy and Biosystematics.
28. **Stewart W N and Rothwell G W (2005).** Paleobotany and the Evolution of Plants, 2nd edn, Cambridge University Press.
29. **Subrahmanyam K.** Aquatic angiosperms. BSI. India
30. **Takhtajan, A. 1962.***Flowering plants- Origin and Dispersal.*
31. **Taylor, D. V. and L. J. Hickey 1997.** *Flowering Plants: Origin, Evolution and Phylogeny***.**CBS Publishers & Distributers, New Delhi.

BOT 103
Practical-I (Core Course)
(Based on BOT 101)

Algae: (08 Practicals)

Practical -1 Cyanophyta: Any two members from Each Order

Practical- 2-4 Chlorophyta: Any two members from Each Order

Practical -5 Charophyceae: *Chara, Nitella*

Practical – 6 Phaeophyta: Any five members from All Orders

Practical – 7 Rhodophyta: Any five members from All Orders

Practical – 8 Class: i. Xanthophyceae – *Vaucheria, Botrydium*

ii. Bacillariophycece- Any Five members

iii. Euglenophyceae- Any two members

Fungi: (08 Practicals)

Representative genera belonging to following divisions and subdivisions of fungi with respect to vegetative, reproductive structures and classification with reasons according to Ainsworth et al. (1973).

Practical – 9 Myxomycota -Any four forms

Practical – 10 Mastigomycotina - Any four forms

Practical – 11 Zygomycotina - Any three forms

Practical – 12-13 Ascomycotina - Any eight forms

Practical – 14-15 Basidiomycotina- Any eight forms

Practical – 16 Deuteromycotina - Any four form

Bryophytes: (08 Practicals)

Morphological, Anatomical and Reproductive studies of the following:

Practical – 17-18 Marchantiales: *Plagiochasma, Targionia, Asterella, Dumortiera*

Practical – 19-21 Jungermanniales: *Pellia, Fossombronia, Pallavicinia, Porella, Frullania*

Practical – 22 Anthocerotales : *Anthoceros, Notothylus*

Practical – 23-24 Musci : *Polytrichum, Pogonatum*

Note:

1. Excursion tour is compulsory to observe algae, fungi and bryophytes in nature.
2. Tour report along with photographs must be submitted at the time of practical examination.
3. Duly certified journals are compulsory at the time of practical examination.

BOT 104. Practical II (Core Course) (Based on BOT.102 Taxonomy of Angiosperms)	
Practical. 1-14.	**Study of families (Sensu: Bentham & Hooker System) w.r.t. morphological characters, floral formula, floral diagram and classification with reasons-** Ranunculaceae, Menispermaceae, Papaveraceae, Capparidaceae, Portulaceae, Sterculiaceae, Tiliaceae, Malpighiaceae, Zygophllaceae, Meliaceae, Rhamneae, Moringeae, Papilionaceae, Myrtaceae, Cucurbitaceae, Umbelliferae, Rubiaceae, Plumbagineae, Apocynaceae, Boraginaceae, Convulvulaceae, Scrophulariaceae, Bignoniaceae, Acanthaceae, Verbenaceae, Labiatae, Nyctagineae, Chenopodiaceae, Polygonaceae, Scitaminae, Amaryllideae, Liliaceae, Commelinaceae, Typhaceae, Cyperaceae, Graminae (Any 20 families from different series)
Practical. 15-18.	Identification of genus and species from locally available wild plants using regional and state floras (At least 20 plant species from locally available families).
Practical. 19-20.	Preparation of artificial bracketed/indented dichotomous keys based on vegetative & reproductive characters from different families, genera and species. (Specimens from different family, same family, different genera of same family, Species from same genera.)
Practical. 21-23.	Study of morphological and biological peculiarities of the specimens from following families. Nepenthaceae, Balanophoraceae, Podostemnaceae, Orobanchaceae, Refflesiaceae, Orchidaceae.
Practical. 24.	Visit to campus & surrounding area, submission of excursion report and photographs (Any 20 wild plants)

Note:

i) Excursion tour compulsory (different locality & geographical area)

ii) Duly certified journals are compulsory at time of practical examination.

M.Sc. Part I Semester I Botany: Skill Based Course

Skill Based Course	BOT 105 Applied Plant Biotechnology	Lecture 60
Course Objectives: 1. To the fundamentals of totipotency, plant tissue culture techniques. 2. To study transgenic technology for the improvement of quality and quantity of Plant and there by product. 3. To understand the advantages of in vitro propagation in various areas. 4. To understand the application and importance of plant tissue culture and transgenic plant in the field of botany		
Unit 1	**BIOTECHNOLOGY**: Basic concept and brief introduction of biotechnology, History, Scope and Importance, Commercial application of biotechnology.	**04 L**
Unit 2	**INTRODUCTION TO TISSUE CULTURE:** Principle of plant tissue culture, Tissue culture laboratory, Equipment's in Tissue culture laboratory, Preparation of Media, Media composition, Cellular totipotency Plant Growth Regulators and their Role, Different type of media, Different types of explants of, Sterilization, Different methods of sterilization -Heat, Radiation and chemical	**06 L**
Unit 3	**CELL AND ORGAN CULTURE**: Plant organ culture; shoot tip, shoot apical meristem, root, leaf, embryo culture, factors influencing embryogenesis, suspension culture in stationary and stirred tank reactors, isolation of single cells and their culture, measurement of growth.	**10 L**
Unit 4	**PRACTICAL APPROACHES OF SINGLE CELL CULTURE:** Somatic embryogenesis, protoplast isolation, regeneration of protoplasts and protoplasts fusion, Synthetic seeds, generation of cybrid and hybrids, cryopreservation of plant cells.	**10 L**
Unit 5	**RECOMBINANT DNA TECHNOLOGY:** Gene cloning, Vectors, Role of Agrobacterium, Gene cloning techniques - Gene gun, Electroporation, Microinjection, Liposome mediated gene transfer, Ultra sonication and Pollen Mediated gene transfer	**08 L**
Unit 6	**TRANSGENIC PLANTS:** Transgenic crops in India, Resistance against Abiotic and biotic stress, Improved crops productivity, Nutraceutical improved crops, transgenic plants for edible vaccine and antibodies.	**08 L**
Unit 7	**APPLICATIONS OF PLANT TISSUE CULTURE:** Applications in agriculture and Horticulture, Application in Forestry, Application of Tissue culture in pharmaceutical industry. In situ and ex-situ conservation. In vitro	**12 L**

	mutagenesis and its application. Production of transgenic plants	

Suggested readings:

1. Henry, R.J. Practical application of plant molecular Biology, Champman and Hall
2. Kalyan kumar De. Introduction to Plant Tissue culture,
3. Bhojwani, Plant Tissue Culture.
4. Montell S.H. Mathews, J.A., Meker, R.A. Principles of Plant Biotechnology.
5. Glover, D.M. and Hanes, B.D. (eds.) 1995. DNA cloning 1: A practical approach, core techniques, 2nd edition, PAS, IRL press at Oxford University Press.
6. Plant cell culture protocols. Humana Press, Inc. New Jersey, USA.
7. Shaw, C.H. (ed.) 1998, Plant Molecular Biology. A practical approach IRI Press, Oxford.
8. Smith, R.H. 2000. Plant Tissue culture: Techniques and Experiments. Academic Press, New York.
9. Susan R. Barnum (1998). Biotechnology: an introduction. Thomson Brooks/cole.
10. George Acquaah (2005). Understanding biotechnology. Pearson.
11. Biotechnology; P.K. Gupta
12. B. D. Singh (2006) Plant Biotechnology, Kalyani Publishers

AC-101: Practicing Cleanliness

(Compulsory; Campus-level Audit Course; Practical; 2 Credits)

Course Objectives (CObs):

- To make students aware of Clean India Mission and inculcate cleanliness practices among them.

- Awareness program on
    - Swachh Bharat Abhiyan (Clean India Mission)
    - Clean Campus Mission
    - Role of youth in Clean India Mission
- Cleaning activities inside and surroundings of Department buildings.
- Tree plantation and further care of planted trees
- Waste (Liquid/Solid/e-waste) Management, Japanese 5-S practices
- Planning and execution of collection of Garbage from different sections of University campus
- Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance.
- Cleanest School/Department and Cleanest Hostel contests
- Painting and Essay writing competitions

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC101.1	Identify need at of cleanliness at home/office and other public places.	**2**
AC101.2	Plan and observe cleanliness programs at home and other places.	**4**
AC101.3	Practice Japanese 5-S practices in regular life.	**3**

M.Sc. Part I Semester II (Botany): Core Courses

Core Course	Bot. 201 **Plant Systematics- II** **(Pteridophytes, Gymnosperms and Palaeobotany)**	**Lecture 60**
Course Objectives: 1. To know the Classification, economic importance of Pteridophytes & Gymnosperms. 2. To Know the distribution of Pteridophytes & Gymnosperms in India. 3. To understand the biodiversity of Pteridophytes and Gymnosperms. 4. Scope, importance, applied aspect of Palaeobotany & methods to study various fossils. 5. To study the important fossils in different group of plants and Indian fossil record. ***Course Learning Outcomes:*** 1. Examine the distribution, morphology, anatomy & reproduction mentioned in the syllabus 2. Students will know about economic importance of Pteridophytes & Gymnosperms 3. Understand the significance of Palaeobotany 4. Familiarize the basic skills to identify Cryptogams & Gymnosperms		
Unit 1	**A) Introduction of Pteridophytes** General characteristics, Habitat, Reproduction (Vegetative & Asexual), Sporophyte, Gametophyte (Sexual reproductive phase), Fertilization & Zygote formation, Embryo development, Life cycles (Homosporous & Heterosporous), Apogamy & Apospory **B) Classification of Pteridophytes** Classification of Pteridophytes up to orders proposed by Reimers (1954) **C) Economic Importance** **D) Soral Evolution**	**05 L**
Unit 2	Distinguishing features, morphology, anatomy, reproduction, phylogeny, evolutionary tendencies and affinities of following orders: **i)** Lycopodiales **ii)** Isoeatales **iii)** Ophioglossales **iv)** Osmundales **v)** Filicales (at least 2 families)	**15 L**
Unit 3	**Gymnosperms** A) Introduction, General Characters, Distinguishing features of Gymnosperms. B) Outline system of classification of Gymnosperms by Sporne (1965) C) Economic importance	**05 L**
Unit 4	General characters, morphology, anatomy, sporogenesis, gametogenesis, embryology, affinities, evolutionary trends and phylogeny of following orders i) Ginkgoles ii) Coniferales iii) Gnetales (Except *Gnetum*)	**15 L**

Unit 5	**Palaeobotany** A) Introduction, Scope and importance B) Applied aspect of Paleobotany C) Techniques for fossil study, Ground thin section, Peel method, Maceration, Indian fossil flora from Upper and Lower Gondwana	**05 L**
Unit 6	Study of distinctive fossil genera along with their external, internal features of following orders i) Psilophytales: *Rhynia,* ii) Lepidodendrales: *Lepidodendron*(complete reconstruction), iii) Calamitales : *Calamites,Annularia,Calamostachys,Paleostachya* iv) Sphenophyllales: *Sphenophyllum,* v) Hydropteridineae: *Rodeites dakshinii* vi) Pteridospermales: *Lyginopteris oldhamia* (Stem) ,*Neuropteris,* vii) *Glossopteris,Vertebraria,Scutum* viii) Bennettitales: *Williamsonia sewardiana,W.spectabilis* ix) Pentoxylales: *Pentoxylon sahnii*(reconstruction) x) Cordaitales: *Cordaites* (Stem) xi) Fossil Angiosperms: Monocot:*Palmoxylon, Cyclanthodendron, Tricoccites* Dicot: *Sahnipushpam, Sahnianthus, Enigmocarpon*	**15 L**

Suggested Readings:

1. Andrews, H.N. (1961) Studies in Palaeobotany, New York,London
2. Arnold, C.A. (1947) An Introduction to Palaeobotany McGraw Hill Co., New York, USA.
3. Banks, H.P. (1970) Evolution and plants of the PasT. McMillan Press Ltd. London,U.K.
4. Bierhorst, D.W. (1971) Morphology of vascular plants Mcmillan Co. New York
5. Bhatnagar, S. P. and Alok Moitra (1996) Gymnosperms, New Age International (P) Limited, Publishers, New Delhi.
6. Chamberlain, C.J. (1935) Gymnosperms: Structure AndEvolution. Dover publ. INC.,New York, USA.
7. Eames, A.J. (1974) Morphology of vascular plants Mc. Grow Hill Publication Co. New Delhi
8. Foster, A.S. & Gifford E.M. (1959) Comparative morphology of vascular plants San Francisco
9. Ganguli, H.C. and Kar A. K. (2001) College Botany Vol. II Book and allied Press. Ltd.

Calcutta, India.

10. Ganguly & Kar (2011) College Botany Vol-II New Central Book Agency Pvt. Ltd. 4th edition

11. John Waltan (1953) Introduction to Study of fossil Plants. Adam and Charles Block, London, UK.

12. Maheshwari, P and R.R. Konar (1971) Pinus CSIR New Delhi, India.

13. Pande B. P. (1994) GymnospermsS. Hand and Co. New Delhi, India.

14. Pandey B.P. (2010) College Botany Vol-2: v.II S.Chand & company, 2nd edition

15. Parihar N.S. (1977) Biology & Morphology of Pteridophytes Central book Depot. Allahabad

16. Parihar N.S. (2019) An Introduction to Embryophyta, Pteridophytes, Surjeet publication 5th edition

17. Pant D. D. (1973) Cycas and the Cycadales Central Book Depot, Allahabad, India.

18. Rashid A. (1999) An Introduction to Pteridophyta, South Asia Books, II edition

19. Saxena and Sarabhai, R. M. (1972) Text Book of Botany, Vol. II,

20. Sharma O.P. (2017) Pteridophyta Mc. Grow Hill Education

21. Seward,A.C.(1969) Fossil Plants Vol.I to IV, Hafner Publ. Co. New York, USA.

22. Shukla, A. C. and S.P. Misra (1982) Essentials of PalaeobotanyVikas Publishing House Pvt. Ltd. Delhi, India.

23. Siddiqui, K.A.(2002) Elements of Paleobotany Kitab Mahal,Allahabad

24. Sporne K.R. (1966) Morphology of Pteridophyta Hutchinson Univ. Library London

25. Sporne K.R. (1967) Morphology of Gymnosperms Hutchinson Univ. Library, London, UK.

26. Surange K.R. (1966) Indian FossilPteridophytes CSIR, New Delhi, India.

27. Vasishtha, P. C. (1983) Botany for Degree Students Vol V Gymnosperms S.Chand & Co. New Delhi, India.

28. Vashishta P.C., Sinha A.K., Anil Kumar (2010) Pteridophyta, S Chand and Company

29. Wilson N. Stewart and Gar W. Rothwell (1993) Palaeobotany and Evolution of Plants- II. Cambridge Univ. Press. Cambridge.

Core course	BOT 202 Plant Physiology and Biochemistry	Lecture 60

Course Objectives:

1. To understand plant-water relationships
2. To understand the plant structures with respect to physiological functions of plants
3. To understand physiology of photosynthesis and respiration in plants
4. To understand lipid metabolism in plants
5. To understand basic concepts in Biochemistry
6. To understand the primary and secondary metabolites and their importance in the plants

Outcome of the course-

1. The students are aware about the knowledge of the process such as diffusion, osmosis and Imbibition that occurs in the plant cells
2. Students will get the knowledge of the important process like Photosynthesis and respiration in plants.
3. The students will able to know the stepwise reactions occur in plant process like photosynthesis, respiration and fatty acid synthesis as well as catabolic activities.
4. Students will aware about the basic concepts of biochemistry.
5. Students will get the structure, composition of primary and secondary metabolites

Unit 1	**Plant-Water relationships** 1.1: Properties of water. 1.2. Permeability, water potential, 1.3. Concept of apoplastic and symplastic movement 1.4. Brief account of different types of physical and physiological processes: Diffusion, Osmosis and Imbibition in plant cells. 1.5: OP, TP and WP, Types of Solutions	**15 L**
Unit 2	**Photosynthesis and Respiration** **A) Photosynthesis-** 2.1 A brief outline of Photosynthetic pigments and the pigment organization in thylakoid membrane 2.2 Light and Dark Reaction 2.3 Regulation of PCR Cycle and C4 Pathway, RUBISCO and PEP Case, C3 – C4 intermediates. **B) Respiration-** 2.4 Brief account of Respiration in plants 2.5 Glycolysis and its regulation in plants 2.6 Regulation of Pentose Phosphate Pathway and TCA Cycle 2.7 Regulation of electron transport chain and role of alternate oxidase.	**20 L**
Unit 3	**Fat Metabolism** 3.1 Introduction, Synthesis of fatty acids and glycerol, Condensation of fatty acids and glycerol 3.2 Glyoxylate cycle (C2 cycle)	**10 L**

Unit 4	**pH and Buffer** 4.1. Hydrogen ion concentration 4.2. Buffer and its types. Importance of buffers 4.3 Brief account of Primary metabolites.	**08 L**
Unit 5	**Secondary metabolites** 5.1. Secondary metabolites –Shikimate Pathway and its role in biosynthesis of Secondary Metabolites. 5.2 Phosphorus Nutrition – Forms of phosphorus in soil. Phosphorus uptake, factors controlling 'P' uptake, 'P' fractions in plants. Role of Pyrophosphate in plant metabolism.	**12 L**

Suggested readings

1. Amarsingh (1977) Practical Plant Physiology. Kalyani Publishers, New Dehli, India.
2. Anand, B. K. & S. K. Manchanda (1976) Text Book of Physiology. Tata McGraw Hill Publications Co. Ltd, Dehli, India.
3. Arditt, J. (1969) Experimentl Plant Physiology, Holt Rinehrt & Winst on Inc, NewYork.
4. Bidwell, R. G. (1979) Plant Physiology. McMillan Publishing Co. Inc. NewYork 26
5. Bonner, J. and J. E. Varner (Eds.) (1976) Plant Biochemistry 3 rd Eds. Academic PressLondon, UK.
6. Buchanan B. B., Gruissem W. and Jones R. L. (2000), Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland, USA
7. Con, E. F. and P. F. Stumpf (1976) Outlines of Biochemistry Wiley Eastern Ltd., New Dehli, India.
8. De. Robertis, E. D. P. and De Robertis, E. M. T. (1987) Cell and Molecular Biology. VIII Eds. Lea & Febiger International Edition Info -Med. Hongkong.
9. Deb, A. C. (2004) Viva & Practical Biochemistry. New Central Book Agency, Kolkata, India.
10. Delvin, R. M. and F. H Whittam (1986) Plant Physiology IV eds. CBS Publishers & Distributors, New Delhi, India.
11. Grewal, R. C. (2000) Plant Physiology. Campus Books International, Darya Ganj, New Delhi, India.
12. Hess, D. (1975) Plant Physiology. Narosa Publishing House, New Delhi, India.
13. Hill, R. & C. P. Whittingham (1957) Photosynthesis. London, UK.
14. Hopkins, W. G. (1995) Introduction to Plant Physiology. John Wiley & Sons, New

Jersey, USA.

15. Jain J. L., Sunjay Jain and Nitin Jain (2008), Fundamentals of Biochemistry, S. Chand & Co Ltd.
16. Keith Wilson, John M Walker and Andreas Hofmann; Samuel Clokie (2018) Wilson and Walker's principles and techniques of biochemistry and molecular biology Cambridge, United Kingdom ; New York, NY : Cambridge University Press
17. Lehnniger, A. L (1984) Principles of Biochemistry CBS Publishing & Distributors, New Delhi, India.
18. Mehta, S. L. Lodha, M. L. and P.V. Sane (Eds.) (1989) Recent advances in PlantBiochemistry. Pub. ICAR, New Delhi, India.
19. Mukherji, S. and A. K. Ghosh (2005) Plant Physiology. New Central Book Agency Kolkata, India.
20. Nobel, P. S. (1999) Physio-chemical and Environmental Plant Physiology (II Eds.) Academic Press, Sandiago, USA.
21. Noggle, G. R. & G. J. Frtiz (1982) Introductory Plant Physiology. Prentice Hall of India New Delhi, India.
22. Taiz, L., Zeiger, P. E. E., Mller, P. E. I. M., & Murphy, P. A. C. A. (2018). Fundamentals of plant physiology. Sinauer Associates.

Core Course	BOT 203 Cytogenetics and Molecular Biology	Lecture 60

Course Objectives:

1. To study structural organization and variation in the chromosome as well as karyotype analysis.
2. To study extra-chromosomal inheritance in the plant system.
3. To study molecular biology about genetic material, its inheritance, modification, replication, and repair.
4. To study transcription, translation post-translation modification of a protein.
5. To study gene regulation in prokaryotes and eukaryotes

Unit 1	**Membrane Structure and Function** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes).	**03 L**
Unit 2	**Structural Organization and Function of Organelles** Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of the cytoskeleton and its role in motility.	**05 L**
Unit 3	**Chromosomes and its Aberration** Types of chromosomes based on centromere, Special types of chromosomes (Polytene Chromosome, Lampbrush chromosome, and B-chromosomes) Organization of chromatin and histones and nonhistone proteins, nucleosomal organization of chromatin, higher levels of chromatin organization in chromosomes. Heterochromatin and Euchromatin, Molecular structure of the Centromere and Telomere. Structure change in a chromosome - (Deletion, Duplication, Inversion, and Translocation), Numerical change in the chromosome (Euploidy, Aneuploidy and its types).	**11 L**
Unit 4	**Cell Cycle, Cell Signalling and Cytoplasmic Inheritance** **Cell cycle**, steps in cell cycle, regulation, and control of cell cycle. Cell division Mitosis and meiosis. Apoptosis – a process of programmed cell death, extrinsic and intrinsic pathways of apoptosis **Cell communication -** general principles. Signaling molecules and their receptors, external and internal signals that modify metabolism, growth, and development of plants. **Cytoplasmic inheritance: -** Cytoplasmic inheritance involving plastid inheritance and mitochondrial inheritance with suitable examples (Mirabilis jalapa, Zea mays).	**11 L**
Unit 5	**Introduction to Molecular biology** Definition, milestones of molecular biology, scope and importance molecular biology	**02 L**
Unit 6	**DNA and its Replication** Physical and chemical properties of nucleic acids, discovery, and types of nucleic	**07 L**

	acids, various types of DNA. DNA replication, repair, and recombination (Unit of replication, enzymes involved, replication origin and replication fork, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).	
Unit 7	**Transcription** RNA synthesis and processing(transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, RNA transport, and polyadenylation, structure, and function of different types of RNA).	**08 L**
Unit 8	**Translation** Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, aminoacylation of t-RNA, t-RNA-identity, aminoacyl t-RNA Synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins) Definition and Properties of Genetic Code	**08**
Unit 9	**Gene Regulation** Gene regulation in Prokaryotes (Operon concept, LAC Operon TRP Operon), Eukaryotic transcriptional regulation (promoter enhancer and silencer, Gene battery), and post-transcriptional regulation.	**05 L**

Suggested readings:

1. Benjamin Lewin (2009) Genes– VI, VII, VIII and IX; Oxford, Univ. Press, USA.
2. Chaudhari, B.D. (2000) Elementary Principles of plant Breeding (2nd Edt.) Oxford &IBH pub. New Delhi, India.
3. De Robertis and De Robertis (2005) Cell and Molecular Biology, 8thEd, LippincottWilliamandWilkins U.S.A.4. Eldon john Gardner,Michel J. Simmons and D. Peter Snustad(1991) Princiles ofgenetics 8thEd . Wiley India edition, New Delhi, India.
4. David E Sadava (2009). Cell biology: Organelle structure and function. CBS.
5. Gupta, P. K. (2007) Genetics: Classical to Modern. Rastogi Publications, Meerut,India.
6. 4 Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons
7. Hartl D L and Jones E W (1998) Genetics Principles and Analysis; (4thed.). Jonesand Barflett Publishers, USA.
8. Harvey Lodish, Arnold Berk, Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell (2000). *Molecular cell biology* (IV Edn). W H Freeman & Company.
9. HexterW and Yost Jr. H T., (1977) The Science of Genetics; Prentice Hall of IndiaPvt. Ltd., New Delhi, India.
10. Kar and Halder, (2009) Cell BiologyGeneticsMolecular Biology; New Central BookAgency (P) Ltd. Kolkata, India.
11. Karp, G. (1999) Cells and Molecular Biology concepts and Experiments; HohnWiley& Sons Inc. USA.
12. Phundan Singh, (1996) Essentials of Plant Breeding; Kalyani publication, NewDelhi,

India.
13. Powar, C. B. (1992) Cell Biology, Himalaya PublishingHouse Nagpur, India.
14. Powar, C. B (2003) Genetics I & II Himalaya Publishing House, Nagpur, India.
15. Swanson, C. P. T. Merz, andW.J. Young (1982) Cytogenetics; Prentice Hall ofIndia Pvt. Ltd., New Delhi, India.
16. Russel, P.J. (1998) Genetics (5th edition); The Benjamin/ Cummings PublishingCompany Inc., USA.
17. Verma, Agarwal, (2005) Cell Biology, Genetics, Molecular Biology, Evolution andEcology: S. Chand and Company, New Delhi, India.

Bot. 204
Practical-I (Core Course)
(Based on Bot. 201 and Bot. 202)

Pteridophytes: (04 Practicals)

Morphological, anatomical and reproductive studies of the following

Practical 1: Lycopodium, Isoetes

Practical 2: Ophioglassum, Osmunda

Practical 3: Gleichinia, Lygodium

Practical 4: Pteris, Adiantum, Asplenium

Gymnosperms: (04 Practicals)

Practical 5-6: Study of External morphology, wood anatomical features, by double stained preparation by taking T. S., T. L. S. and R. L. S. of any six of the following:Pinus, Thuja, Cedrus, Cupressus, Sequoia, Araucaria, Agathis, Podocarpus, Cryptomeria, Juniperus

Practical 7: Study of External morphology of male and female cones of any six of the following: Pinus, Thuja, Cedrus, Cupressus, Sequoia, Araucaria, Agathis, Podocarpus, Cryptomeria, Juniperus

Practical 8: Study of External morphology, anatomy (T. S.) and morphology of reproductive organ of Ephedra. Study of External morphology, anatomy and morphology of reproductive organs of Ginkgo (with P. S./ Specimen)

Paleobotany: (04 Practicals)

Practical 9: Study of following fossils with P.S. or Specimens *Rhynia, Lepidodendron* Stem, *Lepidocarpon Calamites* Stem, *Annularia, Sphenophyllum* Stem

Practical 10: Study of following fossils with P.S. or Specimens *Lyginopteris oldhamia* (Stem), *Neuropteris, Glossopteris Vertebraria,*

Practical 11: Study of following fossils with P.S. or Specimens *Rodeites, Pentoxylon, Cordaites*

Practical 12: Study of following fossils with P.S. or Specimens: *Palmoxylon, Cyclanthodendron, Tricoccites Sahnipushpam, Sahnianthus, Enigmocarpon*

Plant Physiology and Biochemistry (12 Practicals)

Practical 13: To Determine the DPD by suitable osmometer method.

Practical 14: To Determination of osmotic potential of plant cell any suitable method.

Practical 14-15: Demonstration Experiments:

a. Osmosis by Curling experiments
b. To demonstrate the presence of photosynthate in leaves
c. R.Q. (Respiratory Quotient)
d. Kuhne’s tube experiments

Practical 16-17: To study the effect of light intensity and bicarbonate concentration on rate of photosynthesis

Practical 18: To determine the rate of respiration by using Ganong's Potometer

Practical 19-20: Preparation of solutions and buffers

Practical 21-21: Biochemical test from suitable material for.

a. Tannins
b. Alkaloids
c. Phenols

Practical 23-24 Biochemical test from suitable material for.

a. Carbohydrates
b. Proteins
c. Lipids

Bot. 205
Practical-II (Core Course)
(Based on Bot. 203)

Practical 1 -2 To Study any four-cell organelles as per syllabus (SEM/TEM Photographs/Image.)

Practical 3: Demonstration- principle working and uses of following equipments.

1) Research microscope,
2) Camera lucida,
3) Digital camera,
4) Micrometry Ocular and stage micrometer or software measurement technique

Practical 4-5 Karyomorphological studies from slide/photograph.

Practical 6: Preparation of Cytological fixative (Carnoy's fluid I, II, Navashin' s fluid etc.)

Practical 7: Preparation of stains, Aceto-carmine, Haematoxylene, and Feulgen Stain.

Practical 8: Techniques of preparation of permanent and semi permanent slides.

Practical 9-10: Study of Mitosis in pretreated root tips of *Alium cepa, Alium sativum, Medicago falcate (Methi), Zea mays*

i)By Acetocarmine squash preparation
ii)By Haematoxyline squash technique
iii)By Feulgen squash technique

Practical 11-12: i) Study of Meiosis by anther squash and smear technique in *Aloe vera, Alium cepa, Tradescantia,* Zea mays , Rhoeo discolour flower buds

ii) Study of stages of Meiosis division by Permanent slides.

Practical 13: Determination of Mitotic index and Metaphase frequency in *Allium cepa* or other plant material.

Practical 14: Isolation and purification of nuclei and their staining with feulgen Stain.

Practical 15: Demonstration of salivary gland chromosome preparations (Chironomus larvae/Drosophila).

Practical 16-17: Isolation and estimation of DNA from suitable plant material.

Practical 18: Study of chromosomal aberrations with the help of permanent slides or in plant (*Rhoeo discolor*).

Practical 19: Isolation and Janus green staining of mitochondria.

Practical 20: Isolation of chloroplasts to study.

Practical 21: Demonstration of blotting techniques.

Practical 22: Study of polyploidy in onion root tips.

Practical 23: Restriction digestion of plant DNA, its separation by agarose gel electrophoresis, and visualization by ethidium bromide staining.

	AC-201(A): Soft Skills (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional)	
Unit 1	**Introduction to soft skills** Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal setting, life skills, Need for soft skills, Communication skills, Etiquettes& Mannerism.	**2 h**
Unit 2	**Self-Assessment** Goal setting, SWOT analysis, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements, positive attitude, positive thinking and self-esteem. Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.	**4 h**
Unit 3	**Communication Skills** Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait, dressing sense, facial expressions, peculiarity of speaker (habits). Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real-life story for 5 minutes each), Oral review (Each student orally presents a review on a story or a book read by them) Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.	**8 h**
Unit 4	**Formal Group Discussion, Personal Interview & Presentation skills** Topic comprehension, Content organization, Group speaking etiquettes, driving the discussion & skills. Preparation for personal interview: dress code, greeting the panel, crisp self-introduction, neatness, etiquettes, language tone, handling embarrassing & tricky questions, graceful closing. Activity: Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback. Mock interview are to be conducted.	**4 h**
Unit 5	**Aptitude and analytical skills** Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking. Analytical skills: Definition, Types, problem solving	**8 h**
Unit 6	**Life skills** Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.	**4 h**

Suggested readings:

1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd.
2. English for Business Communication: Simon Sweeney, Cambridge University Press
3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press
4. Quantitative Aptitude: R.S. Agrawal

AC-201(B): Practicing Sports Activities

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

SR NO.	NAME OF THE SPORT/GAME (Select ONE of the Following)	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMESTER
1	Volleyball	• General Fitness • Basic Fitness • Specific Fitness • History of the Game • Basic Skill of the Game • Major Skill of the Game • Technique & Tactics of the Game • Game Practice	Morning: 07 to 09 AM OR Evening: 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

AC-201(C): Practicing Yoga **(Personality and Cultural Development Related Audit course; Practical; 2 Credits)** **(Optional)**	
	Course Objectives: • To motivate students towards yoga and provide them required training.
	• Yog: Meaning, Definition & Introduction, Objectives • Primary Introduction of Ashtanga Yoga • Preparation of Yogabhyas • Omkar Sadhana, Prayer, Guru Vandana • Sukshma Vyayamas • Suryanamaskar (12 Postures) • Asanas : ▪ Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan ▪ Supine (Shayansthiti) - Uttan Padaasan(Ekpad/Dwipad), Pavanmuktasana, Viparitakarani Aasan, Khandarasan, Shavasana ▪ Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, Saralhasta Bhujangasana, Shalabhasana(Ekpad/Dwipad), Makarasana ▪ Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana, Ardh Chakrasana • Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana - 6 Types • Pranayama : Anuloma-viloma, Bhramari

AC-201(D): Introduction to Indian Music (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional: Campus-level)	
	Course Objectives: • To motivate students towards Indian music and provide them minimum required training. .
	• Definition and brief about generation of Swar, Saptak, Thaat, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc. • Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa. • Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information) • Detailed information of Tambora • Detailed information of Harmonium and Tablaa. • Five filmy songs based on Indian Classical Music (Theory and Presentation) • Sound Management - Basic information of Sound Recording (including Practicals) • Composition of Music as per the Story • Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

||अंतरी पेटवू ज्ञानज्योत||

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS

for

Master of Science (M. Sc.)

<u>Zoology</u>

Choice Based Credit System

(Proposed Structure)
(Outcome Based Curriculum)

2021 - 2022

Program at a Glance

Name of the program (Degree) :	M. Sc. (Zoology)
Faculty	Science and Technology
Duration of the Program	Two years (four semesters)
Medium of Instruction and Examination	English
Exam Pattern	60 : 40 (60 marks University exam and 40 marks continuous internal assessment)
Passing standards	40% in each exam separately \ (Separate head of passing)
Evaluation mode	CGPA
Total Credits of the program	88 (64 core credits including 4 credits of project/dissertation, 08 skill enhancement credits, 08 subject elective credits and 08 audit credits)

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Summary of Distribution of Credits under CBCS Scheme for M.Sc. Zoology

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV
01	Core	**16**	**16**	**16**	**12**
02	Skill based	**04**	**04**	**-**	**-**
03	Elective	**-**	**-**	**04**	**04**
04	Project	**-**	**-**	**-**	**04**
05	Audit	**02**	**02**	**02**	**02**
06	Total Credits	**22**	**22**	**22**	**22**

Subject Type	Core	Skill based	School Elective	Project	Audit	Total
Credits	**60**	**08**	**08**	**04**	**08**	**88**

Total Credits = 88

KBC North Maharashtra University Jalgaon
M. Sc. Zoology
Choice Based Credit System (Outcome Based Curriculum) with effect from 2021 -2022
Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Practical)	Total Credits	
I	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
II	4	12 + 4	**16**	1	4 + 0	4	1	2	2	**22**
III	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
IV	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
Total Credits	**64**			**16**			**8**			**88**

(T= Theory; P=Practical)

Structure of Curriculum

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
(A)	**Prerequisite and Core Courses**									
	Theory	4	2	4	3	4	2	4	2	36
	Practical	4	2	4	1	4	2	4	2	28
(B)	**Skill Based / Subject Elective Courses**									
1	Theory /Practical	4	1	4	1	4	1	4	1	16
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	2	1	--	--	--	--	--	--	2
2	Personality and Cultural Development Related Course	--	--	2	1	--	--	--	--	2
3	Technology Related + Value Added Course	--	--	--	--	2	1	--	--	--
4	Professional and Social + Value Added Course	--	--	--	--	--	--	2	1	2
	Total Credit Value	14	6	14	6	14	6	14	6	88

List of Audit Courses (Select any ONE course of Choice from Semester II; Semester III and Semester IV)

Semester I (Compulsory)		**Semester II** (Choose One)		**Semester III** (Choose One)		**Semester IV**(Choose One)	
		Personality and Cultural Development		**Technology + Value Added Course**		**Professional and Social + Value Added Course**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Sport Activities	AC-301B	Cyber Security	AC-401B	Current Affairs
		AC-201C	Yoga	AC-301C	Seminar + Review Writing	AC-401C	Seminar + Review Writing
		AC-201D	Music	AC-301D	Biostatistics	AC-401D	Intellectual Property Rights (IPR)

Semester-wise Course Structure of M.Sc. Zoology

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
Zoo-101	Core	Structure and Functional Anatomy of Invertebrates	4	--	4	40	--	60	--	4
Zoo-102	Core	Cellular organization and Developmental Biology	4	--	4	40	--	60	--	4
Zoo-103	Core	Practical I	--	4+4	8	--	40	--	60	4
Zoo-104	Core	Practical II	--	4+4	8	--	40	--	60	4
Zoo-105	Skill Based	Goatery	4	--	4	40	--	60	--	4
Zoo AC-101	Audit Course	Practicing Cleanliness	--	2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
Zoo-201	Core	Structure and Functional Anatomy of Vertebrates	4	--	4	40	--	60	--	4
Zoo-202	Core	Biochemistry	4	--	4	40	--	60	--	4
Zoo-203	Core	Tools and Techniques in Biology	4	--	4	40	--	60	--	4
Zoo-204	Core	Practical I	--	4+4	8	--	40	--	60	4
Zoo-205	Skill Based	Aquaculture & Ecology	4+4	--	8	40	--	60	--	4
Zoo AC-201 A/B/C/D	Audit Course	Choose one out of Four (AC-201A/ AC-201B/AC-201C/AC-201D) from Personality and Cultural Development	--	2	2	--	100	--	--	2
Total Credit for Semester II: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit course:2)										

Semester III (wef Academic year 2022-23)

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
Zoo-301	Core (Any one from A,B,C&D	A)Animal Physiology I B)Reproductive Physiology I C)Entomology I D)Helminthology I	4	--	4	40	--	60	--	4
Zoo-302	Core	Enzymology and Immunology	4	--	4	40	--	60	--	4
Zoo-303	Core	Practical I	--	4+4	8	--	40	--	60	4
Zoo-304	Core	Practical II	--	4+4	8	--	40	--	60	4
Zoo-305	Elective (Select any one)	(A)Animal behaviour (B) Forensic Zoology (C) Endocrinology	4	--	4	40	--	60	--	4
Zoo AC-301 A/B/C/D	Audit Course	Choose one out of Four (AC-301A/ AC-301B/AC-301C/AC-301D) from Technology + Value Added Courses	--	2	2		100	--	--	2
Total Credit for Semester III: 22 (T = Theory: 8; P = Practical: 8; Skill Based: 4; Audit Course: 2)										

Semester IV (wef Academic year 2022-23)

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
Zoo-401	Core (Any one from A,B,C& D	A) Animal Physiology II B) Reproductive Physiology II C) Entomology II D) Helminthology II	4	--	4	40	--	60	--	4
Zoo-402	Core	Molecular Biology	4	--	4	40	--	60	--	4
Zoo-403	Core	Practical I (corresponds to 401 and 402)	--	4+4	8	--	40	--	60	4
Zoo-404	Core	Project	--	4+4	8	--	40	--	60	4
Zoo-405	Elective (Select any one)	(A)Zoogeography (B)Writing & presenting scientific research paper (C)Computational Biology	4	--	4	40	--	60	--	4
Zoo AC-401 A/B/C/D	Audit Course	Choose one out of Four (AC-401A/ AC-401B/ AC-401C/ AC-401D) from Professional and Social + Value Added Courses	--	2	2		100	--	--	2
Total Credit for Semester IV: 22 (T = Theory: 8; P = Practical: 8; Skill Based: 4; Audit Course: 2)										

MSc I Sem I Zoology 2021-21

MSc I Sem I Core Courses		
Zoo - 101: Structure and Functional Anatomy of Invertebrates		
Total Hours: 60	**Program specific objective** • To understand the structural and functional anatomy of non-chordates. • To acquire the knowledge about locomotory, nutritional and organs of digestion and its mechanism • To understand the respiratory, excretory and nervous coordinating organization • To learn about the larval forms, colonial and social life of invertebrates.	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • enlighten themself with knowledge related to structural & functional anatomy of invertebrate animals. • enrich themselves with understandings of organs and systems of locomotory, nutrition, digestion and other vital process. • know the larval forms found in invertebrates and their significance. • understand the social life in honey bees.	**Lectures** 60
Unit	**Topics**	
Unit I	A)Structural organization of invertebrates B) Diversity and phylogeny of invertebrate C) Organization of Coelom: i)Acoelomates, ii) Pseudocoelomates iii) Coelomates - Protostomia and Deuterostomia	**12**
Unit II	A) Locomotion: i) Locomotory organelles – Cilia, flagella ii) Flagella,Ciliary and amoeboid movement in protozoa B)Nutrition and Digestion: i) Pattern of feeding and digestion in lower metazoan, ii) Filter feeding in polychaeta, iii) Filter feeding and digestion in mollusca and deuterostoma	**12**
Unit III	Respiration: i)Organs of respiration- Gills and lophophores, ii)Gills and lungs in Mollusca, iii)Gills and trachea in Arthropoda, iv)Respiratory pigments in invertebrates. v)Mechanism of respiration in gastropoda and insecta.	**10**
Unit IV	A) Nervous system: i) Primitive nervous system- Coelenterates and Echinodermata, ii) Advanced nervous system- Annelida, Arthropoda	**14**

	(Crustacea andInsecta) and Mollusca (Cephalopoda). iii) Trends in neural evolution. B)Excretion and osmoregulation: i) Organs and Mechanism of excretion - Coelom, Coelomoducts,Nephridia and Malpighian tubules, ii) Osmoregulation in terrestrial and aquatic invertebrates.	
Unit V	A)Invertebrate larvae: i) Larval forms of Platyhelminthes, Crustacea, Mollusca and Echinodermata, ii) Significance of larval forms. B)Colonial and social life: i) Protozoan, Sponge and Coelenterate colonies ii) Social life in honey bee.	**12**
Suggested Readings	• Barnes R. O.: The Invertebrates, W. B. Saunders and Co. • Barrington E.J.W.: Invertebrates, Structure and function, homes Nelson and Sons,Ltd., London • Hyman L.H.: The Invertebrate Volume 1 to 8, McGraw Hill Co. New York • Jordan, E. L.: The Invertebrates, S. C. Chand, New Delhi. • Kotpal R. L.: Modern Text book of Zoology : Invertebrates, Rastogi publications,Meerut • Kotpal R.L.: Protozoa to Echinodermata Series, • Marshall and William : A text book of Zoology:Invertebrate Vol. I, CBS publishers,New Delhi. • Prasad S. N.: Life of Invertebrates, Vikas publishing house, New Delhi. • Russel Hunter : A Biology of higher invertebrates, McMillon Co. Ltd. London	

MSc I Sem I Core Courses		
Zoo - 102: Cellular organization and Developmental Biology		
Total Hours: 60	**Program specific objective** • To understand the cellular organization with specific reference to plasma membrane, cell organelles and cell cycle. • To acquire the knowledge about basic concept of gametogenesis, fertilization and embryonic development. • To understand the concept of aging, apoptosis and senescence • To learn about the morphogenesis and organogenesis in specific animals.	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • Enrich themselves with the cellular organization with specific reference to plasma membrane, cell organelles and cell cycle. • acquire the knowledge about basic concept of gametogenesis,fertilization and embryonic development. • understand the concept of aging, apoptosis and senescence • know about the morphogenesis and organogenesis in specific animals.	**Lectures** 60
Unit	**Topics**	
Unit I	1.Structure and function of Plasma Membrane: a) Different models of Plasma Membrane b) Functions of Plasma Membrane –diffusion, osmosis, ion channels,active and passive transport, ion pumps 2.Structural organization and function of intracellular organelles: a) Nucleus, Mitochondria, Golgi bodies,Lysosomes,Endoplasmic reticulum, b) Structure and function of cytoskeleton and its role inmotility, c) Structure and function of filaments	**12**
Unit II	3. Cell cycle: a) Steps in cell cycle b) Regulation of cell cycle. 4. Cell signaling: a) Signaling molecules – Hormones, neurotransmitters, second messengers. b) Types of signaling receptors - Extra cellular and intra cellular. c) Signal transduction pathways, signaling through G- protein coupled receptors, regulation of signaling pathways.	**12**
Unit III	Gametogenesis, fertilization and early development: a) Formation of gametes, b) Cell surface molecules in sperm-egg recognition in animals; c) Zygote formation, Cleavage, Blastulation, Gastrulation	
Unit IV	Basic concepts of development: a) Potency, commitment, specification, induction, competence, determination and differentiation; b) Morphogenetic gradients; cell fate and cell lineages; c) Stem cells; genomic equivalence and the cytoplasmic determinants; imprinting	

	D)Aging, Apoptosis and Senescence	
Unit V	Morphogenesis and Organogenesis in animals: a) Cell aggregation and differentiation in *Dictyostelium*; b) Axes and pattern formation in *Drosophila*, frog and chick; c) Organogenesis – vulva formation in *Caenorhabditis elegans;* eyelens induction, limb development and regeneration in *Planaria*and *Hemidactylusflaviviridis*. d) Differentiation of neurons, post embryonic development-larvalformation, metamorphosis; environmental regulation of normaldevelopment; sex determination.	
Suggested Readings	• De Roberts: Cell biology • Du Praw E.J.: Cell and Molecular biology • J. D. Watson: Molecular Biology of the gene • Prakash S. Lohar : Cell and Molecular Biology, MJP Publishers, Chennai • J. R. Baker: Cytological techniques • Gerald Karp: Cell and Molecular Biology, John Wiley and SonsInternational, London • Arumugum: Developmental Biology • Mourice: Animal growth and development • David R. Newth: Animal growth and development • Gilbert: Developmental Biology • B.M. Patten: Early embryology of Chick • B.M. Patten: Foundation of embryology • M. Sussaman: Animal growth and development	

<table>
<tr><th colspan="3">MSc I Sem I Core Courses</th></tr>
<tr><th colspan="3">Zoo - 103: Practical I (corresponding to Zoo101)</th></tr>
<tr><td>Lectures
60</td><td>Program specific objective
• To acquire the practical skill about dissection of Grasshopper or Cockroach related to their digestive, nervous and reproductive system.
• To perform mountings of various significant parts of Grasshopper/Cockroach
• understand the concept of systematics or taxonomic features of invertebrate animals.</td><td>Credits:
4</td></tr>
<tr><td></td><td>Program specific outcomes
After successful completion of this course, students are expected to:
• perform dissection of Grasshopper or Cockroach related to their digestive, nervous and reproductive system.
• acquire practical skills for mountings of various significant parts of Grasshopper/Cockroach
• Classify the invertebrate animals belonging to phylum Porifera to Hemichordata.</td><td>Lectures
60</td></tr>
<tr><td></td><td>1. Dissection of Grasshopper/Cockroach so as to expose its – (E)
i. Digestive system
ii. Nervous System
iii. Reproductive system (Male and Female)
2. Mounting of following – (E)
i. Nephridia and Spermatheca of earthworm,
ii. Mouthparts of Grasshopper/Cockroach,
iii. Cornea and Wings of Grasshopper/Cockroach
iv. Tracheal and spiracles of Grasshopper/Cockroach
v. Ommatidium of Cockroach
3. Classification of Invertebrates - Porifera to Annelida up to order (one examplefrom each order)
4. Classification of Invertebrates -Arthropoda to Hemichordata up to order (oneexample from each order)</td><td></td></tr>
</table>

MSc I Sem I Core Courses		
Zoo - 104: Practical II (corresponding to Zoo102)		
Total Hours: 60	**Program specific objective** • To acquire knowledge about various cell organelles by studying their micro-photographs. . • To understand the principle PAS reaction. • To understand the process of preparation of mitotic spindle from cell material. • To learn technical skill to detect DNA and Protein in the given sample. • To acquire the skill related to detection of Mitochondria.	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • learn about various cell organelles by studying their micro-photographs. . • acquire the principle and protocol of PAS reaction. • gain the skill of preparation of mitotic spindle from cell material. • acquire technical skill to detect DNA and Protein in the given sample. • gain the skill related to detection of Mitochondria.	
Cellular organization	1.Study of electron microphotographs of various cell organelles. 2. Preparation of mitotic Chromosomes from any suitable cell material. 3. Detection of carbohydrates by PAS reaction. 4. Detection of protein by bromophenol blue reaction. 5. Detection of DNA by Feulgen reaction. 6. Detection of Mitochondria by Janus green method	
Develop--mental Biology	Preparation of Permanent slide of Chick Embryo 2. Study of different types of eggs – on the basis of amount of yolk, distribution of yolk, presence and absence of shell. 3. Study of Cleavages- Snail, Amphioxus, fish, frog, birds and mammals 4. Study of Blastulae- Amphioxus, frog and birds. 5. Study of Gastrulae- Amphioxus, frog and birds. 6. Study of types of placenta - Based on Distribution of villi on chorion, Histologicaltypes of placenta	

MSc I Sem I Skill BasedCourse		
Zoo - 105: Goatery		
Total Hours: 60	**Program specific objective** • To start Goat rearing as a small business enterprise by liaising with different stake holders • To manage Goat rearing effectively as a small business enterprise 5. • To gain all round knowledge of Goat rearing as a business enterprise rather than as a community profession	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • understand, appreciate and develop the self-confidence for embarking on self-employment / entrepreneurship. • Understandvarious breeds of Goat, their characteristics and their adaptability. • gain the knowledge related to Goat rearing, to devise a simple marketing and sales strategies and plan for a small business.	**Lectures** 60
Unit	**Topics**	
Unit I	Professional Knowledge and Entrepreneurship 1. Knowledge of selfconfidence , attitude 2. Entrepreneurial competencies 3. Banking, insurance , financial accountancy andmanagement 4. Legal aspects ,regulatory aspects	**10**
Unit II	Domain/Technical Knowledge 5.History of Goat breeding – practices , present scenario, prospects 6. Various breeds of Goat, their characteristics, and their adaptability 7. Up gradation of Goat breeds, recent introductions 8. Housing in Goat rearing 9. Common diseases in Goat, diagnosis and remedies 10. Feed and Feeding 11. Fodder and Fodder crops 12. Systems of Goat rearing, management practices for lambrearing to produce healthy adults	**20**
Unit III	Professional Skills 13. Engage in rearing of Goat 14. Select appropriate breeds of Goat for the purpose 15. Feed the Goat 16. Manage the Pest and Diseases affecting Goat 17. De-worming of Goat 18. Collection of Samples of diseased Goat 19. Build Goat Housing	**15**

	20. Manage the young ones 21. Sheering of Goat	
Unit IV	Core Skills 22.Business Opportunity Identification 23. Market Survey and Business Plan Development 24. Planning and Risk Assessment 25. Problem solving 26. Time management 27. Communication 28. Business Management skills	**15**
Suggested Readings	• Frank H. Baker and Mason E. Miller: Sheep And Goat Handbook, Vol. 4.CRC Press. • Mohan Chand Rajbar:Commercial Goat Farming in India-Guide: An entrepreneur manual to successful goat production and marketing in India Kindle Edition. • Board EiriHand Book of Goat Farming, Engineers India Research Institute. • Carol A. Amundson:How to Raise Goats: Third Edition, Everything You Need to Know. Atlantic Publishers and Distributors.	

MSc I Sem II Zoology 2021-21

MSc I Sem II Core Courses		
Zoo - 201: Structure and Functional Anatomy of Vertebrates		
Total Hours: 60	**Program specific objective** • To understand habit, habitat and taxonomic status of vertebrate animals. • To know the basic aspects of structural and functional anatomy of vertebrate animals. • To learn about adaptive radiation in vertebrates	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • gain the knowledge of the systematic position, habit and habitat of vertebrate animals • acquire the knowledge about structural and functional anatomy of vertebrates • understand distinguishing features between structure and function of vertebrates	**Lectures** 60
Unit	**Topics**	
Unit I	**A) Organization of Protochordates:** i) Urochordata with respect to *Salpa*: Morphology and Anatomy ii) Cephalochordata with respect to *Amphioxus*: Morphology and Anatomy **B) Origin and Phylogeny of Vertebrates:** **C) Cyclostomata:** Affinities and Phylogenetic status of Cyclostomata	**12**
Unit II	**Concept of Adaptive Radiation:** A) Fishes: Adaptive radiation in Chondrichthyes and Ostiochthyes B) Amphibia: Origin and evolution of Amphibia C) Reptilia: Evolution and adaptive radiation in Reptiles. D) Aves: i) Affinities of birds, ii) Origin and ancestry of birds, iii) Birds as glorified reptiles E) Mammals: i) Origin and ancestry of mammals, ii) Adaptive radiations in Prototheria, Metatheria and Eutherian Mammals.	**12**
Unit III	**Study of Endoskeleton of Human:** A) Axial Skeleton:	**12**

	Skull, Vertebral Column, Rib Cage B) Appendicular Skeleton: Shoulder Girdle, Skeleton of Upper limb, Pelvic Girdle, Skeleton of Lower limb C) Functions of Human Skeleton.	
Unit IV	A) **Comparative account of Vertebrate Systems:** i) Circulatory system ii) Urogenital system iii) Nervous system B) Neuro-endocrine interrelationship of Vertebrates	**12**
Unit V	**Receptor organs in Vertebrates:** Dogfish, Frog, Lizard, Pigeon, Rabbit: i) Olfactory ii) Gustatory iii) Photoreceptors (Eye) iv) Statoacoustic (Ear)	**12**
Suggested Readings	• Alexander, R. M.: The chordate. Cambridge University press London. • Ballairs: Reptiles (Hutchinson) • Bourne, G. M.: The structure and function of nervous tissue. Academic Press, New York. • Carter, G. S.: Structure and Habit in vertebrate evolutions. Sedgwich and Jackson, London. • Eecles, J. C.: The understanding of the brain. McGraw Hill Co., New York. • Green: Anatomy of Rat (Hafner) • Hyman: Comparative vertebrate Anatomy, University of Chicago Press. • Kingsley J. S.: Outlines of Comparative Anatomy of Vertebrates, Central book Depot, Allahabad.	

<table>
<tr><th colspan="3">MSc I Sem II Core Courses</th></tr>
<tr><th colspan="3">Zoo - 202: Biochemistry</th></tr>
<tr><td>Total Hours: 60</td><td>Program specific objective
• To know fundamental aspects of Biochemistry.
• To study different biological reaction mechanism.
• To know the importance of metabolism.
• To study the biochemical molecules and their interactions</td><td>Credits: 4</td></tr>
<tr><td></td><td>Program specific outcomes
After successful completion of this course, students are expected to:
• understand the basic terms related to biochemistry
• illustrate the importance of pH, buffer and water in living systems
• acquire the knowledge of structure and functions of various biomolecules and their interactions.
• gain the facts about different forms of DNA, chemistry of hormones and vitamins.</td><td>Lectures
60</td></tr>
<tr><td>Unit</td><td>Topics</td><td></td></tr>
<tr><td>Unit I</td><td>Basics of Biochemistry
a) Covalent and Non-covalent bonds.
b) Acids and bases: Proton donors and acceptors; strong/weak acids/bases; ionization of water and the ion product.
c) pH scale and the physiological pH range; dissociation constant - Ka and pKa;
d) Henderson-Hasselbalch equation; buffer solutions; Normality and Molarity</td><td>12</td></tr>
<tr><td>Unit II</td><td>Chemistry of biomolecules and their significance:
a) Carbohydrates:
i) Classification of carbohydrates;
ii) Derivatives of monosaccharides: Phosphate esters, acids and lactones; amino sugars;
iii) Oligosaccharides – Important diasaccharides.
iv) Polysaccharides: Storage and structural polysaccharides;
b) Lipids: Definition, classification, structure of fatty acids, triacylglycerols, phospholipids and sphingolipids, Steroid hormones; Lipids as constituents of biological membranes
c) Amino acids: Structure, classification; non-protein amino acids, essential and non-essential amino acids; modified amino acids and function.
d) Nucleic acids: Structure of bases, nucleosides and nucleotides; importance of nucleic acids.</td><td>12</td></tr>
<tr><td>Unit III</td><td>Protein Structure:
a) Primary, secondary, tertiary and quaternary structures.</td><td>12</td></tr>
</table>

	b) Fibrous proteins and globular proteins- examples and biological significance. c) Conformation of protein - Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds. d) Stability of protein structures.	
Unit IV	**Confirmation of Nucleic acids:** a) A, B, Z-DNA, b) t-RNA, c) micro-RNA. **Chemistry of Hormones:** a) Types: Amine, peptide and steroids. b) Properties of hormones. c) Mode of action of peptide and steroid hormones.	**12**
Unit V	**Vitamins (Structural formula not expected):** a) Definition, Classifications: Fat and Water soluble vitamins. b) Fat soluble vitamins: A, D, E and K with respect to sources and daily requirements. c) Water soluble vitamins: B complex (B1, B2, B6 and B12) with respect to sources and daily requirements. d) Principle role in metabolism and Deficiency diseases.	**12**
Suggested Readings	• Biochemical Calculations: Segel Irvin H., Publisher: John Wiley and Sons, New York, 2nd Ed., (1997). • Biochemistry: Berg Jeremy, Tymoczko John, Stryer Lubert, Publisher: W. H. Freeman, New York, 6th Ed, (2007). • Biochemistry: Geoffrey Zubay, William C Brown Pub; 4th edition (June 1999) • Biochemistry: Satyanarayan • Biochemistry: Stryer • Biochemistry: Voet Donald and Voet Judith G. John, Publisher: Wiley and Sons, New York, 3rd Ed. (2005). • Enzymes, Biochemistry, Biotechnology and Clinical chemistry: Palmer Trevor, Publisher: Horwood Pub. Co., England, (2001). • Harper's Biochemistry: Robert Murray, D. K. Granner, Peter A. Mayer and Victor W. Rodwell, International 25th edition. • Lehninger's Principles of Biochemistry: Nelson D. L. and Cox M. M. W. H. Freeman & Co. NY, 4th edition, (2005). • Principles and techniques of practical Biochemistry: K. Wilson and J. Walkar, ISBN edition	

MSc I Sem II Core Courses		
Zoo - 203:Tools and Techniques in Biology		
Total Hours: 60	**Program specific objective** • To know basic terms of biological techniques. • To study the applications of the various biological techniques. • To know the principle, working and applications of basic techniques used in biology.	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • explain the importance and applications of biological techniques. • illustrate the principle, working, materials used and applications of various biological techniques. • gain the knowledge related to radio activity and immunological techniques.	**Lectures** 60
Unit	**Topics**	
Unit I	**Principle, parts and applications of Microscopic Techniques:** i) **Mircoscope:** Light, phase contrast, interference, fluorescence, polarization, ii) Inverted and electron microscopy. **Principles and applications of Instruments:** i) UV-Vis spectrometry ii) Colorimeter iii) Fluorimeter	**12**
Unit II	**Principles and Uses of analytical instruments**: i) Balances, pH meter, ii) Densitometric scanner, chemiluminometer. iii) Radioactivity counter, Differential scanning calorimeter. iv) ESR and NMR spectrometers.	**12**
Unit III	**Cell culture Techniques:** i) Design and functioning of tissue culture laboratory ii) Cell proliferation measurement iii) Cell viability testing iv) Culture media preparation and cell harvesting methods	**12**
Unit IV	**Separation Techniques:** i) **Centrifugation techniques:** Principles and working of centrifuge, RPM, rotors and its types, types of centrifuge (high speed centrifuge, ultra - centrifuge and gradient centrifuge) ii) **Chromatographic techniques:** Basic principles of chromatography, Rf value calculation, adsorption, absorption, solvents and solutes iii) Paper chromatography, column chromatography, gel filtration, ion exchange chromatography, HPLC, gas chromatography.	**12**

	iv) **Electrophoresis:** Gel electrophoresis (one and two dimensional) SDS-PAGE, AGAROSE. Various methods and agents used in detection of bands. v) **Blotting techniques:** Southern blotting, northern blotting, and western blotting, south western blotting.	
Unit V	**Radio Activity and Immunological techniques** i) Radio labeling and radioactive techniques ii) Properties of different types of radioisotopes in biological system, radio degradation, half-life period, auto radiography, safety guidance. iii) Rocket immune-electrophoresis and Ouchterlony double diffusion method iv) Biosensors	**12**
Suggested Readings	• Bullock, J. D., Kristiansen, B.: Basic Biotechnology, 1987, Academic press, New York. • D. B. Tembhare: Techniques in Life Sciences, Himalaya Publishing House. • Keith Wilson, John Walker: Principles and Techniques of Practical Biochemistry • Keshav Trehan: Biotechnology. Wiley Eastern Limited, Bangalore, 1990. • Plummer, L: Practical Biochemistry Tata McGraw-Hill. • Prave, P. Faust, V., Sitting, W and Sukatsch, D.A.: Fundamental of Biotechnology, VCL Publishers, New York. 1987. • Spier, R. E. and Griffins, J.B.: Animal Cell Biotechnology, Vol. I&II, Academic Press, Orlande, 1985. • T. Poddar, S. Mukhopadhyay, S. K. Das: An Advanced Laboratory Manual of Zoology, MacMillan. • Wilson: Principles and Techniques of Practical Biochemistry	

MSc I Sem II Core Courses		
Zoo - 204: Practical I (corresponding to Zoo 201 + 202 + 203)		
Total Hours: 60	**Program specific objective** • To know anatomy and physiology of vertebrate animals. • Analysis of tissues / cells with reference to DNA, RNA, Protein, vitamins, etc. • To know biochemical processes their reactions and role in life.	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • acquire the knowledge related to characters, classification, anatomy and physiology of vertebrates. • gain the knowledge related to principle, class, structure and functions of various biomolecules. • .understand the tools and techniques used in biology.	
Unit		
	Structural and Functional Anatomy of Vertebrates	
	• Classification of Vertebrates - Urochordata to Amphibia up to order (one examplefrom each order) • Classification of Invertebrates - Reptilia to Mammalia up to order (one examplefrom each order) • Study of Axial and Appendicular skeleton of Rabbit. • Study of eye ball muscles of Scoliodon / Pecten from eye ball of hen. • Comparative study of Heart of Frog, Calotes, Pigeon, Rat. • Comparative study of Brain of Frog, Calotes, Pigeon, Rat.	
	Biochemistry	
	• Preparation of buffer of given molarity and pH. • Determination of pKa value of glycine. • Determination of protein by Barford reaction • Estimation of Nucleic acid, DNA / RNA. • Estimation of Vitamin 'C' from suitable source.	
	Tools and Techniques in Biology	
	• Calibration of pH meter. • Study of Compound and Phase Contrast microscopy. • To verify Beer-Lamberts Law. • Cell fractionation by using density gradient centrifuge (any suitable gradient) • Test Cell viability and Counting. • Determination of Molecular Weight of DNA by electrophoresis • Study of agglutination reaction and its significance performing WIDAL test.	

<table>
<tr><td colspan="3">MSc I Sem II Skill Based Course</td></tr>
<tr><td colspan="3">Zoo - 205: Aquaculture and Ecology</td></tr>
<tr><td>Total Hours: 60</td><td>Program specific objective
• To know the differentiating ability of abiotic and biotic components of ecosystem, interactions of various factors of ecosystem.
• To know the various biodiversity, hotspot and conservation of ecosystems.</td><td>Credits: 4</td></tr>
<tr><td></td><td>Program specific outcomes
After successful completion of this course, students are expected to:
• acquire skills of analysis of abiotic and biotic factors present in environment and their interactions for various associations.
• understanding various biodiversity, hotspot and conservation of ecosystems.</td><td></td></tr>
<tr><td></td><td>Aquaculture</td><td></td></tr>
<tr><td></td><td>• Aquaculture: Concept and its scope; Nutritional value of fish
• Physicochemical parameter of water for fish culture:
pH, Calcium, Total Alkalinity, Nitrate, Ammonia, Total hardness of fresh water
• Construction and Management of Fish culture pond:
Construction of ponds, management of ponds, Predatory and weed fishes and their control, Aquatic weeds and their control, Aquatic insects and their control, fish feeding: natural and artificial.
• Fish breeding: Natural and Induced
Natural breeding in pond water, Induced breeding- Pituitary extract, selection of breeders, injection of pituitary extract, spawning, Advantages of induced breeding.
• Transport of fish seed and Brood fish:
Causes of mortality in transport, methods for packaging and transport, open systems, closed systems, use of chemicals in live fish transport, anesthetic drugs, antiseptics and antibiotics.
• Fish Culture:
Selection of cultivable fish, monoculture, composite culture, culture of Indian major carps, Culture of common carps, culture of cat fishes, paddy cum fish culture, mari culture, cage culture, integrated fish farming
• Fish preservation, processing and byproducts
Fish preservation techniques, fish byproducts
• Fish pathology:
Bacterial, fungal, protozoan and worm diseases of fish.
• Technologies in Fisheries Development:
Geographic Information System (GIS) technology, Use of Information Communication Technology (ICT) in fishes: production</td><td>30</td></tr>
</table>

	aspects, marketing aspects.	
	Ecology	
	• **Introduction:** The Environment: Physical and Biotic environment; Biotic and Abiotic Interactions. • **Population Ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. • **Species Interactions:** Types of interactions, interspecific competition, herbivore, carnivore, symbiosis. Levels of species diversity and its measurement. • **Ecological Succession:** Types; mechanisms; changes involved in succession; concept of climax. • **Ecosystem:** Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). • **Applied Ecology:** Environmental pollution; Global environmental change; Biodiversity- Concept, Patterns, Importance; Biodiversity Hotspots; Status, Monitoring and documentation; Major drivers of biodiversity change; Biodiversity management approaches. • **Conservation Biology:** Principles of conservation, Major approaches to management, Indian case studies on conservation / management strategy (Project Tiger, Biosphere reserves).	**30**
Suggested Readings	• Bailey, N.T.J (1959): Statistical methods in Biology, ELBS and The English Universities Press Ltd. UK. • Khanna S.S.: An Introduction to fishes, Central Book Depot, Allahabad. • Sharma P.D.: Ecology, Rastogi publication, Meerut. • Talwar P.K. and A.G. Jhingran: Inland fishes Vol. I and II, Oxford and IBM Publishing Co. Pvt. Ltd. • Trivedi R. K., Goel P. K., Trisal C. L.: Practical methods in Ecology and Environmental Science Environmental Publishers, Karad.	

MSc II Sem III Zoology (wef Academic year 2022-23)

MSc II Sem III Core Courses		
Zoo- 301: (A) Animal Physiology – II		
Total Hours: 60	**Program specific objective** • To learn about the various aspects of Animal physiology. • To acquire a broad understanding of physiological processes.	**Credits: 4**
	Program specific outcomes • To understand the structure and functioning of Animal physiology • To gain the detail knowledge on Animal physiology	**Lectures** 60
Unit	**Topics**	
Unit I	**A)Defination, significance and scopes of physiology** **B)Water Relation and Ionic Regulation** i) Role of membranes in osmotic and ionic regulation; Role of body fluid; ii) Adaptation to marine habitat; Adaptation to brackish water habitat; Adaptation to Fresh water habitat; Adaptation to terrestrial habitat C) **Thermoregulation:** i)Homeostasis; ii)Classification of Animals Based on Thermoregulation; iii)Vants Hoff law; Lethal temperature; iv)Effect of cold Acclimation; v)Thermoregulatory Mechanisms; Vi)Thermoregulation in Camel.	**15**
Unit II	**Metabolism** a) **Carbohydrate Metabolism**: Intermediary Metabolism; Glycogenesis; Glycogenolysis; Glycolysis, Krebs cycle,Electron transport system; Respiratory chain; Oxidativephosphorylation; Energetics of Glucose; Metabolism;Pasteur effect; Gluconeogenesis; Cori cycle or lactic acidcycle; Uronic acid pathway; Crabtree effect, b) **Lipid metabolism**: Metabolism of lipids; Oxidation ofGlycerols; Fatty Acid, Oxidation; β-Oxidation;Ketogenesis; Ketosis; Ketolysis; Biosynthesis of FattyAcids; Biosynthesis of Triglycerides, c) **Protein Metabolism**: Deamination; Transamination; Decarboxylation; Ornithine cycle; Krebs Cycle, Citric Acid Cycle; Catabolism of the Carbon; Skeleton of amino acids; Pyruvic acid; Amino acids entering by α-Ketoglutaric Acid; Amino Acids entering by Succinyl Co-enzyme A; Catabolism of Amino Acids that are both Ketogenic and Glucogenic; Anabolism of Proteins; Energetics of amino Acids Oxidation.	**15**
Unit III	**Nutrition and Digestive system** a) Types of nutrition; Ingestion; Feeding mechanism; Digestion; Enzymes; b) Physiology of digestion; Absorption; Assimilation; Egestion or defaecation, c) The evolution of digestive mechanism: Phagocytosis; A	**10**

	digestive cavity (Intracellular digestion), d) Organization of Vertebrate Digestive System, e) Functional Adaptations of the Alimentary Canal, f) Types of Digestion.	
Unit IV	**Respiration** a) Introduction; b) Mechanism of respiration in man; c) Tidal volume and Vital capacity; d) Control of respiration; e) Respiratory pigments: a) Hemoglobin, b)Haemocyanin, c) Haemoerythrin, d) Chlorocruorin, e) Molpadin, f) Pinnaglobin, g) Vanadium, h) Echinochrome f) Haemoglobin as an Oxygen Carrier; Transport of Gases- Oxygen transport: Oxygen, Dissociation Curve; Bohr's effect; Chloride shift;Respiratory Quotient; g)Anaerobiosis	**10**
Unit V	**Circulatory system** a) Introduction; Functions of Circulatory system in Vertebrates; Closed and open Circulatory system; b) Types of Circulation: a)Systemic circulation b)Pulmonary circulation, c)Advantages of Double Circulation; c) Types of Heart: Pulsating Heart, Tubular Heart, Chambered Heart, Accessory heart d) Physiological types of Hearts: Neurogenic heart and Myogenic heart, e) ECG; Heart Sound; Cardiac cycle; Cardiac output; f) General plans of Circulation: Annelid plan, Amphioxus plan, Gill plan of fishes, Lung plan of Mammals; g) Blood vessels: i) Arteries and arterioles ii)Veins and Venules, iii)Microcirculation	**15**
	Total	**60**
Suggested Readings	G. J. Tortora: Principle of Anatomy and Physiology • Hoar: General and Comparative physiology • Dr. P.V. Jabade: General Physiology • B. K. Berry: Animal Physiology • C. C. Chatterjee: Human Physiology • Goel and Shastri: Textbook of Animal Physiology • K.S. Nelson: Animal Physiology • Holurn: Principles of Physiology and Biochemistry • Bell and Davidson: Textbook of Physiology and Biochemistry • Withers: Comparative Animal Physiology • Mohan P. Arora: Animal Physiology R. C. Sobti; Animal Physiology	

MSc I Sem II Core Courses		
Zoo -303: Practical I Corresponding to Zoo 301 (A) Animal Physiology I		
Total Hours: 60	**Program specific objective** • To know process of preparation of buffers and saline • To estimate SGOT and SGPT and analyse vital functions • To understandprocess of estimating biochemicals	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • acquire the knowledge related to process of preparation of buffers and saline • gain the knowledge related to estimation of SGOT and SGTP • learn the process of estimations of various biochemicals	
Practical	1. Preparation of Phosphate and Bicarbonate Buffers, given Normality solutions, Physiological Mammalian Saline Solution. 2. To demonstrate the principle of Osmosis. 3. Estimation of SGOT/SGPT from given biological sample. 4. Study of adaption in brackish, Fresh, marine water and terrestrial habitat. 5. Determination of oxygen consumption of any suitable animal. 6. Determination of Salivary Enzyme digestion and Effect of Temperature on Enzyme Activity. 7. Recording of lung volumes and capacities by spirometry. 8. Determination of Fatty acids and Amino Acid from Lipid and Protein Digestion respectively. 9. Antioxidant activity of any suitable material. 10. Estimation of plasma proteins by copper sulphate specific gravity method. 11. Estimation of Blood Glucose level.	

MSc II Sem III Core Courses		
Zoo – 301 (B): Reproductive Physiology-I		
Total Hours: 60	**Program specific objective** • To learn about the various aspects of reproductive physiology. • To acquire a broad understanding of the hormonal regulation of physiological processes. • To build reproductively healthy society by providing proper knowledge related to reproductive aspects.	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • Understand the structure of male and female reproductive systems particularly in humans. • Understand the functioning of male and female reproductive systems particularly in humans. • Comprehension of the interplay of various hormones in the functioning and regulation of the male and female reproductive systems.	**Lectures** 60
Unit	**Topics**	
Unit I	**Male Reproductive System :** • Internal and External Genitalia • Histological structure and functions of testis • Male accessory ducts and accessory reproductive organs:- Epididymis, Seminal vesicle, Prostate gland, Bulbourethral gland • Cryptorchidism • Semen	**14**
Unit II	**Female reproductive System:** • Internal and External Genitalia • Histological structure and functions of:- ovary ,Graafian follicle corpus luteum and corpus albicans • Structure and functions of:- Fallopian tube ,Uterus • Structure and functions of:- Bartholin's gland, Mammary glands	**14**
Unit III	**Gametogenesis-** • Structure of sperm • Spermatogenesis , Spermiogenesis,, Maturation and storage of sperm, Motility, capacitation and fate of spermatozoa. • Structure of ovum • Oogenesis , Ovulation, Gametogenesis at the chromosomal level: mitosis and meiosis	**14**
Unit IV	**Reproductive cycles-** • Estrous and menstrual cycles • Hormonal control of normal menstrual cycle • Puberty and delayed puberty , menarche and menopause	**10**
Unit V	**Chemistry, biosynthesis, mode of action and functions of Sex hormones and Gonadotropins** • Male Sex hormones :- androgen • Female sex hormones:- oestrogens and progesterone • Hormones of pituitary gland:- FSH, LH	**08**

Suggested Readings	• Prakash S Lohar, 2012 – Endocrinology Hormones and Human Health, MJP Publishers, Chennai • P. J. Hogarth, 1978- Biology of Reproduction Wiley, New York. • J. S. Perry, 1971- The Ovarian cycle of animals, Oliver and Boyed. • C.R. Austin and R. V. Short, 1972 Reproduction in Mammals, Vol. 1-8, Cam. Uni. Press. • P. Gibian and E.J. Platz, eds, 1970- Mammalian Reproduction, Springer Verlag. • Robert H. Williams, 1981 – Text book of Endocrinology, W. B. Saunders Company • Chandi Charan Chatterjee, 1985 – Human Physiology Vol.II Tenth Edition, Medical Allied Agency, Calcutta, India. • Arthur J. Vander, James H. Sherman and Dorothy S. Luciano – Human Physiology, • Mcgraw-Hill International Editions, Biological Sciences Series. • Nalbandov, A. V.- Reproduction Physiology.	

MSc I Sem II Core Courses		
Zoo - 303:Practical corresponding to ZOO 301 (B) Reproductive Physiology - I		
Total Hours: 60	**Program specific objective** • To demonstrate endocrine glands and their physiological role • To study different stages of reproductive cycle • To understand histology of organs of reproduction	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • acquire the knowledge related to endocrine glands • gain the knowledge related to reproductive cycle • understand the histology of organs related to reproductive system	
Practical	• Demonstration of rat/mice endocrine glands with the help of figure/chart/model. • Histological structure of male and female reproductive organs in rat/mice/human. • Study of different stages of estrous cycle. • Microscopic observations of spermatozoa / ova from suitable mammal • Histological structure of male accessory reproductive organs. • Histological structure of female accessory reproductive organs. • Cellular structure of anterior pituitary gland.	

MSc II Sem III Core Courses		
Zoo - 301: (C) Entomology I		
Total Hours: 60	**Program specific objective** • To understand habit, habitat and taxonomic status of vertebrate animals. • To know the basic aspects of structural and functional anatomy of vertebrate animals.	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • Acquire the knowledge of entomology and insects and understand origin and evolution of insects and their relation to other arthropods. • Understand the classification of insects up to family with distinguishing characters and examples of each order and family. • Understand the structure, chemical composition and functions of Integument and its derivatives, modifications of insect body regions and their appendages. • Acquire the knowledge of comparative anatomical and histological structure of various body systems. • Understand the location, structure and functions of various Endocrine and Exocrine glands, Light and Sound producing organs in various insects.	**Lectures** 60
Unit	**Topics**	
Unit I	General outline of Classification and Phylogeny of insects. Classification of following insect orders up to families A) Apterygota: Thysanura, Collembolla	**12**
Unit II	B) Pterygota: a) Odonata b) Orthoptera – Tettigonidae, Gryllotalpidae, Acrididae c) Dyctioptera- Blattidae, Mantidae d) Isoptera e) Mallophaga f) Siphanuculata g) Hemiptera: • Suborder- Homoptera - Flugoridae, Cicadidae, Aphididae • Suborder- Heteroptera – Cimiadae, Pyrrochoridae, Pentatomidae, Belostomidae	**12**
Unit III	h) Coleoptera: • Suborder- Adephaga- Carabidae, Dysticidae • Suborder- Polyphaga- Hydrophilidae, Scarabidae, Bupristidae, Tenebrionidae, Curcurlionidae i) Diptera: • Suborder- Nematocera- Culicidae, Chironomidae • Suborder- Brachaeocera- Tabanidae	**12**

	• Suborder- Cyclorrhapha- Syrphidae, Muscidae, Hippoboscidae, Glossinidae j) Lepidoptera: Nymphalidae, Papillionidae, Sphingidae, Noctuidae k) Hymenoptera: • Symphyta- Tenthreadinidae • Apocrita- Apidae, Ichnnemonidae	
Unit IV	A) Integument and its derivatives B) Comparative study of – • Head and its appendages • Thorax and its appendages and • Abdomen and its appendages	**12**
Unit V	A) Comparative anatomical and histological study of the following: • Alimentary canal and associated glands • Circulatory system • Ventilatory system • Excretory system and fat bodies • Nervous system and sense organs • Reproductive system B) Light and sound producing organs	**12**
Suggested Readings	• Chapman R. F.: The Insect: Structure and Function, E.L.B.S., and E.U.P. London. • Comstock J. H.: An Introduction to Entomology, Ithaca, New York. • Fox R. M and J. W. Fox: Introduction to comparative Entomology, Reinhold, New York. • Mani M. S.: General Entomology, 2nd edition, Oxford and IBH Publishing Company, New Delhi. • Nayar K. K., T. N. Anathakrishnan and B.V. David: General and Applied Entomology, Tata McGraw-Hill, New Delhi. • Richards O. W. and R. G. Davies: Imm's text book of entomology, Methuen and com, London, Vol. I and II • Ross H. H.: A Text book of Entomology, John Wiley and Sons, Ins. New York. • Snodgrass R. E.: Principles of insect morphology, Tata Mc-Graw Hill Bombay. • Tembhare D. B.: Modern Entomology, 2nd edition, Himalaya Publication House, Bombay.	

MSc II Sem III Core Courses		
Zoo - 304: Practical I (corresponding to Zoo 301(C) Entomology I)		
Total Hours: 60	**Program specific objective** • To know the knowledge of entomology and insects and understand origin and evolution of insects and their relation to other arthropods. • Understand the outline of classification of insects up to family with distinguishing characters and examples of each order and family. • To know the location, structure and functions of various endocrine and exocrine glands, light and sound producing organs in various insects.	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • Acquire the knowledge of entomology and insects and understand origin and evolution of insects and their relation to other arthropods. • Give outline of classification of insects up to family with distinguishing characters and examples of each order and family. • Understand the structure, chemical composition and functions of Integument and its derivatives, modifications of insect body regions and their appendages. • Understand the location, structure and functions of various endocrine and exocrine glands, light and sound producing organs in various insects.	
Unit	**Zoo 301(C) Entomology I**	
	• Collection and preservation techniques of insects	
	• Classification of insects upto orders and families as per syllabus	
	• Pictorial Collection and Identification of 25 insect species related to different orders and families	
	• Culturing/rearing of any suitable insect/s (Housefly/ Drosophila)	
	• Histology of Integument and its derivatives with the help of Slides (D)	
	• Comparative study of Head capsule – any four (adults or larvae) from local area	

	• Temporary preparation of Insects,
	  • Mouthparts, Antennae, Legs, Wings and Genitalia.
	  • Halter of Housefly	

	• Study of Bugs, Beetles, House Fly with reference to following systems (Any 2 insects) • Digestive system	

	• Reproductive system • Nervous system	

	• Histology of different organs of –
	  • Alimentary canal,
	  • Trachea,
	  • Heart,
	  • Muscle,
	  • Blood of suitable insects	

	• Compulsory visit to Agriculture College or University or Research institute.	
Suggested Readings	• Chapman R. F.: The Insect: Structure and Function, E.L.B.S., and E.U.P. London. • Comstock J. H.: An Introduction to Entomology, Ithaca, New York. • Fox R. M and J. W. Fox: Introduction to comparative Entomology, Reinhold, New York. • Mani M. S.: General Entomology, 2nd edition, Oxford and IBH Publishing Company, New Delhi. • Nayar K. K., T.N. Anathakrishnan and B.V. David: General and Applied Entomology, Tata McGraw-Hill, New Delhi. • Richards O. W. and R. G. Davies: Imm's text book of entomology, Methuen and com, London, Vol. I and II • Ross H. H.: A Text book of Entomology, John Wiley and Sons, Ins. New York. • Snodgrass R. E.: Principles of insect morphology, Tata Mc-Graw Hill Bombay. • Tembhare D. B.: Modern Entomology, 2nd edition, Himalaya Publication House, Bombay.	

<table>
<tr><th colspan="3">M. Sc. II: Semester III Core Courses</th></tr>
<tr><th colspan="3">Zoo 301 (D) Helminthology-1</th></tr>
<tr><td>Total Hours: 60</td><td>Program specific objective
• The programme has been designed in such a way so that the students get the flavour of both classical and modern aspects of Zoology/Animal Sciences.
• It aims to enable the students to study Heminthology-1 as a core course.
• The lab courses have been designed in such a way that students will be trained to join public or private labs.</td><td>Credits: 4</td></tr>
<tr><td></td><td>Program specific outcomes
The student at the completion of the course will be able to:
• Understand the Parasitology and Heminthology.
• Know about the classification of Helminthes.
• To be familiar with the life cycle of various parasites
• Students learn about the Nature, pathogenicity and prevention of endoparasites.
• Their identification, nature of damage control of these endoparasites.</td><td>Lectures 60</td></tr>
<tr><td>Unit</td><td>Topics</td><td></td></tr>
<tr><td>Unit 1</td><td>1. Introduction to Parasitology and scope of Helminthology
2. Origin and evolution of parasites.
3. Inter-specific biological relationships , symbiosis, Commensalisms and parasitism.
4. Adaptation in parasites.
5. Types of Parasites.
6. Types of hosts- Definitive and intermediate, primary, secondary specific host, Paratenic, Carrier, Susceptible, Resistant, Accidental, Vectors etc.</td><td>12</td></tr>
<tr><td>Unit 2</td><td>1. General organization and Classification of Platyhelminthes up to order level. Cestodes (Cestodarians and Eucestodes), Trematodes (Monogenea, Aspidobothria and Digenea)
2. Functional anatomy of Reproductive system
a. Trematodes (Digeneans)
b. Cestodes (Pseudophyllideans & Cyclophyllideans).
3. Types of Cercaria.
4. Different types of larvae in cestodes and their pathogenicity.
5. Holdfast organs with its adaptations in cestodes</td><td>14</td></tr>
<tr><td>Unit 3</td><td>1. Life cycle patterns of Digenetic Trematodes
a) Single intermediate host life cycle.
b) Two intermediate host life cycles
2. Life cycle patterns in Cestodes
a) No intermediate host life cycle
b) Single intermediate host life cycle
c) Two intermediate host life cycles.</td><td>12</td></tr>
<tr><td>Unit 4</td><td>Geographical distribution, habitat, morphology (Structure), life cycle, pathogenicity, diagnosis, treatment & prevention of the following Trematodes
1. Pragonimus westermani
2. Fasciolopsis buski
3. Gastrodiccoides hominis.</td><td>10</td></tr>
</table>

Unit 5	Geographical distribution, habitat, morphology (Structure), life cycle, pathogenicity, diagnosis, treatment and prevention of the following Cestodes: *1) Diphyhidium canium 2) Diphyllobothrium latum 3) Echinococcous granulosus 4) Taenia saginata 5) Hymenolepis nana*	12
Suggested Readings	• Medical Parasitology by Markell, Voge and John, 8thed. W.B. Saunders Co. • The Biology of animal parasites, Cheng T.C. (1964)-Saunders • International Student Edition. • The advances in the Zoology of tapeworm from 1970- Wardle and Mcleod • Text book Medical Parasitology Jaypee Brothers, - Medical Publishers, New York. - Panikar C.K.J (1988) • The Parasitology of Trematodes Oliver and Boyd Ltd. Edinburgh - Smyth J.D (1977) • Parasitology (Protozoology and Helminthology) –Sood Pamnik (1993) CBS Publication and Distrubution, Delhi. • Human helmintology Manual for Clinical, Sanitarians Medical Zoologists – Faust, Emerest Caroll. • Systema Helminthum Vol. II Cestoda - Yamaguti S. (1963) Inter-Science Publishers, London. • Synopsis of Digenetic Trematodes of Vertebrates – Yamaguti • S. (1971) Vol. I & II Keigaku Publishing Co., Tokyo, Japan. • Keys to the Cestode Parasites of Vertebrates, CBA • International - Khalil, Jones and Bray (1994) • Cestodes Parasites of Indian Mammals - Nama (1990)	

<table>
<tr><th colspan="3">MSc I Sem II Core Courses</th></tr>
<tr><th colspan="3">Zoo - 303: Practical I Practical corresponding to ZOO 301 (D) Helminthology I</th></tr>
<tr><td>Total Hours: 60</td><td>Program specific objective
• To know process of Collection, fixation and staining methods of worms
• To understand use of identification keys for cestodes and trematodes.
• To learn Histopathology of host and worms</td><td>Credits: 4</td></tr>
<tr><td></td><td>Program specific outcomes
After successful completion of this course, students are expected to:
• Study the Collection, fixation and staining methods of worms
• Understand key of Identification for cestodes and trematodes.
• Practice the study of Histopathology of host and worms
• Study the various types of parasites</td><td></td></tr>
<tr><td>Practical</td><td>• Study of different types of animal associations with suitable examples.
• Collection, fixation and preservation of Cestodes from locally available hosts
• Collection, fixation and preservation of trematodes from locally available hosts.
• Staining and identification of cestodes and preparation of permanent slides
• Staining and identification of trematodes and preparation of permanent slides
• Histopathology of host tissue, to study host parasites relation
• Study of different cestodes (10) and trematodes (10) from permanent slides.
• Examination of ova in fecal samples of any suitable animal.
• Submission of five permanent slides at the time of practical examination.</td><td></td></tr>
</table>

M. Sc. II: Semester III Core Courses		
Zoo 302 Enzymology and Immunology		
Total Hours: 60	**Program specific objective** • To acquire the flavour of modern aspects of Zoology/Animal Sciences. • To enable the students to study Enzymology and Immunology as a core course. • To learn practicing skill so that to join public or private labs.	Credits: 4
	Program specific outcomes The student at the completion of the course will be able to: • Know about the Enzymology and Immunology. • To be familiar with the Enzyme structure, properties and its activity • Understand the basic principles of Enzymology and Immunology • To understand the principle and mechanism of immunoglobulins	Lectures 60
Unit	**Topics**	
Unit I	**Enzyme structure and properties** : a) Enzyme Classification and nomenclature (International Union of Biochemistry (I.U.B.); Enzyme Commission number (EC) b) Primary and secondary structure, tertiary structure, the active site, quaternary structure, examples of enzyme- ribonuclease and chymotrypsin and their mechanism of action.	12
Unit II	**Enzyme activity:** a) Methods of investigating the mechanisms of enzyme catalyzed reactions- Isotopes labeling, b) Kinetics methods (enzyme velocity, units) steady-state methods, continuous methods. c) Steady-state enzyme kinetics- Effect of substrate concentration on initial velocity, d) Michaelis-Menten Hypothesis, Briggs- Haldane Hypothesis, Determination of Km and Vmax.	12
Unit III	**Enzyme immobilization and inhibition:** a) Enzyme purification techniques, b) Immobilization techniques, experimental procedures, enzyme stabilization, properties of immobilized enzyme c) Enzyme inhibition Competitive, non-competitive and uncompetitive inhibition, d) Allosteric activation and inhibition- sequential and concerned symmetry models.	12

Unit IV	**Central cell types of the immune system**: T and B lymphocytes, the NK cells, the neutrophilic, basophilic and eosinophilic granulocytes and the macrophages Types, structure, and function of molecules: immunoglobulins, T-cell receptors, MHC molecules, complement proteins, a few key cytokines and chemokines and their receptors.	12
Unit V	• Defense against as bacteria, fungi, virus and parasites • Mechanisms behind several immunological diseases, as hypersensitivity reactions, allergies, autoimmunity and immuno deficiencies. • Mechanisms of action of certain immunosuppressive drugs as glucocorticoids and cyklosporin. • Immunological methods: ELISA, Western blot, production of monoclonal and polyclonal antibodies	12
Suggested readings	• Immunology (6 th Edition) by Roit IM, Brostoff J and Male D. Mosby, An imprint of Elsevier Sci Ltd., 2002. • Kuby Immunology (4 th Edition) by Golds RA, Kindt TJ, Osborne A. W.H. Freeman and Co. Ltd., New York, USA, 1994. • Textbook on Principles of Bacteriology, Virology and Immunology, 5 Volumes (9 th Edition) by Topley and Wilson. Edward Arnold, London, 1995. • Basic and Clinical Immunology, by Stites DP. Appleton & Lang Press. • Immunology, by Weissman and Wood. Benjamin Cummings. • Fundamentals of Immunology, by Coleman RM, Lombard MF, Sicard RE and Rencricca NJ. Wm. C. Brown Publishers, 1989.	

<table>
<tr><th colspan="3">MSc I Sem II Core Courses</th></tr>
<tr><th colspan="3">Zoo -304: Practical I Corresponding to Zoo 302 Enzymology and Immunology</th></tr>
<tr><td>Total Hours: 60</td><td>Program specific objective
• To know process of cell fractionation technique
• To analysethe enzyme activity and Km value
• To understandimmunological techniques</td><td>Credits: 4</td></tr>
<tr><td></td><td>Program specific outcomes
After successful completion of this course, students are expected to:
• acquire the knowledge related to process of cell fractionation
• gain practical skill related enzyme analysis and Km
• learn various immunological techniques.</td><td></td></tr>
<tr><td rowspan="2">Practical</td><td>Practicalcorresponding to Enzymology
• Preparation of tissue homogenate and fractionation of liver cell components
• Effect of activators and inhibitors on enzyme activity
• Determination of α-amylase by starch digestion
• Determination of tryptic activity by casein digestion method
• Determination of pancreatic lipase activity
• Determination of Km Value of enzyme</td><td rowspan="2"></td></tr>
<tr><td>Practical corresponding to Immunology
• Chemistry of immunoglobulin molecules, classes and physiological importance.
• Use of ELISA technique (HIV) or any suitable method
• Isolation and purification Bovine serum immunoglobulin G (IgG) fraction by suitable method
• Study of agglutination reaction and its significance performing WIDAL test.
• Determination of Antigen and Antibody reaction by using any suitable method</td></tr>
</table>

M. Sc. II: Semester III Elective Courses		
ZOO 305 (A) Animal behavior		
Total Hours: 60	**Program specific objective** 1. The programme has been designed in such a way so that the students get the flavour of both classical and modern aspects of Zoology/Animal Sciences. 2. It aims to enable the students to study Heminthology-1 as a core course. 3. The lab courses have been designed in such a way that students will be trained to join public or private labs.	Credits: 4
	Program specific outcomes The student at the completion of the course will be able to: ➢ Understand the Feeding and Antipredator behavior of animals. ➢ Know about the Aggression, Territoriality and Conflict behavior. ➢ To be familiar with the Biological Communication ➢ Students learn about the Orientation and Navigation	Lectures 60
Unit I	**Introduction:** 1.1 What is Behavior? Behavioral Ecology.	04
Unit II	**Feeding and Antipredator Behavior:** **2.1** Food preferences, Feeding Techniques, Using Tools, Feeding in Group-living Herbivores, Social Carnivores, 2.2 Anti Predator Behavior, Concealment, Camouflage, Warning Coloration and Mimicry, Freezing, Escape, Social Antipredator Behavior, Confusion Effect, Detection, The Development of Anti Predator Behavior.	14
Unit III	**Aggression, Territoriality and Conflict behavior:** **3.1** Forms of Aggressive Behavior, Aggression and Competition, Types of Aggressive Behavior. 3.2 Social Use of Space (Territoriality), Size and Boundaries of Territory, Territorial Model, Dominance Hierarchiess, Dominance in Females, Dominance in males, Advantage of Dominance, Factors Affecting aggression, Limbic System, Hormones, Genetic Control, 3.3 External factors in Aggression, Learning and Experience, Pain and Frustration, Xenophobia,Crowding, Breeding, Feeding, Restrain of Aggression, Displays,, Territorial Conflicts	14
Unit IV	**Biological Communication:** **4.1** How signal convey information, Discrete and Graded Signals, Distance and Duration, Composite Signals, Syntax and Context, Metacommunication, Information and Manipulation, Messages and their Meaning, Signals, 4.2 Measurement of Communication, Observation, Quantification, Channels of Communication, Odor, Sound, Touch, Surface Vibration, Electric Field, Vision.	14
Unit V	**Orientation and Navigation:** 5.1 Navigation, Invertebrates, Topographic Features, Sun, Stellar Cues, Meteorlogical Cues, Olfactory Cues, Geomagnetic Cues, Mammals, 5.2 Other Navigation Mechanisms.	14
Suggested Readings	• Reena Mathur: Animal Behaviour, Rastogi Publication, Meerut • M.P.Arora: Animal Behaviour Himalaya Publishing House, Mumbai • Harjindra singh: A text book of Animal Behaviour, Anmol Publiccations Pvt. Ltd, NewDelhi)	

M. Sc. II: Semester III Elective Courses		
ZOO 305 (B) Forensic Zoology		
Total Hours: 60	**Program specific objective** • The programme has been designed in such a way so that the students get the flavour of modern aspects of Zoology/Animal Sciences. • It aims to enable the students to study Forensic Science as a elective course.	Credits: 4
	Program specific outcomes The student at the completion of the course will be able to: • Understand the History and development of forensic science. • Know about the forensic science laboratories. • To be familiar with the Biological evidences, collection and packaging. • Students learn about the analysis of biological fluids	Lectures 60
Unit	**Topics**	
Unit I	Forensic Science : Definitions, History and Development Scope and importance of forensic science	06
Unit II	**Forensic Science Laboratories And Facilitie**s: Growth of Forensic Science Laboratories in India – Central and State level laboratories; Educational setup in Forensic Science in India; Services and functionalities provided by various FSLs	12
Unit III	**Biological Evidences Collection and Packaging**: Protection of Biological Evidences; Documentation; Recognition of Biological evidences encountered in various cases; Search & Collection of Biological Evidences; Packaging & transportation of Biological Evidences	15
Unit IV	**Analysis of Biological Fluid**- Saliva; Semen; Vaginal Fluid; Urine; Sweat; Serological Concepts; Antigen / Antibodies; Polyclonal antibodies; Monoclonal antibodies; Antiglobulins; Human & Animal Hair morphology; Blood Grouping – Human & Non-human; Analysis of Skeletal Remains	15
Unit V	**Forensic Entomology** Basic Principle of Insect Biology; Life Cycle; Estimation of Time of Death; Preservation of Sample.	12
Suggested Readings	• Nanda, B.B. and Tewari, R.K. (2001) : Forensic Science in India : A vision for the twenty first century Select Publisher, New Delhi. • James, S.H and Nordby, J.J. (2003) Forensic Science: An introduction to scientific and investigative techniques CRC Press, USA. • Barnett (2001): Ethics in Forensic Science. • Saferstien : Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA. • Saferstein : Criminalistics, 1976, Prentice Hall Inc., USA. • Nickolas : Scientific Criminal Investigation • Deforest, Gansellen & Lee : Introduction to Criminalistics. • Sharma, B.R. : Forensic Science in Criminal Investigaion and Trials, Central Law Agency, Allahabad, 1974. • Kirk : Criminal Investigation, 1953, Interscience Publisher Inc. New York	

M. Sc. II: Semester III Elective Courses		
ZOO 305 (C) Endocrinology		
Total Hours: 60	**Program specific objective** • The programme has been designed in such a way so that the students get the flavour of modern aspects of Zoology/Animal Sciences. • It aims to enable the students to study Endocrinology as a elective course.	**Credits: 4**
	Program specific outcomes The student at the completion of the course will be able to: • Understand the Histology of endocrine glands. • Know about the synthesis, transport and metabolism of hormones. • To be familiar with the hormone replacement theory • Students learn about the classification of hormones	**Lectures 60**
Unit	**Topics**	
Unit I	1.1 Histology of vertebrate endocrine glands: Pituitary gland, Thyroid gland, Parathyroid gland, Adrenal gland, Pineal and Thymus gland 1.2 Melatonin function: Jet-lag and sleep disturbances. Melatonin as an anti-oxidant. Melatonin and cancer. Melatonin and depressive disorders. Melatonin and endocrine disorders. Adverse effects of Melatonin. 1.3 Histophysiologies of endocrine placenta, testis and ovary in vertebrates 1.4 Structure and functions of Islets of Langerhans 1.5 Histophysiologies of Urohypophysis and Corpuscles of Staninus in fishes	12
Unit II	2.1 Classification of Hormones (Peptides, Steroids and amino acid derived) a. Hormone action at cellular level 2.3 Hormone action at genetic level 2.4 Hormones in biological clock 2.5 Role of hormones in digestion 2.6Hormonal regulation of carbohydrate, Lipid and Protein metabolism 2.7 Hormonal regulation of Growth and Reproduction	12
Unit III	3.1 Synthesis, transport (release) and metabolism of steroid hormones 3.2 Synthesis, transport and metabolism of T3, T4 and epinephrine 3.3 Synthesis transport and metabolism of insulin 3.4 Prostaglandins 3.5 Ectohormones in insects and mammals	12
Unit IV	4.1 Thyroid hormones and disorders 4.2 Parathyroid hormones and disorders 4.3 Pituitary hormones and major Disorders 4.4 Adrenal Gland hormones and Disorders 4.5 Diabetes: Diabetes Type I, Diabetes Type II, Diabetic Kidney Problems, Diabetes And Pregnancy, Diabetic Nerve Problems, Autoimmune diabetes 4.6. Comparative study of steroid and non-steroid hormones in	12

	reproduction	
Unit V	5.1 Hormone replacement therapy 5.2 Risks and benefits of Hormone replacement therapy 5.3 Other hormones: Rennin, angiotensin, cytokines, ANF, Erytropoietin 5.4 Evolution of hormones 5.5 Neuroendocrine mechanism in insects and crustacean metamorphosis 5.6 Neuroendocrine mechanism in Amphibian metamorphosis	12
Suggested Readings	• .Lohar Prakash S.2014 Endocrinology:Hormone and Human Health.MJP Publishers, Chennai • Human Physiology- C. C. ChatterjiVol. I and II • Comparative Vertebrate Endocrinology, Bentley: Cambridge • University Press, 1998 • Fundamentals of Comparative Endocrinology, Chester-Jones et al.: Plenum Press, New York, London, 1987. • Comparative Endocrinology, Gorbman et al.: John Wiley & Sons,New York, 1983 • Vertebrate Endocrinology, Norris: (2nd ed.), Lea & Febiger, 1997. • Vertebrate Endocrinology Schreibman & Pang: Vol. I-IV, • Fundamentals & Biomedical Implications, Academic Press, 1985 &onwards • Endocrinology, Hadley: Prentice hall. International Edition. 2000 • Text Book of Endocrinology, 10th edition Larson: Williams. W. B. Saunders Company, Philadelphia. 2002. • William's text book of Endocrinology. (XI edition) H. M. Kronenberg, S. Melmed, K.S. Polonsky and P. R. Larsen. Publisher - Saunders, Elsevier Inc. (2009).	

MSc II Sem IV Core Courses		
Zoo- 401: (A) Animal Physiology – I		
Total Hours: 60	**Program specific objective** • To learn about the anatomy and physiology. • To understanding the various systems of animal body.	**Credits: 4**
	Program specific outcomes • To understand the functioning of Animal physiology • To obtain the detail knowledge on structure of animal systems.	**Lectures** 60
Unit	**Topics**	
Unit I	**A)Excretion and Osmoregulation** i)Definition of Excretion; Types of excretory Products, ii)Comparative aspect of Excretory organs in Invertebrates and Vertebrates, iii)Osmoregulation in Invertebrates and Vertebrates B) **Nervous System** i)Nervous cordination: Brain; Spinal cord, Neurons ii)Nerve Fibres; Neuroglea; Nerve impulse; Neuromuscular junction; iii) Neurotransmitters; Reflex arc; Types ofReflexes; iv) Evolution of nervous system; v)EEG	**12**
Unit II	**Physiology of Muscles** a) Types: Phasic muscles, Tonic Muscles, Striated Muscles,Smooth muscles, Cardiac muscles b) Chemical Composition of Muscle: Water; Proteins; Actin; Myosin; Tropomyosin; Troponin; Actinin; c) Neuromuscular junction; Motor unit; Membrane excitation; d) Mechanism of muscle contraction; Sliding filament theory; e) General properties of Muscles; Properties of Voluntary muscles; Physical and Chemical aspects of muscle contraction; Molecular basis of Muscle contraction; Control of Muscle contraction; f) Role of Regulator proteins and calcium in muscle contraction;Changes during muscle contraction; Single muscle twitch; Latent phase or period; Contraction phase; Relaxation phase; g) Invertebrate muscle, h) Tetanus	**14**
Unit IV	**Endocrine System** a) Properties and types of Hormones, Mechanism of Hormone action b) The Pituitary Gland: Pituitary Gland in Different Chordates, It Hormones, c) Gigantism, Acromegaly, Dwarfism; d) Thyroid Gland: Cretinism, myxoedema, exophthalmic Goitre; e) Parathyroid Gland: Functions of PTH, Disorders of parathyroid; f) Pancreas: Islets of Langerhans: Diabetes g) Adrenal Gland: Addison’s disease, Cushing’s syndrome;	**14**

	h) Thymus Gland: Thymosin; i) The pineal Gland: Melatonin, j) Reproductive glands; Testes; Prostate gland, Ovary; Placenta; k) Gastrointestinal hormones; Renal Hormones; Prostaglandins; l) Endocrine Glands in Invertebrates: Neurosecretory cells and Neurosecretion; Neurosecretion in Insects; Pheromones	
Unit V	**Reproductive System** a) Patterns of Animal Reproduction: Asexual and Sexual i)Sexual Reproduction; Male Reproductive System- Spermatogenesis, Transportation of sperm, Composition of Semen; Female Reproductive System- Puberty; Oogenesis; Graafian Follicles; Menstrual cycle; Ovulation; Fertilization; Implantation; Oestrus Cycle: b) Hormonal Control of Reproductive Cycle; Menopause; c) Hormonal Control of Pregnancy; Parturition; d) Hormonal Control of Lactation	**12**
Unit VI	**Sensory Physiology** a) Sensory coding - Transduction, Relationship between Stimulus Intensity and Response, Central control of Sensory Reception; b) Chemoreception - Gustation and Olfaction; c) Thermoreceptors and Infrared reception; d) Mechanoreception, Mechanotransduction - Invertebrate and vertebrate Mechanoreceptors - Muscles spindle, e) Acoustico lateralis System, f) Echolocation; g) Electroreception; h) Magnatoreception	**08**
	Total	**60**
Suggested Readings	• Prakash S Lohar: Endocrinology-Hormones and Human Health, MJP Pulishers, Chennai • G. J. Tortora: Principle of Anatomy and Physiology • Hoar: General and Comparative physiology • Dr. P.V. Jabade: General Physiology • B.K. Berry: Animal Physiology • C.C. Chatterjee: Human Physiology • Goel and Shastri: Textbook of Animal Physiology • K.S. Nelson: Animal Physiology • Holurn: Principles of Physiology and Biochemistry • Bell and Davidson: Textbook of Physiology and Biochemistry • Harper, Physiological chemistry • Mariakuttikan N. Arumugam: Animal Physiology • Itta Sambasiviah, A. P. Kamalakara Rao, S. Augustiane Chellappa: A Textbook of Animal Physiology and Ecology	

MSc I Sem II Core Courses		
Zoo 403 Practical correspond to Zoo - 401 (A) Animal Physiology II		
	Program specific objective • To understand the process of determining GFR • To analyse reflexes in man an sensivity • To understand process of ovulation, semen analysis	**Credits: 2**
	Program specific outcomes After successful completion of this course, students are expected to: • acquire the knowledge related to determination of GFR • gain the knowledge related to reflexes in man • understand the process of ovulation and semen analysis.	
Practical	1) To demonstrate the principle of dialysis. 2) Determination of GFR. 3) Determination of Nitrogenous Excretory Product – Uric acid 4) Reflexes in man. 5) Study of different types of muscles. 6) Super-ovulation in Rat. 7) To study the oestrous cycle by vaginal smear method. 8) Assessing skin sensitivity - locating different receptors. 9) Study of Endocrine glands with the help of Slides/ Photographs 10) Qualitative estimation of hCG. 11) Perform Semen analysis (Motility, Sperm count, Morphology of sperm) 12) Isolation of Haemoglobin.	

MSc II Sem IV Core Courses		
Zoo – 401 B: Reproductive Physiology-II		
Total Hours: 60	**Program specific objective** • To learn about the various aspects of reproductive physiology and events. • To acquire a broad understanding of the hormonal regulation of physiological processes. • To create awareness of new technologies in assisted reproduction as well as contraceptive methods. • To build healthy society by providing proper knowledge related to reproductive aspects.	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • Understand the functioning of male and female reproductive systems particularly in humans. • Comprehension of the interplay of various hormones in the functioning and regulation of the male and female reproductive systems. • Know about infertility • Know about modern contraceptive devices	**Lectures** 60
Unit	**Topics**	
Unit I	**Fertilization-** • Ejaculation, Insemination, • Gamate transport (ovum and sperm) • Sperm capacitation and activation • Entry of sperm into ovum, Acrosomal reaction, Activation of ovum • Significance of fertilization • Early development:- Early cleavages, blastomeres	**12**
Unit II	**Implantation and Pregnancy** • Morphological and physiological relationship between blastocyst and uterus during implantation. • Abnormal implantation • Hormonal changes during pregnancy. • Ectopic pregnancy and pseudo pregnancy • Role of Hormones during Pregnancy:- Progesterone hCG, HPL, relaxin	**12**
Unit III	**Placenta, Parturition and Lactation** • Formation and development of placenta • Histological structure of placenta • Endocrine functions of placenta **Parturition** • Initiation of labour • Properties of uterine muscles • Process and factors involved in parturition **Lactation** • Development of mammary gland • Hormonal control on the Functions of mammary gland	**12**

	• Lactogenesis	
Unit IV	**Reproductive Health** • Definition, Reproductive Health Care programme • Goals of RCH programme • **Birth Control Methods** • **A)** Natural Temporary methods :- Safe period, Coitus inerruptus, Lactational amenorrhea • **B)** Male and female contraceptives with their Advantages and disadvantages :- Chemical means, Mechanical means (Barrier), Physiological devices(Oral pills), Birth control Implants • **C)** Permanent method: - Tubectomy, Vasectomy	**12**
Unit V	**Problems and Remedies related to Reproduction** • MTP (Medical Termination of Pregnancy) • Amniocentesis , PNDT Definition and Legal acts • Sexually Transmitted Diseases:- Syphilis, Gonorrhoea • Male and female infertility(sterility) • Artificial/assisted reproductive techniques :- IVF, GIFT, ZIFT, ICSI, AI, IUI, Surrogacy, Sperm bank.	**12**
Suggested Readings	• Prakash S Lohar, 2012 – Endocrinology Hormones and Human Health, MJP Publishers, Chennai • P. J. Hogarth, 1978- Biology of Reproduction Wiley, New York. • J. S. Perry, 1971- The Ovarian cycle of animals, Oliver and Boyed. • C.R. Austin and R. V. Short, 1972 Reproduction in Mammals, Vol. 1-8, Cam. Uni. Press. • P. Gibian and E.J. Platz, eds, 1970- Mammalian Reproduction, Springer Verlag. • Robert H. Williams, 1981 – Text book of Endocrinology, W. B. Saunders Company • Chandi Charan Chatterjee, 1985 – Human Physiology Vol.II Tenth Edition, Medical Allied Agency, Calcutta, India. • Arthur J. Vander, James H. Sherman and Dorothy S. Luciano – Human Physiology, • Mcgraw-Hill International Editions, Biological Sciences Series. • Nalbandov, A. V.- Reproduction Physiology.	

<table>
<tr><th colspan="3">MSc I Sem II Core Courses</th></tr>
<tr><th colspan="3">Zoo 403 Practical correspond to Zoo - 401 (B) Reproductive Physiology II</th></tr>
<tr><td></td><td>Program specific objective
• To know different stages of embryonic development
• To study placenta and types of contraceptives
• To estimate biochemicals associated with reproduction</td><td>Credits: 2</td></tr>
<tr><td></td><td>Program specific outcomes
After successful completion of this course, students are expected to:
• acquire the knowledge related to embryonic development
• gain the knowledge related to histology of placenta and types of contraceptives
• Estimate biochemicals associated with reproduction.</td><td></td></tr>
<tr><td>Practical</td><td>1. Study of various stages of development of mammalian egg, cleavage, blastula,gastrula.
2. Study of histological slides of placenta.
3. Study of types of contraceptives.
4. Demonstration of surgical operation in rat/mice- tubectomy.
5. Demonstration of surgical operation in rat/mice- vasectomy.
6. Collection of Mammalian sperms.
7. Pregnancy test (immunological)
8. Estimation of total gonadal (testis) cholesterol from rat/mice.
9. Estimation of total adrenal cholesterol from rat/mice.
10. Estimation of Ascorbic acid from Ovary / Testis.
11. Estimation of Protein from Ovary / Testis by Lowry’s method
12. Estimation of Glycogen from Ovary / Testis by Anthrone Method</td><td></td></tr>
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<tr><td colspan="3" align="center">MSc II Sem IV Core Courses</td></tr>
<tr><td colspan="3" align="center">Zoo - 401: (C) Entomology II
Insect Physiology and Applied Entomology</td></tr>
<tr><td>Total Hours: 60</td><td>Program specific objective
• To develop a strong foundation in entomology, including understanding of the importance of insects to human society.
• To know the process of digestion and metabolism, circulation, excretion, respiration, role of hormone in insect reproduction.
• To familiarize the students with identification of insect pests, vectors and their control methods.
• To develop a sufficient background for those students who wish to study more advanced entomological topics.</td><td>Credits: 4</td></tr>
<tr><td></td><td>Program specific outcomes
After successful completion of this course, students are expected to:
• Acquire the knowledge of process the process of digestion and metabolism, circulation, excretion, respiration, role of hormone in insect reproduction.
• Understand the systematic position, habit and habitat of Insects pests.
• Acquire the knowledge about morphology, physiology, ecology, behavior and physiology of insect pests.
• Acquire the knowledge of identification of insect pests, vectors and their control methods.</td><td>Lectures
60</td></tr>
<tr><td>Unit</td><td align="center">Topics</td><td></td></tr>
<tr><td></td><td align="center">Insect Physiology</td><td></td></tr>
<tr><td>Unit I</td><td>A) Penetration of substances through cuticle
B) Nutritional requirement and Mechanism of Digestion
C) Circulation :
a) Circulatory Mechanisms in Terrestrial and Aquatic insects
b) Control of Heart beat
D) Excretion in Terrestrial and Aquatic insects
E) Respiration :
a) Diffusion theory of respiration
b) Respiratory Mechanisms in Terrestrial and Aquatic insects</td><td>12</td></tr>
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<table>
<tr><td>Unit II</td><td>A) Physiological Properties of Insect Muscle
B) Locomotion - Terrestrial, Aerial and Aquatic
C) Neural Integration and Sense Organs
D) Role of Hormones in Reproduction,
E) Metamorphosis and Regeneration</td><td>12</td></tr>
<tr><td></td><td>Applied Entomology</td><td></td></tr>
<tr><td>Unit III</td><td>General biology of important pests of crops cultivated in Maharashtra in particular and India in general :
A) Agricultural Crop pests: Sugarcane, Paddy, Maize, Jawar.
B) Fiber crop pests: Cotton, Jute
C) Vegetable pests: Bhendi, Brinjal, Cabbage, Pea, Chillies, Onion.
D) Fruit pests: Lemon, Mango, Guava, Ber-cucurbita
E) Oil seed plant: Ground nut, Castor, Soyabean, Mustard, Sesamum</td><td>12</td></tr>
<tr><td>Unit IV</td><td>A) Important pests of forest trees and steps taken to check their infestation :
a) Termites, c) Forest defoliators,
b) Borers d) Sap suckers
B) Household and stored grain pests their control :
a) Rice weevil, c) Pulse beetle,
b) Tribolium d) Rice moth</td><td>12</td></tr>
<tr><td>Unit V</td><td>A) Medical and Veterinary entomology with reference to important Vectors and their control measure :
a) Mosquito, b) Housefly, c) Flea and d) Sand fly
B) Integrated pests Management (I.P.M.),
C) Role of insects in forensic science</td><td>12</td></tr>
<tr><td>Suggested Readings</td><td>• Bursell E.: An Introduction to Insect Physiology, Academic Press Inc. New York, 1978
• Crop pests and how to fight them: Govt. of Maharashtra Pub. Bombay.
• Pfadt R.E.: Fundamental of Applied Entomology, Mac Millan, New York, 2nd Ed.1971.
• Pradhan S.: Insect pests of crop, NBY, New Delhi 1969.
• Rock Stein M.: The Physiology of Insects by Vol. I- VI, Academic press London 1973-76.
• Roy D. N. and A WA Brawn: Entomology, The Banglore Printing and Publ. Co. Ltd. 1970.
• Short JRI: Introduction to Applied Entomology, Longmans Green London 1963.
• Simi KGV Trustees of Britmus London: Insects and other Arthropods of Medical importance, 1973.
• Wigglesworth V. B.: The principles of Insect Physiology, Chapman and Hall Ltd. London. 7th Ed. 1972.</td><td></td></tr>
</table>

<table>
<tr><td colspan="3">MSc II Sem IV Core Courses</td></tr>
<tr><td colspan="3">Zoo - 403: Practical I (corresponding to Zoo 401 (C) Entomology II)
Insect Physiology and Applied Entomology</td></tr>
<tr><td>Total Hours: 60</td><td>Program specific objective
• To develop a strong foundation in entomology, including understanding of the importance of insects to human society.
• To know the process of digestion and metabolism, circulation, excretion, respiration, role of hormone in insect reproduction.
• To familiarize the students with identification of insect pests, vectors and their control methods.
• To develop a sufficient background for those students who wish to study more advanced entomological topics.</td><td>Credits: 2</td></tr>
<tr><td></td><td>Program specific outcomes
After successful completion of this course, students are expected to:
• Acquire the knowledge of process the process of digestion and metabolism, circulation, excretion, respiration, role of hormone in insect reproduction.
• Understand the systematic position, habit and habitat of Insects pests.
• Acquire the knowledge about morphology, physiology, ecology, behavior and physiology of insect pests.
• Acquire the knowledge of identification of insect pests, vectors and their control methods.</td><td></td></tr>
<tr><td></td><td>Insect Physiology</td><td></td></tr>
<tr><td></td><td>• Detection of chitin in insects
• Detection of $CaCO_3$ in Malphigian tubules of cockroach
• Study of haemocytes in insect haemolymph
• Detection of Uric acid in Malphigian tubules of cockroach
• Estimation of Amylase activity in alimentary canal of Cockroach
• Counting of Heart beats of cockroach by using normal insect saline and effect of drugs, temperature on Heart beats</td><td></td></tr>
<tr><td></td><td>Applied Entomology</td><td></td></tr>
</table>

<table>
<tr><td></td><td>

- Study of insect pests of agricultural importance
  - Agricultural crop pests: Maize, Sugarcane
  - Pests of Vegetables: Bhendi, Brinjal, Cabbage
  - Pests of Fiber Crops: Cotton and Jute
  - Pests of Fruit Plants: Lemons, Mango, guava.
  - Pests Oil Seeds: Ground nut, Soyabean

</td><td></td></tr>
<tr><td></td><td>

- Study of Insect Vectors of Man:
Mosquitoes, House fly, Bedbug, Head louse
- Study of Insect Pest of Cattle and Domestic Animals:
Mite, Horn fly, Horse fly

</td><td></td></tr>
<tr><td></td><td>

- Study of Stored Grain and Household Pests:
Flour beetle, Rice weevil, Pulse beetle
- Study of Forest Pests:
Termites, Borers, Defoliators etc.
- Study of Forensic Insects:
Flesh fly, Blow fly
- Compulsory Field Trip:
To visit Agriculture University, Institute etc.

</td><td></td></tr>
<tr><td>Suggested Readings</td><td>

- Bursell E.: An Introduction to Insect Physiology, Academic Press Inc. New York, 1978
- Crop pests and how to fight them: Govt. of Maharashtra Pub. Bombay.
- Pfadt R.E.: Fundamental of Applied Entomology, Mac Millan, New York, 2^{nd} Ed.1971.
- Pradhan S.: Insect pests of crop, NBY, New Delhi 1969.
- Rock Stein M.: The Physiology of Insects by Vol. I- VI, Academic press London 1973-76.
- Roy D. N. and A WA Brawn: Entomology, The Banglore Printing and Publ. Co. Ltd. 1970.
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- Simi KGV Trustees of Britmus London: Insects and other Arthropods of Medical importance, 1973.
- Wigglesworth V. B.: The principles of Insect Physiology, Chapman and Hall Ltd. London. 7th Ed. 1972.

</td><td></td></tr>
</table>

M. Sc. II: Semester IV Core Courses		
Zoo 401 (D) Helminthology-1I		
Total Hours: 60	**Program specific objective** • The programme has been designed in such a way so that the students get the flavour of classical and modern aspects of Zoology/Animal Sciences. • It aims to enable the students to study Heminthology-I1 as a core course. • The lab courses have been designed in such a way that students will be trained to join public or private labs.	Credits: 4
	Program specific outcomes The student at the completion of the course will be able to: • Understand the Helminthology-II. • Know about the classification of Nematodes. • To be familiar with the life cycle of various nematodes • Students learn about the Nature, pathogenicity and prevention of ecto and endoparasites. • Their identification, nature of damage control of these nematodes.	Lectures 60
Unit	**Topics**	
Unit I	1. General control measure of endo-parasites. Chemical, Biological, Physical/ Mechanical, Culture and Legislative. 2. Economic importance of parasites, direct or indirect effect on human, animal, farm animals and agriculture, poultry and fisheries pathogenicity. 3. General pattern of parasitic transmission. 4. Parasitic zoonosis.	14
Unit II	Study of medically and veterinary important Parasitic Nematodes. a. Intestinal nematodes infective in egg stage. b. Intestinal nematodes infective in larval stage. c. Blood & tissue dwelling nematodes	08
Unit III	1. Feeding and nutrition's in Nematodes. 2. Reproductive system in male, female, fertilization, development and hatching of eggs. 3. Molting and Development in nematodes. 4. Different life cycle patterns in Nematodes. 5. Morphology, life cycle, pathogenicity, control and Prevention of following types. *a. Strongyloides stercoralis* *b. Wuchereria bancrofti* *c. Trichenella spiralis* *d. Trichuris trichura*	16

	e) Dracunculuc medinensis	
Unit IV	1. General organization and Outline classification of plant Nematodes. 2. Feeding habits and modifications in anterior region. 3. Symptoms of Nematode injuries to plants (above ground. below ground)	10
Unit V	1. Controlling nematode diseases of plants (Cultural, biological, chemical, physical, legislative) 2. Life cycle studies of followings *a.* Root knot Nematodes (*Meloidogyne)* b. Citrus Nematodes (*Tylenchulus)* c. Bud and leaf Nematodes (*Aphelenchoides)* *d.* Seed gall Nematodes (*Anguina)*	12
Suggested Readings	• Text book of medical Parasitology - Dey • Structure of Nematode - Allen bird • An introduction to Nematodology - Chitwood • Organization and Biology of nematodes -Crool • Physiology of nematodes - Lee • Principal of Nematodology - Throne • Applied Parasitology - Hiware, Jadhav and Mohekar • Physiology of nematode parasite - Smith • Animal Nematodes from Indian Mammals - Nama, Shinde and Jadhav • Vertebrate Nematodes - York and Mapelston • Physiology of nematode parasites - Bee • Nematodes Parasites of domestic animal - Levine • Structure of Nematodes -Allen Bird • Biology of nematode - Crool	

<table>
<tr><td colspan="3">MSc I Sem II Core Courses</td></tr>
<tr><td colspan="3">Zoo 403 Practical correspond to Zoo - 401 (D) Helminthology II</td></tr>
<tr><td>Total Hours: 60</td><td>Program specific objective
• To understand the process of Study the Collection, fixation and staining methods of nematodes
• To understand key of Identification for nematodes.
• To practice camera lucida for sketching of nematodes
• To study the various types of nematodes in vertebrates</td><td>Credits: 2</td></tr>
<tr><td></td><td>Program specific outcomes
After successful completion of this course, students are expected to:
• Study the Collection, fixation and staining methods of nematodes
• Understand key of Identification for nematodes.
• Practice camera lucida for sketching of nematodes
• Study the various types of nematodes in vertebrates</td><td></td></tr>
<tr><td>Practical</td><td>• Techniques for collection and Fixation of nematodes from various hosts.
• Basic techniques of preservation and mounting of Nematodes.
• Identification of collected nematodes.
• Sketching of the nematodes with the help of Camera Lucida
• Examination of fecal sample of sheep, goat and chicken for different helminthes ova and their identification.
• Study of permanent whole mount slides: (At least 8).</td><td></td></tr>
</table>

	• Submission of permanent slides at the time of examination. • Visit to veterinary and medical parasitology laboratory	

<table>
<tr><th colspan="3">MSc II Sem IV Core Courses</th></tr>
<tr><th colspan="3">Zoo – 402: Molecular Biology</th></tr>
<tr><td>Total Hours: 60</td><td>Program specific objective
To understand the basic structure of cells, tissues and their working system.
Know the handling skill in laboratory methods of estimation, determination, working of cells and their molecules.
Use of binocular research microscope and bioinstrumentation in laboratory.</td><td>Credits: 4</td></tr>
<tr><td></td><td>Program specific outcomes
After successful completion of this course, students are expected to:
Acquire skills related to molecular analysis of biological species, cells and tissues.
Predict the outcome of various cellular reactions carried out in cell and cellular system under various conditions.
Predict the role of genes and its relevance to human genetics and diseases.</td><td>Lectures
60</td></tr>
<tr><td>Unit</td><td>Topics</td><td></td></tr>
<tr><td>Unit I</td><td>DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms</td><td>12</td></tr>
<tr><td>Unit II</td><td>RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport</td><td>12</td></tr>
<tr><td>Unit III</td><td>Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proofreading, translational inhibitors, post- translational modification of proteins.</td><td>12</td></tr>
<tr><td>Unit IV</td><td>Control of gene expression at transcription and translation level: Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing</td><td>12</td></tr>
<tr><td>Unit V</td><td>Tools and Techniques in Molecular Biology. i. Polymerase chain reaction (PCR); ii. Electrophoresis- PAGE, SDS - PAGE and Agarose gel electrophoresis. iii. Blotting techniques: Southern, Northern and Western blotting iv. ELISA technique and v. DNA finger printing</td><td>12</td></tr>
<tr><td>Suggested Readings</td><td>Prakash S. Lohar : Cell and Molecular Biology, MJP Publishers, Chennai</td><td></td></tr>
</table>

	• Gerald Karp: Cell and Molecular Biology, John Wiley and Sons International, London • H.S. Bhamrah: Molecular Cell Biology • J.D. Watson: Molecular Biology of the gene • P.K. Gupta: Cell and Molecular Biology	

MSc I Sem II Core Courses		
Zoo 403 Practical correspond to Zoo - 402 Molecular Biology		
Total Hours: 60	**Program specific objective** • To know process of making paper model of DNA • To estimate DNA and demonstrate vital staining • To understand the process of AGE and PAGE	**Credits: 2**
	Program specific outcomes After successful completion of this course, students are expected to: • acquire the knowledge related to preparation of DNA model • learn the process of estimation of DNA and vital staining • understand the process of AGE and PAGE.	
Practical	1. Study of cell fractionation (D) 2. Preparation of Paper Model of DNA (D) 3. Extraction of DNA from rat liver/ Spleen (E) 4. Estimation of DNA from suitable material by Diphenylamine reagent. (E) 5. Estimation of RNA from suitable material by Orcinol reagent. (E) 6. Vital staining of mitochondria by using Janus Green B stain. (E) 7. Preparation of salivary gland chromosome from Chironomus / Drosophila larva. (E) 8. Isolation of Genomic DNA from suitable material. 9. Determination of Thermal melting point (Tm) of nucleic acid. 10. Isolation of plasmid DNA and detection by Agarose gel electrophoresis. 11. Detection of protein by PAGE and molecular determination. **12.** Gene mapping in Prokarytes problem.	

MSc II Sem IV **Zoo 404: Project**	**Credit 4**
Special Instruction	Project on suitable topic should be given to each student in the beginning of 3rd Semester and through the year work should supervised and finally Project Report with following points should be typed, bind (at least 30 pages) and submitted to department before final examination (4th Semester).
	Title of the Project: Define a short, significant title which reflects clearly the contents of the report.
	Abstract: Succint abstract of less than one page.
	Table of content: The table of content lists all chapters (headings/subheadings) including page number
	Introduction: Explain why this work is important giving a general introduction to the subject, list the basic knowledge needed and outline the purpose of the report.
	Background and results to date: List relevant work by others, or preliminary results you have achieved with a detailed and accurate explanation and interpretation. Include relevant photographs, figures or tables to illustrate the text. This section should frame the research questions that your subsequent research will address.
	Aims and Objectives: List the main research question(s) you want to answer. Explain whether your research will provide a definitive answer or simply contribute towards an answer.
	Methodology: Explain the methods and techniques which will be used for your project depending on the subject: field work, laboratory work, modeling technique, interdisciplinary collaboration, data type, data acquisition, infrastructure, software, etc.
	Discussion / Conclusion: Explain what is striking/noteworthy about the results. Summarize the state of knowledge and understanding after the completion of your work. Discuss the results and interpretation in light of the validity and accuracy of the data, methods and theories as well as any connections to other people's work. Explain where your research methodology could fail and what a negative result implies for your research question
	Acknowledgement: Thank the people who have helped to successfully complete your project, like project partners, tutors, etc.
	Reference & Literature (Bibliography): List papers and publication you have already cited in your proposal or which you have collected for further reading. The style of each reference follows that of international scientific journals.

	Appendix: Add pictures, tables or other elements which are relevant, but that might distract from the main flow of the proposal.

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MSc II Sem IV Elective Course (Any one from A,B and C)		
Zoo 405 (A): Zoogeography		
Total Hours: 60	**Program specific objective** • The course is designed to provide students with an understanding of zoogeography, the study of the spatial patterns, or geography, of animals. • Examine environmental and zoogeographic patterns • Develop an understanding of the influence of earth history and basic zoogeographic processes on animals • Explore the application of zoogeography to conservation of animals • The course will finish by applying this knowledge to an understanding of current issues in biodiversity.	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • show mastery in the broad areas of environmental factors and their variation on various spatial and temporal scales • learn ecological and evolutionary biogeography, and application of such knowledge to conservation biology.	**Lectures** 60
Unit	**Topics**	
Unit I	**Introduction to Zoogeography** • History. Concepts- Zoogeography. • Definitions, Nature, Scope, Principles, Disciplines – Geography, Plant ecology and evolution, Geology, Ethnology • Environmental and geographical settings Physical Setting: the Geographic Template • The Changing Earth, continental drift.	**12**
Unit II	**The Geography of Communities** • Distributions of communities • Glaciation and its biotic effects • Glaciation and Biogeographic Dynamics of the Pleistocene • Speciation and its geographical context Endemism, cosmopolitanism, and disjunction • Classification and Mapping of Animals. • Factors of animal mapping: Shape of area, Structure of area, Ecology of area, History of area, Relict area, Geography of area, Dynamic of area, Community area, areas of Aquatic animals.	**12**

Unit III	**Dispersal and Immigration** • Animal Dispersai :- Factors of Animals dispersal: – Climate, Vegetation, Physical barriers, other animals. • Types of Animals dispersal- Active, Passive, Gradual, Rapid, Seasonal, Forced, Anthropogenic. • Barriers of Animals dispersal – Physical, climatic, biological Water, Ecological, Living environment, Time and distance. • Modes of dispersal • Dispersal routes of faunas.	**12**
Unit IV	**The Geography of Diversification** • Types of distribution of animals- Areography, Ecogeographic Rules, and Diversity Gradients • The Distribution of Species: Ecological Foundations • Distributions of single species, • Types of Distribution continuous discontinuous Bipolar. • Bathymetric distribution- Geobiotic Limnobiotic Holobiotic. • Theories of distribution of animals climatic and evolution theory of Matthew, age and area theory of Willis • Zoogeographical regions of the world with characteristic fauna	**12**
Unit V	• Eco- Geographic System Concept, Allen's Eco-geographic system, evolution of new species and their causes, faunal main and sub-regions-land, aquatic. • Factors affecting on ecology of animals - light , weather , food , temperature, space, mobility, shelter, soil , plant formation and size of population. • Marine realm and characteristics. Biogeography and the Geography of Extinction Conservation Biogeography	**12**
Suggested Readings	• Frank Evers Beddard (2008): A Text-Book of Zoogeography, Published by BiblioBazaar, • John R. Merrick (2006): Evolution and Biogeography of Australasian Vertebrates. Publisher • Savindra Singh (1997): Environmental science, Prayang Pustak Bhawan, Allahabad • Tiwari S.K. (1985): Zoo-Geography of India and South East Asia. International Book Dist. Dehra Dun. • Tiwari, S. K Wallace.(2006): Fundamentals of World Zoogeography. Vedams eBooks (P) Ltd (India) • Wallace A.R., (1962): The geographical distribution of animals. Hafner Publ. Co. • Illies, J .1974 .Introduction to zoogeography .Macmillan . • International commission for zoological Nomenclature(ICZN). 1999 . International code ofzoological Nomenclature. Nature History Museum Cromwell Road, London S W 7 5BDUK • .Kapoor, v.c Theory and practice of Animal Taxonomy Oxford – IBH publishing co., N Delhi ,Mumbai & Kolkata . • Mayer , E. Principles of systematic zoology . Mc-Graw Hill publication, New Delhi Simpson , G.C. Principles of Animal Taxonomy. Oxford –IBH publishing co, New Delhi	

MSc II Sem IV Elective Course		
Zoo – 405 (B):Writing and Presenting Scientific Research Paper		
Total Hours: 60	**Program specific objective** • To understand the process of writing, presentation and publication of research paper • To learn the skills related to presentation of paper • To avoid the mistakes in writing research paper	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • acquire the knowledge of writing, presentation and publication of research paper • gain the skills related to presentation of paper • learn to avoid the mistakes in writing research paper	**Lectures** 60
Unit	**Topics**	
Unit I	**Introduction to writing research project** Purpose of writing research report of dissertation and thesis, style and structure of research report, preliminary section. **Review of Literature** Purpose, method and Types**:** Aargumentative, Integrative, Historical, Methodological, systematic and theoretical.	**12**
Unit II	**Writing a research report**: Main body of the report, - introduction, review of literature, methods of study, results and analysis of data, summary, suggestion, conclusion of data and reference section. **General precautions**, editing and correction, final evaluation of research report, **IMMRAD** pattern of research report.	**12**
Unit III	**Use of visual aid for effective presentation**: Power point presentation: Synopsis, summary, abstract, tables, graphs,Summary, References, Acknowledgement Poster presentation: Appropriate size of the poster with Title, author,	**12**

	affiliation, introduction material and methods, results, summary selection of appropriate font size, table, figure, etc	
Unit IV	**Common mistakes in writing scientific paper** • Unclear aim • Structure of the manuscript is confusing • Methods without enough details • Wrong statistic used • Sections are mixed up • Conclusions do not match with present results • Writing inaccurate • Citations/references are incomplete	**12**
Unit V	**Guidelines for paper publication:** • Formatting of the paper as per rules of **journal** • Guidelines for Author. • Submission of Article. • Assigned Reviewers. • Decision by Reviewers. • Reviews to the Author. • Updated Paper Received. • Feedback.	**12**
Suggested Readings	• Dr. Nageshwar Rao and Dr. Rajendra P. Das: Communication Skills, HimalayaPublishing House 2005 • Margerson, J.E.: The Art of effective communication, Excel Books New Delhi • Richard, W. Clark and Barbara, L. Clinton: Effective Speech Communication, MacMillan, Mac Graw Hill, New York, 1999 • N. Gurumani, Research Methodology for biological sciences, MJP publishers,Chennai • Gopen, G.D. and Swan J.A. The Science of Writing, American Scientist, 1990 •• Hall, G.M. How to write a paper, By Word publication, 1996	

MSc II Sem IV Elective Course		
Zoo – 405 (C):Computational Biology		
Total Hours: 60	**Program specific objective** • To get introduced to the basic concepts of Computational biology • To overview about types of Biological data and database search tools. • To acquire knowledge about computational tools for Proteomics and Genomics	**Credits: 4**
	Program specific outcomes After successful completion of this course, students are expected to: • learn the basic concepts of Computational biology • gain knowledge about types of Biological data and database search tools. • acquire skill to use computational tools for Proteomics and Genomics	**Lectures** 60
Unit	**Topics**	
Unit I	• Definition, Objectives and scope of Computational Biology • Application of Bioinformatics in various Fields. • Concept of Biological database • Types and significance of biological database	**12**
Unit II	• Concept of Sequence alignment • Types of sequence alignment • BLAST, types and applications • FASTA, format and applications	**12**
Unit III	• Proteomics : Definition and significance • Protein structure visualization tools • Protein sequence databases- • Protein folding and disorders • PDB and Protein microarray	**12**

Unit IV	• Genomics: Definition and significance • Comparative, structural and functional genomics • DNA microarry • Human Genome Project	**12**
Unit V	A)Computational analysis of the genomics of • *Escherchia coli* • *Drosophila melanogaster* • *Rattus rattus* B) GenBank, DDBJ, EMBL	**12**
Suggested Readings	• Attwood, T.K., Michie, A.D. and Jones, M.L.(1996): DbBrowser: integrated access to databaseworldwide. *TiBS*. Vol. 21(5), 191. • Barnes, M.R. and Gray, I.C.(2003) eds.,*Bioinformatics for Geneticists*, first edition. Wiley,ISBN 0-470-84394-2 • Prakash S.Lohar (2011) Bioinformatics ISBN 978-81-8094-066-8 MJP Publishers, Triplicane, Chennai. • Lesk, A.M. (2001): *Introduction to ProteinArchitecture: The Structural Biology of Proteins*(Oxford: Oxford University Press). • Pocock,M.R. et al. (2000) BioJava: open sourcecomponents for bioinformatics. ACM SIGBIO	

Kavayitri Bahinabai Chaudahri
North Maharashtra University, Jalgaon
M. Sc. (Part I) Zoology
Equivalence 2017-18 (Old courses) with 2021-22 (New Courses)

Paper Code	Old Courses 2017-18	Paper Code	New Courses 2021-22
Semester I			
ZOO 101	Structure and Function of Invertebrates	ZOO 101	Structural and Functional Anatomy of Invertebrates
ZOO 102	Cell and Developmental Biology	ZOO 102	Cellular Organization and Developmental Biology
ZOO 103	Quantitative Biology	ZOO 103	Practical I: Zoo 101
ZOO 104	Practical	ZOO 104	Practical I: Zoo 102
ZOO 105	Practical	ZOO 105	Goatary (Skill based)
		AC 101	Practicing Cleanliness
Semester II			
ZOO 201	Structure and Function of Vertebrates	ZOO 201	Structural and Functional Anatomy of Vertebrates
ZOO 202	Biochemistry and Enzymology	ZOO 202	Biochemistry
ZOO 203	Tools and Techniques for Biology	ZOO 203	Tools and Techniques in Biology
ZOO 204	Practical	ZOO 204	Practical I: Zoo 201+202+203
ZOO 205	Practical	ZOO 205	Aquaculture and Ecology (Skill based)
		Audit Course	Any one
		AC-201A	Soft Skills
		AC-201B	Sport Activities
		AC-201C	Yoga
		AC-201D	Music

KBC North Maharashtra University, Jalgaon

M. Sc. (Part II) Zoology

Equivalence 2018-19 (Old courses) with 2022-23 (New Courses)

Paper Code	Old Courses 2018-19	Paper Code	New Courses 2022-23
Semester III			
ZOO 301 (Any one from A,B,C,and D) Specialized paper	(A) Entomology I or (B) Animal Physiology I (C) Reproductive Physiology I (D) Helminthology I	ZOO 301 (Any one from A,B,C,and D) Specialized paper	(A) Animal Physiology I (B) Reproductive Physiology I (C) Entomology I (D) Helminthology I
ZOO 302	Immunology and Molecular Biology	ZOO 302	Enzymology and Immunology
ZOO 303	Genetics	Elective course ZOO 303 (Any one)	Animal Behaviour Forensic Zoology Endocrinology
		Audit Course	Any one
		AC-301A	Computer Skills
		AC-301B	Cyber Security
		AC-301C	Seminar + Review Writing
		AC-301D	Biostatistics
ZOO 304	ZOO 304: Practical 301 + 302	ZOO 304	Practical I: Zoo 301
ZOO 305	ZOO 305: Practical 302 + 303	ZOO 305	Practical II: Zoo 302
		AC-301 Audit Course	Any one
		AC-301A	Computer Skills
		AC-301B	Cyber Security
		AC-301C	Seminar + Review Writing
		AC-301D	Biostatistics
Semester IV			
ZOO 401 (Any one from A,B,C,and D) Specialized paper	(A) Entomology II or (B) Animal Physiology II or (C) Reproductive Physiology II or (D) Helminthology II	ZOO 401 (Any one from A,B,C,and D) Specialized paper	(A) Animal Physiology II (B) Reproductive Physiology II (C) Entomology II (D) Helminthology II
ZOO 402	Systematic and Evolutionary Biology	ZOO 402	Molecular Biology
ZOO 403	Skill in Communication and	ZOO 403	A) Zoogeography

	Writing Research Paper	Elective (Select any one)	B) Writing scientific research paper C) Computational Biology
ZOO 404	ZOO 404: Practical 401 + 402	ZOO 404	Practical I: Zoo 401 + Zoo 402
ZOO 405	ZOO 405: Practical 402 + 403	ZOO 405	Project
		Audit Course	Any one
		AC-401A	Human Rights
		AC-401B	Current Affairs
		AC-401C	Seminar + Review Writing
		AC-401D	Intellectual Property Rights (IPR)

‘A’ Grade
NAAC Re-Accredited
(3^{rd} Cycle)

KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY, JALGAON

Academic Curriculum
(For Affiliated Colleges of KBC NMU)

M. Sc. Part-1
CHEMISTRY
(Semester I and II)

Choice Based Credit System (60:40 Pattern)
(Outcome Based Curriculum)
As Per U.G.C. Guidelines

To Be Implemented From

Academic Year 2021-22

SYLLABUS

M. Sc. Part-1
CHEMISTRY (Semester I and II)

Summary of Distribution of Credits under CBCS Scheme
[at affiliated colleges w.e.f. academic year 2021-22]

Sr. No.	Type of course	Sem I	Sem II	Sem III	Sem IV
01	Core	**12**	**12**	**12**	**08**
02	Core Skill Based	**02**	**20**	**-**	**12**
03	Elective	**-**	**-**	**04**	**04**
04	Project	**-**	**-**	**-**	**06**
05	Audit	**02**	**02**	**02**	**02**
06	Total Credits	**16**	**34**	**18**	**32**

Subject Type	Core	Core Skill Based	Elective	Project	Audit	Total
Credits	**44**	**34**	**08**	**06**	**08**	**100**

Total Credits = 100

Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon

M. Sc. Part-1 Chemistry (Sem-I and II)
[at affiliated colleges w.e.f. academic year 2021-22]

Choice Based Credit System (Outcome Based Curriculum)

Course credit scheme

Semester	(A) Core Courses			(B) Core Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Practical)	Total Credits	
I	3	12	**12**	1	2 + 0	02	1	2	2	**16**
II	3	12	**12**	4	2 + 18	20	1	2	2	**34**
III	3	12	**12**	1	4 + 0	04	1	2	2	**18**
IV	2	08	**08**	4	4 + 18	22	1	2	2	**32**
Total Credits	**44**			**48**			**8**			**100**

(T, Theory; P, Practical)

Structure of Curriculum

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
(A)	**Prerequisite and Core Courses**									
	Theory	14	4	14	4	12	3	08	2	48
	Practical	-	-	18	3	-	-	18	3	36
(B)	**Core Skill Based / Subject Elective Courses**									
1	Theory /Practical	-	-	-	-	4	1	4	1	08
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course			2	1					2
3	Technology Related + Value Added Course					2	1			2
4	Professional and Social + Value Added Course							2	1	2
	Total Credit Value	16	5	34	8	18	5	32	7	100

***List of Audit Courses** (Select any ONE course of Choice from Semester II; Semester III and Semester IV)*							
Semester I (Compulsory)		**Semester II** (Choose One) **Personality and Cultural Development**		**Semester III** (Choose One) **Technology + Value Added Course**		**Semester IV**(Choose One) **Professional and Social + Value Added Course**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Practicing Sport Activities	AC-301B	Cyber Security	AC-401B	Current Affairs
		AC-201C	Practicing Yoga	AC-301C	Molecular Docking	AC-401C	Technical Report Writing
		AC-201D	Introduction to Indian Music	AC-301D	Seminar on Review of Research Paper	AC-401D	Intellectual Property Rights (IPR)

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Syllabus under CBCS for M. Sc. Part-I Chemistry
Syllabus Structure (w.e.f. 2021-22)
Semester-I

Course Code	Course Type	Title of the Course	Contact hours/week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th (L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
CH-110	Core	Physical Chemistry-I	04	--	04	40	--	60	--	100	--	04
CH-130	Core	Inorganic Chemistry-I	04	--	04	40	--	60	--	100	--	04
CH-150	Core	Organic Chemistry-I	04	--	04	40	--	60	--	100	--	04
CH-190	Core Skill Based	Industrial Safety and Good Laboratory Practices	02	--	02	20	--	30	--	50	--	02
AC-101	**Audit Course**	Practicing Cleanliness	--	02	02	--	100	--	--	--	100	02

Semester-II

Course Code	Course Type	Title of the Course	Contact hours/week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th (L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
CH-210	Core	Physical Chemistry-II	04	--	04	40	--	60	--	100	--	04
CH-230	Core	Inorganic Chemistry-II	04	--	04	40	--	60	--	100	--	04
CH-250	Core	Organic Chemistry-II	04	--	04	40	--	60	--	100	--	04
CH-290	Core Skill Based	Instrumentation and Analysis	02	--	02	20	--	30	--	50	--	02
*CH-P-1	Core Skill Based	Physical Chemistry Practical-I	--	06	06	--	40	--	60	--	100	06
*CH-I-1	Core Skill Based	Inorganic Chemistry Practical-I	--	06	06	--	40	--	60	--	100	06
*CH-O-1	Core Skill Based	Organic Chemistry Practical-I	--	06	06	--	40	--	60	--	100	06
AC-201 (A)/ (B)/(C)/(D)	**Audit Course**	Choose one out of four (AC-201 A/B/C/D) (Personality and Cultural Development Related)	--	02	02	100	--	--	--	100	--	02

*** To be started from Semester-I & evaluated at the end of Semester-II**

List of elective courses to be offered in Semester-II:

AC-201 (A): Soft Skills	**AC-201 (C): Practicing Yoga**
AC-201 (B): Practicing Sports Activities	**AC-201 (D): Introduction to Indian Music**

Syllabus for M.Sc. Part-I Chemistry

(Semester - I & II)

Course Structure for First Year

Course Code	Course Type	Title of the Course
		Semester – I
CH-110	Core	Physical Chemistry-I
CH-130	Core	Inorganic Chemistry-I
CH-150	Core	Organic Chemistry-I
CH-190	Core Skill Based	Industrial Safety and Good Laboratory Practices
AC-101	Audit Course	Practicing Cleanliness
		Semester – II
CH-210	Core	Physical Chemistry-II
CH-230	Core	Inorganic Chemistry-II
CH-250	Core	Organic Chemistry-II
CH-290	Core Skill Based	Instrumentation and Analysis
CH-P-1	Core Skill Based	Physical Chemistry Practical-I
CH-I-1	Core Skill Based	Inorganic Chemistry Practical-I
CH-O-1	Core Skill Based	Organic Chemistry Practical-I
AC-201 (A)/ (B)/(C)/(D)	**Audit Course**	Choose one out of four (AC-201 A/B/C/D) (Personality and Cultural Development Related) AC-201 (A): Soft Skills AC-201 (B): Practicing Sports Activities AC-201 (C): Practicing Yoga AC-201 (D): Introduction to Indian Music

Important Notes:

1. Each theory course prescribed for M. Sc. should be covered in 4 lectures, each of 60 minutes duration per week per course including lectures, tutorials, seminars, classroom discussions etc. (Total 60 hrs. / theory course)

2. Each practical course will require 06 hours of laboratory work per week and will be extended over two semesters. All three practical courses will be examined at the end of the academic year. (Total 180 hrs. / practical course)

3. There should not be more than 10 students in a batch for M. Sc. Practical course.

4. For theory course, the question paper (Internal/External) should include numerical, short answer, long answer, MCQ questions, problem solving approach to test understanding of the subject.

5. In the 60 lectures theory course about 10 lectures will include tutorials, student seminars, classroom discussions and tests.

6. The marks for each paper are distributed as external examination 60 marks and internal examination 40 marks. For internal assessment of each theory and practical course, 2 written tests will be taken.

7. The 75 % attendance of students is compulsory.

8. Students should visit at least five chemical industries in the first year of M. Sc. and submit the observations/report to the Department.

Semester-wise Course Structure of M.Sc. Organic Chemistry

Program at a Glance

Name of the program (Degree)	:	M. Sc. (Organic Chemistry)
Faculty	:	Science and Technology
Duration of the Program	:	Two years (four semesters)
Medium of Instruction and Examination	:	English
Exam Pattern	:	60 : 40 Pattern (60 marks University exam and 40 marks continuous internal departmental exam/assessment)
Passing standards	:	40% in each exam separately (separate head of passing)
Evaluation mode	:	CGPA
Total Credits of the program	:	100 (44 core credits including 6 credits of project/dissertation, 34 skill enhancement credits, 08 subject elective credits and 08 audit credits)

CH-110: Physical Chemistry - I (60 L, 100 Marks and 4 Credits)		
Course Objectives: 1. To learn the principals and foundations of quantum chemistry. 2. To get oriented towards the basic theory underlying the chemical bond. 3. To acquire knowledge about the different possible equilibrium in nuclear decay processes. 4. To learn the basic concepts about the interaction of high energy radiations with matter. 5. To learn the theory and concepts behind the electrochemical processes and ionic equilibria.		
Unit No.	**Name of the unit**	**Lectures**
1	**Essentials of Quantum Chemistry** Recapitulation of basic concepts of quantum chemistry, Schrodinger equation, normalization with examples, Hermitian operator and its theorems, postulates of quantum mechanics, free particle, particle in one dimensional box and its application for excitation energies in linear conjugated systems, two and three dimensional box, wavefunction and probability density plots, degeneracy, simple harmonic oscillator, energy eigenvalues, Ψ and Ψ^2 plots, even and odd functions, rigid rotator, spherical polar coordinates, separation of variables and energy values. Hydrogen atom Schrodinger wave equation (derivation not expected), radiation distribution functions, dependence of spherical harmonics of angles (shape of orbitals only introduction), and related numerical. **Ref. 2, 3, 4, 6, 8**	**12**
2	**Chemical Bonding** Variation principle, approximation, LCAO-MO, H_2^+ molecular ion, importance of coulomb and exchange integrals, Born-Oppenheimer approximation and the approximated Hamiltonian, VBT to H_2 molecule (derivation not expected) Comparison between MOT and VBT, valence electron approximation, HMO theory and its application to ethylene and butadiene. **Ref. 2, 3, 4, 6, 8**	**12**
3	**Nuclear Chemistry** Parent-daughter decay-growth relationships: daughter nucleus stable, general expression for activity of daughter, parent shorter and longer lived than daughter, parent and daughter of nearly the same half-life, secular and transient equilibrium. Applications of radioactivity: Typical reactions involved in the preparation of radio isotopes (^{22}Na, ^{32}P), Szilard - Chalmer's reaction, Isotope dilution and neutron activation analysis, and related numerical **Ref. 5, 8**	**12**
4	**Radiation Chemistry** Elements of radiation chemistry: primary effects of interaction of radiation with matter, LET, Bremsstrahlung. Interaction of gamma radiation with matter: photoelectric effect, Compton scattering and pair production, units of measuring radiation absorption. Radiation dosimetry: units of dose, Fricke and Ceric sulphate dosimeters, conversion of measured dose values and related numerical.	**12**

	Ref. 5, 8	
5	**Electrochemistry** Strong electrolytes, ionic strength, activity and activity coefficients of strong electrolytes, Debye Huckel theory of conductivity (derivations not expected), ionic atmosphere, relaxation and electrophoretic effects, DHO equation (mathematical derivation not expected), its validity and deviations, Debye-Huckel theory of activity coefficients: Debye-Huckel limiting law (derivation expected), its testing and deviations. Transport number: definition and its relation to ionic mobility, Moving boundary and Hittorf's theoretical and experimental method and related numerical **Ref. 1, 6, 7, 8**	**12**

References:

1. P. W. Atkins, J. D. Paula, Physical Chemistry, Oxford University Press
2. Donald McQuerry , Quantum Chemistry, Viva Books
3. R. K. Prasad, Quantum Chemistry, New Age International
4. I. Levine, Quantum Chemistry, Pearson Education
5. H. J. Arnikar, Essentials of Nuclear Chemistry
6. D. A. McQuerry & J. D. Simon, Physical Chemistry Molecular Approach, Viva Books
7. S. H. Maron and C. F. Prutton, Principles of Physical Chemistry, Oxford and IBH Publishing Co.
8. Dr. L. S. Patil, Physical Chemistry I, Shree Book Co. Mumbai

Course Outcomes (CO):

After successful completion of the course students are expected to

No.	CO	Cognitive level
1	Apply the quantum mechanical principles to simple systems of chemical interests	**3**
2	Differentiate between the nature of chemical bond concept from MOT and VBT	**2**
3	To identify and write the different types of equilibriums in a given nuclear decay process	**4**
4	To explain the concept of Radiation dose measurement and its practical applications	**2**
5	To be able to calculate the ionic strength and activity coefficients by using the basic concepts underlying.	**5**

CH-130: Inorganic Chemistry - I (60 L, 100 Marks and 4 Credits)		
Course Objectives: 1. The course offers the basic concepts of inorganic chemistry lying on synthesis, structure, bonding and properties of some selected main group elements. 2. The course helps to build up a conceptual framework for understanding the principles and theories for chemical bonding and properties of inorganic compounds. 3. The course furnishes detail knowledge about synthesis, types of bonding, properties etc.		
Unit No.	**Name of the unit**	**Lectures**
1	**Molecular Symmetry and Applications** Molecular term symbol for homonuclear diatomic molecules H_2,B_2,C_2,N_2,$O_2$and F_2 molecules Linear tri-atomic molecules – BeH_2, CO_2. Trigonal planar molecule- BF_3, Tetrahedral Molecule – CH_4, Trigonal pyramidal molecule NH_3, Angular Tri-atomic molecules H_2O, NO_2.	**12**
2	**Organometallic compounds of transition metals** Organometallic compounds, molecule orbital theory and 18 electron rule, counting electrons in complexes, alkyl and aryl complexes, alkene complexes, metal π complexes- metal carbonyl and metal nitrosyls.	**12**
3	**Chemistry of non-transition elements** Hydrides-classification, electron deficient, precise and rich hydrides. Study of PH_3, SbH_3, AsH_3, Selenides, Tellurides. Synthesis, properties and structures of alkali and alkaline earth metal compounds, Synthesis and reactivity of inorganic polymer of Si and P.	**12**
4	**Molecular symmetry** Symmetry elements and operations, symmetry planes, reflections, inversion centre, proper / improper axes of rotation, equivalent symmetry elements and atoms, symmetry elements and optical isomerism, Classification of point groups and procedure to determine the point group, with at least one example of each point group.	**12**
5	**Transition Metal Carbonyls and Related Compounds** Introduction, preparation and properties of transition metal carbonyls, structure of transition metal carbonyls, carbonyl hydrides, carbonylate anions and cations, carbonyl halides, phosphine and phosphorous trihalide complexes, dinitrogen complexes, nitric oxide complexes, cyano complexes.	**12**

References:
1. J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry Principles of Structures and R eactivity, 4th edition, New York, NY: Harper Collins College Publishers, 1993.
2. J. D. Lee, Concise Inorganic Chemistry, 5thedn., Blackwell Science, London, 2006.
3. A. G. Sharpe, Inorganic chemistry, 3rd edition, ISBN 9788131706992, Pearson Education, 1981.
4. F.A. Cotton, Chemical Applications of Group Theory,ISBN: 978-0-471-51094-9, 1990.
5. D.F. Shrivers, P.W. Atkins and C.H. Langfor, Inorganic Chemistry, CH Langford, 1990.
6. B.R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., 2005.
7. H. B. Gray, Electrons and Chemical Bonding. W. A. Benjamin, Inc., New York, 1965.
8. H. J. Emeleus and A.G. Sharpe, Modern Aspects of Inorganic Chemistry, Universal Book S tall, New Delhi.
9. K. Lal, S.K. Agarwal, Advanced Inorganic Chemistry, Pragati Prakashan, Meerut, 2017
10. G. S. Manku, Theoretical Principles of Inorganic Chemistry, Tata McGraw-Hill Ed
11. B. Douglas, D.H. Mc. Daniel, J.J. Alexander, Concepts and Models of Inorganic Chemistr, 2nd edition.
12. R. Sarkar, General and Inorganic Chemistry, Part one, New Central Book Agency, Kolkat.
13. P. K. Bhattacharya, Group Theory and its Chemical applications, Himalaya Publishing Ho use.
14. F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann, Advance Inorganic Chemistr, Si xth Edition, John Wiley & Sons, Inc.

Course Outcomes (CO):

After successful completion of the course students are expected to

No.	CO	Cognitive level
1	Apply the fundamental knowledge about the synthesis, structure, bonding and properties of some selected main group elements which are very important in different fields.	**3**
2	Apply fundamental knowledge about molecular symmetry, MOT, organometallic compounds, ionic solids and bioinorganic compounds.	**3**
3	Explain various concepts and theories of various topics from inorganic chemistry.	**2**

CH-150: Organic Chemistry – I (60 L, 100 Marks and 4 Credits)		
Course Objectives: To make the students conversant with the 1. Study of basic concepts of organic chemistry. 2. Study of reaction intermediates. 3. Study of the different classes, mechanism & stereochemistry of reactions.		
Unit No.	**Name of the Units**	**Lectures**
1	**Aromaticity** Huckel's (4n+2) and 4n rules. Aromatic and antiaromatic compounds up-to 18 carbon atoms. Homoaromatic compounds. Aromaticity of all benzenoid systems, heterocycles, azulenes, tropolones, fulvenes, sydnones, annulenes, aromatic ions and Fullerene (C60). **Ref. 3. Page No. 40-67** **Ref. 5, 7, 9 Relevant pages**	**04**
2	**Reactive Intermediates and Concerted Reactions** **(Carbocations, Carbanions, Carbene, Nitrene, and Arynes)** Organic reactive intermediates and their structure, methods of generation, structure, stability and important reactions involving carbocations, carbanions, nitrenes, carbenes, arynes. **Ref. 3. Page No. 165-186, 195-202** **Ref. 4, 5, 6 Relevant pages**	**10**
3	**A. Nucleophilic Substitution reaction** **Aliphatic nucleophilic substitution** a) S_N1, S_N2 and S_N^i mechanism and stereochemistry (regioselectivity and stereospecificity of substitution reaction). b) Nucleophilic substitution at an allylic, aliphatic and vinylic carbon. c) Effect of substrate structure, nucleophile, leaving group and solvent on rate of $S_N1$and S_N2 reactions, ambident nucleophile. **Aromatic nucleophilic substitution** S_NAr, S_N1, Benzyne and S_NR1 reactions, effect of substrate structure, leaving group, solvent and attacking nucleophile. **B. The neighbouring group mechanism** The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance. Non-classical carbocations, phenonium ions, norbornyl system. **Ref. 2. Page No. 406-443.** **Ref. 3. Page No. 255-262, 265-272, 286-289, 298-320** **Ref. 4, 5, 7, 8, 10 Relevant pages**	**14**
4	**Electrophilic Substitution reaction** a) Arenium ion mechanism, orientation and reactivity, energy profile diagram, ortho, para, ipso attack, orientation in other ring systems, six and five membered heterocycles with one hetero atom. b) Important reactions like Friedel crafts alkylation and acylation, nitration, halogenation, formylation, chloromethylation, sulphonation, diazo coupling.	**12**

	Ref. 1. Page No. 447-562 **Ref. 2, 3, 4, 5, 7, 8 Relevant pages**	
5	**Addition reaction** a) Addition to carbon-carbon multiple bonds and carbon heteroatom multiple bonds- Mechanism and stereochemical aspects of addition reaction involving electrophile. b) Structural effects and reactivity: Halogenations, Hydrohalogenation, Hydration, Hydroxylation, Hydroboration, Epoxidation, Carbene addition, Hydrogenation, Ozonolysis. **Ref. 1. Page No. 517-557** **Ref.3, 8, 9, 10 Relevant pages**	**10**
6	**Elimination reaction** a) E1, E2, E1CB mechanisms, Stereo chemistry of elimination, Elimination versus substitution, anti and syn elimination. b) Dehydrohalogenation, Dehalogenation, Dehydration, Hoffmann and Saytzeff's elimination, Pyrolytic elimination. **Ref. 1. Page No. 466-501** **Ref.3, 4, 8, 9, 10 Relevant pages**	**10**

References:

1. Organic chemistry, Fifth edition by Staney H. Pine.
2. Organic Chemistry – by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford).
3. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Forth Edition by Jerry March.
4. A Guide book to Reaction Mechanism in Organic Chemistry–Peter Sykes.
5. Advance Organic Chemistry (Part A and B) –by A. Carey and R.J. Sundherg.
6. Modern methods of organic synthesis – W. Carruthers (Cambridge) .
7. Organic Chemistry: A Brief Course by Robert C. Atkins, Francis A Carey.
8. Organic Reactions & their Mechanisms- P. S. Kalsi.
9. Organic Chemistry- Morrison & Boyd.
10. Stereochemistry conformations and mechanism by P.S. Kalsi

Course Outcomes (CO):

After successful completion of the course students are expected to

No.	CO	Cognitive level
1	Apply the fundamental concepts of organic reaction mechanism in theoretical and practical work, may be in academic, research laboratories, and industries.	**3**
2	Understand the importance and types of organic reactions and their applications.	**2**
3	Acquire knowledge of important characteristics of organic compounds.	**4**

CH-190: Industrial Safety and Good Laboratory Practices (30 L, 50 Marks and 2 Credits)		
Course Objectives: To make the students conversant with the 1. This course offers to create awareness about laboratory safety. 2. This course offers to increase alertness about any hazardous handling at workplace. 3. This course offers to increase awareness about personal protective equipment.		
Unit No.	**Name of the Units**	**Lectures**
1	**Hazards and Safety measures** A) History and importance of safety and health in Laboratory - Moral, legal and financial reasons B) Different types of Hazards at workplace handling chemicals - Physical, chemical, biological, allergens, hazards pertaining electrical system - Effect of hazards on health - Where to find Hazard Information - Reading Labels C) Safety Measures: Safe clothing, hair, dangling jewelry, proper responsible attitude, good housekeeping, use of proper PPE, no food in the laboratories.	**06**
2	**Basic of laboratory safety** Personal Protective and other safety equipment and their uses and demonstration, different types of safety goggles, apron, masks, different filters for masks, face shield, full body suit, safety shoes, helmet, breathing apparatus suit, safety belt and ear muffs along with inspection methods. Emergency exit, its location and approach path, periodic inspection fire extinguishers, first aid kit, its contents and need for monitoring. Eye wash fountains and safety showers, fire drill, and chemical accident drills, accident-free days and incentives to follow safety rules, accident recording and investigation for future controls.	**06**
3	**Introduction to industrial safety** Types of fire extinguishers and their method of use, Material Safety Data Sheets (MSDS), Globally Harmonized System (GHS) Signs (http://www.calstatela.ed/univ/ehs/msds.php) Importance and use of current 16 points format, Labels, Pictograms and some of their discrepancies, Globally Harmonized System for Safety Data Sheets (SDS), label changes (2014).	**06**
4	**Laboratory and chemical waste management** Inventory management, storage and disposal, waste classification, hazardous waste, non-hazardous waste, mixed waste, waste disposal, actions required for - chemical spills, mercury spills, injuries, fires, building evacuations, emergency evacuation procedure.	**06**
5	**Good Laboratory Practices (GLP)** Good Laboratory Practices (GLP), introduction and principles of GLP, performance of laboratory studies and calibration using Standard Operating Procedures (SOPs), instrument validation, reagent certification, laboratory notebook maintenance to contemporary standards, maintenance of laboratory records based on instrument and reagent certification, introduction to ISO and NABL accreditation.	**06**

References:

1. L. Moran, T. Masciangioli, Chemical Laboratory Safety and Security: A Guide to Prudent Chemical Management, The National Academies Press, Washington, DC, 2010.
2. D. C. Finster, Safety in Academic Chemical Laboratory, Vol. II, ACS Publication, 7th Edition, 2003.
3. OECD Series on Principles of Good Laboratory Practices and Compliance Monitoring, 1997.
4. Handbook of Good Laboratory Practices, TDR, WHO, UNICEF, UNDP, 2009.
5. L. Huber, A Primer for Good Laboratory Practices and Good Manufacturing Practices, Agilent Technologies, 2002.
6. T. Kletz, What Went Wrong, Gulf Professional Publisher, 1998.

Course Outcomes (CO):

After successful completion of the course students are expected to

No.	CO	Cognitive level
1	Understand the importance of laboratory safety.	**1**
2	Aware and follow healthy laboratory practices.	**2**
3	Acquire the knowledge about personal protective equipment.	**4**

AC-101: Practicing Cleanliness (Compulsory; College-level Audit Course; Practical; 2 Credits)		
Course Objectives (CObs): • To make students aware of Clean India Mission and inculcate cleanliness practices among them.		

	• Awareness program on
	  ○ Swachh Bharat Abhiyan (Clean India Mission)
	  ○ Clean Campus Mission
	  ○ Role of youth in Clean India Mission
	• Cleaning activities inside and surroundings of Department buildings.
	• Tree plantation and further care of planted trees
	• Waste (Liquid/Solid/e-waste) Management, Japanese 5-S practices
	• Planning and execution of collection of Garbage from different sections of University campus
	• Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance.
	• Cleanest School/Department and Cleanest Hostel contests
	• Painting and Essay writing competitions	

Course Outcomes (CO):
On completion of this course, the student will be able to:

No.	CO	Cognitive level
1	Identify need at of cleanliness at home/office and other public places.	**2**
2	Plan and observe cleanliness programs at home and other places.	**4**
3	Practice cleanliness practices in day-to-day life.	**3**

CH - 210: Physical Chemistry - II (60 L, 100 Marks and 4 Credits)		
Course Objectives: 1. To orient and acquaint the PG students towards the fundamental and advanced aspects of thermodynamics and statistical thermodynamics. 2. To acquire knowledge about kinetics of complex reactions and fast reactions. 3. To evoke the fundamental concepts of YR, electronic and Raman spectroscopy and understand the advance concept involved in it.		
Unit No.	**Name of the Units**	**Lectures**
1	**Thermodynamics** Introduction, enthalpy of a system, molar heat capacities, relation between Cp and Cv, Joule-Thomson effect, third law of thermodynamics, concept and importance of absolute entropy, standard entropy and residual entropy, Maxwell relations (derivation expected), thermodynamic equation of state, partial molar quantity and its significance, partial molar volumes, chemical potential, Gibbs-Duhem equation, thermodynamics of mixing-Gibb's free energy of mixing, entropy of mixing, enthalpy of mixing and related numerical **Ref: 2, 8, 13, 14**	**12**
2	**Statistical thermodynamics** Introduction, Concept of Boltzmann Ensemble, Thermodynamic probability, Sterling approximation, Boltzmann distribution law, partition function and its significance, energy and entropy in terms of partition function, separation of partition functions, translational partition function, translation energy and entropy from it, rotational partition function, rotational energy and entropy from it, vibrational partition function, vibrational energy and entropy from it and related numerical. **Ref:1, 2, 8, 13, 14**	**12**
3	**Chemical kinetics** Introduction, complex reactions, reactions approaching equilibrium (opposing reactions), consecutive elementary reactions (sequential reactions), parallel reactions and its kinetics, elucidation of mechanism of complex reactions: rate determining step of the reaction and steady state approximation, pre-equilibria, Michaelis-Menten mechanism of enzyme catalysis, chain reactions and its characteristics, steps involved in chain reactions with suitable example. Explosion, Types of explosion, explosion limits and related numerical. Fast reactions, techniques for the study of fast reactions: flow methods and flash photolysis. **Ref: 2, 8, 13, 14.**	**12**
4	**Infra-red Spectroscopy** Introduction, the vibrating diatomic molecule, the energy of a diatomic molecule, the simple harmonic oscillator, the anharmonic oscillator, the diatomic vibrating rotator: Born-Oppenheimer approximation, breakdown of Born-Oppenheimer approximation, the vibrations of polyatomic molecules, fundamental vibrations and their symmetry (water molecule and carbon dioxide molecule) and related numerical. **Ref: 8, 11, 14**	**12**

5	**Electronic and Raman spectroscopy** (a) Electronic spectroscopy: Electronic vibrational spectra, intensity of vibrational electronic spectra, Franck-Condon principle, rotational fine structure, Fortrat diagram, dissociation energy, pre-dissociation. (b) Raman Spectroscopy: Introduction, Rayleigh and Raman scattering, quantum theory of Raman effect, classical theory of the Raman effect: Molecular polarizability, Raman activity of vibrations (water molecule and carbon dioxide molecule), rule of mutual exclusion. and related numericals. **Ref: 8, 11, 14.**	**12**

References:

1. Maron, S. H. and Prutton, C. F. (2012) Principles of Physical Chemistry (4th Edition), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Atkins, P. W. (1998) Physical Chemistry, ELBS.
3. Barrow, G. M. (2003) Physical Chemistry, International Student Edition.
4. Moore, W. J. (1998) Physical Chemistry, Orient Longman.
5. McQuarrie, D. A. And Simon, J. D. (2006) Physical Chemistry- A Molecular Approach, Viva Books Ovt. Ltd., New Delhi.
6. Nash, L. K. (1968) Elementary Statistical Thermodynamics, Addition-Wesley, Reading.
7. Gupta, M. C. (1990) Statistical Thermodynamics, M. C. Gupta, Wiley Eastern Ltd.
8. Laidler, K. J. (1965) Chemical Kinetics, Second Edition.
9. Frost, A. A. and Pearson, R. G. Kinetics and Mechanism, Second Edition.
10. Agrawal, G. L. Basic Chemical Kinetics by Tata McGraw-Hill Publishing Company Ltd., New Delhi.
11. Banwell, C. N. and McCash, E. M. (1996) Fundamentals of Molecular Spectroscopy, McGraw Hill International (UK).
12. Bahl, B. S., Bahl, A., Tuli, G. D. (2005) Essentials of Physical Chemistry by Chand and Co Ltd., New Delhi.
13. Puri, B. R., Sharma, L. R. and Pathania M. S. (2007) Principles of Physical Chemistry (42nd Edition), , Vishal Publishing Co., Jalandhar.
14. Dr. L. S. Patil, Physical Chemistry II, Shree Book Co. Mumbai.

Course Outcomes (CO):

On completion of this course, the student will be able to:

No.	CO	Cognitive level
1	Students will gain an understanding of Joule-Thomson effect, third law of thermodynamics, absolute entropy, standard entropy and residual entropy and partial molar quantity and its significance.	**2**
2	Students should understand the importance of statistical thermodynamics and concept of partition functions.	**2**
3	Students should able to understand core study of chemical kinetics and spectroscopy.	**2**

CH - 230: Inorganic Chemistry - II (60 L, 100 Marks and 4 Credits)		
Course Objectives: 1. This course offers to impart the basic knowledge about spectroscopy of inorganic compounds 2. This course also offers to study the reaction mechanism in transition metal complexes. 3. This course helps to understand catalysis and structure reactivity of molecules.		
Unit No.	***Name of the Units***	***Lectures***
1	**The Ionic bond** Structures of ionic solids, radius ratio rules, calculation of limiting radius ratio Values of coordination no.3, 4, 6, close packing, classification of ionic structures – Ionic compounds of the type AX (ZnS, NaCl, CsCl), Ionic compounds of the type AX_2 (CaF_2, TiO_2, SiO_2); Layer structures (CdI_2, [NiAs]) Structures containing polyatomic ions.	**12**
2	**Electronic Spectra** Energy levels in an atom, coupling of orbital angular momenta, coupling of spin angular momenta, spin orbit coupling. Determining the ground state terms – Hund's rule, Hole formulation, Derivation of the terms for a P2 & P3 configuration, calculation of the number of microstates, Electronic spectra of transition metal complexes – Laporte 'orbital' selection rule, spin selection rule, splitting of electronic energy levels and spectroscopic states.	**12**
3	**Reaction mechanism in transition metal complexes** Ligand substitution reaction, classification of mechanism, substitution of square planer complexes, nucleophilicity of entering group, shape of activated complexes, K1 pathway, substitution in octahedral complexes, rate law and their interpretation, activation of octahedral complexes, base hydrolysis, stereochemistry, isomerization reactions.	**12**
4	**Catalysis** Catalysis, description of catalyst, properties of catalyst, types of catalyst, catalytic steps in organotransition metal catalyst, hydrogenation of alkenes, hydroformylation, Monsanto acetic acid synthesis, Wacker oxidation of alkenes, alkene polymerization, heterogeneous catalysis, nature of heterogeneous catalyst, examples of heterogeneous catalysts (hydrogenation, oxidation).	**12**
5	**Preparation & Application of Complexes** Preparation of complexes, Application of complexes in analytical chemistry, complexometric titration, Application of complexes in metallurgy, Application of complexes in industry, Application of complexes in medical field. Presence of metal complexes in biological system (Haemoglobin, Chlorophyll, Vitamin-B_{12})	**12**

References:

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry Principles of Structures and Reactivity, 4th edition, New York, NY: Harper Collins College Publishers, 1993.
2. J.D. Lee, Concise Inorganic Chemistry, 5thedn., Blackwell Science, London, 2006.
3. A. G. Sharpe, Inorganic chemistry, 3rd edition, ISBN 9788131706992, Pearson Education,1981.
4. F.A. Cotton, Chemical Applications of Group Theory, ISBN: 978-0-471-51094-9, 1990.
5. D.F. Shrivers, P.W. Atkins and C.H. Lang for, Inorganic Chemistry, CH Langford, 1990.
6. B.R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co.,2005.
7. H. B. Gray, Electrons and Chemical Bonding. W. A. Benjamin, Inc., New York, 1965.
8. H. J. Emeleus and A.G. Sharpe, Modern Aspects of Inorganic Chemistry, Universal Book Stall, New Delhi.
9. K. lal, S.K. Agarwal, Advanced Inorganic Chemistry, Pragati Prakashan, Meerut, 2017.
10. G.S. Manku, Theoretical Principles of Inorganic Chemistry, Tata McGraw-Hill Ed.
11. B. Douglas, D.H. Mc. Daniel, J.J. Alexander, Concepts and Models of Inorganic Chemistry, 2nd edition.
12. R. Sarkar, General and Inorganic Chemistry, Part one, New Central Book Agency, Kolkata.
13. P.K. Bhattacharya, Group Theory and its Chemical applications, Himalaya Publishing House.
14. F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann, Advance Inorganic Chemistry, Sixth Edition, JOHN WILEY & SONS, INC.
15. K. Arora, Concept and Applications of Group Theory, Anmol Publication Pvt. Ltd., New Delhi.
16. W. L. Jolly, Modern Inorganic Chemistry, 2nd edition, Tata McGraw Hill Co.

Course Outcomes (CO):

On completion of this course, the student will be able to:

No.	CO	Cognitive level
1	Understand the concept of microstates, spectroscopic terms and orgel diagram of inorganic compounds.	**2**
2	Gain knowledge about magnetic properties and charged transfer spectra of transition metal complexes.	**2**
3	Students are able to analyze structure reactivity and reaction mechanisms of metal complexes.	**4**

CH - 250: Organic Chemistry - II (60 L, 100 Marks and 4 Credits)		
Course Objectives: 1. This course also offers to learn various name reactions, rearrangement and reagents used in organic chemistry. 2. The course offers to study the importance of stereochemistry and organic spectroscopy for structure elucidation with respect to laboratory and industrial applications. 3. This course helps to understand the principles behind UV, IR, ^{1}HNMR, ^{13}CNMR and Mass spectroscopy.		
Unit No.	**Name of the Units**	**Lectures**
1	**Rearrangements** Wagner-Meerwein (with Demjanov), Pinacol, Wolff, Arndt-Eistert Synthesis, Hofmann, Curtius, Schmidt, Lossen, Beckmann, Baeyer-Villiger, Favorskii, Benzilic acid, Stevens, Wittig, Claisen, Cope, oxy-cope, Meisenheimer, Sommelet-Hauser, Dienone-phenol, Ciamician-Dennsted, Fries (with photo Fries) rearrangements	**12**
2	**Selective Name Reactions** Aldol Condensation, Henry reaction, Perkin reaction, Stobbe Condensation, Dieckmann Condensation, Benzoin Condensation, Reimer-Tiemann reaction, Reformatsky reaction, Darzens reaction, Michael reaction, Mannich reaction, Shapiro reaction, Bomford-Stevens reaction, Nef reaction, Baylis Hilman reaction, Cannizaro reaction, Knovengeal reaction, Sharpless reaction, Barton reaction, Hofmann Loffler-Freytag reaction, Vilsmeir-Haack reaction	**14**
3	**Reagents in Organic Synthesis** **A] Oxidizing Reagent:** CrO_3, $Na_2/K_2Cr_2O_7$, Collins reagent, PDC (Cornforth reagent), PCC (Corey's reagent), $KMnO_4$, MnO_2, SeO_2, $Pb(OAc)_4$, Pd-C, OsO_4, Peracid, (m-CPBA), O_3, H_2O_2, $NaIO_4$, HIO_4, $Al(O\text{-}i\text{-}R)_3$ (Oppenauer oxidation), Swern oxidation, DDQ, NBS and B_2H_6 **B] Reducing Reagent:** $LiAlH_4$, $NaBH_4$, $NaCNBH_3$, MPV reduction, Na/liquor NH_3, Na/alcohol, H_2/Pd-C, H_2/Pd-$BaCO_3$, DIBALH and Wolff Kishner reduction, Zn-Hg/H_2O/HCl, Zn(Cu), Baker's yeast, LDC (Gilman's reagent), LDA (Lithium diisopropylamide), DCC (dicyclohexylcarbodimide), Woodward and Prevost hydroxylation and Baker's yeast.	**14**
4	**Stereochemistry** Stereochemical principles (stereoisomers, chirality, optical activity, enantiomers, diastereoisomers, epimer, anomer), R-S nomenclature, Meso Compounds, E-Z nomenclature, Threo and Erythro nomenclature. optical activity in biphenyls, spiranes, allenes, Racimic modification and racimation, optical purity, pro-stereoisomerism (Homomorphic, Homotopic, Heterotopic, enantiotropic, diastrophic-atoms, groups and faces). Interconversion of Fischer, Newman and Sawhorse Projections, stereospecific and stereoselective reactions Conformational analysis of cyclic (cyclohexane, mono-substituted cyclohexane) and acyclic compounds (ethane, propane, butane).	**14**

5	**Spectroscopy:** Instrumentation, Sample Preparation for UV, IR, NMR (^{1}H and ^{13}C), Mass Spectrometry. Joint problems based on UV, IR, NMR (^{1}H and ^{13}C), Mass.	**06**

References:

1. S. H. Pine – Organic Chemistry, 5th Edition, McGraw-Hill.
2. P. S. Kalsi – Organic Reactions and Their Mechanisms
3. J. Clayden, N. Greeves, S. Warren – Organic Chemistry, IInd Edition, Oxford University Press.
4. Peter Sykes-A Guidebook to Mechanism in Organic Chemistry
5. W Carruthers and Iain Coldham – Modern Methods of Organic Synthesis
6. P. S. Kalsi –Stereochemistry: Conformation and Mechanism, 8th Edition, New Age International.
7. F. A. Carey, R. J. Sundberg – Advanced Organic Chemistry Part-B: Reactions and Synthesis, 5th Edition, Springer.
8. D. Nasipuri – Stereochemistry of Organic Compounds: Principles and Applications, Revised 2ndEdition, New Age International.
9. E. L. Eliel – Stereochemistry of Carbon Compounds, McGraw-Hill.
10. P. S. Kalsi – Spectroscopy of Organic Compounds, 6th Edition, New Age International.
11. D. L. Pavia, G. M. Lampman, G. S. Kriz, J. R. Vyvyan – Introduction to Spectroscopy.
12. R. M. Silverstein, F. X. Webster – Spectrometric Identification of Org. Compounds.

Course Outcomes (CO):

On completion of this course, the student will be able to:

No.	CO	Cognitive level
1	Students will learn the basic name reactions and rearrangement reactions.	**2**
2	Students will understand the applications of reagents in organic synthesis.	**2**
3	Students will apply the basic knowledge about core study of spectroscopy and stereochemistry	**3**

CH - 290: Instrumentation and Analysis (30 L, 50 Marks and 2 Credits)		
Course Objectives: 1. This course covers both fundamental and practical aspects of chemical analysis. 2. The student will learn about instrumentation, working and applications in chemistry. 3. This course also covers solving numerical problems.		
Unit No.	**Name of the Units**	**Lectures**
1	**Errors, statistics and sampling:** Accuracy and precision, Error, types of error, systematic and random errors, minimization of errors, mean and standard deviations, reliability of results, confidence interval, comparison of results, student T test, F test, Comparison of two samples (Paired T test), correlation and regression, correlation coefficient and liner regression, Sampling, the basis of sampling, sampling procedure and sampling statistics.	**06**
2	**Voltammetry:** Excitation signals Linear-sweep Voltammetry- voltammetric instruments, voltammetric electrodes, voltammograms, hydrodynamic voltammetry and voltammetric detectors.	**06**
3	**Electrogravimetric Analysis:** Theory of electrogravimetric analysis, terms used in electrogravimetric analysis, completeness of deposition, Electrolytic separation of metals, character of the deposit, electrolytic separation of metals with controlled cathode potential, apparatus and determination of copper (constant current procedure).	**06**
4	**Ultra-purity and ultra-trace analysis:** Ultra-purity and ultra-trace analysis, laboratory dosing, purification of reagents, Preconcentration Techniques and contamination control during analytical operation.	**06**
5	**Chemical Aspects to Nanomaterials:** Nanoscience and nanotechnology, effect of making into small size, general theme of classification of nanomaterial, application of nanomaterials, characterization of nanomaterials using XRD, SEM-EDAX, and TEM.	**06**

References:

1. H. H.; Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Jr. Instrumental Methods of Analysis.
2. G. R. Chattwal and S. Anand, Instrumental Methods and Chemical Analysis.
3. D. A. Skoog and D. M. West, Fundamentals of Analytical Chemistry", 4th Ed., CBS College, Publishing, New York.
4. Vogel's Text Book of Quantitative Chemical analysis (Sixth Edition) By- J.
5. Mendham, R.C. Denny, J.D. Barnes, M.J.K. Thomas (Pearson Education- Low Price Edition)

Course Outcomes (CO):

On completion of this course, the student will be able to:

No.	CO	Cognitive level
1	Explain various theoretical concepts of analytical chemistry.	**2**
2	Build up ability to solve the numerical problems.	**3**
3	Apply theoretical principles, working of various classical and modern instrumentation techniques.	**3**

<table>
<tr><th colspan="3">AC-201(A): Soft Skills
(Personality and Cultural Development Related Audit course; Practical; 2 Credits)</th></tr>
<tr><td></td><td>Course Objectives (CObs):
• To develop soft skills and communication skills amongst the students.</td><td></td></tr>
<tr><td>1</td><td>Introduction to soft skills
Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal setting, life skills, Need for soft skills, Communication skills, Etiquettes& Mannerism.</td><td>2 h</td></tr>
<tr><td>2</td><td>Self-Assessment
Goal setting, SWOT analysis, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements, positive attitude, positive thinking and self-esteem.
Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.</td><td>4 h</td></tr>
<tr><td>3</td><td>Communication Skills
Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait, dressing sense, facial expressions, peculiarity of speaker (habits).
Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real-life story for 5 minutes each), Oral review (Each student orally presents a review on a story or a book read by them)
Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills
Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.</td><td>8 h</td></tr>
<tr><td>4</td><td>Formal Group Discussion, Personal Interview & Presentation skills
Topic comprehension, Content organization, Group speaking etiquettes, driving the discussion & skills.
Preparation for personal interview: dress code, greeting the panel, crisp self-introduction, neatness, etiquettes, language tone, handling embarrassing & tricky questions, graceful closing.
Activity: Each batch is divided into two groups of 12 to 14 students each. Two rounds of GD for each group should be conducted and teacher should give them feedback. Mock interviews to be conducted.</td><td>4 h</td></tr>
<tr><td>5</td><td>Aptitude and analytical skills
Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking.
Analytical skills: Definition, Types, problem solving</td><td>8 h</td></tr>
<tr><td>6</td><td>Life skills
Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities
Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.</td><td>4 h</td></tr>
<tr><td colspan="3">Suggested readings:
1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd.
2. English for Business Communication: Simon Sweeney, Cambridge University Press
3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press
4. Quantitative Aptitude: R.S. Agrawal</td></tr>
</table>

Course Outcomes (CO):

On completion of this course, the student will be able to:

No.	CO	Cognitive level
1	Grasp soft skills and communication skills.	**2**
2	Apply life skills to manage the situations.	**4**

CH-P-1: Physical Chemistry Practical-I (180 Hrs., 100 Marks and 6 Credits)

Course Objectives: The practical course is designed

1. To understand the basic principles of different techniques used in laboratory and provide hands on training on various instruments.
2. To understand the standardization of instruments to make appropriate measurements, analyze the data and report the results.
3. To understand the basic principles of different techniques used in laboratory.
4. to develop the experimental skills in physical chemistry
5. To acquire the knowledge about verification of theoretical aspects.
6. To understand the standardization of instruments like colorimeter, polarimeter etc. and their application.

Students should perform minimum of twenty (20) experiments.
It is expected to perform at least two experiments from each technique.

INSTRUMENTAL

Conductometry

1. Determine the conductance of strong electrolyte ($KCl/NaCl/AgNO_3/HCl$) at various concentrations and verify the applicability of DHO equation.
2. Determine the amount of trichloroacetic acid, monochloroacetic acid and acetic acid in the given by conductometric titration against sodium hydroxide solution.
3. Determine the solubility of sparingly soluble salt ($BaSO_4$) at different temperatures conductometrically and determination of ΔG, ΔH and ΔS of the solution.
4. Study the second order velocity constant of hydrolysis of ethyl acetate by sodium hydroxide using conductance measurement.
5. Determination of critical micellar concentration (CMC) of sodium lauryl sulphate from the measurement of conductivities at different concentrations.
6. To determine the concentration of Fe^{2+} ions by titrating with potassium dichromate solution conductometrically.

Potentiometry

1. To determine the stability constant of a complex ion $[Ag_2(S_2O_3)]^{-3}$ potentiometrically.
2. To determine standard free energy change ΔG^0 and equilibrium constant for the reaction $Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$ potentiometrically.
3. To determine the activity coefficient of an electrolyte (HCl) by potentiometry.
4. To determine the amount of each halide in a mixture of halides containing a) KI and KBr/KCl or b) KI / KBr and KCl potentiometrically.
5. To titrate ferrous ammonium sulphate solution with potassium dichromate solution potentiometrically using bimetallic electrode pair.
6. To determine the transport number of Ag^+ and NO_3^- ion.

pH metry

1. Determination of Hammette constant of a given substituted benzoic acid by pH measurements.
2. To determine acidic and basic dissociation constant of amino acid and the iso-electric point of the acid.
3. To determine the three dissociation constants of polybasic acid such as H_3PO_4 by pH measurements.
4. Determine the effect of KCl on the pH of HCL solution.

Colorimetry / Spectrophotometry

1. To determine the pKa and Ka of given indicator by colorimetry / spectrophotometry
2. To determine the empirical formula of Ferric salicylate complex by Job's method and verify by slope ratio method.
3. Determine the amount of Cu (II) and Fe (III) in a mixture by titrating it against standard EDTA solution spectrophotometrically.
4. Determination of iron in water using a colorimeter.
5. Simultaneous determination of $Cr_2O_7^{2-}$ and MnO_4^- ions or Co^{2+} and Ni^{2+} in the solution by spectrophotometry.
6. Record the UV spectrum of Benzene, Pyridine and Pyrimidine in methanol. Compare and discuss the various transition involved in terms of MO theory.

Polarimetry

1. Polarimetric determination of the specific rotation of camphor in benzene and carbon tetrachloride.
2. Determine the percentage of two optically active substances (d-glucose and d-tartaric acid) in a mixture polarimetrically.

Refractometry

To measure refractometrically average polarizability of some of the common solvents.

NON-INSTRUMENTAL

Chemical Kinetics

1. To determine the rate constant for depolymerization of diacetone alcohol catalysed by sodium hydroxide using dilatometer.
2. Study the kinetics of reaction between potassium persulphate and potassium iodide.
   a) Determine the rate constant.
   b) Study the influence of ionic strength on the rate constant.
3. To determine energy of activation of the hydrolysis of methyl acetate in presence of hydrochloric acid (Calculations and graphs expected from excel programming)
4. Determine the colorimetrically the order and energy of activation for decomposition of violate coloured complex of ceric ion and N-phenylanthranilic acid.

Other Non-instrumental experiments

1. Determined the transport number of H^+ and Cl^- ions by moving boundary method.
2. To obtain solubility curve for liquid say water-acetic acid-chloroform system
3. Investigate the adsorption of acetic acid in aqueous solution by using activated charcoal and verify Freundlich's adsorption isotherm.
4. Determination of partial molar volume of ethanol in dilute aqueous solutions.
5. To study the effect of addition of an electrolyte ($KCl/NaCl/NH_4Cl/Na_2SO_4$ / K_2SO_4) on solubility of an organic acid (benzoic acid or salicylic acid).

Cryoscopy:-

To determine the mean activity coefficient of an electrolyte (NaCl) in dilute solution by cryoscopic measurement.

References:

1. Findley's Practical Physical Chemistry (9th edition), Edited by B. P. Levitt (Longman Group Ltd).
2. Systematic Experimental Physical Chemistry (2nd edition), By S. W. Rajbhoj and Dr. T. K. Chondekar (Anjali Publication, Aurangabad).
3. Advanced Practical Physical Chemistry (26th edition), By J. B. Yadav (Goel Publishing House, Meerut).
4. Experimental Physical Chemistry, By V. D. Athawale, P. Mathur (New Age international Ltd, New Delhi)
5. Advanced Practical in Physical Chemistry (13th edition or latest) By Dr. Pande, Dr. Mrs. Datar, Dr. Mrs Bhadane, Manali Publication, Pune.
6. University Practical Chemistry by P. C. Kamboj, Vishal Publishing Co. Jalandhar, Panjab.
7. Practical Physical Chemistry, By A. M. James and F. F. Prichard, Longman Group Ltd.
8. Advanced Physical Chemistry Experiments by Dr. J. N. Gurtu and Amit Gurtu, Pragati Prakashan Meerut.

Course Outcomes (CO):

After successful completion of the course students are expected to

No.	CO	Cognitive level
1	Students will understand the preparation for each experiment.	**2**
2	Setup and standardize the potentiometer, P^H meter and conductometer.	**3**
3	Identify thermodynamics and kinetics of simple systems.	**4**
4	To know Safety requirements and lab skills to perform physico-chemical experiments.	**2**
5	To apply the principles and techniques to different systems.	**3**

CH-I-1: Inorganic Chemistry Practical-I
(180 Hrs., 100 Marks and 6 Credits)

Course Objectives: The practical course is designed
1. To understand the basic principles of different techniques used in laboratory analysis.
2. To provide hands on training on various techniques of analysis.
3. Develop the ability to analyze drug samples
4. To make appropriate measurements, analyze the data and report the results.

Students should perform minimum of twenty (20) experiments.

Analysis of ore (minimum two)

a. Pyrolusite ore - Estimation of silica gravimetrically and Manganese volumetrically.
b. Haematite - Estimation of copper volumetrically and Iron gravimetrically.
c. Chromite ore – Estimation of Iron gravimetrically and chromium volumetrically.

Analysis of binary mixtures by gravimetric and volumetric method (minimum five)

a) Copper- Nickel
b) Copper -Magnesium
b) Copper-Zinc
c) Iron-Magnesium
d) Nickel-Zinc
e) Lead-Tin

Drug Analysis (minimum one)

a. Determination of iron from given drug sample.
b. Determination of Calcium from given Calcium tablet.

Thermochemistry (minimum two salts)

To determine the lattice energy of binary salts (NaCl, KCl, $CaCl_2$).

Preparation of the following complexes and determination of its purity (minimum four)

a) Potassium trioxalatoferrate(III)trihydate
b) Tris(acetylacetonato)iron(III)
c) Potassium di aqua bis(oxalato) chromate (III)
d) Prussian Blue (Potassium Ferric Ferro cyanide)
e) Chloropenta-amminecobalt (III) chloride

Chromatography (minimum two)

a) Determination of the Rf value of Pb, Cu, Cd ions by using paper chromatographic technique.
b) Determination of the Rf value of Fe, Al, Cr ions by using paper chromatographic technique.
c) Determination of the Rf value of Ba, Sr, Ca ions by using paper chromatographic technique.

Instrumental method of Analysis (minimum four experiment)

a) To determine the strength of given mixture of carbonate and bicarbonate by pH metric method
b) To determine Ca in the given solution by flame photometrically, by calibration curve Method**.**

c) Spectrophotometry (**any one**)

1. Estimation of phosphate from waste water by calibration curve method
2. Estimation of Manganese from steel.

d) To determine the amount of copper present by iodometric method (potentiometrically)

e) Estimation of Boric acid using NH_4OH by conductometric method.

References:

1. A Text book of Quantitative Analysis by A.I.Vogel , 4**th** edition
2. Advanced Practical Inorganic Chemistry By Gurdeep Raj Goel Publishing House.
3. Post Graduate Practical Chemistry (Part – 1) by H.N. Patel, S.P. Turakhia,S.S. Kelkar, S.R. Puniyani, Himalaya Publishing House.
4. Applied Analytical Chemistry: Vermani.
5. University Practical Chemistry by P.C.Kamboj
6. Commercial Methods of Analysis: Shell &Biffen

Course Outcomes (CO):

After successful completion of the course students are expected to

No.	CO	Cognitive level
1	Students will understand the process of ore analysis.	**2**
2	Students able to apply their knowledge for binary mixture separation of inorganic compounds using quantitative analysis	**3**
3	Students can analyze contents present in drug	**4**
4	Students able to evaluate the lattice energy of binary salt	**6**
5	Students are able to synthesize and evaluate the complex and also able to determination of complex purity.	**5**
6	Students understand the techniques of chromatography and its application in analysis.	**2**
7	Students able to handle and perform the instrumental analysis techniques.	**3**

CH-O-1: Organic Chemistry Practical-I
(180 Hrs., 100 Marks and 6 Credits)

Course Objectives: The practical course is designed

1. To make students aware of how to perform organic compounds in laboratory.
2. The course includes synthesis of some derivatives and organic compounds, which will help them while working in research laboratory in future.
3. This course will help them in industry or while doing research in medicinal chemistry for Drug development.
4. To make student aware of green chemistry and role of green chemistry in pollution reduction and pollution control.
5. The students learn how to avoid solvents and do solvent free reaction.
6. Also, the work-up procedure in many experiments is made more eco-friendly to environment.

Introduction to Laboratory Safety (Minimum 2 Practical)

- Meaning of safety signs on container of chemicals, safety handling of chemicals
- Handling of glassware's and care to be taken, handling of organic flammable as well as toxic solvents in laboratory,
- Use of Personal Protective Equipment (PPE) (safety goggles, shoes and gloves)
- Fire extinguisher and its use,
- Chemical Spills/Clean up: action to be taken in accidental cases e.g. cleaning of acid spill over, use eye wash station and bath station in emergency, etc. (compulsory)
- Behaviour: No food or drink policy; include information about where food and drink are allowed (if such a space exists). Explicitly state that disruptive or destructive behaviour will not be tolerated.

Single Stage Preparation Monitored by TLC (Minimum 6)

1. Acetophenone to Benzalacetophenone.
2. Resorcinol to 7-hydroxy, 4-methyl coumarin.
3. Camphor to Borneol.
4. Benzophenone to Benzhydrol.
5. Acetoacetic ester to Pyrazolone.
6. Paramino Benzoic Acid to Parachloro Benzoic Acid.
7. 2-methoxy naphthalene to 1- formyl-2-methoxy napthalene.
8. Gycine to Benzoylglycine.
9. p- nitrotoluene to p- nitrobenzoic acid.
10. Fischer Indole Synthesis-Reaction of phenyl hydrazine and cyclohexanone
11. Knoevenagel condensation reaction-Reaction of aldehyde and malononitrile.
12. Anthracene to Anthraquinone
13. Benzaldehyde to Cinnamic acid
14. Anisole to 2,4-Dinitroanisole

Purification Techniques (Minimum 8 Demonstration/Experiments)

1. Purification of two organic solids by recrystallization using solvents other than water
2. Purification of two organic liquids by upward/downward/traditional distillation technique
3. Column Chromatography technique should be performed for any one of the above

preparations
4. Purification by Sublimation Method
5. Thin Layer Chromatography technique for identification of two different compounds present in mixtures
6. Solvent extraction using Soxhlet extractor.
7. Solvent extraction by separatory funnel
8. Steam distillation.

Use of Chemistry software's like, ISI draw, Chem Draw, Chem Sketch (Minimum 4)
2. Draw the structure of simple aliphatic and aromatic compounds, heterocyclic compounds with different substituent. (Minimum Ten Compounds).
3. IUPAC name and predict the NMR Signals.
4. Sketch Design reaction mechanism scheme of any two addition and two substitution reactions.
5. Literature Search and references.

Preparation of Derivatives: (Minimum 6)
1. Acetyl
2. Benzoyl
3. Semicarbazone,
4. Amide
5. Aryloxyacetic acid,
6. Ester
7. Oxime

Introduction to Green Chemistry

Concept of green chemistry, twelve principals of green chemistry, applications of green chemistry for sustainable development, Atom economy.

Green Chemistry Preparations (Minimum 4)
1. Bromination of acetanilide using Cerric ammonium nitrate.
2. Preparation of Benzilic Acid using NaOH /KOH under Solvent-free Conditions.
3. Photo reduction of benzophenone to benzopinacol in presence of sun light using isopropanol and acetic acid.
4. Nitration of salicylic acid
5. Preparation of 1, 1-bis-2-naphthol under grinding at room temperature.
6. Alternative Green Procedure for Preparation of a Derivative for Carboxylic Acid.
7. Alternative Green Procedures for Organic Qualitative Analysis - Detection of N, S, Cl, Br, I.

Interpretation of UV, FT-IR and ^{1}H-NMR spectrum of above synthesized compounds. (Minimum 10 Compounds)

References:

1. A text book of practical organic chemistry- A. I. Vogel.

2. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal
3. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST
4. R. K. Bansal, Laboratory Manual of Organic Chemistry, New Age International Publisher

Course Outcomes (CO):

After successful completion of the course students are expected to

No.	CO	Cognitive level
1	Students understand the important of safety techniques and handling of chemicals.	**2**
2	Students are made aware of carrying out different types of reactions and their workup methods.	**2**
3	Students able to perform purification techniques in organic chemistry like recrystallization, distillation, steam distillation and extraction.	**3**
4	This practical course is designed to make student aware of green chemistry and role of green chemistry in pollution reduction.	**5**
5	Students are able to apply their knowledge for development of experiment involve green chemistry.	**6**

AC-201(B): Practicing Sports Activities (Personality and Cultural Development Related Audit course; Practical; 2 Credits)
Course Objectives (CObs): • To motivate students towards sports and provide them required training.

SR NO.	NAME OF THE SPORT/GAME (Select ONE of the Following)	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMESTER
1	Volleyball	• General Fitness • Basic Fitness • Specific Fitness • History of the Game • Basic Skill of the Game • Major Skill of the Game • Technique & Tactics of the Game • Game Practice	Morning : 07 to 09 AM OR Evening : 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

Course Outcomes (CO):

On completion of this course, the student will be able to:

No.	CO	Cognitive level
1	Play any sports on the ground.	**2**
2	Become healthier and fit.	**3**

AC-201(C): Practicing Yoga **(Personality and Cultural Development Related Audit course; Practical; 2 Credits)**	
Course Objectives: • To motivate students towards yoga and provide them required training.	
	• Yog: Meaning, Definition & Introduction, Objectives • Primary Introduction of Ashtanga Yoga • Preparation of Yogabhyas • Omkar Sadhana, Prayer, Guru Vandana • Sukshma Vyayamas • Suryanamaskar (12 Postures) • Asanas : ▪ Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan ▪ Supine (Shayansthiti) - Uttan Padaasan(Ekpad/Dwipad), Pavanmuktasana, Viparitakarani Aasan, Khandarasan, Shavasana ▪ Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, Saralhasta Bhujangasana, Shalabhasana(Ekpad/Dwipad), Makarasana ▪ Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana, Ardh Chakrasana • Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana - 6 Types • Pranayama : Anuloma-viloma, Bhramari

Course Outcomes (CO):
On completion of this course, the student will be able to:

No.	CO	Cognitive level
1	Perform different yoga.	**2**
2	Perform different asanas.	**3**

AC-201(D): Introduction to Indian Music (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional: Campus-level)	
	Course Objectives: • To motivate students towards Indian music and provide them minimum required training. .
	• Definition and brief about generation of Swar, Saptak, Thaat, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc. • Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa. • Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information) • Detailed information of Tambora • Detailed information of Harmonium and Tablaa. • Five filmy songs based on Indian Classical Music (Theory and Presentation) • Sound Management - Basic information of Sound Recording (including Practicals) • Composition of Music as per the Story • Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.

Course Outcomes (CO):
On completion of this course, the student will be able to:

No.	CO	Cognitive level
1	Identify different types of Indian music.	**3**
2	Develop more interest to learn and practice Indian music.	**4**

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

॥अंतरी पेटवू ज्ञानज्योत॥

'A' Grade
NAAC Re Accredited
(3rd Cycle)

SYLLABUS

for

Master of Science (M. Sc.)
[Physics]

Choice Based Credit System
(Outcome Based Curriculum)

2021 - 2022

Summary of Distribution of Credits under CBCS Scheme for M.Sc. (Physics)

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV	Total
01	Core	**16**	**16**	**08**	**08**	**48**
02	Skill based	**04**	**04**	**04**	**04**	**16**
03	Elective	**-**	**-**	**04**	**04**	**08**
04	Project	**-**	**-**	**04**	**04**	**08**
05	Audit	**02**	**02**	**02**	**02**	**08**
06	Total Credits	**22**	**22**	**22**	**22**	**88**

Subject Type	Core	Skill based	Elective	Project	Audit	Total
Credits	**48**	**16**	**08**	**08**	**08**	**88**

Total Credits = 88

Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon
M. Sc. Physics
Choice Based Credit System (Outcome Based Curriculum) with effect from 2021 -2022

Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Practical)	Total Credits	
I	4	16 + 0	**16**	1	0 + 4	**4**	1	2	2	**22**
II	4	16 + 0	**16**	1	0 + 4	**4**	1	2	2	**22**
III	2	08 + 0	**08**	3	4 + 8	**12**	1	2	2	**22**
IV	2	08 + 0	**08**	3	4 + 8	**12**	1	2	2	**22**
Total Credits	**48**			**32**			**8**			**88**

(T, Theory; P, Practical)

Structure of Curriculum

		First Year				**Second Year**				**Total Credit Value**
		Semester I		**Semester II**		**Semester III**		**Semester IV**		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
(A)	**Prerequisite and Core Courses**									
	Theory	16	4	16	4	8	2	8	2	48
	Practical					8	2	8	2	16
(B)	**Skill Based / Subject Elective Courses**									
1	Theory /Practical	4	1	4	1	4	1	4	1	16
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course			2	1					2
3	Technology Related + Value Added Course					2	1			2
4	Professional and Social + Value Added Course							2	1	2
	Total Credit Value	22	6	22	6	22	6	22	6	88

List of Audit Courses (Select any ONE course of Choice from Semester II; Semester III and Semester IV)

Semester I (Compulsory)		**Semester II** (Choose One) **Personality and Cultural Development**		**Semester III** (Choose One) **Technology + Value Added Course**		**Semester IV**(Choose One) **Professional and Social + Value Added Course**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Sport Activities	AC-301B	Cyber Security	AC-401B	Current Affairs
		AC-201C	Yoga	AC-301C	Seminar + Review Writing	AC-401C	Seminar + Review Writing
		AC-201D	Music	AC-301D	Biostatistics	AC-401D	Intellectual Property Rights (IPR)

Semester-wise Course Structure of M.Sc. Subject name

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
PHY-101	Core	Mathematical Methods for Physics	4	--	4	40	--	60	--	4
PHY -102	Core	Classical Mechanics	4	--	4	40	--	60	--	4
PHY -103	Core	Solid State Physics	4	-	4	40	-	60	-	4
PHY -104 A/B/C	Skill Based (Select any one)	**A)**:Physics of Semiconductor Devices **B)**: Electronic Instrumentation **C)**Bio- Physics	4	-	4	40	-	60	-	4
PHY -105	Core	Basic Physics Laboratory – I	-	4+4	8	-	40	-	60	4
AC-101	Audit Course	Practicing Cleanliness	-	2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 16; P = Practical:4; Skill Based:4; Audit Course:2)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
PHY-201	Core	Statistical Mechanics	4	--	4	40	--	60	--	4
PHY -202	Core	Classical Electrodynamics	4	--	4	40	--	60	--	4
PHY -203	Core	Quantum Mechanics	4	--	4	40	--	60	--	4
PHY-204	Skill Based	Material Science	4	-	4	40	-	60	-	4
PHY-205	Core	Basic Physics Laboratory – II	-	4+4	8	-	40	-	60	4
AC-201 A/B/C/D	Audit Course(Select any one)	AC-201A -Soft Skills/ AC-201B- Sport Activities/ AC-201C- Yoga/ AC-201D Music) from Personality and Cultural Development	--	2	2	--	100	--	--	2
Total Credit for Semester II: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit course:2)										

Semester III

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
PHY-301	Core	Atomic and Molecular Physics	4	--	4	40	--	60	--	4
PHY-302 A/B/C	Elective (Select any one)	A)Materials Synthesis and Preliminary Analysis B) Computational Method sand Programming Using 'C' Language C) Acoustics and Entertainment Physics	4	-	4	40		60	-	4
PHY-303 A/B/C	Skill Based(Select any one)	A)Systematic Materials Analysis B) Microprocessor and its Applications C) Communication Electronics	4		4	40		60		4
PHY-304	Core	Special Laboratory-I	-	4+4	8	-	40	-	60	4
PHY-305	Project Based	Project Work-II (Literature Survey, Definition of Problem, Experimental work, Oral etc.)	--	4+4	8	--	40	--	60	4
AC-301 A/B/C/D	Audit Course(Select any one)	**Choose one out of Four (AC-301A-** Computer Skills / **AC-301B -** Cyber Security/ **AC-301C-** Seminar + Review Writing / **AC-301D-** Biostatistics**) from Technology + Value Added Courses**		2	2		100	--	--	2
Total Credit for Semester III: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Semester IV

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
PHY-401	Core	Nuclear Physics	4	--	4	40	--	60	--	4
PHY -402 A/B/C	Skill Based	A) Nanomaterials: Synthesis, Properties and Applications B) LASER and it's Applications C) Astrophysics	4	-	4	40	-	60	-	4
PHY-403 A/B/C	Elective (Select any one)	A) Renewable Energy Sources B) Microwave: Applications C)Environmental Physics	4	--	4	40	--	60	--	4
PHY -404	Core	Special Laboratory-II	--	4+4	8	--	40	--	60	4
PHY -405	Project	Project Work-II (Characterization, Analysis of Result, Conclusions, Project	--	4+4	8	--	40	--	60	4

	Based	Report, Oral etc.)								
AC-401 A/B/C/D	Audit Course(Select any one)	**Choose one out of Four (AC-401A-** Human Rights **/ AC-401B –Current Affairs / AC-401C-** Seminar + Review Writing **/ AC-401D -** Intellectual Property Rights (IPR)) **from Professional and Social + Value Added Courses**		2	2		100	--	--	2
Total Credit for Semester IV: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

M. Sc. Programme

Number of teaching days/ year	180
Number of teaching days/ term	90
Number of contact hours for theory course or practical course/ week	04
Number of teaching hours for theory course/ term	52
Number of contact hours/ term for test, seminar and tutorial	08
Total number of contact hours/ term for course	52+08=60

Program at a Glance

Name of the program (Degree)	: M. Sc. (Physics)
Faculty	: Science and Technology
Duration of the Program	: Two years (four semesters)
Medium of Instruction and Examination	: English
Exam Pattern	: 60: 40 (60 marks University exam. And 40 marks continuous internal Assessment)
Passing standards	: 40% in each exam separately (Separate head of passing)
Evaluation mode	: CBCS
Total Credits of the program	: 88 (64 core credits including 4 credits of project/dissertation, 08 skill enhancement credits, 08 subject elective credits and 08 audit credits)

Program Objectives for M.Sc. Program:

The objectives of this Programme are to develop:

1. The students through high quality of education/study which enables them to succeed in career in which can understanding of physics is relevant.

2. The ability to think logically, to analyze problems and phenomena and to devise explanations or solutions.

3. An appreciation of the role of mathematical modeling of physical phenomena to produce predictions which can be tested against experimental observations.

4. An awareness of the importance of accurate experimentation in the understanding of natural phenomena.

5. The practical and technical skills required for physics experimentation.

6. An awareness of the value and the power of computer based techniques for experimentation, analysis and presentation and a familiarity in their exploitation.

7. An ability to communicate the concepts and discoveries of physics both orally and in writing.

8. An ability to organize time and meet deadlines.

9. An additional skills resulting from the experience of more extensive project work.

10. An ability to integrate 'Information Communication Technology' with basic concepts of physics to promote relevant education and training.

11. The qualities of adoptability, innovation and dynamism.

Important Instructions:

1. B. Sc. (Physics) students are eligible to offer this program.

2. Two written tests, one oral test and one seminar (per semester) should be conducted for each course in addition to regular teaching schedule.

3. Faculty members are advised to use 'compact disks' and computers as teaching aids so as to ingrain the basic ideas of Physics.

4. Students are advised to borrow scientific information (published worldwide) from scientific websites on Internet**.**

5. A well-equipped computer laboratory with at least 5 computers is necessary to conduct related experiments and Project

6. Student should start the Project work soon after the commencement of third semester. Literature survey, Definition of the problem, Pre-oral before finalization of the topic, Preliminary experimental work, Oral to assign the internal marks etc should be covered in the third semester**.**

7. Student should carry out the experimental work, keep record of the observations and results and should draw the conclusions of the project. Systematic project report should be prepared. Teacher should arrange oral examination to assign internal marks.

Program Outcomes (PO) for M.Sc. Program:

Upon successful completion of the M.Sc. program, student will be able to:

PO No.	PO	
PO1	M.Sc. Physics students can find jobs in public and private sectors. There are many opportunities available for M. Sc. Physics students in technical as well as scientific fields. They can work as Scientist, Assistant Scientist, Quality Control Manager, Laboratory Technician, School Science Technician or Research Analyst in any government or private organization. Besides these, they can also go for teaching in government or private institutions.	**General**

PO2	There are many opportunities available in IT field for M. Sc. Physics graduates. Many IT companies such as Infosys, Wipro and TCS are recruiting M. Sc. Physics graduates for software jobs. They can also get jobs in Energy Plants. Another job available for these graduates is Technician in Electronic Industry. They can apply for jobs in many companies in automobile industry. Some of those companies are Maruti Udyog, TATA Motors and Tech Mahindra.	Private Sector
PO3	: There are vast opportunities available for M.Sc. graduates in Government sector. They can apply for jobs in Scientific Research and Development Organizations such as The Defense Research and Development Organization (DRDO), CSIR, Physical Research Laboratory (PRL) Ahmedabad, Saha Institute of Nuclear Physics Kolkata and Nuclear Science Centre New Delhi. They can also apply for various jobs in popular government organizations such as: • Bhabha Atomic Research Centre (BARC) • Atomic Energy Regulatory Board (AERB) • Oil and Natural Gas Corporation (ONGC) • Bharat Heavy Electricals Limited (BHEL) • National Thermal Power Corporation (NTPC) • Indian Space Research Organization (ISRO) • National Chemical Laboratory (NCL) • Indian Institute of Tropical Meteorology (IITM) They can also apply for the various competitive exams conducted by Union Public Service Commission such as IFS, IPS and IAS. Several other government exams conducted for recruiting M.Sc. Physics graduates are given below: • Tax Assistant Exam, Statistical Investigator Exam, Combined Graduate Level Exam. After qualifying NET or SET exam they can apply for teaching jobs in government colleges or schools. Another option available for M.Sc. Physics graduate is to apply for jobs in public sector banking. Several banks are conducting exam every year for recruiting graduates to the post of Probationary Officers. They can also find many jobs in Railway sector. They should qualify the exams conducted by Railway Recruitment Board to get a job in Railway sector. These graduates can also apply for Combined Defense Services Exams conducted for recruiting candidates to various posts in Defense Department.	Government Sector
PO4	There are wide opportunities available for M. Sc. Physics graduates in foreign countries. They can work in several health care, manufacturing and electronics companies in foreign countries. Students having high percentage during their post-graduation can apply for jobs in National Aeronautics and Space Administration (NASA), one of most famous space research organization in the world.	Foreign countries
PO5	: Those who have completed M. Sc. degree in Physics can find a long term career in the research field. Even though they are joining the research organization as assistant /research fellow (JRF, SRF), can earn lot of experience and/or Ph.D. Degree. After these achievements, they will have chances to get promoted to higher posts.	Long term Career in Research

Program Specific Outcomes (PSOs) for M.Sc. Physics program:

Students who graduate with a Master of Science in **Physics** will:

The Master of Science in Physics program provides the candidate with knowledge, general competence, and analytical skills on an advanced level, needed in industry, consultancy, education, and research.

PSO No.	PSO	Cognitive level
PSO1	Apply the knowledge and skill in the design and development of Electronics circuits to fulfill the needs of Electronic Industry	
PSO2	Become professionally trained in the area of electronics, optical communication nonlinear circuits, materials characterization and lasers.	
PSO3	Pursue researches related to Physics and Materials characterization	
PSO4	Demonstrate highest standards of Actuarial ethical conduct and Professional Actuarial behavior, critical, interpersonal and communication skills as well as a commitment to life-long learning	
PSO5	Prepare students to become Physics professionals with comprehensive knowledge and Practical skills for emerging requirement	
PSO6	Prepare students who will achieve peer-recognition; as an individual or in a team; through demonstration of good analytical, design and implementation skills.	
PSO7	To prepare them to take up higher studies of interdisciplinary nature.	
PSO8	To give exposure to a vibrant academic ambience and To create a sense of academic and social ethics among the students	

Distribution of Course papers for M. Sc. Part I (Physics)

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part I					
Semester I : Theory Courses					
PHY-101	Mathematical Methods for Physics	Core course	04	100	03
PHY -102	Classical Mechanics	Core course	04	100	03
PHY-103	Solid State Physics	Core course	**04**	**100**	**03**
PHY104	**A)**:Physics of Semiconductor Devices Or **B)**: Electronic Instrumentation Or **C)**Bio- Physics	Skill based	**04**	**100**	**03**
Semester I : Practical Courses					
PHY-105	Basic Physics Laboratory – I	Core course	**04+04**	100	06
AC-101	Practicing Cleanliness AC-201A -Soft Skills/ AC-201B- Sport Activities/ AC-201C- Yoga/ AC-201D Music) from Personality and Cultural Development	Audit Course	**02**	**100**	
Semester II : Theory Courses					
PHY-201	Statistical Mechanics	Core course	**04**	**100**	**03**
PHY-202	Classical Electrodynamics	Core course	**04**	**100**	**03**
PHY-203	Quantum Mechanics	Core course	**04**	**100**	**03**
PHY-204	Material Science	Skill based	**04**	**100**	**03**
Semester II : Practical Courses					
PHY-205	Basic Physics Laboratory – II	Core course	**04+04**	**100**	**06**
AC-201A/B/C/D	Choose one out of Four (AC-201A/ AC-201B/ AC-201C/ AC-201D) from Personality and Cultural Development (Audit Course)	Audit Course	**02**	**100**	

M.Sc. Part I Semester I Physics: Core Courses

	PHY - 101: Mathematical Methods for Physics	Lecture
	Course description: This course is aimed at introducing the concepts of Mathematical physics to the students. **Course objectives**: 1. To impart knowledge of basic concepts in Mathematical physics. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Vector Space**: Revision of vector space, Sub spaces, Linear combinations of vectors, Linear span, Linear dependence and independence, Basis and dimensions, Linear transformations, Linear operator, Matrix representation of linear operator. Inner product space - Definition of inner product space, Properties (Conjugate symmetry, linearity, non-negativity), Norm of a vector, Schwarz's inequality, Triangle in equality, Cauchy's inequality, Law of Parallelogram, Orthogonally, Orthonormal set, Orthonormal basis, Gram-Schmidt Orthogonalization Process. **(H-6, M-8)**	**08 L**
Unit 2	**Matrix Algebra**: Types of matrices (Symmetric, Skew symmetric, Hermitian, Skew Hermitian, Adjugate, Unitary and Orthogonal), Eigen values and Eigen vectors of a matrix, Diagonalization of matrix, Caley-Hamilton theorem. **(H-5, M-6)**	**05 L**
Unit 3	**Fourier Series:** Definition, Determination of Fourier coefficient, Dirichlet theorem, Extension of interval, Half range Fourier sine and cosine series, Complex form of Fourier series, Parseval'sidentity, Fourier integrals. **(H-10, M-8)**	**10L**
Unit 4	**Integral Transforms:** Definition of Laplace Transform, Properties (Linearity,	**14 L**

	Shifting, Change of Scale), Laplace Transform of derivative, Laplace transform of integrals, Derivative of Laplace transform, initial and final values theorems, Multiplication by power of t, division by t, Inverse Laplace transform- Definition, Proofs of Linearity, I^{st} & II^{nd} shifting theorem, Convolution theorem(Statement only), Applications to solution of differential equations. Definition of Fourier transformation, Fourier cosine transforms. **(H-14, M-18)**	
Unit 5	**Special Functions**: Legendre, Hermit, & Laguerre Functions (Generating functions, Recurrence relations, Orthogonally, Rodrigue's Formula), Associated Legendre equation, Associated Legendre function, Properties of Associated Legendre function, Recurrence formulae for Associated Legendre function, Laguerre polynomials, Associated Laguerre Polynomials, Orthogonally of associated Laguerre polynomials, Recurrence formulae for Associated Lageurre polynomials. Generating function for Jn(x), Integral representation for Jn(x), Reccurence relation for Jn(x), Bessel's Function of half odd order (J+1/2(x), J-1/2(x), J+3/2(x), J-3/2(x)), Integral formula of Laguerre polynomials Orthogonally of Bessel's equations. **(H-12, M-15)**	**12 L**
Unit 6	**Complex Analysis:** Complex number, Conjugate complex numbers, Function of Complex variable, Analytic function, Cauchy- Riemann condition, Cauchy's theorem, Cauchy's integral formula, Derivative of analytic function, Taylors theorem, Lorentz's theorem, Cauchy's residue theorem, Evaluation of definite integrals(integration round the unit circle). **(H-5, M-5)**	**05 L**

Suggested readings / References:-

1. Linear algebra By Seymour Lipschutz, Schaum outline series.
2. Theory & Problems of Matrices by Frank Ayres.
3. Mathematical Method For Physics by Arfken.
4. Mathematical Method in Physics by B. D. Gupta.
5. MMP by H.K.Das (S. Chand Publication).
6 .Mathematical Physics by B. S. Rajput.
7. Fourier Series by Seymour Lipschutz ,Schaum outline series.
8. Laplace Transforms by Seymour Lipschutz ,Schaum outline series.
9. Complex Variables & Applications by J. W. Brown.
10. Mathematics for physical science by Mary Boas.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C101.1	Course outcome: Learner will be able to …. Apply the concept and knowledge of Mathematical physics to understand and solve real life problems.	
C101.2	Knowledge about Vector calculus, Bessel Functions, Legendre Differential equations, complex variable, Laplace transforms, Fourier Series etc and their physical significance is learnt by students. These mathematical concepts are widely used in various physics derivations.	
C101.3	Understanding of the Basic Mathematical physics will create scientific temperament.	

	PHY-102: Classical Mechanics	
	Course description: This course is aimed at introducing the fundamentals of Classical Mechanics to Post Graduate students. ***Course Objectives***:: 1. To impart knowledge of basic concepts in Classical Mechanics. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Mechanics of System of particles:** Conservation of linear and angular momentum of system of particles, Relation between about any point and about Centre of mass, Discuss similar relations for kinetic energy also. Scattering of Particles: Elastic and inelastic collision, Lab. and C.M. system of coordinates, Differential and total cross section, Impact parameter, Rutherford's scattering, Relation of cross-section between C.M. and Lab Frame. **(H-10, M-14)**	**10 L**
Unit 2	**Lagrangian Formulation:** Types of constraints, degrees of freedom, Generalized coordinates, Concept of virtual displacement and virtual work, D'Alemberts principle, Lagrange's equation from D'Alemberts principle, Properties of Lagrange's equation, Applications of Lagrange's equation (simple pendulum, linear simple harmonic oscillator, compound pendulum and Atwood's machine). **(H-10, M-10)**	**10 L**
Unit 3	**Hamilton's equation of motion**: Introduction, Legendre's dual transformation, Hamilton's function and Hamilton's equations of Motion, Properties of the Hamiltonian and of Hamilton's equations of motion, Routhian, Configuration space, Phase space and State space, Lagrangian and Hamiltonian of relativistic particles and light rays. **(H-10, M-12)**	**10 L**
Unit 4	**Principle of Least Action and Hamilton's principle:** Introduction, Principle of least action, Hamilton's principle, Comparison between Fermat's principle of least action in optics & Maupertuis' principle of least action in mechanics, Derivation of Euler-Lagrange equations of motion from Hamilton's principle, Derivation of Hamilton's equations of motion for holonomic systems from Hamilton's principle, Invariance of Hamilton's principle under generalized coordinate transformation. **(H-12, M-14)**	**12 L**
Unit 5	**Canonical transformations and Hamilton-Jacobi theory**: Gauge transformation, Canonical transformation, Condition for transformation to be canonical, Poisson brackets, Canonical equations in terms of Poisson bracket notation, Infinitesimal transformation, Relation between infinitesimal transformations and Poisson brackets, The Hamilton - Jacobi equations, Solution of harmonic oscillator. **(H-10, M-10)**	**10 L**

Suggested readings:/Reference Books:

1. Introduction to Classical Mechanics: R. G. Takwale and P. S. Puranik.
2. Classical Mechanics: N. C. Rana and P. S. Joag, Tata McGraw -Hill Publishing Co. Ltd.
3. Classical Mechanics: P. V. Panat, Narosa Publishing House.2008
4. Classical Mechanics: Gupta, Kumar and Sharma, Pragati Publication
5. Classical Mechanics: Herbert Goldstein, Narosa Publishing House.
6. Classical Mechanics: J. C. Upadhyaya, Himalaya Publishing House.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C102.1	Outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Classical Mechanics to real life problems.	
C102.2	2. Understanding of the Classical Mechanics will create scientific temperament.	
C102.3	This paper enables the students to understand : • The Lagrangian and Hamiltonian approaches in classical mechanics. • The classical background of Quantum mechanics and get familiarized with Poisson brackets and Hamilton -Jacobi equation.	

	PHY - 103: Solid State Physics	
	Course description: This course is aimed at introducing the fundamentals of Solid state Physics to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Solid state Physics. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Band theory of Solids**: Nearly free electron model, Bloch theorem (with proof), Kronig Penny model, Motion of electrons in 1-D according to band theory, Distinction between metals, insulators and intrinsic semiconductor, origin of energy gap, Effective mass of an electron. (Ref: 2, 6 & 8) **(H-8, M-8)**	**08 L**
Unit 2	**Defects in solids:** Defect (Imperfection), Classification of defects, Point defect: Schottky defect, Frenkel defect and Interstitial defect, Determination of number of concentration of defects in interstitial defect, Schottky defect and Frenkel defects, Elementary idea about dislocation. (Ref:1,4&9) **(H-5, M-8)**	**05 L**
Unit 3	**Lattice vibrations and phonons:** Concept of lattice vibration, Elastic waves in an infinite and finite one dimensional array of identical atoms, Lattice vibrations of diatomic lattice, Optical and Acoustic modes of vibrations, Quantization of lattice vibrations: Phonons. (Ref: 5 & 6) **(H-7, M-8)**	**07 L**
Unit 4	**Theory of Dielectrics, Piezoelectricity and Ferroelectrics:** Polarization of dielectric, Dielectric constant, Local electric field, Polarizability, Clausius Mosotti relation, Dipolar polarizability, Calculation of Ionic & Electronic polarizability, Total polarizability, Piezoelectricity, Ferro electricity, Theories of Ferro electricity: Dielectric behavior above T_c, Spontaneous polarization below T_c and Ferroelectric Hysteresis, Applications of ferroelectrics. (Ref: 1, 3, 6, 8& 9) **(H-9, M-10)**	**09 L**
Unit 5	**Magnetism**: Origin of magnetic moments, Classification of magnetic materials, Langevin's classical theory of diamagnetism, Langevin's classical theory of Para magnetism, Weiss theory of Para magnetism, Paramagnetic susceptibility of conduction electron, Ferromagnetic domains, ferromagnetic Hysteresis, Exchange energy, Anisotropy energy, Bloch wall, Weiss theory of ferromagnetism, Two sub-lattice model of Anti ferromagnetism, Neel's model of ferrimagnetism. (Ref: 1, 4,8 &9) **(H-13, M-14)**	**13 L**
Unit-6	**Superconductivity**: Basic concept, Occurrence, Meissner effect, Critical field, Type-I and type-II superconductors, Heat capacity, Energy gap, Microwave and IR properties, Critical currents, Thermodynamics of super conducting transitions, London equation, Coherence length, London penetration depth, BCS theory of superconductivity, High T_c super conducting materials, Qualitative discussion of Josephson superconductor tunneling (a.c. &d.c.). (Ref: 1, 3, 6, 7,8& 9) **(H-10, M-12)**	**10 L**

Suggested readings:/Reference Books:

1. Fundamentals of Solid State Physics: B.S.Saxena , R.C.Gupta & P.N.Saxena, PragatiPrakashan, Meerut 11^{th}Ed.
2. Solid State Physics : R. L. Katiyar, Campus Books International, New Delhi . 2009.
3. Solid State Physics : R. L. Singhal, Kedarnath Ramnath Prakashan, Meerut.
4. Solid State Physics : S.L. Gupta & V. Kumar, K. Nath & Co. Meerut.
5. Solid State Physics: A.J. Dekkar, McMillan students Ed.
6. Introduction to Solid State Physics: C. Kittle, Wiley Eastern Ltd; 7th Ed.
7. Solid State Physics: C. M. Kachhava, Tata McGraw Hill Eds.
8. Solid State Physics: R. K. Puri and V. K. Babbar.
9. Elementary Solid State Physics: M. Ali Omar.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C103.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Solid state Physics understand and solve the real life problems.	
C103.2	2. Understanding of the course will create scientific temperament..	
C103.3	After successful completion of this paper, the student will be well • Introducing the behavior of ferroelectric and ferromagnetic material in terms of their properties and applications. • Superconductivity and lattice defects. • Introducing basic concepts via diffraction methods, lattice vibrations and free electrons, Hall effect. • Understanding the basic transport properties of metals and semiconductors. • Their introduction to the band structures for studying different materials.	

M.Sc. Part I Semester I(Physics): (Skill Based Course)

	PHY - 104: (A) Physics of Semiconductor Devices	
	Course description: This course is aimed at introducing the fundamentals of Physics of Semiconductor Devices to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Physics of Semiconductor Devices. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Charge Carriers and Fermi Level in Semiconductors in Equilibrium:** Equilibrium distribution of electrons and holes, Intrinsic carrier concentration and Fermi level position, Doping of semiconductors with impurities, Extrinsic semiconductors: Equilibrium distribution of electrons and holes, Degenerate and non-degenerate semiconductors, Impurity carrier concentration, Charge neutrality equation, Equilibrium electron and hole concentration and its temperature dependence, Position of Fermi level and its variation with temperature and concentration. **(H-9, M-10)**	**09 L**
Unit 2	**Current Transport Phenomena and Continuity Equation: Drift of carriers:** Drift current, mobility and its temperature dependence. Diffusion current, diffusion constant, Total current density, Non-uniform impurity distribution and induced internal field. Einstein's relation, Non-equilibrium excess carriers and Continuity equation. Excess carrier generation, recombination and injection and its mathematical analysis using continuity equation, Life-time and diffusion length of carriers, Concept of quasi Fermi levels. **(H-9, M-10)**	**09 L**
Unit 3	**Characterization of semiconductor solids:** Hall effect, Measurement of resistivity, mobility, carrier concentration, diffusivity, Hall coefficient and carrier types for majority carriers, Hall effect in intrinsic semiconductors. Haynes-Shockley experiment, Mobility, diffusivity and life time of minority carriers. **(H-5, M-7)**	**05 L**
Unit 4	**P-N Junctions-Characteristics and Devices:** Junction in equilibrium, Continuity of Fermi level across the junction, Junction under forward and reverse bias, Zero bias, Built-in-potential, Electric field in depletion region, Space Charge width, Biased junction, Space charge width under electric field, Junction Capacitance, Diffusion capacitance, One sided junction, Non-uniformly doped junctions, Linearly graded, Hyper abrupt etc.,	**13 L**

	Break down in P-N junction, Avalanche and Zener Breakdown. a) PN Junction diode: Carrier distribution profile, Ideal P-N junction current, small signal equivalent, Current voltage characteristics of junction diode. b) Zener diode: Reverse bias breakdown, principle of operation, device design for particular breakdown voltage. c) Photovoltaic Cell: Principle of operation, forward and reverse bias characteristics, equivalent circuit, applications. **(H-13, M-15)**	
Unit 5	**Metal-semiconductor Junction Diode:** Structure, metal semiconductor contacts, energy band diagram for different cases, barrier formation, Schottky barrier diode, Non ideal effects on barrier heights, Current voltage characteristics, Comparison of barrier diode and PN-junction diode, Metal Semiconductor Ohmic contact, Ideal non-rectifying barriers, Heterojunction. **(H-7, M-8)**	**07 L**
Unit 6	**Bipolar Junction Transistor:** Structure, The basic principle of operation, Modes of operation, Carrier concentration profile in various regions in forward active mode, current gain and current gain factors, Equivalent circuit models: Ebers-Moll model, the dependence of Ebers-Moll parameters on the structure and operating point, Maximum transition current, Voltage and power rating. **(H-9, M-10)**	**09 L**

Suggested readings:/Reference Books:

1. Semiconductor and electronic Devices, Adir Bar-lev (1987), Prentice Hall of India.
2. Advanced Theory of Semiconductor Devices, Hess, K.(1988)Englewood Cliffs, N. J. , PH India
3. Physics of Semiconductor Devices, Roy.D.K. (1992), University Press, India.
4. Physics of Semiconductor Devices, Shur,M.(1990) Englewood Cliffs, N. J. Prentice Hall of India.
5. Solid State Electronic Devices, Streetman, B.G. (1990),3rded; Englewood Cliffs, N. J. PH India.
6. Semiconductor Devices; Physics and Technology, Sze, S.M. (1981) Wiley Eastern Ltd.
7. Physics of Semiconductor Devices, Sze, S. M. (1985) Wiley Eastern Ltd.
8. Fundamentals of Semiconductor Theory and Device Physics, Wang, S.(1989) Englewood Cliffs. N.J., PHIndia
9. Semiconductor Devices - Basic Principles, Jasprit Singh, John Wiley & Sons, Inc.(2002).
10. Semiconductor Devices, Zambuto, M .(1989), McGraw Hill.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C104.A,1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Physics of Semiconductor Devices to understand and solve the real life problems.	
C104.A.2	2. Understanding of the course will create scientific temperament.	
C104.A.3	On completion of this course the student will learn about : • Operational amplifiers, comparator and applications, Voltage regulators and features of Timer 555. • Modulation and communications. • Comparator and applications	

	PHY - 104: (B) : Electronic Instrumentation	
	Course description: This course is aimed at introducing the fundamentals of Physics of Electronic Instrumentation to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Physics of Electronic Instrumentation. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Signal representation & generation:** Periodic signals, periodic signals, modulated signals (A.M., F.M., P.M.), sampled data pulse Modulation (PWM, PAM, PPM), definition and their graphical representation. Generation of sine, Square, triangular, linear ramp & saw tooth waveforms. **(H-8, M-10)**	08 L
Unit 2	**Measurement of electrical signals**: Meters: comparison of analog & digital meters, moving coil, moving iron, electrodynamics, Induction meter, clamp on meter. CRO: Detail study of CRT, Block diagram of general purpose CRO, Dual beam and dual trace oscilloscope, measurement of voltage, current, resistance, frequency, phase, capacitance & inductance using CRO. **(H-14, M-14)**	14 L
Unit 3	**Bio-electric Signals and Electrodes:** Basic Physics of membrane potential, resting membrane potential of nerves, nerve action potential, origin of bio-electric signals, recording electrodes, polarization, skin contact impedance, electrodes for ECG, electrodes for EEG, electrical conductivity of electrodes jellies and creams, microelectrodes. **(H-8, M-10)**	08 L
Unit 4	**Telemetry System:** Multiplexer: Analog & digital multiplexer, Sample and hold Circuit. Data transmission system. Telemetry system Block diagram, Characteristics, Land line Telemetry, Radio telemetry, Processing system. **(H-8, M-10)**	08 L
Unit 5	**Applications of electronic system:** Frequency selective wave analyzer, Spectrum analyzer, Lock-in amplifier, Fiber optic sensors. Measurement of Humidity, Hygrometers, Measurement of pH, Measurement of thermal Conductivity (gas analyzer), Nuclear instrumentation-types of radiation, Geiger Muller tube, ionization chamber. Flow meters: Classification, working principle, electromagnetic flow meter, Ultrasonic flow meter. **(H-14, M-16)**	14 L

Suggested readings:/Reference Books:

1. Transducers& Instrumentation: D.V.S.Murthy.
2. Instrumentation-Devices &system: C.S.Rangan, G.R.Sharma, V.S.V.Mani.
3. Principles of measurement and Instrumentation : Alan S.Morris.
4. Electronic Instrumentation: Kalsi
5. Electrical & electronic measurement Instrumentation: A.K. Sawhney.
6. Modern electronic instrumentation & measurement Technique: Helfrick Cooper.
7. Handbook of Bio-medical Instrumentation – R.S. Khandpur, TMH, New Delhi
8. Introduction to Bio-medical equipment Technology- J.J Carr, Pearson Pvt.Ltd.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C104.B.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Physics of Electronic Instrumentation to understand and solve the real life problems.	
C104.B.2	2. Understanding of the course will create scientific temperament.	
C104.B.3	On completion of this course the student will learn about : • Fabrication of integrated devices. • Applications of electronic system. • Bio-electric Signals and Electrodes	

	PHY - 104: (C) Bio-Physics	
	Course description: This course is aimed at introducing the fundamentals of Bio-Physics to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Bio-Physics. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Cellular Basis of Life:** Cell components-structure and function, plant and animal cells, Biomolecules- General idea about structure and functions- H_2O, Proteins, carbohydrates, fats and nucleic acids, Introduction to Biological energy, Energy consumption, Respiration, Energy production, photosynthesis, ATP synthesis. **(H-12, M-8)**	12 L
Unit 2	**Protein structure:** 4 levels, Ramachandran plot, Interpretations, classifications (by structure and function), Nucleic acids, Types of DNA, properties, RNA, Base pairing, Transcription and Translation. **(H-6, M-8)**	06 L
Unit 3	**Confirmation Analysis:** Asymmetric carbon, Fisher conventions, L-D type systems, Torsion angle, Newmann projection, Cis-trans peptide. **(H-6, M-6)**	06 L
Unit 4	Membrane Biophysics & Transport: A) Structure and function of membrane, membrane proteins. B) Transport across membrane, processes, chemical potential, flux equation, Nernst equation, Using–Teorell unidirectional flux ratio, Osmotic pressure, Osmotic phenomenon in leaky membrane, The Donnan equilibrium – Goldmann equation. **(H-10, M-11)**	10 L
Unit 5	**Bioenergetics:** Entropy in biological systems, Information processing, Photosynthesis pathways, Redox potentials, Glow curves, Orders of kinetics, Thermodynamics in photosynthesis, Thermo luminescence, Mitochondrial bioenergetics. **(H-8, M-11)**	08 L
Unit 6	**Enzyme Kinetics:** Classification of enzymes, Activation energy barrier, substrate concentration, Vmax, Km competitive inhibition, Allosteric enzymes. **(H-5, M-8)**	05 L
Unit 7	**Neuro biophysics:** Structure and function of neuron, types of synapses, testing potential, local depolarization, action potential: Generation and propagation, equivalent circuit of cell, voltage clamp, Na-K pump, equivalent circuit. **(H-5, M-8)**	05 L

Suggested readings:/Reference Books:

1 Biophysics: A introduction by Rodney M.S., Colteril. John Willey and Sons Ltd.
2. Biophysics: Vasantha Pattabhi, M. Gantham, Narosa Publishing House.
3. Biophysical Plant Physiology and ecology, P.S. Nobel (University of California, Los Angeles and W.H. Freeman & Co., San franscisco, 1983).
4. Biophysics & Physiology of excuitable membranes, Adleman, (Van-Nostrand eehihod.Co.1971).
5. Problems of Biological Physics. L.A. Bluemonfeld (Springer-Verlag-Berlin 1979).
6. The structure and function of proteins. L Dickerson & J.Geis (Harpes&Reod 1975.)
7. Biology, a human approach, I.W.Sherman and V.G.Sherman (Oxford Uni. Press 1979).
8. Essentials of Biophysics, P. Narayanan, New Age Publications, 2000.
9. Principles of Biochemistry: Lahninger.
10. Neuron to brain, S.W. Kuffler and J.G. Nichols (SinacuerAsso. Inc. 1995).

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C104.C.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Bio-Physics to understand and solve the real life problems.	
C104.C2	2. Understanding of the course will create scientific temperament.	
C104.C.3	On completion of this course the student will learn about : • Cell components-structure and function.	

	• Membrane Biophysics & Transport. • Bioenergetics. • Neuro biophysics: Structure and function of neuron, types of synapses, testing potential.	

M.Sc. Part I Semester I Semester I : Practical Courses I (Core course)

PHY-105: Basic Physics Laboratory – I	
	Course description: This course is aimed at introducing the fundamentals of Basic Laboratory Physicsto Under the students. **Course objectives:** 1. To impart knowledge of basic concepts in Laboratory Physics and Mechanics. 2. To provide the knowledge and methodology necessary for Practical in Physics. 3. The course involves the related experiments based on the Practicals.
	Group A **Note: At least 4 experiments from each group and minimum, 10 experiments should be performed**
1	λ by Michelson Interferometer.
2	Febry -Perot Interferometer. Determination of wavelength of monochromatic source.
3	To determine ultrasonic velocity and to obtain compressibility of a given liquid.
4	Magnetic susceptibility of paramagnetic material by Quincke's method.
5	"e/m" by Millikan oil drop method
6	Diffraction at single and double slits using laser source.
7	Surface tension by ripples method.
8	Determination of elastic constants by Cornu's method.
9	Determination of thickness of thin transparent sheet like mica using Michelson interferometer.
10	Determination of Rydberg constant using Hydrogen discharge tube.
11	To find the values of Cauchy's constants for the material of the given prism using Hg.
Group B	
1	Design and build ERPS using IC 723 and study its line and load regulation.
2	Design, build and test the phase shift oscillator using IC-741.
3	Design, build and test Schmitt trigger circuit using 741.
4	To study the characteristics of LDR, Photodiode and Phototransistor.
5	Design, build and test first order & second order low pass filter using IC 741.
6	Design, build and test first order & second order high pass filter using IC 741.
7	Design, build and test precision rectifier using IC 741.
8	Design, build and test Astable /monostablemultivibrator using IC 741/IC 555.
9	Design, build and test voltage to frequency converter.
10	Design, build and test the temperature to frequency converter. 11.Design, build and test transformer less class-B push pull amplifier.
	NOTE: This list is flexible; one can add any suitable experiment (of appropriate standard) from Physics with prior permission of BOS in Physics, NMU, Jalgaon.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C105.1	Course outcome: Learner will be able to ….	

	1. Apply the concept and use of knowledge of the Basic Physics Laboratory course to real life problems.	
C105.2	2. Understanding of the Basic Physics Laboratory course which will create scientific temperament.	
C105.3	Students will have hand on experience of : • Amplifiers, diodes, various logic gates, flip-flops and multivibrator. • Solar cell, Michelson interferometer, photovoltaic cell, lasers and various optoelectronic devices. • Hall coefficient, Curie temperature, B-H curve. • Digital electronics experiments. • Understands in depth about thin film preparation and production controlling techniques and the application of thin films in the field of science & Technology.	

M.Sc. Part I Semester I Physics : Audit Courses

AC-101: Practicing Cleanliness

(Compulsory; Campus-level Audit Course; Practical; 2 Credits)

Course Objectives (CObs):

- To make students aware of Clean India Mission and inculcate cleanliness practices among them.

	• Awareness program on o Swachh Bharat Abhiyan (Clean India Mission) o Clean Campus Mission o Role of youth in Clean India Mission • Cleaning activities inside and surroundings of Department buildings. • Tree plantation and further care of planted trees • Waste (Liquid/Solid/e-waste) Management, Japanese 5-S practices • Planning and execution of collection of Garbage from different sections of University campus • Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance. • Cleanest School/Department and Cleanest Hostel contests • Painting and Essay writing competitions	

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC101.1	Identify need at of cleanliness at home/office and other public places.	**2**
AC101.2	Plan and observe cleanliness programs at home and other places.	**4**
AC101.3	Practice Japanese 5-S practices in regular life.	**3**

M.Sc. Part I Semester II (Physics): Core Courses

PHY – 201: Statistical Mechanics		
	Course description: This course is aimed at introducing the fundamentals of Statistical Mechanics to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Statistical Mechanics. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Phase Space and Ensembles:** Phase space, Types of Ensembles, Partition function, Liouville's theorem, Principles of conservation of density and extension in phase space, Grand canonical ensemble, Physical interpretation of α, Chemical potential in the equilibrium state, Fluctuations in number of particles of a system in grand canonical ensemble, Partition function of Classical ideal gas and calculation of thermodynamic quantities, Entropy of mixing and Gibb's paradox, Sackur-Tetrode equation. **(H-14, M-14)**	**14 L**
Unit 2	**Classical and Quantum Statistical Mechanics:** Brief outline of classical and Quantum statistics, Symmetry of wave functions, The quantum distribution functions, Maxwell Boltzmann statistics, Bose Einstein. Statistics, Photon statistics, Fermi Dirac statistics, The Boltzmann limit of Boson and Fermions gases, Evaluation of partition function for quantum monatomic gas, Partition function for diatomic molecules, Equation of state for an ideal gas. **(H-12, M-12)**	**12 L**
Unit 3	**Ideal Bose Systems:** Photon gas: Black body radiation, radiation properties such as pressure, density, emissivity and equilibrium number of photons in a cavity. Einstein's derivation of Planck's law, Bose Einstein condensation, Specific heat from lattice vibrations, Debye's model of solids: Phonon gas. **(H-10, M-12)**	**10 L**
Unit 4	**Ideal Fermi Systems:** Fermi energy, Mean energy of fermions at absolute zero temperature, Fermi energy as a function of temperature, Electronic specific heat, White Dwarfs, Compressibility of Fermi gas, Pauli paramagnetism, Relativistic degenerate gas. **(H-8, M-12)**	**08 L**
Unit 5	Phase transition and Critical Phenomena: Phase transitions, Conditions for phase equilibrium, Order parameter, I^{st} order phase transition, II^{nd} order Phase transition, Critical indices, van der Waals theory of liquid gas transition, Mayer theory of condensation, Curie Weiss theory of magnetic transition, Ising model. **(H-8, M-10)**	**08 L**

Suggested Readings:/ Reference Books:

1. Fundamentals of Statistical Mechanics: B.B. Laud, New Age Int.l Publishers (2003)
2. Introduction to Statistical Mechanics: S. K. Sinha, Narosa Publication, New Delhi (2007).
3. Fundamentals of Statistical & Thermal Physics: F. Reif, Mcgraw Hill Company, (1965).
4. Statistical Mechanics: R. K. Patharia, Butterworth-Heinemann (Elsevier) (2/e Reprint 2004).
5. Statistical Physics: Harvey Gould and Jan Tobochnik..

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C201.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Statistical Mechanics to understand and solve the real life problems.	
C201.2	2. Understanding of the course will create scientific temperament..	

C201.3	The students should be able to : • Explain statistical physics and thermodynamics as logical consequences of the postulates of statistical mechanics. • Apply the principles of statistical mechanics to selected problems. • Grasp the basis of ensemble approach in statistical mechanics to a range of situations. • To learn the fundamental differences between classical and quantum statistics and learn about quantum statistical distribution laws. • Study important examples of ideal Bose systems and Fermi systems.	

	PHY - 202: Classical Electrodynamics	
	Course description: This course is aimed at introducing the fundamentals of Classical Electrodynamics to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Classical Electrodynamics. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Electrostatics and Multipole Fields:** Electrostatics energy and energy density and free space and in dielectrics ,Thermo dynamic interpretation of Electrostatics energy, Electric dipole, Multipole expansion of potential, The dipole potential, The quadrupole potential and quadupole moment, further remarks concerning electric multipoles. **(H-10, M-10)**	**10 L**
Unit 2	**Electromagnetic Waves:** Plane waves in non conducting media, Polarization, Energy Flux in a plane wave, Radiation Pressure and Momentum, Plane waves in a conducting medium, the Skin effect, Current distribution in conductors –The Skin depth. **(H-10, M-10)**	**10 L**
Unit 3	**Reflection, Refraction and Dispersion:** Boundary conditions for the electromagnetic field vectors B, E, D and H at interface between two media, Reflection and Refraction at the boundary of two non-conducting media, General treatment of reflection and refraction, Fresnel's equations-Incident wave polarized with its vectors E normal and parallel to the plane of incidence, The coefficients of reflection and transmission at the interface between two dielectrics, Brewster angle and degree of polarization, Rectangular wave guide, Dispersion (Normal and Anomalous), Dispersion in liquid and solid. **(H-12, M-15)**	**12 L**
Unit 4	**Electromagnetic Fields and Radiating systems:** Lienard-Wiechart Potentials, Electric and magnetic fields of charge in uniform rectilinear motion, Electric and magnetic fields produced by arbitrary moving charge, Radiation due to non relativistic charges and relativistic charges, Radiating systems, Radiation due to an oscillating electric dipole, Radiation due to a small current element, Linear half wave antenna. **(H-12, M-15)**	**12 L**
Unit 5	**Relativistic Electrodynamics:** Galilean transformations, Lorentz transformations, Velocity momentum and energy in relativity, four vectors in electrodynamics. Covariant form of electric and magnetic field- Electromagnetic field tensor. **(H-8, M-10)**	**08 L**

Suggested readings / Reference books:-

1) Electrodynamics by Gupta, Kumar and Singh
2) Classical Electromagnetic Radiation by Jerry B. Marion
3) Electromagnetic by B. B. Laud.
4) Classical Electrodynamics by J. D. Jackson
5) Introduction to Electrodynamics by A. Z. Capri & P. V. Panat

6) Classical Electricity & Magnetism by Panofsky Phillips 7) Foundations of Electromagnetic theory by Reitz & Milford 8) Electromagnetic theory & Electrodynamics by Satyaprakash, Kedarnath. 9) Introduction to Electrodynamics by David Griffith.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C202.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Classical Electrodynamics to understand and solve the real life problems.	
C202.2	2. Understanding of the course will create scientific temperament.	
C202.3	3 After successful completion of the course, the student is expected to : • Have gained elaborated knowledge about the electrostatics and laws governing the charge distribution. • Have gained ability to apply Laplace equation for calculating potentials. • Study in depth about Polarization, bound charges and boundary conditions. • Realize the importance of application of Biot Savarts Law and Amperes law. • Understand the relevance of different magnetization and the boundary condition of magnetic field.	

	PHY - 203: Quantum Mechanics	
	Course Objectives: 1. To Course description: This course is aimed at introducing the fundamentals of Quantum Mechanics to the students. Course objectives: 1. To impart knowledge of basic concepts in Quantum Mechanics. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Operator methods in quantum mechanics:** Linear vector space and its properties, examples, Linear independence of vectors , dimensions, bases and expansion theorem, Inner product & unitary spaces, Orthonormal sets, completeness, Hilbert spaces. Operators: Linear operators, Identity operator, Null operator, Inverse operator, Eigen values & eigen functions, Hermitian operators and their properties, Expansion of eigen functions, Continuous spectrum, Parity operator & its properties, Projection operator, Equation of motion. **(H-10, M-12)**	**10 L**
Unit 2	**Matrix formulation of Quantum Mechanics**: Dirac's Bra and Ket notations for vectors and their properties, Ket vector as a column matrix and bra vector as a row matrix, Operators as matrices, Matrix form of wave function, Unitary transformation, Eigen value problem, Quantum Dynamics: Schrodinger, Heisenberg and Interaction representations, Defining equations for the operators a and a+, Computation of values of a a+, a+a, [a, a+], [a, H], [a+, H], Eigen values & Eigen functions of 1-D harmonic oscillator using ladder operators a and a+, Matrices for the operators: a, a+, x, p, H, Derivation of Schrodinger's equation from a and a+. **(H-14, M-16)**	**14 L**
Unit 3	**Angular Momentum**: Total angular momentum operator J. Commutation relation of components J_x, J_y and J_z. Ladder Operators J_+ and J_- , Commutation relations of J_2 and J_z with J_+ and J_- , Commutation between J_+ and J_-, Eigen values and Eigen functions of J_2 and J_z, Angular momentum Matrices, Electronic states in a central field, Addition of angular momenta, Computation of Clebesch- Gordan coefficients for (j_1 = ½ & j_2 = ½)	**14 L**

	and for ($j_1 = 1$ & $j_2 = ½$). **(H-14, M-16)**	
Unit 4	**Approximation Methods**: a) Time independent Perturbation Theory: Non degenerate case – Evaluation of first order energy and first order wave function, Evaluation of second order energy and second order wave function, Application to: Perturbed Harmonic Oscillator, b) Variation Method: Basic principles, Applications to: one dimensional harmonic oscillator, Ground state energy of hydrogen atom. c) The WKB approximation: The principle of the method, the WKB wave function, Application to: transmission through a barrier. **(H-14, M-16)**	**14 L**

Suggested readings:/Reference Books:

1. Advanced Quantum Mechanics: SatyaPrakash, Kedarnath Ramnath, Meerut.
2. Quantum Mechanics: G. R. Chatwal & S. K. Anand, Himalaya Publishing House.
3. A text book of Quantum Mechanics: P.M.Mathews & K.Venkatesan, Tata McGraw Hill Pvt. Ltd.
4. Quantum Mechanics: John L Powell & Bernd rasemann., Narosa Publishing House.
5. Quantum Mechanics: A.K.Ghatak&S.Loknathan, The Macmillan company of India Ltd..
6. Quantum Mechanics: L. I. Schiff. McGraw Hill.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C203.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Quantum Mechanics to real life problems.	
C203.2	2. Understanding of the course will create scientific temperament.	
C203.3	After successful completion of this paper, the student will be well • Linear vector spaces, versed in Hilbert space, concepts of basis and operators and bra and ket notation. • Both Schrödinger and Heisenberg formulations and their applications. • Theory of angular momentum and spin matrices, orbital angular momentum and Clebsh Gordan Coefficients. • Space -time symmetries and conservation laws, theory of identical particles, Oscillators • Time Dependent and independent Perturbation Theory, Variational Method, WKB Method, Collision Theory and Relativistic Quantum Mechanics.	

M.Sc. Part I Semester II (Physics): Skill Based Course

	PHY - 204: Material Science	
	Course description: This course is aimed at introducing the fundamentals of Material Science to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Material Science. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Phase diagram**: Solid solutions, types of solid solutions, Hume-Rothery rules, intermediate phase/ compounds Phase equilibrium, Gibbs Phase rule, Lever rule,	**11 L**

	Equilibrium Phase Diagrams, Unary diagrams, Binary diagrams, typical isomorphous Phase diagram, Cooling curves for isomorphous binary system Al2O3-Cr2O3, properties of eutectic, peritectic, monotectic and eutectoid-systems. Phase diagram for isomorphous system-. Eutectic phase diagram for Pb-Sn system. **(H-11, M-12)**	
Unit 2	**Phases in alloys and Phase transformations:** Iron-Carbon phase diagram and different phases of the system. Phase transformations in steel during heating and transformation of austenite during cooling. Transformation rate effects and TTT diagrams, Microstructure and Property Changes in Fe-C Alloys. **(H-13, M-14)**	**13 L**
Unit 3	**Applications and Processing of Metals and Alloys:** Types of metals and alloys: Ferrous materials -A Steels: Low carbon steels, Medium carbon steels, High carbon steels, Stainless steels. Cast irons: Gray cast iron, White cast iron, Nodular (or ductile) cast iron, Malleable cast iron. Non-ferrous materials: Aluminium alloys, Copper alloys, Magnesium alloys, Titanium alloys, Refractory metals Noble metals, free cutting steel, structural steel, high speed steel, ball, bearing steel. Cu-alloys: Brasses and Bronzes-Properties and applications, Cu-Ni – alloys. Thermal processing of metals and alloys: Annealing processes: Process annealing, Stress relief, Full annealing, Normalizing. Quenching and Tempering processes. Case Hardening: Induction hardening, Flame hardening, Laser hardening, Carburizing, Cyaniding. **(H-14, M-16)**	**14 L**
Unit 4	**Applications and Processing of Ceramics:** Ceramics: Structure, types and properties. Glasses, Clay products, Refractories, Abrasive ceramics, Cements, Advanced ceramics, typical ceramics and respective applications. Fabrication and processing of ceramics. Glasses- structure, Glass transition, properties of glasses. Metallic glasses-introduction, preparation of metallic glasses, mechanical and magnetic properties, principal uses of metallic glasses. **(H-8, M-12)**	**08 L**
Unit 5	**Solar Energy materials:** Solar energy spectrum, photovoltaic conversion materials: Si, GaAs, CdS, $CuInSe_2$, fabrication of CdS/Cu_2S cell, introduction to organic solar cells. **(H-6, M-6)**	**06 L**

Suggested readings:/Reference Books:

1. Introduction to engineering materials: B. K. Agrawal, Tata McGraw-Hill Pub.
2. Material Science and Engineering, A first course : V. Raghavan, Prentice Hall Of India.
3. Introduction to Materials Science: H. B. Lal, Dominant Publishers, New Delhi.
4. Composite Material Science and Engineering, Springer, 2001. By Krishnan K. Chawla.
5. Material Science and Engineering: R. K. Rajput , S. K. Kataria & Sons, New Delhi,2002.
6. Solid State Physics-Structure and Properties of Materials: M. A. Wahab, Narosa Publishing.
7. Material Science and Engineering- An introduction W. D. Callister Jr sixth edition.
8. Foundations of Material Science and Engineering- William F. Smith.
9. Mechanical Metallurgy, Third Edition, G. E. Dieter McGraw-Hill, New York, 1986.
10. Introduction of Dislocations, D. Hull, Third Edition, Butterworth-Heinemann, Woburn, U.K.
11. Introduction to Ceramics, Second Edition W. D. Kingery, H. K. Bowen, and D. R. Uhlmann.
12. Physical Ceramics for Engineers L. H. Van Vlack, Addison-Wesley Longman.
13. Heat treating, Vol. 4, ASM Handbook, , ASM International, Materials Park, OH, 1991.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C204.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Physics of material Science to understand and solve the real life problems.	
C204.2	2. Understanding of the course will create scientific temperament.	
C204.3	3 The student will get familiar with • Crystal imperfections. • Diffusion in solids and mechanical properties. • Phase transformations and heat treatment	

M.Sc. Part I Semester II Semester II : Practical Courses II (Core course)

PHY- 205: Basic Physics Laboratory – II	
Course description: This course is aimed at introducing the fundamentals of Basic Physics Laboratory to Under the students. **Course objectives:** 1. To impart knowledge of basic concepts inBasic Physics and Mechanics etc. 2. To provide the knowledge and methodology necessary for Practical problems in Physics. 3. The course involves the related experiments based on the Practicas.	
Important note: At least 4 experiments from each group and minimum, 10 experiments should be performed. **Group A**	
1	Determination of Brewster's angle & estimation of refractive index of a given transparent material by using spectrometer and sodium lamp.
2	Study of normal Zeeman effect using LG plate.
3	Construction & study of Pb-Sn binary phase diagram from direct cooling curve of a particular composition and the given transition temperature data.
4	Determination of ionic conductivity & activation energy of NaCl/KCl solid specimen.
5	Hall effect: Determination of Hall coefficient, mobility and type of charge carriers.
6	To investigate the characteristics of radiation emitted by bodies at elevated temperatures (Black body radiation) and determine various constants.
7	Study of magneto resistance in semiconductors.
8	Determination of dielectric constant at high frequency by Lecher wire.
9	To determine Young's modulus of a metallic rod by Searle's optical interference method (Newton's Rings).
10	.Audiometry of human using an audiometer.
11	.Magnetic susceptibility by Guoy method..
12	.Measurement of electrical conductivity of silicon/germanium material at different temperatures by Four Probe method
Group B	
1	.Design, build & test square, triangular and sine wave generator using IC -741.
2	Build & test dual power supply using three pin regulators: 78XX and 79XX series
3	Instrumentation amplifier with thermocouple transducer AD-590.
4	Capacitance measurement using IC 555 .
5	Design, Build and test Inductance simulation circuit using IC 741.
6	Design, build and test the DC to DC converter circuit.
7	Design, build & test Notch filter using IC-741
8	Study of voltage control oscillator using IC 566.
9	Study of optocoupler MCT 2E and their applications.
10	.Active filters for bio-signals: design & testing.
11	.Build and test temperature controller using Solid State Relay (SSR) and PT-100.
NOTE: **This list is flexible; one can add any suitable experiment (of appropriate standard) from Physics with prior permission of BOS in Physics, NMU, Jalgaon**.	

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C205.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Basic Physics Laboratory course to real life problems.	
C205.2	2. Understanding of the Basic Physics Laboratory course which will create scientific temperament.	
C205.3	Students will have hand on experience of : • Zeeman effect using LG plate. • Construction & study of Pb-Sn binary phase diagram Hall coefficient. • Dielectric constant at high frequency. • Magnetic susceptibility. • Design, build & test square, triangular and sine wave generator etc.	

M.Sc. Part I Semester II (Physics): Audit Courses

	AC-201(A): Soft Skills **(Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional:)**	
	Course description: This course is aimed at introducing the fundamentals Soft Skills to Under the students. **Course objectives:** 1. To impart knowledge of basic concepts Soft Skills. 2. To provide the knowledge and methodology necessary for Soft Skills 3. The course involves the fundamentals and knowledge of Soft Skills based on the Practicals.	
Unit 1	**Introduction to soft skills:** Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal setting, life skills, Need for soft skills, Communication skills, Etiquettes& Mannerism.	**2 H**
Unit 2	**Self-Assessment:** Goal setting, SWOT analysis, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements, positive attitude, positive thinking and self-esteem. Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.	**4 H**
Unit 3	**Communication Skills:** Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait, dressing sense, facial expressions, peculiarity of speaker (habits). Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real-life story for 5 minutes each), Oral review (Each student orally presents a review on a story or a book read by them) Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.	**8 H**
Unit 4	**Formal Group Discussion, Personal Interview & Presentation skills:** Topic comprehension, Content organization, Group speaking etiquettes, driving the discussion & skills. Preparation for personal interview: dress code, greeting the panel, crisp self-introduction, neatness, etiquettes, language tone, handling embarrassing & tricky questions, graceful closing.	**4 H**

	Activity: Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback. Mock interview are to be conducted.	
Unit 5	**Aptitude and analytical skills** Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking. Analytical skills: Definition, Types, problem solving	**8 H**
Unit 6	**Life skills** Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.	**4 H**

Suggested readings:

1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd.
2. English for Business Communication: Simon Sweeney, Cambridge University Press
3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press
4. Quantitative Aptitude: R.S. Agrawal

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201A.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Soft Skillsto real life problems.	
AC201A.2	On completion of this course the student will learn about: • Self-Assessment. • Communication Skills. • Formal Group Discussion, Personal Interview & Presentation skills. • Aptitude and analytical skills. • Life skills, Time management etc.	

AC-201(B): Practicing Sports Activities

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives (CObs):

- To motivate students towards sports and provide them required training.

SR NO.	NAME OF THE SPORT/GAME (Select ONE of the Following)	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMESTER
1	Volleyball	• General Fitness • Basic Fitness • Specific Fitness • History of the Game • Basic Skill of the Game • Major Skill of the Game • Technique & Tactics of the Game • Game Practice	Morning : 07 to 09 AM OR Evening : 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201B.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Sports to real life problems	
AC201B.2	On completion of this course the student will learn about: Varies type of Games, • General Fitness • Basic Fitness • Specific Fitness • Basic Skill of the Game • Major Skill of the Game and Technique & Tactics of the Game	

AC-201(C): Practicing Yoga

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional:)

***Course Objectives*:**

- To motivate students towards yoga and provide them required training.

- Yoga: Meaning, Definition & Introduction, Objectives
- Primary Introduction of Ashtanga Yoga
- Preparation of Yogabhyas
- Omkar Sadhana, Prayer, Guru Vandana
- Sukshma Vyayamas
- Suryanamaskar (12 Postures)
- Asanas :
  - Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan
  - Supine (Shayansthiti) - Uttan Padaasan(Ekpad/Dwipad), Pavanmuktasana, Viparitakarani Aasan, Khandarasan, Shavasana
  - Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, Saralhasta Bhujangasana, Shalabhasana(Ekpad/Dwipad), Makarasana
  - Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana, Ardh Chakrasana
- Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana - 6 Types
- Pranayama : Anuloma-viloma, Bhramari

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201C.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Yoga to real life problems	
AC201C.2	On completion of this course the student will learn about: • Primary Introduction of Ashtanga Yoga • Omkar Sadhana, Prayer, Guru Vandana • Sukshma Vyayamas • Suryanamaskar (12 Postures) and Asanas • Pranayama : Anuloma-viloma, Bhramari	

AC-201(D): Introduction to Indian Music

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

	Course Objectives: • To motivate students towards Indian music and provide them minimum required training. .
	• Definition and brief about generation of Swar, Saptak, Thaat, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc. • Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa. • Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information) • Detailed information of Tambora • Detailed information of Harmonium and Tablaa. • Five filmy songs based on Indian Classical Music (Theory and Presentation) • Sound Management - Basic information of Sound Recording (including Practicals) • Composition of Music as per the Story • Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201D.1	Identify different types of Indian music.	**3**
AC201D.2	Develop more interest to learn and practice Indian music.	**4**

Distribution of Course papers for M.Sc. Part II (Physics)

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part II (Subject Name)					
Semester III : Theory Courses					
PHY -301	Atomic and Molecular Physics	Core course	04	100	03
PHY-302	Any ONE of the following A) Materials Synthesis and Preliminary Analysis OR B)Computational Methods and Programming Using 'C' Language OR C) Acoustics and Entertainment Physics	Elective course	04	100	03
PHY -303	Any ONE of the following A) Systematic Materials Analysis OR B)Microprocessor and its Applications OR C) Communication Electronics	Skill Course	04	100	03
Semester III : Practical Courses					
PHY -304	Special Laboratory I	Core course	04+04	100	06
PHY -305	Project Work-I(Literature Survey, Definition of Problem, Experimental work, Oral etc.)	Skill course	04+04	100	06
AC-301A/B/C/D	**Choose one out of Four (AC-301A-** Computer Skills / **AC-301B -** Cyber Security/ **AC-301C-** Seminar + Review Writing / **AC-301D-** Biostatistics) **from Technology + Value Added Courses**	Audit course	02	100	
Semester IV : Theory Courses					
PHY -401	Nuclear Physics	Core course	04	100	03
PHY -402	Any ONE of the following A) Nanomaterials: Synthesis, Properties and Applications OR B) LASER and it's Applications OR C) Astrophysics	Core course	04	100	03
PHY -403	Any ONE of the following A) Renewable Energy Sources OR B) Microwave: Theory and Applications OR C) Environmental Physics	Elective course	04	100	03
Semester IV : Practical Courses					
PHY -404	Special Laboratory II	Core course	04+04	100	06
PHY -405	Project Work-II(Characterization, Analysis of Result, Conclusions, Project Report, Oral etc.)	Skill based	04+04	100	06
AC-401A/B/C/D	**Choose one out of Four (AC-401A-**Human Rights / **AC-401B –Current Affairs / AC-401C-** Seminar + Review Writing / **AC-401D** - Intellectual Property Rights (IPR)) **from Professional and Social + Value Added Courses**	Audit course	02	100	

M.Sc. Part II Semester III (Physics): (Core Courses)

PHY– 301: Atomic and Molecular Physics		
	Course description: This course is aimed at introducing the fundamentals of Atomic and Molecular Physics to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Atomic and Molecular Physics. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Atomic spectra:** Introduction, origin of hyperfine structure, hyperfine structure of two or more valence electrons, Zeeman Effect in hyperfine structure, Back Goudsmit effect in hyperfine structure. **(H-14, M-17)**	14 L
Unit 2	**Rotational Spectra:** Classification of molecular spectra (pure rotational spectra, Rotation-vibration spectra, visible and UV spectra),Types of molecules: Diatomic linear symmetric top, asymmetric top and spherical top molecules, Introduction to rotational spectra, relative intensities of spectral lines, rotational spectra of rigid and non-rigid molecules through microwave spectroscopy, Determination of moment of inertia and bond length from rotational spectra. **(H-10, M-12)**	10 L
Unit 3	**Vibrational spectra:** Anharmonic oscillator, deduction of molecular properties from vibrational spectra of diatomic molecules. **(H-4, M-5)**	04 L
Unit 4	**Rotation-Vibrational spectra:** Coupling of rotation and vibration, rotation-vibration spectra, selection rules and transitions for the vibrating rotator, intensities in rotation and irrotational spectra, parallel and perpendicular bands of linear molecules, isotope effect in vibrational rotational spectra. **(H-5, M-6)**	05 L
Unit 5	**Electronic spectra of Diatomic molecules**: Electronic energy curves, potential energy curves, stable and unstable molecular states, vibrational structure of electronic spectra, general formula, graphical representation, rotational structure of electronic spectra, P,Q,R branches of band, Band head formation, shading of bands: fortrat diagram, intensities in electronic – vibrational bands structure, Frank Condon principle. **(H-7, M-07)**	07 L
Unit 6	**RAMAN spectra:** Raman effect, quantum theory, Molecular polarizability, Pure rotational Raman spectra of diatomic molecules, vibration rotation Raman spectrum of diatomic molecule, intensity alternations in Raman spectra of diatomic molecules, applications of IR & Raman spectroscopy in the structure determination of simple molecules, polarization of Raman lines. **(H-7, M-7)**	07 L
Unit 7	**NMR spectroscopy:** Resonance Technique: NMR – nuclear spin magnetic moment, interaction of nuclear magnet with external field. Quantum description of N.M.R, NMR spectrometer, Chemical shift, spin – spin interaction, Application of NMR spectroscopy. **(H-5, M-6)**	05 L

Suggested Readings: / References:

1. Molecular Spectra & Molecular Structure: G. Herzberg, Vol. 1 & 2 (Von no strand Co. Inc 1965)
2. Fundamentals of Molecular Spectroscopy: C.B. Banwell.
3. Atomic and Molecular Spectra: Rajkumar
4. Fundamental of molecular spectroscopy: Raymond Chang, McGraw Hill-Kogakusha Ltd, London 1971.
5. Introduction to IR & Raman spectroscopy: Calthup, Daiy& Wimberley, Academic press1964.
6. Spectroscopy Vol I & II: Edited by B.P. Stranghan& S. Walker.
7. Spectroscopy and Molecular Structure: C. W. King Holt Reinhardt & Winston Inc. 1964.
8. Atomic Spectra – H. E. White
9. Physical Methods in Inorganic Chemistry – Drago
10. Physical Chemistry – Puri, Sharma, Patharia.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C301.1	After successful completion of the course, the student is expected to : know about different atom model and will be able to differentiate different atomic systems, different coupling schemes and their interactions with magnetic and electric fields.	
C301.2	Have gained ability to apply the techniques of microwave and infrared spectroscopy to elucidate the structure of molecules.	
C301.3	• Be able to apply the principle of Raman spectroscopy and its applications in the different field of science & Technology. • To become familiar with different resonance spectroscopic techniques and its applications. • To find solutions to problems related different spectroscopic systems.	

M.Sc. Part II Semester III (Physics): Elective Course (Select only one)

PHY-302(A): Materials Synthesis and Preliminary Analysis		
Unit 1	**Nucleation , Growth of Thin Films and Single crystal:** Condensation, Langmuir-Frankel theory of condensation. Theories of nucleation: Capillarity model, Atomistic model, Various stages of growth. Types thin film deposition techniques (list only**).** **(H-5, M-7)** **Single crystals:** Importance of growing single crystals and their uses, Thermodynamic principles and crystal growth equilibrium. Theory of crystal growth, Nucleation, Growth of single crystal by water solution method, growth by Gel method, growth by Flux method, Hydrothermal growth. **(H-5, M-7)**	**10 L**
Unit 2	**Physical Vapour Deposition Techniques:** **Thermal evaporation:** General considerations, evaporation methods: Resistance heating, Flash evaporation, R.F. heating, Electron beam (e-beam) heating, Molecular Beam Epitaxy (MBE**).** **(H-6, M-7)** **Sputtering:** Cathodic sputtering- Sputtering process, glow discharge sputtering pressure, Deposit distribution, current and voltage dependence, cathode, contamination problem, Deposition control, Sputtering variants, Low pressure sputtering: Magnetic field, Assisted(triode)sputtering, R.F. sputtering, Ion-beam sputtering. Reactive sputtering. **(H-6, M-7)**	**12 L**
Unit 3	**Chemical vapour deposition Techniques:** Principle, chemical reactions used. Pyrolysis (Thermal decomposition), Hydrogen reduction, Halide disproportionation, Transfer reactions, polymerization**.** **(H-4, M-5)**	**04 L**
Unit 4	**Chemical Bath Deposition Technique:** **Electode less deposition:** Mechanisms of chemical bath deposition. Introduction, Nuclean, Adhesion and film growth processes in Ion-by-Ion mechanism, Hydroxide cluster mechanism, complex decomposition mechanism. **(H-5, M-5)** **Chemical Spray Method:** Nucleation and growth process in film deposition, General idea of air pressure spray pyrolysis, Ultrasonic spray pyrolysis to prepare nanostructured films. **(H-5, M-5)**	**10 L**
Unit 5	**Thick film deposition technique:** Fundamental aspect of the process, Design aids, Screens, Substrate materials, Screen printing, Firing process, Components and network: Passive components, active components, Assembly, packaging and testing:	**08 L**

	soldering methods for component attachment, wire bonding, packaging, testing. **(H-8, M-7)**	
Unit 6	**Thickness measurement and Electrical Properties of films:** **Thickness measurement:** Optical interference technique, Multiple beam interferometry, Quartz crystal microbalance, Stylus (Talyestep) method. **(H-4, M-5)** **Electrical Properties:** Electrical conductivity of bulk, thin and thick films, two probe, Van-der Pauw and Four probe methods, Hall measurements, TEP measurements. **(H-4, M-5)**	**08 L**

Suggested Readings: References:

1. Thin Film Phenomenon, K.L. Chopra, McGraw Hill, 1969.
2. Hand book of Thin Film Technology L.I. Maissel & R.Glang, McGraw Hill, 1970.
3. Thin Film Processes: J.L. Vossen and W. Kern, Academic Press, 1978.
4. Thin Film Fundamentals, A.Goswami, New Age International Publishers.
5. Chemical Solution Deposition of Semiconductors Films : Gary Hodes- Weizmann Institute of Science, Rehorot, Iszael. New York-Basar.
6. The materials science of Thin Films: M.Ohring Academic Press,1992.
7. Active and Passive Thin Film Devices: T.J.Coutts, Acadmeic Press 1978.
8. An Introduction to Physics and Technology of Thin Films : A Wegendristel and Y.Wang, World Scientific 1994.
9. Handbook of Sensor and Actuators- Thick Film Sensors- Edited by M.Prudenziati, Elsevier (1994), Vol. I, Series editor S. Middelhoek.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C302.A.1	After successful completion of the course, the student is expected to : know about Films Thin Deposition Techniques	
C302.A.2	Have gained ability to apply the techniques of Chemical vapour deposition Techniques , Principle and chemical reactions	
C302.A.3	The students will know the Mechanical response of Materials under • Chemical Spray Method: Nucleation and growth process in film deposition. • Thickness measurements. • Thick film deposition technique. • Gel method, growth by Flux method, Hydrothermal growth. Electrical Growth of single crystal by water solution method	

PHY-302(B): Computational Methods and Programming Using 'C' Language

	Course description: This course is aimed at introducing the fundamentals of Computational Methods and Programming Using 'C' Language to the students. **Course objectives:** 1) To impart knowledge of basic concepts in Computational Methods and Programming Using 'C' Language and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The **graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.**	
Unit 1	**'C ' Language:** a) Review of C language for preparing and running 'C'programs. **(H-5, M-6)**	**05 L**

	b) Pointers: The concepts of pointers, The address operator, pointer arithmetic, pointers as function parameters, pointers and arrays, Dynamic storage allocation. **(H-4, M-4)**	**04 L**
	c) Structures and Unions: Declaration and period operator, structure initialization, structure and arrays, structure and functions, structure and pointers, structure within structure, Unions, Rules to use unions. **(H-4, M-4)**	**04 L**
	d) File handling: Opening and closing a data file, creating a data file, processing a data file. **(H-3, M-4)**	**03 L**
Unit 2	**Numerical methods:** In the following topics on numerical methods, students are expected to write programs using' C' language as well as perform numerical calculations using electronic calculators and mathematical tables. **a) Iterative methods to obtain roots of equations:** The method of successive bisection, false position method, Newton Raphson method. Derivation of formula and advantages as well as limitations of these methods solve each other. **(H-7, M-9)**	**07 L**
	b) Interpolation: Definition of Interpolation and extrapolation, finite differences, Interpolation with equally spaced and unevenly spaced points. Lagrange's interpolation, curve fitting, polynomial least squares and cubic spline fitting. **H-8, M-9)**	**08 L**
	c) Numerical Integration: Derivation and application of Trapezoidal, Simpson1/3 and Simpson' s 3/8 th rule. **(H-8, M-9)**	**08 L**
	d) Solution of simultaneous line are equations: Gauss elimination method, pivotal condensation, Gauss Seidal method. **(H-7, M-9)**	**07 L**
	e) Solution of first order differential equation: Euler's method, Runge-Kutta methods. **(H-6, M-6)**	**06 L**

Suggested Readings: References:

1. The 'C' Programming Language: Kernighan B.W. & Ritchie D.M.(Prentice Hall India Pvt. Ltd.).
2. Letus 'C': Yashwant Kanetkar (BPB Publications).
3. Schaum's outline of theory and problems of programming with 'C': Gottfried B.S. (Tata McGraw Hill Publishing Co. Ltd.).
4. Programming in ANSIC (IIndEdition)-E. Balagurusamy (Tata McGraw Hill Publishing Co. Ltd.)
5. The C language Trainer with C graphics and C++ -J.Jayasri (New Age International Pvt. Ltd. New Delhi.)
6. The spirt of 'C'–Mullish Cooper (Jaico Publishing Co. New Delhi).
7. Programming in ANSIC–Ramkumar (Tata McGraw Hill).
8. Introductory methods of Numerical Analysis-S.S. Sastry.
9. Numerical methods for engineers with programming and software applications-Steven C Chapra, Raymond P. Canale. (McGraw Hill).
10. Numerical Methods problems and solutions– M.K..Jain, S.R.K. Iyengar, R.K. Jain (Wiley Eastern Ltd).
11. Computer Oriented Numerical Methods – V. Rajaraman (Prentice Hall India Pvt Ltd.).

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C302.B.1	After successful completion of the course, the student is expected to : know about Computational Methods and Programming Using 'C' Language and Applications	
C302.B.2	Have gained ability to apply the techniques of Computational Methods and Programming Using 'C' Language	
C302.B.3	The students will know the: • Review of C language for preparing and running 'C' programs. • Structures and Unions: Declaration and period operator, structure initialization. • Numerical Integration: Derivation and application of Trapezoidal, Simpson 1/3 and Simpson' s 3/8 th rule.	

PHY-302(C): Acoustics and Entertainment Physics		
	Course description: This course is aimed at introducing the fundamentals of Acoustics and Entertainment Physicsto the students. **Course objectives:** 1) To impart knowledge of basic concepts in Acoustics and Entertainment Physics and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The **graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.**	
Unit 1	**Basic Principles:** Sound wave propagation ,Plane and Spherical waves, Plane wave equation(without derivation) ,Acoustic Intensity, Energy density, Acoustic impedance, **Decibel Scales :** Intensity level, Sound Pressure level, Sound power level, Loudness level, Equivalent continuous sound level, Laeqt, Perceived noise level LEPN, Noise pollution level, LNP. Human Speech and hearing mechanism, Threshold of audibility and feeling, Analogy among Electrical, Mechanical and Acoustical systems. **(H-10, M-10)**	**10 L**
Unit 2	Architectural Acoustics: Reverberation time, Decay of sound in a live room, Sabine Equation, Decay of sound in a dead room, Eyring's Journals, Optimum reverberation time, Coefficient of absorption and its measurement. Methods of measurement of reverberation time, Synthetic reverberation, Acoustical evaluation of Theatre/ auditoria/studios, Requirements for good acoustics of Theatre/Studios/auditoria. Sound reinforcement systems for auditoria. Amplifier power requirements, Audio delayers. **(H-10, M-12)**	**10 L**
Unit 3	**Loudspeakers:** Direct radiator dynamic loudspeakers, Horn loudspeakers, Directional characteristics, Equivalent circuits, Efficiency of loudspeakers, Special Purpose loudspeakers, Loudspeaker systems, woofer, midrange/squankes, tweeter, Crossover, networks, Loudspeaker Cabinets. **(H-6, M-6)**	**06 L**
Unit 4	**Microphones:** Carbon, Condenser, Moving coil dynamic and ribbon microphones, Microphone sensitivity, directional characteristics and applications, Calibration of microphones. **(H-6, M-6)**	**06 L**
Unit 5	**Sound Recording and Reproducing systems:** Basic requirements of a system for good quality recording and reproduction, Hi-Fi system, volume compressors. Viviters and expanders, Graphic equalizers. Monophonic and stereophonic sound reproducing systems. Magnetic tape sound recording and reproducing systems, Basic principles Analogue recording, Digital Audio tape, recording (DAT), Noise reduction in sound reproducing system-(I) Dolby A. B. System, Basic principles of compact Disc (CD), audio systems. **(H-10, M-12)**	**10 L**
Unit 6	**Musical Acoustics:** Characteristics of musical notes: Vibratio, tremolo, portamento, waveforms of typical musical tones, Basic principles of musical instruments, Electronic musical instruments, Computer music, MIDI and applications. **(H-5, M-7)**	**05 L**
Unit 7	**Ultrasonic and underwater acoustics:** Ultrasonic transducers-Principles and applications, Under water acoustics-Principles and applications of underwater transducers, underwater communication, SONAR. **(H-5, M-7)**	**05 L**

Suggested Readings: References:

1. Fundamentals of acoustics (2nd Ed.)-Kinsler and Frey.
2. Acoustics-W.W.Sets (Schwm series)
3. Music Physics and Engineering-HIF Olson
4. Acoustics Measurement-L.L.Bernek
5. Basic Acoustics-D.E.Hall

6. Technical Aspects of sound-(Vol. I) Richardson 7. Noise reduction-L.L.Bernk. 8. Audio Cyclopedia-H. Tremanic 9. Hand book of sound Engineers (New Audio cyclopedia)-G.M. Balloh(Ed.) 10. Acoustic techniques for the Home and Studio-F Alton Everest. 11. Design for good acoustics and noise control-J.E. Moore.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO
C302.C.1	After successful completion of the course, the student is expected to : know about Acoustics and Entertainment Physicsand Applications
C302.C.2	Have gained ability to apply the techniques of Acoustics and Entertainment Physics
C302.C.3	The students will know the : • Review of C language for preparing and running 'C' programs. • Structures and Unions: Declaration and period operator, structure initialization. • Numerical Integration: Derivation and application of Trapezoidal, Simpson 1/3 and Simpson' s 3/8 thrule.

M.Sc. Part II Semester III (Physics): Skill Course (Select only one)

PHY-303(A): Systematic Materials Analysis		
	Course description: This course is aimed at introducing the fundamentals of Systematic Materials Analysisto the students. **Course objectives:** 1) To impart knowledge of basic concepts in Systematic Materials Analysisand its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The **graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.**	
Unit 1	**Characterization Techniques:** Importance of materials characterization, Classification of characterization techniques, Destructive and non-destructive techniques, Electromagnetic spectrum, Properties of electromagnetic radiation. **(H-6, M-6)**	**06 L**
Unit 2	**Infrared Spectroscopy:** Range of IR absorption, Requirements for infrared radiation Absorption, Theory of IR absorption Spectroscopy, Linear molecules, Spherical top molecules, Symmetric top molecules, Asymmetric molecules, Spectrophotometers, Application of IR Spectroscopy, Limitation of IR Spectroscopy. **(H-7, M-10)**	**07 L**
Unit 3	**UltraViolet & Visible Spectroscopy:** Regions of UV-Visible radiation, Colour and light absorption, The chromophore concept, Theory of electronic spectroscopy– orbital involved in electronic transitions, Laws of light absorption-Beer's and Lambert's laws, Instrumentation. U.V. spectrometer, Sample and reference cells, Applications of UV visible spectroscopy. **(H-10, M-12)**	**10 L**

Unit 4	**X-Ray Diffraction:** Crystalline state, X-ray diffraction processes, Preliminary discussion of powder and single crystal pattern and their information content, Structure determination, Particle size determination, Crystallography by diffraction of radiation other than X-ray, Applications of X-ray diffraction measurements. **(H-10, M-10)**	10 L
Unit 5	**Electron Microscopy:** Demerits of optical microscope at nano level, Need of Electron Microscopy, Why electrons? Electron Specimen interaction (Emission of secondary electrons, back scattered electrons, characteristics x-rays, transmitted electrons), Specimen interaction volume, resolution, Scanning electron microscope (SEM) Schematic diagram, Short details of each component, Field Emission Gun, Field Emission Electron Scanning electron microscope(FESEM),Principle of Image Formation, Energy Dispersive Analysis of X-rays (EDAX), Transmission electron microscope(TEM), Merits of TEM over SEM/FESEM. **(H-14, M-16)**	14 L
Unit 6	**Scanning Tunneling Microscopy:** An Introduction to Quantum Mechanical Tunneling, Basic Principles of STM, Two Modes of Scanning, Interpreting STM Images, and Applications of STM. **(H-5, M-6)**	05 L

Suggested Readings: References:

1. Elements of X-ray diffraction, B.D.Cullity, Addision-Wesely Publishing Co., USA.
2. SEM micro characterization of semiconductors, D.B. Holt, and D.C. Joy, Academic Press, New Delhi.
3. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw-Hill Publ. Delhi.
4. Instrumental methods of Analysis (Seventh Edition) H.H. Willard, L.L. Merritt, John A Dean, F.A. Settle CBS Publishers and Distributors, New Delhi-110002.
5. Introduction to Nanoscience and Nanotechnology, K.K. Chattopadhyay and A.N. Banerjee, PHI Pvt. Ltd., New Delhi- 110001. 5. Characterization of Materials, Volume1, & 2, Elton N. Kaufman, Wiley-Inter science.
6. Hand book of Microscopy for Nanotechnology, NanYao, Ahong LinWang, Kluwer Academic Publishers.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C303.A.1	After successful completion of the course, the student is expected to : know about Systematic Materials Analysis and Applications	
C303.A.2	Have gained ability to apply the techniques of Introduction to Characterization Techniques: Importance of materials characterization	
C303.A.3	The students will know the Mechanical response of Materials under • Infrared Spectroscopy. • Ultra Violet & Visible Spectroscopy: Regions of UV-Visible radiation. • Scanning Tunneling Microscopy: An Introduction to Quantum Mechanical Tunneling. • Crystalline state, Xray diffraction processes.	

PHY-303(B): Microprocessor and its Applications

Course description:

This course is aimed at introducing the fundamentals of **Microprocessor and its Applications**
to the students.

Course objectives:

	1) To impart knowledge of basic concepts in Microprocessor and its Applications. 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**The 8086 Microprocessor:** Register organization of 8086, 8086 Architecture, Pin configuration, Physical Memory organization, General bus operation, I/O address capability, Special purpose activities, minimum and maximum mode of 8086 systems with timings. **(H-15, M-20)**	**15 L**
Unit 2	**Instruction set of 8086 and programming:** Addressing modes of 8086, Instruction set of 8086, Assembler directives and operators. Simple programs like addition of two numbers, BCD addition, find the largest number, addition of two 3 x 3 matrices, move the string of data, find the number of positive numbers and negative numbers from, a given series of signed numbers etc. **(H-17, M-20)**	**17 L**
Unit 3	**Special Architectural features:** Stack structure of 8086, Interrupts and interrupt service routine, Interrupt programming, Macros. (Programming is not expected). **(H-6, M-10)**	**06 L**
Unit 4	**Programmable Peripheral Devices and their Interfacing:** i] Programmable peripheral interface 8255, ii] Programmable Communication interface 8251USART, iii] Programmable DMA interface 8257, iv] Programmable interrupt Controller 8259. **(H-10, M-5)**	**10 L**
Unit 5	**32 bit Processor:** Features of 80386, 80486, 80586 (Pentium), MMX (Multimedia Extension) **(H-4, M-5)**	**04 L**

Suggested Readings: References:

1. Advance Microprocessor and Peripherals: A.K.Ray, K.M.Bhurchandi., Tata McGraw Hill, New Delhi.
2. Microprocessor and Interfacing: DauglasV.Hall, McGraw Hill International Edition.
3. Architecture, Programming and Design: Yu Cheng Liu,G.A.Gibson, 2ndEdition. PHI Publications.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C303.B.1	After successful completion of the course, the student is expected to : know about Microprocessor and its Applications	
C303.B.2	Have gained ability to apply the techniques of Programmable Peripheral Devices and their Interfacing	
C303.B.3	The students will know the Mechanical response of Materials under- • The 8086 Microprocessor: Register organization of 8086, 8086 Architecture. • 32 bit Processor: Features of 80386, 80486, 80586 (Pentium). • Instruction set of 8086 and programming: Addressing modes of 8086	

PHY-303(C): Communication Electronics

	Course description: This course is aimed at introducing the fundamentals of Communication Electronics to the students. **Course objectives:** 1) To impart knowledge of basic concepts in Communication Electronics and its applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of	

	areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Electronic Communication:** Importance of Communication, Introduction to Elements of communication systems and types of electronics communication (Simplex, Duplex, Analog, Digital, Base band and modulated signals) [kennedy]. **(H-3, M- 4)**	**03 L**
Unit 2	**Modulation Systems Amplitude Modulation:** (Spectrum of an Amplitude Modulated signal, Low level AM Modulator), Single Sideband (SSB) Modulation, Generation of SSB signal (Filter Method), Vestigial-Sideband (VSB) Modulation, Demodulation of AM Waves (Square-law Detectors, Linear Diode Detector) Frequency and Phase Modulation:- FM generation (Parameter Variation method), Frequency multiplication, FM Demodulation (Slope Detector) Pulse Modulation, Pulse Code Modulation (PCM), Pulse Amplitude Modulation (PAM), Time-Division Multiplexing (TDM), Pulse Time Modulation (PTM) [Roddy & Coolen]. **(H-11, M-12)**	**11 L**
Unit 3	**Radiation & Propagation of Waves Electromagnetic Radiation:** (Fundamentals of electromagnetic waves & effect of environment), Propagation of waves (Ground or surface waves, sky wave propagation- The ionosphere, space waves, Tropospheric scattering propagation, Extraterrestrial communications) [Kennedy]. **(H-7, M-8)**	**07 L**
Unit 4	**Antennas:** Antenna parameters- power gain, isotropic radiator, radiation resistance, directivity, directional gain, radiation parameter, polarization, effective apparatus, effective length, front to back ratio. Types of antenna- Half wave dipole (without mathematical derivation), Yagi & dish antenna. [Roddy & Coolen]. **(H-7, M-8)**	**07 L**
Unit 5	**Television Fundamental**: Introduction to TV, TV systems & standards, Black & White transmission & reception, Colour transmission & reception. [Kennedy] **(H-4, M-5)**	**04 L**
Unit 6	**Radar and Satellite Systems Fundamentals of RADAR system:** Block Diagram, Frequencies and Powers used in RADAR, RADAR performance Factors, Effects of Noise, Basic Pulse RADAR systems (Block Diagram and Description), Antenna and Scanning, Moving target Indication (Doppler Effect), Other RADAR systems (RADAR Beacons, Phased RADAR), RADAR applications. [Kennedy]; Orbital Satellites, Geostationary Satellites, Look Angles (angle of elevation, Azimuth angle), Satellite system Link Model (UP Link Model, Transponder, Down-Link Model) [Roddy] **(H-10, M-10)**	**10 L**
Unit 7	**An overview of Telecommunication:** History of Telecommunication, Telecommunication network, Internet, classification of data network, by spatial distance (WAN, MAN, LAN), by Cellular concept, Mobile Telephone communication [A. A. Gokhale] **(H-4, M-6)**	**04 L**
Unit 8	**Introduction To Fiber Optic Technology:** Introduction, Principle of light transmission in a fiber, losses in fiber, dispersion, light sources for fiber optics, photo detector, fiber optic communication system.[Roddy & Coolen] **(H-6, M-7)**	**06 L**

Suggested Readings: References:

1. Electronic communication System- Kennedy & Davis (Tata Mc-Graw Hill) 4th ed.
2. Electronic communication- Roddy & Coolen. (PHI) 3rd ed.
3. Satellite Communication- Dennis Roddy, (Mc-Graw Hill), 3rd ed. 9
4. Fiber Optic Communication- John Senior, (Prentice Hall International), 2nd ed.
5. Antenna & Wave Propagation- K. D. Prasad, (Satya Prakashan New Delhi)
6. Introduction to Telecommunication-Anu A Gokhale, (Cengage Learning) 2nded.
7. Electronic communication-Sanjeev Gupta (Khanna Publication, New Delhi).
8. Electronic communication: Fundamentals Through Advances-Wame Tomdsi (Prentice Hall Publications)

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C303.C.1	After successful completion of the course, the student is expected to :	

	know about Communication Electronics and Applications	
C303.C.2	Have gained ability to apply the techniques of Introduction to Elements of communication systems and types of electronics communication	
C303.C.3	The students will know the Mechanical response of Materials under • Modulation Systems Amplitude Modulation. • Radiation & Propagation of Waves of Electromagnetic Radiation. • Types of antenna- Half wave dipole. • Television Fundamental, Introduction to TV, TV systems. • Radar and Satellite Systems Fundamentals of RADAR system: Block Diagram, Frequencies and Powers	

M.Sc. Part II Semester III (Physics): Practical (Core course)

PHY -304: Special Laboratory I	
Course description: This course is aimed at introducing the fundamentals of Special Laboratory I to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Special Physics II. 2. To provide the knowledge and methodology necessary for Practical problems in Physics. 3. The course involves the related experiments based on the Practical.	
Group A **Perform at least TEN experiments from the following**	
1	1. To measure the thermoelectric power of semiconductor. 2. Study of Haynes-Schokley experiment for determination of mobility and diffusion constant. 3. Measurement of thickness of thin film by Tolansky method. 4. Study of electron spin resonance spectrum for given sample and determination of Lande 'g' factor. 5. To record and analyze the spectral response of a given photo conducting sample. 6. Determination of resonance frequency of piezoelectric element. 7. Study of hysteresis of hard and soft ferrites. 8. Skin depth of electromagnetic radiation in Al. 9. Determination of Fermi energy in Cu. 10. Coherence & width of spectral lines using Michelson interferometer. 11. The Franck-Hertz experiment. 12. Absorption Spectrum Of Iodine Vapour. 13. Charge on an electron using spectrometer.
2	**Material Synthesis** 1. Deposition of metallic thin films by vacuum evaporation method and measurement of resistance/resistivity/ conductivity and TCR at different temperatures by the two probe/four probe method. 2. Deposition of thin films by spray pyrolysis method and thickness measurement by gravimetric method. 3. Measurement of reflectivity and transferability of thin films by using He-Ne laser. 4. Determination of refractive index of a transparent film by Abe's method. 5. Study of vacuum system to measure speed of rotary pump. 6. Pattern generation by Photolithography. 7. Electrical conductivity measurements in thick films. 8. Synthesis of CdS thin film by chemical bath deposition (CBD) method.

	9. Stress measurement of transparent conducting oxides (Newton's ring method) 10. Determination of band gap energy of a given sample using absorption/transmission spectra.
3	**Material Science:** 1. Study of phase transformation in a ferroelectric crystal. 2. Study of creep behaviour of Sn-Pb alloy. 3. Thermoluminescence of alkali halides. 4. Determination of diffusion coefficient of cobalt atoms in Gel medium. 5. Determination of crystal structure of given material by X-ray diffract meter. 6. Determination of grain size of a given sample by Scherer method. 7. Determination of direct and indirect band gap of a given materials by UV-visible spectroscopy. 8. Determination of inter atomic bond length in a diatomic molecule by studying rotational vibrational IR spectra. 9. Study of Beer Lamberts Law in absorption spectroscopy using IR spectroscopy. 10. Synthesis of conducting oxide films by pyrolysis method.
4	**Communication Electronics**: 1. Pulse amplitude modulation. 2. Pulse position modulation. 3. Pulse width modulation. 4. Study of delta modulation. 5. Characteristics of antenna. 6. Study of amplitude modulator and demodulator. 7. Study of frequency modulator. 8. Study of FSK modulator and demodulator. 9. Study of Digital multiplexer.
5	**Microprocessors:** 1. Square, Triangular and Ramp wave generator using microprocessor. 2. Interfacing an eight bit ADC with microprocessor. 3. Write a program for four digit hexadecimal counters. The counter should stop and resume counting by pressing a key. 4. Temperature measurement using ADC. 5. Read data through thumb wheel switches and display it on monitor and 7-segment display. 6. Write a program to control relay switches with a delay of 1 second. 7. Average the given set of data and display the result in decimal form. 8. Stepper motor speed control using microprocessor. 9. Read string through keyboard which is terminated by any specified character and reverse the string. 10. Read two digit hexadecimal number through key board and convert it into binary form. 11. Interrupt driven clock.(Ref. Ramesh S. Gaonkar Page No.376)
6	**Computational Methods & 'C' Language programming :** 1. Draw a flowchart and write a program to find the root of the equation f(x)=0 by Bisection method. 2. Draw a flowchart and write a program to find the root of the equation f(x)=0 by Newton Raphson method. 3. Draw a flowchart and write a program to find the root of the equation f(x)=0 by False position method. 4. Draw a flowchart and write a program to integrate the given function using Trapezoidal rule. 5. Draw a flowchart and write a program to integrate the given function using Simpson's 1/3 rule. 6. Draw a flowchart and write a program to integrate the given function using Simpson's 3/8 rule. 7. Draw a flowchart and write a program for fitting of a polynomial of degree n usingLagrange's Interpolation formula. 8. Draw a flowchart and write a program to solve given set of simultaneous equationsusing Gauss Elimination method.

	9. Draw a flowchart and write a program to solve given set of simultaneous equationsusing Gauss Seidal method. 10. Draw a flowchart and write a program to solve given differential equation usingEuler's simple method. 11. Draw a flowchart and write a program to solve given differential equation usingRungekutta method. 12. Draw a flowchart and write a program for finding the inverse of a givenmatrix./transpose of a matrix. 13. Implement strlen ( ), Stract ( ), Strcpy ( ), Strcmp ( ) using pointers. 14. Write a menu driven program to create, list, modify and calculate the student record details. Assume the file structure: Register No., Subject 1 mark, Subject 2 mark and Subject 3 mark.
7	**Biomedical Instrumentation** : 1. ECG preamplifier- instrumentation amplifiers design & testing. 2. Active filters for bio-signals-design & testing. 3. Wave shaping circuits for cardiac pacemaker. 4. Acoustic impedance measurement. 5. Recording of action potentials with extra cellular electrodes. 6. ECG signal recording with surface electrodes. 7. Blood pressure measurement with transducer/pressure differentiation circuits.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C304.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Special Physics II course to real life problems.	
C304.2	2. Understanding of the Special Physics II course which will create scientific temperament..	
C304.3	Students will have hand on experience of Practical Based on : • Measurement of thickness of thin film by Tolansky method. • Franck-Hertz experiment. Magnetic susceptibility. • Material Synthesis. • Material Science. • Communication Electronics. • Microprocessors. • Computational Methods & 'C' Language programming. • Biomedical Instrumentation	

PHY-305 M. Sc. Project – I(Skill Base)

	Course Objectives: 1. To give exposure to the students to research culture and technology. 2. To introduce students how to select a research topic, plan, perform experiments, collect data and analyse the data. 3. To foster self-confidence and self-reliance in the students as he/she learns to work and think independently.	
	Activities: 1. To display the list of 'project titles' on notice board. 2. To organize a meeting of project supervisors' and students for discussion about	

	projects. 3. To finalize the project titles so as to match student's particular interest. 4. Survey of the Literature. 5. To set the experiment/to start Preliminary Experimental work. 6. Internal examination. The guide should regularly monitor the progress of the project work. **ASSESSMENT OF PROJECT TERM WORK (FIRST TERM)**: Student should submit a Progress Report on the work done by him/her during the First Phase of the project including following points; 1. Project Selection, 2. Literature Search Strategy, 3. Literature Review, 4. Project Planning. Student will have to give a seminar on the above topics. **Internal examination (40 marks): Components of internal assessment: Project Selection (05 Mark.) Literature Collection and Literature Revive(10 marks) planning and design (10 marks), Submission of progress report (10 marks), and regular attendance (5 marks) recorded: Research Supervisors** **External Examination system should be held on fourth semester with assessment of PHY-405.**	

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C305.1	Conceive a problem based on published research and carry out comprehensive survey of literature	**4**
C305.2	Plan and carry out task in given framework of dissertation and present the work in written and viva	**6**
C305.3	Use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.	**6**
C305.4	Learn handling of instruments, use of chemicals and how to conduct the experiments	**3**
C305.5	Learn how to present the project in power point and answer the queries to examiners as well as science of writing	**6**

M.Sc. Part II Semester III Physics: Audit Courses

AC-301(A): Computer Skills **(Technology + Value added Audit course; Practical; 2 Credits)** **(Optional: Campus + Program level)**		
Course Objectives (CObs): • To inculcate different daily useful computer skills among students.		
Unit 1	**Elements of Information Technology** 1.1 Information Types: Text, Audio, Video, and Image, storage formats. 1.2 Components: Operating System, Hardware and Software, firmware. 1.3 Devices: Computer, Mobile Phones, Tablet, Touch Screen, Scanner, Printer, Projector, smart boards. 1.4 Processor & Memory: Processor functions, speed, Memory types: RAM /ROM /HDD /DVD-ROM/Flash drives, memory measurement metrics.	**2 H**
Unit 2	**Office Automation-Text Processing** 2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View,	**5 H**

	Reading Layout View. 2.2 Working with Files: Create New Documents, Open Existing Documents, Save Documents to different formats, Rename Documents, Close Documents. 2.3 Working with Text: Type and Insert Text, Highlight Text, Formatting Text, Delete Text, Spelling and Grammar, paragraphs, indentation, margins. 2.4 Lists: Bulleted and Numbered List. 2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Move and Resize Tables, Moving the order of the column and/or rows inside a table, Table Properties. 2.6 Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents. 2.7 Paragraph Formatting, Paragraph Attributes, Non-printing characters. 2.8 Types of document files: RTF, PDF, DOCX etc.	
Unit 3	**Office Automation-Worksheet Data Processing** 3.1 Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets. 3.2 Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows and Columns, Selecting Cells, Moving and Copying Cells. 3.3 Formulas and Functions: Formulas, Linking Worksheets, Basic Functions, AutoSum, Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill, Deleting Rows, Columns, and Cells. 3.4 Charting: Chart Types, drawing charts, Ranges, formatting charts.	**5 H**
Unit 4	**Office Automation- Presentation Techniques and slide shows** 4.1 Create a new presentation, AutoContent Wizard, Design Template, Blank Presentation, Open an Existing Presentation, PowerPoint screen, Screen Layout. 4.2 Working with slides: Insert a new slide, Notes, Slide layout, Apply a design template, Reorder Slides, Hide Slides, Hide Slide text, Add content, resize a placeholder or textbox, Move a placeholder or text box, Delete a placeholder or text box, Placeholder or Text box properties, Bulleted and numbered lists, Adding notes. 4.3 Work with text: Add text and edit options, Format text, Copy text formatting, Replace fonts, Line spacing, Change case, Spelling check, Spelling options. 4.4 Working with tables: Adding a table, Entering text, Deleting a table, Changing row width, Adding a row/column, Deleting a row/column, Combining cells, Splitting a cell, Adding color to cells, To align text vertically in cells, To change table borders, Graphics, Add clip art, Add an image from a file, Save & Print, slide shows, slide animation/transitions.	**6 H**
Unit 5	**Internet & Applications:** 5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing the Internet, Brief history, Browsing the Web, Hypertext and hyperlinks, browsers, Uniform resource locator 5.2 Internet Resources: Email, Parts of email, 5.3 Protecting the computer: Password protection, Viruses, Virus protection software, Updating the software, Scanning files, Net banking precautions. 5.4 Social Networking: Features, Social impact, emerging trends, issues, Social Networking sites: Facebook, Twitter, linkedin, orkut, online booking services 5.5 Online Resources: Wikipedia, Blog, Job portals, C.V. writing 5.6 e-learning: e-Books, e-Magazines, e-News papers, OCW(open course wares): Sakshat (NPTEL) portal, MIT courseware	**4 H**
Unit 6	**Cloud Computing Basics** 6.1 Introduction to cloud computing 6.2 Cloud computing models: SAS, AAS, PAS 6.3 Examples of SAS, AAS, PAS (Drop Box, Google Drive, Google Docs, Office 365 Prezi, etc.)	**3 H**

Suggested readings:

1. TCI, "Introduction to Computers and Application Software", Publisher: Jones & Bartlett Learning, 2010, ISBN: 1449609821, 9781449609825
2. Laura Story, Dawna Walls, "Microsoft Office 2010 Fundamentals", Publisher: Cengage Learning, 2010, ISBN: 0538472464, 9780538472463

3. June Jamrich Parsons, Dan Oja, "Computer Concepts Illustrated series", Edition 5, Publisher Course Technology, 2005, ISBN 0619273550, 9780619273552 4. Cloud computing online resources

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301A.1	Identify their lacunas about some computer skills and try to overcome the same.	**2**
AC301A.2	Practice the learned computer skills in real life and do their jobs more effectively.	**3**

AC-301(B): Cyber Security

(Technology + Value added Audit course; Practical; 2 Credits)

(Optional: Campus + Program level)

Course Objectives (CObs):

- To make students aware of different daily useful cyber security skills/rules.

Unit 1	**Networking Concepts Overview** Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet.	**3 H**
Unit 2	**Security Concepts** Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux.	**7 H**
Unit 3	**Security Threats and vulnerabilities** Overview of Security threats, Hacking Techniques, Password Cracking, Types of password attacks, Insecure Network connections, Wi-Fi attacks & countermeasures, Information Warfare and Surveillance. Cyber crime: e-mail related cyber crimes, Social network related cyber crimes, Desktop related cyber crimes, Social Engineering related cyber crimes, Network related cyber crimes, Cyber terrorism, Banking crimes.	**7 H**
Unit 4	**Cryptography** Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure.	**5 H**
Unit 5	**System & Network Security** System Security: Desktop Security, email security: PGP and SMIME, Web Security: web authentication, Security certificates, SSL and SET, Network Security: Overview of IDS, Intrusion Detection Systems and Intrusion Prevention Systems, Overview of Firewalls, Types of Firewalls, VPN Security, Security in Multimedia Networks, Fax Security.	**3 H**
Unit 6	**OS Security** OS Security Vulnerabilities updates and patches, OS integrity checks, Anti-virus software, Design of secure OS and OS hardening, configuring the OS for security, Trusted OS.	**2 H**
Unit 7	**Security Laws and Standards** Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its	**3 H**

	amendments.	

Suggested readings:

1. Skills Factory, Certificate in Cyber Security, Text Book Special edition, Specially published for KBC NMU, Jalgaon.
2. BPB Publication, "Fundamentals of Cyber Security", Mayank Bhushan, Rajkumar Singh Rathore, Aatif Jamshed.
3. Create Space Independent Publishing Platform, "Cyber Security Basics", Don Franke, ISBN-13: 978-1522952190ISBN-10: 1522952195.
4. Online references.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301B.1	Practice learned cyber security skills/rules in real life.	**3**
AC301B.2	Provide guidance about cyber security skills/rules to their friends, parents and relatives.	**2**

AC-301(C): Seminar + Review Writing

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant biological information.

Writing a Scientific Literature Review:

- Choosing a topic, Deciding the scope of topic, Significance and impact of scientific problem being addressed, Relevance to subject, current issues and social relevance, Strengths and limitations of the study, Enticing broad audience.
- Literature Survey and Information to consider in the review:
  - Literature search using authentic library resources (print and non-print, digital and virtual) for Almanacs, Encyclopaedia, Dissertations, Theses, Research papers, Review articles, Reference/ Textbooks, and Popular articles (INFLIBNET, Google Scholar, Pub Med, Highwire, Google patents, Indian patent database, etc.).
  - Analyzing the literature quality (indexing, peer review, citations, journal impact factor, etc.).
- Deciding a writing approach (theoretical, experimental, interpretive, clinical, etc.), prepare the highlights and drawing important conclusion from literature.
- Sections to include and tips for writing them: Abstract, Introduction, Body, Discussion, Conclusion, References.
- Reference styles (MLA, APA, etc.), Use of bibliography/ reference/ citation managers and generators (Reference Manager, EndNote, RefWorks, Mendeley, Zotero, Qiqqa, etc.).
- Ethics of publication: Approval and consent, Data ethics (accuracy, falsification, fabrication, and confidentiality), Plagiarism and self-plagiarism, collaborative authorship, conflict of interest, legal consequences.
- Content similarity detection, Use of anti-plagiarism services (Urkund, iThenticate, Turnitin, Copyscape, Grammarly, etc.).

Seminar Activity:

- Students are encouraged to deliver seminars on the topics of research, preferably published research paper in a reputed and indexed journal to develop presentation skills and enable to build confidence which will lead them to read different themes and enhance their scientific approach and knowledge assimilation abilities.
- Presentations must be created and presented by students using digital platform using a suitable software in the presence of student audience and faculty for evaluation.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301C.1	Retrieve, analyses, comprehend the scientific information on a given topic and derive logical inferences.	**4**
AC301C.2	Compile the scientific information on a topic, verify for similarity index or plagiarism.	**2**
AC301C.3	Deliver the interactive presentation of scientific data before audience and participate in open discussion with confidence.	**2**

AC-301(D): Biostatistics

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To learn basic statistical concepts/methods and their applications in biological processes and experiments.

Unit 1	**Descriptive Statistics and Presentation of Data** • Types of Data: qualitative and quantitative data; nominal and ordinal data; discrete and continuous data; frequency and non-frequency data, Different types of scale - nominal, ordinal, ratio and interval. • Analysis of univariate Quantitative Data: Concepts of central tendency or location, dispersion, skewness and kurtosis, measures of dispersion: range, quartile deviation, variance, standard deviation. • Analysis of bivariate Data: measures of association, correlation. • Presentation of Data: construction of tables with one or more factors of classification, diagrammatic and graphical representation of non-frequency data, frequency distributions, histogram. • Graphical presentation of data through bar graph, line graph, pie chart, histogram, dot plot, box-plot, multiple line/bar graphs etc.	**8 H**
Unit 2	**Correlation and regression** • Bivariate data: scatter diagram, coefficient of determination, rank correlation: Spearman's rank correlation coefficient. • Meaning and concept of regression, fitting of simple linear regression and quadratic regression in single predictor variable. • Multivariate data: multiple regression, coefficient of determination, R-square and its interpretation, testing significance of predictor variables.	**8 H**
Unit 3	**Testing of hypothesis and basic statistical designs** • Introduction of methods of sampling. • Statistical hypothesis, problem of testing of hypothesis, simple and composite hypothesis, types of errors, p-value, conclusions in hypothesis testing. • Statistical tests: one sample t-test, paired t-test, test for proportions, chi-square test for testing independence/association of attributes. • Design of experiments: introduction to basic terms of design of experiments, standard designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), concept of ANOVA, F-test in ANOVA, interpretation of results from ANOVA.	**8 H**
Unit 4	**PRACTICALS (Emphasis on examples from Biological Sciences)** • Based on graphical Representation. • Based on measures of Central Tendency & Dispersion. • Based on Distributions Binomial Poisson Normal.	**6 H**

	• Based on t, f, z and Chi-square. • Based on basic statistical designs.	

Suggested readings:

1. Le CT (2003) Introductory Biostatistics. 1st edition, John Wiley
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
5. Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301D.1	Describe and identify data generated from biological processes and experiments.	**1**
AC301D.2	Use summary statistics: measures of central tendency, measures of dispersion with their interpretations for explain the data more effectively through graphical tools.	**3**
AC301D.3	Apply knowledge of correlation, regression analysis and testing of hypothesis to real life data and understand their interpretation.	**3**

M.Sc. Part II Semester IV (Physics): Core Courses

PHY– 401: Nuclear Physics		
	Course description: This course is aimed at introducing the fundamentals of Nuclear Physics to the students. **Course objectives:** 1) To impart knowledge of basic concepts Nuclear Physics and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**General Properties of Nuclei:** Constituents of nucleus and their properties; packing fraction; mass defects; binding energy; average binding energy and its variation with mass number; concept of parity; magnetic dipole moment; electric quadruple moment; problems. **(H-5, M-6)**	**05 L**
Unit 2	**Nuclear Model:** Types of nuclear models (list only); Liquid drop model: assumptions, semi empirical mass formula, achievements, failure and limitations of liquid drop model; Shell model, basic assumptions, nuclear magic numbers, experimental evidences of nuclear magic number and its significance, achievements and limitations of shell model; rules for angular momenta and parity of nuclear ground state; prediction of angular momenta and parity of nuclear ground state; nuclear energy level and their applications; problems. **(H-7, M-8)**	**07 L**
Unit 3	**Nucleon – Nucleon Interaction:** The deuteron problem; radius of deuteron; magnetic dipole moment and electric quadruple moment of deuteron; Nature of interactions: electromagnetic, weak interactions and hadronic interactions; nucleon - nucleon scattering; scattering cross section; Low-energy neutron proton scattering and proton-proton scattering, High energy neutron-proton and proton -proton scattering. **(H-8, M-8)**	**08 L**
Unit 4	**Interaction of charged particle and EM radiations with matter:** Energy loss of charged particles (Bohr formula); stopping power; range and straggling; Cerenkov radiation; gamma (γ) ray interaction through matter; law of absorption of γ – rays; linear and mass absorption coefficient; the photoelectric process; Compton effect; pair production and annihilation of electron – positron pair; Dirac's theory of pair production; problems. **(H-14, M-18)**	**14 L**
Unit 5	**Particle accelerators and Radiation Detectors:** Classification of accelerators; Van-de-Graft generator; linear accelerator; synchrocyclotron; pellet on; microtone; types of detectors; scintillation detector and photomultiplier tube (PMT); semiconductor detector; bubble chamber; cloud chamber; spark chamber. **(H-10, M-12)**	**10 L**
Unit 6	**Elementary Particle Physics** Introduction; classification of elementary particles; particle interactions; elementary particle and their intrinsic quantum numbers (charge, Lepton number, Baryon number, iso-spin, strangeness etc.); conservation laws; Invariance under charge; Electrons and Positrons, Protons and antiprotons, Neutrons and antineutrons, Neutrinos and antineutrinos; Quark: assumption and properties; Quark model; colour of a Quark and its importance. **(H-8, M-8)**	**08 L**

Suggested Readings: Reference Books:

1. Concepts of Nuclear Physics: B.L. Choen, Tata McGraw Hill.
2. Subatomic Physics: Franenfelder and Hanley, Prentice Hal.l
3. Nuclei and Particles: E. Segre.
4. Atomic Nucleus: R. C. Evans.
5. Basic Nuclear Physics: B.N. Shrivastava.
6. Introduction to Nuclear Physics: David Halliday.
7. Introduction to Nuclear Physics: Herald Enge. 30.
8. Nuclear Physics: Irving Kaplan.
9. Elements of Nuclear Physics: M.L. Pandya and Yadav.
10. An Introduction to Nuclear Physics: Bhide & Joshi.
11. Nuclear Physics: D.C. Tayal.

12. Radiation Detectors By Ramamurthy and Kapoor. 13. Introduction to Nuclear Physics By S. B. Patel. 14. Radiation Detection Techniques By Price. 15. Introduction to Nuclear Techniques By Knoll.

Course Outcomes (Cots):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C401.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Nuclear Physics course to real life problems.	
C401.2	2. Understanding of the Nuclear Physics course which will create scientific temperament.	
C401.3	Students will have hand on experience of theory Based on : • General Properties of Nuclei Constituents of nucleus and their properties. • Interaction of charged particle and EM radiations with matter Energy loss of charged particles. • Particle accelerators and Radiation Detectors Classification of accelerators; Van-de-Graft generator etc. • Elementary Particle Physics Introduction; classification of elementary particles; particle interactions. • Nucleon – Nucleon Interaction The deuteron problem.	

M.Sc. Part II Semester IV (Physics): SkillCourse(Select only one)

	PHY- 402 (A): Nanomaterials: Synthesis, Properties and Applications	
	Course description: This course is aimed at introducing the fundamentals of Nanomaterials: Synthesis, Properties and Applications to the students. **Course objectives:** 1) To impart knowledge of basic concepts Nanomaterials: Synthesis, Properties and its applications 2) The graduates will have knowledge of fundamental concepts and principles in a variety of areas of Nanoscience and Nano Technology with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques related to Nanomaterials.	
Unit 1	**Introduction:** Definition of, Nanomaterials-Definition and Necessity, Properties of Nanoscale, Comparison of Nanomaterials with bulk material, What is nanotechnology? What should we expect from it? Introduction to low dimensional structures: Quantum wells, Quantum wires and Quantum dots, Nanoclusters and Nanocrystals. Quantum mechanics for low dimensional structures: Electron confinements, Schrodinger equation for particle in one dimensional box, Density of states, Density of states for a zero dimensional quantum dots, Density of states for 1-D Quantum wire, Density of states for two dimensional thin films, Density of states for a particle in three dimensional box. **(H-10, M-12)**	**10 L**
Unit 2	**Techniques for synthesis of nanomaterials**: I. Physical methods: High energy ball milling, Physical vapour deposition: Resistive heating, LASER ablation, sputter deposition.	**20 L**

	II Chemical methods: Colloid, Synthesis of colloids, Growth of nanoparticles, synthesis of metal nanoparticles by colloidal route, synthesis of semiconductor nanoparticles by colloidal route, Langmuir-Blodgett method, Sol-gel method, Synthesis of metal oxides by sol-gel technique. III Biological, methods: Introduction, Synthesis of nanoparticles using Microorganisms, Synthesis using plant extracts, Use of proteins and Temples like DNA. IV Hybrid techniques: Chemical vapor deposition, Ultrasonic automization, Electrochemical. V Nanolithography: Lithography using photons, using particle beams, Scanning probe lithography. **(H-20, M-24)**	
Unit 3	**Synthesis of some special Nanomaterials**: Synthesis of magnetic nanoparticles, Magnetic properties-Super paramagnetic materials, processes for their biocompatibility, applications of magnetic nanoparticles. Carbon nanotubes: Synthesis of SWNT and MWNT, Applications of SWNT and MWNT. **(H-6, M-08)**	**06 L**
Unit 4	**Nanophotonics**: Foundation for nanophotonics, Synthesis of metal chalcogenides (S, Se and Te) nanocomposites, photo conducting and photoluminescence properties of metal chalcogenides, photoconductivityofnanorods. **(H-6, M-08)**	**06 L**
Unit 5	**Characterization of Nanomaterials**: X-ray diffraction- structural studies, Interpretation of broadening of peaks, Electron microscopy (FESEM/TEM)- Micro structural properties (Topographical and morphological studies) Scanning Tunneling Microscopy-Determination of surface structures UV-VIS- optical properties related to Quantum confinement, Electrical and thermal transport properties, Plasmon resonance peaks and blue shiftatNanoscale. **(H-10, M-08)**	**10 L**

Suggested readings: Reference Books: /

1. Nanotechnology: Michel Kohler, Wolfgang Fritzsche.
2. Nanomaterials: Synthesis, Properties and Applications: A.S. Edelstein and R.C. 20 Cammarata, Institute of Physics Publishing Bristol and Philadelphia.
3. Nanoparticles: Buildingblocks for Nanotechnology, Vincent Rotello-Springer.
4. Introduction to Nanotechnology: Charles P. Poole Jr., Frank J.Owens
5. Nanoparticles Edited by GunterSchmid.
6. Nanoscale Science and Technology: Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, John Wiley & Sons Ltd.
7. Nanoparticles &Nanostructure films: Preparation, Characterization & Applications: Wiley-VCH 8. Nanomaterials:AnIntroductiontoSynthesis,PropertiesandApplications:DieterVollath
9. NanostructuredMaterialsandNanotechnology:HariSinghNalwa,AcademicPress
10. Nanophotonics: Paras N Prasad, Wiley Interscience John Willey & Sons, Inc Publication
11. Handbook of Microscopy for Nanotechnology: Nan Yao, Zhong Lin Wang, Kluwer Academic Publishers.
12. Nanotechnology: Principles and Practice, S.K.Kulkarni, Capital Publishing Company.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C402.A.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Nanomaterials: Synthesis, Properties and Applications course to real life problems.	
C402A..2	2. Understanding of the Nanomaterials: Synthesis, Properties and Applications Physics course which will create scientific temperament..	
C402.A.3	Students will have hand on experience of Theory Based on : • Comparison of Nanomaterials with bulk material. • Different Techniques for synthesis of Nanomaterials of magnetic nanoparticles, Magnetic properties-Super paramagnetic materials. • Foundation for nanophotonics, Synthesis of metal chalcogenides (S, Se and Te) nanocomposites	

PHY-402(B):LASER and its Applications		
	Course description: This course is aimed at introducing the fundamentals of LASER and its Applications to the students. **Course objectives:** 1) To impart knowledge of basic concepts LASER and its Applications and Applications and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Basics of Lasers**: Introduction, Brief history of LASER, Interaction of radiation with matter, Einstein's prediction about emission, Absorption, Spontaneous and Stimulated emission, Einstein's coefficients and relations between them, Condition for light amplification, Population inversion, Pumping and pumping methods, Active medium, Pumping schemes. **(H-8, M-8)**	08 L
Unit 2	**Principles of Lasers**: Introduction, Optical resonator, Basic components of laser, Principle of laser action, Difficulties in laser process and their removal, Threshold condition for laser oscillation, resonance frequencies, Laser operating frequencies, Cavity configurations, Modes; Longitudinal and Transverse modes, Single mode operation. **(H-8, M-10)**	08 L
Unit 3	**Laser Rate equations:** Two level system. Three and four level system, Rate equations for three and four level system, Threshold pumping power, Relative merits and demerits of three and four level systems. **(H-6, M-8)**	06 L
Unit 4	**Laser Systems and Types**: Classification of Lasers: CW and Pulsed lasers, Detail discussion about constructional features, energy level diagrams, Laser action and working, characteristics etc of the following laser systems: I) Solid State Lasers: The Ruby Laser, Nd-YAG Laser, Nd-Glass Laser etc. II) Dye (Liquid) Lasers, III) Gas Lasers: • Atomic Gas Lasers: He-Ne Laser. • Ion Gas Lasers: Argon ion and Krypton ion lasers, He-Cd metal vapour laser, • Molecular gas Lasers: CO_2 Lasers, Eximer laser, N_2 laser etc. IV)Semiconductor lasers, V). Chemical Lasers: HF laser. CO_2 mixture lasers.**(H-14, M-18)**	14 L
Unit 5	**Laser beam characteristics**: Directionality, Intensity, Coherence, Monochromaticity, Polarization, Speckles', Measurements of Laser power, energy-wavelength, frequency, line width. etc. **(H-6, M-6)**	06 L
Unit 6	**Applications of Lasers**: Applications of lasers in Material Processing and Mechanical industries, Medicine and Surgery, Defense and Military applications, Laser Range finders. Optical communication, Holography, Electronic industries. Laser Spectroscopy. **(H-10, M-10)**	10 L

Suggested Readings: Reference Books:

1. Lasers – A.G.Sigman- Oxford University Press 1986.
2. Principles of Lasers- O.Suelto-Plenum, 1982.
3. An introduction to lasers and their applications. – D.C.O.Shea, W. Russell and W.T.Rhodes, Addison – Welslay Pub.Co. (1977)
4. Laser Systems and Applications- SatyaPrakash , PragatiPrkashan, IInd Ed, (2012)
5. An introduction to Lasers - Theory and Applications- M. N. Avadhanulu, S. Chand & C0. (2008)
6. Principles of laser and their Applications – by Callen, O'shea, Rhodes.
7. Lasers and non linear Optics – B.B. Laud (2nd edition).

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C402.B.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the LASER and its Applications course to real life problems.	
C402.B.2	2. Understanding of the LASER and its Applications of Physics course which will create scientific temperament.	
C402.B.3	Students will have hand on experience of Theory Based on : • Basics of Lasers: Introduction, Brief history of LASER, Interaction of radiation with matter, Einstein's prediction. • Laser Rate equations: Two level system. Three and four level system. • Laser beam characteristics: Directionality, Intensity, Coherence, Monochromaticity, Polarization, Speckles'. • Applications of lasers in Material Processing and Mechanical industries, Medicine and Surgery, Defence and Military applications.	

PHY-402(C): Astrophysics		
	Course description: This course is aimed at introducing the fundamentals of Astrophysics to the students. **Course objectives:** 1) To impart knowledge of basic concepts Astrophysics and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Astronomical Instruments:** Optical telescopes-refracting and reflecting- (Newtonian & Cassegrain), Radio telescopes, Hubble's space telescope, spectroscopes, photometry, spectro-photometry, Detectors & image processing. **(H-8, M-8)**	**08 L**
Unit 2	**Message from starlight:** Electromagnetic spectrum, Radiation from heated object, Doppler effect, Stellar spectra, determination of abundance of elements from stellar spectra. **(H-6, M-8)**	**06L**
Unit 3	**The Hertzsprung- Russel diagram:** Brightness and luminosity, population of stars, H-R diagram, variable and binary stars. **(H-4, M-6)**	**04 L**
Unit4	**Stellar Evolution:** Nuclear Fusion, Fusion reactions in stars formation of Helium, Carbon Oxygen and other reactions, E equation of state for stellar interior, Mechanical and thermal equilibrium in stars, stellar evolution, white dwarfs red giants, pulsars, neutron stars, black holes. **(H-10, M-12)**	**10 L**
Unit 5	**Galaxies:** Types of galaxies, evolution of galaxies, radio galaxies, seyfert galaxies, quasars, milky way galaxy. **(H-8,M-8)**	**08 L**
Unit 6	**General theory of relativity:** Space time & gravitation, vectors & tensors-contravariant & covariant vectors, symmetric and antisymmetric tensors, contraction, space time curvature, Geodesics, Principle of equivalence. **(H-9, M-10)**	**09L**
Unit 7	**Cosmology:** Big bang theory, steady state universe, oscillating universe, Hubble's law, experimental evidences for big bang, open and close universes. **(H-7, M-8)**	**07L**
Suggested Readings: Reference Books: 1. Astronomy-Fundamentals and Frontiers-Robert Jastow and Malcolm H. Thompson (Pub. John Wiley & Sons). 2. An Introduction to Astrophysics-Baidyanath Basu(Pub. Prentice Hall India Pvt. Ltd.).		

3. Introduction to Cosmology– J. V. Naralikar (Pub: Cambridge University Press).
4. An Introduction to the study of stellar structure-S. Chandarashekhar (Pub: Dover).
5. Measure of the universe-T.D. North (Pub. Oxford University Press).

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C402.C.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the LASER and its Applications course to real life problems.	
C402.C.2	2. Understanding of the LASER and its Applications of Physics course which will create scientific temperament..	
C402.C.3	Students will have hand on experience of theory based on : • Basics of Lasers: Introduction, Brief history of LASER, Interaction of radiation with matter, Einstein's prediction. • Laser Rate equations: Two level system. Three and four level system. • Laser beam characteristics: Directionality, Intensity, Coherence, Monochromaticity, Polarization, Speckles. • Applications of lasers in Material Processing and Mechanical industries, Medicine and Surgery, Defence and Military applications.	

M.Sc. Part II Semester IV (Physics): Elective Course (Select only one)

	PHY-403(A): Renewable Energy Sources	
	Course description: This course is aimed at introducing the fundamentals of Renewable Energy Sources to the students. **Course objectives:** 1) To impart knowledge of basic concepts Renewable Energy Sources and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Solar Energy**: Solar Energy conversion systems and their applications, Fundamentals of photovoltaic. Energy conversion, Principles of photo voltaic cell, Materials and fabrication technologies of P. V cell, P.V. systems: configuration, output power and conversion efficiency, Basic P.V. system for power generation, Applications and limitations of P.V systems. **(H-9, M-10)**	**09 L**
Unit 2	**Biomass Energy Conversion Technologies**: Origin of biomass, Biomass energy resources, Biomass energy conversion processes, generation of gaseous fuels from biomass, digesters and their designs, Energy from Cereals, grains, sugar, fruits, starch etc. **(H-8 M-10)**	**08 L**
Unit 3	**Wind Energy**: Introduction to wind energy, Nature & Origin of winds, Power in a wind stream, principles and basic components of wind mill, Efficiency of wind turbine, horizontal and vertical axis wind mills, performance of wind mills, merits and limitations of wind energy conversions. **(H-9, M-10)**	**09 L**
Unit 4	**Ocean Energy**: Ocean as the potential energy resource: various ocean energy	**07 L**

	conversion technologies, Introduction to OTEC, Principle of OTEC, Open cycle OTEC system, closed cycle OTEC system, Ocean waves, energy and power from ocean waves, origin of tidal energy, Tidal energy conversion. **(H-7, M-8)**	
Unit 5	**Geothermal Energy**: Geothermal energy as are new able source of energy, Types of geothermal resources, Origin of geothermal resources, Hydro geothermal, Geopressure, geothermal and Petro geothermal resources, Basics of geothermal electric power plant. **(H-6, M-7)**	**06 L**
Unit 6	**Emerging trends in Renewable Energy sources:** Fuel Cells: Principle and operation of fuel cell, classification and types of fuel cells, Phosphoric acid fuel cell (PAFC), Alkaline fuel cell (AFC),Molten carbonate fuel cell (MCFC), Solid oxide fuel cell(SOFC), Fuels for fuel cells, Performance characteristics of fuel cells. Hydrogen Energy: Hydrogen as clean source of energy, sources Production, storage, Use of hydrogen as fuel, conversion to energy, Applications. **(H-13, M-15)**	**13 L**

Suggested Readings: Reference Books:

1. Energy Technology Non-Conventional, Renewable and Conventional, S. Rao, Dr.B.B. Parulekar, Khanna Publications, 3rdEd, 2005.
2. Non-Conventional Energy Sources, G. D. Rai, Khanna Publications, 2000.
3. Solar Energy Utilization, G.D. Rai, Khanna Publishers (1996).
4. Non-Conventional Energy Resources, Khan B.H., Tata McGraw Hill. 2006.
5. Solar Energy Conversion, S. P. Sukhatme (2ndedition).
6. Solar Cells, M.A. Green.
7. Hydrogen as Energy carrier Technologies systems Economy-Winter & Nitch.
8. Solar Energy Conversion– A. E. Dixnon & J. D. Leslie.
9. Biomass Energy– S.H. Pawar, L.J. Bhosale, A.B. Sabale, S.K. Goel.
10. Renewable Energy Sources and Conversion Technology, Bansal, N.K., M.KM. Meliss (1990)Tata McGraw Hill.
11. Non Conventional and Renewable energy sources, S.S. Thipse, Narosa Publishing House Pvt. Ltd.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C403.A.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Renewable Energy Sources course to real life problems.	
C403.A.2	2. Understanding of the Renewable Energy Sources of Physics course which will create scientific temperament..	
C403.A.3	Students will have hand on experience of Theory Based on: • Solar Energy: Solar Energy conversion systems and their applications. • Bio mass Energy Conversion Technologies: Origin of biomass, Biomass energy resources. • Ocean Energy: Ocean as the potential energy resource. • Emerging trends in Renewable Energy sources.	

PHY-403(B):Microwaves: Theory and Applications		
	Course description: This course is aimed at introducing the fundamentals of Microwaves: Theory and Applications to the students. **Course objectives:** 1) To impart knowledge of basic concepts Microwaves: Theory and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Transmission Lines:** Introduction to microwaves, applications of microwaves, Skin effect, Transmission line theory, Transmission line equations and their solutions, Open and terminated transmission lines, Line impedances, Line admittance, reflection coefficient, transmission coefficient, standing wave ratio, Impedance matching, Smith chart, Single stub matching and double stub matching. **(H-8, M-10)**	**08 L**
Unit 2	**Waveguides:** Rectangular and Circular waveguides, Solution of wave equation in rectangular coordinate, TE and TM modes in rectangular waveguide, Power transmission in rectangular waveguides, Power losses and excitation modes in rectangular waveguides. **(H-7, M-8)**	**07 L**
Unit 3	**Waveguide components:** Attenuators, filters, junctions, rectangular cavity resonator, circular cavity resonator, Enplane (series tee), H-plane (shunt tee), magic tee (Hybrid tee), directional couplers, hybrid rings (Rat-Race), waveguide corners, bends, loads, Microwave circular isolators. **(H-7, M-8)**	**07 L**
Unit 4	Microwave Generators: Microwave generation problems and principles, Tubes: Two cavity klystron and Reflex-klystron. Two cavity Klystron operation as amplifiers and oscillators, velocity modulation, bunching process, output power and beam loading efficiency of klystron. Reflex Klystron: Velocity modulation, power output efficiency, electronic admittance. Magnetron, Traveling wave tube amplifier: construction and operation. Microwave transistors: Principle of operation, microwave characteristics-cutoff frequency, current gain, power gain. Varactor diode: Principle of operation, use of varactor diode for frequency multiplication. Microwave Tunnel diode: Principle of operation, Gunn diode, PIN diode: Principle of operation, microwave characteristics. **(H-10, M-12)**	**10 L**
Unit 5	**Microwave Antennas:** Transmitting and receiving antenna: Horn antenna, Microwave dish antenna, antenna gain, resistance and band width, Beam width and polarization, Introduction to Micro strip antenna. **(H-6, M-6)**	**06 L**
Unit 6	**Measurements:** Smith chart: Derivation, use of chart for solving various problems in wave guide/ transmission lines, Microwave measurements: Measurement of impedance, power, frequency, attenuation, SWR, dielectric constant, quality factor. **(H-7, M-8)**	**07 L**
Unit 7	**Applications:** Radar: Block diagram and working of pulsed Radar system. Satellite: Active, passive, design requirements, payload, launching sequence. Microwave link, Microwave Remote Sensing Microwave ovens: Design requirements, sizes available, and application areas, Applications of microwaves in the medical field. **(H-7, M-8)**	**07L**

Suggested Readings: / Reference Books:

1. Microwave Devices and Circuits - Samuel Y. Liao, Prentice-Hall, New Delhi, 2006.
2. Microwave Engineering – Annapurna das & S.K. Das, Tata McGraw Hill, 2009.
3. Foundation of microwave engineering – Colin R.E. McGraw Hill 1969.
4. Introduction to microwaves – Atwater, McGraw Hill 1962-63.
5. Introduction to microwave – Wheeler, McGraw Hill 1962-63.
6. Microwave semiconductor devices and their circuit application.- Watson , McGraw-Hill 1962-63.
7. Microwave circuits and elements – M.L.Sisodia 8. Microwave circuits & passive Devices–M. L. Sisodia, G.S. Raghuvanshi, Wiley Eastern Ltd, 1987.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C403.B.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Microwaves: Theory and Applications course to real life problems.	
C403.B.2	2. Understanding of the Microwaves: Theory and Applications Physics course which will create scientific temperament..	
C403.B.3	Students will have hand on experience of Theory Based on : • Transmission Lines: Introduction to microwaves, applications of microwaves. • Waveguides: Rectangular and Circular waveguides. • Microwave generation problems and principles. • Microwave Antennas: Transmitting and receiving antenna. • Applications: Radar: Block diagram and working of pulsed Radar system. • Satellite: Active, passive, design requirements.	

	PHY-403(C): Environmental Physics	
	Course description: This course is aimed at introducing the Environmental Physics: Theory and Applications to the students. **Course objectives:** 1) To impart knowledge of basic concepts Environmental Physics s: Theory and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Introduction:** Meaning of Environment, Environmental science an overview, definition, concept & scope, types of environmental approaches, Nomenclature, environmental segments, Natural cycles (hydrologic, oxygen, nitrogen cycle). **(H-7, M-8)**	**07 L**
Unit 2	**Atmosphere:** Composition of atmosphere, Major regions of atmosphere, evolution of atmosphere, earth's radiation balance, Particles in the atmosphere, chemical & photochemical reactions in the atmosphere. **(H-8, M-8)**	**08 L**
Unit 3	**Environmental Resources:** Forest-Utilization, degradation & conservation, water-water cycle, degradation & conservation, Soil-utilization degradation & conservation. **(H-7, M-8)**	**07L**
Unit 4	**Pollution & environmental problems:** Meaning of pollution, sources, causes elementary fluid dynamics, factors governing air, water and noise pollution Green house effect/Global warming ozone hole. El Nino phenomenon. Acid Rain. **(H-6, M-8)**	**06 L**
Unit 5	**Water Pollution:** Aquatic environment, water pollutant, Sources of contamination of water pollution, waste water treatment, water quality parameters & standards, sampling, preservation, monitoring techniques pH dissolved oxygen, chemical oxygen demand, total oxygen demand, analysis of water quality parameter. **(H-9, M-10)**	**09 L**
Unit 6	**Air Pollution:** Air pollutant, air quality standard, sampling, monitoring, sampling, analysis technique, Gaseous and particulate matter. **(H-7, M-8)**	**07L**
Unit 7	**Global & Regional Climate:** Elements of weather and climate, stability and vertical and horizontal motion of air and water, viscous force, inertia force, Reynolds number, energy balance, pressure gradient force, global climate model and climate of India. **(H-8, M-10)**	**08L**
Suggested Readings: / Reference Books: 1. Environmental Chemistry: A.K. De		

2. Environmental Chemistry: O.D. Tyagi, M. Mehra (Anmol Publications). 3. Physics of atmosphere: J.T. Hougtion (Cambridge Uni.Press:1977) 4. Renewable Energy Sources: Elbs.1988.J.T.Widell & J. Weir. 5. Water Pollution (problems and Prospects): V.K. Prabhakar (Anmol Publications). 6. The Physics of Mansoons: R. N. Keshavmurthy & M. Shankar Rao Allied Publishers, 1992. 7. Solar Energy: S.P. Sukhatme. 8. Solid State Energy Conversion: S.H. Pawar, V.H.Shinde. 9. Environmental Physics: Egbert Boekar and Rienk Van Groundelle (John Willey). 10. An Introduction to Solar Energy for Scientists and Engineers: Sol-Wieder John Wiley, 1982. 11. Numerical Weather Prediction: G.J. Haltiner and R.T. Williams John Wiley, 1980.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C403.C.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Environmental Physics: Theory and Applications course to real life problems.	
C403.C.2	2. Understanding of the Environmental Physics: Theory and Applications Physics course which will create scientific temperament..	
C403.C.3	Students will have hand on experience of theory based on: • Meaning of Environment, Environmental science an overview, definition, concept & scope. • Composition of atmosphere, Major regions of atmosphere, evolution of atmosphere, earth's radiation balance. • Environmental Resources: Forest-Utilization, degradation & conservation, water-water cycle. • Water Pollution.. • Air Pollution.	

M.Sc. Part II Semester IV (Physics): Core Based Courses

PHY-404 Special Laboratory II	
	Course description: This course is aimed at introducing the Special Laboratory II: Practical and Applications to the students. **Course objectives:** 1) To impart knowledge of basic concepts Special Laboratory II: Practical and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The **graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.**
	Perform at least **TEN** experiments from the following.

1	1. To find water of crystallization in Copper sulphate by TGA. 2. Differential thermal analysis [DTA] of $CuSO_4$, $5H_2O$. 3. Schottky barrier determination for various semiconductors. 4. To analyses the Raman Spectrum of a sample. 5. To determine Young's modulus of a metallic rod by Searle's optical interference method (Newton's Rings). 6. To analyses the photoluminescence spectrum of a given sample. 7. Determination of Curie temperature of a given sample. 8. Determination of calorific value of wood/cow dung. 9. Determination of wind power. 10. Wind data analysis of a given site. 11. Study of power vs. load characteristics of solar P.V. systems and study of series and parallel combination of solar P.V. panels. 12. Study of Optical Properties of Selective Coatings. 13. Hyperfine structure of spectral lines using FP etalon/L.G. plate. 14. To study the Quantum defects of S and P states of Na atom using constant deviation spectrometer. 15. Study of dielectric behavior of $BaTiO_3$ sample.
2	**Nanomaterials** 1. Synthesis of metal nanoparticles. 2. Synthesis of porous silicon. 3. Absorption by metal nanoparticles. 4. X-ray Diffraction of nanoparticles. 5. Photoluminescence of nanoparticles. 6. Synthesis of semiconductor nanoparticles by chemical method. 7. Optical absorption of nanoparticles (observation of Blue shift with size of particles). 8. Photoluminescence of nanoparticles (Luminescence decay time). 9. X-ray diffraction studies of nanoparticles (effect of temperature). 10. Density of states calculation of small clusters (experiments on computer).
3	**LASERS:** 1. To verify Heisenberg uncertainty principle using He-Ne laser source. 2. Study of Faraday's effect using Laser source. 3. Diameter of a given wire by diffraction. 4. Determination of bandwidth of a given optical fiber. 5. Measurement of reflectivity and transferability of thin film by using He-Ne laser. 6. Verification of Brewster's law of polarization using He-Ne laser. 7. Study of magneto-optic rotation and magneto-optic modulation. 8. To determine the wavelength of a LASER source using an engraved scale as a reflecting diffraction grating.
4	**Astrophysics :** 1. To estimate the temperature of an artificial tar by photometry. 2. To study characteristics of a CCD camera. 3. To study the solar limb darkening effect. 4. To polar assign an astronomical telescope. 5. To estimate there active magnitudes of a group of stars by a CCD camera.
5	**Microwaves :** 1. Study of passive components. 2. Study of various loads. 3. To study characteristics curve of Klystron. 4. Determination of constants of transmission line, strip lines. 5. Study of cavity resonator.

	6. Study of ring resonator and rejection filter. 7. To design, fabricate and test astripline resonator. 8. To find dielectric constant of given liquid using microwave bench. 9. Measurement of Quality factor Q of a microwave resonator.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C404.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Special Laboratory II: Practical and Applications course to real life problems.	
C404.2	2. Understanding of Special Laboratory II: Practical Physics and Applications Physics course which will create scientific temperament.	
	Students will have hand on experience of theory based on : • Schottky barrier determination for various semiconductors. • To analyse the Raman Spectrum of a sample. • Nanoparticles. • LASERS. • Astrophysics. • Microwaves.	

M.Sc. Part II Semester IV (Physics): Skill Based Courses

PHY-405: M. Sc. Project – II (Project Dissertation)

Course Objectives:
1. To give exposure to the students to research culture and technology
2. To introduce students how to select a research topic, plan, perform experiments, collect data and analyse the data
3. To foster self-confidence and self-reliance in the students as he/she learns to work and think independently

Activities:

1. To complete the experimental work.
2. To carry out the measurements.
3. To characterize the samples.
4. To obtain the results.
5. To draw the conclusions.
6. To write the project report.
7. To appear for Internal examination
8. To appear for External examination

Project Report:

1. Students have to write a ‘project report’.
2. A report should be a concise account of project work containing full descriptions of the aims, method and outcomes.
3. Length of report should not normally exceed 40 pages. Assessment Criteria of the project: The

following criteria are to be used in assessing the project work:

(i)The conduct of project work:

The following questions are considered in assessing how well students have carried out the project work.:

1. How difficult was the project?
2. How well did the student understand the scientific principles behind the project?
3. How well did the student plan the project work?
4. How much effort was put into the project?
5. Was an interim report presented on time?
6. Is the student's project logbooks adequate?
7. How much initiative and/or originality did the student contribute to the project?
8. How well did the student cope with problems that arose during the course of project?
9. Did a project reach a stage of completion where meaningful results were obtained and definite conclusions could be drawn?

(ii) The Project Report:

1. How well did the report set out the background?
2. How well did the report describe the underlying them?
3. Was the report a reasonable length?
4. How well was the report structured?
5. How understandable was the written content?
6. How well did the report describe the execution of the project?
7. Did the report have an adequate summary or conclusions?

(iii) Oral Examination:

1. Did the student adequately describe what he/she had done in their project?
2. Did the student have a clear interpretation of his/her results?
3. What was the clarity and overall standard of the presentation?
4. How well was the talk/presentation structured?
5. Did the student cover all the relevant material in a reasonable time?

The project is allotted during the third semester. The students will get an opportunity to become a part of ongoing research activities in the respective supervisor's laboratory. The students will acquire skill to write, compile and analyze data if any, and present the detailed technical/scientific report. At the end of successful project semester training, potentially the students become employable in the industries/organizations.

It is expected that the students will design experiments and collect experimental data. At the end, they will submit a detailed thesis for evaluation. The students should be introduced to research methodology in the beginning through few lectures.

The systematic approach towards the execution of project should be as follows:

1. Selection of topic relevant to priority areas of Physics.
2. Collection of literature on the topic of research from libraries, internet, online journals, Planning of research experiments.
3. Performing the experiments with scientific and statistical acceptability.
4. Presentation of observations and results.
5. Interpretation of results and drawing important conclusions.
6. Discussion of obtained results with respect to literature reports.
7. Writing monthly progress report

8. Preparation of report (Dissertation) containing introduction, materials and methods, results and discussion, conclusions, bibliography and submission of at least 3 copies (1 copy retained in the department and after examination submitted to Library, 1 copy submitted to the guide and 1 copy kept with the candidate). 9. Presentation of research data during university examination and submission of project dissertation in abound form.
1. **Internal examination (40 marks):** Components of continuous internal assessment: Submission of progress report (8 marks), Literature collected, experiment planning and design (10 marks), Experiments conducted (10 marks), outcome of the experiments and viva (8 marks) and regular attendance (4 marks) recorded: Research Supervisors 2. **External examination, [PHY-305(60 Marks) + PHY-405 (60 marks)]** and Components of external assessment: Subject matter (5+5 marks), Review of literature (10+10 marks), Writing of dissertation submitted in bound form at the time of examination (Title page, Certificate, Main content: Abstract, Introduction, Literature, Materials and methods, results and discussion and conclusion with relevant references) (15+15 marks), Presentation structure (PPT format) (10+10 marks), Overall presentation reflecting contribution of work (5+5 marks), Response to questions (15+15 marks).
Suggested readings: Refer the topic in research papers, review articles published in peer reviewed and SCI indexed journals, reference books, abstracts, etc. related to topic of project dissertation

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C405.1	Conceive a problem based on published research and carry out comprehensive survey of literature	**4**
C405.2	Plan and carry out task in given framework of dissertation and present the work in written and viva	**6**
C405.3	Use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.	**6**
C405.4	Learn handling of instruments, use of chemicals and how to conduct the experiments	**3**
C405.5	Learn how to present the project in power point and answer the queries to examiners as well as science of writing	**6**

M.Sc. Part II Semester IV (Physics): Audit Courses

	AC-401(A): Human Rights **(Professional and Social + Value Added Audit course; Practical; 2 Credits)** **(Optional:)**	
	Course Objectives (CObs): • To make students aware about human rights and human values.	
Unit 1	**Introduction to Human Rights** 1.1 Concept of Human Rights 1.2 Nature and Scope of Human Rights 1.3 Fundamental Rights and Fundamental Duties 1.4 Interrelation of Rights and Duties	**6 H**
Unit 2	**Human Rights in India** 2.1 Meaning and Significance of **:** 1) Right to Equality 2) Right to Freedom, 3) Right against Exploitation, 4) Right to Freedom of Religion, 5) Cultural and Educational Rights, and 6) Right to Constitutional Remedies.	**8 H**

	2.2 Constitutional Provisions for Human Rights 2.3 Declaration of Human Rights 2.4: National Human Rights Commission	
Unit 3	**Human Values** 3.1: Meaning and Definitions of Values 3.2: Importance of values in the life of Individual 3.3: Types of Values 3.4: Programmes for conservation of Values	**8 H**
Unit 4	**Status of Social and Economically Disadvantaged people and their rights** 4.1: Rights of women and children in the context of Social status 4.2: The Minorities and Human Rights 4.3: Status of SC/ST and other Indigenous People in the Indian Scenario 4.4: Human rights of economically disadvantaged Society	**8 H**
Suggested readings: 1. Human rights education – YCMOU, Nasik 2. Value education – SCERT, Pune 3. Human rights reference handbook – Lucille whare		

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401A.1	Practice the learned issues under human rights and human values in real life.	**3**
AC401A.2	Provide social justices to people around them and provide guidance about human rights to their friends, parents and relatives.	**5**

	AC-401(B): Current Affairs **(Professional and Social + Value Added Audit course; Practical; 2 Credits)** **(Optional:)**		
	Course Objectives (CObs): • To make students updated about current affairs of India and world.		
	Title	**Content**	**Hours**
Unit 1	Politics & Economy	• National & International Political Activity, Organization. • Economy & Business, Corporate world	**08**
Unit 2	Awards and recognitions	• National & International Awards and recognitions • Books and authors	**07**
Unit 3	Science & Technology	• Software, Automobile, Space Research • New inventions and discoveries	**07**
Unit 4	Environment & Sports	• Summit & conference, Ecology & Climate, Organization. • National & International Games, Olympics, commonwealth etc.	**08**
Suggested readings (Use recent years' data and current literature): 1. India 2019, by Publications Division Government of India. 2. Manorama Year Book by Philip Mathew. 3. India 2019, Rajiv Maharshi. 4. Quick General Knowledge 2018 with Current Affairs Update, Disha Experts. 5. General Knowledge 2018: Latest Who's Who & Current Affairs by RPH Editorial Board.			

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401B.1	Identify important issues currently/ recently happening in India or world.	**5**
AC401B.2	Summarize current affairs regularly.	**6**

AC-401(C): Seminar + Review Writing

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant biological information.

Writing a Scientific Literature Review:

- Choosing a topic, Deciding the scope of topic, Significance and impact of scientific problem being addressed, Relevance to subject, current issues and social relevance, Strengths and limitations of the study, Enticing broad audience.
- Literature Survey and Information to consider in the review:
    - Literature search using authentic library resources (print and non-print, digital and virtual) for Almanacs, Encyclopaedia, Dissertations, Theses, Research papers, Review articles, Reference/ Textbooks, and Popular articles (INFLIBNET, Google Scholar, PubMed, Highwire, Google patents, Indian patent database, etc.)
    - Analyzing the literature quality (indexing, peer review, citations, journal impact factor, etc.)
- Deciding a writing approach (theoretical, experimental, interpretive, clinical, etc.), prepare the highlights and drawing important conclusion from literature
- Sections to include and tips for writing them: Abstract, Introduction, Body, Discussion, Conclusion, References
- Reference styles (MLA, APA, etc.), Use of bibliography/ reference/ citation managers and generators (Reference Manager, End Note, Ref Works, Mendeley, Zotero, Qiqqa, etc.)
- Ethics of publication: Approval and consent, Data ethics (accuracy, falsification, fabrication, and confidentiality), Plagiarism and self-plagiarism, collaborative authorship, conflict of interest, legal consequences
- Content similarity detection, Use of anti-plagiarism services (Urkund, iThenticate, Turnitin, Copyscape, Grammarly, etc.)

Seminar Activity:

- Students are encouraged to deliver seminars on the topics of research, preferably published research paper in a reputed and indexed journal to develop presentation skills and enable to build confidence which will lead them to read different themes and enhance their scientific approach and knowledge assimilation abilities.
- Presentations must be created and presented by students using digital platform using a suitable software in the presence of student audience and faculty for evaluation

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401C.1	Retrieve, analyse, comprehend the scientific information on a given topic and derive logical inferences.	**4**
AC401C.2	Compile the scientific information on a topic, verify for similarity index or plagiarism.	**2**
AC401C.3	Deliver the interactive presentation of scientific data before audience and participate in open discussion with confidence.	**2**

	AC-401(D): Intellectual Property Rights (IPR) **(Professional and Social + Value Added Audit course; Practical; 2 Credits)** **(Optional: Program-level)**	
	Course Objectives (CObs): • To provide basic knowledge on intellectual property rights and their implications. • To understand ethical issues relevant to biology from the perspective of national and international law.	
Unit 1	**History and Introduction to Intellectual Property Rights:** Evolution of patent Laws, History of Indian Patent System, Concept of IPR, Designs, Trademarks TM, Trade Secret (TS), Domain Names, Geographical Indications, Copyright	**6 H**
Unit 2	**Classification of patents and ownership:** Classification of patents in India, Classification of patents by WIPO, Categories of Patent, Special Patents Ownership of patent, Rights of patent holder and co-owners, Duties of patent holder and co-owners, Transfer of patent Rights, Limitations of patent Rights, Restoration of Patents, Infringement of patent Rights and Offences, Actions against Infringement and Remedies and Relief	**6 H**
Unit 3	**Protection of biological materials and Biodiversity** Methods of protection of plant and plant products, Essentialities of plant protection, Plant variety protection and Farmers' Right Act, UPOV convention (plant Varieties) 1961, National Biodiversity Act- 2002, Protection of environment and biodiversity	**6 H.**
Unit 4	**Biosafety and good laboratory practices** Overview of biosafety, Risk assessment, Cartagena protocol on Biosafety, Biosafety Levels, GMOs and LMOs, Gene flow and environmental impact, opportunities and challenges Roles of Institutional Biosafety Committee, RCGM, GEAC in food and agriculture Risk analysis, assessment and management, International regulatory bodies Importance of good laboratory practices, General good laboratory practices	**6 H**
Unit 5	**Bioethics** Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies etc Bioethics in research – cloning and stem cell research in human, animal rights/welfare in experimentation Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations, biopiracy	**6 H**

Suggested readings:

1. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
2. Deepa Goel, Shomini Parashar (2013) IPR, Biosafety and Bioethics Always learning, Pearson Education India, ISBN 9332514240, 9789332514249.
3. Department of Biotechnology http://dbtindia.gov.in/guidelines-biosafety.
4. Ganguli, P. (2001). Intellectual property rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub.
5. International Union for the Protection of New Varieties of Plants. http://www.upov.int.
6. Kuhse, H. (2010). Bioethics: An anthology. Malden, MA: Blackwell.
7. National Biodiversity Authority. http://www.nbaindia.org.
8. National Portal of India. http://www.archive.india.gov.in.
9. Office of the Controller General of Patents, Design & Trademarks; Government of India. http://www.ipindia.nic.in/.
10. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem formulation in the environmental risk assessment for genetically modified plants. Transgenic Research, 19(3), 425-436. doi: 10.1007/s11248-009-9321-9.
11. World Intellectual Property Organisation. http://www.wipo.int.
12. World Trade Organisation. http://www.wto.org.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401D.1	Understand to classify, identify advantages of intellectual property and IPR	**3**
AC401D.2	Understand the need to protect biological diversity and follow bioethical practices in research work, awareness to protect intellectual property relevant to biology	**2**

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Equivalence Subject:

Old Course		New Course	
Course Number	Title of the Course	Course Number	Title of the Course
Sem. I		**Sem. I**	
PHY-101	Mathematical Methods for Physics	PHY-101	Mathematical Methods for Physics
PHY -102	Classical Mechanics	PHY -102	Classical Mechanics
PHY-103	Quantum Mechanics	PHY-103	Solid State Physics
PHY-104	Solid State Physics	PHY -104(A)	**A)**:Physics of Semiconductor Devices Or
		PHY -104(B)	**B)**: Electronic Instrumentation Or
		PHY -104(C)	**C)**Bio- Physics
PHY -105	Basic Physics Laboratory – I	PHY-105	Basic Physics Laboratory – I
Sem. II		**Sem .II**	
PHY-201	Statistical Mechanics	PHY-201	Statistical Mechanics
PHY -202	Classical Electrodynamics	PHY -202	Classical Electrodynamics
PHY -203	Material Science	PHY -203	Quantum Mechanics
PHY-204(A)	PHY 204 (A) : Physics of Semiconductor Devices	PHY-204	Material Science
PHY-204(B)	PHY 204 (B) : Electronic Instrumentation		
PHY-204(C)	PHY 204 (C) : Bio- Physics		
PHY-205	Basic Physics Laboratory – II	PHY-205	Basic Physics Laboratory – II
Sem. III		**Sem. III**	
PHY-301	Atomic and Molecular Physics	PHY-301	Atomic and Molecular Physics
PHY-302(A)	A)Materials Synthesis Methods	PHY-302(A)	A) Materials Synthesis and preliminary analysis
PHY-302(B)	B)Microprocessor and its Applications	PHY-302(B)	B) Computational Method sand Programming Using ‘C’ Language OR
PHY-302(C)	C)Communication Electronics	PHY-302(C)	C) Acoustics and Entertainment Physics
PHY-303	A)Systematic Materials Analysis	PHY-303(A)	A)Systematic Materials Analysis)OR
	B) Computational Methods and Programming Using ‘C’ Language	PHY-303(B)	B) Microprocessor and its Applications OR
	C) Acoustics and Entertainment Electronics	PHY-303(C)	C) Communication Electronics
PHY-304	Special Laboratory-I	PHY-304	Special Laboratory-I
PHY-305	Project Work-II (Literature Survey, Definition of Problem, Experimental work, Oral etc.)	PHY-305	Project Work-II (Literature Survey, Definition of Problem, Experimental work, Oral etc.)
Sem. IV		**Sem. IV**	
PHY-401	Nuclear Physics	PHY-401	Nuclear Physics
PHY -402(A)	A)Nanomaterials : Synthesis, Properties and Applications	PHY -402(A)	A)Nanomaterials: Synthesis, Properties and Applications OR

PHY -402(B)	B) LASER and it’s Applications	PHY -402(B)	B) LASER and it’s Applications OR
PHY -402(C)	C) Astrophysics	PHY -402(C)	C) Astrophysics
PHY-403(A)	A) Renewable Energy Sources	PHY-403(A)	A) Renewable Energy Sources OR
PHY-403(B)	B) Microwave: Applications	PHY-403(B)	B) Microwave: Applications OR
PHY-403(C)	C) Environmental Physics	PHY-403(C)	C) Environmental Physics
PHY -404	Special Laboratory-II	PHY -404	Special Laboratory-II
PHY -405	Project Work-II (Characterization, Analysis of Result, Conclusions, Project Report, Oral etc.)	PHY -405	Project Work-II (Characterization, Analysis of Result, Conclusions, Project Report, Oral etc.)

KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

Affiliated Colleges

MASTER OF SCIENCE in Computer Science
[M. Sc. (Computer Science)]

Syllabus

[*under CBCS*]

Faculty of Science and Technology

With effect from 2021-22

MASTER OF SCIENCE in Computer Science

[M.Sc. (Computer Science)]

PROGRAMME OBJECTIVES (POs):

1) **Broadly Educated and Versatile** - Able to draw upon foundational knowledge, learn, adapt and successfully bring to bear analytical and computational approaches on changing societal and technological challenges.
2) **Inspiring and Collaborative** - Able to induce and contribute to diverse teams, expertise, and experiences.
3) **Innovative** - Drives scientific and societal advancement through technological innovation and entrepreneurship.
4) **Engaged** - Is and remains engaged with the academics, technical and scientific professional communities.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

M.Sc. (Computer Science) Programme has been designed to prepare graduates for attaining the following program outcomes:

1) An ability to apply knowledge of computer science appropriate to the discipline.
2) An ability to apply computer science foundations, algorithmic principles, and computer science theory in the modeling and design of computational systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.
3) Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
4) Communicate effectively in a variety of professional and research contexts.
5) Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
6) Apply computer science theory and software development fundamentals to produce computing-based solutions.
7) Acquire and apply new knowledge as needed, using appropriate learning strategies.

MASTER OF SCIENCE in Computer Science [M.Sc. (Computer Science)]

Degree Name	:	Master of Science in Computer Science [M.Sc. (Computer Science)]
Faculty	:	Science and Technology
Duration	:	02 years, Full Time course
Medium of Instruction	:	English
Pattern	:	Semester Pattern (04 semesters)
Examination Pattern	:	60% (External Assessment) + 40% (Internal Assessment)
Passing Standard	:	Separate Passing for internal as well as external assessment.
Evaluation Mode	:	CGPA
Lecture	:	Clock hour (60 minutes)

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon
Affiliated Colleges
Syllabus under CBCS for Master of Science in Computer Science [M.Sc. (Computer Science)]
Course Structure (w.e.f. 2021-22)

COURSE STRUCTURE WITH CREDIT

Semester-I

Course Code	Course Type	Title of the Course	Contact Hours/Week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
CS-101	**Core**	Database Management System (DBMS)	04	-	04	40	-	60	-	100	-	04
CS-102	**Core**	Automata Theory and Computability	04	-	04	40	-	60	-	100	-	04
CS-103	**Core**	Operating Systems	04	-	04	40	-	60	-	100	-	04
CS-104	Skill Based	Object Oriented Programming using JAVA	**04**	**-**	**04**	**40**	**-**	**60**	**-**	100	**-**	**04**
CS LAB-I	**Core**	LAB on JAVA programming	-	04	04	-	40	-	60	-	100	04
CS LAB-II	**Core**	LAB on DBMS	-	04	04	-	40	-	60	-	100	04
AC-101	**Audit Course**	**Practicing Cleanliness**	**-**	**02**	**02**	**-**	**100**	**-**	**-**	**-**	**100**	**02**

Semester-II

Course Code	Course Type	Title of the Course	Contact Hours/Week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
CS-201	**Core**	Compiler Construction	04	-	04	40	-	60	-	100	-	04
CS-202	**Core**	Artificial Intelligence	04	-	04	40	-	60	-	100	-	04
CS-203	**Core**	Design and Analysis of Algorithms	04	-	04	40	-	60	-	100	-	04
CS-204	Skill Based	Python Programming	**04**	**-**	**04**	**40**	**-**	**60**	**-**	100	**-**	**04**
CS LAB-III	**Core**	LAB on Design and Analysis of Algorithms (DAA)	-	04	04	-	40	-	60	-	100	04
CS LAB-IV	**Core**	LAB on Python Programming	-	04	04	-	40	-	60	-	100	04
AC- 201 (A)/(B)/(C)/(D)	**Elective Audit Course**	**Choose one out of four (AC-201(A)/(B)/(C)/(D))** (Personality and Cultural Development Related)	**-**	**02**	**02**	**-**	**100**	**-**	**-**	**-**	**100**	**02**

List of Elective Audit Courses to be offered in Semester-II:

AC-201 (A) : Soft Skills

AC-201 (B) : Practicing Sports Activities

AC-201 (C) : Practicing Yoga

AC-201 (D) : Introduction to Indian Music

Semester-III

Course Code	Course Type	Title of the Course	Contact Hours/Week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
CS-301	**Core**	Web Application Development Technology	04	-	04	40	-	60	-	100	-	04
CS-302	**Core**	Digital Image Processing	04	-	04	40	-	60	-	100	-	04
CS-303	**Core**	Software Engineering	04	-	04	40	-	60	-	100	-	04
CS-304(A)/(B)/ (C)	Elective	Choose one from CS-304(A), CS-304(B) and CS-304(C)	**04**	**-**	**04**	**40**	**-**	**60**	**-**	100	**-**	**04**
CS LAB-V	**Core**	LAB on Web Application Development Technology	-	04	04	-	40	-	60	-	100	04
CS LAB-VI	**Core**	LAB on Digital Image Processing	-	04	04	-	40	-	60	-	100	04
AC-301 (A)/(B)/(C)/(D)	**Elective Audit Course**	**Choose one out of four (AC-301 (A)/(B)/(C)/(D))** (Technology + Value added course)	**-**	**02**	**02**	**-**	**100**	**-**	**-**	**-**	**100**	**02**

List of Elective Courses to be offered in Semester-III:

CS-304(A): Big Data Analytics   CS-304(B): Windows WCF and WPF Programming   CS-304(C): Web Analytics

List of Elective Audit Courses to be offered in Semester-III:

AC-301 (A) : Computer Skills   AC-301 (B) : Cyber Security

AC-301 (C) : Linux (Spoken Tutorial Course)   AC-301 (D) : Advance C++ (Spoken Tutorial Course)

Note: Syllabus for Spoken Tutorial Courses AC-301 (C)/(D) is available at https://spoken-tutorial.org developed at IIT Bombay for MHRD, Government of India.

Semester IV

Course Code	Course Type	Title of the Course	Contact Hours/Week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
CS-401	**Core**	Natural Language Processing	04	-	04	40	-	60	-	100	-	04
CS-402	**Core**	Data Warehousing and Data Mining (DWDM)	04	-	04	40	-	60	-	100	-	04
CS-403(A)/(B)/ (C)	Elective	Choose one from CS-403(A), CS-403(B) and CS-403(C)	**04**	**-**	**04**	**40**	**-**	**60**	**-**	100	**-**	**04**
CS LAB-VII	**Core**	Data Warehousing and Data Mining (DWDM)	-	04	04	-	40	-	60	-	100	04
AC-401 (A)/(B)/(C)/(D)	**Elective Audit Course**	**Choose one out of four (AC-401 (A)/(B)/(C)/(D))** (Technology + Value added course)	**-**	**02**	**02**	**-**	**100**	**-**	**-**	**-**	**100**	**02**
Mini Project	**Core**	**Mini Project**									**200**	**06**

List of Elective Courses to be offered in Semester-IV:

CS-403(A) Optimization of Algorithm CS-403(B) Machine Learning CS-403(C) Advanced Network Programming

List of Elective Audit Courses to be offered in Semester-VI:

AC-401 (A) : Human Rights

AC-401 (B) : Current Affairs or Research Methodology

AC-401 (C) : Seminar plus Review

AC-401 (D) : Intellectual Property Rights(IPR)

Semester-I

Course Code: **CS-102** **Database Management System (DBMS)** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:

1) The course emphasizes the understanding of the fundamentals of relational systems including data models, database architectures, and database manipulations.
2) To develop conceptual understanding of database management system
3) To understand how a real-world problem can be mapped to schemas
4) To educate students with different Database Languages.
5) Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

Unit-I **[10]** Max Marks:**12**

Introduction: Database system application and purpose, Characteristics of DBMS, Database Users, 1-tier, 2-tier and 3-tier architecture of DBMS along with its advantages, Levels of Database Architecture, Data Models, Data-schemas and instances, Data Independence, Role and responsibilities of DBA, Concepts of ER Diagrams and Normalization.

Unit-II **[15]** Max Marks:**25**

Relational Databases: Structure of Relational Databases, Database Schemas, Keys, Schema diagrams, Relational Query Languages, Relational Operation. Overview of SQL, SQL Data Definition, Basic Structure of SQL Queries, Basic Operations, Set Operations, Null Values, Aggregate Functions, Nested Sub queries, Modification of Databases. Join Expressions, Views, Transactions, Integrity Constraints, SQL data types and Schemas, Authorization, Accessing SQL from Programming Languages, Overview of Dynamic SQL and SQL CLI. Functions and Procedures, Triggers. The relational Algebra fundamental and extended Operations. Tuple and Domain Relational Calculus.

Unit-III **[12]** Max Marks:**23**

Transaction Management and Query Processing: Transaction Concept, Model, Storage Structure, Atomicity and Durability, Isolation, Levels of Isolation, Overview of Query Processing, Measuring Query Cost, Selection Operation, Sorting, Join Operation, Other Operations and Evaluation of Expression. Overview of Query Optimization, Transformation of Relational Expression, Choice of Evaluation Plan.

Unit-IV **[10]** Max Marks:**15**

Concurrency Control and Recovery System: Lock based Protocol, Timestamp based Protocol, Validation based Protocol, Deadlock Handling, Failure Classification, Storage, Recovery and Atomicity, Recovery Algorithms, Buffer Management, Early lock release and logical undo operations, Remote Backup Systems. Case study: ARIES

Unit-V **[13]** Max Marks:**25**

Advanced Topics in Databases: Type your unit content here. (comma separated) Introduction to Object Databases: Shortcomings of Relational Data Model, The Conceptual Object Data Model, Objects in SQL:1999 and SQL:2003. Introduction to XML and Web Data: Semi-structured Data, Overview of XML, XML Data Definitions, XML Schema, XML Data Manipulation: XQuery, XPath Query Languages: XPath and SQL/XML. Distributed Databases: Overview, Homogeneous and Heterogeneous Databases, Distributed Data Storage, Distributed Transactions, Commit Protocols, Concurrency Control, Cloud based Databases.

References:

1. Michael Kifer, Arthur Bernstein, P.M, Lewis and P.K. Panigrahi, "Database Systems: An Application Oriented Approach", Second Edition, Pearson Education, ISBN:978-81-317-0374-8.
2. C.J.Date, A. Kannan and S. Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, ISBN:978-81-7758-556-8
3. A. Silberschatz, H.F.Korth, and S.Sudarshan, "Database System Concepts", TMH Publications, Sixth Edition, ISBN:978-007-132522-6.

Course Outcome:

Upon successful completion of this course, students will be able to

1. To analyze Database design methodology.
2. Acquire knowledge of fundamentals of Database Management System.
3. Analyze the difference between traditional file system and DBMS.
4. To deal with different Database languages.
5. Draw various data models for Database, writing and executing queries to get expected results.

Course Code: **CS-103** **Automata Theory and Computability** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:

Students will try to learn:

1. To learn fundamentals of Grammars and Languages.
2. To understand the relation between Regular Language and Finite Automata and machines.
3. To learn how to design Automata's and machines as Acceptors, Verifiers and Translators.
4. To understand the relation between Contexts free Languages, PDA and TM.
5. To learn how to design PDA as acceptor and TM as Calculators.
6. To understand the decidability and complexity measures.

Unit-I **[10]** Max Marks: **20**

Grammars: Production systems, Chomskian Hierarchy, Right linear grammar and Finite state automata, Context free grammars, Normal forms, uvwxy theorem, Parikh mapping, Self-embedding property, Subfamilies of CFL, Derivation trees and ambiguity

Unit-II **[10]** Max Marks: **20**

Finite State Automata: Nondeterministic and deterministic FSA, NFSA with ε- moves, Regular Expressions, Equivalence of regular expression and FSA, Pumping lemma, closure properties and decidability, Myhill - Nerode theorem and minimization, Finite automata with output

Unit-III **[08]** Max Marks: **15**
Pushdown Automata: Acceptance by empty store and final state, Equivalence between pushdown automata and context-free grammars, Closure properties of CFL, Deterministic pushdown automata

Unit-IV **[12]** Max Marks:**20**
Turing Machines: Techniques for Turing machine construction, Generalized and restricted versions equivalent to the basic model, Godel numbering, Universal Turing Machine, Recursively enumerable sets and recursive sets, Computable functions, time space complexity measures, context sensitive languages and linear bound automata

Unit-V **[08]** Max Marks: **10**
Decidability: Post's correspondence problem, Rice's theorem, decidability of membership, emptiness and equivalence problems of languages

Unit-VI **[10]** Max Marks: **15**
Complexity Measures: Time and tape complexity measures of Turing machines, Random access machines, the classes P and NP, NP-Completeness, satisfiability and Cook's theorem, Polynomial reduction and some NP-complete problems, Regulated rewriting L systems, Grammar systems

References:

1. K. Krithivasan and R. Rama (2009). Introduction to Formal Languages, Automata Theory and Computation: Pearson Education, ISBN 9788131723562.
2. J. E. Hopcroft, R.Motwani and J.D.Ullman (2001). Introduction to Automata Theory Languages and computation: Pearson Education Asia, ISBN 978-0321455369.
3. Peter Linz (2006). An Introduction to Formal Language and Automata 4th Edition: Narosa Publishing house, ISBN 978-1-4496-1552-9.
4. M.Sipser (1997). Introduction to the Theory of Computation; Singapore: Brooks/Cole, Thomson Learning ISBN, 978-1133187790.
5. John. C. Martin (2003). Introduction to the Languages and the Theory of Computation Third edition Tata McGraw-Hill ISBN 9780070660489.
6. 6. http://nptel.ac.in/

Course Outcome:

Students will able to:

1. Understand, design, construct, analyse and interpret Regular languages, Expression and Grammars.
2. Design different types of Finite Automata and Machines as Acceptor, Verifier and Translator.
3. Understand, design, analyse and interpret languages, Expression and Grammars.
4. Design different types of Push down Automata and Turing Machine.

Course Code: **CS-104** **Operating Systems** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:

The student should be able to

- understand different types of operating systems and the concepts that underlies operating systems.
- learn the fundamental concepts and algorithms that will be used in existing commercial operating systems.
- understand the issues related to protection and security.

Unit-I **[04]** Max Marks:**08**

Introduction: review of computer organization, introduction to popular operating systems like UNIX, Windows, etc., OS structure, system calls, functions of OS, evolution of OSs.

Unit-II **[03]** Max Marks:**06**

Computer organization interface: using interrupt handler to pass control between a running program and OS.

Unit-III **[08]** Max Marks:**12**

Concept of a process: states, operations with examples from UNIX (fork, exec), Process scheduling, inter-process communication (shared memory and message passing), UNIX signals.

Unit-IV **[04]** Max Marks:**06**

Threads: multithreaded model, scheduler activations, examples of threaded programs.

Unit-V **[06]** Max Marks:**10**

Scheduling: multi-programming and time sharing, scheduling algorithms, multiprocessor scheduling, thread scheduling (examples using POSIX threads).

Unit-VI **[08]** Max Marks:**12**

Process synchronization: critical sections, classical two process and n-process solutions, hardware primitives for synchronization, semaphores, monitors, classical problems in synchronization (producer-consumer, readers-writer, dining philosophers, etc.).

Unit-VII **[06]** Max Marks:**10**

Deadlocks: modelling, characterization, prevention and avoidance, detection and recovery.

Unit-VIII **[07]** Max Marks:**12**

Memory management: with and without swapping, paging and segmentation, demand paging, virtual memory, page replacement algorithms, working set model, implementations from operating systems such as UNIX. Current Hardware support for paging: e.g., Pentium/ MIPS processor etc.

Unit-IX **[07]** Max Marks:**12**

Secondary storage and Input/Output: device controllers and device drivers, disks, scheduling algorithms, file systems, directory structure, device controllers and device drivers, disks, disk space management, disk scheduling, NFS, RAID, other devices. operations on them, UNIX FS, UFS protection and security, NFS

Unit-X **[04]** Max Marks:**06**

Protection and security: Illustrations of security model of UNIX and other OSs. Examples of attacks.

Unit-XI **[03]** Max Marks:**06**

Epilogue: Pointers to advanced topics (distributed OS, multimedia OS, embedded OS, real-time OS, OS for multiprocessor machines).

All above topics shall be illustrated using UNIX as case-studies.

References:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne (2009), Operating System Concepts, 8th Ed., John Wiley, *ISBN* 0-471-69466-5.
2. William Stallings (2014), Operating Systems: Internals and Design Principles. Pearson, 8th Ed., *ISBN*-13: 978-0-13-230998-1
3. AS Tanenbaum (2009), Modern Operating Systems, 3rd Ed., Pearson, *ISBN*: 0135013011
4. AS Tanenbaum, AS Woodhull (2006), Operating Systems Design and Implementation, 3rd Ed., Prentice Hall, *ISBN*-10: 0131429388
5. M. J. Bach (1986), Design of the Unix Operating System, Prentice Hall of India, *ISBN* 0 -13-201757-1 025

Course Outcome:

Upon completion of the subject, students will be able to:

- understand different types of operating systems.
- gain extensive knowledge on principles and modules of the operating systems.
- understand key mechanisms in the design of operating systems modules.
- understand process management, thread management, memory management, file management and deadlock handling.
- compare performance of different processor scheduling algorithms.
- produce algorithmic solutions to process synchronization problems
- understand the issues related to protection and security.

Course Code: **CS-105** **Object Oriented Programming using JAVA** *Clock Hours:* **60** *Total Marks:* **100**

Course Objectives:

Students will try:

1. To learn fundamentals of Java programming language and its constructs.
2. To understand concept of object-oriented programming concept using Java.
3. To study the concept of the Inheritance, Interfaces, Lambda Expressions, and Inner Classes.
4. To understand the concept of the Exceptions and Generic Programming

5. To learn about the Graphics Programming, Event Handling, Swing Components, and Database Programming

Unit- I **[08]** Max Marks:**12**

An Introduction to Java: Java as a Programming Platform, The Java "White Paper" Buzzwords, Java Applets and the Internet, Common Misconceptions about Java, The Java Programming Environment, Installation, A Simple Java Program, Comments, Data Types, Variables, Operators, Strings, Input and Output, Control Flow, Big Numbers, Arrays.

Unit-II **[08]** Max Marks:**12**

Objects and Classes: Introduction to Object-Oriented Programming, Using Predefined Classes, Defining Your Own Classes, Static Fields and Methods, Method Parameters, Object Construction, Packages, The Class Path, Documentation Comments

Unit-III **[10]** Max Marks:**16**

Inheritance, Interfaces, Lambda Expressions, and Inner Classes: Classes, Super classes, and Subclasses, Object: The Cosmic Superclass, Generic Array Lists, Object Wrappers and Autoboxing, Methods with a Variable Number of Parameters, Enumeration, Classes, Reflection, Interfaces, Examples of Interfaces, Lambda Expressions, Inner Classes, Proxies

Unit-IV **[10]** Max Marks:**16**

Exceptions and Generic Programming: Dealing with Errors, Catching Exceptions, Assertions and Logging, Why Generic Programming? Simple Generic Class, Generic Methods, Bounds for Type Variables, Inheritance Rules for Generic Types, Wildcard Types, Reflection and Generics

Unit-V **[12]** Max Marks:**24**

Graphics Programming, Event Handling and Swing Components: Introducing Swing, Creating a Frame, Positioning a Frame, Displaying Information in a Component, Working with 2D Shapes, Using Color, Using Special Fonts for Text, Displaying Images, Basics of Event Handling, Actions, Mouse Events, The AWT Event Hierarchy, Swing and the Model-View-Controller Design Pattern, Introduction to Layout Management, Text Input, Choice Components, Menus, Sophisticated Layout Management, Dialog Boxes.

Unit-VI **[12]** Max Marks:**20**

Deployment and Concurrency and Database Programming: JAR Files, Storage of Application Preferences, Service Loaders, Applets, Java Web Start, Threads, Interrupting Threads, Thread States, Thread Properties, Synchronization, Blocking Queues, Thread-Safe Collections, Callables and Futures, Executors, Synchronizers, Threads and Swing, The Design of JDBC, The Structured Query Language, JDBC Configuration, Working with JDBC Statements, Query Execution, Scrollable and Updatable Result Sets, Row Sets, Metadata.

References:

1. Cay S. Horstmann Core Java Volume I—Fundamentals (December 2015), Tenth Edition, Prentice Hall, ISBN: 9780134177335
2. Cay S. Horstmann Core Java, Volume II—Advanced Features (December 2016), Tenth Edition, Prentice Hall, ISBN: 9780134177878

3. Herbert Schildt, Java: The Complete Reference, Ninth Edition, McGraw Hill Education, ISBN 978-0-07-180855-2

Course Outcome:

Students will able to:

1. To understands the fundamentals of Java programming language and its constructs.
2. To understand concept of object-oriented programming concept using Java.
3. To implement the applications using the concept of the Inheritance, Interfaces, Lambda Expressions, and Inner Classes.
4. To design and implement the real-world application using the concept of the Exceptions and Generic Programming
5. To understand how to use concept of the Graphics Programming, Event Handling, Swing Components, and JDBC in their application.

Course Code: **CS LAB-I** **LAB on JAVA programming** *Total Marks:* **100**

Course Objectives:

The main objectives of this course are:

JAVA programming

- Gain knowledge about basic Java language syntax and semantics to write Java programs and use concepts such as variables, conditional and iterative execution methods etc.
- Understand the fundamentals of object-oriented programming in Java, including defining classes, objects, files, invoking methods etc and exception handling mechanisms.
- Understand the principles of inheritance, packages and interfaces
- Using Swing library and various GUI components, Applet programming, JDBC, generic programming and multithreaded programming

JAVA programming

1. Write a program that demonstrates program structure of java.
2. Write a program that demonstrates string operations.
3. Write a program that demonstrates package creation and use in program.
4. Write a program that demonstrate inner class.
5. Write a program that demonstrates inheritance.
6. Write a program that demonstrates 2D shapes on frames.
7. Write a program that demonstrates text and fonts.
8. Write a program that demonstrates event handling for various types of events.
9. Write a program to illustrate use of various swing components.
10. Write a program that demonstrates use of dialog box.
11. Write a program to create own dialog box.
12. Write a program to create toolbar, menu & popup menu.
13. Write a program to implement file handlings.
14. Write a program that demonstrates Applet programming.
15. Write a program to implement generic programming.
16. Write a program that demonstrates JDBC on applet/application.
17. Write a program that demonstrates multithreading.

Course Outcome:
The above exercise shall make the students competent in the following ways and will be able to learn following parameters at the end of the course.

JAVA programming

- Write Java application programs using OOP principles and proper program structuring
- Implementing user interface: 2D shapes, events, dialog box, menu and popup menu
- Developing Applets, multithreaded programs
- Implementing generic and JDBC programming
- Demonstrate the concepts of polymorphism and inheritance
- Write Java programs to implement error handling techniques using exception handling

Course Code: **CS LAB-II** **LAB on DBMS** *Total Marks:* **100**

Course Objectives:

1) The course mainly concentrates on understanding of the fundamentals of Data Definition Language and Data Manipulation Languages.
2) To develop conceptual understanding of database management system
3) To understand how a real-world schema can be implemented
4) To educate students with different Database Languages.
5) Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

1. Creating database tables and using data types.
   - Create table
   - Modify table
   - Drop table
2. Practical Based on Data Manipulation.
   - Adding data with Insert
   - Modify data with Update
   - Deleting records with Delete
3. Practical Based on Implementing the Constraints.
   - NULL and NOT NULL
   - Primary Key Constraint
   - Foreign Key Constraint
   - Unique Constraint
   - Check Constraint
   - Default Constraint
4. Practical for Retrieving Data Using following clauses.
   - Simple select clause
   - Accessing specific data with Where
   - Ordered By
   - Distinct
   - Group By
5. Practical Based on Aggregate Functions.

- AVG
- COUNT
- MAX
- MIN
- SUM
- CUBE

6. Practical Based on implementing all String functions.
7. Practical Based on implementing Date and Time Functions.
8. Practical Based on implementing use of UNION, INTERSECTION, SET DIFFERENCE.
9. Implement Nested Queries & all types of JOIN operation.
10. Practical Based on performing different operations on a view.
11. Practical Based on implementing use of Procedures.
12. Practical Based on implementing use of Triggers
13. Practical Based on implementing Cursor.
14. ++++VB.NET, C#.NET, JAVA, D2K, etc.
15. Practical based on creating Data Reports.
16. Design entity relationship models for a business problem and develop a normalized database structure

Course Outcome:

After successful completion of this course, students will be able to

1.To understand Database design methodology.
2.Acquire knowledge in fundamentals of Database Management System.
3.Work with popular Database languages.
4.Realise various data models for Database and Write queries in SQL.
5. Familiar with basic database storage structures and access techniques.

Semester-II

Course Code: **CS-201** **Compiler Construction** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:

To cover the major topics in compiler design with emphasis on solving the problems encountered in designing a compiler regardless of the source language or the target machine.

Unit-I **[05]** Max Marks:**10**

Compiler structure: analysis-synthesis model of compilation, various phases of a compiler, tool-based approach to compiler construction.

Unit-II **[06]** Max Marks:**15**

Lexical analysis: Interface with input, parser and symbol table, token, lexeme and patterns, Difficulties in lexical analysis, Error reporting, Implementation, Regular definition, Transition diagrams, LEX.

Unit-III **[15]** Max Marks:**30**

Syntax analysis: CFGs, ambiguity, associativity, precedence, top down parsing, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, operator precedence grammars, LR parsers (SLR, LALR, LR), YACC.

Syntax directed definitions: inherited and synthesized attributes, dependency graph, evaluation order, bottom up and top down evaluation of attributes, L- and S-attributed definitions.

Type checking: type system, type expressions, structural and name equivalence of types, type conversion, overloaded functions and operators, polymorphic functions.

Unit-IV **[10]** Max Marks:**15**

Run time system: storage organization, activation tree, activation record, parameter passing, symbol table, dynamic storage allocation.

Unit-V **[10]** Max Marks:**15**

Intermediate code generation: Intermediate representations, translation of declarations, assignments, control flow, Boolean expressions and procedure calls. Implementation issues.

Unit-VI **[10]** Max Marks:**15**

Code generation and instruction selection: issues, basic blocks and flow graphs, register allocation, code generation, dag representation of programs, code generation from dags, peep hole optimization, code generator generators, specifications of machine.

References:

1. Aho A.V., R. Sethi and J.D. Ullman. Compiler Principle, Techniques and Tools: Addison Wesley, ISBN 0-321-48681-1.
2. Barret, Couch. Compiler Construction Theory and Practice: Computer Science series, Asian Student Ed, ISBN 978-0574213358
3. Dhamdhere D.M. Compiler Construction Principle and Practice: McMillan India, ISBN 9780333904060
4. Gres D. Compiler Construction for Digital Computer: Wiley, ISBN 047132776X.
5. David Galles (2009). Modern Compiler Design: Pearson Education, ISBN 9788131709412

Course Outcome:

Understanding of basic structure of compiler, concepts and terminology in programming languages, lexical analysis, finite state techniques, scanner generator, parsing, kinds of parsers, designing lexical analyzer, scanner and parsers, principal ideas with intermediate code generation, optimizations.

Understanding of all concepts essential to design compiler in general for programming languages.

Course Code: **CS-202** **Artificial Intelligence** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:
The primary objective of this course is to introduce the basic principles, techniques, and applications of Artificial Intelligence. Emphasis will be placed on the teaching of these fundamentals, not on providing a mastery of specific software or tools programming environments.

The student should be made to:

1) Gain a historical perspective of AI and its foundations.
2) Study the concepts of Artificial Intelligence.
3) Investigate applications of AI techniques in intelligent agents
4) Learn the methods of solving problems using Artificial Intelligence.
5) Learn various peculiar search strategies for AI

Unit-I **[08]** Max Marks:**10**
Introduction: Overview and Historical Perspective, Turing test, Physical Symbol Systems and the scope of Symbolic AI, Agents.

Unit-II **[06]** Max Marks:**10**
State Space Search: Depth First Search, Breadth First Search, DFID.

Unit-III **[08]** Max Marks:**12**
Heuristic Search: Best First Search, Hill Climbing, Beam Search, Tabu Search.

Unit-IV **[08]** Max Marks:**15**
Randomized Search: Simulated Annealing, Genetic Algorithms, Ant Colony Optimization.

Unit-V **[08]** Max Marks:**12**
Problem Decomposition: Goal Trees, AO*, Rule Based Systems, Rete Net.

Unit-VI **[06]** Max Marks:**12**
Game Playing: Minimax Algorithm, AlphaBeta Algorithm, SSS*.

Unit-VII **[08]** Max Marks:**14**
Planning and Constraint Satisfaction: Domains, Forward and Backward Search, Goal Stack Planning, Plan Space Planning, Graphplan, Constraint Propagation.

Unit-VIII **[08]** Max Marks:**15**
Logic and Inferences: Propositional Logic, First Order Logic, Soundness and Completeness, Forward and Backward chaining.

References:
1. Deepak Khemani (2013). A First Course in Artificial Intelligence, McGraw Hill Education (India), ISBN 9781259029981

2. Elaine Rich and Kevin Knight (1991). Artificial Intelligence, Tata McGraw Hill, ISBN 13: 9780070087705
3. Stuart Russell and Peter Norvig (2009). Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall, ISBN-13: 978-0-13-604259-4.

Course Outcome:

At the end of the course, the student should be able to:
1) Identify problems that are amenable to solution by AI methods.
2) Identify appropriate AI methods to solve a given problem.
3) Design smart system using different informed search / uninformed search or heuristic approaches.
4) Apply the suitable algorithms to solve AI problems.

***Course Code:* CS-203** **Design and Analysis of Algorithms** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:
To Understand and learn
1. Basic concepts of algorithms and analyze the performance of algorithms.
2. Algorithm design techniques for developing algorithms.
3. Searching and traversal algorithms for graphs.
4. Nondeterministic algorithms and NP class of problem.

Unit-I **[10]** Max Marks:**15**
Introduction: What Is An Algorithm?, Algorithm Specification, Pseudocode Conventions, Recursive Algorithms, Complexity, Asymptotic Notation, Practical Complexities And Performance Measurement
Tree And Graph Representations, Binary Trees Basics, Heaps And Heap Sort, Sets And Disjoint Set Union And Find.

Unit-II **[12]** Max Marks:**15**
Divide and Conquer: General Method, Binary Search, Finding Maximum and Minimum, Merge Sort, Quick Sort, Strassen’s Matrix Multiplication.

Unit-III **[08]** Max Marks:**15**
The Greedy Method: General Method, Knapsack Problem, Huffman Code, Minimum-Cost Spanning Trees (Prim’s & Kruskal’s Algorithm), Optimal Storage On Tapes, Single-Source Shortest Paths.

Unit-IV **[08]** Max Marks:**15**

Dynamic Programming: General Method, All-Pair Shortest Path, Matrix Chain Multiplication, Longest Common Sub Sequence, 0/1knapsack, Flow Shop Scheduling

Unit-V **[06]** Max Marks:**15**
Basic Search and Traversal Techniques: Breadth First Search and Traversal, Depth First Search And Traversal, Spanning Trees.

Unit-VI **[08]** Max Marks:**15**
Backtracking: General Method, Constrains, 8-Queens Problem Graph Coloring

References:

1. Horowitz E. and Sahni S. "Fundamentals of computer Algorithms" Galgotia publications. ISBN:0716783169
2. Horowitz E., Sahni S. and Rajshekaran S(),Computer Algorithms, Computer Science Press, ISBN-10: 8173716129
3. S. Dasgupta, C. H. Papadimitriou, and U. V. Vazirani(2006), Algorithms. McGraw-Hill publications, ISBN 9780073523408
4. Cormen, Leiserson and Rivest, Introduction to Algorithms, Prentice Hall of India, ISBN: 978-81-203-4007-7

Course Outcome:
1. Analyze the asymptotic performance of algorithms.
2. Write rigorous correctness proofs for algorithms.
3. Design and analyze divide-and-conquer based algorithms.
4. Devise and Synthesize greedy and dynamic-programming based algorithms.
5. Employ graphs to model problems solvable using traversal techniques.
6. Able to model problems using backtracking
7. Able to classify nondeterministic polynomial time algorithms.

Course Code: **CS-205** **Python Programming** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:
The student should be able to
- understand the fundamental concepts of Python programming.
- learn that how python programming supports some constructs of functional programming.
- work with strings, lists, tuples, dictionaries, and files.
- define their own classes, methods and module for solving real world problems.
- use regular expression for searching patterns in given strings.

Unit-I **[12]** Max Marks:**20**
The Python Programming Language, Python Data, Variables, Expressions and Statements, Values and Data Types, Type conversion Functions, Operators and Operands, Input, Order of

Operations, Functions, Calling Functions, Passing Functions, Formal Arguments, Variable-length Arguments, Functional Programming, Boolean Expressions, Logical operators, Precedence of Operators, Conditional Execution, Unary Selection, Nested conditionals, Chained conditionals, Boolean Functions, Iteration, The for loop, The while Statement

Unit-II **[08]** Max Marks:**15**

Strings, A Collection Data Type, Operations on Strings, Index Operator: Working with the Characters of a String, String Methods, Length, The Slice Operator, String Comparison, Lists, List Values, List Length, Accessing Elements, List Membership, Concatenation and Repetition, List Slices, Lists are Mutable, List Deletion, Objects and References, Aliasing, Cloning Lists, Repetition and References, List Methods, Append versus Concatenate Lists and for loops, Using Lists as Parameters, Nested Lists, Strings and Lists, List Type Conversion Function, Tuples, Tuple operators and built-in functions, Tuples and Mutability, Tuple Assignment, Tuples as Return Values

Unit-III **[15]** Max Marks:**20**

Dictionaries, Dictionary Operations, Dictionary Methods, Dictionary Keys, Aliasing and Copying, Sparse Matrices, Working with Data Files, Finding a File on your Disk, Reading a File, Iterating over lines in a file, Writing Text Files, Object Oriented Programming, Classes, Instances, Class method Calls, Coding Class Tree, Attributes, Building and Method Invocation, Composition, Inheritance, Operator Overloading, Encapsulation and Information Hiding, Search Algorithms, Sorting Algorithms, Hash Tables

Unit-IV **[10]** Max Marks:**20**

Regular Expressions, Exceptions, Standard Exceptions, Exceptions Syntax, The try/except/else Statement, The try/finally Statement, Unified try/except/finally, The raise Statement, The assert Statement, with/as Context Managers String-Based Exceptions, Class-Based Exceptions, General raise Statement Forms, Nesting Exception Handlers, Exception Idioms, Exception Design Tips. Catch All Exceptions, Catch A Specific Exception, Catch Multiple Specific Exceptions, Clean-up After Exceptions, GUI Programming using TKinter.

Unit-V **[15]** Max Marks:**25**

Advance Function Topics: Anonymous Function Lambda, Mapping Functions over Sequences: map, Functional Programming Tools: filter and reduce, List Comprehensions Revisited: Mappings. Modules: Python Program Architecture, Module Creation, Module usage, Module Namespaces, Reloading Modules, Module Packages. Data Hiding in Modules, Enabling Future Language Features, Mixed Usage Modes, Changing the Module Search Path, The import as Extension, Relative Import Syntax, Module Design Concepts

References:

1. John V Guttag (2013), Introduction to Computation and Programming Using Python, Prentice Hall of India, 2013, ISBN: 9780262525008
2. R. Nageswara Rao(2016), Core Python Programming, Dreamtech Press, 2016, ISBN-13: 9789351199427
3. Wesley J. Chun(2006), Core Python Programming - Second Edition, Prentice Hall, ISBN-13: 978-0132269933, ISBN-10: 0132269937

4. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser(2013), Data Structures and Algorithms in Pyhon”, Wiley, 2013, ISBN : 978-1-118-54958-2, ISBN : 978-1-118-29027-9(HardCover)
5. Kenneth A. Lambert(2011), Fundamentals of Python – First Programs, CENGAGE Publication, 2011, ISBN 1111822700, ISBN 9781111822705
6. Luke Sneeringer(2015), Professional Python, Wiley Inc.,2015, ISBN: 1119070856
7. Mark Lutz (2007), Learning Python, 3rd Edition, O'Reilly Media, Inc., 2007, ISBN-13: 978-0-596-51398- 6, ISBN-10: 0-596-51398-4

Course Outcome:

Upon completion of the subject, students will be able to:

- understand the basic concepts of Python programming.
- write Python programs that supports some constructs of functional programming like map, reduce, filter.
- understand the use of strings, lists, tuples, dictionaries, and files and able to manipulates data available within them with help of various functions.
- understand how to write user defined classes, methods as well as module creation and handle exceptions while implementing python programs.
- use regular expression for validating email address or domain name.

Course Code: **CS- LAB-III** **LAB on Design and Analysis of Algorithms (DAA)** *Total Marks:* **100**

Course Objectives:

Understand and learn

1. To convert the algorithms to code.
2. To measure the complexities at run time.
3. To modify the algorithms for efficiency.
4. To debug and test the programs.
5. To conclude using profile of outcomes.

OS: Windows/Linux, **Programming Language:** C++/Java/C#

1. Write a program for creating max./min. heap using
   - INSERT
   - ADJUST/HEAPIFY
2. Write a program to implement union and find operation.
3. Write a program to find minimum and maximum form a given array.
4. Write a program for searching element form given array using binary search for n=1000,2000,3000 find exact time of execution.
5. Write a program for sorting given array in ascending/descending order with n=1000,2000,3000 find exact time of execution using
   - Heap sort
   - Merge sort
   - Quick sort
6. Write a program for matrix multiplication using Strassen's matrix multiplication.
7. Write a program to find solution of Knapsack instant.

8. Write a program to find shortest path using single source shortest path.
9. Write a program to find Minimum-Cost Spanning Trees (Prim's & Kruskal's Algorithm).
10. Write a program to find shortest path using all pair path.
11. Write a program to find longest common subsequence.
12. Write a program to implement breadth first and depth first search.
13. Write a program to implement breadth first and depth first traversal.
14. Write a program to find all solutions for 8-queen problem using backtracking.

Course Outcome:

1. Able to construct logic for the algorithms designed using designing techniques.
2. Able to do posterior analysis of the algorithms.
3. Able to debug the algorithms.
4. Modify to improve performance of the algorithms.
5. Able to test and profile the algorithms.

Course Code: **CS-LAB-IV** **LAB on Python Programming** *Total Marks:* **100**

Course Objectives:

The student should be able to

- develop the Python programs for searching, sorting, with help of fundamental concepts like lists, dictionary.
- understand the concepts of functions scoping, recursion, list mutability, regular expression in Python programming.
- learn to define their own classes, methods and modules according to the requirement of the problem and use of exception handling concepts.
- define regular expression and develop GUI programs using Tkinter.

1. Develop programs to understand the control structures of python
2. Develop programs to learn different types of structures (list, dictionary, tuples) in python
3. Develop programs to learn concept of functions scoping, recursion and list mutability.
4. Develop programs to understand object oriented programming using python.
5. Develop programs for data structure algorithms using python – searching, sorting and hash tables.
6. Develop programs to learn regular expressions using python.
7. Develop programs to learn GUI programming using Tkinter.
8. Demonstrate the concept of exception handling using try/except/else Statement, Unified try/except/finally, try/finally Statement, raise Statement, assert Statement, catch multiple specific exceptions
9. Demonstrate the concept of String-Based Exceptions, Class-Based Exceptions and Nesting Exception handlers.
10. Demonstrate implementation of the Anonymous Function Lambda.
11. Demonstrate implementation Mapping Functions over Sequences.
12. Demonstrate implementation functional programming tools such as filter and reduce
13. Demonstrate the Module Creation, Module usage, Module Namespaces, Reloading Modules, Module Packages, Data Hiding in Modules.

14. Demonstrate Mixed Usage Modes of modules, Changing the Module Search Path, The import as Extension, Relative Import Syntax, Module Design Concepts

Course Outcome:

Upon completion of the subject, students will be able to:

- implement Python programs that demonstrates all types of sorting and searching techniques.
- write programs that demonstrate the concepts of functions scoping, recursion, list mutability, regular expression and support of function programming constructs through Python programming.
- write Python programs that defines user defined classes, methods and module for solving real world problems as well as use of exception handling concepts whenever necessary.
- implement programs that uses regular expression for searching patterns and validating data.
- develop GUI programs using Tkinter.

Semester-III

Course Code: **CS-301**	**Web Application Development Technology**	*Clock Hours:* **60** *Total Marks:* **100**

Course Objectives:

- To learn .Net Framework
- Creating ASP.Net web applications using standard .net controls.
- Develop database applications using ADO.Net
- Use Web Services and develop simple and complex applications using .Net framework
- Develop a data driven web application.
- Connecting to data sources and managing them.
- Maintain session and controls related information for user used in multi-user web applications
- Understand the fundamentals of developing modular application by using object oriented methodologies

Unit-I **[10]** Max Marks:**15**

Desktop Computing vs. Internet Computing, Internet computing infrastructure, Client side scripting vs. Server Side Scripting technologies, Web Server basics and configuration: IIS, Apache etc., Web site hosting basics, Web Publishing, HTML, introduction to .NET framework, Features of .NET frameowork:CTS,CLS,CLR,.NET technologies, languages'C#.NET,VB.NET, basics of ASP.NET page framework, Visual studio .NET IDE, Page Life Cycle, PostBack, Viewstate, Page directives, ASP.Net page execution cycle, HTTP Pipeline, HTTP Application, HTTP Request, HTTP Response classes, HTTP Modules and HTTP Handlers, State Management, Role of Global.asax, Application configuration using web.config file

Unit-II **[15]** Max Marks:**25**

ASP.NET Control hierarchy, HTML Server Controls, Web Server Controls, User and Server controls, Validation Controls, List bound controls: dropdown lists, list boxes, Repeater, DataList, Data Grid, DataGridView, FormsView controls, Data binding to List Bound Controls, Templating and Styling of ASP.NET server controls

Unit-III **[20]** Max Marks:**25**

Web Page Designing principles, CSS anatomy, Anatomy of Master Pages, nesting master pages, Site map file, Web site Navigation controls, properties:TreeView, Sitemap Path, Menu, Other Navigation methods: Response.Redirect(), Server.Transfer(), Personalization through Profiles, Themes/Skins, Web Site security basics: authentication modes:Windows,Forms,passport, authorization, roles/Membership, access rules, login controls,Web services: working, anatomy, hosting

Unit-IV **[15]** Max Marks:**25**

Database technology: ADO.NET, Anatomy/architecture of ADO.NET, working with Connection, Command, Data Adaptor, DataReader, DataSet, DataTable objects, Editing data in Data Tables, concurrency control. Introduction to MVC, Data Reports

References:

1. Richard Anderson, Brian Francis, Alex Homer, Rob Howard, David Sussman, Karli Watson(2002), Professional ASP.NET 1.0, Special Edition, Wrox Press Ltd., 2002, ISBN 1-861007-0-3-5.
2. Chris Hart, John Kauffman, Dave Sussman, and Chris Ullman(2006), Beginning ASP.NET 2.0, Wiley Publishing, Inc., 2006, ISBN-13: 978-0-7645-8850-1, ISBN-10: 0-7645-8850-8.
3. Beginning ASP.NET 4: in C# and VB, Imar Spaanjaars, Wiley Publishing, Inc 2010., ISBN: 978-0-470-50221-1
4. Bill Evjen, Scott Hanselman, Devin Rader (2008), Professional ASP .NET 3.5 in C# and VB, Wiley Publishing Inc.,2008 ISBN:978-0-470-18757-9.
5. Dino Esposito (2008), Programming Microsoft ASP.NET 3.5, Second Edition, Microsoft Press, 2008, ISBN-10: 0735625271, ISBN-13: 978-0735625273

Auxiliary Resources:

Website URLs

- https://www.asp.net/
- http://asp.net-tutorials.com/

Video Links

- https://www.asp.net/web-forms/videos
- https://www.youtube.com/playlist?list=PL6n9fhu94yhXQS_p1i-HLIftB9Y7Vnxlo&feature=view_all

Course Outcome:

The student will be able apply technical knowledge and perform specific technical skills, including:

- Successful students will able to design web applications using ASP.NET
- Successful students will be able to use ASP.NET controls in web applications.
- Successful students will be able to debug and deploy ASP.NET web applications
- Successful students will be able to create database driven ASP.NET web applications and web services.

Course Code: **CS-302** **Digital Image Processing** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:

1. To equip students with the fundamental knowledge and basic technical competence in the field of Computer Graphics and Digital Image Processing.
2. To provide an understanding of how to scan convert the basic geometrical primitives, basic principles of 2 and 3- dimensional computer graphics.
3. To be able to discuss the application of computer graphics concepts in the development of information visualization, and business applications.
4. Give an in-depth knowledge about the basic theory and algorithms related to Digital Image Processing.
5. Provide awareness about the current technologies and issues specific to Digital Image Enhancement, Restoration, Segmentation, Color Image Processing, and Morphological Image Processing.

Unit-I **[12]** Max Marks:**20**

Introduction to Digital Image Processing & Applications: Digital Image Processing. Applications of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sensing and Acquisition. Image Sampling and Quantization. Some Basic Relationships Between Pixels.

Unit-II **[14] Max Marks:25**

Image Enhancement: Background, Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods,

Introduction to the Fourier Transform and the Frequency Domain, Smoothing Frequency-Domain Filters, Sharpening Frequency Domain Filters, Homomorphic Filtering

Unit-III **[14] Max Marks:20**

Image Restoration and Color Image Processing: A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering,

Color Fundamentals, Color Models, Pseudocolor Image Processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening.

Unit IV **[14] Max Marks: 20**
Morphological Image Processing & Segmentation: Detection of Discontinuities, Edge linking & Boundary Detection, Thresholding, Region based segmentation Laplacian of Gaussian, Derivative of Gaussian, Canny Edge Detection, Morphological operation: Dilation erosion, Opening & Closing, Basic Morphological Algorithm, Image representation schemes.

Unit V **[06] Max Marks: 15**
MATLAB Image processing toolbox: Introduction to MATLAB, Matrix Operations, Introduction to Image Processing Tool Box, Image Read & Write, Filters (spatial and frequency domain), Image Restoration and Reconstruction, Morphological Operations, Edge Detection and linking, Segmentation.

References:

1. Amarendra N Sinha, Arun D. Udai, (2008). Computer Graphics, TMH publication ISBN- 13 : 978-0-07-063437-4.
2. D. Hearn and M. Pauline Baker, Computer Graphics (C Version), Pearson Education, 2nd Edition ISBN-13: 978-0135309247
3. D. F. Rogers and J. A. Adams, Mathematical Elements for Computer Graphics, 2nd Edition, McGraw-Hill International Edition, ISBN-13:978-0-07-0486775
4. R.C.Gonzalez & R.E.Woods, Digital Image Processing, Pearson Education, 3rd edition, ISBN. 13:978-0131687288
5. S. Jayaraman Digital Image Processing TMH (McGraw Hill) publication, ISBN-13:978-0-07-0144798
6. Gonzalez, Woods & Steven, Digital Image Processing using MATLAB, Pearson Education, ISBN-13:978-0130085191

Course Outcome:
1. Developed scientific and strategic approach to solve complex problems Computer in the domain of Computer Graphics and Digital Image Processing.
2. Demonstrated various algorithms for scan conversion and filling of basic primitives objects and their comparative analysis and applied 2-D and 3-D geometric transformations, viewing and clipping on graphical objects.
3. Built the mathematical foundations for digital image representation, image acquisition, image transformation, image enhancement and restoration.
4. Developed a theoretical foundation of fundamental concepts of digital image processing.
5. Exposed students to MATLAB Image Processing Toolbox.

Course Code: **CS-303** **Software Engineering** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:
Students will try to learn:
- The nature of software development and software life cycle process models.
- Explain methods of capturing, specifying, visualizing and analyzing software requirements.

- Understand concepts and principles of software design and user-centric approach and principles of effective user interfaces.
- To know basics of testing and understanding concept of software quality assurance and software configuration management process.
- Understand need of project management and project management life cycle.
- Understand project scheduling concept and risk management associated to various type of projects.

Unit-I **[10]** Max Marks:**10**

Introduction and Process Models: Nature of Software, Software Engineering the process, Software Myths. Process Models: Generic process model, Prescriptive process models, Specialized process models, Unified process, Personal and Team process model, Process Technology, Product and Process. Agility, cost of change, Agile process, Extreme Programming, Agile Process models: Adaptive Software development, Scrum, Dynamic system development model, Crystal, Feature Driven development, Lean Software development, Agile modelling, Agile Unified process. Tool set for Agile process

Unit-II **[10]** Max Marks:**15**

Requirement Analysis and Modelling: Requirement Engineering, Establishing Groundwork, Eliciting Requirements Developing Use cases, Building Requirement model, Negotiating and Validating requirements. Requirement analysis, Scenario based modelling, UML models that supplements use case, Data modelling concepts, class based modelling. Requirement Modelling strategy, Flow oriented modelling, Creating Behaviour model, Pattern for Requirement modelling.

Unit-III **[08]** Max Marks:**15**

Quality Assurance and Change Management: Elements of SQA, SQA Tasks, Goal and Metrics, Formal approaches to SQA, Software Reliability, ISO 9000 Quality standards, SQA Plan. Software Configuration Management, SCM Repository, SCM process

Unit-IV **[11]** Max Marks:**20**

Design Concept: Design process, Design Concept: Abstraction, Architecture, Pattern, Separation of concept, Modularity, Information hiding, Functional independence, Refinement, Aspects, Refactoring. Design Model: Data design element, Architectural design element, Interface design element, Component level design element, Deployment level design element.

Unit-V **[11]** Max Marks:**20**

Architectural and Component Level Design: Software Architectures, Architectural Genres, Architectural styles, Architectural design, Accessing alternatives Architectural design, Architectural mapping using dataflow. Introduction to component, Designing class based component, Conducting component level design, Designing traditional component, component based development.

Unit-VI **[10]** Max Marks:**20**

Software Testing: Strategic approach to software testing, Test strategies for conventional software, Validation Testing, System testing, Software testing fundamentals, Internal and external view of testing, White box testing, Basic path testing, Control structure testing, Black box testing, model based testing, Testing for specialized Environment, Architectures and applications.

References:

1. R. S. Pressman, "Software Engineering: A Practitioner's Approach", McGraw-Hill International Edition, Seventh Edition, ISBN:978-007-126782-3.
2. Pankaj Jalote, "Software Engineering: A Precise Approach", Wiley India Pvt. Limited ISBN: 978-81-265-2311-5.
3. K. K. Aggarwal and Yogesh Singh, "Software Engineering", Third Edition, New Age International Publishers, ISBN:978-81-224-2360-0.

Course Outcome:

Students will able to:

- Understand and demonstrate basic knowledge in software engineering
- Define various software application domains and remember different process model used in software development.
- Explain needs for software specifications also they can classify different types of software requirements and their gathering techniques.
- Convert the requirements model into the design model and demonstrate use of software and user interface design principles.
- Distinguish among SCM and SQA and can classify different testing strategies and tactics and compare them.
- Justify role of SDLC in Software Project Development
- Generate project schedule and can construct, design and develop network diagram for different type of Projects.

Course Code: **CS-304(A)** **Big Data Analytics** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:

1. To understand the Big Data challenges & opportunities, its applications
2. Understanding of concepts of map and reduce and functional programming
3. Gain conceptual understanding of Hadoop Distributed File System.
4. To solve the case studies related to real life situations
5. To bridge the gap between academics and industry needs.

Course Outcomes:

- Recognize the characteristics, applications of big data that make it useful to real-world problems.
- Process available data using big data tools hadoop file system and predict outcomes to solve given problem.
- Study & Design various case studies using big data tools/commands and analyse it.

Unit-I

Introduction to Big data : Big Data :Definition & taxonomy , Sources of Big Data , 3V's of Big Data (need for Hadoop), Varying data structures, Characteristics of Big Data 1, Applications of Big Data 1.7 Challenges in Big Data 1.8 Big Data Implications for Industries Big Data Analytics for Telecom/Banking/Retail/HealthCare/IT/Operations

Unit-II

Emerging Database Landscape: Scale-Out Architecture, RDBMS Vs Non-Relational Database , Database Workload & its Characteristics , Implication of Big Data Scale on Data Processing

Unit- III

Application Architecture & Data Modeling For Big Data And Analytics , Big Data Warehouse & Analytics, Big data Warehouse System requirements & Hybrid Architectures , Enterprise Data Platform Ecosystem , Big Data and Master Data Management , Understanding data integration Pattern , Big Data Workload Design Approaches , Map-Reduce patterns ,Algorithms and Use Cases

Unit- IV

The Hadoop Ecosystem: Introduction to Hadoop, Hadoop Architecture, History of Hadoop-Facebook,Dynamo,Yahoo,Google, Hadoop Components :HDFS, Mapreduce , Introduction to Pig,Hive ,HBase ,Mahout, Installation of single node cluster-installation of java Hadoop configuration

Unit- V

Extracting Value From Big Data : Real Time Analytics , In-Memory Data Grid for real Time Analysis , Map reduce & Real Time Processing ,Use Cases

Unit- VI

Big Data Analytics Methodology : Big Data Analytics Methodology-Analyze & evaluate business cases, Develop Business Hypothesis –Analyze outcomes, Build & Prepare Data Sets ,Select & Build Analytical Model ,Design for Big Data scale .Build production ready system ,setting up the Big Data Analytics system ,Gathering data ,measure & monitor

References:

1) Madhu Jagdeesh,Soumendra Mohanty,Harsha Srivatsa,"Big Data Imperatives: Enterprise Big Data Warehouse,BI Implementations and Analytics",1st Edition, Apress(2013)
2) Frank J.Ohlhorst,"Big Data Analytics:Turning Big Data into Big Money",Wiley Publishers(2012)
3) Cristian Molaro,Surekha Parekh,Terry Purcell,"DB2 11:The Database for Big Data & Analytics",MC Press,(2013)
4) Tom White,"Hadoop-The Definitive Guide,Storage and analysis at internet scale",SPD, O'Really.
5) DT Editorial Services,"Big Data, Black Book-Covers Hadoop2, MapReduce,Hive,YARN, Pig, R and Data Visualization" Dreamtech Press,(2015).
6) Big Data Case Study by Bernard Marr –Willey Publications

Course Code: **CS-304(B)** **Windows, WCF and WPF Programming** *Clock Hours:* **60** *Total Marks:* **100**

Course Objectives:

Course Outcomes:

Unit 1:
Windows Programming : Windows environment – a simple windows program – windows and messages – creating the window – displaying the window – message loop – the window procedure – message processing – text output – painting and repainting – Mouse-Keyboard- introduction to GDI – device context – basic drawing – child window controls.

Unit 2: Windows Communication Foundation [WCF] : Windows Communication Foundation Overview, Windows Communication Foundation Concepts, Understanding Windows Communication Foundation, Addresses,Understanding and Programming WCF Binding, Understanding and Programming WCF Contracts, Clients, Services, Security.

Unit 3: Windows Presentation Foundation [WPF] : Overview of Windows Presentation Foundation, WPF and .Net Programming, Anatomy of EPF- Enabled Application, Building a Rich UI with Microsoft Expression Blend, Custom Controls, Security

References:

1) Charles Petzold, “Windows Programming”,4th illustrated Edition, , 1996, ISBN: 9781556156762, Microsoft Press
2) Scott Klein, “Professional WCF Programming .Net Development with Windows Communication Foundation”,2007, ISBN: 9780470089842,Wiley Publishing Inc.
3) Chris Andrade, Shawn Livermore, Mike Meyers, Scott Van Vilet, “Professional WPF Programming .Net Development with Windows Presentation Foundation”, 2007, ISBN: 9780470041802 , Wiley Publishing Inc.

Course Code: **CS-304(C)** **Web Analytics** *Clock Hours:* **60** *Total Marks:* **100**

Course Objectives:
1) Understand social media, web and social media analytics, and their potential impact.
2) Determine how to Leverage social media for better services and Understand usability metrics, web and social media metrics.
3) Use various data sources and collect data relating to the metrics and key performance indicators.
4) Identify key performance indicators for a given goal, identify data relating to the metrics and key performance indicators.

Course Outcomes:

Unit-1 Introduction
1.1 What is web Analytics
1.2 Importance of web Analytics
1.3 Web Analytics process
1.4 Types of web analytics
1.5 Web analytics technical requirements
1.6 Web analytics 2.0 framework

Unit-2 Qualitative Analysis
2.1 Heuristic evaluations:
2.1.1Conducting a heuristic evaluation
2.1.2. Benefits of heuristic evaluations
2.2 Site Visits:
2.2.1. Conducting a site visit,
2.2.2. Benefits of site visits
2.3 Surveys:
2.3.1. Website surveys
2.3.2. Post-visit surveys
2.3.3. creating and running a survey
2.3.4. Benefits of surveys.

Unit-3 Web Metrics
3.1 Key metrics
3.2 Dashboard
3.2.1. Implementation
3.2.2. metrics
3.2.3. Types of metrics
3.3 Conversion
3.3.1. goals,
3.3.2. funnels
3.4 Data sources
3.4.1. server log
3.4.2. visitors data
3.4.3. search engine statistics and conversion funnels
3.5 Data segmentation
3.6 Analysis
3.7 Emerging analytics
3.7.1. e commerce
3.7.2. mobile analytics
3.7.3. A/B testing
3.8 Social Media Analytics
3.8.1. Sentimental Analysis

3.8.2. Text Analysis
3.9 Annotation and Reporting
3.9.1. Automated
3.9.2. Actionable

Unit-4 Web Analytics

4.1 Introduction to analytic 2.0
4.2 Competitive intelligence analysis
4.3 CI data sources:
4.3.1. Toolbar data
4.3.2. Panel data
4.3.3. ISP data
4.3.4. Search engine data
4.3.5. Hybrid data
4.4 Website traffic analysis:
4.4.1. Comparing long term traffic trends
4.4.2 Analyzing competitive site overlap and opportunities.

Unit-5 Google Analytics:

5.1 Audience analysis
5.2 Acquisition analysis
5.3 Behaviour analysis
5.4 Conversion analysis
5.5 Google website optimizer
5.6 Implementation technology
5.7 Privacy issues

References:

1) Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc.2nd ed.
2) Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed.
3) Kaushik A., Web Analytics: An Hour a Day, 1st ed.
4) Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons

Course Code: **CS LAB-V** | **LAB on Web Application Development Technology** | *Total Marks:* **100**

Course Objectives:

i. Students will understand the working of Internet, Types of Web Sites/applications, basics of Web hosting and working of IIS web server.
ii. Students will get practical hands-on experience on Microsoft ASP.NET Web Application Development Technology and required Programming Language (C#.Net/VB.NET)
iii. Basic hands on the C#.Net/VB.NET programming language.
iv. Students will practically understand actual working of the theoretical concepts.
v. Students

vi. Students will undertake Project Work and its Demonstration in Viva-voce.

1. Demonstrate followings in IIS:
   a. Creation of Virtual Directory, Home directory, Home page, hosting of website
2. Demonstrate Page Life Cycle of ASP.NET. Use important page events for your demonstration.
3. Write VB.Net/C# console applications to demonstrate: OO concepts: polymorphism, encapsulation, inheritance, interface inheritance, abstract classes/methods, overloading, overriding, collection classes, properties
4. Demonstrate concept of postback and viewstate using web form server controls of ASP.NET
5. Demonstrate various Web form server controls using sample data entry screen form for registering for a service on website. Also use validation controls to validate input data.
6. Demonstrate DropDown List box, CheckButtonList, RadioButtonList controls.
7. Demonstrate Databinding using Hashtable, ArraryList, DataTable data sources.
8. Demonstrate Repeater control with the help of various templates.
9. Demonstrate paging, sorting, filtering of data in asp:DataGrid/DataGridView.
10. Demonstrate editing process in DataGrid and DataList controls. Make use of necessary templates for proper visual appearance.
11. Demonstrate State Management features of ASP.NET using sample shopping cart application.
12. Create sample website for demonstrating use of Profiles/Themes using skin files.
13. Demonstrate Master Pages and website navigation controls(sitemap path, treeview, menu) using SiteMap file.
14. Demonstrate Properties of website navigation controls.
15. Demonstrate Authorization/Authentication using Login controls and Roles/Membership/AccessRules
16. Demonstrate creation of simple/complex DataReader/DataSet Objects.
17. Demosntrate editing in DataTable objects.
18. Demonstrate Web Service hosting, access in ASP.NET

Course Outcome:

i. Students will get hands-on experience on basic concepts in web applications development using ASP.NET technology.
ii. Students can develop or undertake professional looking real life web sites using ASP.Net technology.
iii. It will help students to grasp other Web Application Development technologies/platforms easily through learn-by-comparison approach so that the learning curve will be smooth and faster.

Course Code: **CS LAB-VI** **LAB on Digital Image Processing** *Total Marks:* **100**

Course Objectives:

1. The student will gain a deeper knowledge about a chosen field of computer graphics and image processing while working on one of the more complex projects solved in the Laboratory.
2. To implement line, circle and ellipse drawing algorithms and 2 and 3-dimensional geometric transformations using C++.
3. To be able to design and develop the programs for viewing and clipping on graphical objects.
4. To introduce MATLAB to implement the complex algorithms of Digital Image Processing.
5. Provide hands-on experience to process digital images and expose students to MATLAB Image Processing Toolbox for Digital Image Enhancement, Restoration, Segmentation, Color Image Processing, and Morphological Image Processing.

1. Introduction to Image Processing Toolbox
2. Read an 8 bit image and then apply different image enhancement techniques:
   - Brightness improvement
   - Brightness reduction
   - Thresholding
   - Negative of an image
   - Log transformation
   - Power Law transformation.
3. Implement different interpolation techniques using MATLAB/ SciLab
4. Read an image, plot its histogram then do histogram equalization. Comment about the result.
5. Read an image and apply
   - Implement Gray level slicing (intensity level slicing) in to read cameraman image.
   - Read an 8 bit image and to see the effect of each bit on the image.
   - Read an image and to extract 8 different planes i.e. ‘bit plane slicing.”
6. Implement various Smoothing spatial filter.
7. Read an image and apply
   - Gaussian 3x3 mask for burring
   - High pass filter mask with different masks
   - Laplacian operator with centre value positive and negative
   - High boost filtering.
8. Write a program to implement various low pass filters and high pass filter in frequency domain.
9. Write a program for erosion and dilation, opening & closing using inbuilt and without inbuilt function.
10. Implement and study the effect of Different Mask (Sobel, Prewitt and Roberts)
11. Implement various noise models and their Histogram
12. Implement inverse filter and wiener filter over image and comment on them

Course Outcome:

1. Developed scientific and strategic approach to solve complex problems Computer in the domain of Computer Graphics and Digital Image Processing using C++ and MATLAB respectively.
2. Implemented various algorithms for scan conversion and filling of basic primitives objects and their comparative analysis and applied 2-D and 3-D geometric transformations, viewing and clipping on graphical objects.
3. Exposed students to MATLAB and Image Processing Toolbox.
4. Used various tools in MATLAB to implemented image transformation, image enhancement in spatial and frequency domain.
5. Developed the programs on various digital image processing techniques.

Semester-IV

Course Code: **CS-401** **Natural Language Processing** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:

i. The prime objective of this course is to introduce the students to the field of Language Computing and its applications ranging from classical to modern context.
ii. Course also aims to provide understanding of various NLP tasks and NLP abstractions such as Morphological analysis, POS tagging, concept of syntactic parsing, semantic analysis etc.
iii. Course provide knowledge of different approaches/algorithms for carrying out NLP tasks.
iv. Course also discusses concepts of Language grammar and grammar representation in Computational Linguistics.

Unit-I **[08]** Max Marks:**12**

Introduction to NLP, brief history, NLP applications: Speech to Text(STT), Text to Speech(TTS), Story Understanding, NL Generation, QA system, Machine Translation, Text Summarization, Text classification, Sentiment Analysis, Grammar/Spell Checkers etc., challenges/Open Problems, NLP abstraction levels, Natural Language (NL) Characteristics and NL computing approaches/techniques and steps, NL tasks: Segmentation, Chunking, tagging, NER, Parsing, Word Sense Disambiguation, NL Generation, **Web 2.0 Applications** : Sentiment Analysis; Text Entailment; Cross Lingual Information Retrieval (CLIR).

Unit-II **[12]** Max Marks:**16**

Text Processing Challenges, Overview of Language Scripts and their representation on Machines using Character Sets, Language, Corpus and Application Dependence issues, Segmentation: word level (Tokenization), Sentence level. Regular Expression and Automata
Morphology, Types, Survey of English and Indian Languages Morphology, Morphological parsing FSA and FST, Porter stemmer, Rule based, and Paradigm based Morphology, Human Morphological Processing, Machine Learning approaches

Unit-III **[12]** Max Marks:**18**

Word Classes ad Part-of-Speech tagging (POS), survey of POS tagsets, Rule based approaches (ENGTOWL), Stochastic approaches(Probabilistic, N-gram and HMM), TBL morphology, unknown word handling, evaluation metrics: Precision/Recall/F-measure, error analysis

Unit-IV **[15]** Max Marks:**22**

NL parsing basics, approaches: Top Down, Bottom Up, Overview of Grammar Formalisms: constituency and dependency school, Grammar notations CFG, LFG, PCFG, LTAG, Feature-Unification, overview of English CFG, Indian Language Parsing in Paninian Karaka Theory, CFG parsing using Earley's and CYK algorithms, Probabilistic parsing

Unit-V **[15]** Max Marks:**22**

Concepts and issues in NL, Theories and approaches for Semantic Analysis, Meaning Representation, word similarity, Lexical Semantics, word senses and relationships, WordNet (English and IndoWordnet), Word Sense Disambiguation: Lesk Algorithm Walker's algorithm, Coreferences Resolution: Anaphora, Cataphora

References:

1. Indurkhya, N., & Damerau, F. J. (Eds.). (2010). *Handbook of Natural Language Processing, 2nd Edition.* New York: CRC Press Taylor and Francis Group, Boca Raton London, New York. ISBN-10: 1420085921, ISBN-13: 978-1420085921
2. Martin, J. H., & Jurafsky, D.(2013), *Speech and Language Processing,* Pearson Education India; 2 edition, ISBN-10: 9332518416, ISBN-13: 978-9332518414
3. Manning, Christopher and Heinrich, Schutze(1999), Foundations of Statistical Natural Language Processing", MIT Press, ISBN-10: 0262133601, ISBN-13: 978-0262133609.
4. Akshar Bharati, Chaitanya, V., Kulkarni, A., & Sangal, R. (July 1997). *Machine translation in Stages* (Vol. 10 no. 3). Mumbai: NCST, Mumbai.
5. Bharati, A., Chaitanya, V., & Sangal, R. (1995). *Natural Language Processing: A Paninian Perspective,* New Delhi: Prentice Hall of India, ISBN 10: 8120309219, ISBN 13: 9788120309210.
6. Steven Bird, Edward Loper (2016),Natural Language Processing With Python, Ed. 2, O'Reilly Media,ISBN 1491913428, 9781491913420

Auxiliary Resources:

a. Web Links
   1. https://see.stanford.edu/Course/CS224N
   2. https://web.stanford.edu/~jurafsky/NLPCourseraSlides.html

b. Video Links
   1. http://www.nptelvideos.in/2012/11/natural-language-processing.html
   2. https://www.youtube.com/playlist?list=PL6397E4B26D00A269

Course Outcome:

i. Students will get idea about know-hows, issues and challenge in Natural Language Processing and NLP applications and their relevance in the classical and modern context.

ii. Student will get understanding of Computational techniques and approaches for solving NLP problems and develop modules for NLP tasks and tools such as Morph Analyzer, POS tagger, Chunker, Parser, WSD tool etc.

iii. Students will also be introduced to various grammar formalisms, which they can apply in different fields of study.

iv. Students can take up project work or work in R&D firms working in NLP and its allied areas

Course Code: **CS-402**	**Data Warehousing and Data Mining (DWDM)**	*Clock Hours:* **60** *Total Marks:* **100**

Course Objectives:

1. To comprehend evolution of decision making, operational vs decision support system and the concept of data warehouse.
2. To understand transactional and analytical processing
3. Significance of analytical processing and importance of data pre-processing.
4. Learn various data pre-processing techniques, methods.
5. Understand and apply various techniques/algorithms to obtain meaningful patterns from data (Association mining, classification and clustering)

Unit-I **[08]** Max Marks:**12**

Introduction to Data Warehousing: Evolution of decision system, Failure of past decision support system, Operational v/s decision support systems, Data warehousing lifecycle, Architecture, Building blocks, Components of DW, Data Marts and Metadata

Unit-II **[08]** Max Marks:**12**

Data Pre-processing: need for pre-processing of the data, Descriptive data summarization, Data cleaning, Data Integration and transformation, Data reduction, Data discretization and concept hierarchy generation.

Unit-III **[10]** Max Marks:**15**

OLAP Analytical Processing: OLAP in Data warehouse, Demand for online analytical processing, need for multidimensional analysis, limitations of other analysis methods, OLAP definitions and rules, OLAP characteristics, major features and functions, OLAP models-ROLAP, MOLAP, HOLAP, Differentiation, Data cubes and operations on cubes.

Unit-IV **[06]** Max Marks:**09**

Data Mining: Introduction-Data Mining functionalities, Classification of Data Mining Systems, basic Data Mining task, Data Mining Issues

Unit-V **[08]** Max Marks:**12**

Association Rule Mining: Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.

Unit-VI **[10]** Max Marks:**15**

Classification and Prediction : Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.

Unit-VII **[10]** Max Marks:**15**

Cluster Analysis : Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis

References:

1. Jiawei Han and MichelineKamber "Data Mining Concepts and Techniques" Second Edition, Elsevier, Reprinted 2008.
2. M. H. Dunham. Data Mining: Introductory and Advanced Topics. Pearson Education. 2001.
3. H. Witten and E. Frank. Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann. 2000.
4. D. Hand, H. Mannila and P. Smyth. Principles of Data Mining. Prentice-Hall. 2001
5. Tan Steinbach, Vipin Kumar, Introduction to Data mining, Pearson Eduction
6. Jarke Vassiliou, Fundamentals of Data Warehouses, IInd Edition, Springer
7. Anahory Murray, Data Warehousing in Real World, Pearson Education
8. Paulraj Ponniah , Data Warehousing.

Course Outcomes:

After this course students shall be able to –

1. Explain organization of data warehousing and data marts.
2. Differentiate between OLTAP and OLAP
3. Apply data pre-processing techniques
4. Write basic algorithms for extracting patterns from data (association mining, classification and clustering)
5. Solve problems related with various aspects of data mining.

*Course Code:***CS-403(A)** **Optimization Algorithms** *Clock Hours:***60**
Total Marks: **90**

Course Objectives:

1. To introduce with the branch of OR and its role in decision making.
2. To list out various types of applications of operations research (OR).
3. To explain Linear Programming Problem (LPP) and practice with techniques to solve various types of LPP (transportation problem, assignment problems, special cases of duality, Integer programming problems)
4. Describe the significance, concept of game theory and algorithms to solve game theory problems.
5. Introduce critical path analysis using network problems.

Unit-I **[05]** Max Marks:**08**
Overview of operations Research: Introduction, Applications, Role of OR in Decision Making, Feasible and optimal Solutions

Unit-II **[15]** Max Marks:**20**
Linear Programming: Special Types: Transportation Problem as LPP, Initial Basic Feasible Solution, North West corner Rule, Lowest Cost Method, Vogel's Approximation Method, MoDi method for optimization, Degeneracy.
Assignment problem, Hungarian Method, Special cases of assignment problem

Unit-III **[18]** Max Marks:**24**
Linear Programming Problems: Introduction, Formulation of Mathematical model of LPP, Standard form of linear programming problems, Solving LPP using Graphical method, Infeasible LPP, Unbounded LPP, Basic feasible solutions, Simplex method for solving LPP, augmentation using Slack and artificial variables, Big M and two phase method, Degeneracy, alternative optima, Interpretation of final Simplex table, Duality: concept, applications and example.

Unit-IV **[06]** Max Marks:**08**
Integer Programming: Introduction, How it differs from LPP, Pure and mixed integer programming problems, Binary IPP, Techniques to solve IPP.

Unit-V **[08]** Max Marks:**15**
Network Models: Definitions, Applications, Representation of a problem in network form, Critical Path Analysis, Resource planning, Giantt Chart.

Unit-VI **[08]** Max Marks:**15**
Game Theory : Concept, Two party zero sum game, Pay off matrix, Pure and mixed strategy games, Rule of Dominance, Subgame method, Brown's Algorithm

References:

1. Hamdy Taha (2010). Operations Research: An Introduction. Pearson Education. ISBN: 978-0132555937
2. L C Jhamb. Quantitative Techniques For Managerial Decisions Vol I, Vol II. Everest Publishing House, ISBN: 8186314628
3. PanneerSelvan R (2006). Operations Research. Prentice Hall of India. ISBN: 978-8120329287

Course Outcome:

After completion of this course students shall be able to-

1. write about OR and decision making.
2. Differentiate between feasible and optimal solution
3. Apply solving techniques to all types of LPP.
4. Apply solving techniques to network problems and game theory problems as well.

Course Code: **CS-403(B)** **Machine Learning** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:

- To introduce students to the basic concepts and techniques of Machine Learning.
- To have a thorough understanding of the Supervised and Unsupervised learning techniques
- To understand regression, classification and clustering
- To study the various probability based learning techniques
- To understand graphical models of machine learning algorithms

Unit-I **[08]** Max Marks:**10**
Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation

Unit-II **[08]** Max Marks:**15**
Linear regression, Decision trees, overfitting

Unit-III **[09]** Max Marks:**15**
Instance based learning, Feature reduction, Collaborative filtering based recommendation

Unit-IV **[08]** Max Marks:**15**
Probability and Bayes learning

Unit-V **[09]** Max Marks:**15**
Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM

Unit-VI **[09]** Max Marks:**15**
Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network

Unit-VII **[09]** Max Marks**:15**
Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model

References:

1. Tom Mitchell (1997). Machine Learning. First Edition, McGraw- Hill, ISBN 10: 0070428077 ISBN 13: 9780070428072
2. Ethem Alpaydin (2009). Introduction to Machine Learning, Edition 2, The MIT Press. ISBN 978-0-262-01243-0

Course Code: **CS-403(C)** **Advance Network Programming** *Clock Hours:* **60**
Total Marks: **100**

Course Objectives:
• To introduce students to the basic concepts and techniques of Machine Learning.
• To have a thorough understanding of the Supervised and Unsupervised learning techniques
• To understand regression, classification and clustering
• To study the various probability based learning techniques
• To understand graphical models of machine learning algorithms

Unit-1. Network fundamentals
Project model IEEE 802, Network topologies Network infrastructure, Network Protocols UDP, TCP, Introduction to TCP/IP Architecture of the TCP/IP model.
Unit-2. Client server Programming and Application
The client server model and software design, the socket interface, concurrent processing in clientserver software, program interface to protocol algorithms & issues in client Software design, example client software, algorithms & issues in server software design Iterative connectionless server, iterative connection oriented server, single process Concurrent server concurrent connection oriented server, multiprotocol server , multi-service server concurrency in client external data representation remote procedure call concept,RPCgenconcept.
Unit-3. Network Interface Layer
Overview of network interface layer media access control standards, mapping the Physical address to the IP address. Internet Layer: Purpose of the internet layer, classes of lpv4 addresses, basics of routing, IP datagram ICMP, IGMP Transport Layer Types of data transfer connection-less data transfer, connection-oriented data transfer
Unit-4. Mobile Ad-Hoc Network
Overview of Wireless Ad-Hoc Network- MANET and WSN, Routing in Ad-Hoc Network, Routing Protocols for Ad-Hoc Wireless Network (Proactive, Reactive and Hybrid) Clustering Protocol

References:

1) Douglas E. Corner, David Stevens, “Intranetworking with TCP/IP volume III Client Server Programming and Applications”, 2nd Edition, 1994, ISBN: 8178084880, Prentice Hallof India.
2) Douglas E. Corner,David Stevens, “Internetworking with TCP/IP volume I, Principles protocols & Architecture”, 3rd Edition, 2015, ISBN: 8131706230, PHI.
3) Douglas E. Corner, David Stevens,”Internetworking with TCP/IP volume II Design Implementation and internals”, 3rd Edition, 2003, ISBN: 8120309278, Prentice Hall India Learning Private Limited.
4) TCP/IP Bible, 1st Ed., Scringer LaSalle, Parihar Gupta, Hungry Minds IDG Looks India (P) Ltd.
5) SudipMisra, Isaac Woungang, “Guide to Ad-hoc Network”, 2009, ISBN: 9781848003286, Springer.

Course Code: **CS LAB-VII** **LAB Data Warehousing and Data Mining(DWDM)** *Total Marks:* **100**

Course Objectives:

- To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse.

DWDM Assignments:
WEKA : Data processing in WEKA
Classification algorithms: decision tree classification, naive Bayesian classification, a brief introduction to other classifiers
Clustering algorithms: methods to cluster continuous data, methods to cluster categorical data
Association Mining: Apriori algorithm
Course Outcomes:

- Organize strategic data in an enterprise and build a data Warehouse.

Course Code: **CS-401** **Mini Project Guidelines** *Total Marks:* **200**
Course Objectives:

- To provide comprehensive learning platform to students where they can enhance their employ ability skills and become job ready along with real corporate exposure.
- To enhance students' knowledge in one technology.
- To increase self-confidence of students and helps in finding their own proficiency.
- To cultivate student's leadership ability and responsibility to perform or execute the given task.
- To provide learners hands on practice within a real job situation.

Six credits shall be awarded to the Mini Project course, which will commence in the IV^{th} Semester and the final work and report will be completed at the end of IV^{th} Semester of M. Sc. (Computer Science). The student is expected to work on software development project. The project work should have coding part. Student will have to submit the bound project report in university prescribed format at the end of the semester. Student will have to appear for Project Viva-voce and the marks and the credits will be allotted at the end of IV^{th} semester of M. Sc. (Computer Science).
Course Outcomes:

- Capability to acquire and apply fundamental principles of Computers Science.
- Become master in one's specialized technology.
- Become updated with all the latest changes in technological world.
- Ability to communicate efficiently.
- Knack to be a multi-skilled Computer Science professional with good technical knowledge, management, leadership and entrepreneurship skills.

- Ability to identify, formulate and model problems and find engineering solution based on a systems approach.
- Capability and enthusiasm for self-improvement through continuous professional development and life-long learning

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

||अंतरी पेटवू ज्ञानज्योत||

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS

for

Master of Science (M. Sc.)

Biotechnology

Choice Based Credit System

(Outcome Based Curriculum)

For

Affiliated Colleges of
Kavayitri Bahinabai Chaudhari North Maharashtra University
Jalgaon 425 001 (MS)

2021 - 2022

Program at a Glance

Name of the program (Degree)	**:**	*M. Sc.*
Subject	**:**	*Biotechnology*
Faculty	**:**	*Science and Technology*
Duration of the Program	**:**	*Two years (four semesters)*
Medium of Instruction and Examination	**:**	*English*
Credits of the program	**:**	*Total 88 credits (64 core credits including 4 credits of project/dissertation, skill enhancement- 08, subject elective credits 08 and audit 08 credits*
Examination Pattern	**:**	*The 60 : 40 (60 marks University assessment (exam) and 40 marks continuous internal college assessment (exam)*
Evaluation mode	**:**	*CGPA*
Passing standards	**:**	*The 40% in each exam separately (separate head of passing)*
Result	**:**	*As per the University's rules of CGPA system*

Prologue

The requirement for trained and skilled human resource is the need of time in the higher education and industry to match with rapid pace of technology development. Students need to acquire thorough knowledge of theoretical concepts and hands-on laboratory methods in the subject. Thus, it is imperative to revise and update the curriculum to accommodate the fundamental aspects as well as advanced developments in various disciplines of ***Biotechnology*** *and to complement the needs of its applied sectors. The program is designed to provide skilled manpower in this subject, facilitate to improve linkages with industries, and intended to offer practical skills needed to pursue the jobs in a chosen profession. Beside this, the students will be enlightened with knowledge in the newer areas of Bioinformatics, Bioinstrumentations, Biomolecules, Genetics, Immunology, etc.. Students are taught how to plan experiments, perform them carefully, analyse* *the data accurately, and present the results both, qualitatively and quantitatively through their dissertations or the project work. The students are encouraged to deliver seminars on the topics of research to develop presentation skills and enable to build confidence which will lead them to read about different themes and enhances their assimilation abilities. A project component in the final semester will enable students to select a research problem, plan to execute experiments related to it, collect data and analyse it, and present the results in the form of an oral presentation as well as a thesis. This not only equips the student for a career in research as well as industry, but also fosters self- confidence and self-reliance in the student as he/she learns to work and think independently. At the end of the programme the student will be well-versed in this subject as well as be familiar with the most recent advances in the field of Life Sciences, and will have gained hands-on experience in this subject of study. The student will be able to take up a suitable position in academia or industry and will be equipped to pursue a career in research or be an entrepreneur, if so desired.*

Process of Curriculum Design

The Choice-Based Credit System (CBCS) provides a framework within which there is flexibility in the design of courses and their content, simultaneously also providing the student a choice of the courses he/she wishes to study. The courses are assigned credits based on teaching hours, which in turn is linked to course content and structure. When revising the syllabi for the courses, the courses to be implemented as well as the content of each course was extensively discussed and debated on, over meetings between the faculty members and the students. Several alumni contributed to useful inputs. Furthermore, the opinions of prospective employers of the corporate sector were also sought and obtained. The opinions of experts were taken into consideration as well. The syllabi presented here are the culmination of the combined efforts of the faculty members, feedback obtained from students, alumni, external experts and members of industry.

The student will acquire knowledge about different branches of Biotechnology such as Genetic Engineering, plant biotechnology, and Microbial Diversity, Molecular Biology, Pharmaceutical Biotechnology and familiar with various applications of Biotechnology such as Applied and Environmental Biotechnology, Industrial Biotechnology, Agricultural Biotechnology and Food Biotechnology . The student can design and execute experiments related to Basic Biotechnology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics and can execute a *short research project incorporating techniques of Basic and Advanced Biotechnology under supervision.*

Program Objectives for M.Sc. Program:

1. *To impart the profound theoretical and practical knowledge of the specific science discipline along with the fundamental core concepts*
2. *To train the students to employ modern techniques, tools, methodologies, equipment, hardware/software etc. to perform objective oriented scientific and planned experiments.*
3. *To groom the students for all-round development and mold them in a trained workforce to provide teaching-learning, research, business, professional supports in the various science disciplines.*
4. *To make the student to develop the ability to think analytically, independently and draw logical conclusions to solve real-life problems.*
5. *To utilize the skills and knowledge gained through the subject to deal with real life situations and problems related to society, environment, research and development etc.*

Structure of M.Sc. program in Biotechnology

M.Sc. Biotechnology program is of two years duration and is conducted into four semesters. Since inception, the program was mostly student centric. Now in lieu of accreditation standards of NAAC, the university adopted outcome-based education approach. The various courses of the program are designed to include classroom teaching, laboratory work, project, seminars, assignments, etc. Three categories of courses are being offered in this program: (A) Prerequisites and Core courses (12 theory and 8 practical's of 4 credit each as mandatory courses), (B) Skill Based/ Subject Elective courses (04 courses of 4 credits each) and (C) Audit courses (4 Courses of 2 credits each). The core courses of 4 credits include theory as well as practical. The core courses embody a research-based course that leads to a project dissertation. The student is required to accumulate 22 credits each semester, a total of 88 credits, to fulfil the requirements for a M.Sc. degree. Forty percent of the total marks for each course will be awarded through internal assessment. Final examinations for four credit courses will be of three hours duration while *examinations for each laboratory- based courses will be held over two days of three hours (incubation based practicals) each or one day of 5-6 hours each. However, there could be certain changes in the number of classes of theory and practicals, ways of teaching either through online or offline mode and even the examination pattern owing to the prevailing situation like pandemic and as per the need by following the rules and regulations.*

Duration

The duration of M.Sc. degree program shall consist of two academic years divided in to four semesters. Each Semester consist of 90 working days. Each theory and practical course should be completed in about 50 lectures.

Medium of instruction

The medium of instruction and examination for each course shall be English.

Credit to contact hour

One credit is equivalent to 15 periods of 60 minutes each for theory course lecture. While credit weightage for self-learning based on e-content shall be 50% or less than that for lectures.

Attendance

The student enrolled for M.Sc. biotechnology must have 75% attendance in each course in order to appear for term end examinations, otherwise the candidate may not be allowed to appear for term end examination as per ordinance.

Examination

Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination. Separate head of passing in Internal and External examination is mandatory. In case of failure in internal examination of particular course, student will have to appear for the same in next semester as per the schedule of the examination. In case a student fails in particular course in a semester and the same course(s) are revised/removed from curriculum in due course, the student will have to appear as per new curriculum and or pattern in subsequent semester at his own responsibility observing the course equivalence..

Term end examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each).

Internal examination (40 marks each semester)

Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions. Two internal tests (20 marks each) will be conducted during semester as a part of continuous assessment.

Practical Examination

Practical examination shall be conducted at the end of the semester. Practical examination will be of minimum 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am - 1pm/ 2 – 5 pm for 2 consecutive days) in case of Biotechnology practicals where incubation condition, allied aspects are essential. There shall be 5 marks for laboratory record book and well written certified journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination.

Summary of Distribution of Credits under CBCS Scheme for M.Sc. at Affiliated Colleges [w.e.f. 2021-22]

Sr. No	***Type of course***	***Sem I***	***Sem II***	***Sem III***	***Sem IV***
01	*Core*	***16***	***16***	***16***	***12***
02	*Skill based*	***04***	***04***	***-***	***-***
03	*Elective*	***-***	***-***	***04***	***04***
04	*Project*	***-***	***-***	***-***	***04***
05	*Audit*	***02***	***02***	***02***	***02***
06	*Total Credits*	***22***	***22***	***22***	***22***

Subject Type	***Core***	***Skill based***	***Elective***	***Project***	***Audit***	***Total***
Credits	***60***	***08***	***08***	***04***	***08***	***88***

Total Credits = 88

Affiliated Colleges of
Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon
M. Sc. Biotechnology

Choice Based Credit System with effect from 2021 -2022

Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Pract.)	Total Credits	
I	4	12 + 4	**16**	1	0 +4	4	1	2	2	**22**
II	4	12 + 4	**16**	1	0 + 4	4	1	2	2	**22**
III	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
IV	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
Total Credits	**64**			**16**			**8**			**88**

(T, Theory; P, Practical)

Structure of Curriculum

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
(A)	**Prerequisite and Core Courses**									
	Theory	4	3	4	3	4	2	4	2	40
	Practical	4	1	4	1	4	2	4	2	24
(B)	**Skill Based/ Subject Elective Courses**									
1	Theory /Practical	4	1	4	1	4	1	4	1	16
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course			2	1					2
3	Technology Related + Value Added Course					2	1			2
4	Professional and Social + Value Added Course							2	1	2
	Total Credit Value	14	6	14	6	14	6	14	6	88

List of Audit Courses (Select any ONE course of Choice from Semester II)

Semester I (Compulsory)		**Semester II** (Choose One) **Personality and Cultural Development**	
Course Code	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills
		AC-201B	Sport Activities
		AC-201C	Yoga
		AC-201D	Music

Distribution of Course papers for M. Sc. Part I BIOTECHNOLOGY

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BT-101	Core	Microbial Diversity and Physiology	4	--	4	40	--	60	--	4
BT-102	Core	Biomolecules and Molecular Enzymology	4	--	4	40	--	60	--	4
BT-103	Core	Immunology	4	-	4	40	--	60	--	4
BT-104	Core	Laboratory course-I	--	4+4	8	--	40	--	60	4
BT-105	Skill Based	Laboratory Course –II	--	4+4	8	--	40	--	60	4
AC-101	Audit Course	Practicing Cleanliness		2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit Course:2)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BT-201	Core	Molecular Biology	4	--	4	40	--	60	--	4
BT 202	Core	Bioinstrumentation and Biostatistics	4	--	4	40	--	60	--	4
BT-203	Core	Bioprocess Engineering and Technology	4	--	4	40	--	60	--	4
BT-204	Core	Laboratory Course –III	--	4+4	8	--	40	--	60	4
BT-205	Skill Based	Laboratory Course –IV	--	4+4	8	--	40	--	60	4
AC-201(A/B/C/D)	Audit Course	Choose one out of Four (AC-201A/ AC-201B/AC-201C/AC-201D) for Personality and Cultural Development	--	2	2	--	100	--	--	2
Total Credit for Semester II: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit course:2)										

EA: External Assessment, IA : Internal Assessment

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part I BIOTECHNOLOGY					
Semester I : Theory Courses					
BT-101	Microbial Diversity and Physiology	Core course	04	100	03
BT -102	Biomolecules and Molecular Enzymology	Core course	04	100	03
BT -103	Immunology	Core course	04	100	03
Semester I : Practical Courses					
BT -104	Laboratory Course-I	Core course	04+04	100	06
BT -105	Laboratory Course-II	Skill based	04+04	100	06
AC-101	Practicing Cleanliness	Audit Course	02	100	
Semester II : Theory Courses					
BT -201	Molecular Biology	Core course	04	100	03
BT-202	Bioinstrumentation and Biostatistics	Core course	04	100	03
BT -203	Bioprocess Engineering and Technology	Core course	04	100	03
Semester II : Practical Courses					
BT-204	Laboratory Course-III	Core course	04+04	100	06
BT-205	Laboratory Course-IV	Skill based	04+04	100	06
AC-201A/B/C/D	Choose one out of Four (AC-201A/ AC-201B/ AC-201C/ AC-201D) for Personality and Cultural Development (Audit Course)	Audit Course	02	100	

M.Sc. Biotechnology program objectives

After completion, the students are expected to understand the:

(a) basic and applied aspects of molecular biology and plant biotechnology, Biomolecules and Enzymology and applications of basic aspects of microbial diversity.

(b) principles, working and application of bioinstruments used in learning Biotechnology,

(d) characteristics and significance of algae, fungi, viruses,

(e) impact of various groups of microbes on earth atmosphere, human, plant and animal health and technology development,

(f) structure, properties, pathways, significance and applications of microbial biomolecules,

(g) basic and applied aspects of Genetic makeup of bacteria, algae, fungi and viruses,

(h) causes, mechanisms and consequences of defect in gene/genome of microorganisms, and

(i) basic concepts of microbial enzymes, enzyme kinetics, regulation of enzyme activity, industrial applications of enzymes, enzyme function in non-aqueous environment.

BT- 101 : MICROBIAL DIVERSITY AND PHYSIOLOGY

100 Marks [50 Hrs]

Course Objectives:

1. To understand the ubiquitous nature of microbes to build basic concept
2. To give basic knowledge on Prokaryotic and Eukaryotic
3. To provide knowledge on characteristics of various microbes

Course Outcomes: On completion of this course, the student will be able to:

1. differentiate various groups of microbes and microbial taxonomy
2. acquire knowledge on adaptability of extremophiles and microbial diversity
3. acquaint with the scope of microbiology in different diversified areas

UNIT I

Classification of microorganism: the five-kingdom concept of classification, Bacteria: Purple and green bacteria; Cyanobacteria; Acetic acid bacteria; Spirilla; Spirochaetes; Pseudomonads; Lactic and propionic acid bacteria; Mycobacteria; Rickettsia. Archaea: Chlamydias and Mycoplasmas, Archaea as earliest Life forms; Halophiles; Methanogens; Hyperthermophilic archaea; Thermoplasma. Eukarya: Algae, Fungi, Slime molds and Protozoa. Viruses: Bacterial, Plant, Animal and Tumor viruses; Discovery, classification and structure of viruses.

UNIT II

Prokaryotic and Eukaryotic cell structures; pure culture techniques- isolation, cultivation, enumeration and preservation of microbes; staining techniques- simple and differential staining. Nutritional requirements and nutritional grouping of microorganisms; Different media (simple, complex and defined)- Growth curve; Axenic culture, Synchronous culture, Continuous culture; Effects of physical and chemical factors on microbial growth.

UNIT III

Microbes in natural habitats - air, water & soil. Industrial application of microbes-Wine, Beer, Cheese, Yogurt. Primary and secondary metabolites and their applications; preservation of food; biogas; bio-fertilizers and bio-pesticides; leaching of ores by microorganisms; microorganisms and pollution control-bioremediation. Microbial ecology: Biogeochemical cycling, Microbes in marine & freshwater environments, Microbes in terrestrial environment, Microbial interactions.

UNIT - IV

Mechanisms involved in transport of nutrients in microbes, Unique pathways of microbial metabolism: ED, PK pathways; Respiration; Fermentations; Amphibolic pathways; Anaplerotic reactions. Bacterial cell wall biosynthesis, Photoautotrophy, Chemolithotrophy, Methylotrophy, Metabolic diversity among micro-organisms: Photosynthesis in microorganisms; Methanogenesis and acetogenesis; Nitrogen fixation; Hydrocarbon transformation

UNIT V

Phylogenetic relationships between various genera of microbes, Evolutionary chronometers, New approaches to bacterial taxonomy classification including ribotyping: ribosomal RNA sequencing, FISH assay, micrometry, capillary electrophoresis. Methods to assess microbial diversity, Merits and demerits of culture dependent and culture independent methods. Molecular analysis of bacterial community: Denaturing Gradient Gel Electrophoresis (DGGE), Metagenomics.

Recommended Books:

1. Microbiology, L.M. Prescott, J.P. Harley and D.A. Klein, 6/e, 2005. McGraw Hill, Boston.
2. Fundamental Principles of Bacteriology, A.J. Salle, 1999. Tata McGraw - Hill Publishing Co. Ltd, New Delhi.
3. Medical Microbiology, D. Greenwood, R. Slack & J. Peutherer, 1997. ELST with Chur. Liv., Hong Kong.
4. Microbial Ecology. Fundamentals and Applications, R. M. Atlas and R. Bartha, 2000.
5. Microbiology, M.J. Pelzer Jr., E.C.S. Chan and N.R. Kreig, 1993. McGraw Hill Inc., New York.
6. Microbial Functional Genomics, J.Zhou, D.K. Thomson. Y.Xu. J.M. Tiedje. J.Wiley, 2004.

BT-102: BIOMOLECULES AND MOLECULAR ENZYMOLOGY

100 Marks [50 Hrs]

Course Objectives:

1. To know the structural organization, characteristics and metabolism of biomolecules
2. To learn microbial metabolic pathways and its enzymatic regulation
3. To acquire knowledge on transport of solute and energy metabolism and to understand basic aspects of microbial enzyme

.

Course Outcomes:

On completion of this course, the student will be able to:

1. acquire knowledge on metabolism of biomolecules and to apply the knowledge to explore applications of various enzymes
2. familiar with amino acids, proteins, lipids, nucleic acids and enzymes and kinetics of enzyme

UNIT-I

Carbohydrates: Classification, structure, function and properties of sugars, storage polysaccharides and cell walls, Glycolysis, gluconeogenesis, HMP shunt and glycogen metabolism. Synthesis of cellulose and starch, Oxidative phosphorylation, Regulation of carbohydrate metabolism.

Lipids: Classification, nomenclature and structure of fatty acids, triacylglycerols, sphingolipids and phospholipids, waxes, glycolopids and sterols. Beta-oxidation of fatty acids, biosynthesis of fatty acids and triacylglycerols, Lipid proteins system, Regulation of lipid metabolism.

UNIT II

DNA: General structure and functions of purines, pyrimidines, nucleosides, nucleotides; hydrolysis of nucleic acids. Strategies of coiling and supercoiling, concept of linking number, twisting number and writhing number, Forms of DNA, The law of DNA constancy and C-value paradox.

Proteins: Classification, Primary, secondary, tertiary and quaternary structure of proteins, Sequencing, stabilizing bonds, Ramchandran Plot. Optical and chemical properties of peptides and small proteins. Hydrolysis of proteins.

UNIT III

Classification and nomenclature of enzymes, Isolation, purification and large-scale production of enzymes, Mechanism of enzyme action: concept of active site and energetic of enzyme substrate complex formation.

Coenzymes and Cofactors: Structure and function of coenzyme - reactions involving TPP, pyrodoxal phosphate, nicotinamide, flavin nucleotide, coenzyme A and biotin.

UNIT IV

Enzyme kinetics: Units of enzyme activity, Specific activity of enzyme and Methods of enzyme assay, Enzyme specificity. Unisubstrate enzyme kinetics; Kinetics of multisubstrate reactions, Significance of Vmax and Km. Steady state enzyme kinetics: Effect of substrate concentration on initial velocity, Henry, Michaels Menton hypothesis, L B plot, Briggs Haldane Hypothesis, Hill and Satchard plots.

UNIT-V

Allosteric enzymes; Sigmoidal kinetics and their physiological significance; Symmetric and sequential modes for action of allosteric enzymes and their significance, Multienzyme system. Enzyme inhibition: type of inhibition; Competitive, non-competitive and uncompetitive kinetics, Feedback inhibition and feed forward stimulation; Enzyme repression, induction and degradation.

The preparation of immobilised enzymes –rationale, choice of matrix, methods of immobilization kinetics and their uses, Whole cell immobilization, Immobilized enzymes and their industrial application, Enzyme engineering and its applications.

Recommended Books:

1. Lehninger's Principles of Biochemistry by Nelson DL and Cox MM, CBS Publications, 2000
2. Biochemistry by Stryer L. (4th Edition). W.H. Freeman & Co., New York, USA, 1992.
3. Fundamentals of Enzymology (3rd edition) by Price NC and Stevens L. Oxford University Press, NY, USA, 2000.
4. Harper's Biochemistry. Ed. Murray RK, Granner DK, Mayes PA and Rodwell VW. Appleton and Lange, Stamford, Connecticut.
5. Fundamentals of Biochemistry. Ed Voet & Voet JG. John Wiley & Sons, Inc., 1999
6. Molecular Biomethods Handbook, R.Rapley & J.M. Walker, 1998. Humana press.
7. Biochemistry 4th edition, G. Zubay, 1998. Mc Millan Publishing Co. New York.
8. Fundamentals of Enzymology : Nicholes C. Price and Lewis Stevens, Oxford Univ. Press.
9. Enzyme Structure and mechanism : Alan Fersht, Reading, USA.
10. Understanding Enzymes : Trevor Palmer

BT–103: IMMUNOLOGY

100 Marks [50 Hrs]

Course Objectives:

1. To understand various components of host immune system, its structure and function
2. To acquaint with operational mechanisms of the host defence system, allergy, GVR

Course Outcomes:

On completion of this course, the student will be able to:

1. understand fundamental basis of immune system and immune response
2. apply host defence, allergy, organ transplant and immunological diseases
3. use various immunochemical techniques for diagnosis of diseases.

UNIT I

Innate immune mechanisms and adaptive immune responses, Organs of immune system: Primary Lymphoid Organs, Secondary Lymphoid Organs, Cell of immune system: Hematopoiesis, Mononuclear cells and granulocyte, Antigen presenting cells lymphocytes and their subsets. Antigens, Super antigen, Heptanes, Factor affecting immunogenicity, Immunoglobulins: molecular structures, types and function, Antigenic determinants on immunoglobulins, Antigen-Antibody interactions

UNIT II

Major Histocompatibility systems: Structure of MHC I and II molecules, Gene Organization of MHC complex in mouse and humans. Recognition of antigens by T and B cells: Antigen processing, Role of MHC molecules in Antigen presentation and co stimulatory signals. T-Cell receptor complex, T- Cell accessory membrane molecules, activation of T –cells, B-cell receptor complex, activation of B-cells.

UNIT III

Complement System, components, Activation pathway and regulation of activation pathway, complement deficiency,

Inflammation: its mediators and the process, cell-adhesion molecules and their role in inflammation, lymphocyte homing.

Cytokines: Structure and functions, cytokine receptors, therapeutic applications of cytokines.

UNIT IV

Hypersensitivity: definition, IgE mediated hypersensitivity, mechanism of mast cell degranulation, mediators of type I reactions and consequences. Type II reactions, immune complex mediated hypersensitivity and delayed type hypersensitivity.

Immunodeficiency Syndrome: Primary Immunodeficiencies and Secondary Immunodeficiencies and their diagnosis and therapeutic approaches. Autoimmunity: Organ-specific diseases, systemic disease, mechanism of autoimmunity.

UNIT V

Immunodiagnostics: Precipitation techniques, Agglutination, Fluorescence Techniques, ELISA, RIA, Western Blotting, immunoelectrophoresis, Fluorescent activated cell sorter, immunoelectrofocusing, Monoclonal antibodies: production, characterization and application in diagnosis and therapy.

Recommended Books:

1. Immunology, Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby 5th Edition, 2003. W. H. Freeman & Company.
2. Immunology- A short Course, Eli Benamini, Richard Coico, Geoffrey Sunshine.
3. Immunology by Tizzard
4. Fundamentals of Immunology, William Paul.
5. Immunology, L.M. Roitt, J. Brestoff and D.K. Male
6. Immunology by Abbas.
7. Clinical parasitology a practical approach by Zubey
8. Immunological techniques, D.M. Weir, 1992.
9. Current Protocols in Immunology 3 Volumes, Wiley Publications 1994.
10. Monoclonal Antibodies: Principles and Practice, J. W. Goding, 1983. Academic Press
11. Hybridoma Technology in the Biosciences and medicine, T.A. Springer, 1985. Plenum Press NY.
12. Vaccines, New Approaches to immunization, F.Brown, R.M.Chanock, KA Lerner, 1986. Cold spring Harborolab.
13. Topley and Wilson principles of bacteriology, Virology and immunology, G. Wilson, A.Miles, M.T.Paker, 1984. Arnold, Heineman.
14. Basic Immunology by Arun Ingale, NCBA Publication

BT-104 Laboratory Course – I

Marks 100

Course Objectives:

1. To familiarize the student in biochemical techniques and learn basic microbial biochemistry
3. To familiarize in General Microbiology techniques

Course Outcomes: On completion of this course, the student will be able to:

1. acquire expertise in basic biochemical techniques.
2. get knowledge in the analysis and estimation of biomolecules
3. develop expertise in basic analytical techniques of microbiology.

1. Isolation and maintenance of microorganism by plating, streaking and serial dilution method/ slants and sub culture for storage of microorganism.
2. Measurement of growth by colony forming unit and turbidometry.
3. Bacterial growth - Growth curve, factors affecting bacterial growth - pH, Temperature and Salinity/Biochemical tests for identification of bacteria.

4. Isolation of UV-mutant, isolation of antibiotic resistant strains and tryptophan mutant
5. Antimicrobial assay, phenol coefficient, agar plate sensitive method.
6. Analysis of water for potability and determination of MPN
7. Determination of viable count /Correlation of viable counting and optical density of cultures
8. Quantitative assay of protein by Lowry/ Biuret/ Bradford method.
9. Quantitative assay of sugar by DNSA/ Benedict reagent.
10. Determination of Acid Value of fats
11. Quantitative estimation of amino acids.
12. Estimation of DNA by DPA method
13. Estimation of RNA by Orcinol method

Recommended Books:

1. Practical Biochemistry: Principles and techniques (5th Edition) by K. Wilson and J. Walker.Cambridge University Press, Cambridge, 2000.
2. An Introduction to Practical Biochemistry by Plummer D. (3rd Edition) Tata MacGraw Hill Publisher, 2005.
3. Laboratory Manual in Biochemistry by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999.
4. Methods in Agricultural Biochemistry (2nd edition) by Sadashivam S and Manikam A. New Age International (P) Ltd, Publishers, New Delhi and Tamil Nadu Agricultural University, Coimbatore, 1996.
5. Microbiology – a Laboratory Manual (4th Edition) by Cappuccino JG and Sherman N. Addison Wesley, 1999.
6. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation (2nd edition) by Aneja KR. Wishwa Prakashan, New Age International Pvt Ltd., 1996.
7. Lab Exercise in Microbiology (3rd edition) by Harley JP and Prescott Lm. WCB/Mac Graw Hill, USA, 1996.
8. Laboratory techniques in Biochemistry and Molecular Biology, Work and Work.
9. A Biologists guide to Principles and Techniques of Practical Biochemistry by Wilson and Goulding
10. A Laboratory Manual in General Microbiology by Benson HJ. WCB Wm C, Brown Publishers.
11. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation (2nd edition) by Aneja KR. Wishwa Prakashan, New Age International Pvt Ltd., 1996.

BT-105 Laboratory Course - II

Marks 100

Course Objectives
1. To impart hands on training in enzyme kinetics and immunochemical techniques
2. To familiarize the student with basic immunology and immunodiagnostic tools

Course Outcomes: On completion of this course, the student will be able to:
1. undertake enzyme kinetics in industrial application
2. apply molecular diagnostic and immunodiagnostic techniques.

1. Blood Film Preparation and identification of cells.
2. Direct agglutination reaction: determination of human blood group antigens
3. Double diffusion/ Radial immunodiffusion.
4. Purification of IgG from serum.
5. Diagnosis assay for typhoid using Widal test
6. Preparation of antibody-enzyme conjugates.
7. ELISA / Western blotting.
8. Purification of H and O antigen from microorganism.
9. Rocket immunoelectrophoresis
10. Determination of specific activity, enzyme activity, Turn over number, Km and Vmax
11. Effect of pH and temperature on enzyme activity
12. Colorimetric determination of pk
13. Enzyme immobilization

Recommended Books

1. Immunological techniques, D.M. Weir, 1992.
2. Current Protocols in Immunology 3 Volumes, Wiley Publications 1994.
3. Monoclonal Antibodies: Principles and Practice, J. W. Goding, 1983. Academic Press
4. Vaccines, New Approaches to immunization, F.Brown, R.M.Chanock, KA Lerner, 1986. Cold spring Harborolab.
5. Topley and Wilson principles of bacteriology, Virology and immunology, G. Wilson, A.Miles, M.T.Paker, 1984. Arnold, Heineman.
6. Basic and Clinical Immunology, D.P. Stities and J.D. Stobo.
7. Practical Biochemistry: Principles and techniques (5th Edition) by K. Wilson and J. Walker.Cambridge University Press, Cambridge, 2000.
8. An Introduction to Practical Biochemistry by Plummer D. (3rd Edition) Tata MacGraw Hill Publisher, 2005.
9. Experimental Biochemistry: A Student Campanion by Rao BS and Deshpande V. I.K. International Pvt Ltd., New Delhi, 2005.
10. Laboratory Manual in Biochemistry by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999.

9. Experimental Biochemistry: A Student Campanion by Rao BS and Deshpande V. I.K. International Pvt Ltd., New Delhi, 2005.
10. Laboratory Manual in Biochemistry by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999.

M.Sc. Part I Semester I Audit Course(s)

AC-101: Practicing Cleanliness

(Compulsory; Campus-level Audit Course; Practical; 2 Credits)

Course Objectives (CObs):

- To make students aware of Clean India Mission, inculcate cleanliness practices and community health awareness.

- Awareness program on
  - Swachh Bharat Abhiyan (Clean India Mission)
  - Clean Campus Mission
  - Role of youth in Clean India Mission
  - Community health awareness
- Cleaning activities inside and surroundings of Department buildings.
- Tree plantation and further care of planted trees
- Waste (Liquid/Solid/e-waste) Management, Japanese 5-S practices
- Planning and execution of collection of Garbage from different sections of University campus
- Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance.
- Cleanest Department and Cleanest Hostel contests
- Painting and Essay writing competitions
- Community health awareness to keep communicable diseases away

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC101.1	Identify need at of cleanliness at home/office and other public places.	**2**
AC101.2	Plan and observe cleanliness programs at home and other places.	**4**
AC101.3	Practice Japanese 5-S practices in regular life.	**3**

Semester II

BT-201: MOLECULAR BIOLOGY

100 Marks [50 Hrs]

Course Objectives:

1. To extend the knowledge on structure and functions of genetic material
2. To introduce genome organization, transcription and translation process in Prokaryotes and Eukaryotes and study various tools to understand molecular mechanisms.

Course Outcomes:

On the completion of this course, the student will be able to:

1. receive elaborate knowledge on nucleic acids and molecular mechanisms in Prokaryotes and Eukaryotes
2. understand gene expressions and signal sequences in Prokaryotes and Eukaryotes

Unit I-

Concept of Gene, Nature of Gene, Gene cistron relationship in Prokaryotes and Eukaryotes, DNA Replication machinery in Prokaryotes and its comparison with Eukaryotes, Replication fork, fidelity of replication, Enzymes involved in replication: DNA Polymerase; Primases; Ligases; Helicases; Topoisomerases; Gyrases and Single Stranded Binding Proteins.

Molecular methods of DNA replication, Models of replication, theta mode of replication, rolling circle model of replication, unidirectional replication, Bi directional replication, replication of linear DNA. Regulation of DNA replication.

Unit II

Types of DNA damage: deamination, oxidative damage, alkylation, pyrimidine dimmers

DNA mutations: spontaneous and inducible and mutagenic agents

DNA repair pathways: methyl directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination, SOS system

Unit III

Transcription in prokaryotes: Initiation, elongation and termination, Transcription in Eukaryotes, Control of transcriptional termination: Attenuation and antitermination**,** Splicing of RNA, Response Elements, Post-transcriptional Modification

Unit IV

Protein synthesis and processing: Ribosome structure, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetases, formation of initiation complex, intiation factors and their regulation, elongation and elongation factors, termination, translational inhibitors.

Post- translational modification of proteins: Types and Significance, Protein targeting, Protein folding.

Unit V

Regulation of gene expression in prokaryotes: Operon concept, induction and repression, Structure and regulation of lactose, arabinose and tryptophan operons.

Regulation of gene expression in eukaryotes, Control of gene expression at transcription and translation level.

Recommended Books:

1. Genes IX Benjamin Lewin
2. Molecular Biology , turner et al
3. Cell and Molecular Biology: Concepts and Experiments, Gerald Karp
4. An Introduction to Genetic Analysis, Griffiths et al
5. Genome (1999), Brown
6. Concepts of Genetics, klug and Cummings
7. Proteins, Creighton
8. Molecular Cell Biology, Lodish et al
9. Biochemistry and Molecular Biology of Plants (2000), Buchanan
10. Molecular Biology of the Gene, by James D. Watson, Tania A. Baker, Stephen P. Bell, and
11. Alexander Gann (2007), Publisher: Benjamin Cummings; 6th edition

12. Fundamental Molecular Biology by Lizabeth A. Allison (2007), Publisher: Wiley-Blackwell; 1st edition
13. Molecular Biology by Robert F. Weaver (2007) Publisher: Mcgraw-Hill College; 4th edition
14. Cell and Molecular Biology: Concepts and Experiments by Gerald Karp (2007) Publisher: Wiley; 5th edition
15. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, and
16. Martin Raff Publisher: Garland Science; 5th edition,

BT-202: BIOINSTRUMENTATION AND BIOSTATISTICS

100 Marks [50 Hrs]

***Course Objectives*:**

1. To introduce the student to the variety of biophysical and biochemical techniques
2. To make them familiar with various approaches of analytical techniques and Biostatistics

***Course Outcomes*:**

On completion of this course, the student will be able to:

1. acquire knowledge on basic biophysical and biochemical aspects and Biostatistics
2. learn purification of molecules, analytical tools, electrophoretic separation
3. learn how to interpret protein mobility on PAGE under native and SDS

UNIT-I:

Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning and Transmission, Electron Microscopy, Confocal Microscopy, Cytophotometry and Flow Cytometry.
Principle and techniques: Preparative, Analytical Centrifuges, ultracentrifuges, Sedimentation analysis RCF and Density Gradient Centrifugation.

UNIT–II:

Chromatography Techniques: Theory and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GLC and HPLC. Basic principles of electrophoresis, Factors affecting separation, Theory and applications of: paper, starch, agarose and Polyacrylamide (native and denaturing) gel electrophoresis (PAGE) and 2DE

UNIT–III

Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, NMR, ESR, Atomic Absorption Spectroscopy, X-ray Diffraction, MS, MALDI-TOF, ORD and CD
Radioactivity: Radioisotopes, Radioactive Decay,GM Counter, Liquid Scintillation counter, Solid Scintillation counters, Auto radiography: Principle and applications.

Unit IV

Introduction to Biostatistics, Common terms, notions and applications, Statistical population and Sampling methods. Classification and tabulation of data diagrammatic and graphical presentation, Frequency distribution, Measures of central value, Measures of variability; Standard deviation, standard Error, Range, Mean Deviation, Coefficient of variation, Analysis of variance.

Unit V

Comparison of means: chi square test, students t test, ANOVA with interpretation of data-introduction to MANOVA- statistical tables and their use - significance test and fixing levels of significance-use of statistical software.
Regression: Basic of regression, regression coefficient, regression analysis: Estimation, testing,

prediction, checking and residual analysis. Design of Experiments, randomization, local control, complimentary Randomized, randomized block design.

RECOMMENDED BOOKS

1. Physical Biochemistry: Application to Biochemistry and Molecular Biology – Freilder.
2. Biochemical Technique : Theory and Practice , Robyt & White
3. Principle of Instrumental Analysis – Skoog & West
4. Principle & Technique – Practical Biochemistry 5th Ed. (2000) - Walker J. & Wilson K.
5. Biophysical Chemistry – Upadhyay & Nath.

BT-203 BIOPROCESS ENGINEERING AND TECHNOLOGY

Marks 100 [50 hrs]

***Course Objectives*:**

1. To develop skills to modify, design and operate different types of fermenters and attachments.
2. To understand and implement various fermentation procedures.
3. To train students in scale up fermentation operations.

***Course Outcomes*:**

Upon completion of the course, it is expected that students will be able to:

1. Describe the design and operation of various types of fermenters.
2. Elaborate the theoretical aspects and practical requirements for the growth of microorganisms in industries and R and D organizations.
3. Describe the theoretical basis of fermentation technology for industrial applications.
4. Understand and conduct fermentation process kinetics.

Unit I

Introduction to bioprocesses engineering. Sources of microorganisms: Culture collection centres. Enrichment, isolation, preservation and maintenance of industrial strains. Screening for the desired product: primary, secondary and High-throughput screening. Improvement of strain producing primary and secondary metabolites. Methods used in strain improvement: mutagenesis, protoplast fusion and genetic engineering. Production of recombinant molecules in heterologus system.

Unit II

Designing of stirred tank reactor: Ideal Properties of Bioreactor, Body Construction, Agitator, Types of impellors, Baffles foam separators, sparger, culture vessel, cooling and heating devices. Probes for on-line monitoring. Computer control of fermentation process, Neural network. Measurement and control of process parameters (pH, temperature, cell density, gas and liquid flow). Reactors for specialized applications: Packed bed reactors, Airlift bioreactors, Fluidized bed reactors and Trickle flow reactors.

Unit III

Growth kinetics: Batch, Fed-batch and Continuous culture. Media: Importance of media in fermentation, C and N substrates for industrial media, media formulation and modification. Sterilization of media, reactor and air: Factors affecting sterilization, Batch and Continuous sterilization, Del factor, D and Z value. Development of inoculum for bacterial, yeast and mycelial processes.

Unit IV

Fluid dynamics: Classification of fluids, Fluid flow and mixing, concept of Reynold's number, Rheological properties of fermentation process. Mass transfer of oxygen and heat in the bioreactor: Concept, significance and determination of mass transfer coefficient, factors affecting oxygen availability. Scale-up of the process.

Unit V

Downstream processing: Strategy for recovery, Harvesting of Biomass, Removal of microbial cells and solid matter, foam separation, filtration, centrifugation, cell disruption. Liquid liquid extraction: Solvents used, two-phase aqueous extraction, supercritical fluid extraction. Drying and crystallization. Bioprocess economics. Comparison between SSC and SLC, Factors affecting solid-state fermentations. Safety consideration in downstream processing.

Recommended Books:

1. Introduction to Industrial microbiology, Cruger-ACS Publication
2. Industrial microbiology- Casida- ACS Publication
3. Comprensive Biotechnology Vol III Mooyoung Elsevier Publication
4. Biochemical Engineering, Aiba *et al*
5. Biochemical Engineering Fundamentals, Baily and Ollis
6. Fermentation Biotechnology-Principles, Process and Products(1998), Ward,O.P
7. Process Engineering in Biotechnology, Jackson A.T.
8. Bioreaction Engineering Principles, Nielson & Villadson
9. Industrial Microbiology (1992)4th edition,Prescott & Dunn
10. Microbial Biotechnology (1998) Glazer & Nikaido
11. A Text Book of Industrial Microbiology,2nds edition (2002),Cruger and Cruger
12. Manual of Industrial Microbiology & Biotechnology 2nd edition (1999),

BT-204 Laboratory Course - III

1. Isolation of genomic DNA from bacteria, animal and plant cells. Marks 100
2. Restriction Digestion/Size fractionation of restricted DNA fragments by Agarose Gel

   Electrophoresis
3. Isolation of plasmid DNA by using alkaline lysis method.
4. Determination of Tm of nucleic acid/Quantitation of DNA
5. Isolation of RNA
6. Transformation of *E. coli*
7. Electrophoresis of proteins
8. Amino acid separations by paper chromatography
9. Separation of lipids by thin layer chromatography

10 Ion Exchange and gel filtration column chromatography

11 Separation of sub cellular organelles by differential centrifugation

12 Demonstration of LCMS, HPLC, GC, AAS

Recommended Books:

1. *Practical Biochemistry: Principles and techniques* (5th Edition) by K. Wilson and J. Walker. Cambridge University Press, Cambridge, 2000.
2. *An Introduction to Practical Biochemistry* by Plummer D. (3rd edition) Tata MacGraw Hill Publisher, 2005.
3. *Laboratory Manual in Biochemistry* by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999.
4. *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation* (2nd edition) by Aneja KR. Wishwa Prakashan, New Age International Pvt Ltd., 1996.
5. *Principles of Fermentation Technology* by Stanbury PF, Whitaker A and Hall SJ. Aditya Books (P) Ltd., New Delhi, 1997.
6. *Process Biotechnology: Fundamentals* (2nd Edition) by Mukhopadhyay SN, Viva Books Pvt Ltd., New Delhi, 2004.
7. *Biotechnology: Hand Book* by Board N. Asia Pacific Business Press Inc., New Delhi, 2005.
   Solid Substrate Cultivation edited by Doelle HW, Mitchell DA and Rolz CE. Elsevier Applied Science, London, 1992.

BT-205 Laboratory Course - IV

Marks 100

1. Isolation of actinomycetes, molds and yeasts by enrichment technique
2. Study of Growth Kinetics of Yeast by turbidometry
3. Screening and maintenance of industrially important microorganisms
4. Enrichment and isolation of mutants
5. Selection of mutants by gradient plate technique
6. Preparation of inoculum for mycelia cultures
7. Production of the enzyme/s in shake flask/ Batch fermentation in conical flask
8. Production of citric acid by fermentation of different carbon sources by *Aspergillus niger*
9. Alcohol fermentation using different substrates and its downstream process
10. Determination of TDP
11. Determination of TDT
12. Assay of antibiotic using sensitive bacterial strain
13. Data presentation (tables/figures): 1-D and 2-D bar charts, pie diagrams, graphs (using computer software packages)
14. Chi-squared test for goodness of fit

M.Sc. Part I Semester II : Audit Courses

	AC-201(A): Soft Skills **(Personality and Cultural Development Related Audit course; Practical; 2 Credits)** **(Optional: Campus-level)**	
	Course Objectives (CObs): • To inculcate different soft skills among students.	
Unit 1	**Introduction to soft skills** Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal setting, life skills, Need for soft skills, Communication skills, Etiquettes& Mannerism.	**2 hrs.**
Unit 2	**Self-Assessment** Goal setting, SWOT analysis, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements, positive attitude, positive thinking and self-esteem. Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.	**4 hrs.**
Unit 3	**Communication Skills** Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait, dressing sense, facial expressions, peculiarity of speaker (habits). Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real-life story for 5 minutes each), Oral review (Each student orally presents a review on a story or a book read by them)	**8 hrs.**

	Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.	
Unit 4	**Formal Group Discussion, Personal Interview & Presentation skills** Topic comprehension, Content organization, Group speaking etiquettes, driving the discussion & skills. Preparation for personal interview: dress code, greeting the panel, crisp self-introduction, neatness, etiquettes, language tone, handling embarrassing & tricky questions, graceful closing. Activity: Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback. Mock interview are to be conducted.	**4 hrs.**
Unit 5	**Aptitude and analytical skills** Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking. Analytical skills: Definition, Types, problem solving	**8 hrs.**
Unit 6	**Life skills** Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.	**4 hrs.**

Suggested readings:

1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd.
2. English for Business Communication: Simon Sweeney, Cambridge University Press
3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press
4. Quantitative Aptitude: R.S. Agrawal

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201A.1	Identify their lacunas about some soft skills and try to overcome the same.	**2**
AC201A.2	Practice learned soft skills in real life and do their jobs more effectively.	**3**

AC-201(B): Practicing Sports Activities

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives (CObs):

- To motivate students towards sports and provide them required training.

SR NO.	NAME OF THE SPORT/GAME (Select ONE of the Following)	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMESTER
1	Volleyball	• General Fitness • Basic Fitness • Specific Fitness • History of the Game • Basic Skill of the Game • Major Skill of the Game • Technique & Tactics of the Game • Game Practice	Morning : 07 to 09 AM OR Evening : 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201B.1	Identify one or more sports of their choice and develop more interest to participate at University/National level sport events.	**2**
AC201B.2	Practice the learned sports activities regularly in real life.	**3**

AC-201(C): Practicing Yoga

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)

(Optional: Campus-level)

Course Objectives:

- To motivate students towards yoga and provide them required training.

- Yog: Meaning, Definition & Introduction, Objectives
- Primary Introduction of Ashtanga Yoga
- Preparation of Yogabhyas
- Omkar Sadhana, Prayer, Guru Vandana
- Sukshma Vyayamas
- Suryanamaskar (12 Postures)
- Asanas :
  - Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan
  - Supine (Shayansthiti) - Uttan Padaasan(Ekpad/Dwipad), Pavanmuktasana, Viparitakarani Aasan, Khandarasan, Shavasana
  - Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, Saralhasta Bhujangasana, Shalabhasana(Ekpad/Dwipad), Makarasana
  - Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana, Ardh Chakrasana

	• Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana - 6 Types • Pranayama : Anuloma-viloma, Bhramari

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201C.1	Identify and practice some Yoga asanas regularly in their life to remain healthy.	**2**
AC201C.2	Provide guidance and practice about Yoga to their friends, parents and relatives.	**3**

AC-201(D): Introduction to Indian Music

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

	Course Objectives: • To motivate students towards Indian music and provide them minimum required training. .
	• Definition and brief about generation of Swar, Saptak, Thaat, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc. • Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa. • Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information) • Detailed information of Tambora • Detailed information of Harmonium and Tablaa. • Five filmy songs based on Indian Classical Music (Theory and Presentation) • Sound Management - Basic information of Sound Recording (including Practicals) • Composition of Music as per the Story • Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201D.1	Identify different types of Indian music.	**3**
AC201D.2	Develop more interest to learn and practice Indian music.	**4**

Epilogue

Skills imparted:

This is the first-year syllabus of the two-year post-graduate course in Biotechnology. Overall, the curriculum is designed in such way that the student will get basic and applied knowledge of the subject. One of the major objectives considered during designing is to create human resource which is technically sound with knowledge having practical utility. The included basic subjects in theory and practical would be helpful to find out unseen facts in various problems in day to day life. The subjects like genetic engineering, and bioinstrumentation are designed in such a way that students will get theoretical and practical knowledge of modern scientific advances in the field. To make skillful human resource with precision, the important allied courses are also included. This course after completion of 2 years would give not only the practical knowledge of industry and industrial processes but also make aware the students with the global environmental problems like pollutions, contamination, infections and food quality.

Practical courses are based on theory courses and are designed to improve research-oriented skills of students.

Job opportunity: The designed curriculum offers job opportunities in various sectors like,

- Pharmaceutical industry: Clinical, medicine, vaccine, QC division
- Biotech industry: Recombinant product, QC, QA
- Agrochemical & pesticide industry
- Chemical industry: synthesis, testing
- Environmental protection industry & Agencies
- Research leading up to Ph. D. degree
- Marketing of biological & pharmaceutical products
- Food and nutraceutical industry, Govt. agencies

Entrepreneurship: This is another avenue available for the candidates making them sound in technical knowledge of Biotechnology upon completion of this two year post graduate course that could be useful in Entrepreneurship in Biotechnology.

Equivalence

M.Sc. Biotechnology (Affiliated Colleges)

Old syllabus AY 2018-2019	**New CBCS pattern syllabus 2021-22**
SEM-I	
BT-101: Microbial Physiology and Diversity (T)	**BT-101**: Microbial Diversity and Physiology (T)
BT-102: Biochemistry (T)	**BT-102**: Biomolecules and Molecular Enzymology (T)
BT-103: Immunology (T)	**BT-103**: Immunology (T)
BT-104: Methods in Microbiology and Biochemistry (P)	**BT-104**: Laboratory Course-I (P)
BT-105: Methods in Enzymology and Immunology (P)	**MB-105**: Laboratory Course-II (P)
SEM-II	
BT-201: Molecular Biology (T)	**BT-201**: Molecular Biology (T)
BT-202: Bioanalytical Tools (T)	**BT-202**: Bioinstrumentation and Biostatistics (T)
BT-203: Bioprocess Technology (T)	**BT-203**: Bioprocess Engineering and Technology (T)
BT-204: Methods in Molecular Biology & Biochemistry (P)	**BT-204**: Laboratory Course-III (P)
BT-205: Methods in Industrial Biotechnology (P)	**BT-205**: Laboratory Course-IV (P)

AY: Academic Year, (T) : Theory, (P): Practical

Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

॥अंतरी पेटवू ज्ञानज्योत॥

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS

for

Master of Science (M. Sc.)

Microbiology

Choice Based Credit System
(Outcome Based Curriculum)

For

Affiliated Colleges of
Kavayitri Bahinabai Chaudhari North Maharashtra University
Jalgaon 425 001 (MS)

2021 - 2022

Program at a Glance

Name of the program (Degree)	**:**	*M. Sc.*
Subject	**:**	*Microbiology*
Faculty	**:**	*Science and Technology*
Duration of the Program	**:**	*Two years (four semesters)*
Medium of Instruction and Examination	**:**	*English*
Credits of the program	**:**	*Total 88 credits (64 core credits including 4 credits of project/dissertation, skill enhancement- 08, subject elective credits 08 and audit 08 credits*
Examination Pattern	**:**	*The 60 : 40 (60 marks University assessment (exam) and 40 marks continuous internal college assessment (exam)*
Evaluation mode	**:**	*CGPA*
Passing standards	**:**	*The 40% in each exam separately (separate head of passing)*
Result	**:**	*As per the University's rules of CGPA system*

Prologue

The requirement for trained and skilled human resource is the need of time in the higher education and industry to match with rapid pace of technology development. Students need to acquire thorough knowledge of theoretical concepts and hands-on laboratory methods in the subject. Thus, it is imperative to revise and update the curriculum to accommodate the fundamental aspects as well as advanced developments in various disciplines of Microbiology and to complement the needs of its applied sectors. The program is designed to provide skilled manpower in this subject, facilitate to improve linkages with industries, and intended to offer practical skills needed to pursue the jobs in a chosen profession. Beside this, the students will be enlightened with knowledge in the newer areas of Bioinformatics, Bioinstrumentations, Biomolecules, Genetics, Immunology, etc.. Students are taught how to plan experiments, perform them carefully, analyse the data accurately, and present the results both, qualitatively and quantitatively through their dissertations or the project work. The students are encouraged to deliver seminars on the *topics of research to develop presentation skills and enable to build confidence which will lead them to read about different themes and enhances their assimilation abilities. A project component in the final semester will enable students to select a research problem, plan to execute experiments related to it, collect data and analyse it, and present the results in the form of an oral presentation as well as a thesis. This not only equips the student for a career in research as well as industry, but also fosters self- confidence and self-reliance in the student as he/she learns to work and think independently. At the end of the programme the student will be well-versed in this subject as well as be familiar with the most recent advances in the field of Life Sciences and will have gained hands-on experience in this subject of study. The student will be able to take up a suitable position in academia or industry and will be equipped to pursue a career in research or be an entrepreneur, if so desired.*

Process of Curriculum Design

The Choice-Based Credit System (CBCS) provides a framework within which there is flexibility in the design of courses and their content, simultaneously also providing the student a choice of the courses he/she wishes to study. The courses are assigned credits based on teaching hours, which in turn is linked to course content and structure. When revising the syllabi for the courses, the courses to be implemented as well as the content of each course was extensively discussed and debated on, over meetings between the faculty members and the students. Several alumni contributed to useful inputs. Furthermore, the opinions of prospective employers of the corporate sector were also sought and obtained. The opinions of experts were taken into consideration as well. The syllabi presented here are the culmination of the combined efforts of the faculty members, feedback obtained from students, alumni, external experts and members of industry.

The student will acquire knowledge about Microbiology such as Genetic Engineering, plant-microbes interaction, and Microbial Diversity, Molecular Biology, Pharmaceutical Microbiology, Fermentation Technology Applied and Environmental Microbiology, Industrial Microbiology Immunology, Agricultural and Food Microbiology. The student can design and execute experiments related to Basic Microbiology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics and can execute a short *research project incorporating techniques of Basic and Applied Microbiology under supervision.*

Program Objectives for M.Sc. Program:

1. *To impart the profound theoretical and practical knowledge of the specific science discipline along with the fundamental core concepts*
2. *To train the students to employ modern techniques, tools, methodologies, equipment, hardware/software etc. to perform objective oriented scientific and planned experiments.*
3. *To groom the students for all-round development and mold them in a trained workforce to provide teaching-learning, research, business, professional supports in the various science disciplines.*
4. *To make the student to develop the ability to think analytically, independently and draw logical conclusions to solve real-life problems.*
5. *To utilize the skills and knowledge gained through the subject to deal with real life situations and problems related to society, environment, research and development etc.*

Structure of M.Sc. program in Microbiology

M.Sc. Microbiology program is of two years duration and is conducted into four semesters. Since inception, the program was mostly student centric. Now in lieu of accreditation standards of NAAC, the university adopted outcome-based education approach. The various courses of the program are designed to include classroom teaching, laboratory work, project, seminars, assignments, etc. Three categories of courses are being offered in this program: (A) Prerequisites and Core courses (12 theory and 8 practical's of 4 credit each as mandatory courses), (B) Skill Based/ Subject Elective courses (04 courses of 4 credits each) and (C) Audit courses (4 Courses of 2 credits each). The core courses of 4 credits include theory as well as practical. The core courses embody a research-based course that leads to a project dissertation. The student is required to accumulate 22 credits each semester, a total of 88 credits, to fulfil the requirements for a M.Sc. degree. Forty percent of the total marks for each course will be awarded *through internal assessment. Final examinations for four credit courses will be of three hours duration while examinations for each laboratory- based courses will be held over two days of three hours (incubation based practicals) each or one day of 5-6 hours each. However, there could be certain changes in the number of classes of theory and practicals, ways of teaching either through online or offline mode and even the examination pattern owing to the prevailing situation like pandemic and as per the need by following the rules and regulations.*

Duration

The duration of M.Sc. degree program shall consist of two academic years divided in to four semesters. Each Semester consist of 90 working days. Each theory and practical course should be completed in about 50 lectures.

Medium of instruction

The medium of instruction and examination for each course shall be English.

Credit to contact hour

One credit is equivalent to 15 periods of 60 minutes each for theory course lecture. While credit weightage for self-learning based on e-content shall be 50% or less than that for lectures.

Attendance

The student enrolled for this M.Sc. course must have 75% attendance in each course in order to appear for term end examinations, otherwise the candidate may not be allowed to appear for term end examination as per ordinance.

Examination

Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination. Separate head of passing in Internal and External examination is mandatory. In case of failure in internal examination of particular course, student will have to appear for the same in next semester as per the schedule of the examination. In case a student fails in particular course in a semester and the same course(s) are revised/removed from curriculum in due course, the student will have to appear as per new curriculum and or pattern in subsequent semester at his own responsibility observing the course equivalence..

Term end examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each).

Internal examination (40 marks each semester)

Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions. Two internal tests (20 marks each) will be conducted during semester as a part of continuous assessment.

Practical Examination

Practical examination shall be conducted at the end of the semester. Practical examination will be of minimum 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am - 1pm / 2 – 5 pm for 2 consecutive days) in case of practicals where incubation condition, allied aspects are essential. There shall be 5 marks for laboratory record book and well written certified journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination.

Summary of Distribution of Credits under CBCS Scheme

for M.Sc. at Affiliated Colleges [w.e.f. 2021-22]

Sr. No	***Type of course***	***Sem I***	***Sem II***	***Sem III***	***Sem IV***
01	*Core*	***16***	***16***	***16***	***12***
02	*Skill based*	***04***	***04***	**-**	**-**
03	*Elective*	**-**	**-**	***04***	***04***
04	*Project*	**-**	**-**	**-**	***04***
05	*Audit*	***02***	***02***	***02***	***02***
06	*Total Credits*	***22***	***22***	***22***	***22***

Subject Type	***Core***	***Skill based***	***Elective***	***Project***	***Audit***	***Total***
Credits	***60***	***08***	***08***	***04***	***08***	***88***

Total Credits = 88

Affiliated Colleges of
Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon
Choice Based Credit System (Outcome Based Curriculum) with effect from 2021 -2022

Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course			Total Credits (A+B+C)
	No. of Courses	Credits	Total Credits	No. of Courses	Credits	Total Credits	No. of Courses	Credits (Pract.)	Total Credits	
I	4	8 + 8	**1**	1	4 + 0	4	1	2	2	**2**
I	4	12 + 4	**1**	1	0 + 4	4	1	2	2	**2**
I	4	8 + 8	**1**	1	4 + 0	4	1	2	2	**2**
I	3	8 + 4	**1**	2	8 + 0	8	1	2	2	**2**
Total	**6**			**1**			**8**			**8**

(T, Theory; P, Practical)

Structure of Curriculum

		First				Second				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
	Prerequisite and									
(A)	Theory	4	2	4	3	4	2	4	2	36
	Practical	4	2	4	1	4	2	4	1	24
(B)	**Skill Based / Subject Elective Courses**									
1	Theory /Practical	4	1	4	1	4	1	8	2	20
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing	2	1							2
2	Personality & and Cultural Development			2	1					2
3	Technology Related + Value					2	1			
4	Professional and Social + Value							2	1	2
	Total Credit Value	14	6	14	6	14	6	14	6	88

List of Audit Courses (Select any ONE course of Choice from Semester II)

Semester I (Compulsory)		**Semester II** (Choose One) — **Personality and Cultural Development**	
Course Code	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills
		AC-201B	Sport Activities
		AC-201C	Yoga
		AC-201D	Music

Semester-wise Course Structure of M.Sc. Microbiology

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
MB-101	Core	Microbial Taxonomy and Diversity	4	--	4	40	--	60	--	4
MB-102	Core	Microbial Physiology and Biochemistry	4	--	4	40	--	60	--	4
MB-103	Core	Methods in Microbiology	--	4+4	8	--	40	--	60	4
MB-104	Core	Methods in Microbial Chemistry	--	4+4	8	--	40	--	60	4
MB-105	Skill Based	Bioinstrumentation	4	--	4	40	--	60	--	4
AC-101	Audit Course	Practicing Cleanliness		2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
MB-201	Core	Molecular Biology and Bioinformatics	4	--	4	40	--	60	--	4
MB-202	Core	Microbial Enzymology	4	--	4	40	--	60	--	4
MB-203	Core	Immunology	4	--	4	40	--	60	--	4
MB-204	Core	Methods in Molecular Biology and Immunology	--	4+4	8	--	40	--	60	4
MB-205	Skill Based	Methods in Enzymology	--	4+4	8	--	40	--	60	4
AC-201 A/B/C/D	Audit Course	Choose one out of Four (AC-201A/ AC-201B/AC-201C/AC-201D) from Personality and Cultural Development	--	2	2	--	100	--	--	2
Total Credit for Semester II: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit course:2)										

Program Outcomes (PO) for M.Sc. Program:

Upon successful completion of the M.Sc. program, student will be able to:

PO No.	PO	Cognitive level
PO1	Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.	**2**
PO2	Administer the skills in handling scientific instruments, planning and performing in laboratory experiments	**3**
PO3	Analyse the given scientific experimental data critically and systematically and the ability to draw the objective conclusions.	**4**
PO4	Develop various skills such as communication, managerial, leadership, entrepreneurship, teamwork, social, research etc., which will help in expressing ideas and views clearly and effectively	**3**
PO5	Model and formulate the real problems and find solution based-on knowledge acquired	**6**
PO6	To evaluate how developments in any science subject helps in the development of other science subjects and vice-versa and how interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments.	**5**

Program Specific Objectives for M.Sc. Microbiology program:

After completion, the students are expected to understand the;

- Basic concepts, principles and methods of Microbial Diversity, microbial Systematics and Bioinstruments used in isolation and identification of microbes and structural determination of biomolecules.
- Basic and applied aspects of Genetic makeup of bacteria, algae, fungi and viruses.
- Causes, mechanisms and consequences of defect in gene/genome of microorganisms.
- Basic concepts of microbial enzymes, enzyme kinetics, regulation of enzyme activity, industrial applications of enzymes.
- Biotechnological significance of enzymes of extremophiles in agriculture, environment, medicine and industry.
- Concepts and significance of enzymes in non-aqueous environment.

Program Specific Outcomes (PSOs) for M.Sc. Microbiology program:

Students who graduate with a Master of Science in Microbiology will:

PSO No.	PSO	Cognitive level
PSO1	Demonstrate an understanding of structure and metabolism of macromolecules, understand the regulation of metabolic pathways and understand the role of microbes in industry, health and environment.	**2**
PSO2	Gain proficiency in laboratory techniques in both microbiology and molecular biology and be able to apply the scientific methods to the processes of experimentation and hypothesis testing.	**3**
PSO3	Acquire significant knowledge on various aspects related to microbiology including biochemical techniques, immunology, physiology, agriculture, environment, pharmaceutical, molecular biology, applied recombinant DNA technology and technical skills related to microbial metabolites.	**4**
PSO4	Learn to work as a team as well as independently to retrieve information, carry out Research investigations and result interpretations.	**6**
PSO5	Develop the ability to understand and practice the ethics surrounding scientific research.	**5**
PSO6	Realize the impact of science in society and plan to pursue research.	**5**

Distribution of Course papers for M. Sc. Part I Microbiology

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part I Microbiology					
Semester I : Theory Courses					
MB-101	Microbial Taxonomy and Diversity	Core course	04	100	03
MB-102	Microbial Physiology and Biochemistry	Core course	04	100	03
MB-105	Bioinstrumentation	Skill based	04	100	03
Semester I : Practical Courses					
MB-103	Methods in Microbiology	Core course	**04+04**	**100**	**06**
MB-104	Methods in Microbial Chemistry	Core course	**04+04**	**100**	**06**
AC-101	Practicing Cleanliness	Audit Course	**02**	**100**	
Semester II : Theory Courses					
MB-201	Molecular Biology and Bioinformatics	Core course	**04**	**100**	**03**
MB-202	Microbial Enzymology	Core course	**04**	**100**	**03**
MB-203	Immunology	Core course	**04**	**100**	**03**
Semester II : Practical Courses					
MB-204	Methods in Molecular Biology and Immunology	Core course	**04+04**	**100**	**06**
MB-205	Methods in Enzymology	Skill based	**04+04**	**100**	**06**
AC-201A/B/C/D	Choose one out of Four (AC-201A/ AC-201B/ AC-201C/ AC-201D) from Personality and Cultural Development (Audit Course)	Audit Course	**02**	**100**	

M.Sc. Part I Semester I Microbiology: Core Courses

	MB - 101: Microbial Taxonomy and Diversity	
	Course Objectives: 1. To understand the ubiquitous nature of microbes to build basic concept 2. To give basic knowledge on extremophiles 3. To provide knowledge on characteristics of various microbes	
Unit 1	**Microbial Taxonomy** • **Concept:** Taxonomic ranks, Domain and species • **Introduction to Bergey's manual of Systematic bacteriology, 9th edition** • **Current techniques used for identification:** DNA fingerprinting electrophoresis, Ribotyping, DNA Fingerprinting using Pulsed Field Gel Electrophoresis (PFGE), Randomly amplified polymorphic DNA (RAPD), Fatty acid analysis, Use of NA probes • **Metagenomics concept, culturable and non-**culturable microbial diversity	**08 L**
Unit 2	**Extremophilic bacteria and Archea** • **Biotopes, Biochemistry and Physiology of adaptation to extreme environment and cultivation strategies of:** Thermophile, Psychrophile, Barophile, Halophile, Acidophile, Alkaliphile, Methanogens • **Applications of extremophiles**	**14 L**
Unit 3	**Algae** • **Characteristics:** Algae (Colonial Algae, Filamentous Algae, Siphonous Algae, Parenchymatous and Pseudo parenchymatous algae), • **Cytomorphology and Ultrastructure:** algal cell (Mucilage and Sheaths, Frustule, Cell Wall, Flagella and Associated Structures, Plastids, algal movement) • **Nutrition:** Physical and chemical requirements, Types based on nutrition • **Reproduction**: Vegetative, Asexual Reproduction, Binary Fission or Cellular Bisection, Zoospore, Aplanospore, Autospore. Fragmentation, Resting Stages, Sexual Reproduction. • **Significance of algae**: Biogeochemical role, Food, Extracts (Agar, Alginate, Carrageenan), Animal Feed, Fertilizers, Cosmetics, Therapeutic Supplements, Algal pigments, Microalgae as biofertilizer, Lichens • **Algal farming for biodiesel** • **BGA:** General features, cultivation and significance • **Prochloronus and cyanelles**	**8L**
Unit 4	**Fungi** • **Characteristics:** Fungi (Yeast, moulds and dimorphic fungi) and their Classification • **Cyto-morphology and Ultrastructure:** Fungal hyphae, thallus • **Nutrition:** Physical and chemical requirements, Types based on nutrition • **Reproduction**: sexual, asexual, fungal spores and parasexual • **Endophytic fungi**: Characteristics, cultivation and significance • **Ecological significance and applications of Fungi:** Biogeochemical role of fungi, Mycoses, Mycotoxins, Biocontrol, Mycorrhiza and Insect symbionts	**10 L**
Unit 5	**Virus** • **Virus structure:** Virus proteins, Capsids, Virion membranes, Ultrastructure of HIV, plant virus (TMV) and bacterial virus (T4 virus) • **Classification of viruses** • **Methods used in virology:** Cultivation of viruses, Isolation of viruses,	**10 L**

	Centrifugation, Structural investigations of cells and virions, Electrophoretic techniques, Detection of viruses and virus components, Infectivity assays. • **Detection and enumeration of viruses** • **Viruses in cancer:** oncogenic viruses, sources and mechanism of oncogenesis, Epstein-Barr virus-linked cancers, Kaposi's sarcoma, Cell lines derived from virus-associated cancers, Prevention of virus-induced cancers, Diagnosis and treatment • **Emerging viruses:** Viruses in new host species and in new areas, recently discovered viruses, Re-emerging viruses, Virus surveillance • **Prions:** nature of prions, Prion transmission, Transmissible spongiform encephalopathy	

Suggested readings:

1. Carter, John B and Saunders, Venetia A. (2007) **Virology:** Principles and applications, John Wiley and Sons Ltd., London
2. Wagner, E. K. and Hewlett, M. J (2004) Basic Virology, 2nd Edn., Blackwell Publications, Oxford,
3. Conrat, H.F. Kimball, P.C. and Levy, J. A (1994) Virology, 3rd Edn., Prentice Hall, Eaglewood Cliff, New Jersey, USA
4. Hull, R. (2002) Matthew's Plant Virology, 4th Edn., Academic Press, London
5. Dimmock, N. J. Easton, A. J. and Leppard, K. N. (2001) Introduction to Modern Virology, 5th Edn., Blackwell Science, London
6. Laura Barsanti, and Paolo Gualtieri (2006) Algae: Anatomy, Biochemistry and Biotechnology, Taylor & Francis Group, UK
7. Becker, E. W. (1994) Microalgae- Biotechnology and Microbiology, Cambridge University Press, UK. Burnett, J. H.
8. Kevin Kavanagh (2005) Fungi: Biology and Applications, John Wiley & Sons Ltd., West Sussex,
9. Jim Deacon (2006) Fungal Biology, 4th Ed. Blackwell Publishing Ltd., West Sussex
10. Alexopoulous, C. J. and Mims, C. W. (1979) Introduction to Mycology, Wiley Eastern Ltd., Delhi
11. Griffin, D. H. (1994) Fungal Physiology, Wiley-Liss, New York
12. Kathy Talaro and Barry Chess (2012) Foundations in Microbiology, 8th Edn., The McGraw-Hill Companies, Inc., New Delhi
13. Tortora, Funke and Case (2010) Microbiology, 10th Edn., Brenjamin Cummings Inc., California
14. Moselio Schaechter (2009) Desk encyclopaedia of Microbiology, 2nd Edn., Elsevier
15. Prescott, Harley and Klein's (2002) Microbiology, 5th Edn. The McGraw-Hill Companies, Inc.,
16. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2017) Foundations in Microbiology, 9th Edn., Nirali Prakashan, Pune
17. Fred A. Rainey and Aharon Oren (2006) Extremophiles, Methods in Microbiology, Volume 35, Elsevier and Academic Press, London
18. Martin Dworkin (Editor) (2006) The Prokaryotes: A Handbook on the Biology of Bacteria, Volume 2, Ecophysiology and Biochemistry, Springer-Verlag, New York
19. Michael T. Madigan, John M. Martinko, Paul V. Dunlap, David P. Clark, (2009) Brock Biology of Microorganism, Benjamin Cummings, California, USA.
20. Bergey's Manual of Systematic Bacteriology (2001) Editor-in-chief: Garrity, George M. Boone, David R.; Castenholz, Richard W. (Eds.), (4 Volumes) Springer/ Williams and Wilkins, USA
21. Kushner, D.J. eds. (1978) Microbial life in extreme environments. Academic Press, London.
22. Horikoshi, K., Grant, W.D. eds. (1998) Extremophiles, Microbial Life in Extreme Environments. Wiley-Liss Publishers, New York.
23. Willey, J., Sherwood, L., Woolverton, C.J. and Prescott, L.M. (2017) Prescott's Microbiology, 10^{th} edn., NY: McGraw-Hill Education, New York

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO	CO	Cognitive

No.		level
C101.1	Differentiate various groups of microbes and microbial taxonomy	2
C101.2	Acquire knowledge on adaptability of extremophiles and microbial diversity	3
C101.3	Acquaint with the scope of microbiology in different diversified areas.	4

	MB-102: Microbial Physiology and Biochemistry	
	Course Objectives: 1. To know the structural organization, characteristics and metabolism of biomolecules 2. To learn microbial metabolic pathways and its enzymatic regulation 3. To acquire knowledge on transport of solute and energy metabolism	
Unit 1	**Structure and properties of Biomolecules** • **Classification, Structure and function of:** carbohydrates, lipids, proteins, nucleic acids and vitamins. • **Conformation of proteins:** Primary, secondary, tertiary and quaternary structure; Ramachandran plot, domains; motif and folds • **Structural stability:** protein and nucleic acid	10 L
Unit 2	**Transport and Energy metabolism** • Cell membrane and its ultrastructure • **Types of cellular transport**: passive, facilitated, active, translocation, liposomes for transduction, Na/K+ ATPase, ABC transporter • Response to stress. • **Energy metabolism:** Free energy, Bacterial and Mitochondrial ETC, ATP Synthase complex, inhibitors of ETC and energetics of ETC	10 L
Unit 3	**Metabolism of carbohydrates** • **Metabolic pathway, bioenergetics and regulation of:** EMP, HMP, TCA, Glyoxylate pathway, C3 and C4 pathway • **Alternative glycolytic pathways**	12 L
Unit 4	**Metabolism of Lipids** • **Metabolic pathway, Bioenergetics and regulation of:** Fatty acid synthesis, Catabolism of lipids • FAS Complex	06 L
Unit 5	**Amino acid and Nucleotide metabolism** • **Metabolic pathway, Bioenergetics and regulation of:** amino acid degradation • **Metabolic fates of amino groups** • **Metabolic pathway, Bioenergetics and regulation:** Purines and Pyrimidine biosynthesis: De novo pathway and Salvage pathway, ribonucleotide reductase	12 L

Suggested readings:

1. White, D. (2000) The Physiology and Biochemistry of Prokaryotes, Oxford University Press, New York, USA
2. White, D., Drummond, J. and Fuqua, C. (2011) The Physiology and Biochemistry of Prokaryotes, 4th edn., Oxford University Press, New York
3. Cohen, G.N. (2014) Microbial Biochemistry, 2nd edn., Springer
4. Gottschalke, G (2004) Bacterial Metabolism, Springer, Weinheim
5. Moat, A. G., Foster, J. and Spector, M.P. (2002) Microbial Physiology, 4th edn., Wiley Interscience Publ., New York
6. Nelson, D.L. and Cox, M.M. (2000) Lehninger's Principles of Biochemistry, CBS Publications, New Delhi
7. Stryer, L. (2002) Biochemistry, 5th Edn., W.H. Freeman and Co., New York, USA

8. Price, N.C. and Stevens, L. (2000) Fundamentals of Enzymology, 3rd edn., Oxford University Press, NY, USA.
9. Voet, D., Voet, J.G. and Pratt C.W. (1999) Fundamentals of Biochemistry. John Wiley and Sons, Inc., Chicheter, UK
10. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2003) Harper's Biochemistry. Appleton and Lange, Stamford, Connecticut.
11. Jain, J.L., Jain, S. and Jain, N. (2009) Fundamentals of Biochemistry, S Chand, New Delhi
12. Doelle, H.W. (1975) Microbial Metabolism, 2nd Edn, Academic Press, London

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C102.1	Acquire knowledge on metabolism of biomolecules	**3**
C102.2	Familiarise with amino acids, proteins, lipids, nucleic acids and enzymes	**4**
C102.3	Understand biochemical reactions in microbial cells and metabolic pathway diversity	**2**

MB-103: Methods in Microbiology

Course Objectives:
1. To familiarize in General Microbiology techniques
2. To learn the basic microbial techniques used for characterization of microbial system
3. To know about effect of environmental condition on microbes

1	Biosafety: Safe Laboratory techniques, Equipment related hazards, Biosafety cabinets, Transport of infectious material/cultures, Waste disposals, Fire and electricity hazards, Immunisation to staff.
2	Growth Curve of yeast by Turbidity (Spectrophotometer/ Nephelometer) and Dry mass (Centrifugation) measurement
3	Isolation and cultivation of cyanobacteria/ Algae
4	Study on fungal hyphal growth and study on isolation, morphology of Actinomycetes
5	Isolation of Bacteriophage by plaque assay and enumeration
6	Isolation and partial characterisation of Acidophile/ Alkalophiles/ Halophile/ Thermophile/ Psychrophile bacteria from acidic/alkaline/high salt/high/low temperature environments
7	Cultivation of cancer cell lines (HeLa/ CHO/---)
8	SDS PAGE of protein
9	Agarose gel electrophoresis of DNA
10	Gel Permeation Chromatography/Affinity chromatography
11	16S rRNA gene sequence analysis using BLAST and preparation of phylogenetic tree
12	Demonstration of HPLC/ GC/AAS

Suggested readings:

1. Norris, J. R. Ribbons D. W. (Ed) (1969) Methods in Microbiology, Volume 1, Academic Press Inc. Ltd., London
2. Harley, J. P., Lansing, M. Prescott, H. (2002) 5th Edn., Laboratory Exercises in Microbiology, The McGraw−Hill Companies, New York
3. Benson, H.J. (2001) Microbiological Applications Lab Manual, 8th Edn. The McGraw−Hill Companies, New York
4. Aneja, K.R. (1996) Experiments in Microbiology, 3rd edn., Wishwa Prakashan, New Delhi.
5. Parija, S.C. (2005) Text Book of Practical Microbiology, Ahuja Publishing House, New Delhi.

6. Dubey, R.C. and Maheshwari, D.K. (2004) Practical Microbiology, S. Chand and Co. New Delhi.
7. Cappuccino, J.G. and Sherman, N. (2014) Microbiology: A Laboratory Manual. 10th Edition, Pearson Education Inc., San Francisco.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C103.1	Develop expertise in basic analytical techniques of microbiology.	**3**
C103.2	Get knowledge in the analysis of biomolecules	**3**
C103.3	Carry out microbial techniques related to isolation, identification of algae, fungi, archea	**4**

MB - 104: Methods in Microbial Chemistry

	Course Objectives: 1. To familiarize the student in biochemical techniques and learn basic microbial biochemistry 3. To utilize bioinformatics software tool to understand the biomolecule
1	Basic biochemical techniques: Use of hand glove, Use of pipette aid, Preparation of standard solutions and buffers, Dilution approaches.
2	Determination of pKa value of amino acid
3	Quantitative analysis reducing sugar by DNSA method
4	Quantitative analysis of total carbohydrate by Phenol sulphuric acid method
5	Quantitative analysis of protein by Folin-Ciocalteu / Biuret method and UV absorption method
6	Quantitative analysis of amino acids by ninhydrin method
7	Quantitative estimation of fatty acids by titration method
8	Determination of Iodine number and acid number of lipid sample
9	Detection of changes in the conformation of bovine serum albumin by viscosity measurement
10	Identification of the C-terminal amino acid of Protein
11	Quantitate estimation of DNA by Diphenyl Amine method
12	Quantitate estimation of RNA by Orcinol method
13	Study of biomolecules using RasMol/ SPDBV software
14	Demonstration of TLC for detection of biomolecules: Sugars and amino acids

Suggested readings:

1. Thomas, G.M. and Shalkhammer, (2004) Analytical Biotechnology, Springer, New Delhi
2. Thimmaiah, S.R. (2006) Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.
3. Plummer, D.T. (2001) An Introduction to Practical Biochemistry, 3rd edn., McGraw Hill Ltd. New Delhi
4. Sawhey, S.K. and Singh, R. (2002) Introductory Practical Biochemistry, Narosa Publication House, New Delhi.
5. Jayaraman, J. (2008) Laboratory Manual in Biochemistry, New Age International, New Delhi.
6. Schmauder, H.P, Schweizer, M. and Schewizer, L.M. (2003) Methods in Biotechnology, Taylor and Francis Ltd., London

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C104.1	Acquire expertise in basic biochemical techniques	**3**
C104.2	Get knowledge in the analysis and estimation of biomolecules	**4**
C104.3	Carry out biochemical analysis	**5**

M.Sc. Part I Semester I Microbiology: Skill Based Course

	MB - 105: Bioinstrumentation	
	Course Objectives: 1. To introduce the student to the variety of biophysical and biochemical techniques 2. To make them familiar with various approaches of analytical techniques	
Unit 1	**Principles of biophysical chemistry** • pH, pOH, pKa, Isoelectric pH, Henderson-Hasselbalch equation, buffer, colligative properties.	**05 L**
Unit 2	**Separation techniques** • **Chromatography:** Principle, design and applications of TLC, HPTLC, GC, HPLC, Gel filtration, • **Electrophoresis and electrofocusing:** Principle, design and applications of Agarose gel and capillary electrophoresis, PAGE, Iso-electric focusing. • Centrifugation and Ultracentrifugation	**16 L**
Unit 3	**Biophysical methods** • **Analysis of biomolecules**: UV/visible spectrophotometer, fluorescence, circular dichroism, IR, NMR and ESR spectroscopy, • **Structure determination**: X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry.	**16 L**
Unit 4	**Radiolabeling techniques** • Properties of different types of radioisotopes used in biology, • Detection and measurement of radioactivity • Incorporation of radioisotopes in biological tissues and cells, • Safety guidelines for Radiolabeling techniques	**08 L**
Unit 5	**Microscopic techniques** • Scanning and transmission microscopes, different fixation and staining techniques for Electron microscope, freeze-etch and freeze-fracture methods for Electron microscope, • Image processing methods in microscopy.	**05 L**

Suggested readings:

1. Cantor, C.R. and Schimmel, P.R. (2008)
2. Upadhyay, A., Upadhyay, K. and Nath, N. (2000) **Biophysical Chemistry,** Himalaya Publisher, Nagpur.
3. Friefelder A, D. (1993) **Physical Biochemistry,** 2nd Edn. W. H. Freeman & Co., USA.
4. Van Holde, K. E. (1985) **Physical Biochemistry**, 2nd Edn., Prentice Hall Inc. New Jersey.
5. Skoog, D.A., Hollier, F.J. and Nieman, I.A. (1998) **Principles of Instrumental Analysis,** Harcourt Brace College Publishers, Orlando
6. Wilson, K. and Walker, J. (2000) **Practical Biochemistry: Principles and techniques,** 5th Edn., Cambridge University Press, Cambridge,
7. Willard, H.H. and Merrit, Jr. L.L. (1986) **Instrumental Methods of Chemical Analysis,** CBS Publishers, New Delhi

8. Wilson, K. and Goulding, K.H. **Biologists Guide to Principle and Techniques of Practical Biochemistry,** ELBS Publications, London
9. Mikkelsen, S.R. and Corton, E. (2004) **Bioanalytical Chemistry**, Wiley Interscience, New York
10. Sivasankar, B. (2005) **Bioseparations Principles and Techniques**, Prentice Hall of India Pvt. Ltd., New Delhi
11. Bengt Nölting (2009) **Methods in Modern Biophysics**, 3rd Edn., Springer, Berlin

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C105.1	Acquire knowledge on basic biophysical and biochemical aspects	**3**
C105.2	Learn purification of molecules, analytical tools, electrophoretic separation	**4**
C105.3	Learn how to interpret protein mobility on page under native and SDS	**3**

M.Sc. Part I Semester I Audit Course(s)

AC-101: Practicing Cleanliness

(Compulsory; Campus-level Audit Course; Practical; 2 Credits)

Course Objectives (CObs):

- To make students aware of Clean India Mission, inculcate cleanliness practices and community health awareness.

- Awareness program on
  - Swachh Bharat Abhiyan (Clean India Mission)
  - Clean Campus Mission
  - Role of youth in Clean India Mission
  - Community health awareness
- Cleaning activities inside and surroundings of Department buildings.
- Tree plantation and further care of planted trees
- Waste (Liquid/Solid/e-waste) Management, Japanese 5-S practices
- Planning and execution of collection of Garbage from different sections of University campus
- Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance.
- Cleanest Department and Cleanest Hostel contests
- Painting and Essay writing competitions
- Community health awareness to keep communicable diseases away

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC101.1	Identify need at of cleanliness at home/office and other public places.	**2**
AC101.2	Plan and observe cleanliness programs at home and other places.	**4**
AC101.3	Practice Japanese 5-S practices in regular life.	**3**

M.Sc. Part I Semester II (Microbiology): Core Courses

MB – 201: Molecular Biology and Bioinformatics		
	Course Objectives: 1. To extend the knowledge on structure and functions of genetic material 2. To introduce genome organization, transcription and translation process in Prokaryotes and study various tools to understand molecular mechanisms. 3. To introduce the basic principles of bioinformatics	
Unit 1	**Basics molecular biology**	**10 L**
	• DNA: topological properties (linking, writhing, twisting number), Structure of super helix, Base flipping, Palindrome, Inverted repeats and stem and loop. • Overview of DNA replication • RNA: Structure, types and functions • Denaturation and renaturation kinetics of nucleic acids • Proteins: Domain and motifs Histone proteins, • DNA-Protein interactions: helix-loop-helix, helix-turn-helix, leucine zipper, Zinc finger motifs,	
Unit 2	**Transcription**	**10 L**
	• Types of RNA polymerase (prokaryotic & eukaryotic), Process of transcription • mRNA processing, editing: capping, adenylation, splicing, RNA transport • Transcriptional regulation: transcriptional bursting/pulsing, specificity factors, enhancers, repressors, activators and general transcription factors • Post-transcriptional modifications, RNA degradation, nuclear transport, mRNA localization, anti-sigma factors, RNAi (siRNA, miRNA and CRISPR mechanism)	
Unit 3	**Translation**	**10 L**
	• Ribosome (structure and composition), Activation of tRNA, tRNA synthetase • Genetic code and its properties • Steps: Initiation: factors and their regulation, Elongation, Termination • Inhibitors • Post translational modification of proteins and protein degradation • Translational regulation: Cytoplasmic polyadenylation, UTR sequence elements, RNA binding proteins, ribosomal regulation, non-sense mediated RNA decay, 5` decapping	
Unit 4	**Protein targeting and degradation**	**10 L**
	• Signal hypothesis • Signal sequences in bacteria • Membrane and Lysosomal protein targeting • HSP and Chaperons • Protein degradation	
Unit 5	**Basic Bioinformatics**	**10 L**
	• Biological databases: Nucleic acid databases (GenBank, EMBL, DDBJ) • Protein sequence data base (UniProt, PDB) • Scoring matrices, local. global and multiple sequence alignment • Database search for homologous sequences, BLAST • Phylogenetic analysis: Overview and tree construction methods	

Suggested Readings:

- Lewin B. (2013) Gene XI, Pearson Prentice Hall, Pearson Education, Inc., NT, USA (ISBN: 0-13-123826-4)

- Malacinski GM (2003) Essentials of Molecular Biology, 4th edn., Jones and Batiett, London. (ISBN: 0-7637-2133-6)
- Watson JD, Baker JA, Bell SP, Gann A, Lewin M, Losick R (2007) Molecular Biology of the Gene, 6th edn., Benjamin Cummings- CSHL Press, USA
- Stryer, Lubert (2002) Biochemistry 5th edn. W. H. Freeman and Co. New York
- Wink M. (2006) An Introduction to Molecular Biotechnology, Wiley-VCH Verlag Gmbh and Co., Weinheim, Germany (ISBN: 978-3-527-31412-6/3-527-31412-1)
- Weaver, RF (1999) Molecular Biology, WCB McGraw-Hill Co. Inc., NY (ISBN: 0-697-14750-9)
- Brown, TA (1995) Essential Molecular Biology, Vol. I, A Practical Approach, IRL Press, Oxford, UK
- Nelson DL & Cox MM (2005) Lehninger's Principles of Biochemistry, 4th edn., McMillan Worth Publ. Inc. NY
- Russell, PJ (1998) Genetics, 5th edn, Benjamin-Cummings Publ. Co. Inc., NY (ISBN: 0-321-0038-2)
- Oliver, RP and Schweizer, M. (1999) Molecular Fungal Biology, Cambridge University Press, Cambridge, UK (ISBN: 0-521-56784-X)
- Klug, WS and Cummings, MR (2003) Concepts of Genetics, 7th edn., Pearson Education Inc., (ISBN: 81-7808-884-3)
- Bates, AD and Maxwell, A (2006) DNA Topology, Indian Edn., Oxford University Press, New Delhi (ISBN: 0-19-56831-X)
- Turner, PC, McLennan, AG, Bates AD and White, MRH (2002) Instant Notes: Molecular Biology, 2nd edn., Viva Books Pvt. Ltd., New Delhi (ISBN: 81-7649-215-9)
- Lesk, AM (2002) Introduction to Bioinformatics, Oxford University Press, UK (ISBN:0-19-925196-7)
- Korf, I, Yandell, M and Bedell, J (2003) An Essential Guide to the Basic Local Alignment Search Tool-BLAST, O'Reilly Network Publishers, Tokyo (ISBN:)
- Baxevanis, A. D. and Ouellette, B. F. F. (2001) Bioinformatics: A practical guide to the analysis of genes and proteins. Second Edition. John Wiley & Sons, New York.
- Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.
- Zoe L. and Terence C. (2004) Bioinformatics: Managing Scientific Data, Morgan Kaufmann Publishers, New Delhi.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C201.1	Receive elaborate knowledge on nucleic acids and molecular mechanisms in bacteria	**3**
C201.2	Understand gene expressions and signal sequences in bacteria	**2**
C201.3	Get thorough knowledge about fundamental aspects on bioinformatics	**5**

	MB - 202: Microbial Enzymology	
	Course Objectives: 1. To understand basic aspects of microbial enzyme 2. To learn the kinetics of enzyme catalysed reactions and applications of enzymes 3. To introduce what kind of catalytic mechanism is adopted in enzyme	
Unit 1	**Basic Enzymology**	**10 L**

	• General Characteristics of enzyme, Ribozyme, Abzyme and Coenzymes • Enzyme Nomenclature, classes of enzymes, enzyme activity, Specific activity, katal, Substrate specificity, Active site • Effects of pH, temperature, substrate concentration, activator on enzyme activity • Enyme turnover: Concept and significance. • Isoenzyme: concept and properties, ex. LDH • Multienzyme complexes: pyruvate dehydrogenase and fatty acid synthetase, advantages of multienzyme complex	
Unit 2	**Enzyme Kinetics** • Elementary reactions, Reversible reactions, Rates of reactions, Transition state, • Equilibrium and steady state theory • The Michaelis–Menten Equation, Concept of Km and Vmax, Double reciprocal plot, Analysis of Kinetic Data. • Enzyme Inhibition: Competitive Inhibition, Non-competitive, Uncompetitive Inhibition and Mixed Inhibition, • Bi-substrate, and Multi substrate reactions	**10 L**
Unit 3	**Catalytic Mechanisms and regulation** • Acid–Base Catalysis, Covalent Catalysis, Metal Ion Catalysis, Electrostatic Catalysis, Catalysis through Proximity and Orientation Effects, Catalysis by Preferential Transition State Binding • Serine Proteases: Kinetics and Catalytic Groups, X-Ray Structures, Catalytic Mechanism, Testing the Catalytic Mechanism, Zymogens • Enzyme regulation: feedback inhibition, feed forward stimulation, enzyme reparation, induction and degradation, enzyme regulation by cAMP, covalent modification, allosteric regulation of enzymes w.r.t. ATCase	**10 L**
Unit 4	**Industrial applications of Enzymes** • Perspective of use of enzyme in industry • Source, Significance and biotechnological applications of Cellulases, Proteases in dough/Flour and protein hydrolysate, Amylases in starch industry, Lipases in oil industry, Pectinases in fruit industry, Laccases	**10 L**
Unit 5	**Extremozymes** • Microbial source, characteristics and biotechnological significance of extremozymes of thermophiles, psychrophiles, acidophiles, alkalophiles, halophiles • Non-aqueous enzymology	**10 L**

Suggested readings

1. Stryer, L. (2004) **Biochemistry**, 5th Edn., W. H. Freeman & Co., New York
2. Palmer, T. (2004) **Enzymes: Biochemistry, Biotechnology and Clinical Chemistry,** Affiliated East-West Press Pvt. Ltd., New Delhi
3. Price, N. C. and Stevens, L. (2000) **Fundamentals of Enzymology**, Oxford University Press, New York.
4. Dixon, M. Webb, E. C., Throne, C.J.R. and Tipton, K. F., **Enzymes**, Academic Press, NY.
5. Cook, Paul, F. and Cleland, W.W. (2007) **Enzyme Kinetics and Mechanism**. Garland Science, New York.
6. Nooralabettu, K. P. (2011) **Enzyme Technology Pacemakar of Biotechnology,** PHI Learning Pvt. Ltd., New Dehli
7. Shanmugam, S. and Sathishkumar, T. (2009) **Enzyme Technology,** I K International, Delhi
8. Satyanaryana, T. (1999) **Biochemistry**, Books and Allied Pvt. Ltd., Calcutta
9. Nelson, D.L. and Cox, M.M. (2000) **Lehninger's Principles of Biochemistry**, CBS Publications, New Delhi.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C202.1	Understand fundamental as well as kinetics of enzyme catalysed reactions	**2**
C202.2	Apply the knowledge to explore applications of various enzymes	**3**
C202.3	Identify how extremophiles act as a source of extremozyme.	**5**

	MB - 203: Immunology	
	Course Objectives: 1. To understand various components of host immune system, its structure and function 2. To acquaint with operational mechanisms of the host defence system, allergy, GVR	
Unit 1	**Overview of the Immune System** • Cells and organs of the immune system • Cytokines and Interleukins • Characteristics and Types: Antigen, Immunogen, Allergen. • Antibody: Types, structure, Antibody diversity (Somatic gene recombination, Genesis of light and heavy chain) • Major Histocompatibility Complex: properties of MHC genes, structure, properties and cellular distribution of MHC molecules, binding of peptides to MHC	**10 L**
Unit 2	**Immune Response** • Cell mediated Immune response: T cell, Types of T cells, T cell activation • Humoral Immune response: B cell, Plasma cell, B cell activation (T dependent and T-independent pathway), regulation of humoral immune responses by Fc receptors • Complement system and Opsonisation • Inflammatory response • Immunologic tolerance: General features of immunologic tolerance, T and B lymphocyte tolerance, tolerance induced by foreign protein antigens	**12 L**
Unit 3	**Hyper immune response** • Graft rejection: Immunological basis, First set and second set of reaction, Significance of HLA and MHC, Immunological Tolerance • Hypersensitivity: types and mechanism with example	**08 L**
Unit 4	**Immune response to infections and diseases** • Immunity against viral and protozoal infections • Cancer immunology: Types of tumours, oncogenesis and tumour antigens (TATAs, TSTA) • Autoimmune diseases: Mechanisms for induction of autoimmunity, Organ-specific and systemic, Treatment of autoimmune diseases • Immunodeficiency diseases (e.g. SCID, CVI, AIDS)	**10 L**
Unit 5	**Histochemical and immunotechniques** • Production of monoclonal and polyclonal antibodies, detection of molecules using ELISA, RIA, western blot, immunoprecipitation and immuno-fluorescence microscopy, • *in situ* localization by FISH and GISH	**10 L**

Suggested readings:

1. Goldsby, R.A., Kindt, T.J. and Osborne, B. and Kuby, A. (2003) **Immunology**, 5th edn., W. H. Freeman and Company, New York.
2. Roitt, I. (2000) **Essentials of Immunology**, 5th edn., Blackwell ELBS Science Publication, Oxford.

3. Paul, W. E (2013) **Fundamental Immunology**, 7th edn., Lippincott Williams and Wilkins Publishers, USA
4. Tizard, I. R. (1995) **Immunology: An Introduction**, Saunders College Publishing, Philadelphia
5. Banerjee, A. K. and Banerjee, N. (2006) **Fundamentals of Microbiology and Immunology**, New Central Book Agency (Pvt.) Ltd., Kolkata
6. Coleman, R.M., Lombard, M.F. and Sicard, R.E. (2000) **Fundamental Immunology**, 4th edn., WmC Publications, London
7. Barrett, James T. (1998) **Microbiology and Immunology Concepts**, Lippincott Williams & Wilkins, Philadelphia, PA
8. Janeway, Charles, Travers, Paul, Walport, Mark and Shlomchik, Mark (2004) **Immunobiology,** Garland Science,
9. Owen, J.A., Punt, J. and Stranford, S.A. (2013) Kuby Immunology, 7th edn, WH Freeman, USA

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C203.1	Understand fundamental basis of immune system and immune response	**2**
C203.2	Apply host defence, allergy, organ transplant and immunological diseases	**3**
C203.3	Use various immunochemical techniques for diagnosis of diseases.	**5**

MB - 204: Methods in Molecular Biology and Immunology

Course Objectives:
1. To impart hands on training in molecular biology and immunochemical techniques
2. To familiarize the student with bacterial gene transfer and immunodiagnostic tools

1	To study bacterial transformation
2	To study bacterial conjugation
3	Isolation and detection of bacterial/ Fungal DNA
4	Plasmid isolation and curing
5	Restriction digestion by endonucleases
6	PCR amplification of DNA
7	To study the spontaneous mutation by Fluctuation test
8	Immuno-diffusion by Ouchterlony double diffusion
9	Immuno-electrophoresis
10	Bacterial gene expression using IPTG inducible promoter
11	ELISA
12	Western/Southern/Northern blot

Suggested readings:

1. Schmauder, H. P., Schweizer, M. and Schweizer, L. M. (2003) **Methods in Biotechnology**, Taylor and Francis, London
2. Joe Sambrook (2001) **Molecular Cloning: A Laboratory Manual**, 3rd Edn., (3 volume set) Cold Spring Harbor Laboratory Press,
3. Sawhey, S.K. and Singh, R. (2002) **Introductory Practical Biochemistry,** Narosa Publication House, New Delhi.
4. Thimmaiah, S.R. (2006) **Standard Methods of Biochemical Analysis**, Kalyani Publishers, Delhi.
5. Davis, L.G., Dibner, M.D. and Battey, J.F. (1986) **Basic Methods in Molecular Biology**, Appleton and Lange, Norwalk.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C204.1	Undertake gene transfer in different bacteria and make use of PCR amplification of DNA.	**5**
C204.2	Apply molecular diagnostic and immunodiagnostic techniques.	**3**

M.Sc. Part I Semester II (Microbiology): Skill Based Course

MB - 205: Methods in Enzymology

Course Objectives:
1. To introduce qualitative and quantitative tools to search for enzyme from microbes
2. To learn enzyme characteristics and identify use of enzyme

Important note: Use any ONE suitable enzyme from microbial source: Amylase/ Protease/ Phytase/ Laccase/ Lipase/ β-Galactosidase/ Xylanase/ Cellulase for the following experiments

1	Qualitative assay of enzyme detection in microbial source
2	Quantitative assay of enzyme (activity and specific activity)
3	Effect of pH and temperature on enzyme activity
4	Effect of activator and inhibitor on enzyme activity
5	Partial Purification of enzyme by ammonium sulphate precipitation and dialysis or solvent Purification fold and purified enzyme yield calculations of enzyme purification procedures
6	Enzyme Purification by Ultrafiltration/
7	Determination of K_m and V_{max} of enzyme
8	Kinetic study of Inhibitors on K_m and V_{max}
9	Native PAGE
10	Enzyme stabilization by immobilization technique: gel entrapment/ crosslinking
11	Production of maltodextrin using amylase or blood stain removal / gelatinolysis of X-ray film by protease
12	Structural prediction using ExPaSy server
13	Determination of enzyme activity in organic solvent media

Suggested readings:

1. Thimmaiah, S.R. (2006) **Standard Methods of Biochemical Analysis**, Kalyani Publishers, Delhi.
2. Bisswanger, Hans (2011) **Practical Enzymology**, Wiley-VCH, Germany
3. Robert Eisenthal and Michael Danson (2002) **Enzyme Assays: A Practical Approach,** 2nd Edn. Oxford University Press, USA
4. Plummer, D.T. (2001) **In introduction to Practical Biochemistry**, 3rd edn., McGraw Hill Ltd. Delhi
5. Sawhey, S.K. and Singh, R. (2002) **Introductory Practical Biochemistry,** Narosa Publication House, New Delhi.
6. Jayaraman, J. (2008) **Laboratory Manual in Biochemistry**, New Age International, New Delhi

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C205.1	Isolate, purify enzyme of interest from microbial system, characterize the	**5**

	enzyme and trace out application(s) of that enzyme	
C205.2	Use the technique of enzyme assay to determine its specific activity, pH and temperature optima, Km, Vmax, Kcat of enzyme and activation energy using Arrhenius plot.	**4**
C205.3	Immobilize enzyme for particular application and familiarize with algorithm for protein	**5**

M.Sc. Part I Semester II : Audit Courses

	AC-201(A): Soft Skills **(Personality and Cultural Development Related Audit course; Practical; 2 Credits)** **(Optional: Campus-level)**	
	Course Objectives (CObs): • To inculcate different soft skills among students.	
Unit 1	**Introduction to soft skills** Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal setting, life skills, Need for soft skills, Communication skills, Etiquettes& Mannerism.	**2 hrs.**
Unit 2	**Self-Assessment** Goal setting, SWOT analysis, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements, positive attitude, positive thinking and self-esteem. Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.	**4 hrs.**
Unit 3	**Communication Skills** Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait, dressing sense, facial expressions, peculiarity of speaker (habits). Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real-life story for 5 minutes each), Oral review (Each student orally presents a review on a story or a book read by them) Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.	**8 hrs.**
Unit 4	**Formal Group Discussion, Personal Interview & Presentation skills** Topic comprehension, Content organization, Group speaking etiquettes, driving the discussion & skills. Preparation for personal interview: dress code, greeting the panel, crisp self-introduction, neatness, etiquettes, language tone, handling embarrassing & tricky questions, graceful closing. Activity: Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback. Mock interview are to be conducted.	**4 hrs.**
Unit 5	**Aptitude and analytical skills** Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking. Analytical skills: Definition, Types, problem solving	**8 hrs.**

Unit 6	**Life skills** Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.	**4 hrs.**

Suggested readings:

1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd.
2. English for Business Communication: Simon Sweeney, Cambridge University Press
3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press
4. Quantitative Aptitude: R.S. Agrawal

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201A.1	Identify their lacunas about some soft skills and try to overcome the same.	**2**
AC201A.2	Practice learned soft skills in real life and do their jobs more effectively.	**3**

AC-201(B): Practicing Sports Activities

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives (CObs):

- To motivate students towards sports and provide them required training.

SR NO.	NAME OF THE SPORT/GAME (Select ONE of the Following)	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMESTER
1	Volleyball	• General Fitness • Basic Fitness • Specific Fitness • History of the Game • Basic Skill of the Game • Major Skill of the Game • Technique & Tactics of the Game • Game Practice	Morning : 07 to 09 AM OR Evening : 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201B.1	Identify one or more sports of their choice and develop more interest to participate at University/National level sport events.	**2**
AC201B.2	Practice the learned sports activities regularly in real life.	**3**

AC-201(C): Practicing Yoga

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives:

- To motivate students towards yoga and provide them required training.

- Yog: Meaning, Definition & Introduction, Objectives
- Primary Introduction of Ashtanga Yoga
- Preparation of Yogabhyas
- Omkar Sadhana, Prayer, Guru Vandana
- Sukshma Vyayamas
- Suryanamaskar (12 Postures)
- Asanas :
  - Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan
  - Supine (Shayansthiti) - Uttan Padaasan(Ekpad/Dwipad), Pavanmuktasana, Viparitakarani Aasan, Khandarasan, Shavasana
  - Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, Saralhasta Bhujangasana, Shalabhasana(Ekpad/Dwipad), Makarasana
  - Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana, Ardh Chakrasana
- Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana - 6 Types
- Pranayama : Anuloma-viloma, Bhramari

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201C.1	Identify and practice some Yoga asanas regularly in their life to remain healthy.	**2**
AC201C.2	Provide guidance and practice about Yoga to their friends, parents and relatives.	**3**

AC-201(D): Introduction to Indian Music

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives:

- To motivate students towards Indian music and provide them minimum required training.
- Definition and brief about generation of Swar, Saptak, Thaat, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc.
- Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa.
- Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information)
- Detailed information of Tambora
- Detailed information of Harmonium and Tablaa.
- Five filmy songs based on Indian Classical Music (Theory and Presentation)
- Sound Management - Basic information of Sound Recording (including Practicals)
- Composition of Music as per the Story
- Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201D.1	Identify different types of Indian music.	**3**
AC201D.2	Develop more interest to learn and practice Indian music.	**4**

Epilogue

Skills imparted:
This is the first-year syllabus of the two-year post-graduate course in Microbiology. Overall, the curriculum is designed in such way that the student will get basic and applied knowledge of the subject. One of the major objectives considered during designing is to create human resource which is technically sound with knowledge having practical utility. The included basic subjects in theory and practical would be helpful to find out unseen facts in various problems in day to day life. The subjects like genetic engineering, and bioinstrumentation are designed in such a way that students will get theoretical and practical knowledge of modern scientific advances in the field. To make skillful human resource with precision, the important allied courses are also included. This course after completion of 2 years would give not only the practical knowledge of industry and industrial processes but also make aware the students with the global environmental problems like pollutions, contamination, infections and food quality.

Practical courses are based on theory courses and are designed to improve research-oriented skills of students.

Job opportunity: The designed curriculum offers job opportunities in various sectors like,
- Pharmaceutical industry: Clinical, medicine, vaccine, QC division
- Biotech industry: Recombinant product, QC, QA
- Agrochemical & pesticide industry
- Chemical industry: synthesis, testing
- Environmental protection industry & Agencies
- Research leading up to Ph. D. degree
- Marketing of biological & pharmaceutical products
- Food and nutraceutical industry, Govt. agencies

Entrepreneurship: This is another avenue available for the candidates making them sound in technical knowledge of Microbiology upon completion of this two year post graduate course that could be useful in Entrepreneurship in Microbiology.

Equivalence

M.Sc. Microbiology (Affiliated Colleges)

Old Syllabus (AY 2018-2019)	New Syllabus (CBCS pattern AY 2021-22)
SEM-I	
MB-101: Microbial Taxonomy and Diversity (T)	**MB-101**: Microbial Taxonomy and Diversity (T)
MB 102: Microbial Biochemistry (T)	**MB 102** - Microbial Physiology and Biochemistry (T)
MB-103: Bioanalytical Techniques (T)	**MB-105**: Bioinstrumentation (T)
MB 104: Methods in Microbiology (P)	**MB 103**: Methods in Microbiology (P)
MB 105: Methods in Biochemistry (P)	**MB 104**: Methods in Microbial Chemistry (P)
SEM-II	
MB-201: Microbial Genetics (T)	**MB 201**: Molecular Biology and Bioinformatics (T)
MB-202: Microbial Enzymology (T)	**MB 202**: Microbial Enzymology (T)
MB-203: Immunology (T)	**MB 203**: Immunology (T)
MB-204: Methods in Enzymology (P)	**MB 205**: Methods in Enzymology (P)
MB-205: Methods in Molecular Biology & Immunology (P)	**MB 204**: Methods in Molecular Biology & Immunology (P)

AY: Academic Year, (T) : Theory, (P): Practical

==x==

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

।।अंतरी पेटवू ज्ञानज्योत।।

SYLLABUS

for

Master of Science (M. Sc.) [Mathematics]

Choice Based Credit System

(Outcome Based Curriculum)

2021 - 2022

Summary of Distribution of Credits under CBCS Scheme for M.Sc. (Mathematics)

Sr. No	**Type of course**	**Sem I**	**Sem II**	**Sem III**	**Sem IV**
01	Core	**16**	**16**	**16**	**12**
02	Skill based	**04**	**04**	**-**	**-**
03	Elective	**-**	**-**	**04**	**08**
04	Project	**-**	**-**	**-**	**-**
05	Audit	**02**	**02**	**02**	**02**
06	Total Credits	**22**	**22**	**22**	**22**

Subject Type	**Core**	**Skill based**	**School Elective**	**Project**	**Audit**	**Total**
Credits	**60**	**08**	**12**	**00**	**08**	**88**

Total Credits = 88

Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon

M. Sc. (Mathematics)

Choice Based Credit System (Outcome Based Curriculum) with effect from 2021 -2022

Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Practical)	Total Credits	
I	4	16	**16**	1	4 + 0	4	1	2	2	**22**
II	4	16	**16**	1	4 + 0	4	1	2	2	**22**
III	4	16	**16**	1	4 + 0	4	1	2	2	**22**
IV	4	12	**12**	2	8 + 0	8	1	2	2	**22**
Total Credits	**60**			**20**			**8**			**88**

(T, Theory; P, Practical)

Structure of Curriculum

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
(A)	**Prerequisite and Core Courses**									
	Theory	4	4	4	4	4	4	4	3	60
	Practical	0	0	0	0	0	0	0	0	00
(B)	**Skill Based / Subject Elective Courses**									
1	Theory /Practical	4	1	4	1	4	1	4	2	20
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course			2	1					2
3	Technology Related + Value Added Course					2	1			
4	Professional and Social + Value Added Course							2	1	2
	Total Credit/ Courses	22	6	22	6	22	6	22	6	88

List of Audit Courses (Select any ONE course of Choice from Semester II; Semester III and Semester IV)							
Semester I (Compulsory)		**Semester II** (Choose One)		**Semester III** (Choose One)		**Semester IV**(Choose One)	
		Personality and Cultural Development		**Technology + Value Added Course**		**Professional and Social + Value Added Course**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Sport Activities	AC-301B	Cyber Security	AC-401B	Current Affairs
		AC-201C	Yoga	AC-301C	Project work on typesetting in Latex	AC-401C	Review +Seminar of Research Papers in Mathematics
		AC-201D	Music	AC-301D	Project work on Recent topics in Mathematics	AC-401D	Vedic Mathematics

Semester-wise Course Structure of M.Sc. Mathematics

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
MT-101	Core	Advanced Real Analysis	4	--	4	40	--	60	--	4
MT -102	Core	Topology	4	--	4	40	--	60	--	4
MT -103	Core	Abstract Algebra	4	--	4	40	--	60	--	4
MT -104	Core	Partial Differential Equations	4	--	4	40	--	60	--	4
MT -105	Skill Based	Programming in C++	4	--	4	40	--	60	--	4
AC -101	Audit Course	Practicing Cleanliness	--	2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 16; P = Practical:00; Skill Based:04; Audit Course:02)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
MT -201	Core	Number Theory	4	--	4	40	--	60	--	4
MT -202	Core	Complex Analysis	4	--	4	40	--	60	--	4
MT -203	Core	Linear Algebra	4	--	4	40	--	60	--	4
MT -204	Core	Classical Mechanics	4	--	4	40	--	60	--	4
MT -205	Skill Based	Python Programming	4	--	4	40	--	60	--	4
AC-201 A/B/C/D	Audit Course	Choose one out of Four (AC-201A/ AC-201B/AC-201C/AC-201D) from Personality and Cultural Development	--	2	2	--	100	--	--	2
Total Credit for Semester II: 22 (T = Theory Course: 16; P = Practical:00; Skill Based course:04; Audit course:02)										

Semester III

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
MT-301	Core	Topics in Functional Analysis	4	--	4	40	--	60	--	4
MT -302	Core	Numerical Analysis	4	--	4	40	--	60	--	4
MT -303	Core	Topics in Field Theory	4	--	4	40	--	60	--	4
MT -304	Core	Fluid Dynamics	4	--	4	40	--	60	--	4
MT -305	Elective (Select any **one**)	Statistical Techniques	4	--	4	40	--	60	--	4
MT -306		Lattice Theory								
AC-301 A/B/C/D	Audit Course	Choose one out of Four (AC-301A/ AC-301B/AC-301C/AC-301D) from Technology + Value Added Courses	--	2	2	--	100	--	--	2
Total Credit for Semester III: 22 (T = Theory Course: 16; P = Practical:00; Elective Course:4; Audit Course:02)										

Semester IV

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
MT-401	Core	Linear Integral Equations	4	--	4	40	--	60	--	4
MT -402	Core	Operations Research	4	--	4	40	--	60	--	4
MT -403	Core	Commutative Algebra	4	--	4	40	--	60	--	4
MT -404	Elective (Select any **two**)	Advanced Abstract Algebra	8	--	8	40	--	60	--	8
MT -405		Algebraic Topology								
MT -406		Theory of Special Functions								
MT -407		Cryptography								
AC-401 A/B/C/D	Audit Course	Choose one out of Four (AC-401A/ AC-401B/ AC-401C/ AC-401D) from Professional and Social + Value Added Courses	--	2	2	--	100	--	--	2
Total Credit for Semester IV: 22 (T = Theory Course: 12; P = Practical:00; Elective Course:08; Audit Course:02)										

Program at a Glance

Name of the program (Degree)	: M. Sc. (Name of the Subject)
Faculty	: Science and Technology
Duration of the Program	: Two years (four semesters)
Medium of Instruction and Examination	: English
Exam Pattern	: 60 : 40 (60 marks University exam and 40 marks continuous internal assessment)
Passing standards	: 40% in each exam separately (separate head of passing)
Evaluation mode	: CGPA
Total Credits of the program	: 88 (60 core credits, 08 Skill enhancement credits, 12 Elective credits and 08 audit credits)

Program Objectives for M.Sc. Mathematics Program:

- To prepare skilled manpower with scientific knowledge of Mathematics for solving real life and industrial based problems
- To inculcate critical thinking to carry out scientific investigations in Mathematics.
- To equip the student with mathematical, software based and social thinking based skills to analyze problems, formulate hypothesis, evaluate or validate results, and draw reasonable conclusions thereof.
- Prepare students to purse research or careers in mathematical sciences and allied fields
- Imbibe effective scientific and technical communication in both oral and writing.

Program Outcomes (PO) for M.Sc. Mathematics Program:

Upon successful completion of the M.Sc. program, student will be able to:

PO No.	PO	Cognitive level
PO1	Understand the fundamental axioms in mathematics and equipped with the capabilities of developing ideas based on them	2
PO2	Develop themselves as a professionals in mathematics	6
PO3	Carry our scientific research in mathematics and related fields.	5
PO4	Apply mathematical methods/tools/skills in other scientific, engineering and industrial domains	3
PO5	Nurture problem solving skills, social thinking, creativity through skill and audit based courses.	4
PO6	Prepare themselves for competitive examinations	3

Program Specific Objectives for M.Sc. Mathematics program:

- To provide quality education through effective teaching learning processes by introducing Choice based credit systems and latest software skills.
- Enable students to enhance mathematical skills and understand the fundamental concepts of pure and applied mathematics.
- To provide an opportunity through up to date curriculum to develop scientific temper among the students results into skilled manpower.
- To inculcate innovative skills, team work, ethical practices among students so as to meet societal expectations through audit courses.
- To inculcate the inquisitiveness for mathematics and motivate the students for research in mathematics. .

Program Specific Outcomes (PSOs) for M.Sc. Mathematics program:

Students who graduate with a Master of Science in **Mathematics** will:

PSO No.	PSO	Cognitive level
PSO1	Understand the technicalities of mathematics and software's to explore the acquire knowledge for further developments.	2
PSO2	Employ confidently the techniques of mathematics for solving problems and scientific investigations.	4
PSO3	Apply the knowledge of mathematical concepts in interdisciplinary fields.	3
PSO4	Continue to acquire mathematical knowledge and skills appropriate for their professional activities and demonstrate highest standard and ethics.	6
PSO5	Pursue research in advanced areas of pure and applied mathematics.	5
PSO6	Qualify national level tests like NET/SET/GATE etc.	4

Distribution of Course papers for M. Sc. Part I (Mathematics)

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part I					
Semester I : Theory Courses					
MT-101	Advanced Real Analysis	Core course	04	100	03
MT -102	Topology	Core course	04	100	03
MT -103	Abstract Algebra	Core course	04	100	03
MT -104	Partial Differential Equations	Core course	04	100	03
MT -105	Programming in C++	Skill based	04	100	03
Semester I : Audit Courses					
AC-101		Audit Course	02	100	--
Semester II : Theory Courses					
MT -201	Number Theory	Core course	04	100	03
MT -202	Complex Analysis	Core course	04	100	03
MT -203	Linear Algebra	Core course	04	100	03
MT -204	Classical Mechanics	Core course	04	100	03
Semester II : Practical Courses					
MT -205	Python Programming	Skill based	04	100	03
AC-201A/B/C/D	Choose one out of Four (AC-201A/ AC-201B/ AC-201C/ AC-201D) from Personality and Cultural Development (Audit Course)	Audit Course	02	100	--

	MT-101: Advanced Real Analysis	Lecture
	Course Objectives: The aim of this course is • To understand basic elements of measure theory such as measurable sets, functions. • To solve Lebesgue integration and differentiation. • To understand the concepts of abstract measure theory with the help of classical Banach spaces.	
Unit 1	Countable and uncountable sets, Infinite sets and the axioms of choice, Cardinal numbers and their arithmetic, Schroeder- Bernstein theorem, Cantor's theorem and the continuum Hypothesis, Zorn's lemma, Well Ordering principle, Cantor set, Cantor like sets, The Lebesgue functions.	08 L
Unit 2	Measure on the real line: Lebesgue Outer measure, Measurable sets, Regularity, Measurable functions, Borel sets and Lebesgue measurability.	17 L
Unit 3	Integration of functions of a real variable, Integration of nonnegative function, The general integral, Integration of series, Riemann and Lebesgue integrals.	15 L
Unit 4	Differentiation: The four derivatives, Functions of bounded variation, Lebesgue differentiation theorem, Differentiation and Integration.	10 L
Unit 5	Differentiation of monotone function: Vitali covering theorem (lemma), Fundamental theorem for integral calculus for Lebesgue integral, Absolutely continuous functions.	10 L

Suggested readings:

1. G. de Barra, (2000) **Measure Theory and Integration**, New Age International (p) Limited, New Delhi. **(Chapter 1. Art 1.5,1.7, Chapter 2. Art 2.1,2.5, Chapter 3 Art 3.1 to 3.4 Chapter 4 Art 4.1, 4.3 to 4.5 Chapter 9 Art 9.3)**
2. H. L.Royden,(2009) **Real analysis**, Prentice-Hall of India (P) Limited, New Delhi, 4th Edition **(Chapter Art-1)**

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C101.1	Acquire fundamentals of Countability, Continuum hypothesis and Zorn's lemma	2
C101.2	Understand and analyze Lebesgue measure, measurable functions and their properties	4
C101.3	Solve integrations of functions not necessarily defined on closed sets and verify their properties.	3

	MT-102: Topology	
	Course Objectives: • Students will learn the concept of topology, topology generated by basis. • Students will learn, subspaces, closed sets, limit points of a set. • Students will learn continuous functions on topological spaces, product topology, metric topology. • Students will learn connectedness of a set, compactness and separation axioms	
Unit 1	Topological Spaces, Basis for a Topology, The Order Topology, The Product Topology on $X \times Y$, The Subspace Topology, Closed Sets and Limit Points,	12L
Unit 2	Continuous Functions, The Product Topology, The Metric Topology, The Quotient Topology	12L
Unit 3	Connected Spaces, Connected Subspaces of the Real Line, Components and Local Connectedness	12L
Unit 4	Compact Spaces, Compact Subspaces of the Real Line, Limit Point Compactness, Local Compactness	12L
Unit 5	The Countability Axioms, The Separation Axioms, Normal Spaces, The Urysohn Lemma, The Tietze Extension Theorem(Sec 30-33, 35 [1])	12L
Suggested readings: 1. J. R. Munkres, (1992) **Topology (A first course)**, Prentice Hall of India Ltd. (Sections 12-17, 18-20, 22-33) 2. K. D. Joshi: **Introduction to general topology**, New Age International Private Limited) 3. C. Wayne Patty , **Foundations of Topology**, Jones and Bartlett Publishers, Inc; 2nd edition		

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C102.1	understand the definition of topology, examples, basis, order topology.	2
C102.2	understand the subspaces, closed sets, limit points of a set.	2
C102.3	understand continuous functions on topological spaces, product topology, metric topology.	2
C102.4	understand connectedness of a set, compact ness and separation axioms.	2

	MT - 103: Abstract Algebra	Lecture
	Course Objectives: 1. To know the concept and applications of Finite groups. 2. To study well known theorems for finite groups: Cauchy's Theorem, Sylow's Theorem, Jordan - Holder Theorem. 3. To know concepts of particular types of integral domains: ED, PID, UFD.	
Unit 1	**Finite groups:** Direct products, External direct product of groups, Conjugate classes, Class equation, Cauchy's Theorem.	12 L
Unit 2	**Sylow theorems and solvable groups:** Sylow p-subgroups, Sylow theorems, Solvable group, Normal series, Composition series, Jordan-Holder Theorem.	15 L
Unit 3	**Integral domains:** Greatest common divisor, prime element, irreducible element, Euclidean domain, principal ideal domain, Factorization domain, Unique Factorization domain.	15 L
Unit 4	**Polynomial rings:** Polynomial rings, Roots of polynomials, Eisenstein's criterion, primitive polynomial, Gauss lemma, Gaus theorem, factorization of polynomials.	12 L
Unit 5	**Noetherian rings:** Finitely generated ideals, Chain conditions, Noetherian rings, Hilbert basis theorem.	06 L

Suggested readings:

1. Gopalakrishnan N. S. (2018), **University Algebra**, Wiley Eastern Limited, New Delhi. (Sec. 1.10, 1.12, 1.13, 1.14, Sec. 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16).
2. Gopalakrishnan N. S. (2016), **Commutative Algebra**, Universities Press (India) Pvt. Ltd. (Sec. 3.1).
3. Herstein I. N. (1975), **Topics in Algebra**, John Wiley and Sons, New Delhi.
4. Jacobson N. (2012), **Basic Algebra-I**, Second Edition, Hindustan Publishing Corporation.
5. Fraleigh J. B. (2003), **A first Course in Abstract Algebra**, Pearson.
6. Bhattacharya P.B., Jain S.K. and Nagpaul S.R. (1994), **Basic Abstract Algebra**, Cambridge Press.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C103.1	Understand class equation for finite groups and its applications.	2
C103.2	Explain Sylow theory and solvable groups.	3
C103.3	Learn Euclidean domains, Principal ideal domains, unique factorization domains, Noetherian rings and the Hilbert Basis Theorem.	4

	MT - 104: Partial Differential Equations	Lecture
	Course Objectives: • To understand the concepts and applications of Differential equations. • To improve problem solving and logical thinking abilities of students. • To use the concepts of Differential equations to develop mathematical skills.	
Unit 1	**Partial Differential Equations of First Order:** First order PDE, classification of integrals, Linear equations of first order, Pfaffian differential equations, compatible systems, Cauchy Problem, Integral surfaces through a given curve for partial differential equations, Charpit's method, Jacobi's method.	15 L
Unit 2	**Partial Differential Equations of Second Order:** Origin of second order partial differential equation, Linear equations with constant coefficients, Equations with variable coefficients, Method of separation of variables, Nonlinear equations of the second order.	15 L
Unit 3	**Laplace Equation:** The occurrence of Laplace's equation in physics, Elementary solution of Laplace's equation, Families of equipotential surfaces, Boundary value problems, Method of separation of variables	10L
Unit 4	**The Wave Equation:** The occurrence of wave equation in physics, Elementary solutions of the one-dimensional wave equation, Riemann-Volterra solution of the one-dimensional wave equation, Method of separation of variables.	10 L
Unit 5	**The Diffusion Equation:** The occurrence of the diffusion equation in physics, Elementary solutions of the diffusion equation, Separation of variables.	10 L

Suggested readings:

1. Sneddon, I. N.(1957) **Elements of Partial Differential Equations**, McGraw Hill, New York
2. Amarnath, T. (2008) **An Elementary Course in Partial Differential Equations**, 2nd Edition, Narosa Publishing House.
3. John, F. (1982) **Partial Differential Equations**, Springer-Verlag, New York.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C104.1	Find solutions of partial differential equations and determine the existence, uniqueness of solution of partial differential equations.	3
C104.2	Apply the concepts of partial differential equations to solve problems in allied fields.	3
C104.3	Know the important theorems and their applications.	4

	MT 105 Programming in C++	Lecture
	Course Objectives: The objectives of this course are: • To understand how C++ improves C with object-oriented features. • To learn how to write inline functions for efficiency and performance. • To learn how to design C++ classes for code reuse and to learn how to overload functions and operators in C++.	
Unit 1	**Principles of Objective Oriented Programming** Object Oriented Programming Paradigm, Basic Concepts of Object Oriented Programming, Benefits of Object Oriented Programming, Object Oriented Languages, Applications of Object Oriented Programming, C++.	12 L
Unit 2	**Token Expressions & Control Structures** Tokens, Keywords, Identifiers and Constants, Data Types, Type Compatibility, Variables, Operators in C++,Implicit Conversions, Operator Overloading, Operator Precedence, Control Structures.	12 L
Unit 3	**Functions in C++, Classes & Objects.** The Main Function, Function Prototyping, Call by Reference, Return by Reference, Inline Functions, Function Overloading, Friend and Virtual Functions. Specifying a class, Member Functions, Arrays within a class, Static Member Functions, Arrays of Objects, Friendly Functions.	12 L
Unit 4	**Constructors & Destructors, Operator Overloading, Inheritance** Constructors, Parameterized Constructors, Copy Constructors, Dynamic Constructors, Destructors, Defining Operator Overloading, Overloading Operators, Rules for Overloading Operators, Type Conversions	12 L
Unit 5	**Pointers, Virtual Functions & Polymorphism, Working with Files, Exception handling** Pointers, Pointers to Objects, this pointer, Pointer to Derived Classes, Virtual Functions, Classes for File Stream Operations, Opening and Closing a File, File Modes, File Pointers, Input Output Operations, Updating a File	12 L

Suggested readings:

1. E. Balaguruswamy, (2012) **Object-Oriented Programming with C++**, 5th Edition, Tata McGraw Hill, New Delh
2. John R. Hubbard,(2000) **Schaum's Outline of Fundamentals of Computing with C++**, Schaum's Outline Series.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C105.1	Visualize the features of C++ supporting object-oriented programming.	1
C105.2	Construct how to produce object-oriented software using C++	3
C105.3	Survey the major object-oriented concepts to implement object-oriented programs in C++, encapsulation, inheritance and polymorphism	4

AC-101: Practicing Cleanliness

(Compulsory; Campus-level Audit Course; Practical; 2 Credits)

Course Objectives (CObs):

- To make students aware of Clean India Mission and inculcate cleanliness practices among them.

	• Awareness program on o Swachh Bharat Abhiyan (Clean India Mission) o Clean Campus Mission o Role of youth in Clean India Mission • Cleaning activities inside and surroundings of Department buildings. • Tree plantation and further care of planted trees • Waste(Liquid/Solid/e-waste) Management, Japanese 5-S practices • Planning and execution of collection of Garbage from different sections of University campus • Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance. • Cleanest School/Department and Cleanest Hostel contests • Painting and Essay writing competitions	

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC101.1	Identify need at of cleanliness at home/office and other public places.	2
AC101.2	Plan and observe cleanliness programs at home and other places.	4
AC101.3	Practice Japanese 5-S practices in regular life.	3

	MT - 201: Number Theory	Lecture
	Course Objectives: • To know concept of arithmetic functions. • To study congruences and quadratic residues. • To know the concepts of primitive root theory.	
Unit 1	**Arithmetic functions:** The Mobius function $\mu(n)$, The Euler totient function $\phi(n)$, Dirichlet product of arithmetic functions, Dirichlet inverses and the Mobius inversion formula. The Mangolt function $\Lambda(n)$, Multiplicative functions	12 L
Unit 2	**Dirichlet multiplication and Formal power series:** Dirichlet multiplication, The inverse of a completely, multiplicative function, Liouvilles function $\lambda(n)$, The divisor function $\sigma(n)$, Generalized convolutions. Formal power series, Bell series of an arithmetical function, Bell series and Dirichlet multiplication, Derivatives of arithmetical functions, The Selberg identity.	12 L
Unit 3	**Congruences:** Residue classes, Complete and reduced residue systems and Euler-Fermat's theorem, Polynomial congruences $mod\ p$. Lagranges theorem and its applications, Polynomial congruences with prime power moduli. The principle of cross classification.	12 L
Unit 4	**Quadratic residues and Quadratic Reciprocity law:** Quadratic residues, Legendre's symbol and its properties, Evaluation of $(-1 \mid p)$ and $(2 \mid p)$, Gauss lemma, The Quadratic Reciprocity law and its applications, The Jacobi Symbol. Applications to Diophantine equations.	12 L
Unit 5	**Primitive roots:** The exponent of a number modulo m, Primitive roots, Primitive roots and reduced residue systems, The non-existence of primitive roots $mod\ p^n$ and $2p^n$ for odd primes p and $n \geq 1$. The non-existence of primitive roots in the remaining cases. The number of primitive roots $mod\ m$. The primitive roots and quadratic residues. The index calculus.	12 L

Suggested readings:

1. Apostol T. M. (1972), **Introduction to Analytic Number Theory**, Springer International Student Edition. (Sec. 2.1 - 2.19, Sec. 5.2, 5.4, 5.5, 5.6, 5.9, 5.10, Sec. 9.1 to 9.8, Sec. 10.1 to 10.10)
2. Burton D. M. (1980), **Elementary Number Theory**, Universal Book Stall.
3. Silverman Joseph H. (2001), **A Friendly Introduction to Number Theory** (Second Edition), Prentice Hall.
4. Niven Ivan, Zuckerman Herbert S. and Montgomery Hugh L. (1991), **An introduction to the theory of numbers** (Fifth Edition), John Wiley and sons.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C201.1	Understand the concept of Mobius function $\mu(n)$, The Euler totient function $\phi(n)$, Mangolt function $\Lambda(n)$, Liouvilles function $\lambda(n)$, The divisor function $\sigma(n)$, Bell series.	2
C201.2	Explain Residue classes, Lagrange's theorem and its applications, Polynomial congruences with prime power moduli.	2
C201.3	Learn Quadratic residues, existence and non-existence of primitive roots.	2

M.Sc. Part I Semester II (Mathematics): Core Courses

	MT - 202: Complex Analysis	Lecture
	Course Objectives: • To make student aware of advances in complex analysis • To know Mobius transformation and conformal mappings • To Improve the logical thinking ability to find applications	
Unit 1	Power series, Analytic functions, Branch of a logarithm, Mobius (Bilinear) Transformations and Conformal Mappings.	10 L
Unit 2	Riemann-Stieltjes Integrals, Power Series representation of analytic functions, Taylor's Theorem, Cauchy's Estimate, Zeros of an analytic function, Liouville's theorem, Fundamental Theorem of Algebra, Maximum Modulus Theorem.	15 L
Unit 3	Index of a closed curve, Cauchy's theorem, Cauchy's Integral Formula, Higher Order derivatives, Morera's Theorem, The Homotopic version of Cauchy's Theorem and simple connectivity, Counting of Zeros, The Open mapping theorem, Goursat's theorem.	10L
Unit 4	Singularities, Classification of Singularities, Laurent's series, Casorati-Weierstrass theorem, Residues, Cauchy's residue theorem, Evaluation of integrals, Meromorphic functions, The Argument principle, Rouche' theorem, Schwartz lemma.	15 L
Unit 5	Convex functions and Hadamard's three circles theorem, The space of continuous functions, Spaces of analytic functions, The Riemann mapping theorem	10 L

Suggested readings:

1. J. B. Conway, (1995) **Functions of One Complex variable,** Springer Int. Student Edition.
2. S. Ponnusammy and H. Silverman (2006) **Complex Variables with Applications**, Birkhauser.
3. S. Ponnusammy: **Foundations of Complex Analysis**, 2nd edition Alpha, Narosa Publishing House.
4. L. V. Ahlfors, (1996) **Complex Analysis**, McGraw-Hill Book Co.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C202.1	Acquire useful knowledge of complex analysis	1
C202.2	understand the concept of power series about complex analysis	1
C202.3	solve the complex integration in various forms	4
C202.4	gain the knowledge of singularities	1
C202.5	prepare themselves for competitive examinations:SET, NET, GATE etc.	3

	MT - 203: Linear Algebra	Lecture
	Course Objectives: • To develop skills and to acquire knowledge of Linear Algebra, Rings and Modules • To prepare students for further courses in mathematics and/or related disciplines (e.g. Commutative algebra, homological agebra, etc.). • To develop the ability to demonstrate underlying principles of the subject and the ability to solve unseen mathematical problems.	
Unit 1	Modules, Submodules, R-homomorphism, Isomorphism.	12 L
Unit 2	Cyclic modules, Faithful modules, Direct sum of modules, free modules, Rank.	12 L
Unit 3	Torsion and Torsion free modules, Structure theorem for finitely generated modules over PID, Application to group Theorem.	12 L
Unit 4	Jordan and Rational canonical forms.	16 L
Unit 5	Local rings, Noetherian modules, Primary decomposition for modules.	08 L

Suggested readings:

1. N. S. Gopalkrishnan (1988) **University Algebra**, Wiley – Eastern. (Sec. 3.6, 3.7, Sec. 5.10)
2. C. S. Musli (2001) **Introduction to Rings & Modules**. Cambridge University Press. (Sec. 2.1, 2.2, 2.3, 3.2)
3. I. N. Herstein (1988) Topics in Algebra, Wiley – Eastern.
4. M. F. Atiyah and I. G. MacDonald (2018) **Algebra**, CRC Press, Boca Raton.
5. J. Lambek (1966) **Lectures on Rings and Modules**, Blaisdell Publications, Massachusetts.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C203.1	Understand and interpret the concepts of modules and submodules, Homomorphism and isomorphism in modules, types of modules and group theorem.	2
C203.2	Understand the concepts of Jordan and Rational canonical forms and use them to solve problems involved in matrix theory and computer algebra.	2
C203.3	Understand the concepts of Local rings and modules, Noetherian modules, Primary decomposition for modules.	2

	MT - 204: Classical Mechanics	Lecture
	Course Objectives: • Gain deeper conceptual understanding of classical mechanics. • To understand how to represent the equations of motion for complicated mechanical systems using the Langrangian and Hamiltonian formulations of classical mechanics. • Advance skills and capability for formulating and solving problems.	
Unit 1	Mechanics of particle, Mechanics of the system of particle, constraints and their type, D'Alembert's principle and Lagrange's equations, velocity dependent potential and the dissipation function, simple applications of the Langrangian formations.	10 L
Unit 2	Hamilton's principle some techniques of the calculus of variations, Derivation of Langrangian equations from Hamilton's principle, Generalised coordinates, Holonomic & Non-holonomic systems, Extension of Hamilton's principle to non-holonomic system, Lagranges Equations of first kind and second kind, uniqueness of solution, conservation theorems and symmetry properties.	10 L
Unit 3	The independent co-ordinates of a rigid body, orthogonal transformations Formal properties of the transformations matrix, The Euler angles, The Cayley-Klein parameters and related quantities finite rotations, Rate of the change of a vector, linear momentum, Angular momentum and Kinetic energy of motion about a point. Tensors and dyadics, The inertia tensor and the moment of inertia, The eigen values of the inertia tensor and Principle axis transformations.	15 L
Unit 4	Legendre transformations and the Hamilton equation of motion, cyclic coordinates and conservation theorems, Routh's equations, Derivation of Hamilton's equation from a variational principle, The principle of least action.	10 L
Unit 5	The equations of canonical transformations, Generating Functions, Examples of Canonical transformations, Conditions for a transformation to be Canonical, Bilinear invariant conditions, Definition, Identities, Poisson theorem, Jacobi-Poisson theorem, Jacobi identity(statement only), Poisson Brackets, properties, Invariance of Poisson Bracket's with respect to Canonical transformations, Poisson's identity	15 L

Suggested readings:

1. H. Goldstein (2011), **Classical Mechanics**, Narosa Publishing Home, New Delhi. (1.1-1.6, 2.1-2.7, 4.1-4.5,4.9,5.1-5.4, 8.1-8.6, 9.1-9.6)
2. Carban and Steble, **Classical Mechanics**, John Wiley press Cambridge
3. Marian, (1970) **Classical Dynamics of particle & system**, Academic Press
4. Sudarsan & Mukunda (2015), **Classical Mechanics**, World Scientific Publishing Co Pte Ltd
5. J. C. Upadhyaya (2019), **Classical Mechanics,** Himalaya Publishing House.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C204.1	Define and understand basic mechanical concepts related to advanced problems of classical mechanical systems and application of Langrangian formation	3
C204.2	Derived the Lagrange's equation and Hamilton principle.	2
C204.3	Demonstrate knowledge and understanding of fundamental concept-- the Cayley-Klein parameters,linear & angular momentum, Tensors and dyadic, and Principle axis transformations.	3
C204.4	Understand the concept of Legendre's transformation and apply to derived the Hamilton's Equation.	2
C204.5	Understand the concept of canonical transformation and apply to derived Poisson's Identity&Poisson's Bracket's	2

	MT - 205: Python Programming	Lecture
***Course Objectives*:** • To acquire proficiency in using different functions and capabilities of Python. • To demonstrate the use of Python to for plotting. • Be familiar with the built-in functions and Sympy module to solve problems in Algebra		
Unit 1	Installing Python, IDLE, Typing, Getting input, Printing, Variables, (Book [1])	12 L
Unit 2	For loop, numbers. Math operator, math functions, if, elseif statements (Book [1])	12 L
	strings, lists, while loop, Functions, arguments, local variables (Book [1])	12 L
Unit 3	Visualing data with graphs: Understanding the Cartesian Coordinate Plane, Working with Lists and Tuples, Creating Graphs with Matplotlib, Customizing Graphs, Plotting with Formulas, Newton's Law of Universal Gravitation, Projectile Motion. (Book [2])	12 L
Unit 4	Algebra and Symbolic math with Sympy: Defining Symbols and Symbolic Operations. Working with Expressions, Solving Equations, Solving Quadratic Equations, Solving for One Variable in Terms of Others, Solving a System of Linear Equations, Plotting Using SymPy, Plotting Expressions Input by the User, Plotting Multiple Functions. (Book [2])	12 L
Suggested readings: 1. Heinold Brian, (2012), **A Practical Introduction to Python Programming**, (Licensed under a Creative Commons Attribution-Non commercial-Share Alike 3.0 Unported License) Available online. (Ch: 1-4, 6-7, 9, 13) 2. Shah Amit, (2015), **Doing Math with Python**, No Starch Press Inc. William Pollock, USA. (Ch:2 and Ch: 4)		

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C205.1	Acquire skill in Python package particularly basics of Python	**2**
C205.2	Represents data with the help of plotting in Python	**3**
C205.3	Understand symbolic mathematics and solve system of equations with Python programming.	**3**

	AC-201(A): Soft Skills (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional:)	
	Course Objectives (CObs): • To. Acquire spoken English skill for all development • To develop personality development of the students • To improve group discussion, interview and presentation skill among the students	
Unit 1	**Introduction to soft skills** Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal setting, life skills, Need for soft skills, Communication skills, Etiquettes& Mannerism.	2 h
Unit 2	**Self-Assessment** Goal setting, SWOT analysis, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements, positive attitude, positive thinking and self-esteem. Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.	4 h
Unit 3	**Communication Skills** Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait, dressing sense, facial expressions, peculiarity of speaker (habits). Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real-life story for 5 minutes each), Oral review (Each student orally presents a review on a story or a book read by them) Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.	8 h
Unit 4	**Formal Group Discussion, Personal Interview & Presentation skills** Topic comprehension, Content organization, Group speaking etiquettes, driving the discussion & skills. Preparation for personal interview: dress code, greeting the panel, crisp self-introduction, neatness, etiquettes, language tone, handling embarrassing & tricky questions, graceful closing. Activity: Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback. Mock interview are to be conducted.	4 h
Unit 5	**Aptitude and analytical skills** Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic	8 h

	test, situational tests, logical thinking. Analytical skills: Definition, Types, problem solving	
Unit 6	**Life skills** Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.	4 h

Suggested readings:

1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd.
2. English for Business Communication: Simon Sweeney, Cambridge University Press
3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press
4. Quantitative Aptitude: R.S. Agrawal

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201A.1	Improve communication skill	3
AC201A.2	Take self assessment and think of SWOT analysis	3
AC201A.2	Able to face interviews and do presentations with confidence.	3

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AC-201(B): Practicing Sports Activities

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives (CObs):

- To motivate students towards sports and provide them required training.

SR NO.	NAME OF THE SPORT/GAME (Select ONE of the Following)	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMESTER
1	Volleyball	• General Fitness • Basic Fitness • Specific Fitness • History of the Game • Basic Skill of the Game • Major Skill of the Game • Technique & Tactics of the Game • Game Practice	Morning : 07 to 09 AM OR Evening : 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201B.1	Acquire sport skill among them self	3
AC201B.2	Keep them self physical and mentally fine.	3

AC-201(C): Practicing Yoga (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional:)	
	Course Objectives: • To motivate students towards yoga and provide them required training.
	• Yog: Meaning, Definition & Introduction, Objectives • Primary Introduction of Ashtanga Yoga • Preparation of Yogabhyas • Omkar Sadhana, Prayer, Guru Vandana • Sukshma Vyayamas • Suryanamaskar (12 Postures) • Asanas : ▪ Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan ▪ Supine (Shayansthiti) - Uttan Padaasan(Ekpad/Dwipad), Pavanmuktasana, Viparitakarani Aasan, Khandarasan, Shavasana ▪ Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, Saralhasta Bhujangasana, Shalabhasana(Ekpad/Dwipad), Makarasana ▪ Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana, Ardh Chakrasana • Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana - 6 Types • Pranayama : Anuloma-viloma, Bhramari

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201C.1	Acquire Yoga skills for mental and physical health	3
AC201C.2	Develop self confidence for problems arise in their real life.	3

<table>
<tr><th colspan="2">AC-201(D): Introduction to Indian Music
(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)</th></tr>
<tr><td></td><td>Course Objectives:
• To motivate students towards Indian music and provide them minimum required training.</td></tr>
<tr><td></td><td>• Definition and brief about generation of Swar, Saptak, Thaat, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc.
• Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa.
• Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information)
• Detailed information of Tambora
• Detailed information of Harmonium and Tablaa.
• Five filmy songs based on Indian Classical Music (Theory and Presentation)
• Sound Management - Basic information of Sound Recording (including Practicals)
• Composition of Music as per the Story
• Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.</td></tr>
</table>

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201D.1	Identify different types of Indian music.	3
AC201D.2	Develop more interest to learn and practice Indian music.	4

Distribution of Course papers for M.Sc. Part II (Mathematics)

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part II (Mathematics)					
Semester III : Theory Courses					
MT-301	Topics in Functional Analysis	Core course	04	100	03
MT-302	Numerical Analysis	Core course	04	100	03
MT-303	Topics in Field Theory	Core course	04	100	03
MT-304	Fluid Dynamics	Core course	04	100	03
MT -305	Statistical Techniques	Elective Course (Any one)	04	100	03
MT -306	Lattice Theory				
AC-301A/B/C/D	Choose one out of Four (AC-301A/ AC-301B/AC-301C/AC-301D) from Technology + Value Added Courses	Audit course	02	100	--
Semester IV : Theory Courses					
MT-401	Linear Integral Equations	Core course	04	100	03
MT-402	Operations Research	Core course	04	100	03
MT-403	Commutative Algebra	Core course	04	100	03
MT-404	Advanced Abstract Algebra	Elective courses (Any two)	08	100	03 (for each corse)
MT-405	Algebraic Topology				
MT-406	Theory of Special Functions				
MT-407	Cryptography				
AC-401A/B/C/D	Choose one out of Four (AC-401A/ AC-401B/AC-401C/AC-401D) from Professional and Social + Value Added Courses	Audit course	02	100	--

	MT-301: Topics in Functional Analysis	Lectures
	Course Objectives: • To acquire concepts and results of normed linear space, inner product spaces and some linear operations • The normed linear spaces which are complete metric space are especially very important for developing problem solving capabilities.	
Unit I	Normed linear spaces, Banach Spaces, Quotient spaces, Continuous linear Transformations. The Hahn-Banach theorem and its consequences, conjugate space and separability, Second conjugate space. The natural embedding of normed linear space and its second conjugate space, Weak *Topology on conjugate space.	12 L
Unit II	The open mapping theorem, Projection on Banach space, The closed graph theorem, the conjugate of an operations, The uniform boundedness theorem (Banach-Steinhauss theorem). Inner Product spaces, Hilbert space: Definition, examples and simple properties, Schwartz's inequality, Orthogonal complements, Projection theorem, Orthogonal sets.	12 L
Unit III	The Bessel's inequality, Fourier expansion and Parseval's equations, Gram-Schmidt orthogonalization process, Separable Hilbert space, The conjugate space, Riesz Theorem.	12L
Unit IV	Operations and their adjoint on a Hilbert space, self adjoint operators, Normal and unitary operators projections. Finite dimensional spectral theory.	12 L
Unit V	Determinants and spectrum of an operator, The spectral theorem, Fixed points, Definition and examples, Banach contraction mapping theorem, Brouwer's fixed point theorem, Schauder's fixed point theorem.	12 L

Suggested Readings:

1. Simmons G. F., (1963) **Introduction to Topology and Modern Analysis**, McGraw Hill Book Company New York 1963. (Chapter 9, Art 46 to 51. Chapter 10, Art 52 to 59, Chapter 11, Art 61 to 62, Appendix ONE)
2. Limaye B. V., (1996) **Functional Analysis**, second editions, New Age International (P), Ltd., Publishers. (chapter 6 Art 21 to 24, Appendix A)
3. B. Chaudhary and Sudarshan Nanda, **Functional Analysis with applications**, Wiley-Eastern.
4. Bachman G and Narici L, **Functional Analysis**, Academic Press.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C301.1	Know how functional analysis uses and unifies idea from vector spaces	2
C301.2	apply fundamental theorem from theory of normed and Banach space	3
C301.3	Understand and apply from theory of Hilbert spaces to others areas	2

	MT - 302: Numerical Analysis	Lecture
	Course Objectives: • To know concept of Numerical Method to solve systems of solutions. • To study interpolations, numerical and differential methods for solving problems in allied fields of mathematics. • To get the ability to solve differential equations with the techniques in numerical methods.	
Unit 1	Solution of Algebraic and Transcendental Equations: Bisection Method, Iteration Method, Method of False Position, Newton-Raphson Method, Ramanujan's Method, Muller's Method.	12 L
Unit 2	Interpolation: Errors in Polynomial Interpolation, Finite Differences, Detection of Errors by use of Difference Tables, Differences of a Polynomial, Newton's formulae for Interpolation, Central Difference, Interpolation with unevenly spaced points, Divided differences.	12 L
Unit 3	Numerical Differentiation and Integration: Numerical Differentiation, Maximum and Minimum values of a Tabulated Function, Numerical Integration.	12 L
Unit 4	Matrices and Linear systems of Equations: Basic Definitions, Solution of Linear Systems - Direct Methods, Solution of Linear Systems - Iterative Methods, Eigenvalue Problem.	12L
Unit 5	Numerical Solutions of Ordinary Differential Equations: Solution by Taylor's Series, Picard's Method of successive approximations, Euler's Method, Runge - Kutta methods, Predictor Corrector methods.	12 L

Suggested readings:

1. S. S. Sastry, (2004) **Introductory Methods of Numerical Analysis**, Prentice Hall of India Private Ltd. {Chapter 2, Art. 2.1-2.7, Chapter 3, Art. 3.1-3.7, 3.9, 3.11,Chapter 5, Art. 5.1 -5.4, {Chapter 6, Art.6.1-6.5, Chapter 7, Art. 7.1 - 7.6}.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain: Numerical **methods for Scientific and Engineering Computation**, New Age international Publishers.
3. V.N. Vedamurthy and N.Ch.S.N. Iyengar: **Numerical methods**, Vikash Publishing House.
4. C. Gerald and O. Wheatley: **Applied Numerical Analysis**, Addison Publishing company.
5. E. Balagurswamy: **Numerical Methods**, Tata McGraw-Hill.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C302.1	Acquire techniques of numerical methods	2
C302.2	Solve system of equations with the help of numerical techniques	3
C302.3	Find solutions of differential equations numerically	3

	MT - 303: Topics in Field Theory	Lecture
	Course Objectives: • To give knowledge of extensions on fields. • To study Galois Theory, Perfect fields of finite fields. • To acquire knowledge about Roots of unity, solvability of polynomials by radicals and constructability of geometrical figures	
Unit 1	**Algebraic Extensions of Fields:** Field Extension, Algebraic Extension, Minimal Polynomial, Finite Fields, Finite Extension	12 L
Unit 2	**Splitting Field and Irreducible Polynomial:** Algebraic closure, algebraically closed fields, Simple Extension, Splitting field, Irreducible polynomials and Eisenstein criterion, multiple roots, F-isomorphism.	12 L
Unit 3	**Normal and Separable Extensions:** Normal extension, Separable and Inseparable extensions, Perfect fields of finite fields. Purely Inseparable Extension.	12 L
Unit 4	**Galois Extensions:** Galois extensions, Galois Group, Fixed Field, Fundamental theorem of Galois theory, Fundamental theorem of Algebra.	12 L
Unit 5	**Solvability by Radicals:** Roots of unity, Cyclic Extension, Solvability by radicals, Geometric construction, Transcendental extensions, Transcendental base.	12 L

Suggested readings:

1. N.S. Gopalakrishnan, (2003) **University Algebra**, New Age International (P), Ltd., Publishers. (Chapter-4: Art.-4.1 to 4.9.)
2. P. B. Bhattacharyya, S. K. Jain and S. R. Nagpaul, **Basic Abstract Algebra**, Cambridge University Press, Second Edition.
3. N. Jacobson, (2012) **Basic Algebra I**, Second Edition, Hindustan Publishing Corporation.
4. M. Nagata, (1997) **Field Theory**, Marcel-Dekker Inc.
5. I. S. Luthar, I. B. S. Passi, (2004) **Algebra**, Vol. 4, Field Theory, Narosa Publishing House
6. T. A. Hungerford, Algebra, Graduate Texts in Mathematics, Vol. 73, Springer Verlag.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C303.1	Understand extensions on fields, Eisenstein criterion, reducible and irreducible polynomials, algebraically closed field.	2
C303.2	understanding fundamentals of Normal extensions, Separable and Inseparable extensions.	2
C303.3	understand the applicability of Galois theory and Roots of Unity, Solve the problems on solvability by radicals, basic knowledge of Transcendental extensions	2

	MT - 304: Fluid Dynamics	Lecture
	Course Objectives: • Create a base to understand the motion of fluid. • Develop various techniques to solve the problems of fluid flow. • Benefit at advanced studies in the various fields of fluid motion.	
Unit 1	**Kinematics:** Introduction to some identities, formulae & theorems in vector calculus, Properties of fluids, Types of fluids, Types of flows, Eulerian & Lagrangian Methods, Real fluids & Ideal fluids, Velocity of a fluid at a point, Streamlines & Pathlines, The velocity potential, Velocity vector, Local and Particle Rates of Change, The equation of Continuity, Acceleration of fluid, Conditions at a rigid Boundary, General Analysis of Fluid Motion.	12L
Unit 2	**Equation of Motion:** Pressure at a point in a fluid at rest, Pressure at a point in a moving fluid, Conditions at a boundary of two Inviscid Immiscible fluids, Euler's equation of motion, Bernoulli's equation, Discussion of the case of steady motion under conservative body forces, some potential theorems, some flows involving axial symmetry, Some special two-dimensional flows, Impulsive motion, Some further aspects of vertex motion.	12 L
Unit 3	**Three Dimensional Flows:** Introduction, Sources, Sinks, Doublets, Images in a Rigid infinite plane, Images in Solid spheres, Axi-symmetric flows, Stokes's Stream function, Some special forms of the stream function for Axi-symmetric irrotational motions.	12 L
Unit 4	**Two Dimensional Flows:** Meaning of two-dimensional flow, Use of cylindrical polar coordinates, Stream function, Complex potential for two dimensional irrotational incompressible flow, Complex velocity potentials for standard Two-dimensional flows-uniform stream, line sources & line sinks, line doublets, line vortices, Two-dimensional image systems, Milne-Thomson circle theorem-Applications, extension of circle theorem, Theorem of Blasius.	12 L
Unit 5	**Viscous Flow:** Stress components in a Real fluid, Relations between cartesian components of stress, Translation motion of fluid element, The rate of strain quadric and principal stresses, Some properties of the rate of strain quadric, Stress analysis in fluid motion, Relations between stress and rate of strain, Coefficient of viscosity& Laminar flow, The Navier-Stokes equation of motion of a viscous fluid, Some solvable problems in viscous flow, Steady viscous flow.	12 L

Suggested readings:

1. F. Chorlton, Textbook of Fluid Dynamics, CBS Publisher. Ch (1): 1.1-1.20; Ch (2): 2.1-2.11; Ch (3): 3.1-3.12; Ch (4): 4.1-4.5; Ch (5): 5.1-5.9; Ch (8): 8.1-8.11.
2. G. K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press.
3. R. W. Fox, A. T. McDonald, P. J. Pritchard, Introduction to Fluid Mechanics, Sixth Edition, John Wiley & Sons.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C304.1	understand the concept of fluid & their types, lines to study of fluid flow.	2
C304.2	understand the equation of motion of fluid.	2
C304.3	understand the information regarding three-dimensional flows.	2
C304.4	understand the concept of two-dimensional flows.	2
C304.5	understand various models in viscous flows.	2

M.Sc. Part II Semester III (Mathematics): Elective Course (Select only one)

	MT 305-Statistical Techniques	Lecture
	Course Objectives: • To aware student about statistical concepts like mean, mode, median, regression, correlation, • To aware students about application of statistical techniques, sampling and distributions. • Students are expected to learn mathematical methods for Statistics, Mathematical Statistics, core Statistical Methods as per the syllabi provided by UGC or suggested by NET/SET.	
Unit 1	Revision of Basic concepts: Discrete and Continuous series, Arithmetic Mean, Geometric Mean, Harmonic Mean, Median and Mode.Range, Quartile deviation, Mean deviation, Standard deviation, Variance and coefficient of variation, Probability: Sample space, discrete probability, Mathematical theory of probability, independent events, Addition and Multiplication theorems of probability.	12 L
Unit 2	Conditional probability and Baye's theorem, Theoretical distributions: Random variable, probability distribution of a discrete and continuous random variable. Probability density function, mathematical expectation. Binomial, Poisson and Normal distributions and their properties.	12 L
Unit 3	Correlation: Definition, meaning, scatter diagram method, Karl Pearson's method, Probable error, Standard error and Rank correlation and concurrent deviations. Regression: Definition, meaning, two lines of regression, regression coefficients, standard error and relation between correlation and regression.	12 L
Unit 4	Sampling and Large sample tests: Introduction to sampling, Simple random sampling, stratified sampling and systematic sampling. Testing of hypothesis, level of significance, tests of significance for large samples. Tests for single proportion, difference of proportion, single mean, difference of means, difference of S.D.	12 L
Unit 5	Exact sampling distributions: Chi-Square variate and Chi-Square distribution, conditions of validity of Chi-Square test, applications of Chi-square distribution, Chi –Square test for population variance, Chi-square test for Goodness of fit and Independence of Attributes. Definition of student's 't' distribution and derivation, Fisher's 't' distribution constants of t-distribution, graph of t-distribution, application, test for single mean, test for difference of means, paired t-test testing significance of observed sample. Definition of F statistic, F-distribution, applications, F-test for equality of population variances	12 L

Suggested readings:

1. E.J. Dudewicz and S.N. Mishra (1988), Modern Mathematical Statistics, John Willey & Sons.
2. Erwin Kreyszig (1970) Introductory Mathematical Statistics, Willey International Ltd.
3. J.K. Goyal and J.N. Sharma (2014) Mathematical Statistics, Krushna Prakashan.
4. S.C. Gupta and V.K. Kapoor (2001): Mathematical Statistics, Sultan Chand & Co-New Delhi.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
MT 305.1	Upon successful completion of this course : 1. Students will understand Basic concepts : Discrete and Continuous series, Arithmetic Mean, Geometric Mean, Harmonic Mean, Median and Mode. Range, Quartile deviation, Mean deviation, Standard deviation, Variance and coefficient of variation. 4. Correlation: Definition, meaning, scatter diagram method, Karl Pearson's method, Probable error, Standard error and Rank correlation and concurrent deviations.	2
MT 305.2	Solving examples based on Sample space, discrete probability, Mathematical theory of probability, independent events, Addition and Multiplication theorems of probability, conditional probability and Baye's theorem.	2
MT 305.3	Making applications Theoretical distributions: Random variable, probability distribution of a discrete and continuous random variable.Probability density function, mathematical expectation.Binomial, Poisson and Normal distributions and their properties.	3
MT 305.4	Analzing statistical data to study Correlation, scatter diagram method, Karl Pearson's method, Probable error, Standard error and Rank correlation and concurrent deviations.	4

M.Sc. Part II Semester III (Mathematics): Elective Course (Select only one)

	MT-306: Lattice Theory	Lectures
	Course Objectives: • This course is mainly introduced for the students to understand Lattice Theory and to some extents Boolean algebras. • The syllabus of Lattice Theory discusses Modular lattice, Distribute Lattice, Boolean Lattices and Characterization theorem, Dedekind characterization, stone algebra. • The last units discuss standard and neutral elements, semi modular lattice and modular pairs.	
Unit I	Two Definitions of Lattices: Introduction to Posets, Duality principle, Semi-lattice, How to Describe Lattices: Join and Meet table, Covering, Some Algebraic Concepts: Homomorphism, sublattice, Lattice ideal, Congruence relations, Congruence lattice, The homomorphism theorem, Product of lattices, complete lattices, ideal lattice.	10 L
Unit-II	Polynomials. Identities and Inequalities, n-ry polynomial, lattice inequality, preservation of identities, Special Element: relatively complemented lattice, S(L), pseudocomplemnted semillatice, join and meet irreducible elements.	14 L
Unit- III	Distributive lattice, Stone, Nachbin, Hashimato theorem, Congruence Relations, Distributive Lattices with Pseudocomplementation: S(L) and D(L) and properties.	12 L
Unit- IV	Distributive, Standard and Neutral Elements, Distributive, Standard and Neutral Ideals, Structure Theorems	12 L
Unit- V	Semimodular lattices, isomorphism theorem and Modular pairs.	12 L

Suggested Readings:

- George Gratzer, (1978) **General Lattice Theory**, Academic press, New York. (Chapter 1: Sections 1, 2, 3, 4, 6, Chapter 2: Sections 3 , 6 Chapter 3: Section 2,3,4 Chapter 4: Section 2)
- Birkhoff G., (1968) **Lattice Theory**, Amer. Math. Soc., Colloq. Publ., New York, 1968
- Crawley P. and Dilworth R.P. (1973) **Algebraic theory of lattices**, Prentice-Hall, Englewood Cliffs, N.J.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C306.1	Understand Lattice and Lattice as an algebraic structures	2
C306.2	Explain Homomorphism between two Lattices, Boolean algebra	2
C306.3	understand neutral elements, structure theorem	2

AC-301(A): Computer Skills (Technology + Value added Audit course; Practical; 2 Credits) (Optional: Campus + Program level)		
Course Objectives (CObs): • To inculcate different daily useful computer skills among students.		
Unit 1	**Elements of Information Technology** 1.1 Information Types: Text, Audio, Video, and Image, storage formats 1.2 Components: Operating System, Hardware and Software, firmware 1.3 Devices: Computer, Mobile Phones, Tablet, Touch Screen, Scanner, Printer, Projector,smart boards 1.4 Processor & Memory: Processor functions, speed, Memory types: RAM /ROM /HDD /DVD-ROM/Flash drives, memory measurement metrics	2 L
Unit 2	**Office Automation-Text Processing** 2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View, ReadingLayout View 2.2 Working with Files: Create New Documents, Open Existing Documents, SaveDocuments to different formats, Rename Documents, Close Documents 2.3 Working with Text: Type and Insert Text, Highlight Text, Formatting Text, Delete Text,Spelling and Grammar, paragraphs, indentation, margins 2.4 Lists: Bulleted and Numbered Lists, 2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Moveand Resize Tables, Moving the order of the column and/or rows inside a table, TableProperties 2.6 Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents, 2.7 Paragraph Formatting, Paragraph Attributes, Non-printing characters 2.8 Types of document files: RTF, PDF, DOCX etc.	5 L
Unit 3	**Office Automation-Worksheet Data Processing** 3.1 Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets, 3.2 Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows and Columns, Selecting Cells, Moving and Copying Cells 3.3 Formulas and Functions: Formulas, Linking Worksheets, Basic Functions, AutoSum, Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill, Deleting Rows, Columns, and Cells 3.4 Charting: Chart Types, drawing charts, Ranges, formatting charts	5 L
Unit 4	**Office Automation- Presentation Techniques and slide shows** 4.1 Create a new presentation, AutoContent Wizard, Design Template, Blank Presentation,Open an Existing Presentation, PowerPoint screen, Screen Layout 4.2 Working with slides: Insert a new slide, Notes, Slide layout, Apply a design template,Reorder Slides, Hide Slides, Hide Slide text, Add content, resize a placeholder or textbox, Move a placeholder or text box, Delete a placeholder or text box, Placeholder orText box properties, Bulleted and numbered lists, Adding notes 4.3 Work with text: Add text and edit options, Format text, Copy text formatting, Replacefonts, Line spacing, Change case, Spelling check,	6 L

	Spelling options 4.4 Working with tables: Adding a table, Entering text, Deleting a table, Changing rowwidth, Adding a row/column, Deleting a row/column, Combining cells ,Splitting a cell,Adding color to cells, To align text vertically in cells, To change table borders,Graphics, Add clip art, Add an image from a file, Save & Print, slide shows, slideanimation/transitions.	
Unit 5	**Internet & Applications:** 5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing theInternet, Brief history, Browsing the Web, Hypertext and hyperlinks, browsers,Uniform resource locator 5.2 Internet Resources: Email, Parts of email, 5.3 Protecting the computer: Password protection, Viruses, Virus protection software,Updating the software, Scanning files, Net banking precautions. 5.4 Social Networking: Features, Social impact, emerging trends, issues, Social Networking sites: Facebook, Twitter, linkedin, orkut, online booking services 5.5 Online Resources: Wikipedia, Blog, Job portals, C.V. writing 5.6 e-learning: e-Books, e-Magazines, e-News papers, OCW(open course wares): Sakshat(NPTEL) portal, MIT courseware	4 L
Unit 6	**Cloud Computing Basics** 6.1 Introduction to cloud computing 6.2 Cloud computing models: SAS, AAS, PAS 6.3 Examples of SAS, AAS, PAS (DropBox, Google Drive, Google Docs, Office 365 Prezi, etc.)	3 L
Suggested readings: 1. TCI, "Introduction to Computers and Application Software", Publisher: Jones & BartlettLearning, 2010, ISBN: 1449609821, 9781449609825 2. Laura Story, Dawna Walls, "Microsoft Office 2010 Fundamentals", Publisher: CengageLearning, 2010, ISBN: 0538472464, 9780538472463 3. June Jamrich Parsons, Dan Oja, "Computer Concepts Illustrated series", Edition 5,Publisher Course Technology, 2005, ISBN 0619273550, 9780619273552 4. Cloud computing online resources		

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301A.1	Identify their lacunas about some computer skills and try to overcome the same.	2
AC301A.2	Practice the learned computer skills in real life and do their jobs more effectively.	3

AC-301(B): Cyber Security

(Technology + Value added Audit course; Practical; 2 Credits)

(Optional: Campus + Program level)

Course Objectives (CObs):

- To make students aware of different daily useful cyber security skills/rules.

Unit 1	**Networking Concepts Overview** Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet	3 h
Unit 2	**Security Concepts** Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux.	7 h
Unit 3	**Security Threats and vulnerabilities** Overview of Security threats, Hacking Techniques, Password Cracking, Types of password attacks, Insecure Network connections, Wi-Fi attacks & countermeasures, Information Warfare and Surveillance. Cyber crime: e-mail related cyber crimes, Social network related cyber crimes, Desktop related cyber crimes, Social Engineering related cyber crimes, Network related cyber crimes, Cyber terrorism, Banking crimes	7 h
Unit 4	**Cryptography** Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure	5 h
Unit 5	**System & Network Security** System Security: Desktop Security, email security: PGP and SMIME, Web Security: web authentication, Security certificates, SSL and SET, Network Security: Overview of IDS, Intrusion Detection Systems and Intrusion Prevention Systems, Overview of Firewalls, Types of Firewalls, VPN Security, Security in Multimedia Networks, Fax Security.	3 h
Unit 6	**OS Security** OS Security Vulnerabilities updates and patches, OS integrity checks, Anti-virus software, Design of secure OS and OS hardening, configuring the OS for security, Trusted OS.	2 h
Unit 7	**Security Laws and Standards** Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its amendments.	3 h

Suggested readings:

1. Skills Factory, Certificate in Cyber Security, Text Book Special edition, Specially published for KBC NMU, Jalgaon
2. BPB Publication, “Fundamentals of Cyber Security”, Mayank Bhushan, Rajkumar Singh Rathore , Aatif Jamshed
3. Create Space Independent Publishing Platform, “Cyber Security Basics”, Don Franke, ISBN-13: 978-1522952190ISBN-10: 1522952195
4. Online references

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301B.1	Practice learned cyber security skills/rules in real life.	3
AC301B.2	Provide guidance about cyber security skills/rules to their friends, parents and relatives.	2

AC-301(C): Typesetting with Latex

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- Acquire proficiency in basic typesetting of Latex
- Demonstrate the use of Latex for Latter, Bio-data typing,
- Be familiar with Research paper, article and Book typing with cross referencing and bibliography.

Unit 1	The Basics: Simple typesetting, Fonts, Typesize, The Document, Document class, Page style, Page numbering, Formatting lengths, Parts of a document, Dividing the document . Table of contents, Index and Glossary:	07 L
Unit 2	Table of contents, Index, Glossary, Displayed Text, borrowed words, Poetry in typesetting, making lists, Rows and Columns, Keeping tabs, Tables..	08 L
Unit 3	Typesetting Mathematics: The basics, Custom commands, More on mathematics, Mathematics miscellany, New operators, The many faces of mathematics, Symbols. Typesetting Theorems: Theorems in L ATEX, Designer theorems, The amsthm package,	08 L
Unit 4	Housekeeping. Several Kinds of Boxes: LR boxes, Paragraph boxes, Paragraph boxes with specific height, Nested boxes, Rule boxes Floats: The figure environment, The table environment. Cross References in LATEX. Pointing to a page—the package varioref, Pointing outside— the package, Footnotes, Margin pars, and Endnotes: Footnotes, Marginal notes, Endnotes. Bibliography.	07 L

Suggested readings:

1. E. Krishnan and G. S. Krishna, (2003), **Latex Tutorials —A Primer,** Indian TEX Users Group Floor III, SJP Buildings, Cotton Hills Trivandrum 695014, India.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301C.1	Acquire skill of mathematical typing Using Latex	2
AC301C.2	Write communication letters, mathematical note, research articles using Latex typesetting	3
AC301C.3	Type Books, Research thesis with figure, cross referencing and Bibliography	5

AC-301(D): Project on Topics in Mathematics

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- Develop skills to understand and analyze recent topics in Mathematics
- Make aware the students for research in Mathematics
- Make a project work on the knowledge acquired on the topic of interest

1	Choice of topics for project work	04 L
2	Collection of the materials such as books, references, website printouts etc	04 L
3	Analysis of the collected material in an uniform manner	10 L
4	Discussion and guidance from teacher or available expert of the field	04 L
5	Writing articles, research paper etc after finalization of the content	--
6	Preparation of the content of the project	04 L
7	Typing and Binding of the project work	04 L

Suggested readings: (**Sample projects/lists can be found on the following links**)

1. https://eduprojecttopics.com/product-category/mathematics/
2. https://scholarworks.boisestate.edu/math_gradproj/
3. https://uniprojectmaterials.com/mathematics/project-topics-materials-for-final-year-students

5.https://www.monash.edu/__data/assets/pdf_file/0009/2085399/MTH3000_Projects.pdf

6.https://www.uhd.edu/academics/sciences/mathematics-statistics/PublishingImages/Pages/ms-index/MathStatistics-SeniorProject.pdf

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301D.1	Analyze material available at different sources	4
AC301D.2	Write articles/research notes/review on particular topic of interest	3
AC301D.3	develop research skills	3

	MT-401: Linear Integral Equations	Lecture
	Course Objectives: The aim of this course is • To provide adequate knowledge of fundamentals of Fredholm, Volterra and singular integral equations • To understand different methods for finding the solutions of Fredholm, Volterra and singular integral equations. • To motivate students, how to solve problems on differential and integral equations using Laplace and Fourier transforms.	
Unit 1	Definition and classification of linear integral equations, Fredholm integral equation with separable kernel, Singular integral equations, Integro-differential equations, Homogeneous Fredholm equations and eigenfunctions.	12 L
Unit 2	Solutions of Fredholm integral equations by: Successive approximations Method, Successive substitution Method, Adomian decomposition method, Modified decomposition method, Resolvent kernel of Fredholm equations and its properties.	12 L
Unit 3	Solutions of Volterra integral equations: Successive approximations method, Neumann series, Successive substitution Method. Solution of Volterra integral equations by Adomian decomposition method, and the modified decomposition method, Resolvent kernel of Volterra equations and its properties, Convolution type kernels,	12 L
Unit 4	Applications of Laplace and Fourier transforms to solutions of Volterra integral equations, Symmetric Kernels: Fundamental properties of eigenvalues and eigenfunctions for symmetric kernels, expansion in eigenfunctions and bilinear form. Hilbert Schmidt Theorem and its consequences, Solution of symmetric integral equations,	12 L
Unit 5	Operator method in the theory of integral equations, Solution of Volterra and Fredholm integrodifferential equations by Adomian decomposition method, Green's function: Definition, Construction of Green's function and its use in solving boundary value problems.	12 L

Suggested readings:

1. R. P. Kanwal, (1971) Linear Integral Equation- Theory and Technique: Academic Press.
2. Abdul-Majid Wazwaz,(2011) Linear and Nonlinear Integral Equations-Methods and Applications: Springer.
3. L. G. Chambers,(1976) Integral Equations- A Short Course: International Text Book Company.
4. M. A, Krasnov, et.al. (1971) Problems and exercises in Integral equations: Mir Publishers.
5. J. A. Cochran, (1972) The Analysis of Linear Integral Equations: McGraw Hill Pub..
6. 6. C. D. Green, (1969) Integral Equation Methods: Thomas Nelson and sons.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C401.1	Know the relation between differential and integral equations, and how to change from one to another.	2
C401.2	Understand different kinds of kernels and use techniques for solving problems on each kind.	2
C401.3	Use Laplace transform, Fourier transform for solving a wide range of differential and integral equations.	3

	MT-402: Operations Research	Lecture
	Course Objectives: • to introduce the theory of PERT and CPM • to understand the Queuing Models and decision theory • to acquire knowledge of replacement and Inventory models model for solving problems related to industry.	
Unit 1	PERT AND CPM: Introduction, Phases of project management, Network diagrams, Fulkerson's rule, slack, forward pass, backward pass, critical path, project duration, various floats, tabular form, differences between PERT and CPM, Project cost and crashing the Network.	12 L
Unit 2	Queuing Models: Introduction, application of Queuing models, characteristics, arrival and service distribution, Kendall's notation for Queuing models, Single channel queuing theory, M/M/I model and generalization, M/M/I:SIRO/model, M/M/1: FCFS/N/Finite queue length model, M/M/1:FCFS/n/N Limited source model, M/M/C:FCFS/ / Multichannel queuing theory model.	12 L
Unit 3	Decision theory: Steps involved in Decision theory, decision making under uncertainty, Minimax, Maximin, Maximax, Hurwitz and Laplace criteria. Decision making under risk, Expected monetary value and Expected opportunity loss criteria and EVPI, Decision trees.	12 L
Unit 4	Replacement Models: Introduction, Replacement of Items that deteriorate with time with no changes in money value, with change in value of money, replacement of items that fail suddenly, individual replacement policy, group replacement policy and staffing problems.	12 L
Unit 5	Inventory Models: Necessity and maintenance of Inventory, inventory costs, inventory control problems, inventory models with deterministic demand, with probabilistic demand, with price breaks, multi-item deterministic models, forecasting of demand, forecasting methods, seasonal demand, when to order, safety stock and how much to order.	12 L

Suggested readings:

1. V. K. Kapur: Quantitative Techniques for Management, Sultan Chand & Co. New Delhi.
2. P. K. Gupta and D.S. Hira: Operations Research, Sultan Chand & Co., New Delhi.
3. Taha, Operations Research: An introduction, Macmillan publishing Co.
4. Vohra N D, Quantitative techniques in management, Tata Mc-Graw Hill.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C402.1	analyze the results and propose solutions to the decision-making processes in Management and Engineering.	4
C402.2	describe mathematical tools needed to evaluate decision problems	3
C402.3	develop technical knowledge for replacement and inventory models to solve problem arises in allied fields.	4

M.Sc. Part II Semester IV Mathematics: Core course

	MT - 403: Commutative Algebra	Lecture
	Course Objectives: • To know concept of sequence of modules and R-module homomorphisms, Tensor products. • To study ring extensions. • To know the concepts of integral extensions and valuation domain.	
Unit 1	**Projective Modules:** Exact sequences, Projective modules, Finitely generated modules, Shanuel's lemma, Tensor product, Tensor product w. r. t. exact sequences, flat modules, Faithfully flat modules.	15 L
Unit 2	**Localisation:** Jacobson radical, Nakayama lemma, multiplicatively closed set, Localisation, Localisation and exact sequence, localisation and tensor product.	10 L
Unit 3	**Ideal and Chain conditions in modules:** Extension and Contraction of ideals, Artinian modules, Structure theorem of Artinian rings.	10 L
Unit 4	**Integral extensions:** Integral elements, Integral closure, Integral extensions, Going up theorem, Integrally closed domain, Going down theorem	15 L
Unit 5	**Valuation rings:** Valuation rings, Ordered group, valuation on a field, Discrete valuation rings, Dedekind domain.	10 L

Suggested readings:

1. Gopalakrishnan N. S. (2016), **Commutative Algebra**, Universities Press (India) Pvt. Ltd. (Chapter- I: Art.-1.2 to 1.4, Chapter-II: Art.- 2.2 to 2.3, Chapter-III: Art.- 3.1 to 3.3, Chapter-IV: Art.-4.1 to 4.3, Chapter-V: Art- 5.1 to 5.3).
2. Atiyah M. F. and Donald Mac (2007), **Introduction to Commutative Algebra**, Sarat Book House.
3. Eisenbud David (1995), **Commutative Algebra with a view toward Algebraic Geometry,** Springer Verlag, New York.
4. Jacobson N. (1980), **Basic Algebra Vol.-I & II**, Hindustan Publishing Corporation (India).
5. Zarski O. and Samuel P. (1975), **Commutative Algebra**, Springer.
6. Rowen L. (1988), **Ring theory Vol.-I & II**, Academic Press.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C403.1	Understand the concept of exact sequences, projective and flat modules.	2
C403.2	Explain the concepts of Artinian module and Artinian rings.	2
C403.3	Learn the Valuation rings and Discrete valuation rings.	2

	MT - 404: Advanced Abstract Algebra	Lecture
	Course Objectives: • To introduce nil radical of an ideal of a ring and semiprime ideal. • to introduce Jacobson radical and prime radical of a ring. • To introduce the direct sum of rings and study more results on Noetherian rings.	
Unit 1	Basic concepts of maximal ideals, prime ideals and nil radical .of an ideal, semiprime ideal and primary ideals.	12 L
Unit 2	Minimal prime ideals, Prime avoidance theorem, Jacobson radical of a ring, semisimple ring and prime radical of a ring.	12 L
Unit 3	Quasi-regular element, J-radical, J-semisimple ring, regular ring.	12 L
Unit 4	Direct sum of rings, subdirectly reducible and irreducible rings.	12 L
Unit 5	Noetherian ring, irreducible ideals, irrdundant primary representation, Cohen's theorem and Krull intersection theorem.	12 L

Suggested readings:

1. D. M. Burton, (1970) **A first course in ring and ideals**, Addison-Wisley Publishing Company Inc.
   Chapter-V: Art.-5.1 to 5.16, Chapter-VIII: Art.- 8.1 to 8.21, Chapter-IX: Art.-9.4 to 9.6, Chapter-X: Art- 10.1 to 10.6, Chapter-XII: Art.-12.1 to 12.11.
2. N. Jacobson, (1980) **Basic Algebra Vol- I & II**, Hindustan Publishing Corporation, India.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C404.1	Know the different types of ideals and their importance	2
C404.2	Know Jacobson radical and prime radical of a ring with the relative concepts	2
C404.3	Know the direct sum of rings and some advanced results on Noetherian rings	2

	MT 405 Algebraic Topology	Lecture
	• To know the concept of Geometric complexes and simplicial homology. • To study simplicial approximations. • To know the homotopic paths and fundamental group.	
Unit 1	Geometric complexes, polyhedron, orientation of Geometric complexes.	10 L
Unit 2	Chains, Cycles, Boundaries, Homology groups, Examples and structure of homology groups, The Euler-Poincare theorem, Euler's theorem, Pseudo manifolds, Fundamental group of S_n.	15 L
Unit 3	Simplicial approximation, Induced homomorphism on the homology groups, The Brouwer's fixed point theorem.	15 L
Unit 4	Homotopic paths and Fundamental groups, Covering homotopy property for S_1, Examples of Fundamental groups	10 L
Unit 5	Relation between first homology group and fundamental group.	10 L

Suggested readings:

1. F.H. Croom, (1978) **Basic Concepts of Algebraic Topology**, Springer under graduate text. (Chapter-I: Art- 1.1 to 1.4, Chapter-II: Art-2.1 to 2.5, Chapter-III: Art-3.1 to 3.4, and Chapter-IV: Art-4.1 to 4.4.)
2. Satya Deo, (2003) **Algebraic Topology**-A primer, Hindustan Book Agency,.
3. B. K. Lahiri, (2005) **A First Course in Algebraic Topology**, Second Edition, Alpha Science Intl Ltd.
4. E. H. Spanier, (1994) **Algebraic Topology, Third Edition**, Springer Verlag New York Inc.
5. I .M. Singer & J.A. Thorpe, (1976) **Lecture Notes on Elementary Topology and Differential Geometry**, Springer Verlag New York.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C405.1	Understand the fundamental concepts and methods in algebraic topology.	2
C405.1	Explain the well known theorems: The Euler-Poincare theorem, Euler's theorem, Brouwer's fixed point theorem.	2
C405.1	Learn the relation between first homology group and fundamental group.	2

M.Sc. Part II Semester IV (Mathematics): Elective Course

	MT – 406: Theory of Special Functions	Lecture
	Course Objectives: 1. To analyze properties of special functions by their integral representations and symmetries. 2. To determine properties of Legendre polynomials, Rodrigue's formula, Generating function and Fourier Legendre's serieswhich may be solved by application of special functions. 3. To determine properties of solution of Bessel's differential equation and Bessel's functions, Bessel's function of first kind and second kind, Orthogonality of Bessel's functions, The Hypergeometric Functions. 4. Study of Hypergeometric series, Euler's Integral Representation, the Hypergeometric equation, the Barnes Integral for the Hypergeometric function	
Unit I	The Gamma & Beta Functions: The Gamma and Beta integrals, Functions and their properties, The Euler Reflection formula, Riemann Zeta functions, Gauss's multiplication formula for $\Gamma(mx)$, Integral representation for Log $\Gamma(mx)$, The Bohr-Mollerup theorem.	**12 L**
Unit II	Legendre Polynomials: Solution of Legendre differential equation and Legendre polynomials, Rodrigue's formula, Generating function, Recurrence relations,	**12 L**
Unit III	Orthogonal and orthonormal functions, Orthogonal property of Legendre's polynomials, Fourier Legendre's series.	**12 L**
Unit IV	Bessel's Functions: Solution of Bessel's differential equation and Bessel's functions, Bessel's function of first kind and second kind, Orthogonality of Bessel's functions, Fourier Bessel's series.	**12 L**
Unit V	The Hypergeometric Functions: The Hypergeometric series, Euler's Integral Representation, the Hypergeometric equation, the Barnes Integral for the Hypergeometric function.	**12 L**

Suggested Readings:

1. George E. Andrews, Richard Askey, Ranjana Roy, (2010) **Special Functions**, Cambridge University Press. {Chapter 1; 1.1, 1.2, 1.3, 1.5, 1.6, 1.9, Chapter 2; 2.1,2.2, 2.3, 2.4}
2. R. K. Jain and S. R. K. Iyengar, (2008) **Advanced Engineering Mathematics**, Narosa Publishing House, New Delhi. {Chapter 7;7.1, 7.2, Chapter 7; 7.4, 7.5,
3. Mark A. Pinsky, (1991) **Partial Differential Equations and Boundary Value Problem with Applications**, McGraw - Hill, Ins. {Chapter 4; 4.2, Chapter 3; 3.2}
4. Earl D. Rainville, (1960) **Special Functions**, Chelsea Publishing Company, New York, (1960).
5. H. M. Srivastava, **A Treatise, On Generating Functions**, John Wiley & Sons, New York.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C406.1	list the basic concept of integral calculus and special functions of various engineering problem and to know the application of some basic mathematical methods via all these special functions.	2
C406.2	Explain the applications and the usefulness of these special functions.	2
C406.3	Justify the use of gamma function, beta function special functions, Hypergeometric function and Hypergeometric series to: evaluate different types of integral calculus problems and solve differential equations	3

M.Sc. Part II Semester IV (<u>Mathematics</u>): Elective Course

	MT – 406: Cryptography	Lecture
	Course Objectives: • to know how pure mathematics like Finite Fields and Number Theory are used to secure our daily online communication. • Acquire knowledge of different cryptosystems and their mathematical settings	
Unit 1	**Introduction to Cryptography**: Classifications of Cryptography along with few applications of Cryptography in day-to-day activities, Purpose of Cryptography, Basic Terminology, Applications of Modern Algebra and Number Theory in Cryptography **Classical Ciphers**: Some Simple Ciphers - Ceaser Cipher, Shift Cipher, Affine Cipher, Substitution Ciphers with examples, Transposition Ciphers with examples **Cryptanalysis of Classical Ciphers:** Cryptanalysis of Affine Ciphers, Cryptanalysis of Substitution Ciphers, Cryptanalysis of Vigenere Cipher and Cryptanalysis of the Hill Cipher **Shannon's Theory, Perfect Secrecy, and the One-Time Pad:** Perfect Secrecy, Entropy, Properties of Entropy, Spurious Keys and Unicity Distance	08 L
Unit 2	**Mathematical Background for Cryptography:** Algorithm to produce an irreducible polynomial of degree n over $\mathbb{F}$. Modular exponentiation by the repeated squaring, Primality Testing, Probabilistic Algorithms, The Pseudo-prime Test, The Miller-Rabin Test, The Agrawal-Kayal-Saxena (AKS) Algorithm, Primitive Roots,	08 L
Unit 3	**Symmetric (Private) Key Ciphers:** **Block Ciphers**: Feistel Structure — Balanced and Unbalanced, DES Cipher, Substitution-Permutation Network, AES Cipher, Applications of finite fields in designing AES S-box, Modes of Operation **Pseudo-Random Bit Generator (PRBG)**: Random bit generators, Pseudo-random bit generators, Statistical tests, Cryptographically secure pseudorandom bit generation **Stream Ciphers**: Feedback shift registers, Stream ciphers based on LFSRs, Salsa20/20 and ChaCha20 stream ciphers	14 L
Unit 4	**Cryptographic Hash Functions:** Definition and examples of hash functions, Definition of cryptographic hash functions, Properties of cryptographic hash functions, design principle of commonly used cryptographic hash functions **SHA-1, SHA-2 Family:** Detailed discussion of SHA-1 algorithm, Detailed	06 L

	discussion of SHA-256 algorithm. Brief description of SHA-224, SHA-384 and SHA-512 algorithms **SHA-3 and Applications:** Brief description of SHA-3 competition, Keccak Algorithm, SHA-3 standardization, Applications of cryptographic hash functions	
Unit 5	**Asymmetric (Public) Key Ciphers:** **Introduction to Public Key Cryptography:** Trapdoor one-way function, Introduction to Non-secret encryption **Diffie-Hellman Key Exchange and RSA:** Description of Diffie-Hellman (DH) key exchange protocol, RSA cryptosystem with examples, Integer factorization, Attack on RSA cryptosystem **ElGamal Cryptosystem:** Discrete logarithm problem (DLP), ElGamal cryptosystem with examples, algorithm to solve DLP **Elliptic Curve Cryptography:** Elliptic Curves over the Reals, Elliptic Curves Modulo a Prime, Elliptic Curves over Finite Fields, Properties of Elliptic Curves, ElGamal Cryptosystems on Elliptic Curves. **Signature Schemes:** RSA Signature Scheme, Security Requirements for Signature Schemes, The ElGamal Signature Scheme and its variants, Security of the ElGamal Signature Scheme	12 L

Suggested readings:

1. Douglas R. Stinson and Maura B. Paterson,(2019) ***Cryptography Theory and Practice***, CRC Press, Fourth Edition.
2. Hans Delfs and Helmut Knebl,(2015)***Introduction to Cryptography — Principles and Applications***, Springer, Third Edition.
3. Chuck Easttom, (2016)***Modern Cryptography — Applied Mathematics for Encryption for Encryption and Information Security***, McGraw-Hill Education, 2016
4. Jonathan Katz and Yehuda Lindell, (2021) ***Introduction to Modern Cryptography***, CRC Press, Third Edition.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C407.1	explain symmetric and Asymmetric cryptography	2
C407.2	see how Finite Fields and Number Theory are used to design modern cryptosystems for securing our online communication	3
C407.3	explain how digital signature is used in place of handwritten signature on a document	3

	AC-401(A): Human Rights (Professional and Social + Value Added Audit course; Practical; 2 Credits) (Optional:)	
	Course Objectives (CObs): • To make students aware about human rights and human values.	
Unit 1	**Introduction to Human Rights** 1.1 Concept of Human Rights 1.2 Nature and Scope of Human Rights 1.3 Fundamental Rights and Fundamental Duties 1.4 Interrelation of Rights and Duties	6 L
Unit 2	**Human Rights in India** 2.1 Meaning and Significance of : 1) Right to Equality 2) Right to Freedom, 3) Right against Exploitation, 4) Right to Freedom of Religion, 5) Cultural and Educational Rights, and 6) Right to Constitutional Remedies. 2.2 Constitutional Provisions for Human Rights 2.3 Declaration of Human Rights 2.4: National Human Rights Commission	8 L
Unit 3	**Human Values** 3.1: Meaning and Definitions of Values 3.2: Importance of values in the life of Individual 3.3: Types of Values 3.4: Programmes for conservation of Values	8 L
Unit 4	**Status of Social and Economically Disadvantaged people and their rights** 4.1: Rights of women and children in the context of Social status 4.2: The Minorities and Human Rights 4.3: Status of SC/ST and other Indigenous People in the Indian Scenario 4.4: Human rights of economically disadvantaged Society	8 L
Suggested readings: 1. Human rights education – YCMOU, Nasik 2. Value education – SCERT, Pune 3. Human rights reference handbook – Lucille whare		

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401A.1	Practice the learned issues under human rights and human values in real life.	3
AC401A.2	Provide social justices to people around them and provide guidance about human rights to their friends, parents and relatives.	5

	AC-401(B): Current Affairs (Professional and Social + Value Added Audit course; Practical; 2 Credits) (Optional:)		
	Course Objectives (CObs): • To make students updated about current affairs of India and world.		
	Title	Content	Hours
Unit 1	Politics & Economy	• National & International Political Activity, Organization. • Economy & Business, Corporate world	08 L
Unit 2	Awards and recognitions	• National & International Awards and recognitions • Books and authors	07 L
Unit 3	Science & Technology	• Software, Automobile, Space Research • New inventions and discoveries	07 L
Unit 4	Environment & Sports	• Summit & conference, Ecology & Climate, Organization. • National & International Games, Olympics, commonwealth etc.	08 L

Suggested readings (Use recent years' data and current literature):

1. India 2019, by Publications Division Government of India
2. Manorama Year Book by Philip Mathew,
3. India 2019, Rajiv Maharshi
4. Quick General Knowledge 2018 with Current Affairs Update, Disha Experts
5. General Knowledge 2018: Latest Who's Who & Current Affairs by RPH Editorial Board.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401B.1	Identify important issues currently/ recently happening in India or world.	5
AC401B.2	Summarize current affairs regularly.	6

AC-401(C): Review and Seminar of Research Papers in Mathematics		
(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)		
Course Objectives (CObs): • Develop presentation skills for particular topic of interest among the students • Students will acquire analytical thinking on the topic of interest		
Unit 1	Algebra, Semiring Theory, Commutative Algebra, Linear Algebra, Field Theory, Graph theory, Metric spaces, Fixed point theory, Topology, Lie Algebra, Number Theory etc	--
Unit 2	Analysis, Complex Analysis, Differential Equations, Numerical Analysis, Functional Analysis, Integral Equations, Fractional Differential Equations, Integral and Transform Theory etc	--
Unit 3	Mechanics, Fluid Dynamics, Classical Mechanics, Computational Fluid Mechanics, Fuzzy Mathematics, Coding theory, Cryptography etc	--
Unit 4	At least 02 seminars by students on their review done in above topics etc	--
Suggested readings: • **Research papers, Articles, Books, Monographs, recommended websites etc**		

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401C.1	Prepare own notes for presentation	3
AC201C.2	Cultivate research skill	5
AC401C.3	Think analytically	3

AC-401(D): Vedic Mathematics

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To enhance computation skills among the students.
- Improve clarity on mathematical concepts.
- Develop analytical thinking through Vedic Mathematics.

Unit 1	Actual Applications of the Vedic Sutras, Arithmetical Computations, Multiplication, Practical Application (compound multiplication), Practice and Proportion, Division by the Nikhilam method, Division by the Parevartpa method, Argumental Division, Factorization (of simple quadratics), Factorization (of harder quadratics), Factorization of Cubics etc., Highest Common Factor.	
Unit 2	Simple Equations (First Principles), Simple Equations (by Sunyam etc.), Merger Type of Easy Simple Equations, Extension method, Complex Mergers, Simultaneous Simple Equations, Miscellaneous (Simple) Equations, Quadratic Equations, Cubic Equations, Bi-quadratic Equations, Multiple Simultaneous Equations, Simultaneous Quadratic Equations.	
Unit 3	Factorization & Differential Calculus, Partial Fractions, Integration by Partial Fractions, The Vedic Numerical Code, Recurring Decimals, Straight Division, Auxiliary Fractions, Divisibility & Simple Osculators, Divisibility & Complex Multiplex Osculators, Sum & Difference of Squares	
Unit 4	Elementary Squaring, Cubing etc. Straight Squaring, Vargamula (square root), Cube Roots of Exact Cubes, Cube Roots (General), Pythagoras Theorem etc., Apollonius' Theorem, Analytical Conics.	

Suggested readings:

1. Jagadguru Shankaracharya, Sri Bharati Krisna Tirtha Maharaja,(1981), **Vedic Mathematics**, (edited by Dr. V. S. Agrawala), Motilal Banaridas, Delhi.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401D.1	recognize their hidden potential, improve their mathematical abilities	4
AC401D.2	Enhance academic performance particularly in mathematical calculations	3
AC401D.3	know the effectiveness of the Vedic mathematics techniques	2

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Equivalence for M.Sc. (Mathematics) Courses

Old Syllabus (June 2017) (Semester pattern 60:40)		New Syllabus (June 2021) CBCS pattern (Semester pattern 60:40)	
Course code	Paper	Course code	Paper
Semester-1			
MT 101	Advanced Real Analysis	MT 101	Advanced Real Analysis
MT 102	Topology	MT 102	Topology
MT 103	Abstract Algebra	MT 103	Abstract Algebra
MT 104	Ordinary and Partial Differential Equations	MT 104	Partial Differential Equations
Any one of the following			
MT 105	Theory of Fuzzy sets	MT 105	Programming in C++
MT 106	Programming in C++	MT 105	Programming in C++
Semester II			
MT 201	General Measure Theory	MT 204	Classical Mechanics
MT 202	Complex Variables	MT 202	Complex Analysis
MT 203	Linear Algebra	MT 203	Linear Algebra
MT 204	Mathematical Methods	MT 205	Python Programming
Any one of the following			
MT 205	Number Theory	MT 201	Number Theory
MT 206	Classical Mechanics	MT 204	Classical Mechanics

Old Syllabus (June 2018) (Semester pattern 60:40)		New Syllabus (June 2022) CBCS pattern (Semester pattern 60:40)	
Course code	Paper	Course code	Paper
Semester III			
MT 301	Topics in Functional Analysis	MT 301	Topics in Functional Analysis
MT 302	Statistical Techniques	MT 305	Statistical Techniques
MT 303	Topics in Field Theory	MT 303	Topics in Field Theory
Any two of the following			
MT 304	Fluid Dynamics	MT 304	Fluid Dynamics
MT 305	Difference Equations	MT 304	Fluid Dynamics
MT 306	Theory of Lattices	MT 306	Theory of Lattices
MT 307	Elements of Graph Theory	MT 407	Cryptography
Semester-IV			
MT 401	Advanced Mathematical Methods	MT 406	Theory of Special Functions
MT 402	Operations Research	MT 402	Operations Research
MT 403	Commutative Algebra	MT 403	Commutative Algebra
Any two of the following			
MT 404	Advanced Abstract Algebra	MT 404	Advanced Abstract Algebra
MT 405	Advanced Numerical Methods	MT 302	Numerical Analysis
MT 406	Algebraic Topology	MT 405	Algebraic Topology
MT 407	Linear Integral Equations	MT 401	Linear Integral Equations

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon

।।अंतरी पेटवू ज्ञानज्योत।।

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS

For

M.A. / M. Sc.- Ist YEAR (Sem. Ist and IInd)

Subject: Geography

Under

Choice Based Credit System

(With Effect from June - 2021)

Summary of Distribution of Credits under CBCS Scheme
for
M. A /M.Sc. (Geography)

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV
01	Core	**16**	**16**	**16**	**12**
02	Skill based	**04**	**04**	**-**	**-**
03	Elective	**-**	**-**	**04**	**04**
04	Project	**-**	**-**	**-**	**04**
05	Audit	**02**	**02**	**02**	**02**
06	Total Credits	**22**	**22**	**22**	**22**

Subject Type	Core	Skill based	School Elective	Project	Audit	Total
Credits	**60**	**08**	**08**	**04**	**08**	**88**

Total Credits = 88

Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon

M.A / M. Sc. Geography

Choice Based Credit System (Outcome Based Curriculum) with effect from 2021 -2022

Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	**Credits (T+P)**	**Total Credits**	**No. of Courses**	**Credits (T+P)**	**Total Credits**	**No. of Courses**	**Credits (Practical)**	**Total Credits**	
I	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
II	4	12 + 4	**16**	1	0 + 4	4	1	2	2	**22**
III	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
IV	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
Total Credits	**64**			**16**			**8**			**88**

(T, Theory; P, Practical)

Structure of Curriculum

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
(A)	**Prerequisite and Core Courses**									
	Theory	4	2	4	3	4	2	4	2	36
	Practical	4	2	4	1	4	2	4	2	28
(B)	**Skill Based / Subject Elective Courses**									
1	Theory /Practical	4	1	4	1	4	1	4	1	16
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course			2	1					2
3	Technology Related + Value Added Course					2	1			
4	Professional and Social + Value Added Course							2	1	2
	Total Credit Value	14	6	14	6	14	6	14	6	88

List of Audit Courses ***(Select any ONE course of Choice from Semester II; Semester III and Semester IV)***

Semester I (Compulsory)		**Semester II** (Choose One) Personality and Cultural Development		**Semester III** (Choose One) Technology + Value Added Course		**Semester IV** (Choose One) Professional and Social + Value Added Course	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Sport Activities	AC-301B	Cyber Security	AC-401B	Current Affairs
		AC-201C	Yoga	AC-301C	Rainwater Harvesting	AC-401C	Green Audit
		AC-201D	Music	AC-301D	Geo-Tourism	AC-401D	Review of Research Paper.

Semester-wise Course Structure of M.A M.Sc. Geography

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
GG.-101	Core	Principles of Economic Geography	4	--	4	40	--	60	--	4
GG.-102	Core	Principles of Population Geography	4	--	4	40	--	60	--	4
GG.103	Core	Practical in Interpretation of SOI Topographical maps and Surveying by GPS	--	4+4	8	--	40	--	60	4
GG.-104	Core	Practical in Human Geography	--	4+4	8	--	40	--	60	4
GG.-105	Skill Based	Tourism Management	4	--	4	40	--	60	--	4
AC-101	Audit Course	Practicing Cleanliness	-	2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
GG.201	Core	Geographical Thoughts	4	--	4	40	--	60	--	4
GG.-202	Core	Social and Cultural Geography	4	--	4	40	--	60	--	4
GG.-203	Core	Remote Sensing	4	--	4	40	--	60	--	4
GG.-204	Core	Practical in Cartographic Techniques with the help of GIS	--	4+4	8	--	40	--	60	4
GG.205	Skill Based	Practical in Geo-Statistical Methods.	--	4+4	8	--	40	--	60	4
AC-201 A/B/C/D	Audit Course	**(Choose one out of Four)** AC-201A - Soft Skills / AC-201B - Sport Activities/ AC-201C -Yoga / AC-201D- Music	--	2	2	--	100	--	--	2
Total Credit for Semester II: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit course:2)										

Semester III

<table>
<tr><th rowspan="3">Course</th><th rowspan="3">Course Type</th><th rowspan="3">Course Title</th><th colspan="3">Teaching Hours/ Week</th><th colspan="4">Marks (Total 100)</th><th rowspan="3">Credits</th></tr>
<tr><th rowspan="2">T</th><th rowspan="2">P</th><th rowspan="2">Total</th><th colspan="2">Internal</th><th colspan="2">External</th></tr>
<tr><th>T</th><th>P</th><th>T</th><th>P</th></tr>
<tr><td>GG. -301</td><td>Core</td><td>Regional Geography of India</td><td>4</td><td>--</td><td>4</td><td>40</td><td>--</td><td>60</td><td>--</td><td>4</td></tr>
<tr><td>GG.-302</td><td>Core</td><td>Research Methodology</td><td>4</td><td>--</td><td>4</td><td>40</td><td>--</td><td>60</td><td>--</td><td>4</td></tr>
<tr><td>GG.303</td><td>Elective</td><td>(Choose one out of Three.)
GG.303 A
Watershed Management and Planning
GG.303 B
Geographical Information System
GG.303 C
Agricultural Geography</td><td>4</td><td>-</td><td>4</td><td>40</td><td>-</td><td>60</td><td>-</td><td>4</td></tr>
<tr><td>GG. -304</td><td>Core</td><td>Practical in Remote Sensing - Interpretation of Aerial Photographs and Satellite Imageries</td><td>--</td><td>4+4</td><td>8</td><td>--</td><td>40</td><td>--</td><td>60</td><td>4</td></tr>
<tr><td>GG. -305</td><td>Core</td><td>Practical of Computerize Data Analysis Techniques in Geography</td><td>-</td><td>4+4</td><td>8</td><td>-</td><td>40</td><td>-</td><td>60</td><td>4</td></tr>
<tr><td>AC-301 A/B/C/D</td><td>Audit Course</td><td>(Choose one out of Four)
AC-301A - Computer Skills /
AC-301B - Cyber Security /
AC-301C – Rainwater Harvesting /
AC-301D- Geo-tourism</td><td></td><td>2</td><td>2</td><td></td><td>100</td><td>--</td><td>--</td><td>2</td></tr>
<tr><td colspan="11">Total Credit for Semester III: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)</td></tr>
</table>

Semester IV

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
GG. -401	Core	Geomorphology	4	--	4	40	--	60	--	4
GG.-402	Core	Climatology	4	--	4	40	--	60	--	4
GG.-403	Elective	**(Choose one out of Three.)** **GG.403 A** Geography of Rural Settelments. **GG.403 B** Geography of Resourses. **GG.403 C** Industrial Geography	4	-	4	40	-	60	-	4
GG.-404	Core	Practical in Physical Geography	--	4+4	8	--	40	--	60	4
GG.405	Core	Project work	-	4+4	8	-	40	-	60	4
AC-401 A/B/C/D	Audit Course	**(Choose one out of Four)** AC-401A Human Rights / AC-401B Current Affairs / AC-401C Green Audit / AC-401D Review of Research Paper		2	2		100	--	--	2
Total Credit for Semester IV: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Program at a Glance

Name of the program (Degree)	: M.A / M. Sc. (Geography)
Faculty	: Science and Technology
Duration of the Program	: Two years (four semesters)
Medium of Instruction and Examination	: English
Exam Pattern	: 60 : 40 (60 marks University exam and 40 marks continuous internal assessment)
Passing standards	: 40% in each exam separately (separate head of passing)
Evaluation mode	: CGPA
Total Credits of the program	: 88 (64 core credits including 4 credits of project/dissertation, 08 skill enhancement credits, 08 subject elective credits and 08 audit credits)

➢ Program Objectives:

1. To produce skilled experts with varies aspects of Geography employable for positions in the field of education, industry, and government and non-government organizations.
2. To impart knowledge on advances and challenges in Geographical challenges.
3. To enhance the quality and standards of Geography Education.
4. To provide a broad common framework, for exchange, mobility, and free dialogue across the Indian Geography and associated community.
5. To prepare our graduates to become effective scientific communicators/collaborators in multidisciplinary teams providing technical leadership to engage with the challenging Geographical problems of local, national, and global nature.

➢ Program Outcomes:

Upon successful completion of the M.A/M.Sc program in Geography, student will be able to;

1. Understand the unifying themes of both human and physical geography as well as have a working knowledge of the discipline's diverse conceptual and methodological approaches.
2. Demonstrate an ability to develop research questions, critically understand quantitative and qualitative data sources, data bias, and data analysis and presentation, and conduct research using primary and/or secondary source material.
3. Students will be able to apply geographical knowledge for the exploration of GIS, Remote Sensing, and geographical resources.
4. M.A / M. Sc. Geography programme is structured for providing advances and by considering the overall development of students.
5. Students will able to work in public and private sector companies working in the field of GIS, Tourism, and Cartographer.

Equivalences for old courses of M. A / M. Sc Geography (Part I)

Semester – I st

Old Courses (June 2017)		New Courses (June 2021)	
Code of Courses	**Title of the courses**	**Code of Course**	**Title of the courses**
Gg.111	Principles of Economic Geography	GG. 101	Principles of Economic Geography
Gg.112	Principles of Population and Settelement Geography.	GG.102	Principles of Population Geography
Gg.113	Principles of Climatology.	GG.402	Climatology
Gg.114	Principles of Geomorphology.	GG. 401	Geomorphology
Gg.115	Practical in Geography	GG.103	Practical in Interpretation of SOI Topographical maps and Surveying by GPS

Semester – II nd

Old Courses (June 2017)		New Courses (June 2021)	
Code of Courses	**Title of the courses**	**Code of Courses**	**Title of the courses**
Gg.211	Geographical Thoughts	GG. 201	Geographical Thoughts
Gg.212	Social and Cultural Geography	GG.202	Social and Cultural Geography
Gg.213	Remote Sensing.	GG.203	Remote Sensing
Gg.214	Geo-Statistical Methods	GG. 205	#
Gg.215	Practical of Computerize Data Analysis Techniques in Geography	GG.204	Practical in Cartographic Techniques with the help of GIS

 # No equivalent course is available for this paper, so students may be allowed to appear by old course.

Distribution of Course papers for M.A / M. Sc. Part I (Geography)

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.A / M.Sc. Part I					
Semester I : Theory Courses					
GG.-101	Principles of Economic Geography	Core course	04	100	03
GG -102	Principles of Population Geography	Core course	04	100	03
GG -105	Tourism Management	Skill based	04	100	03
Semester I : Practical Courses					
GG -103	Practical in Interpretation of SOI Topographical maps and Surveying by GPS	Core course	**04+04**	**100**	06
GG -104	Practical in Human Geography	Core course	**04+04**	**100**	06
AC-101	Practicing Cleanliness	Audit Course	**02**	**100**	
Semester II : Theory Courses					
GG -201	Geographical Thoughts	Core course	**04**	**100**	03
GG -202	Social and Cultural Geography	Core course	**04**	**100**	03
GG -203	Remote Sensing	Core course	**04**	**100**	03
Semester II : Practical Courses					
GG -204	Practical in Cartographic Techniques with the help of GIS	Core course	**04+04**	**100**	06
GG -205	Practical in Geo-Statistical Methods	Skill based	**04+04**	**100**	06
AC-201A/B/C/D	**Choose one out of Four** AC-201A - Soft Skills / AC-201B - Sport Activities/ AC-201C -Yoga / AC-201D- Music	Audit Course	**02**	**100**	

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon
New Syllabus M.A./M.Sc. Geography
Semester-I (CBCS Pattern)
Core-Course

Gg. 101: Principles of Economic Geography

(With Effect from June 2021)

Total Marks-100 **Credit Points- 04** **Teaching Hours/Week: 04**
Clock Hours : 60

Course Objectives:

1) To understand concept Economic Geography in different walks of the life.
2) The students are able to explain the role of economic landscape in economic development.
3) To understand the economic measures and problems of economic development.
4) To acquaint the students with fundamental knowledge of international trade and impact of globalization on economic development of India

Course Outcomes:

After completion of this course, the students will be able to

1. Evaluate the applicability and importance of economic geography in analyzing the modes of societies and economies' operation.
2. Establish and analyze spatial patterns of economic development.
3. Explain the role of natural and cultural factors in determining economic development of India.

Unit No.	Units	Sub-units	Lectures
I	**Introduction to Economic Geography**	A) Definition, Nature and Scope. B) Approaches to Economic Geography. C) Recent trends in Economic Geography.	**06**
II	**Resources and Economic Development**	A) Meaning of the term 'Resources' B) Classification of Resource. C) Significance of natural and human Resources (Suitable Examples and Characteristics) D) Role of resources in economic development E) Models of economic development. i). Rostow's Model. ii) Myrdal Model	**14**

III	**Economic Landscape**	A) Land, labour, capital, organization. B) Significance of land, labour and capital in different economic activities. C) Spatial variation in the factor cost. D) Location of economic activity- Von Thunen's Model of agricultural location.	**10**
IV	**Economic Measures and Economic Development Region**	A) Measures of economic development. B) Problems of economic development. C) Economic development in developed and underdeveloped countries. D) Economic Regions; i) Definition and concept, types of economic region. ii). Stages in the development of economic regions iii) Economic development regions in India.	**10**
V	**International Trade**	A) Definition of international trade. B) Role of international trade in world economic growth. C) Factors affecting international trade D) India's foreign trade. E) Changing forms of international trade.	**10**
VI	**Economic Development in India**	A) Natural and cultural factors influencing economic development in India. B) Impact of green revolution on economic development in India. C) Impact of globalization on economic development of India. D) Free trade initiatives.	**10**

Weightage

Marks	
Internal Assessment	**40** marks
External Assessment	**60** marks

Suggested readings:

1) Alexander, J. W. (1977) : 'Economic Geography', Prentice Hall of India Pvt. Ltd., New Delhi.
2) Chorley, R. J. and Haggett, P (1970) : 'Socio Economic Models in Geography', Methuen.
3) H. M. Saxena (2013) : 'Economic Geography', Rawat publication, Jaipur.
4) Mitra, A (2002) : 'Resource Studies', Sreedhar publishers, Kolkata.
5) Kanan Chatterjee (2015) : 'Basics of Economic Geography', Concept publishing Company Pvt. Ltd., New Delhi.
6) Ray, P. k. (1997) : 'Economic Geography', New Central Book Agency (P) Ltd., Calcutta.
7) Shelar S. K. (2013) : 'Principles of Economic Geography' Chandralok Prakashan, Kanpur.
8) Garnier, B. J. and Delobez, A (1979), : 'Geography of Marketing', Longman.
9) Janaki V.A(1985) Economic Geography, Concept Publishing Co.
10. Sharma T.C.(2013) Economic Geography of India , Rawat Publication, Jaipur

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Syllabus for **M.A. /M.Sc. Geography**
Semester-I (CBCS Pattern)
Core-Course
Gg. 102 : Principles of Population Geography.
(With Effect from June 2021)

Total Marks-100 **Credit Points- 04** **Teaching Hours/Week: 04**
Clock Hours : 60

Course Objectives:

1) To enable students to acquire knowledge of Population Geography.

2) To study the population structure and characteristics of population.

3) To study the various theories in Population Geography.

4) To understand the World and Indian Population distribution.

Course Outcomes:

After completion of this course, the students will be able to,

1) To undesrstand the concepts in Population geography.
2) Students able to evaluate differet theories of population growth.
3) Students compare different population zones.
4) Students know the various problems of population.

Unit No.	Units	Sub - Units	Lectures
I	**Introduction to Population Geography**	A) Definitions and Meaning. B) Development of Population Geography as discipline. C) Nature and Scope of Population Geography. D) Population geography and Demography. E) Approaches to study the Population Geography.	**08**
II	**Population Distribution**	A) Factors affecting on distribution of population. i) **Physical factors –** topography, climate, soil, availability of water, natural vegetation , geographical location. **ii) Cultural/ Human factors –** religion, family system, Industrial development, transportation , economic factors, government policy, political and	**10**

		agriculture system. B) Population Density - Definitions and meaning. C) Types of density – arithmetic, economic, agricultural, physiological and critical. D) Population distribution in India (According to census 2011). E) World population distribution. F) Problems of over, optimum and under population.	
III	**Population Structure and Characteristics**	A) Sex structure. B) Age structure (importance of age composition and determinants of age structure, age pyramid and age groups.) C) Sex ratio in India, causes of decreasing sex ratio and its impact D) Marital status. E) Literacy and educational attainment. E) Literacy in India. F) Religions in India ((According to census 2011).	**10**
IV	**Fertility and Mortality**	A) Fertility – definitions, social and cultural factors affecting fertility, crude birth rate. B) Mortality – definitions, measures of mortality- Crude death rate, Infant mortality, levels and trends of mortality.	**12**
V	**Dynamics of Migration- Trends and Pattern**	A) Definitions and importance of migration. B) Types of migration – internal migration and types, international migration. C) Causes and effects of migration. D) Brain drain of human resource. E) Lee's theory of Migration.	**10**
VI	**Population Theories**	A) Theory of demographic transition. B) Malthusian theory of population growth. C) Karl Marx's theory of population.	**10**

Weightage

Marks	
Internal Assessment	**40** marks
External Assessment	**60** marks

Suggested readings:

1) Mohammad Hassan (2005) – Population Geography, Rawat publication, Jaipur.
2) Asha A. Bhende and Tara Kanitakar (2006) – Principles of Population Studies, Himalaya Publishing House, Mumbai.
3) Chandana R.C. and Jagjit S.S. (1980) – Introduction to Population geography, Kalyani Publishers, New Dehli.
4) Majid Hussain (1991) – Anmol Publication, New Dehli.
5) Sawant S.B and Athavale A.S. (1994) – Population Geography, Mehat publishing house, Pune.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Syllabus M.A./M.Sc. Geography
Semester-I (CBCS Pattern)
Core-Course
GG-103 : Practical in Interpretation of SOI Topographical Maps and Surveying by GPS.
(With Effect from June 2021)
(10 Students Per Batch)

Total Marks-100 **Credit Points- 04** **Teaching Hours/Week: 08**
Clock Hours : 96

Course Objectives:

1. To introduce the students with basic knowledge of topographical maps.
2. To know the importance and techniques of interpretation of topographical maps.
3. To introduce the students with basic principles of GPS and it's functioning.
4. To give practical knowledge about survey using GPS receiver and to prepare the survey layout using post-processing software.

Course Outcomes:

After completion of this course, the students will be able to,

1. Enhance interpretative skills of the students.
2. Identify the physical and cultural features in SOI topographical maps.
3. Adopt the knowledge of drawing profiles.
4. Understand the GPS and its functions, work, types and components for a filed survey.

Unit No.	Units	Sub-Units	Lectures
I	**SOI Topographical Maps**	A) Arrangement of toposheet on map of India i) Indexing of topographical map. B) Marginal information and grid references . i) Marginal information . ii) Grid references: four and six figure. C) Conventional signs and symbols on SOI topographical map.	**14**
II	**Relief Features by Contours**	A) Relief features by contours. i) Conical hill ii) Plateau iii) Ridge iv) Gorge. v) U Shaped valley vi) V Shaped valley. vii) Waterfall. B) Slopes: Concave and Convex Slopes, Gentle and Steep Slopes, Terraced Slope.	**17**
III	**Profiles**	A) Drawing of Longitudinal Profile, Cross Profile. B) Intervisibility.	**14**

IV	**Interpretation of SOI Topographical Maps**	**(Any Three)** A) Plain Region. B) Plateau Region. C) Mountainous Region . D) Coastal Region. E) Desert Region.	**17**
V	**Fundamental Concepts of GPS**	A) Introduction, Components, types and applications of GPS. B) GPS Satellites. C) Constellation of GPS Satellites. D) Segments.	**14**
VI	**Data Collection and Mapping Using GPS**	A) GPS Survey on field. B) Area measurement using GPS. C) Data Import. D) Processing and Mapping. E) Project work using GPS.	**20**

Weightage

Marks	
Internal Assessment	**40** marks
External Assessment	**60** marks

Suggested readings:

1. Tamaskar B.G. and Deshmukh V.M. (1974), Geographical Interpretation of Indian TopographicalMaps. Orient Longman Limited Bombay
2. Petrie N. (1992), Analysis and Interpretation of Topographical Maps. Orient Longman LimitedCalcutta.
3. Meux A. H. (1960), Reading Topographical Maps. University of London Press Limited
4. Wheeler K.S. Ed (1970), Geography in the field. Blond Educational, London.
5. Gupta, K. K. and Tyagi, V. C. (1992): Working with maps, Survey of India Publication, Dehradun
6. Ramamurthy, K. (1982): Map Interpretation, Rex Printer, Madras
7. Vaidyanadhan, R. (1968): Index to a Set of Sixty Topographic Maps: Illustrating Specified Physiographic Features From India, Council of Scientific and Industrial Research, Ministry of Education, Government of India
8. Gupta, K. K. and Tyagi, V. C. (1992): Working with Maps, Survey of India Publication, Dehradun
9. Basudeb Bhatta (2014): Remote Sensing and GIS, Oxford University Press, New Delhi.
10. Atiqur R. & Shahab A. (2017): Global Positioning System: Concept, Technique and Application, New Age International Publisher, New Delhi
11. Ben L. & Lawrence H. (2016): GPS Systems: Technology, Operation, and Applications, Discover Net Publishing, Walnet Street, USA

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New Syllabus M.A./M.Sc. Geography
Semester-I (CBCS Pattern)
Core-Course

GG-104 : Practical in Human Geography.
(With effect from 2021)
(10 Students Per Batch.)

Total Marks-100 **Credit Points- 04** **Teaching Hours/Week: 08**
Clock Hours : 96

Course Objectives:

1. To introduce some basic research method to the students to be applied to various themes in Human Geography.
2. To indicate the assumptions, limitations, and interpretation of these methods and results.

Course Outcomes:

After completion of this course, the students will be able to,

1. Evaluate and investigation the population data.
2. Understand the data analysis techniques in Human Geography
3. Understand the various basics statistical Techniques for analysis of the geographical data.

Unit No.	Units	Sub-Units	Lectures
I	**Introduction to Research Data in Human Geography and Data Collection Techniques**	A) Introduction to research data. B) Questionnaire: meaning and types. C) Planning, designing of questionnaire for field work. D) Data compilation and analysis.	**15**
II	**Data Analysis Techniques in Population Geography**	**A). Density:** i) Arithmetic density of population. ii) Economic density of population. iii) Nutritional density of population. iv) Agricultural density of population. v) Critical density of population. **B) Measures:** I) General fertility rate. II) Crud death rate. III) Infant mortality rate. **C) Sex Ratio:** i) Sex ratio of all groups of population.	**18**

		ii) Age- sex pyramids.	
III	**Data Analysis Techniques in Settlement Geography**	**A) Rural Settlement Geography** i). Dispersion of rural settlements: Bernhard's method, Demangeon method, Debouvrie's method. **B) Urban Settlement Geography** i) Nearest neighbour analysis- Clerk and Evan's method. ii) Rank size rule.	**16**
IV	**Data Analysis Techniques in Agricultural Geography**	A) Crop concentration by Bhatia. B) Crop diversification by Bhatia. C) Crop combination by Weaver's method. D) Agricultural efficiency by Jasbirsing's method.	**16**
V	**Data Analysis Techniques in Transport and Industrial Geography**	**A) Transport Geography** i) Graph theoretic measures of transport Network, Ratio Measures: a) Alpha b) Beta c) Gamma. **B) Industrial Geography** **i)** Measurement of industrial activity. a) Location Quotient. b) Lorenz curve.	**15**
VI	**Cartographic Techniques Maps**	A) Literacy Rate (Choropleth method). B) Dispersion of settlements (Dot method) C) Functional classification of towns (Use different signs and symbols) D) Land use and Land classification.	**16**

Weightage

Marks	
Internal Assessment	**40 marks**
External Assessment	**60 marks**

Suggested readings:

1. R.B.Mandal: “Statistic for Geography and Social Science”.

2. Monkhouse: “Maps and Diagram”.

3. Masjid Husen “: Agricultural Geography”.

4. Hudson F.S. (1976): “Geography of Settlement”.

5. Yeats, M.H. (1974): “An Introduction to Quantitative Analysis in Human Geography”.

6. Sing J. and Dhillon (1984) “Agricultural Geography”.

7. Sing R.L. “Readings in Rural Settlement Geography”.

8. Michaele E. and E. Hurse: ‘Transportation Geography”.

9. Edward Arnold: “The Study of Urban Geography”.

10. George Omura: Mastering Auto CAD, BPB Publication, b14 Conneaut place, New Delhi

11. Grini Courter and Annette Marquis (1999): “OFFICE 2000” BPB Publication

12. Dr. Sanjay Bhaise and Prof. Devendra Maski: ‘LoksankhyaBhugol’

Pattern of question paper

1. All questions will be compulsory.
2. A mark for Viva-voce is 10 marks.

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New Syllabus M.A./M.Sc. Geography
Semester-I (CBCS Pattern)
Skill Based Course
GG: 105, Tourism Management
(With effect from June 2021)

Total Marks-100 **Credit Points- 04** **Teaching Hours/Week: 04**
Clock Hours : 60

Course Objectives:

To understand concept of tourism management:

1. To provide training, skill development and education needed to prepare individuals for effective job in the tourism and entertainment industries.
2. To understand the management functions of tourism industry including human resource management, financial management, marketing and technology applications.
3. To identify potential career opportunities of our students through internship programs.

Course Outcomes:

After completion of this course, the students will be able to,

1. Tourism Management graduates are hired by both private and government sector companies.
2. Tourism Management course helps students specialize in the industry-specific knowledge and make them business ready for fields such as hotels, vacation resorts, retreat hotels, campgrounds,

Unit No.	Units	Sub-Units	Lectures
I	**Introduction to Geographical Tourism Management**	**A)** Concept of tourism and geo-tourism. **B)** Need and importance of tourism management. **C)** Scope and future of tourism management. **D)** Types of tourism management. General problems of tourism management.	10
II	**Tourism Planning**	**A)** Types of tourism planning. **B)** Problem of tourism planning. **C)** National and International Tourism planning. **D)** Components of tourism planning. Programme implementation.	10
III	**Tourism Marketing & Management**	**A)** Defining of tourism marketing. **B)** Need of marketing in tourism. **C)** Components of Tourism Marketing	12

		& Management- **i)** The tourist product, ii)Special features of tourism marketing, iii) Marketing process, iv) Marketing research, **v) The segmentation, targeting, positioning (STP) marketing model.** vi) Tourism promotion, vii) Advertising.	
IV	**Role of Infrastructure and Transport in Tourism**	**A)** Infrastructure facilities. **B)** Tourism accommodation & Food Services. **C)** Resort and Event Management. **D)** Transportation-Tourism management.	08
V	**Sale Services in Tourism**	**A)** Sales and marketing and Public relations. **B)** Tour and travel documentation services. **C)** Language skill and Business communications. **D)** Tourism management information system. **E)** Customer care and interpersonal skills. **F)** ICT in tourism management.	10
VI	**Tourism impact and Tourism Policy of India**	**A)** Tourism impacts. **B)** Sustainable and green tourism. **C)** Role of Travel agency & Tour operations. **D)** National tourism policy in india-2016.	10

Weightage

Marks	
Internal Assessment	**40 marks**
External Assessment	**60 marks**

Suggested readings:

1) A. K. Bhatia. (1908): Tourism Management and Marketing
2) Alston, A., (1979): Working in the Travel Business, Batsford Publications, London.
3) Anthony, Edwards (1985) International Tourism Forecasts to 1995, EIU, 40 Duke Street, London WIM 5 DG, UK.
4) Balsdon, J. P. V. D. (1966): Life and Leisure in Ancient Rome, London, Bodley Head.
5) Beazely. E. (1970): Designed for Recreation, London: Faber.
6) Bernecker, Paul, Methods and Media of Tourist Publicity, Vienna, Austrian National Tourist Office, 1961.
7) Bhatia, A.K. : Tourism Development, Sterling Publishers Pvt. Ltd., New Delhi110016
8) Brownell. G. G., Travel Agency Management, Birmingham, Southern University Press, 1975
9) Lancaster G. and Massingham, L. (1988) *Essentials of Marketing*. Maidenhead, Berkshire, England. McGraw-Hill.
10) Law B. C. (1968 ed) - Mountain and Rivers of India, Calcutta
11) Mill and Morrison (1992) : The Tourism system an Introductory Text , Prentice Hall
12) P.S. Gill: Dynamics of Tourism (4 Vols) Anmol Publication. New Delhi,
13) R. M. Desai (1988) : Strategy of food and agriculture – Bombay
14) Robinson H.A.A. -Geography of Tourism, MacDonald and Evans, London.
15) Seth: Tourism Management : Sustainable Tourism Development, Guide for Local Planners by WTO, Sterling Publishers Pvt. Ltd., New Delhi-110016
16) Smith, W. R. (1956). Product differentiation and market segmentation as alternative marketing strategies. *Journal of Marketing*. (Vol. 21, Issue 1, July). p3-8.

Model Question Paper Format

For

GG. 103 Practical in Interpretation of SOI Topographical Maps and Surveying by GPS

Note: All questions are compulsory.

Que. 1 – Interpretation of SOI topographical map with the help of following points. (09 Marks)

(a)

(b)

(c)

Que. 2 (A) – Drawing of relief features and slopes with the help of contours. (06 Marks)

(a)

(b)

(c)

(B) Drawing and identification of conventional signs and symbols of SOI topographical maps. (03 Marks)

(C) Drawing of profile. (05 Marks)

(D) Write short note on (any one out of 03). (Chapter I and III) (02Marks)

Que. 3- Survey the given area with the help of GPS (as per instructions of examiner given to you.) (12 Marks)

Que.4-(A) Write shorts notes (any three out of 05) (Chapter V and VI (09 Marks)

(B) Descriptive Question (Chapter V and VI) (04 Marks)

Que. 5 Journal (05 Marks)

Oral (05 Marks)

Model Question Paper Format

For

GG-104 : Practical in Human Geography.

Note: All questions are compulsory.

Que. 1 Solve Example (Attempt any 01 out of 02) **(10 Marks)**

Que.2 Solve Examples (Attempt A and B)

(12 Marks)

(A)

(B)

Que.3 Solve Example(Attempt any 01 out of 02) (12 Marks)

Que.4 (A) Solve Example(Attempt any 01 out of 02) (10Marks)

(B)Write short notes on(Attempt any two out of 04) (06 Marks)

Que. 5 Journal (05 Marks)

Oral (05 Marks)

M.A / M.Sc. Part I

(Semester I)

Subject: ***Audit Course***

AC-101: Practicing Cleanliness **(Compulsory; Audit Course; Practical; 2 Credits)**
Course Objectives (CObs): • To make students aware of Clean India Mission and inculcate cleanliness practices among them.

• Awareness program on
  o Swachh Bharat Abhiyan (Clean India Mission)
  o Clean Campus Mission
  o Role of youth in Clean India Mission
• Cleaning activities inside and surroundings of Department buildings.
• Tree plantation and further care of planted trees
• Waste (Liquid/Solid/e-waste) Management, Japanese 5-S practices
• Planning and execution of collection of Garbage from different sections of University campus
• Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance.
• Cleanest School/Department and Cleanest Hostel contests
• Painting and Essay writing competitions

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	**CO**	**Cognitive level**
AC101.1	Identify need at of cleanliness at home/office and other public places.	**2**
AC101.2	Plan and observe cleanliness programs at home and other places.	**4**
AC101.3	Practice Japanese 5-S practices in regular life.	**3**

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Syllabus M.A./M.Sc. Geography
Semester-II (CBCS Pattern)
Core- Course
GG-201: Geographical Thoughts.
(With Effect from June 2021)

Total Marks-100 **Credit Points- 04** **Teaching Hours/Week: 04**
Clock Hours : 60

Course Objectives:

1. To understand the evolution of geographical, concept, ideas and knowledge.
2. To generalize the valuable contribution of pioneers in the geography
3. To study the major schools of geography in ancient and modern period.
4. To elaborate the trends of historical development of geography.

Course Outcomes:

After completion of this course, the students will be able to,

1. Appreciate the contribution of the thinkers in Geography.
2. Strengthen point presentations on different schools of geographical thought.
3. Know relationship of geography with other disciplines and man-environment relationships.

Unit No.	Units	Sub-Units	Lectures
I	**Nature of Pre- Modern Geography**	A) Impact of 'Dark Age' in Geography. B) Development of Geography: i) Greek Geographers- a) Homer b) Aristotle c) Erastothenis ii) Arabian Geographers- a) Ibn Batuta b) Al Idrisi c) Al Masudi iii) Indian Geographers - a) Aryabhatta b) Varahamihira c) Brahamgupta d) Bhaskarachrya	**12**
II	**Role of Ancient Explorers & Discoveries in Geography**	A) Marco Polo. B) Christopher Columbus. C) Vasco da Gama. D) Captain James Cook.	**08**
III	**History of Modern Geographical Thoughts**	Contribution of modern geographers in the world: A) Contribution of modern geographers- i) Alexander Von Homboldt ii)	**12**

		Fredrich Ratzel iii)Vidal-de-La-Blache iv) Grifith Taylor B) Roman Geographers- i) Strabo ii) Ptolemy.	
IV	**Dualism in Geography**	Dualism/ Dichotomies in Geography. i) Physical Geography v/s Human Geography. ii) General Geography v/s Regional Geography. iii) Determinism v/s Possibilism.	**08**
V	**Evolution of Critical Geography**	Trends in geographic thoughts and methodology. i) Quantitative revolution. ii) Behavioural approach. iii) Humanistic approach. iv) Human welfare approach.	**10**
VI	**Post Modern trends in Geography**	A) Structuralism in Geography. B) Historical materialism. C) Changing concept of 'Space' (with special reference to Harvey) D) Geography in the 21st Century : towards post modernism.	**10**

Weightage

Marks	
Internal Assessment	**40 marks**
External Assessment	**60 marks**

Suggested readings:

1) Taylor G. (1951): Geography in 20th Century, Methuen & Co. London.
2) Husain Majid (1984): Evolution of Geographical Thoughts, Rawat Publication, Jaipur
3) David Harvey: Explanation in Geography
4) Hart M.G. (1986): Geomorphology- Pure and Applied, George Allen & Unwin.
5) Robert E Dickinson: The Makers of Modern Geography.
6) Peter Hagget: Geography, A Modern Syntesis.
7) Saroj K Pal: Statistical Techniques, A Basic Approach to Geography, Mc. Graw Hill.
8) Floyd Sabins: Remote Sensing, Principles and Application, Freeman and Co. New York

9) Hartshown T A & Alexander (1988): Economic Geography, Prentice Hall, International Inc.

10) Brian P Fit Gerald: Development in Geographical Method" Science in Geog. Oxford Uni. Press

11) Kang- tsung : Introduction to Geographic Information System (2002) McGraw Hill.

12) George Joseph : Fundamentals of Remote Sensing (2004) ,University Press Pvt. Ltd. Hyderabad.

13) J.R. Jensen : Remote Sensing of Environment, An Earth Resources, Perspective (2003) ,Person Education Pvt. Ltd. New Delhi.

14) Dr. Sawant,Prakash (1999) Thought and Concepts in Geography, Phadake Prakashan, Kolhapur

15) James, P.E.(1980) All possible Worlds: A History of Geographical ideas, Sachin Publication Jaipur (Indian Reprint)

16) Free Man, T.W, (1965) : Geography as Social Science, Harper International Edition, Harper & Row Publishers, New York.

17) Adhikari, S. 2015. Fundamentals of Geographical Thought, Orient Black swan.

18) Clifford, N. Holloway S.L., Rice, S.P., Valentine, G. 2009. Key Concepts in Geography, 2nd ed, Sage.

19) Couper, P. 2015. A Student′s Introduction to Geographical Thought: Theories, Philosophies, Methodologies, Sage.

20) Cresswell, T. 2013. Geographic Thought: A Critical Introduction, Wiley-Blackwell.

21) Dikshit, R.D. 2004. Geographical Thought: A Contextual History of Ideas, Prentice Hall India.

22) Holt-Jensen, A. 2011. Geography: History and Concepts: A Student's Guide, Sage

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

New Syllabus M.A./M.Sc. Geography
Semester-II (CBCS Pattern)
Core-Course
GG. 202 : Social and Cultural Geography.
(With Effect from June 2021)

Total Marks-100 **Credit Points- 04** **Teaching Hours/Week: 04**
Clock Hours : 60

Course Objectives:

1) To study the Social as well as Cultural situation in the different parts in the world.
2) To analyze the relationship between the geography and socio-cultural factors.
3) To aware the students about various socio-cultural phenomenon.

Course Outcomes:

After completion of this course, the students will be able to,

1) Acquire skills related with socio-cultural factors.
2) Familiar to information about various social factors.
3) Identify various types of cultural landscape of the world.

Unit No.	Units	Sub Units	Lectures
I	**Introduction to Social & Cultural Geography**	A) Meaning B) Definitions C) Nature and Scope of Social & Cultural Geography D) Development of Social & Cultural Geography	**08**
II	**Social Theories**	A) Classical Social Theory i) Modern Social Theory ii) Post Modern Social Theory iii) Social Structure	**08**
III	**The Cultural Complex**	A) Cultural landscape i) Development of cultural landscape ii) Cultural Regions of the world	**08**
IV	**Tribes**	A) Definition, Tribal social formation B) Nomenclature, Language variation C) Distribution at state and district level D) Distribution of the tribes i) Gond ii) Naga iii) Bhill iv) Bushmen	**10**

V	**Themes in Cultural Geography**	A) Themes in cultural geography i) Cultural region ii) Formal cultural region iii) Functional cultural region iv) Cultural diffusion v) Cultural ecology	**12**
VI	**Cultural System**	A) Geography and religion B) Geography and language C) Cultural Nationalism D) Globalization and cultural change E) Cultural Convergence & divergence	**14**

Weightage

Marks	
Internal Assessment	**40 marks**
External Assessment	**60 marks**

Suggested readings:

1) Ajaruddin Ahmad- “Social Geography”, Rawat Publication Jaipur, New Delhi.

2) Emrys Johns (1975) - "Readings in Social Geography", Oxford University Press.

3) Rajit Tirtha: "Geography of India", Eastern Michigan University, U.S.A. & Region.

4) Spencer J.E. and W.L. Thomas: "Introducing Cultural Geography"

5) Wagner P.L. and Mi Kesell M.W.: "Reading Cultural Geography"

6) Majid Husain: "Cultural Geography", Anmol Publication Pvt. Ltd., New Delhi.

7) John Emrys: "Regions in Social Geography"

8) John Emry and Eyles John: "An Introduction of Social Geography"

9) Dr. Jain: "VishwakaSanskrutikBhugol"

10) Majid Husain - Social Geography

11) Kaushik, Chavan, P.K. Pande - Social Geography

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Syllabus M.A./M.Sc. Geography
Semester-II (CBCS Pattern)
Core- Course
Gg. 203 : Remote Sensing.
(**With Effect from June 2021**)

Total Marks-100 **Credit Points- 04** **Teaching Hours/Week: 04**
Clock Hours : 60

Course Objectives:

1) To introduce students with advance techniques of survey and data collection.
2) To acquaint the students with fundamental knowledge and principles of Remote Sensing.
3) To familiar students with variety of applications of Remote Sensing.
4) To acquaint the students with fundamental concepts and importance of Aerial Photographs and satellite imageries.

Course Outcomes:

After completion of this course, the students will be able to,

1) Recognize and explain basic principles of remote sensing including electromagnetic spectrum; the emission, scattering, reflection and absorption of electromagnetic radiation (EMR); variations in EMR interactions with many substances.
2) Recognize and explain properties of remote sensing data acquisition, storage and processing.
3) Recognize properties of aerial photographs and satellite imageries.
4) Recognize and describe applications of remote sensing data in different fields.

Unit No.	Units	Sub units	Lectures
I	**Introduction to Remote Sensing**	A) Introduction. B) Definitions of remote sensing. C) History of remote sensing. D) Process of remote sensing' E) Applications of remote sensing techniques in different fields.	**10**
II	**Fundamentals of Remote Sensing**	A) Concept of energy. B) Electromagnetic energy and radiation. C) Properties of electromagnetic waves. i) Wave velocity. ii) Wave length. iii) Wave frequency. D) Electromagnetic spectrum. E) Interaction of EMR with atmosphere:	**12**

		absorption, scattering [Selective (Rayleigh, Mie and Raman Scattering) and Nonselective], reflection, refraction, and transmission of energy. F) Interaction of EMR with earth surface - Reflection, Absorption, Emission.	
III	**Types of Remote Sensing and Platforms.**	A) Types of remote sensing. i) Based on energy source. a) Passive remote sensing. b) Active remote sensing. ii) Based on use of wavelength regions of electromagnetic spectrum. a) Optical. b) Thermal. c) Microwave. B) Remote sensing platforms. i) Definition of platform. ii) Types of platforms. a) Ground based platform. b) Air borne platform. c) Space borne platform.	**10**
IV	**Aerial Photographs**	A) Introduction to Aerial Photographs. B) Types of aerial photographs. C) Types of camera. D) Types of film. E) Geometry of aerial photographs. F) Iquipments used for the interpretation of aerial photographs (Parallax bar, Stereoscope (Mirror and Pocket Stereoscope). G) Stereoscopic overlapping. H) Methods of scale determination. I) Average scale of aerial photographs. J) Elements of interpretation of aerial photographs.	**12**
V	**Satellite Remote Sensing**	A) Satellite orbit. i) Definitions. ii) Types of orbit. a) Geostationary / Geosynchronous. b) Polar / Sun synchronous. B) Satellite swath. C) Scanning techniques. i) Across-track ii) Along track. D) Sensor - definition and types of Sensor.	**08**

		E) Resolution of sensors (Spectral, Spatial, Radiometric and Temporal). F) Elements of image interpretation.	
VI	**Development of Indian Remote Sensing.**	A) History of IRS development. B) NRSA organization (NRSC). C) Satellites launched by India and their functions. D) Recent development of India in Space Technology.	**08**

Weightage

Marks	
Internal Assessment	**40 marks**
External Assessment	**60 marks**

Suggested readings:

1. Abbasi S.A., K.B. Chari K.B. (2005): Applications of GIS and Remote Sensing in Environmental Management, Discovery Publication House, New Dehli.
2. Agarwal C.S.and Garg P.K. (20020: Text Book on Remote Sensing, Wheeler Publishing Delhi.
3. Prithvish Nag and M. Kudrat (1998): Digital remote Sensing, Concept Publishing Company,
   New Delhi.
4. Bhatta Basudeb (2011): Remote Sensing and GIS, Oxford University Press.
5. Chang, Kang-Taung (2000): Introduction to Geographic information System, Tata McGraw Hill.
6. Joseph George, 2003, Fundamentals of remote sensing. Universities Press.
7. Lillesand, Thomas M. & Kiefer Ralph (2000): Remote Sensing and Image Interpretation, Jonh Willey.
8. Prithvish Nag and M. Kudrat (1998) : Digital remote Sensing , Concept Publishing Company,
   New Delhi.
9. Sabbins, F.F., 1985, Remote sensing Principles and interpretation. W.H. Freeman & Company
10. American Society for Photogrammetry and Remote Sensing, 1999, Remote Sensing for the Earth Sciences, Manual of Remote Sensing,3rd ed.,vol. 3, Wiley, New York.

Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon

New Syllabus for M.A./M.Sc. Geography

Semester–II (CBCS Pattern)

Core- Course

Gg. 204 : Practical in Cartographic Techniques with the Help of GIS

(With Effect from June 2021)
(10 Students Per Batch)

Total Marks-100 **Credit Points- 04** **Teaching Hours/Week: 08**
Clock Hours : 96

Course Objectives:

1) To acquaint the students with basic concepts of GIS.
2) To familiar the students with open-source software, QGIS and its importance in cartography.
3) To acquire the skill of georeferencing process in QGIS.
4) To enable the students to create different political and physical maps using QGIS
5) To acquire the skill of making chloropleth maps based on attribute tables.

Course Outcomes: After completion of this course, the students will be able to,

1) Explain the importance concept of GIS and importance of QGIS in Cartography.
2) Undertake the process of georefencing a toposheet or a scanned map.
3) Create different Political and Physical maps using QGIS.
4) Create chloropheth maps based on attribute data tables.

Unit No.	Units	Sub - units	Lectures
I	**Introduction to GIS**	A) Introduction to GIS: Definitions, Evolution, Components and Objectives. B) Computer fundamentals for GIS. C) Spatial data models – raster and vector. D) Non spatial data. E) Metadata.	**10**
II	**Introduction to Quantum GIS (QGIS)**	A) Concept of Open-source software. B) Introduction to QGIS. C) Difference between ArcGIS and QGIS. D) Downloading and Installation of QGIS. E) Introduction to basic tools and panels in QGIS.	**10**

III	**Georeferencing**	A) Scanning a map or toposheet with required dpi (Raster). B) Downloading a toposheet from SoI webite. C) Uploading map / satellite image in QGIS. D) Selecting Georeferencing points (3 or 4). E) Georeferencing the map or image with the help of selected points.	**18**
IV	**Creating a map using readymade data (packages) Part - I**	A) Download the Natural Earth Quickstart Kit. B) Select an appropriate area for a map. C) Creating map layout. D) Grid and Coordinates. E) Legends.	**18**
V	**Creating a map using readymade data (packages). Part - II**	A) Adding Title and sub-title to the map. B) Formation of appropriate graphical scale. C) Adding Direction (North arrow). D) Exporting the map as image (set appropritate dpi) and as pdf file.	**20**
VI	**Attribute Data and Data Exploration Digitization and map making**	A) Creation of vector data model using line, polygone and point. B) Digitazation and creating an outline map. C) Adding attribute data to a map. D) Symbology based on attribute data. E) Creating map layout and addition coordinates, title, direction, scale and legend.	**20**

Weightage

Marks	
Internal Assessment	**40 marks**
External Assessment	**60 marks**

Suggested readings:

1) *"Geographic Information System Basics"* by Jonathan E. Campbell, UCLA, Michael Shin, UCLA.

   Available for free: http://2012books.lardbucket.org/books/geographic-information-system-basics/index.html

2) Kang-tsung Chang (2007), 'Introduction to Geographic Information Systems' Tata MCGraw Hill, New Delhi.
3) C.P.Lo and Albert K.W. Yeung (2006) "Concepts and Techniques of Geographic information Systems" Prentice Hall of India, New Delhi
4) Burrough, Peter A. and Rachael McDonnell, (1998), 'Principles of Geographical Information Systems' Oxford University press, New York.
5) Magwire, D.J. Goodchild, M.F. and Rhind, D.M., (2005), 'Geographical Information Systems: Principles and Applications', Longman Group, U.K.
6) Burrough, P.A., 1986, Geographical Information System for land Resources System, Oxford Univ. Press, UK.
7) Fotheringham, S.; Rogerson, P. (ed.), 1994. Spatial analysis and GIS. Taylor and Francis, London, UK.
8) Laurini, Robert and Dierk Thompson, 1992, Fundamentals of Spatial Information Systems, Academics Press, ISBN 0-12-438380-7.
9) Maguire,D.J.; Goodchild, M.F.; Rhind,D.W. 1991.Geographical information System, Longman, London,UK
10) Siddiqui, M.A.; 2006, Introduction to Geographical Information System, Sharda Pustak Bhavan, Allahabad.
11) Siddiqui, M.A.; 2011, Concepts and Techniques of Geoinformatics, Sharda Pustak Bhavan, Allahabad.
12) https://www.qgistutorials.com/en/index.html
13) https://docs.qgis.org/3.4/en/docs/training_manual/index.html

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Syllabus M.A./M.Sc. Geography
Semester-II (CBCS Pattern)
Skill Based Course
Gg-205 : Practical in Geo-Statistical Methods.

(With Effect from June 2021)

(10 Students Per Batch)

Total Marks-100 **Credit Points- 04** **Teaching Hours/Week: 08**
Clock Hours : 96

Course Objectives:

1. To introduce some basic research methods to the students.
2. To introduce the importance of statistical techniques in Geography.
3. To introduce the skill and practical approach of Geo Statistical Methods.

Course Outcomes:

After completion of this course, the students will be able to,

1. Understand the importance and use of statistical methods in geography.
2. Use of sampling methods in Geo-statistical data.
3. Examine the relationship between two or more variables with the help of Correlation and regression analysis.
4. Measure probability using some probability distributions.
5. Apply large and small sample tests in Geo-statistical data.

Unit No	Topic	Sub Topic	Periods
I	**Introduction to Geo-Statistical Methods**	A) Introduction. B) Meaning and Definition of Geo-Statistical Methods. C) Importance and use of statistical methods in geography.	12
II	**Sampling and Sample Planning in Geo-Science**	A) Population and Sample. B) Sampling: Objectives, Advantages. C) Methods of Sampling. i). Simple Random Sampling. ii). Stratified Random Sampling. iii.) Systematic Sampling. iv). Cluster Sampling.	18
III	**Bivariate Analysis**	A) Bivariate Data. B) Covariance. C) Correlation: Karl Pearsons Correlation Coefficient. D) Regression: Meaning.	18

		E) Linear Regression. F) Non Linear Regression : Power, Exponential, Logarithmic	
IV	**Probability Distributions**	A) Probability functions and Computation of Probabilities using following distributions B) Binomial Distribution. C) Poisson Distribution. D) Normal Distribution. E) Standard Normal Distribution (Z ~ N (0,1)).	16
V	**Testing of Hypothesis - I**	A) Introduction. B) Types of Hypothesis. C) Type of Errors, Critical Value, Level of Significance, Concept of p-value. D) One tailed and two tailed test. E) Large Sample Tests (Based on Normal Distribution) – i) Test of Significance between sample mean and population mean. ii) Test of Significance between sample proportion and population proportion	16
VI	**Testing of Hypothesis - II**	A) Chi-square test. B) Student's t-test. C) Snedecor's variance ratio test (F test).	16

Weightage

Marks	
Internal Assessment	**40** marks
External Assessment	**60** marks

Suggested readings:

1) Cole, J.P., King, C.A.M. (1968): Quantitative Techniques in Geography. John Wiley & sons Inc.New York.
2) Gregory, S. (1968): Statistical methods and the geographer. Longman, London.
3) Elhance, D.N. (1972): Fundamentals of statistics, Kitab Mahal, Allahabad.
4) Mahmood, A. (1977): Statistical Methods in Geographical Studies, Rajesh Publications, New Delhi

5) Hammond,R., McCullagh P. (1978): Quantitative techniques in Geography An Introduction (2nd Ed.), Oxford University Press, USA.
6) Gupta, C.B. (1978); An introduction to statistical Methods, Vikas Pub.House,New Delhi.
7) 7.King, L.J. (1991): Statistical Analysis in geography. Prentice Hall, Englewood Cliff N.J.
8) Frank, H., & Althoen, S. C. (1994). *Statistics: Concepts and Applications*. Cambridge: Cambridge University Press.
9) Alvi, Z. (1995): Statistical Geography: Methods and Applications, Rawat Publications, Jaipur
10) Mann, P. S. (2007). *Introductory Statistics*. New Delhi: John Wiley and Sons
11) Burt, J.E., Barber, G.M., and Rigby, D.L. (2009): Elementary Statistics for Geographers (3rd Ed.), TheGuilford Press, 653pp.
12) Harris, R., Jarvis,C.(2011): Statistics for Geography and Environmental Science, Prentice Hall.
13) Acevedo, M.F.(2012): Data Analysis and Statistics for Geography, Environmental Science and Engineering, CRC Press.
14) Rogerson,P.A.(2015): Statistical Methods for Geography: A Student's Guide, 4th ed,Sage.

Model question paper format

For

Gg. 204: Practical in Cartographic Techniques with the Help of GIS

Note:

1. **Question 1 is compulsory.**
2. **Solve any two questions from 2 to 4.**

Question 1. Georeference the given part of toposheet / map. (10 Marks)

Question 2. Prepare the map of .... (any country) by using the given dataset. The map must include Title, coordinates, north, scale and legend. (20 Marks)

Question 3. Prepare a choropleth map using the given outline and attribute data. (Jalgaon, Dhule, Nandurbar maps) (20. Marks)

Question 4. Prepare a outline map (vector) with help of given map (raster) using polygons or lines. The map must include Title, coordinates, north, scale etc. (20 Marks)

Question-5 Journal (05 Marks)

Oral (05 Marks)

Model Question Paper Format

For Gg-205 : Practical in Geo-Statistical Methods

Note: All questions are compulsory.

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Que. 1 Solve Example (Attempt any 01 out of 02) **(10 Marks)**

Que.2 Solve Examples (Attempt A and B) (12 Marks)

(A)

(B)

Que.3 Solve Example (Attempt any 01 out of 02) (12 Marks)

Que.4 (A) Solve Example (Attempt any 01 out of 02) (10Marks)

(B)Write short notes on (Attempt any two out of 04) (06 Marks)

Que. 5 Journal (05 Marks)

Oral (05 Marks)

M.A/ M.Sc. Part I

Semester II

Audit Courses

	AC-201(A): Soft Skills **(Personality and Cultural Development Related Audit course; Practical; 2 Credits)** **(Optional:)**	
	Course Objectives (CObs): •	
Unit 1	**Introduction to soft skills** Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal setting, life skills, Need for soft skills, Communication skills, Etiquettes& Mannerism.	**2 h**
Unit 2	**Self-Assessment** Goal setting, SWOT analysis, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements, positive attitude, positive thinking and self-esteem. Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.	**4 h**
Unit 3	**Communication Skills** Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait, dressing sense, facial expressions, peculiarity of speaker (habits). Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real-life story for 5 minutes each), Oral review (Each student orally presents a review on a story or a book read by them) Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.	**8 h**
Unit 4	**Formal Group Discussion, Personal Interview & Presentation skills** Topic comprehension, Content organization, Group speaking etiquettes, driving the discussion & skills. Preparation for personal interview: dress code, greeting the panel, crisp self-introduction, neatness, etiquettes, language tone, handling embarrassing & tricky questions, graceful closing. Activity: Each batch is divided into two groups of 12 to 14 students each. Two	**4 h**

	rounds of a GD for each group should be conducted and teacher should give them feedback. Mock interview are to be conducted.	
Unit 5	**Aptitude and analytical skills** Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking. Analytical skills: Definition, Types, problem solving	**8 h**
Unit 6	**Life skills** Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.	**4 h**

Suggested readings:

1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd.
2. English for Business Communication: Simon Sweeney, Cambridge University Press
3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press
4. Quantitative Aptitude: R.S. Agrawal

AC-201(B): Practicing Sports Activities

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)

(Optional: Campus-level)

Course Objectives (CObs):

- To motivate students towards sports and provide them required training.

SR NO.	NAME OF THE SPORT/GAME (Select ONE of the Following)	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMESTER
1	Volleyball	• General Fitness • Basic Fitness • Specific Fitness • History of the Game • Basic Skill of the Game • Major Skill of the Game • Technique & Tactics of the Game • Game Practice	Morning : 07 to 09 AM OR Evening : 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

AC-201(C): Practicing Yoga **(Personality and Cultural Development Related Audit course; Practical; 2 Credits)** **(Optional)**	
	Course Objectives: • To motivate students towards yoga and provide them required training.
	• Yog: Meaning, Definition & Introduction, Objectives • Primary Introduction of Ashtanga Yoga • Preparation of Yogabhyas • Omkar Sadhana, Prayer, Guru Vandana • Sukshma Vyayamas • Suryanamaskar (12 Postures) • Asanas : ▪ Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan ▪ Supine (Shayansthiti) - Uttan Padaasan(Ekpad/Dwipad), Pavanmuktasana, Viparitakarani Aasan, Khandarasan, Shavasana ▪ Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, Saralhasta Bhujangasana, Shalabhasana(Ekpad/Dwipad), Makarasana ▪ Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana, Ardh Chakrasana • Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana - 6 Types • Pranayama : Anuloma-viloma, Bhramari

AC-201(D): Introduction to Indian Music (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional: Campus-level)	
	Course Objectives: • To motivate students towards Indian music and provide them minimum required training.
	• Definition and brief about generation of Swar, Saptak, Thaat, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc. • Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa. • Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information) • Detailed information of Tambora • Detailed information of Harmonium and Tablaa. • Five filmy songs based on Indian Classical Music (Theory and Presentation) • Sound Management - Basic information of Sound Recording (including Practicals) • Composition of Music as per the Story • Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201D.1	Identify different types of Indian music.	**3**
AC201D.2	Develop more interest to learn and practice Indian music.	**4**

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