Modern College of Arts, Science and Commerce (Autonomous), Ganeshkhind, Pune - 16

DEPARTMENT OF BOTANY

S.Y.B.Sc. Botany

Choice Based Credit System Syllabus

To be implemented from Academic Year 2025-2026

Structure of Course:

Semester	Vertical No. & Name	Name of subject	Subject Code	T/P	Credit
3	Major DSC	Plant Taxonomy and Ecology	24BOT 23101	T	2
		Plant Biotechnology	24BOT 23102	T	2
		Practical Course in Taxonomy, Ecology and Biotechnology	24BOT 23103	P	2
	Major specific IKS	Basics of Ethnobotany	24BOT 23104	T	2
	Minor	Biology of Cells and Molecule	24BOT 23205	T	2
		Practical in Biology of Cells and Molecule	24BOT 23206	P	2
	OE	Agrotourism	24BOT 23307	T	2
	VSEC	Practical Course on Basic skills in Gardening and Nursery Management	24BOT 23408	P	2
	FP1				2
4	Major DSC	Biology of Cells and Molecules	24BOT 24101	T	2
		Essentials of Plant Physiology	24BOT 24102	T	2
		Practical Course in Plant Physiology, Cell and Molecular biology	24 BOT 24103	P	2
	Minor	Ecological Restoration and Conservation	24BOT 24204	T	2
		Practical Course in Ecological Restoration and Conservation	24BOT 24205	P	2
	OE	Practical course in Basics in Floriculture	24BOT 24306	P	2
	VSEC	Practical Course on Field Techniques in plant identification and classification	24BOT 24407	P	2
	SEC	Practical Course on Basics of Phytochemistry	24BOT 24408	P	2
	CEP				2

Preamble:

The SYBSc syllabus is designed in such a way that the knowledge obtained at FYBSc in various Botany subjects will be applied for second year. This includes identification and classification of plants in Taxonomy. Further, more courses are designed to provide a comprehensive understanding of plant biology, including cell and molecular biology, biotechnology, physiology, and Ethnobotany. Some modifications are done in the titles to correlate theory subjects with practical. Open Elective subjects are designed for other faculty students which will enrich their practical knowledge. Through hands-on learning experiences and critical thinking exercises, students develop the knowledge, skills, and ethical values necessary for careers and further academic pursuits in botany and related fields.

Program objectives:

1. To identify and classify plants
2. To enhance understanding about Indian knowledge system in Ethnobotany
3. To obtain hands on experience in courses of plant science
4. To apply knowledge about floriculture and Agrotourism by other faculty students

Program outcome:

After completion of syllabus students will be able to

PO1 Identify and classify plants

PO2 Understand the importance of Indian knowledge system

PO3 Apply knowledge from hands on experience from different courses of plant sciences

PO4 Apply knowledge about floriculture and Agrotourism

Eligibility for Admission:

The FYBSc students having Botany students and obtained 70% credit in previous examinations

Examination details

Name of subject	Subject Code	T/P	Credit	Examination
Plant Taxonomy and Ecology	24BOT 23101	T	2	50 (30 External + 20 internal)
Plant Biotechnology	24BOT 23102	T	2	50 (30 External + 20 internal)
Practical Course in Taxonomy, Ecology and Biotechnology	24BOT 23103	P	2	50 (30 External + 20 internal)
Basics of Ethnobotany	24BOT 23104	T	2	50 (30 External + 20 internal)
Biology of Cells and Molecule	24BOT 23205	T	2	50 (30 External + 20 internal)
Practical in Biology of Cells and Molecule	24BOT 23206	P	2	50 (30 External + 20 internal)
Agrotourism	24BOT 23307	T	2	50 (30 External + 20 internal)
Practical Course on Basic skills in Gardening and Nursery Management	24BOT 23408	P	2	50 (30 External + 20 internal)
FP			2	50 (30 External + 20 internal)
Biology of Cells and Molecules	24BOT 24101	T	2	50 (30 External + 20 internal)
Essentials of Plant Physiology	24BOT 24102	T	2	50 (30 External + 20 internal)
Practical Course in Plant Physiology, Cell and Molecular biology	24 BOT 24103	P	2	50 (30 External + 20 internal)
Ecological Restoration and Conservation	24BOT 24204	T	2	50 (30 External + 20 internal)
Practical Course in Ecological Restoration and Conservation	24BOT 24205	P	2	50 (30 External + 20 internal)
Practical course in Basics in Floriculture	24BOT 24306	P	2	50 (30 External + 20 internal)
Practical Course on Field Techniques in plant identification and classification	24BOT 24407	P	2	50 (30 External + 20 internal)
Practical Course on Basics of Phytochemistry	24BOT 24408	P	2	50 (30 External + 20 internal)
CEP			2	50 (30 External + 20 internal)

Major DSC **Course name – Plant Taxonomy and Ecology** **Course code – 24BOT23101** **Sem III**			
Teaching scheme 2 hrs/week	No. of credits 2	No. of lectures 30	Examination scheme CIE:20 marks ESE:30 marks
Course objectives • To understand the concept, aspects and importance of plant Taxonomy • To apply rules of botanical nomenclature • To identify plants belonging to different families • To study ecology, ecosystem, ecological adaptations and ecological succession			
Course outcome- After completing the course, the students will be able to CO1 – interpret the concept and aspects of plant taxonomy CO2 – apply rules of botanical nomenclature CO3 - identify plants belonging to different families CO4 – analyse ecological principles, ecosystem functioning, adaptations in plants and succession			

Unit	Content	No. of lectures
Unit 1	**Introduction to Plant Taxonomy** 1.1 Concept of plant Taxonomy and Plant Systematics 1.2 Scope and importance	1L
Unit 2	**Aspects of plant Taxonomy** 2.1 Identification – Floras, Herbarium, keys, databases 2.2 Nomenclature – Principles and Key rules of ICN (Author's citation, Valid publication, Typification) 2.3 Classification – Review of Bentham and Hooker's system and APG system of plant classification	6L
Unit 3	**Study of Angiosperm families** (Diagnostic characters, floral formula, floral diagrams, systematic position and economically important plants from each family) 3.1 Magnoliaceae 3.2 Brassicaceae	10 L

	3.3 Fabaceae 3.4 Meliaceae 3.5 Solanaceae 3.6 Lamiaceae 3.7 Euphorbiaceae 3.8 Amaryllidaceae	
Unit 4	**Introduction to Ecology** 4.1 Concept and Definition 4.2 Habitat and Niche 4.3 Role of organism	1L
Unit 5	**Ecosystem Ecology** 5.1 Structure and function of some Indian ecosystems: Terrestrial (forest, grassland) and aquatic (fresh water, Mangroves) 5.2 Ecoregions of India/Biomes of India 5.3 Energy flow trophic organization 5.4 Food chains and food webs 5.5 Ecological pyramids production and productivity	5L
Unit 6	**Ecological adaptations in plants** 6.1 Morphological, physiological and anatomical adaptations in hydrophytes 6.2 Morphological, physiological and anatomical adaptations in Extremophytes (xerophytes & halophytes)	3L
Unit 7	**Ecological succession** 7.1 Introduction to succession; Types of succession, pioneers in succession 7.2 Process of succession e.g. Aquatic and Terrestrial	4L

References

Angiosperm Phylogeny Group (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181: 1–20.

Cooke, T (1903-08) - The Flora of The Presidency of Bombay Vol. I, II, III. (Repr.ed) Botanical Survey of India

Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.

Davis, P. H. and V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi

Naik, V. N. 1984. Taxonomy of Angiosperms Tata McGrow-Hill Publication Com. Ltd., New Delhi

Pandey B.P. (2015). Taxonomy of Angiosperms. Sixth edition. S. Chand & Company Pvt. Ltd.

Sharma P.D. (2002). Ecology and environment. Seventh edition. Rastogi publications

Simpson, M G. 2006. Plant systematics. Elsevier Academic Press.

Singh, Gurcharan. (2013). Plant systematics Theory and Practice. Third edition. Oxford & IBH

Singh, Gurcharan. 2019. Plant Systematics: An Integrated Approach, Fourth Edition. CRC Press.7.

Major DSC **Course name – Plant Biotechnology** **Course code – 24BOT23102** **Sem III**	

Teaching scheme 2 hrs/week	No. of credits 2	No. of lectures 30	Examination scheme CIE:20 marks ESE:30 marks

Course objectives
- To understand the scope of different branches of biotechnology
- To analyse the importance of single cell protein and phytoremediation process
- To understand the plant genetic engineering process
- To learn plant tissue culture technique

Course outcome- After completing the course, the students will be able to
CO1- understand the scope of different branches of biotechnology
CO2- analyse the importance of single cell protein and phytoremediation process
CO3- describe the plant genetic engineering process
CO4- apply knowledge of plant tissue culture technique

Unit	Content	No. of lectures
Unit 1	**Introduction to Plant Biotechnology** 1.1 Definition, concept and scope 1.2 Branches of biotechnology	2L
Unit 2	**Single cell protein** 2.1 Introduction; Need of proteins in diet; 2.2 Production of SCP from algae - *Spirulina* and fungi - *Saccharomyces* (Yeast) 2.3 The economic implications of SCP and Acceptability of SCP	4L
Unit 3	**Environmental Biotechnology** 3.1 Introduction; Phytoremediation- definition and concept 3.2 Methods of phytoremediation- Role of aquatic plants and fungi in environment; Rhizofilteration, phytoextraction, phytostabilization, phytovolatization and phytodegradation 3.3 Environmental sustainability of phytoremediation	5 L

Unit 4	**Basics of Plant Genetic Engineering**
	 4.1 Introduction and structure of DNA; Structure of gene in prokaryotes and eukaryotes (promoter, coding region and terminator)
	 4.2 **General method of gene isolation from the plants –**
	     4.2.1 Instruments used in genetic engineering – PCR,
	         electrophoresis, introduction to blotting techniques,
	         Spectrophotometer, DNA sequencer, etc.
		10L

	4.2.2 DNA isolation, restriction enzymes, restriction digestion of DNA, southern hybridization, ligation of DNA fragments 4.3 Gene cloning- vectors used for gene cloning 4.4 Methods of gene transfer – Direct and vector mediated Applications	
Unit 5	**Plant tissue culture** 5.1 Concept of cell theory and totipotency, history of plant tissue culture, 5.2 Nutrient medium, sterilization techniques, inoculation 5.3 Types of cultures, hardening, applications 5.4 Case studies (Any two) - Orchid cultivation, Bamboo, Sugarcane,	7L
Unit 6	**Nanobiotechnology** 6.1 Definition and concept 6.2 Preparation of nanoparticles; various methods of synthesis 6.3 Applications of nanotechnology in plant science, fungal nanotechnology and agriculture	2L

References

Bhojwani. S.S and Razdan. M.K 2004.Plant tissue culture: Theory and Practice. Elsevier publications.

Dixon R.A. and Gonzales R.A. Plant cell culture, A Practical approach, 2nd Edition

Dubey R.C (2014). A text book of Biotechnology. S. Chand Publishing, Delhi.

George E.F. 1999. Plant Propagation by Tissue Culture: Volume 1 & 2. Exegetics Limited

Glick B.R. and Patten C.L. (2017) Molecular Biotechnology. Principles and Application of Recombinant DNA, 5th Edn. ASM Press, Washington.

Gupta, P. K. (2008). Molecular Biology and Genetic Engineering. India: Global Media Publications

Howe, C. J. (2007). Gene cloning and manipulation. Cambridge University Press.

Nicholl D.S.T (2008) An Introduction to Genetic Engineering, 3rd Edn. Cambridge University Press.

Singh B.D (2010). Biotechnology. Kalyani Publisher, New Delhi.

Major DSC Course name – Practical course in Taxonomy, Ecology and Biotechnology Course code – 24BOT23103 Sem III			
Teaching scheme 4 hrs/week	No. of credits 2	No. of experiments 15	Examination scheme CIE:20 marks ESE:30 marks

Course objectives
- To describe twig and identify plants
- To analyse vegetation of an ecosystem
- To cultivate *Spirulina*
- To propagate plants by tissue culture technique

Course outcome- After completing the course, the students will be able to
CO1- Describe flowering twig and identify plants belonging to families studied
CO2- Analyse vegetation and adaptations in hydrophytes and xerophytes
CO3- Propagate plants by tissue culture
CO4- Cultivate *Spirulina*

Practical experiments

1	Study of family Magnoliaceae	1P
2	Study of family Solanaceae	1P
3	Study of family Euphorbiaceae	1P
4	Study of family Amaryllidaceae	1P
5	Determination of density, abundance, and frequency of plants by list count quadrat method 1P	
6	Study of hydrophytes and xerophytes	2P
7	Excursion tour, submission of report and five herbarium specimens	2P
8	Cultivation of *Spirulina*	2P
9	Study of plants used in phytoremediation	1P
10	Preparation of plant tissue culture medium	1P
11	Sterilization of medium, glassware and other tools	1P
12	Surface sterilization and inoculation of Nodal sector/Embryo/Orchid	1P
13	Construction of model to explain plant genetic engineering	1P

Major specific IKS			
Major specific IKS **Course Name : Basics of Ethnobotany** **Course Code: 24BOT23104** **Semester - III**			
Teaching Scheme: **2 Hours / Week**	**No. of** **Credits: 2**	**No of Lectures: 30**	**Examination Scheme:** **CIE: 20 Marks ESE: 30 Marks**
The main objectives of this course are to:			
☐ To introduce the fundamental concepts, scope, and interdisciplinary nature of Ethnobotany, and explore the contributions of key national and international pioneers in the field. ☐ To examine the relationship between ethnic communities and plant resources, emphasizing traditional knowledge systems, cultural practices, and their role in conservation and sustainable development. ☐ To equip students with field-based research skills and documentation techniques for studying ethnobotanical knowledge, including data collection, species authentication, and ethical considerations.			
Expected Course Outcomes:			
On the successful completion of the course, student will be able to:			
CO1	Students can explain the basic concepts, historical development, and major contributors in the field of Ethnobotany**.**		
CO2	Analyze the role of ethnic groups in plant conservation, traditional medicine, and sustainable use of biodiversity.		
CO3	Apply appropriate field methods and documentation techniques to collect, record, and validate ethnobotanical data.		

Unit	Content	No. of lecture
	CREDIT I	**15 L**
1	1.1 Ethnobotany: Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. 1.2 Review of national and regional contributors in Ethnobotany (J.W.Harshberger, R.E.Schultes, E.K. Janakiammal, S.K. Jain, K.S.Manilal, V.V Sivarajan P.Pushpangadan, Dr. N. Kamat, Dr. Upreti D. K., Dr. Vaidya J. G., Khori & V.D. Vartak) 1.3 Various branches of Ethnobotany - ethno agriculture, ethno pharmacology, ethnomedicine, etc.	**5 L**
2	2.1 Methods and techniques used in Ethnobotany-Field level activities for data collection- Consent forms, Approach, Documentation (Audio, Video recording, Photographs, Interview – Methods, Questionnaire, and Data sheet), 2.2 Authentication of plant species used (Field Diary, Herbarium) Field and Lab Procedures, Preparation of Data Sheet and Data Base. Peoples biodiversity Register (PBR).	**5 L**

3	3.1 Role of Ethnobotany in Modern Medicine	5 L
	3.2 Major and minor ethnic groups of India, and their life styles.	
	2.3 Role of ethnic group in conservation of plant genetic resources.	
	2.4 Role of Ethnobotany in conservation and sustainable development	
	Effect of rising civilization and modernization on traditional knowledge, Concept of Sacred groove and role of sacred groove in biodiversity conservation	
	CREDIT II	**15 L**
4	4.1 Plants used by the ethnic groups: food, forage and fodder crops; fiber crops; vegetable oil-yielding crops; timber-yielding plants;	**10 L**
	4.2 non-wood forest products (NWFPs) such as bamboos, rattans (Palms), raw materials for paper making, gums, tannins, dyes, resins and fruits, etc.	
5	4.3 Biopiracy, Intellectual property rights and traditional knowledge	**5 L**
	4.4 Role of People's Biodiversity Register (PBR) and Biodiversity Management Committees (BMC)	

Reference Books:

1. Jain, S. K., Mudgal, V., Banerjee, D. K., Guha, A., Pal, D. C. and Das, D. (1984). Bibliography of Ethnobotany. Botanical Survey of India, Howrah
2. Jain S.K.(1997). Contribution to Indian Ethnobotany, Sci. Publ. Jodhpur
3. Jose Boban K. (1998). Tribal Ethnomedicine: Continuity and change. APH publishing corporation 5, Ansari Road, Darya Ganj, New Delhi
4. Mathur, P. R. G. (1977). Tribal situation in Kerala. Kerala Historical Society, Trivandrum
5. Snehalatha and Jain, S. K. (1998). Historical Archive in Ethnobotany. Institute of Ethnobotany, NBRI, Lucknow
6. Cunningham, A. B. (2001). Applied Ethnobotany. Earthscan publishers Ltd. London & Sterling, VA, USA Cotton, C.M. (1996).
7. Ethnobotany-Principles and application. John Wiley& Sons Ltd., West Sussex, England
8. In vivo and in vitro assays Glimpses of ethnopharmacology 1994 Eds. P Pushpangadan ,V George and U.Nyman
9. Faulks, P.J. (1958). An introduction to Ethnobotany, Moredale Publ. London
10. Jain, S. K. (1981). Glimpses of Indian Ethnobotany. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi
11. Jain, S. K. (1989). Methods and approaches in Ethnobotany. Society of Ethnobotanists, Lucknow 12 8. Jain, S. K. (1995). A manual of Ethnobotany. Scientific Publishers, Jodhpur

	Minor
	Course name – Biology of cells and Molecule
	Course code – 24BOT23205
	Sem III

Teaching scheme 2 hrs/week	No. of credits 2	No. of lectures 30	Examination scheme CIE:20 marks ESE:30 marks

Course objectives
- To understand structure and functions of plant cell and cell organelles
- To analyze the process of cell division
- To understand the basic processes in cell division
- To describe the aspects of cell and molecular biology

Course outcome- After completing the course, the students will be able to
CO1- Interpret the structure and function of cell and its parts
CO2- Discuss the steps in cell division
CO3- Explain the processes in molecular biology
CO4- Evaluate the different aspects of cell and molecular biology

Unit	Content	No. of lectures
Unit 1	**Plant cell** 1.1 Cell as a unit of structure and function 1.2 Cell theory, Evolution of cell; Characteristics of prokaryotic cell; introduction to endosymbiotic theory, Characteristics of eukaryotic cells 1.3 Structure of plant cell; Chemistry, structure and function of Plant cell wall. 1.4 Overview of membrane function; fluid mosaic model; Chemical composition of membranes	5L
Unit 2	**Cell organelles** 2.1 Nucleus: Structure and functions 2.2 Cytoskeleton: Role and structure of microtubules, microfilaments with reference to cilia and flagella; and intermediary filament. 2.3 Structure and functions of different cell organelles: Chloroplast, Mitochondria, Vacuole, Peroxisomes, Endoplasmic reticulum, Golgi apparatus; Lysosomes	8L
Unit 3	**Cell division** 3.1 Phases of eukaryotic cell cycle, checkpoints in cell cycle 3.2 Mitosis and Meiosis	4 L
Unit 4	**Introduction to Plant Molecular biology**	1L

	4.1 Concept; Central dogma of molecular biology	
Unit 5	**Genetic material**	12 L
	5.1 History of Discovery of DNA; Watson and Crick model of DNA	
	5.2 Packaging of DNA into chromosomes, Euchromatin and Heterochromatin,	
	5.3 Types of DNA,	
	5.4 Mitochondria and chloroplast DNA	
	5.5 Properties and types of RNA	
	5.6 The replication of DNA, Semiconservative mode of DNA replication	
	5.7 Transcription and translation in brief	

References

Cooper, G. M. (2000). The Cell: A Molecular Approach. United Kingdom: ASM Press.

Eduardo D. P. De Robertis and Eduardo M. F. de Robertis. 1987. Cell and Molecular biology. 8th Edition

Gupta, P. K. (2008). Molecular Biology and Genetic Engineering. India: Global Media Publications.

Powar, C. B. (1991). Cell Biology. India: Himalaya Publishing House.

Rastogi, S. C. (2006). Cell And Molecular Biology. India: New Age International (P) Limited.

Verma, P. S. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. India: S. Chand Limited.

Watson J.D. Gann A., Baker T.A., Levine M., Bell S.P. and Losick R. (2014) Molecular Biology of Gene, 7th Edn. Pearson publishers.

Minor
Course name – Practical course in Biology of cells and Molecule
Course code – 24BOT23206
Sem III

Teaching scheme 4 hrs/week	No. of credits 2	No. of experiments 15	Examination scheme CIE:20 marks ESE:30 marks

Course objectives
    • To describe plant cell and organelles
    • To study stages of mitosis and meiosis
    • To extract and determine DNA
    • To understand different aspects of cell and molecular biology			

Course outcome- After completing the course, the students will be able to CO1- describe plant cell and organelles CO2- Analyse stages of mitosis and meiosis CO3- extract and determine DNA CO4- Construct different aspects of cell and molecular biology			

Practical experiments

1. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo   1P
2. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.   1P
3. Measurement of cell size by the technique of micrometry.   1P
4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).   1P
5. Study of cell and its organelles with the help of electron micrographs.   1P
6. Study the phenomenon of plasmolysis and deplasmolysis.   1P
7. Study different stages of mitosis   1P
8. Study of C metaphase   1P
9. Study different stages of meiosis   1P
10. Extraction of DNA from cauliflower by saline citrate method.   1P
11. Determination of DNA by diphenylamine reagent or UV spectrophotometer   1P
12. Construction of protein sequence using genetic code   1P
13. Study of DNA replication mechanisms through photographs   1P
14. Demonstration of Agarose gel electrophoresis   1P
15. Localization of organelles and cell wall using histochemical stains   1P

<table>
<tr><td colspan="4" align="center">**OE**
Course Title: - Agro-Tourism
Course Code: 24 BOT 23307
Semester- III</td></tr>
</table>

Teaching Scheme: **2 Hours / Week**	**No. of** **Credits: 2**	**No of Lectures: 30**	**Examination Scheme:** **CIE: 20 Marks ESE: 30 Marks**

The main objectives of this course are to:
- To introduce the concept, scope, and historical development of agrotourism, and highlight its significance in rural development and the agriculture-tourism interface.
- To familiarize students with different types of agrotourism activities and their socio-economic and geographical implications, including practical aspects like infrastructure and policy.
- To equip students with knowledge about marketing strategies, government policies (like MKPVY), and promotional tools relevant to setting up and managing agrotourism ventures.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Students were able to define and explain the nature, scope, and evolution of agrotourism, and analyze its role in promoting sustainable rural development.
CO2	Identify and categorize various agrotourism activities (farm tours, food tourism, seasonal festivals, eco-activities) and assess the geographical and socio-economic factors influencing their success.
CO3	Demonstrate understanding of government policies, registration procedures, and marketing strategies for promoting and managing Agrotourism centres in Maharashtra and beyond.

Unit	Content	No. of lecture
	CREDIT I	**15 L**
1	**Introduction to Agrotourism:** 1.1 Definition, nature and scope of Agro-tourism; Relationship between botany, agriculture, and tourism 1.2 Difference between tourism, ecotourism and agrotourism 1.3 Historical background and evolution of Agro-tourism 1.4 Needs and opportunities of Agro-tourism 1.5 Importance of Agro-tourism in Rural Development	**4 L**

2	**Types of Agrotourism Activities:**
	2.1 Farm tour, stay and rural accommodation
	2.2 Agricultural festivals and events
	2.3 Concept of Food and Agriculture and Tourism
	      2.3.1 Food Tourism – Tribal food, local food and rural food
	      2.3.2 Agriculture Tourism
		4 L

3	**Important Factors Related to Agrotourism** 3.1 location of Agrotourism Centre 3.2 Geographical Factors – Climate, Edaphic, water 3.3 Socio-economic Factors 3.4 Criteria to start Agrotourism Centres – infrastructure facilities, livestock, Recreation facilities, Other Miscellaneous 3.5 Benefits of Agrotourism Centres 3.6 Challenges of Agrotourism Centers	**7 L**
	CREDIT II	**15 L**

4	**Activities in Agrotourism centers**	5 L
	4.1.1 Farm tours by foot, tractor ride, or horseback	
	4.1.2 Nature trails and birdwatching	
	4.1.3 Fishing in ponds or streams (if available)	
	4.1.4 Camping or glamping on-site, River crossing, trekking, etc	
	4.1.5 Adventure activities - Cycling	
	4.1.6 Folk music or dance performances	
	4.1.7 Local history tours- rural festival, Jatra,	
	4.1.8 Seasonal festivals (e.g., harvest festivals, flower festivals)	
	4.1.9 Workshops on composting, herbal teas, eco-crafting	
5	**Agrotourism Policies & Marketing Strategy**	6 L
	5.1 Agrotourism Policies in Maharashtra State	
	5.2 Maharashtra Krishi Paryatan Vistar Yojna – MKPVY	
	5.2.1 Various guideline related to agrotourism	
	5.2.2 Various proforma – Registration of agrotourism centre, Undertaking and declaration by the farmer	
	5.2.3 Proforma for Police verification for Agrotourism centre owner and Manager	
	5.4 Use of social media, Print media, attractive Booking policies for Individual/Group/Company/Corporate/Education Institute, etc	
6	Visit to Agrotourism centre/Case Studies	4 L

Reference Books

1. Talwar, Prakash. Travel and Tourism Management. Gyan Books Pvt. Ltd., Main Ansari Road, Darya Ganj, aNew Delhi-110 002.

2. Badri, S.C Trends in Tourism Promotion 2003. International Books Distributors, 9/3, Rajpur Road, Dehradun-248 001 Uttarakhand (India).

3. Dennis M. Brown and Richard J Reeder 2004. Agro-tourism offers opportunities for Farm Operators, USA.

4. Michal Sznajder, Lucyna Przezborska, Frank Scrimgeour 2009. Agritourism CABI.

5. Amit Kumar Dwivedi 2010. Agri-Tourism Entrepreneurship: A Tool to Rural Development" in conference proceeding (https://ediindia.ac.in/faculty_corner/index.php/faculty_detail/4).

VSEC
Course name – Basic skills in Gardening & nursery Management
Course code – 24BOT23408
Sem III

Teaching scheme 2 hrs/week	No. of credits 2	No. of Practical 30	Examination scheme CIE:20 marks ESE:30 marks

Course objectives
- To develop a foundational understanding of gardening and nursery
- Learn to identify and classify ornamental plants, trees, shrubs, and flowers using scientific methods.
- To develop hands-on skills for maintaining a healthy and thriving garden.
- Understand the principles of garden design, including plant selection and aesthetic considerations.

Course outcome- After completing the course, the students will be able to
CO1- Develop a foundational understanding of gardening and nursery.
CO2- Learn to identify common plant species, including ornamental plants, trees, shrubs, and flowers in scientific manner.
CO3- Acquire practical skills necessary for maintaining garden
CO4- Explore the principles of garden design, including site assessment, plant selection, and aesthetic considerations for creating visually appealing and functional garden.

1. Study of Tools used in gardening   1 P

2. Study of garden plants with respect to habit (Herbs, Shrubs, Trees, Climbers, etc.)1 P

and uses (ornamentals, medicinal. Vegetables, Palms, Cacti, etc.)

3. Study of Nursery layout   1 P

4. Study on Soil fertility.   1P

5. Method of Composting and Types of inorganic Fertilizers.   1 P

6. Types of pots,(Hanging basket, other) types of potting and repotting.   1 P

7. Propagation method by seed - Testing of Seed viability and methods of breaking2P

seed dormancy.

8. Methods of plant propagation – Seed sowing, Cutting, layering, grafting and1P

budding.

9. Study of bacterial and viral Plant diseases and their control.   1P

10. Study of fungal Plant diseases and their control (Pesticides).   1P

11. Study of practices in water management in Nursery   1P

12. Visit to garden   3 P

Major DSC
Course name – Biology of cells and Molecule
Course code – 24BOT24101
Semester IV

Teaching scheme 2 hrs/week	No. of credits 2	No. of lectures 30	Examination scheme CIE:20 marks ESE:30 marks

Course objectives
- To understand structure and functions of plant cell and cell organelles
- To analyze the process of cell division
- To understand the basic processes in cell division
- To describe the aspects of cell and molecular biology

Course outcome- After completing the course, the students will be able to
CO1- Interpret the structure and function of cell and its parts
CO2- Discuss the steps in cell division
CO3- Explain the processes in molecular biology
CO4- Evaluate the different aspects of cell and molecular biology

Unit	Content	No. of lectures
Unit 1	**Plant cell** 1.1 Cell as a unit of structure and function 1.2 Cell theory, Characteristics of prokaryotic and eukaryotic cells 1.3 Structure of plant cell; Chemistry, structure and function of Plant cell wall. 1.4 Overview of membrane function; fluid mosaic model; Chemical composition of membranes	5L
Unit 2	**Cell organelles** 2.1 Nucleus: Structure and functions 2.2 Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. 2.3 Structure and functions of different cell organelles : Chloroplast, Mitochondria, Vacuole, Peroxisomes, Endoplasmic reticulum, Golgi apparatus; Lysosomes	8L
Unit 3	**Cell division** 3.1 Phases of eukaryotic cell cycle, checkpoints in cell cycle 3.2 Mitosis and meiosis	4 L
Unit 4	**Introduction to Plant Molecuar biology** 4.1 Concept; Central dogma of molecular biology	1L

Unit 5	**Genetic material**	12 L
	5.1 History of discovery of DNA, Watson and Crick model of DNA, Types of DNA,	
	5.2 Packaging of DNA into chromosomes, Euchromatin and Heterochromatin, mitochondria and chloroplast DNA; Properties and types of RNA	
	5.3 The replication of DNA, transcription and translation	

References

Cooper, G. M. (2000). The Cell: A Molecular Approach. United Kingdom: ASM Press.

Eduardo D. P. De Robertis and Eduardo M. F. de Robertis. 1987. Cell and Molecular biology. 8th Edition

Gupta, P. K. (2008). Molecular Biology and Genetic Engineering. India: Global Media Publications.

Powar, C. B. (1991). Cell Biology. India: Himalaya Publishing House.

Rastogi, S. C. (2006). Cell And Molecular Biology. India: New Age International (P) Limited.

Verma, P. S. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. India: S. Chand Limited.

Watson J.D. Gann A., Baker T.A., Levine M., Bell S.P. and Losick R. (2014) Molecular Biology of Gene, 7th Edn. Pearson publishers.

	Major DSC

<div align="center">

Major DSC
Course name – Essentials of Plant Physiology
Course code – 24BOT24102
Semester IV

</div>

Teaching scheme 2 hrs/week	No. of credits 2	No. of lectures 30	Examination scheme CIE:20 marks ESE:30 marks

Course objectives
- To understand various physiological processes in plants
- To describe plant growth and role of growth regulators
- To analyze causes of seed dormancy
- To understand the physiology of flowering

Course outcome- After completing the course, the students will be able to
CO1- Explain various physiological processes in plants
CO2- Describe plant growth and role of growth regulators
CO3- analyze causes of seed dormancy
CO4- Evaluate the physiology of flowering

Unit	Content	No. of lectures
Unit 1	**Introduction to plant physiology** 1.1 Definition, scope and importance	1L
Unit 2	**Osmotic relations in plant cell** 2.1 Physico-chemical properties of water, 2.2 Membrane structure and permeability, Diffusion, Osmosis, Diffusion Pressure Deficit, Plasmolysis and imbibition	5L
Unit 3	**Absorption of water and ascent of sap** 3.1 Availability of water to the roots (types of water), absorbing region of roots 3.2 Mechanism of water absorption, factors affecting water absorption 3.3 Definition of ascent of sap, theories of ascent of sap, factors affecting ascent of sap	7 L
Unit 4	**Transpiration** 4.1 Definition; Types of transpiration 4.2 Mechanism of opening and closing of stomata, factors affecting the rate of transpiration 4.3 Significance of transpiration, guttation	5L
Unit 5	**Plant growth** 5.1 Definition and concept 5.2 Phases of plant growth, factors affecting plant growth,	5L

	measurement of growth	
	5.3 Plant growth regulators, types and role; applications of PGR	
Unit 6	**Seed dormancy and Germination**	4L
	6.1 Definition and types of seed dormancy	
	6.2Methods to break seed dormancy	
	6.3 Metabolic changes during seed germination	
Unit 7	**Physiology of flowering**	3L
	7.1 Photoperiodism and flowering – Concept, definition, short day plants, long day plants and day neutral plants,	
	7.2 Photoperiodic induction, phytochrome and flowering	

References

Bidwell, R.G.S. 1974. Plant Physiology. Macmillan Pub. Co., N.Y.

Devlin, R.M. And F.H. Witham. 1983. Plant Physiology. Willard Grant Press.U.S.A.

Hans-Walter Heldt. 1997. Plant Biochemistry and Molecular Biology. Oxford University Press,

Moore, T.C. 1979. Biochemistry and Physiology of Plant Hormones. Springer-Verlag. Berlin.

Raman, K. 1997. Transport Phenomena in Plants. Narosa Publishing House. New Delhi.

Jain, V.K. (2000): Fundamentals of Plant Physiology,S.Chand&Co, New Delhi.

Pandey, S.N. (1991): Plant Physiology, Vikas Publishing House (P) Ltd., New Delhi, India.

Verma, V. (2007): Text Book of Plant Physiology, Ane Books India, New Delhi.

Nobel, P.S. 2009. Physicochemical and Environmental Plant Physiology.4th edition Academic Press, UK

Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Edition. Sinnauers Associates, Saunders land, Massachusetts, USA

Salisbury F.B. and Ross C.B. 2005. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.

Major DSC
Course name – Practical course in Plant Physiology, cell and molecular biology
Course code – 24BOT24103
Semester IV

Teaching scheme 4 hrs/week	No. of credits 2	No. of experiments 15	Examination scheme CIE:20 marks ESE:30 marks

Course objectives
• To understand physiological processes
• To Explain the structure of a plant cell
• To observe stages of cell division
• To extract DNA from plant material

Course outcome- After completing the course, the students will be able to
CO1- Explain physiological processes
CO2- Analyse stages of mitosis and meiosis
CO3- extract and determine DNA
CO4- Construct different aspects of cell and molecular biology

Practical experiments

1. To find DPD using potato tubers   1P
2. To find the rate of transpiration in wind and shade   1P
3. To study plasmolysis in different plant materials   1P
4. To break seed dormancy in selected seeds   1P
5. To study imbibition using plaster of paris and seeds   1P
6. To classify flowering plants based on Photoperiodism   1P
7. Bioassay of effect of GA on seed germination   1P
8. Effect of root promoting hormone   1P
9. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo* 1P
10. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf   1P
11. Measurement of cell size by the technique of micrometry   1P
12. Study the phenomenon of plasmolysis and deplasmolysis   1P
13. Study different stages of mitosis   1P
14. Study different stages of meiosis   1P
15. Extraction of DNA from cauliflower   1P

Minor
Course name – Ecological Restoration and Conservation
Course code – 24BOT24204
Sem III

Teaching scheme 2 hrs/week	No. of credits 2	No. of lectures 30	Examination scheme CIE:20 marks ESE:30 marks

Course objectives
- Understand the concept of ecological restoration and the conservation
- Classify the types of ecosystems
- Explain the approaches of restoration
- Understand various laws and government policies

Course outcome- After completing the course, the students will be able to
CO1- Explain the importance of ecological restoration and conservation
CO2- Classify the types of ecosystems
CO3- Suggest various approaches to restoration
CO4- explain policies for eco-restoration

Unit	Content	No. of lectures
Unit 1	**Introduction** 1.1 Introduction to ecosystem restoration 1.2 Need and scope of restoration	2L
Unit 2	**Ecosystem ecology** 2.1 Types of ecosystems, structure and function 2.2 Types of food chains and importance of food web 2.3 Role of saprophytic fungi in ecosystems	5L
Unit 3	**Ecosystem disturbance** 3.1 Definition of degraded ecosystem, 3.2 Features of undisturbed ecosystems 3.3 Causes of degradation of terrestrial and aquatic ecosystems	5 L
Unit 4	**Governance** 4.1 Legal aspect of restoration and government policies	4L
Unit 5	**Applying Ecosystem restoration interventions** 5.1 Strategic planning, cost- benefit analysis, accounting process and resource mobilization, 5.2 Selection and implementation of restoration interventions, monitoring and evaluation, capacity building and development	8L
Unit 6	**Case studies** 6.1 Restoration of aquatic ecosystem	6L

| | 6.2 Restoration of terrestrial ecosystem
6.3 Restoration of grassland ecosystem | |

References

Evelyn A. Howell, John A. Harrington, and Stephen B. Glass. 2011. Introduction to Restoration Ecology.
Gary J. Brierley and Kirstie A. Fryirs. 2008. River Futures: An Integrative Scientific Approach to River Repair

Minor
Course name – Practical course in Ecological Restoration and Conservation
Course code – 24BOT24205
Semester IV

Teaching scheme 4 hrs/week	No. of credits 2	No. of experiments 15	Examination scheme CIE:20 marks ESE:30 marks
Course objectives • To survey and understand different ecosystems • To find the causes of ecosystem degradation • To understand food network of different ecosystem • To prepare model of restoration of ecosystem			
Course outcome- After completing the course, the students will be able to CO1- observe different factors of ecosystem CO2- Analyse causes of ecosystem degradation CO3- understand the importance of restoration and conservation of ecosystem CO4- Construct model for ecorestoration			

Practical experiments

1. Survey of degraded aquatic ecosystem and preparation of report   2P

2. Survey of degraded grassland ecosystem and preparation of report   2P

3. Preparation of model for restoration of pond ecosystem   2P

4. Study of saprophytic fungi from forest and grassland ecosystem   1P

5. Preparation of model for restoration of grassland ecosystem   2P

6. Seed dormancy treatment   2P

7. Raising native plants for Eco restoration   2P

8. Visits   2P

OE
Course name – Practical course in Basics of Floriculture
Course code – 24BOT24306
Sem IV

Teaching scheme 4 hrs/week	No. of credits 2	No. of experiments 12	Examination scheme CIE:20 marks ESE:30 marks

Course objectives
• To study different types of flowers
• Study of cultivation techniques and growing medium
• Study of Fertilizers, Composting Techniques, and Disease Management
• Study of Flower Arrangement, Drying Techniques, and Market Practices

Course outcome- After completing the course, the students will be able to
CO1- Students will be able to identify and classify different types of flowers (loose and cut flowers) based on their characteristics.
CO2- Students will understand various cultivation techniques and properties of growing medium.
CO3- Students will acquire the knowledge to select and apply fertilizers, and manage floriculture crops.
CO4- Students will learn to create different flower arrangements and apply drying techniques.

1	Study of different types of flower e.g loose flower, cut flower	1P
2	Study of cultivation techniques e.g. raise bed/pro-tray/pots	1P
3	Study of type of growing medium peat moss, compost, perlite, cocopit, and various combinations.	1P
4	Study of various fertilizers and composting techniques.	1P
5	Study of various diseases and control measure.	1P
6	Study of various storage, packaging and harvesting methods	3P
7	Study of selected loose and cut flowers (available as per season)	1P
8	Stud of water management practices in floriculture.	1P
9	Study of various flower drying techniques.	1P
10	Study of various flower arrangements.	1P
11	Visit to Polyhouse/Floriculture industry etc.	2P
12	Study of local flower market.	1P

VSEC
Course name – Practical course on Field Techniques in Plant Identification and classification **Course code – 24BOT24407** **Semester IV**

Teaching scheme 4 hrs/week	No. of credits 2	No. of experiments 15	Examination scheme CIE:20 marks ESE:30 marks

Course objectives:
- Identify plants based on key characteristics like leaf arrangement, shape, margins, and venation.
- Observe and identify various flower, fruit, and seed types using dichotomous keys and regional floras.
- Learn plant specimen preparation (collection, pressing, drying, mounting, sketching) and use digital plant ID apps.

Course outcome- After completing the course, the students will be able to
CO1- Students will identify plants using vegetative features like leaf arrangement, shape, and venation.
CO2- Students will classify inflorescences, flowers, and fruits using floras, dichotomous keys, and plant ID apps.
CO3- Students will prepare plant specimens, sketch, and use ID resources for fieldwork.

1	Identification based on leaf arrangement, shape, margins, venation, etc.	1P
2	Observation and identification of various inflorescence types	1P
3	Observation and identification of various flower types	1P
4	Observation and identification of various fruit and seed types	1P
5	Preparation of artificial key based on vegetative and reproductive characters.	2P
6	Sketching of plant specimens (illustrations)	1P
7	Collection, pressing, drying, and mounting of plant specimens.	1P
8	Use of regional floras and dichotomous keys for plant identification.	1P
9	Use of digital plant ID apps (e.g., iNaturalist, Pl@ntNet) for plant identification.	1P
10	Recognizing key characteristics of major plant families (e.g., Fabaceae, Poaceae, Asteraceae, Lamiaceae).	2P
11	Field visit	3P

SEC
Course name – Practical course in Basics of Phytochemistry
Course code – 24BOT24408
SemIV

Teaching scheme 4 hrs/week	No. of credits 2	No. of experiments 15	Examination scheme CIE:20 marks ESE:30 marks
Course objectives • To identify and study medicinal plants • To estimate primary and secondary metabolites • To use different techniques of phytochemical extraction • To study different analytical techniques			
Course outcome- After completing the course, the students will be able to CO1- Identify and study medicinal plants CO2- Estimate primary and secondary metabolites CO3- Use different analytical techniques CO4- Analyse different metabolites			

Practical experiments

1. To identify selected medicinal plants by macroscopic and microscopic characters 2P
2. To extract phytochemicals by cold and hot extraction methods   2P
3. To separate leaf pigments by paper chromatography   1P
4. To separate alkaloids by Thin layer chromatography   1P
5. Quantitative estimation of proteins   1P
6. Quantitative estimation of phenols   1P
7. Qualitative estimation of secondary metabolites   1P
8. Qualitative estimation of primary metabolites   1P
9. To understand analytical techniques used in phytochemistry   1P
10. Collection of medicinal plants and their study   1P
11. Visit to herbal garden and submission of report   1P

Progressive Education Society's

Modern College of Arts, Science and

Commerce, Ganeshkhind, Pune – 411 016

(Autonomous)

Affiliated to SPPU

B.Sc. (Chemistry)

(Three Years Integrated Degree Program)

S. Y. B. Sc. CHEMISTRY

NEP Version II

From

Academic Year 2025-26

Board of Studies in Chemistry

**Modern College of Arts, Science and Commerce (Autonomous)
Ganeshkhind, Pune – 411016**

MCGK S.Y.B.Sc. Chemistry – NEP II SYLLABUS 2025-26

S.Y.B.Sc Revised NEP II 25 Apr 2025 CHEMISTRY NEP Curricular Framework

	Vertical 1					Vertical 2	Vertical 3	Vertical 4		Vertical 5				Vertical 6			
	Core		Major specific IKS	Major Elective													
Sem III	Major DSC					Minor	OE	VSEC	SEC	AEC	VEC	IKS	CC	FP	CEP	OJT	22
Credits	4 T 24CHE 23101 2T Chemistry of Functional Groups 24CHE 23102 2T Industrial Analytical Techniques	2 P 24CHE 23103 2P Practical Course in General chemistry	2 24CHE 23104 Chemistry in Ancient India			2 T+2 P 4 24CHE 23205 2T Fundamentals of Biochemistry 24CHE 23206 2P Practical Course of Biochemistry	2 T 24CHE 23307 Food and Health	2 (T/P) 2P 24CHE23408 Practical Course on Binary Mixture Analysis		2			2	24 CHE 23609 FP 2P			
Sem IV	Major DSC	Major DSC				Minor	OE	VSEC	SEC	AEC			CC		CEP		22
Credits	4 T 24CHE 24101 2T Concepts in Physical Chemistry 24CHE 24102 2T Introduction to Coordination Chemistry	2 P 24CHE 24103 Practical Course in Physical and Inorganic chemistry				2 T+2 P 4 2T 24CHE 24204 Chemistry of Biomolecules 24CHE 24205 2P Practical course on Natural Products	2 P 24CHE 24306 Practical Course on Food and Health	2 (T/P) 2P 24CHE 24407 Practical Course on Industrial Analytical Techniques-I	2 T/P 2P 24CHE 24408 Practical Course on Bio-molecules	2			2		2 24CHE 24609 CEP		

Semester III

24CHE23101: Chemistry of Functional Groups (2 credits theory , 30 hr)

24CHE23102: Industrial Analytical Techniques (2 credits theory , 30 hr)

24CHE23103: Practical Course in General chemistry (2 credits practical,60 hr)

24CHE23104: Chemistry in Ancient India   Major Specific IKS (2 credits theory ,30 hr)

24CHE23205: Fundamentals of Biochemistry Minor (2 credits theory, 30 hr)

24CHE23206:   Practical Course on Biochemistry Minor (2 credits practical, 60 hr)

24CHE23307: Food and Health OE (2 credits theory, 30 hr)

24CHE23408: Practical Course on Binary Mixture Analysis (2 credits practical, 60 hr)

24CHE23609: Field Project (2 credits)

Semester IV

24CHE24101: Concepts in Physical Chemistry (2 credits theory , 30 hr)

24CHE24102: Introduction to Coordination Chemistry (2 credits theory , 30 hr)

24CHE24103: Practical Course in Physical and Inorganic Chemistry (2 credits practical, 60 hr)

24CHE24204: Chemistry of Biomolecules   Minor (2 credits theory 30 hr)

24CHE24205: Practical Course on Natural Products   Minor (2 credits practical, 60 hr)

24CHE24306: Practical Course on Food and Health **OE** (2 credits practical, 60 hr)

24CHE24407: Practical Course on Industrial Analytical Techniques (2 credits practical, 60 hr)

24CHE24408: Practical Course on Biomolecules (2 credits practical, 60 hr)

24CHE24609: CEP (2 credits)

Semester III

24CHE23101: **Chemistry of Functional Groups**   **(2 credits theory, 30 hr)**

Sr. No.	Chapters	Lectures
1	Chemistry of Hydrocarbons	12
2	Aromatic Hydrocarbons	08
3	Derivatives of Hydrocarbons	10
	Total	30

Chapter 1: Chemistry of Hydrocarbons: **[12L]**

Introduction, classification of hydrocarbons, IUPAC Nomenclature, preparation and synthesis (two each).

Alkanes: Preparation methods of alkanes: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, and Grignard reaction. Reactions of alkanes: Free radical Substitution: Halogenation.

Alkenes: Preparation methods of alkenes: Elimination reactions: Dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions of alkenes: cis-addition (alk.KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition).

Alkynes: Preparation methods of alkynes: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydrohalogenation of vicinal dihalides. Reactions of alkynes: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline KMnO4.

Basics of Stereochemistry: Introduction, classification, Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Conformations with respect to ethane, butane and cyclohexane. Configuration: Geometrical - cis – trans, and E / Z Nomenclature (for upto two C=C systems). Optical isomerism Enantiomerism, Diastereomerism and Meso compounds). Concept of chirality (upto two carbon atoms). Threo and erythro; D and L; nomenclature; CIP Rules: R/S (for upto 1 Chiral carbon atoms)

Learning Outcomes:
1. Students will be able to give the IUPAC nomenclature of organic compounds for mono functional groups and draw structures.
2. Learning of isomerism, types of isomers and representation of organic molecules.
3. Conformational isomerism in alkanes with energy profile diagram.
4. Concept of geometrical isomerism with E/Z nomenclature.
5. Understanding of optical activity, isomer number, tetrahedral carbon atom, concept of chirality, enantiomers, R/S nomenclature for single chiral Centre.

Chapter-2: Aromatic Hydrocarbons. [8 L]

1. Hückel's rule, concept of aromaticity and examples of monocyclic and polycyclic aromatic hydrocarbons.
2. Aromatic stability of benzene, orientation for reactions.
3. Electrophilic substitution: Nitration, sulfonation, halogenation, Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene), nucleophilic substitution-benzyne intermediate.

Learning Outcomes:
- Application of Huckel's rule to different organic compounds to find out aromatic/non aromatic characters.
- Understanding various substitution reactions of aromatic compounds.

References:
1. Organic Chemistry by Clayden, Oxford university press.
2. Organic Chemistry by Morrison & Boyd, 6th Edition.
3. Stereochemistry of carbon compounds by E.L

Chapter 3: **Derivatives of Hydrocarbons:** [10L]

Hydrocarbon derivatives are often classified based on their functional groups. Examples of these types of hydrocarbon derivatives include alcohols, aldehydes, ketones, amines, esters, ethers, and carboxylic acids. Definition, types, IUPAC Nomenclature, preparation and synthesis (one each) of alkyl halide, alcohols, phenols, aldehydes, ketones, amines, esters, ethers, and carboxylic acids.

Learning Outcomes:
- Various methods of synthesis and reactions of alkyl halides, alcohols and ethers.
- Mechanism with stereochemistry of nucleophilic substitution reactions and elimination reactions.
- Comparative study of nucleophilic substitution reactions and elimination reactions.

References:
1. A guidebook to Mechanism in Organic Chemistry by Peter Sykes, 6th Edition.
2. Organic Chemistry by Morrison & Boyd, 6th Edition
3. Organic Chemistry by J. Clayden, Warren *et al*

24CHE23102: **Industrial Analytical Techniques** (2 Credits Theory, 30 hr)

Sr. No.	Chapters	Lectures
1	Volumetric Analysis	15
2	Conductometry	07
3	Colorimetry	08
	Total	30

Course Outcomes:

CO1: Students should be able to identify the type of volumetric analysis and its applications.

CO2: Students should understand the technique of Conductometry and its applications.

CO3: Students should explain/define different terms used in colorimetry and its applications.

Chapter 1: Volumetric Analysis [15 L]

Introduction to volumetric analysis, classification of reactions in volumetric analysis, standard solutions, equivalents, normalities, and oxidation numbers, preparation of standard solutions, primary and secondary standards. Types of Volumetric Analysis methods:

Neutralization titrations: Theory of indicators, neutralization curves for strong acid strong base, weak acid strong base, weak base strong acid. Preparation of approximate 0.1 M HCl and standardization against anhydrous sodium carbonate, determination of Na_2CO_3 content in washing soda.

Complexometric Titrations: Definition of complexing agent and complexometric titration, EDTA-as complexing agent (structure of EDTA and metal ion EDTA complex), Types of EDTA titration (direct and back titration), pH adjustment and amount of indicator in EDTA titration, metal ion indicators (general properties, solochrome black –T, Patton and Reeder's indicator only), standard EDTA solution, determination of Ca(II) and Mg(II), total hardness of water.

Redox Titrations: Definition of oxidizing agent, reducing agent, redox titration, $K_2Cr_2O_7$ and $KMnO_4$ as oxidizing agents, 1,10- phenanthroline as indicator in reduction titration, diphenylamine as oxidation indicator, $KMnO_4$ as self-indicator, Standard KMnO4 solution and standardization with sodium oxalate, Determination of H_2O_2.

Precipitation titrations: precipitation reactions, determination of end point (formation of coloured ppt., formation of soluble coloured compound, adsorption indicator), standard $AgNO_3$ solution, standardization of $AgNO_3$ solution– potassium chromate indicator- Mohr's titration, determination of chloride and bromide, determination of iodide. Problems based on analysis.

Learning Outcomes:

1. Students will be able to do the calculations of normality, molarity, and oxidation number.
2. Students should be able to explain the different types of volumetric analysis
3. Students will be able to solve the related problems.

Chapter 2: Conductometry [6 L]

Introduction, Electrolytic Conductance, Resistance, conductance, Ohm's law, cell constant, specific and equivalent conductance, molar conductance, variation of equivalent and specific conductance with concentrations, Kohlrausch's law and its applications, conductivity cell, determination of cell constant, conductometric titrations (strong acid-strong base, strong acid-weak base, weak acid strong base) and Numericals.

Learning Outcomes:

1.Discuss / explain Kohlrausch's law and its Applications, Conductivity Cell.

2.Explain / discuss conductometric titrations.

Chapter 3: Colorimetry [6L]

Introduction, interaction of electromagnetic radiation with matter, essential terms: radiant power, transmittance, absorbance, molar, Lambert's Law, Beer's Law, Lambert-Beer's Law, molar absorptivity, deviations from Beer's Law, Colorimeter: Principle, Construction and components, Working. Applications–unknown conc. by calibration curve method, Determination of unknown concentration of Cu(II) by EDTA method, Numericals.

Learning Outcomes:

1. Explain / define different terms in Colorimetry such as radiant power, transmittance, absorbance, molar, Lambert's Law, Beer's Law, molar absorptivity.

2. Apply colorimetric methods of analysis to real problems in analytical laboratories.

References:
1. Analytical Chemistry by G.D. Christian.
2. Calculation of Analytical Chemistry by Hamilton, Simpson & amp;Ellis 7th Edn.
3. Vogel, Textbook of Quantitative Inorganic Analysis, Including   Elementary Instrumental Analysis by A. I. Vogel; J. Bassett .
4. Fundamentals of Analytical Chemistry by F. James Holler; Douglas Skoog; Stanley Crouch.

24CHE23103: Practical Course in General Chemistry
              (2 credits practical , 60 hr)

1. To determine molecular weight of Monobasic acid.
2. To determine molecular weight of Dibasic acid.
3. Estimation of acetamide.
4. Preparation of Quinone from hydroquinone.
5. Preparation of β- naphthyl methyl ether from β- naphthol.
6. Preparation of glucosazone derivative.
7. Estimation of aspirin.
8. Estimation of percentage of acetic acid in vinegar.
9. Determination of amount of oxalic and sulphuric acid in the given sample.
10. Determination of the number of water molecules of crystallisation in Mohr's salt.
11. Determination of strength of given Potassium dichromate solution.

24CHE23104: **Chemistry in Ancient India - Major Specific IKS**
(2 Credits Theory , 30 hr)

Sr. No.	Chapters	Lectures
1	Chapter 1: Introduction	07
2	Chapter 2: Metallurgy	08
3	Chapter 3: Ayurveda	08
4.	Chapter 4: Material Chemistry in ancient times	07
	Total	30

Course Outcomes:
CO1: Students should know the role of metallurgy in ancient India .
CO2: Students should know the areas where Chemistry was significant in ancient India .
CO3: Students should explain Ayurveda importance in ancient India..

Chapter 1: Introduction (4L)
Involvement of chemistry in different areas like metallurgy, ayurveda, archeology, numismatics etc.

Chapter 2: Metallurgy (10L)
Early Chemical Techniques and Technology, Bronze Age: Tin, lead, and copper smelting, Iron Age: Ferrous metallurgy, Extraction of metals: Copper from the pyrites, Extraction of Zinc from calamine.
Visit to Raja Kelkar Museum, Pune and S.P. Pune University, Pune.

Chapter 3: Ayurveda (8 L)
Introduction, preparation of chemical formulations, different chemical processes involved in preparation of medicines
Visit to Rasashala, Pune.

Chapter 4: Material Chemistry in ancient times (7 L)
Introduction to material chemistry in ancient India and its correlation with nano chemistry.
Visit to Bhandarkar Institute, Pune.

Learning Outcomes:
- The students will understand the science heritage of India in metallurgy and ayurvedic medicines.
- The students will be able to relate advancements in science with ancient Indian knowledge.

24CHE23205: (Minor) Fundamentals of Biochemistry
(2 credits theory, 30 hr)

Sr. No.	Chapters	Lectures
1	Carbohydrates	10
2	Stereochemistry of Carbohydrates	10
3	Lipids	10
	Total	30

Course Outcomes:

CO 1: Students will be able to know basic concepts of biomolecules.

CO 2: Students will be able to draw different structure of carbohydrates and reactions of carbohydrates.

CO 3: The students will understand structures and chemistry of lipids.

Chapter 1 : Carbohydrates   **[10L]**

Classification, Structure and Biological Significance of Carbohydrates, Structural Representation of Monosaccharide, Structure of Maltose, Cellobiose, Lactose, Amylose, Amylopectin and Cellulose.

Chapter 2 : Stereochemistry of Carbohydrates   **[10L]**

Concepts of D/ L and R/S, threo, erythro, enantiomers, diastereomers of carbohydrates.

Learning Outcomes:
- Students should understand stereochemistry of carbohydrate and will be able to identify various stereoisomers.
- Students will be able to assign the exact stereochemistry of the carbohydrates

Chapter-3: Lipids   **[10L]**

Classification, Short hand representation of unsaturated fatty acids, Structural representation of Lipids, mechanism of lipid in biosynthesis, Biological significance of Lipids.

Learning Outcomes:

The student will be able to become aware of the types of lipids, structure of lipids and properties of lipids.

24CHE23206: (Minor) Practical Course on Biochemistry
(2 credits Practical, 60 hr)

1. Detection of carbohydrates : Benedict's test, Iodine test, Fehling test
2. Detection of lipids : Emulsion test
3. Detection of proteins: Biuret test, Ninhydrin test, Xanthoproteic test
4. Identification of biomolecules from the given sample. (Any three)
5.To separate the components of a given mixture of amino acids by paper chromatography
  (2 mixtures).
6.To separate the components of a given mixture of sugars by paper chromatography (2 mixtures).
7.To separate the components in a mixture of given biomolecules using Thin Layer Chromatography. (2 mixtures).

24CHE23307 OE: Food and Health   **(2 credits theory , 30 hr)**

Course Outcomes:

CO1: Label the basic parts of digestive organs and recall their functions. Remember the food regulation laws. Define terminologies related to nutrition
CO2: Classify nutrients, toxins, and adulterants. Compare and contrast its features. Justify the advantages and disadvantages of food additives.

CO3: Apply the principles of ancient and modern food preparation and preservation techniques and its utility in retaining the nutritive value of various types of food.

 Chapter 1: Types of Nutrients: (7 L)

Basic concept on Food and Nutrition. Scope of Nutrition, Classification of food. Types of Macro and Micronutrients. Sources and significance. Recommended daily intake. Structure and functions of the digestive system. Process of digestion and absorption of food. Significance of digestive juices in digestion.

Chapter 2: Food Adulterants and Healthy choices: (8 L)

Types of Food toxins. Food adulteration in various daily food items. Healthy alternatives.

Chapter 3: Food preservation methods: (8 L)

Definition, objectives, and principles of food preservation. Different ancient and modern methods of food preservation to retain nutritive value.

Chapter 4: Food analysis and Food regulation laws: (7 L)

Identification and analysis of macro and micronutrients in food. Weight for age, height for age, weight for height, body Mass Index (BMI) Waist - Hip Ratio, (WHR). Skin fold thickness. Simple home testing of food adulterants. National and International Food Adulteration prevention laws. Reading of food labels and ingredients.

Learning Outcomes:

- The students will become aware of various nutrients, adulterants in food and their impact on health.
- The students will know rules and regulations for quality of food.

References:

1. Srilakshmi B (2017): Nutrition Science,6th Multicolour Ed. New Age International (P) Ltd.
2. Mann J and Truswel lS(2017) : Essentials of Human Nutrition, 5th Ed. Oxford University Press.
3. Handbook of Food and Nutrition- Dr.M.Swaminathan, Bangalore Press
4. Sadasivan S and ManikamK(2007): Biochemical Methods, 3rd Ed. New Age International (P)Ltd.
5. GopalanC , Rama Sastri BV and Balasubramanian SC(2016): Nutritive value of Indian Foods, Indian Council of Medical Research.
6. Subalakshmi, G and Udipi, SA(2006):Food processing and preservation, 1st Ed. New Age International (P)Ltd

24CHE23408: VSEC Practical Course on Binary Mixture Analysis (2 credits practical , 60 hr)

1. Organic Qualitative Analysis of Binary Mixture (6 mixtures).
2. Determination of Acidic radicals in the given Inorganic Binary Mixture (1 mixture without phosphate and borate).
3. Determination of Basic radicals in the given Inorganic Binary Mixture   (1 mixture without phosphate or borate).
4. Determination of acidic and basic radicals in the given Inorganic Binary Mixture. (4 mixtures without phosphate and borate).

24CHE23609: Field Project (2 credits)

****

Semester IV

24CHE24101: Concepts in Physical Chemistry   (2 credits theory , 30 hr)

Sr. No.	Chapter No.	Lectures
1.	Chemical Kinetics	14
2.	Surface Chemistry	10
3.	Free Energy	06
	Total	30

Course Outcomes:

CO 1:Students will be able to calculate the rate constant of the chemical reactions.
CO 2:Students should be able to predict the order of chemical reactions and determine them
    experimentally.
CO 3:Students should understand the concept of adsorption and where it can be used for
    different applications.
CO4:Students should understand the application of free energy to chemical reactions.

Chapter 1: Chemical Kinetics   [14L]

Introduction to kinetics, the rates of chemical reactions – definition of rates, rate laws and rate
constants, reaction order and molecularity, determination of rate law, factors affecting reaction
rates, integrated rate laws – zeroth-order reactions, first-order reactions, second-order reactions
(with equal and unequal initial concentration of reactants), half-life period, methods for
determination of order of a reactions, Arrhenius equation- temperature dependence of reaction
rates, interpretation of Arrhenius parameters, reaction dynamics-collision theory and transition-
state theory of bimolecular reactions, comparison of the two theories, Problems.

Learning Outcomes:

1. Students will be able to apply the chemical kinetics to chemical reactions and to solve the
   related problems.
2. Students should be able to understand the concept of order of reaction, activation energy
   and reaction dynamics.

Chapter 2: Surface Chemistry   [10L]

Introduction to surface chemistry - some basic terms related to surface chemistry adsorption,
adsorption materials, factors affecting adsorption, characteristics of adsorption, types of
adsorption, classification of adsorption isotherms, Langmuir adsorption isotherm, Freundlich's
adsorption isotherm, BET theory (only introduction), application of adsorption, problems.

Learning Outcomes:

1. Students should understand the phenomenon of adsorption.
2. Students should be able to apply the adsorption process for various
   chemical reactions and different applications in daily life.

Chapter 3: Free Energy [06L]

Introduction, Helmholtz free energy, variation of Helmholtz free energy with volume and temperature, Helmholtz free change energy for chemical reaction, Gibb's free energy, Variation of Gibb's free energy with pressure and temperature, Gibb's free energy change for chemical reaction, Free energy change for physical transitions, Free energy change for an ideal gas; standard free energy change, Gibb's-Helmholtz equation, Properties and significance of Gibb's free change.

Learning Outcomes:

1. Students will be able to apply the free energy and predict the chemical reactions.
2. Students should be able to understand the concept of free energies and apply it to chemical reactions.

References:

1. Principles of Physical Chemistry. By Maron and Pruton 4th Ed.Oxford and IBH publication.
2. B S Bahl, G D Tuli, Arun Bahl, Essentials of Physical Chemistry.
3. Physical chemistry by Atkins.
4. Principles of Physical Chemistry By Puri, Sharma, And Pathania.
5. Physical Chemistry by K.L Kapoor (Vol. 1)

24CHE24102:Introduction to Coordination Chemistry (2 Credits Theory,30 hr)

Sr. No.	Chapters	Lectures
1	Introduction to Coordination Compounds	15
2	Isomerism in Coordination complexes	15
	Total	30

Course Outcomes:

CO 1: Students are able to understand basic terminology of coordination chemistry.

CO 2: Students are able to draw structures of complexes.

CO 3: Students are able to explain Werner's theory and Sidgwick model of coordinate compounds.

CO 4: Students are able to understand classification of isomerism in coordination compounds.

Chapter 1: Introduction to Coordination Compounds [15 L]

Double salts and coordination compounds, basic definitions: coordinate bond, ligand, types of ligands, chelate, central metal ion, charge on complex ion, calculation of oxidation state of central metal ion, metal ligand ratio; Werner's work and theory, Effective atomic number, equilibrium constant and types, chelate effect, IUPAC nomenclature.
Ref.-1: 194-200, 222-224**; Ref-4:** 483-492**; Ref-6:** 138-140

Learning Outcomes: After studying the Introduction to Coordination Compounds student will able to
1. Define different terms related to the coordination chemistry (double salt, coordination compounds, coordinate bond, ligand, central metal ion, complex ion, coordination number, magnetic moment, crystal field stabilization energy, types of ligands, chelate effect, etc.)
2. Explain Werner's theory of coordination compounds. Differentiate between primary and secondary valency. Correlate coordination number and structure of complex ion.
3. Apply IUPAC nomenclature to coordination compound.

Chapter 2: Isomerism in coordination complexes [15 L]
Introduction, polymerization isomerism, ionization isomerism, hydrate isomerism, linkage isomerism, coordination isomerism, coordination position isomerism, geometric isomerism and subtypes, optical isomerism and subtypes.
Ref-1: 232-236

Learning Outcome: After studying Isomerism in coordination complexes student will able to
1. Explain different type of isomerism observed in coordination complexes with examples.
2. Explain classification of isomerism in coordination complexes.

References:
1. Concise Inorganic Chemistry, J. D. Lee, 5th Ed (1996) Blackwell Science.
2. Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008.
3. Inorganic Chemistry by Miessler and Tarr, Third Ed. (2010), Pearson.
4. Principles of Inorganic Chemistry, Brian W. Pfennig, Wiley (2015).
5. Inorganic Chemistry, Catherine Housecraft, Alan G. Sharpe, Pearson Prentice Hall, 2008.
6. Basics Inorganic Chemistry, Cotton and Wilkinson.

24CHE24103 :   Practical Course in Physical and Inorganic Chemistry
              (2 Credits Practical , 60 hr)

Course Outcomes:

CO 1: Students should be able to perform experiments related to chemical kinetics.

CO 2: Students should relate with different types of Volumetric analysis.

CO 3: Understand systematic methods of identification of substance by Chemical methods.

CO 4: Systematic working skill in the laboratory will be imparted to students.

Section A: Physical Chemistry (Compulsory)

1) To Study the Acid catalysed hydrolysis of an ester (methyl Acetate) and determine the rate constant (k). (first order reaction)

2) To compare the relative strength of HCl and H_2SO_4 or HNO_3 by studying the kinetics of hydrolysis of methyl acetate.

3) Energy of activation of the reaction between $K_2S_2O_8$ and KI with unequal initial concentration.

4) To verify the Freundlich and Langmuir adsorption isotherm for adsorption of acetic acid on activated charcoal.

5) To determine the cell constant of the given cell using 0.01 M KCl solution and determine dissociation constant of a given monobasic weak acid.

6) To determine the critical solution temperature for the Phenol-water system.

Section B: Inorganic Chemistry (Compulsory)

1. Estimation of nitrite.
2. Estimation of neutralising capacity of antacid.
3. Estimation of manganese by Volhard method.
4. Estimation of copper from brass alloy.
5. Preparation of $[Cu(NH_3)_4]SO_4$ complex.
6. Preparation of $[Ni(NH_3)_6]Cl_2$ complex.
7. Industrial Visit (compulsory)

References:

1. Practical Chemistry, O. P. Pandey, D. N. Bajpai, Dr. S. Giri, S Chand Publication.
2. Systematic experimental physical chemistry, S. W. Rajbhoj, T. K.Chondekar, Anjali publication.
3. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.
4. Text book of Practical Organic Chemistry, Vogel, A.I., Tatchell, A.R.,Furnis, B.S., Hannaford, A.J. & Smith, P.W.G. Prentice-Hall, 5th edition.

Sr. No.	Chapters	Lectures
1	Fundamentals of Amino acids	10
2	Reactions of amino acid	10
3	Peptide bonds and Proteins.	10
	Total	30

24CHE24204: (Minor) Chemistry of Biomolecules   (2 Credits 30 hr)

Course Outcomes:

CO 1: The student will understand the structures and types of amino acids.

CO 2: The student will understand the important reactions and significance of amino acids.

Chapter-1: Fundamentals of Amino acids [10 L]

Introduction, Fundamentals, Molecular level (sequencing and 3-D structure), Classification of amino acids., Concept of ampholytes, isoelectric pH, zwitterions, titration curve of glycine.

Learning Outcomes:
- The student will understand the structure and types of amino acids.
- Students will be able to know the importance and classification of amino acid.
- Students will be able to draw structures of amino acids.

Chapter-2: Reactions of amino acids [10L]

Reactions of amino acids with Ninhydrin, Sanger's, Dansyl chloride, Dabsyl chloride and Edmann's reagents and their significance.

Learning Outcome:

Students should understand the reactions of amino acids.

Chapter-3: Peptide bonds and Proteins. [10 L]

Introduction, Definition, the structure of peptide bonds, protein structure at various levels (primary, secondary, tertiary, and quaternary), peptide synthesis, Effect of pH on structure of amino acid, and the roles of proteins in biological systems.

Learning Outcome:
- Students will be able to understand Peptide bond formation.
- The student will be able to write structures of proteins with the N and C terminus of the peptide chain.
- Students will understand the role of proteins in biological processes.

24CHE24205: (Minor) Practical Course on Natural Products
(2 credits practical, 60 hr)

1. Methods of extraction of natural products. (theoretical).
2. Comparative study of cold and hot solvent extractions by using TLC
3. Organic qualitative analysis of extracts (type determination of acid, base, phenol and neutral)
4. Isolation of pigments.
5. Identification of pigments by paper chromatography.
6. Estimation of reducing and non-reducing sugars.
7. Estimation of acid value of fats.

8. Extraction of Eugenol from clove powder.
9. Extraction of Fats from given sample.
10. Making of perfume from natural products.
11. Scientific Survey of use of natural products as cosmetics / perfume / oils etc for sample size of at least ten.
12. Industrial visit.

24CHE24306: (OE) Practical Course on Food and Health   (2 Credits, 60 hr)

1. Determination of moisture content of fruits and vegetables.

2. Quality parameter evaluation of fresh fruits and vegetables.

3. Determination of impurities in oil samples.

4. Detection of adulteration in various foods: Black pepper, Butter, Ghee, Chilli Powder, Honey, Tea, Turmeric etc.

5. Determination of Titratable acidity and pH of fruit juices.

6. Qualitative detection of adulterants in Atta, Maida, Besan, Biscuits etc

7. Activities of Quality Department and Studies on bar codes.

8. Study of National and Codex microbial quality standards.

9. Case study.

24CHE24407: (VSEC) Practical Course on Industrial Analytical Techniques (2 Credits, 60 hr)

1. To investigate the conductometric titration of strong acid against strong base.
2. To investigate the conductometric titration of strong base against weak acid.
3. Study of rate of reaction by conductometric method.
4. To determine the unknown concentration of Copper solution using Cu-EDTA complexometric titration by colorimetry.
5. To determine the unknown concentration of Nickel in a given solution by calibration curve method.
6. Detection of sugars by colorimetric method.
7. Determination of Vitamin C in lime or lemon by titration method.
8. Separation of metal ions by column chromatography-I.
9. Separation of contents from a given mixture of compounds by column chromatography-II.
10. Titration of acid and base for calculation of Errors in the results.
11. Titration for calculation of standard deviations in the results.

24CHE24408: (SEC) Practical Course on Biomolecules   (2 Credits, 60 hr)

1.Detection of carbohydrates: Benedict's test, Iodine test, Fehling test

2. Detection of lipids: Emulsion test

3.Detection of proteins: Biuret test, Ninhydrin test, Xanthoproteic test.

4.Identification of biomolecules from the given sample. (Any three)

5.To separate the components of a given mixture of amino acids by paper chromatography. (2 mixtures).

6.To separate the components of a given mixture of sugars by paper chromatography (2 mixtures).

7.To separate the components in a mixture of given biomolecules using Thin Layer Chromatography (2 mixtures).

24CHE24609: CEP (2 credits)

****

Progressive Education Society's

Modern college of Arts, Science and Commerce,

Ganeshkhind,Pune-16

Autonomous

NEP 2020 (2)

Department of Mathematics

(Under Faculty of Science and Technology)

S.Y.B.Sc.(Regular)

Major Specific Indian Knowledge System

(Major Specific IKS)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2025-2026

S.Y.B.Sc. (Regular)

Major Specific Indian Knowledge System

(Major Specific IKS)

Course Strucutre

Semester	Paper Code	Title of the Paper	Theory (T) / Practical (P)	No. of Credits
3	24MAT23104	Indian Ancient Mathematics	T	2

Evaluation Pattern

Semester	Paper Code	Title of the Paper	CIE Marks	ESE Marks	Total Marks
3	24MAT23104	Indian Ancient Mathematics	20	30	50

CIE : Continuous Internal Evaluation   **ESE :** End Semester Examination

Paper Code : 24MAT23104			
Name of the Paper : Indian Ancient Mathematics (Theory)			
Total No. of Credits : 2		Total No. of lectures : 30	
Course Outcome			
CO	Details		
CO1	Student will be aware of contribution of Indian Mathematicians and their knowledge in Mathematics in ancient time.		
CO2	Student will get the knowledge about the various ways of solving the problem in Mathematics in ancient time.		
Details of Syllabus			
Unit	Subunit	Content	No. of lectures
1		**Introduction to Ancient Indian Mathematics.**	**6**

Details of Syllabus			
Unit	Subunit	Content	No. of lectures
2		**Ancient Indian Mathematician 1.**	6
2	2.1	Pingala , Panini.	
	2.2	Aryabhata , Bhaskara-I.	
	2.3	Bramhagupta.	
3		**Ancient Indian Mathematician 2.**	6
	3.1	Bhaskaracharya (Bhaskara-II).	
	3.2	Madhava.	
4		**Applications of Ancient Indian Mathematics.**	12

Progressive Education Society's

Modern college of Arts, Science and Commerce,

Ganeshkhind,Pune-16

Autonomous

NEP 2020 (2)

Department of Mathematics

(Under Faculty of Science and Technology)

S.Y.B.Sc.(Regular) : Minor : Mathematics

Choice Based Credit System Syllabus

To be implemented from Academic Year 2025-2026

S.Y.B.Sc. (Regular) : Minor : Mathematics

Semester	Paper Number	Paper Code	Title of the Paper	Theory (T) / Practical (P)	No. of Credits
3	I	24MAT23205	Basic Course in Graph Theory	T	2
	II	24MAT23206	Practical Course based on Basic Course in Graph Theory	P	2
4	I	24MAT24204	Basic Course in Matrix Algebra	T	2
	II	24MAT24205	Practical Course based on Basic Course in Matrix Algebra	P	2

Evaluation Pattern

Semester	Paper Number	Paper Code	Title of the Paper	CIE Marks	ESE Marks	Total Marks
3	I	24MAT23205	Basic Course in Graph Theory	20	30	50
	II	24MAT23206	Practical Course based on Basic Course in Graph Theory	20	30	50
4	I	24MAT24204	Basic Course in Matrix Algebra	20	30	50
	II	24MAT24205	Practical Course based on Basic Course in Matrix Algebra	20	30	50

CIE : Continuous Internal Evaluation   **ESE :** End Semester Examination

Syllabus for S.Y.B.Sc. (Mathematics) : Minor

Academic Year : 2025-26

Semester – 3

Paper No. : I		Paper Code : 24MAT23205
Name of the Paper : Basic Course in Graph Theory (Theory)		
Total No. of Credits : 2		**Total No. of lectures : 30**
Course Outcome		
CO	**Details**	
	Students will	
CO1	Learn basic concepts in Graph theory.	
CO2	Develop the skill of converting mathematical problem graphically and vice versa.	
CO3	Learn suitable techniques of analysis of problems.	
CO4	Learn various tools for solving real life problems.	
CO5	Develop a positive attitude towards mathematics as an interesting and valuable subject to study.	
Details of Syllabus		

Unit	Subunit	Content	No. of lectures
1		**Introduction.**	**4**
	1.1	What is a Graph?	
	1.2	Application of Graphs.	
	1.3	Finite and Infinite Graphs.	
	1.4	Incidence and Degree.	
	1.5	Isolated Vertex, Pendant Vertex and Null Graph.	
2		**Paths and Circuits.**	**10**
	2.1	Isomorphism.	
	2.2	Subgraphs.	
	2.3	Walks, Paths, and Circuits.	
	2.4	Connected Graphs, Disconnected Graphs, and Components.	
	2.5	Euler Graphs.	
	2.6	Operations on Graphs.	
	2.7	More on Euler Graphs.	

Details of Syllabus			
Unit	Subunit	Content	No. of lectures
2	2.8	Hamiltonian Paths and Circuits.	
	2.9	The Traveling Salesman Problem.	
3		**Trees and Fundamental Circuits.**	10
	3.1	Trees.	
	3.2	Some Properties of Trees.	
	3.3	Pendant Vertices in a Tree.	
	3.4	Distance and Canters in a Tree.	
	3.5	Rooted and Binary Trees.	
	3.6	Spanning Trees.	
	3.7	Fundamental Circuits.	
	3.8	Spanning Trees in a Weighted Graph.	
4		**Cut-Sets and Cut-Vertices.**	6
	4.1	Cut-Sets.	
	4.2	Some Properties of a Cut-Set.	
	4.3	Fundamental Circuits and Cut-Sets.	

Recommended Book

Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science"Printice-Hall, of India Pvt. Lt. New Delhi.

Unit 1 : Chapter 1: Sec.1.1 to 1.5

Unit 2: Chapter 2: Sec. 2.1 to 2.10 (Excluding 2.3)

Unit 3: Chapter 3: Sec. 3.1 to 3.10 (Excluding 3.9)

Unit 4: Chapter 4 : Sec. 4.1 to 4.5

Reference books

1. John Clark and Derek Holton, A First Look at Graph Theory (Allied Publishers)
2. Robin J. Wilson, Introduction to Graph Theory, Fourth Edition (low price edition)
3. Introduction to Graph Theory, Douglas West 2nd edition.
4. A Textbook of Graph Theory, Balakrishnan, R., Ranganathan, K.

Paper No. : II	Paper Code : 24MAT23206
Name of the Paper : Practical Course based on Basic Course in Graph Theory (Practical)	
Total No. of Credits : 2	**Total No. of Practical : 15**
List of Practical	
Practical 1.	Problems on Unit 1 (Written).
Practical 2.	Problems on Unit 1 (Written).
Practical 3.	Problems on Unit 2(Written).
Practical 4.	Problems on Unit 2 (Written).
Practical 5.	Problems on Unit 2 (Written).
Practical 6.	Problems on Unit 2(Written).
Practical 7.	Problems on Unit 3 (Written).
Practical 8.	Problems on Unit 3 (Written).
Practical 9.	Problems on Unit 3 (Written).
Practical 10.	Problems on Unit 3(Written).
Practical 11.	Problems on Unit 4 (Written).
Practical 12.	Problems on Unit 4 (Written).
Practical 13.	Problems on Unit 4 (Written).
Practical 14.	Miscellaneous.
Practical 15.	Miscellaneous.

Semester - 4

Paper No. : I	Paper Code : 24MAT24204
Name of the Paper : Basic Course in Matrix Algebra (Theory)	
Total No. of Credits : 2	**Total No. of lectures : 30**
Course Outcome	
CO	**Details**
	Students will
CO1	Get equipped with the knowledge of various properties of matrices and how matrices help in solving problems in different dimensions.

Course Outcome	
CO2	Students will be able to perform certain algorithms, justify why these algorithms work, and give some estimates of the running times of these algorithms.
CO3	Students will be able to solve linear systems by using different methods.
CO4	CO4: Students will develop their basics for the course of Linear Algebra of second semester.
CO5	Students will be able to write cohesive and comprehensive solutions to exercises and be able to defend their arguments.
Details of Syllabus	

Unit	Subunit	Content	No. of lectures
1		**Introduction.**	**5**
	1.1	Matrix Operations.	
	1.2	The Inverse of a Matrix.	
2		**Linear Equations in Linear Algebra-I.**	**8**
	2.1	2.1 System of Linear equations.	
	2.2	2.2 Row reduction and echelon forms.	
	2.3	The matrix equation AX=B.	
	2.4	Solution sets of linear systems.	
3		**Linear Equations in Linear Algebra –II.**	**12**
	3.1	Linear Independence.	
	3.2	Introduction to linear transformation.	
	3.3	The matrix of linear transformation.	
	3.4	Subspaces of R n (column space and null space of a matrix).	

Details of Syllabus			
Unit	**Subunit**	**Content**	**No. of lectures**
4		**Determinants.**	**5**
	4.1	4.1 Introduction to determinants.	
	4.2	4.2 Properties of determinants.	
	4.3	4.3 Cramer's rule, Volume and linear transformations.	

Text Book

Linear Algebra and its Applications, David C Lay, Steven R. Lay, Judi

J. MacDonald Pearson Publication,2016, Fifth Edition.

Unit 1: Chapter 2: Sec. 2.1, 2.2, 2.3

Unit 2: Chapter 1: Sec. 1.1, 1.2, 1.3, 1.4, 1.5

Unit 3: Chapter 2: Sec. 2.5,2.8 Chapter 1: 1.7, 1.8, 1.9

Unit 4: Chapter 3: Sec. 3.1, 3.2, 3.3

Reference Books

1. Elementary Linear Algebra with supplemental Applications,Howard Anton and others ,Wiley Student Edition.

2. Matrix and Linear Algebra (aided with MATLAB),KantiBhushanDatta, Eastern Economic Edition.

Paper No. : II	Paper Code : 24MAT24205
Name of the Paper : Practical Course based on Basic Course in Matrix Algebra (Practical)	
Total No. of Credits : 2	**Total No. of Practical : 15**
List of Practical	
Practical 1.	Problems on Unit 1 (Written).
Practical 2.	Problems on Unit 1 (Written).

Practical 3.	Problems on Unit 2(Written).
Practical 4.	Problems on Unit 2 (Written).
Practical 5.	Problems on Unit 2 (Written).
Practical 6.	Problems on Unit 2(Written).
Practical 7.	Problems on Unit 3 (Written).
Practical 8.	Problems on Unit 3 (Written).
Practical 9.	Problems on Unit 3 (Written).
Practical 10.	Problems on Unit 3(Written).
Practical 11.	Problems on Unit 4 (Written).
Practical 12.	Problems on Unit 4 (Written).
Practical 13.	Problems on Unit 4 (Written).
Practical 14.	Miscellaneous.
Practical 15.	Miscellaneous.

Modalities for conducting practical and practical Examination :

1. There will be one 4 hours practical session for each of batch of 15 students per week for each practical course.
2. A question bank consisting of 50 problems in all for each semester, will be the course work for this paper. Question bank will be prepared by the individual subject teacher and the problems included should be changed every year.
3. Each student will maintain a journal to be provided by the college.
4. The internal 20 marks will be given on the basis of journal prepared by student and the cumulative performance of student at practical.
5. External examiner shall be appointed by the college for Mathematics Practical Examination.
6. The duration of practical examination is 2 hours.
7. The practical examination will consist of written examination of 30 marks out of which theory Question paper will be of 25 marks and 5 marks oral examination.

8. The pattern for the practical written (Theory) examination will be as follows:

- **Solve any 5 questions out of 8 questions.**
- **Each question will be of 5 marks.**

9. Study tours may be arranged at places having important Mathematical institutes orhistorical places.

Special Instruction:
a) Before starting each practical necessary introduction, basic definitions and prerequisites must be discussed.
b) Examiners should set separate question papers, solutions and

scheme of marking for each batch and claim the remuneration

as per rule.

Progressive Education Society's

Modern college of Arts, Science and Commerce,

Ganeshkhind,Pune-16

Autonomous

NEP 2020 (2)

Department of Mathematics

(Under Faculty of Science and Technology)

S.Y.B.Sc.(Regular)

Open Elective (OE)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2025-2026

S.Y.B.Sc.(Regular) : Mathematics

Open Elective (OE)

Course Structure

Semester	Paper Code	Title of the Paper	Theory (T) / Practical (P)	No. of Credits
3	24MAT23307	Vedic Mathematics	T	2
4	24MAT24306	Financial Mathematics	P	2

Evaluation Pattern

Semester	Paper Code	Title of the Paper	CIE Marks	ESE Marks	Total Marks
3	24MAT23307	Vedic Mathematics	20	30	50
4	24MAT24306	Financial Mathematics	20	30	50

Detail Syllabus

Semester - 3

Paper Code : 24MAT23307	
Name of the Paper : Vedic Mathematics (Theory)	
Total No. of Credits : 2	**Total No. of lectures : 30**
Course Outcome	

CO	Outcomes
CO1	Student will learn different techniques to solve the basic operations in Mathematics.
CO2	Fast computation skills will be enhanced.
CO3	Student will be able to solve the problems in Competitive examinations in Mathematics

Details of Syllabus

Unit No.	Sub Unit No.	Content	No. of Lectures
1		**Table Formation.**	**2**
	1.1	Tables near to perfect base numbers.	
	1.2	Tables of Even Numbers.	
	1.3	Tables of Odd Numbers.	
	1.4	Tables of numbers having units place as 5, 8, 9....	
	1.5	Tables of more than two digit numbers .	
2		**Multiplication.**	**8**
	2.1	Multiplication of any number by 9, 99, 999, 9999...	
	2.2	Multiplication of numbers more than perfect base numbers.	
	2.3	Multiplication of numbers less than perfect base numbers.	
	2.4	Multiplication of numbers more than sub base numbers.	
	2.5	Multiplication of numbers less than sub base numbers.	
	2.6	Multiplication of any number by 11, 12 to 19.	
	2.7	By any two digit number.	
	2.8	Multiplication of numbers having sum of units place as 10.. -Having sum of last two digits as 100..- Multiplication of numbers having sum of units place near to 10.	
	2.9	General Multiplication - 2-2, 3-3, 4-4, 5-5 etc..	
	2.10	Multiplication of any number by 5, 25, 125 etc...	

Unit No.	Sub Unit No.	Content	No. of Lectures
3		**Squares.**	4
	3.1	Squares of numbers having units place as 5.	
	3.2	Squares of numbers more than perfect base numbers.	
	3.3	Squares of numbers less than perfect base numbers.	
	3.4	Squares of numbers more than sub base numbers	
	3.5	Squares of numbers less than sub base numbers	
	3.6	Squares by duplexing method.	
	3.7	Squares of numbers having last digits as 25, 75...	
	3.8	Squares of 1,11,111,1111,…	
4		**Cubes.**	4
	4.1	Cubing the numbers more than perfect base numbers.	
	4.2	Cubing the numbers less than perfect base numbers.	
	4.3	Cubing any two digit number...	
	4.4	Cubing the numbers near to sub base numbers.	
5		**Square Roots and Cube Roots.**	2
6		**Division.**	2
	6.1	Division of any number by two numbers.	
	6.2	Division of any number by three digit number.	
	6.3	Division of any number by 9…	
	6.4	Divisions of algebraic expressions.	
	6.5	Division of decimal places	

Unit No.	Sub Unit No.	Content	No. of Lectures
7		**Test of Divisibility.**	**3**
	7.1	Test of Divisibility of numbers having units place as 9.	
	7.2	Seven by seven.	
	7.3	Test of Divisibility of numbers having units place as 9.	
	7.4	Test of Divisibility having units place as 1.	
	7.5	Test of Divisibility of 37.	
	7.6	Some other...	
8		**Magic Square.**	**3**
	8.1	Three by three.	
	8.2	Five by five.	
	8.3	Seven by seven.	
	8.4	Nine by nine.	
	8.5	Four by four.	
9		**Compound Interest.**	**1**
	9.1	For 2 years.	
	9.2	For 3 years.	
10		**Fractions**	**1**

Semester - 4

Paper Code : 24MAT24306	
Name of the Paper : Financial Mathematics (Practical)	
Total No. of Credits : 2	**Total No. of Practical : 15**
Course Outcome	

CO	Outcomes
CO1	Student will learn basic calculation of interest.
CO2	Computation skills will be enhanced.
CO3	Student will be able to solve the real life problems.

List of Practical	
Practical 1.	Written practical on Unit 1.
Practical 2.	Written practical on Unit 1.
Practical 3.	Written practical on Unit 1.
Practical 4.	Written practical on Unit 2.
Practical 5.	Written practical on Unit 2.
Practical 6.	Written practical on Unit 2.
Practical 7.	Written practical on Unit 3.
Practical 8.	Written practical on Unit 3.
Practical 9.	Written practical on Unit 3.
Practical 10.	Written practical on Unit 4.
Practical 11.	Written practical on Unit 4.
Practical 12.	Written practical on Unit 5.
Practical 13.	Written practical on Unit 5.
Practical 14.	Miscellaneous.
Practical 15.	Miscellaneous.

Unit	Sub unit	Content
1		**Interest and Annuity**
	1.1	Simple Interest for 1 and 2 year.
	1.2	Compound Interest for 1 and 2 year.
	1.3	Annuity.
	1.4	EMI (Equated Monthly Installment).
2		**Measures of Central Tendency**
	2.1	Arithmetic Mean.
	2.2	Weighted Mean.
	2.3	Combined Mean.
	2.4	Median , Range.
3		**Statistical Measures**
	3.1	Standard Deviation.
	3.2	Permutation.
	3.3	Combination.
	3.4	Variance.
4		**Bank Discount**
	4.1	Finding Future Value(FV).
	4.2	Finding Discount term and Discount rate.
	4.3	Credit and Loans.
5		**Profit and Loss**
	5.1	Percentage.
	5.2	Profit.
	5.3	Loss.

Modalities for conducting practical and practical Examination :

1. There will be one 4 hours practical session for each of batch of 15 students per week for each practical course.
2. A question bank consisting of 50 problems in all for each semester, will be the course work for this paper. Question bank will be prepared by the individual subject teacher and the problems included should be changed every year.
3. Each student will maintain a journal to be provided by the college.
4. The internal 20 marks will be given on the basis of journal prepared by student and the cumulative performance of student at practical.
5. External examiner shall be appointed by the college for Mathematics Practical Examination.
6. The duration of practical examination is 2 hours.
7. The practical examination will consist of written examination of 30 marks out of which theory Question paper will be of 25 marks and 5 marks oral examination.
8. The pattern for the practical written (Theory) examination will be as follows:

   - **Solve any 5 questions out of 8 questions.**
   - **Each question will be of 5 marks.**

9. Study tours may be arranged at places having important Mathematical institutes orhistorical places.

Special Instruction:
   a) Before starting each practical necessary introduction, basic definitions and prerequisites must be discussed.
   b) Examiners should set separate question papers, solutions and
      scheme of marking for each batch and claim the remuneration
      as per rule.

Progressive Education Society's

Modern college of Arts, Science and Commerce,

Ganeshkhind,Pune-16

Autonomous

NEP 2020 (2)

Department of Mathematics

(Under Faculty of Science and Technology)

S.Y.B.Sc.(Regular) : Major : Mathematics

Choice Based Credit System Syllabus

To be implemented from Academic Year 2025-2026

S.Y.B.Sc. (Regular) : Major : Mathematics

Semester	Paper Number	Paper Code	Title of the Paper	Theory (T) / Practical (P)	No. of Credits
3	I	24MAT23101	Multivariable Calculus	T	2
	II	24MAT23102	Graph Theory	T	2
	III	24MAT23103	Practical Course based on Multivariable Calculus and Graph Theory	P	2
4	I	24MAT24101	Linear Algebra	T	2
	II	24MAT24102	Numerical Analysis	T	2
	III	24MAT24103	Practical Course based on Linear Algebra and Numerical Analysis	P	2

Evaluation Pattern

Semester	Paper Number	Paper Code	Title of the Paper	CIE Marks	ESE Marks	Total Marks
3	I	24MAT23101	Multivariable Calculus	20	30	50
	II	24MAT23102	Graph Theory	20	30	50
	III	24MAT23103	Practical Course based on Multivariable Calculus and Graph Theory	20	30	50
4	I	24MAT24101	Linear Algebra	20	30	50
	II	24MAT24102	Numerical Analysis	20	30	50
	III	24MAT24103	Practical Course based on Linear Algebra and Numerical Analysis	20	30	50

CIE : Continuous Internal Evaluation   **ESE :** End Semester Examination

Syllabus for S.Y.B.Sc. (Mathematics) : Major

Academic Year : 2025-26

Semester – 3

Paper No. : I		Paper Code : 24MAT23101
Name of the Paper : Multivariable Calculus (Theory)		
Total No. of Credits : 2		**Total No. of lectures : 30**
Course Outcome		
CO	**Details**	
	Students will	
CO1	Learn functions of functions of several variables.	
CO2	Learn notions of Continuity and Differentiability of multivariable functions.	
CO3	Be able to find extreme values of multivariable functions using derivatives.	
CO4	Learn evaluation of double and triple integration.	

Details of Syllabus

Unit	Subunit	Content	No. of lectures
1		**Limits and Continuity**	**6**
	1.1	Functions of two and three variables.	
	1.2	Neighbourhoods	
	1.3	Limits of a function.	
	1.4	Continuity.	
2		**Partial Derivatives and Differentiability**	**10**
	2.1	Definition and examples.	
	2.2	Higher order Partial Derivatives , Clairaut's theorem (Without proof) , Schwartz's theorem (Without proof) ,Laplace equation , Wave equation	
	2.3	Chain rule , Differentiability and Differentials , Young's theorem(Without proof) , Homogeneous functions , Euler's theorem	
3		**Extreme Values**	**4**
	3.1	Extreme values of functions of two variables.	
	3.2	Necessary conditions for extreme values.	
	3.3	Second derivative test.	

Details of Syllabus			
Unit	**Subunit**	**Content**	**No. of lectures**
3		**Extreme Values**	
	3.4	Lagrange's Multipliers(with one constraints)	
4		**Multiple Integrals.**	**10**
	4.1	Double Integral , Double integrals over Regions.	
	4.2	Double integral in Polar coordinates.	
	4.3	Triple integrals , Triple integrals in spherical coordinates.	
	4.4	Jacobians , Change of variables in multiple integrals.(Results without proofs).	

Text book

Multivariable Calculus 7th Edition By James Stewart, Brooks/Cole, Cengage Learning, 2012, 2008.

   Unit 1:- Chapter 14: Sec- 14.1, 14.2

   Unit 2:- Chapter 14: Sec- 14.3(except the Cobb-Douglas production

          function) , 4.4 (except Tangent Planes and Linear Approximations)

     , Sec-14.5

   Unit 3:- Chapter 14: Sec 14.7, 14.8 (except two constraints)
   Unit 4:- Chapter 15: Sec 15.2, 15.3, 15.4, 15.7 (without Riemann sum and Application), 15.9, 15.10

Reference Books:

1. Basic Multivariable Calculus, J. E. Marsden, A. J. Tromba , A.

Weinstein, SpringerVerlag (Indian Edition).

2. Shanti Narayan, R.K. Mittal, A Text-book of Vector Calculus, S.Chand and Company.

3. D.V. Widder, Advanced Calculus (2nd Edition), Prentice Hall of India ,NewDelhi,(1944).

4. T.M. Apostol , Calculus Vol. II (2nd Edition), John Wiley, New York, (1967).

Paper No. : II	Paper Code : 24MAT23102
Name of the Paper : Graph Theory (Theory)	
Total No. of Credits : 2	**Total No. of lectures : 30**

Course Outcome	
CO	**Details**
	Students will
CO1	Learn basic concepts in Graph theory.
CO2	Develop the skill of converting mathematical problem graphically and vice versa.
CO3	Learn suitable techniques of analysis of problems.
CO4	Learn various tools for solving real life problems.
CO5	Develop a positive attitude towards mathematics as an interesting and valuable subject to study.

Details of Syllabus			
Unit	**Subunit**	**Content**	**No. of lectures**
1		**Introduction.**	**4**
	1.1	What is a Graph?	
	1.2	Application of Graphs.	
	1.3	Finite and Infinite Graphs.	
	1.4	Incidence and Degree.	
	1.5	Isolated Vertex, Pendant Vertex and Null Graph.	
2		**Paths and Circuits.**	**10**
	2.1	Isomorphism.	
	2.2	Subgraphs.	
	2.3	Walks, Paths, and Circuits.	
	2.4	Connected Graphs, Disconnected Graphs, and Components.	
	2.5	Euler Graphs.	
	2.6	Operations on Graphs.	
	2.7	More on Euler Graphs.	
	2.8	Hamiltonian Paths and Circuits.	
	2.9	The Traveling Salesman Problem.	
3		**Trees and Fundamental Circuits.**	**10**
	3.1	Trees.	
	3.2	Some Properties of Trees.	
	3.3	Pendant Vertices in a Tree.	

Details of Syllabus			
Unit	**Subunit**	**Content**	**No. of lectures**
3		**Trees and Fundamental Circuits.**	
	3.4	Distance and Canters in a Tree.	
	3.5	Rooted and Binary Trees.	
	3.6	Spanning Trees.	
	3.7	Fundamental Circuits.	
	3.8	Spanning Trees in a Weighted Graph.	
4		**Cut-Sets and Cut-Vertices.**	**6**
	4.1	Cut-Sets.	
	4.2	Some Properties of a Cut-Set.	
	4.3	Fundamental Circuits and Cut-Sets.	

Recommended Book

Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science"Printice-Hall, of India Pvt. Lt. New Delhi.

Unit 1 : Chapter 1: Sec.1.1 to 1.5

Unit 2: Chapter 2: Sec. 2.1 to 2.10 (Excluding 2.3)

Unit 3: Chapter 3: Sec. 3.1 to 3.10 (Excluding 3.9)

Unit 4: Chapter 4 : Sec. 4.1 to 4.5

Reference books

1. John Clark and Derek Holton, A First Look at Graph Theory (Allied Publishers)
2. Robin J. Wilson, Introduction to Graph Theory, Fourth Edition (low price edition)
3. Introduction to Graph Theory, Douglas West 2nd edition.
4. A Textbook of Graph Theory, Balakrishnan, R., Ranganathan, K.

Paper No. : III	Paper Code : 24MAT23103
Name of the Paper : Practical Course based on Multivariable Calculus and Graph Theory (Practical)	
Total No. of Credits : 2	**Total No. of Practical : 15**
List of Practical	
Practical 1.	Problems on Unit 1 (Written) from 24MAT23101
Practical 2.	Problems on Unit 2 (Written) from 24MAT23101
Practical 3.	Problems on Unit 1 and Unit 2 (Written) from 24MAT23101
Practical 4.	Problems on Unit 3 (Written) from 24MAT23101
Practical 5.	Problems on Unit 4 (Written) from 24MAT23101
Practical 6.	Problems on Unit 3 and Unit 4 (Written) from 24MAT23101
Practical 7.	Applications based on 24MAT23101 using Mathematical software.
Practical 8.	Problems on Unit 1 (Written) from 24MAT23102
Practical 9.	Problems on Unit 2 (Written) from 24MAT23102
Practical 10.	Problems on Unit 1 and Unit 2 (Written) from 24MAT23102
Practical 11.	Problems on Unit 3 (Written) from 24MAT23102
Practical 12.	Problems on Unit 4 (Written) from 24MAT23102
Practical 13.	Problems on Unit 3 and Unit 4 (Written) from 24MAT23102
Practical 14.	Applications based on 24MAT23102 using Mathematical software.
Practical 15.	Miscellaneous.

Semester – 4

Paper No. : I	Paper Code : 24MAT24101
Name of the Paper : Linear Algebra (Theory)	
Total No. of Credits : 2	**Total No. of lectures : 30**
Course Outcome	
CO	**Details**
	Students
CO1	Will be able to formulate , solve and interpret properties of linear systems.

Course Outcome	
CO2	Gets introduced to the concepts of vector space which is used in other pure mathematical subjects and engineering.
CO3	Will be able to identify the subspaces of a given vector space.
CO4	Will learn the importance and applications of linear transformation.
CO5	Will get well equipped with Mathematical Modelling abilities.
Details of Syllabus	

Unit	Subunit	Content	No. of lectures
1		**Matrices and System of Linear Equations.**	**8**
	1.1	Row echelon form of a matrix, reduced row echelon form of a matrix.	
	1.2	Definition of rank of a matrix using row echelon or row reduced echelon form.	
	1.3	System of linear equations- Introduction, matrix form of linear system, definition of row equivalent matrices.	
	1.4	Consistency of homogeneous and non-homogeneous system of linear equations using rank, condition for consistency.	
	1.5	Solution of System of Equations: Gauss elimination and Gauss-Jordan elimination method, examples.	
2		**Vector Spaces-I.**	**8**
	2.1	Definition and Examples.	
	2.2	Subspaces.	
	2.3	Linear Dependence and Independence.	
	2.4	Basis of Vector Space.	
3		**Vector Spaces-II.**	**4**
	3.1	Dimension of a Vector Space.	
	3.2	Row, Column and Null Space of a matrix.	
	3.3	Rank and nullity.	

Details of Syllabus			
Unit	Subunit	Content	No. of lectures
4		**Linear Transformations.**	**10**
	4.1	Definition and Examples, Properties, Equality.	
	4.2	Kernel and range of a linear Transformation.	
	4.3	Rank-Nullity theorem.	
	4.4	Composite and Inverse Transformation.	
	4.5	Matrices and Linear Transformation.	
	4.6	Basic Matrix Transformations in R^2 and R^3	
	4.7	Linear Isomorphism.	

Text Book

Howard Anton, Chris Rorres, Elementary Linear Algebra, Application Version, NinthEdition, Wiley, 11th edition.

Unit-1: Chapter-1: Sec. 1.1, 1.2. , Unit-2: Chapter- Sec. 4: 4.1 to 4.4.

Unit-3: Chapter- Sec. 4: 4.5, 4.7, 4.8 , Unit- 4: Chapter- Sec.8: 8.1 to 8.4, 1.8, 4.9.

Reference Books

(**1**) K. Hoffman and R. Kunze, Linear Algebra, 2nd edition(2014), Prentice Hall of India, NewDelhi

(**2**) Steven J. Leon, Linear Algebra with Applications, 4th edition(1994), Prentice Hall ofIndia. New Delhi

(**3**) Vivek Sahai, Vikas Bist, Linear Algebra, 4th Reprint 2017, Narosa Publishing House, NewDelhi

(**4**) Promode Kumar Saikia, Linear Algebra, 2009, Pearson, Delhi

(**5**) S. Lang, Introduction to Linear Algebra, 2nd edition,1986, Springer-Verlag, New York,Inc.

Paper No. : II	Paper Code : 24MAT24102
Name of the Paper : Numerical Analysis (Theory)	
Total No. of Credits : 2	**Total No. of lectures : 30**

Course Outcome	
CO	**Details**
CO1	Problem solving skills of students are enhanced.
CO2	Students learn how to apply mathematical concepts to practical and real life problems.
CO3	The problems which cannot be solved by usual formulae and methods can be solved approximately by using numerical techniques.
CO4	Student will be able to solve the integration problems which cannot be solved by usual formulae and methods using numerical techniques.

Details of Syllabus			
Unit	**Subunit**	**Content**	**No. of lectures**
1		**Solution of Algebraic and Transcendental Equations.**	**10**
	1.1	Errors and their computations.	
	1.2	Bisection method.	
	1.3	The method of False position.	
	1.4	Newton- Raphson method.	
2		**Interpolation.**	**10**
	2.1	Finite Difference Operators and their relations (Forward, Backwarddifference and Shift operator).	
	2.2	Differences of a polynomial.	
	2.3	Newton's Interpolation Formulae : Forward and Backward (Without proof).	
	2.4	Lagrange's Interpolation Formula (Without proof).	
3		**Numerical Differentiation and Integration.** **(Only Examples)**	**5**
	3.1	Numerical Differentiation (Derivatives using Newton's forward difference formula).	
	3.2	Numerical Integration, General quadrature formula.	
	3.3	Trapezoidal rule.	
	3.4	Simpsons's 1/3rd rule.	
	3.5	Simpsons's 3/8th rule.	

Details of Syllabus			
Unit	**Subunit**	**Content**	**No. of lectures**
4		**Numerical solution of first order ordinary differential equations (Only Examples)**	**5**
	4.1	Taylor's Series method.	
	4.2	Picard's method of successive approximations.	
	4.3	Euler's method.	
	4.4	Modified Euler's methods.	
	4.5	Runge - Kutta Methods.	

Text book

1. S.S. Sastry, Introductory Methods of Numerical Analysis, 5th edition, Prentice Hall ofndia.

Unit 1: Chapter 1: section 1.3, Chapter 2: section 2.2, 2.3, 2.5
Unit 2: Chapter 3: section 3.3, 3.5, 3.6, 3.9(3.9.1 only)
Unit 3: Chapter 4: section 6.2 (excluding 6.2.1 to 6.2.3), 6.4
Unit 4: Chapter 5: section 8.2, 8.3, 8.4 (excluding 8.4.1).

Reference Books

1. C.F. Gerald and O.P. Wheatley, Applied Numerical Analysis,

    Addison Wesley; 7thedition (2003).

2. K.E. Atkinson; An Introduction to Numerical Analysis, Wiley Publications.
3. T. Sauer, Numerical analysis, 3rd edition, Pearson.
4. M. K. Jain, SRK Iyengar and R.K. Jain, Numerical Methods For

    Scientific & Engg 5e,New Age International (P) Ltd (2008).

Paper No. : III	Paper Code : 24MAT24103
Name of the Paper : Practical Course based on Linear Algebra and Numerical Analysis (Practical)	
Total No. of Credits : 2	**Total No. of Practical : 15**
List of Practical	
Practical 1.	Problems on Unit 1 (Written) from 24MAT24101
Practical 2.	Problems on Unit 2 (Written) from 24MAT24101
Practical 3.	Problems on Unit 1 and Unit 2 (Written) from 24MAT24101

List of Practical	
Practical 4.	Problems on Unit 3 (Written) from 24MAT24101
Practical 5.	Problems on Unit 4 (Written) from 24MAT24101
Practical 6.	Problems on Unit 3 and Unit 4 (Written) from 24MAT24101
Practical 7.	Applications based on 24MAT24101 using Mathematical software.
Practical 8.	Problems on Unit 1 (Written) from 24MAT24102
Practical 9.	Problems on Unit 2 (Written) from 24MAT24102
Practical 10.	Problems on Unit 1 and Unit 2 (Written) from 24MAT24102
Practical 11.	Problems on Unit 3 (Written) from 24MAT24102
Practical 12.	Problems on Unit 4 (Written) from 24MAT24102
Practical 13.	Problems on Unit 3 and Unit 4 (Written) from 24MAT24102
Practical 14.	Applications based on 24MAT24102 using Mathematical software.
Practical 15.	Miscellaneous.

Modalities for conducting practical and practical Examination :

1. There will be one 4 hours practical session for each of batch of 15 students per week for each practical course.

2. A question bank consisting of 50 problems in all for each semester, will be the course work for this paper. Question bank will be prepared by the individual subject teacher and the problems included should be changed every year.

3. Each student will maintain a journal to be provided by the college.

4. The internal 20 marks will be given on the basis of journal prepared by student and the cumulative performance of student at practical.

5. External examiner shall be appointed by the college for Mathematics Practical Examination.

6. The duration of practical examination is 2 hours.

7. The practical examination will consist of written examination of 30 marks out of which theory Question paper will be of 25 marks and 5 marks oral examination.

8. The pattern for the practical written (Theory) examination will be as follows:

- **Solve any 5 questions out of 8 questions.**
- **Each question will be of 5 marks.**

9. Study tours may be arranged at places having important Mathematical institutes orhistorical places.

Special Instruction:
  a) Before starting each practical necessary introduction, basic definitions and prerequisites must be discussed.
  b) Examiners should set separate question papers, solutions and

  scheme of marking for each batch and claim the remuneration

  as per rule.

Progressive Education Society's

Modern college of Arts, Science and Commerce,

Ganeshkhind,Pune-16

Autonomous

NEP 2020 (2)

Department of Mathematics

(Under Faculty of Science and Technology)

S.Y.B.Sc.(Regular)

Vocational and Skill Enhancement Courses (VSEC)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2025-2026

S.Y.B.Sc.(Regular)

Vocational and Skill Enhancement Courses (VSEC)

Course Structure

Semester	Paper Code	Title of the Paper	Theory (T) / Practical (P)	No. of Credits
3	24MAT23108	Introduction to C Programming.	P	2
4	24MAT24107	Mathematical Techniques using C Programming.	P	2

Evaluation Pattern

Semester	Paper Code	Title of the Paper	CIE Marks	ESE Marks	Total Marks
3	24MAT23108	Introduction to C Programming.	20	30	50
4	24MAT24107	Mathematical Techniques using C Programming.	20	30	50

CIE : Continuous Internal Evaluation   **ESE :** End Semester Examination

Semester - 3

Paper Code : 24MAT23108	
Name of the Paper : Introduction to C Programming. (Practical)	
Total No. of Credits : 2	**Total No. of Practical : 15**
List of Practical	
Practical 1.	Introduction to Computing, Art of Programming through Algorithms and Flowcharts.

List of Practical	
Practical 2.	History and importance of C, Basic structure of C program, executing a C program. Constants, Variable and Data Types: Introduction, Character Set, C Tokens, Keywords and Identifiers, Constants, Variables, Data Types, Declaration of Variables, Assigning Values to Variables, Defining Symbolic Constants.
Practical 3.	Managing Input and Output Operations: Reading a Character, Writing a Character, Formatted Input, Formatted Output. (Chapter 5) Operators and Expressions: Introduction, Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operator, Bitwise Operators, Special Operators, Arithmetic Expressions, Evaluation of Expressions, Precedence of Arithmetic Operators, Type Conversions in Expressions, Operator Precedence and Associativity.
Practical 4. **Practical 5.** **Practical 6.**	Decision Making and Branching: Introduction, Decision Making with IF Statement, Simple IF Statement, the IF-ELSE Statement, Nesting of IF-ELSE Statements, The ELSE IF Ladder, The Switch statement, The ? : Operator, The goto statement. Decision Making and Looping: Introduction, The while Statement, The do statement, The for statement, Jumps in LOOPS.
Practical 7. **Practical 8.**	Arrays: One-dimensional Arrays, Declaration of One-dimensional Arrays, Initialization of One-dimensional Arrays, Example programs- Bubble sort, Selection sort, Linear search, Binary search, Two-dimensional Arrays, Declaration of Two-dimensional Arrays, Initialization of Two-dimensional Arrays, Example programs-Matrix Multiplication, Transpose of a matrix.

List of Practical	
Practical 9. **Practical 10.**	Character Arrays and Strings: Declaring and Initializing String Variables, Reading Strings from Terminal, Writing Strings to Screen, Arithmetic Operations on Characters, String-handling Functions, Example Programs (with and without using built-in string functions).
Practical 11. **Practical 12.**	User-defined Functions: Need for functions, Elements of User-defined Functions, Definition of Functions, Return Values and their Types, Function Calls, Function Declaration, Category of Functions, No Arguments and no Return Values, Arguments but no Return values, Arguments with Return Values, No Arguments but Returns a Value, Passing Arrays to Functions, Recursion, The Scope, Visibility and Lifetime of variables.
Practical 13.	Pointers: Introduction, Declaring Pointer Variables, Initialization of Pointer variables, accessing a Variable through its Pointer, Pointer Expressions, Pointer Increments and Scale Factor.
Practical 14. **Practical 15.**	Miscellaneous.

Reference Books

1) E. Balguruswamy, "Programming in ANSI C " 8th edition , 2019, McGraw Hill Education, ISBN:978-93-5316-513

2) "Let us C" , Yashwant Kanetkar, 18th Edition

Semester - 4

Paper Code : 24MAT24107	
Name of the Paper : Mathematical Techniques using C Programming. **(Practical)**	
Total No. of Credits : 2	**Total No. of Practical : 15**
List of Practical	
Practical 1. **Practical 2.** **Practical 3.**	Structures: Introduction, Defining a structure, declaring structure variables, accessing structure members, structure initialization, array of structures. File Management in C: Introduction, Defining and opening a file, closing a file, Input/output and Error Handling on Files.
Practical 4. **Practical 5.**	Fermat's theorem to find remainder. Finding gcd and lcm of two numbers. Finding area of given convex polygon.
Practical 6. **Practical 7.** **Practical 8.**	Given set of two dimensional points, find pair/s of points which are farthest apart Given set of two dimensional points, find pair/s of points which are nearest apart Given set of two dimensional points, find nearest neighbour of each point.
Practical 9. **Practical 10.** **Practical 11.**	Solutions of nonlinear equations: bisection method, Regula Falsi method, Newton Raphson method. Numerical integration: trapezoidal rule, Simpsn's $1/3^{rd}$ rule, Simpson's $3/8^{th}$ rule.
Practical 12. **Practical 13.**	Interpolation: Newton's forward difference formula, Newton's Backward difference formula, Lagrange Interpolation.
Practical 14.	Euler Method
Practical 15.	Runge Kutta method.

Modalities for conducting practical and practical Examination :

1. There will be one 4 hours practical session for each of batch of 15 students per week for each practical course.

2. A question bank consisting of 50 problems in all for each semester, will be the course work for this paper. Question bank will be prepared by the individual subject teacher and the problems included should be changed every year.

3. Each student will maintain a journal to be provided by the college.

4. The internal 20 marks will be given on the basis of journal prepared by student and the cumulative performance of student at practical.

5. External examiner shall be appointed by the college for Mathematics Practical Examination.

6. The duration of practical examination is 2 hours.

7. The practical examination will consist of written examination of 30 marks out of which theory Question paper will be of 25 marks and 5 marks oral examination.

8. The pattern for the practical written (Theory) examination will be as follows:

   - **Solve any 5 questions out of 8 questions.**
   - **Each question will be of 5 marks.**

9. Study tours may be arranged at places having important Mathematical institutes orhistorical places.

Special Instruction:
   a) Before starting each practical necessary introduction, basic definitions and prerequisites must be discussed.
   b) Examiners should set separate question papers, solutions and

   scheme of marking for each batch and claim the remuneration

   as per rule.

Progressive Education Society's

Modern College of Arts, Science & Commerce, Ganeshkhind, Pune-16

(An Autonomous College Affiliated to Savitribai Phule Pune University)

Framework of Syllabus

S.Y.B.Sc. Microbiology

Under NEP version II

(To be implemented from 2025-2026)

<div align="center">

Title of the Course: B. Sc. (Microbiology)

</div>

Preamble:

Microbiology is a broad discipline of biology involving study of five types of microorganisms i.e., bacteria, protozoa, algae, fungi and viruses. It deals with the interaction of microorganisms with each other and with plants, animals and the environment. Microorganisms were discovered over three fifty years ago and it is thought that a huge diversity still remains to be explored. Since the inception of microbiology as a branch of science, it has remained an ever-expanding field of active research, broadly categorized as pure and applied science.

Knowledge of different aspects of Microbiology has become crucial and indispensable to society. Microbes can be harnessed for human welfare. They find applications in the fields such as nanotechnology, genetic engineering, pharmaceutical, fermentation, food and agriculture industries and as study models. Some microorganisms cause important diseases of plants and animals including humans. Microbiologists play a significant role in diagnosis, prevention and control of these diseases. There is a continuous demand for microbiologists as a work force in the fields of education, industry and research. Career opportunities for the graduate students are available in industry and research equally.

Introduction:

In the post globalization world higher education has to play a significant role in creation of skilled human resources for the well-being of humanity. The barriers among the academic fields seem to have dissolved. However, the disparities in the field of curriculum aspect, evaluation and mobility exist. With the changing scenario at local and global level, the syllabus restructuring should keep pace with developments in the education sector. The National education policy aims to incorporate interdisciplinary approach to insure overall development of students. NEP is being adopted and implemented to address the issues related to traditional systems and it also aims to maintain the best of earlier curriculum. It caters skill based education where the graduate attributes are first kept in mind to reverse-design the programs, courses and supplementary activities to attain the graduate attributes and learning attributes. The learning outcomes-based curriculum framework for a degree in **B.Sc. (Honours) Microbiology** is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. Effort has been made to integrate use of recent technology and use of MOOCs to assist teaching-learning process among students. The present curriculum focuses on students' needs, skill development, interdisciplinary approach to learning and enhancing employability. The college provides an environment for the overall development of students into responsible citizens with multi-dimensional personalities by inculcating among students a blend of scientific insights, compassionate and progressive attitude, cultural awareness, and time-tested traditional values.

Microbiology curricula are offered at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart basic knowledge of the respective subject from all possible angles. In addition, students are to be trained to apply this knowledge in day-to-day applications and to get a glimpse of research.

Programme outcomes after completing B. Sc. Students are expected to develop

Knowledge Outcomes:

PO1: Demonstrate and apply the fundamental knowledge of the basic principles in the fields of Microbiology

PO2: Create awareness and sense of responsibilities towards environment and apply knowledge to solve the issues related to Environmental pollution.

PO3: Apply fundamental knowledge for doing qualitative and quantitative analyses in various fields.

Skill Outcomes:

PO4: Collaborate effectively on team-oriented projects in the field of sciences.

PO5: Communicate scientific information in a clear and concise manner both orally and in writing

PO6: Explain environmental pollution issues and the remedies thereof.

PO7: Apply the knowledge to develop the sustainable and eco-friendly technology in Industry. **Generic Outcomes:**

PO10: Ability of critical reasoning and judgment.

PO11: Acquired a basic knowledge and skillset for becoming employable.

PO12: Will enhance the scientific temper so as to develop a research interest.

Objectives to be achieved:

- To enrich students' knowledge and train them in the pure microbial sciences.
- To introduce the concepts of application and research in Microbiology.
- To inculcate a sense of scientific responsibilities and social and environment awareness.
- To help students build-up a progressive and successful career.

Course Structure:

The structure of the Three/Four-year bachelor's degree programme allows the opportunity to the students to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices and the feasibility of exploring learning in different institutions. The minimum and maximum credit structure for different levels under the Three/Four -year UG Programme with multiple entry and multiple exit options are as given below:

Levels	Qualification	Credit Requirements		Semester	Year
		Minimum	**Maximum**		
4.5	UG certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Year Bachelor's Degree	120	132	6	3
6.0	Bachelor's Degree-Honours	160	176	8	4

The programs are flexible enough to allow liberty to students in designing them according to their requirements. Students may choose a single Major, one Major with a Minor, and one Major with two Minors.

Medium of Instruction: English

Award of Credits:

- Each course having 4 credits shall be evaluated out of 100 marks and student should secure at least 40 marks to earn full credits of that course.

- Each course having 2 credits shall be evaluated out of 50 marks and student should secure at least 20 marks to earn full credits of that course.

- GPA shall be calculated based on the marks obtained in the respective subject, provided that student should have obtained credits for that course.

Evaluation Pattern:

- Each course carrying 100 marks shall be evaluated with Continuous Assessment (CA) and End Semester Evaluation (ESE) mechanism.
- Continuous assessment shall be of 40 marks for theory and practical course. The End Semester Evaluation (ESE) shall be of 60 marks for theory and practical course. To pass in a course, a student has to secure a total of minimum 40 marks provided that he should secure minimum 24 marks in (ESE)
- Each course carrying 50 marks shall be evaluated with Continuous Assessment (CA) and End Semester Evaluation (ESE) mechanism.
- Continuous assessment shall be of 20 marks while ESE shall be of 30 marks.
- To pass in a course, a student has to secure a total of minimum 20 marks provided that he/she should secure minimum12 marks in University Evaluation (UE).
- For Internal examination minimum two tests per paper of which one has to be a written test of 10 marks.
- Methods of assessment for Internal exams: Seminars, Viva-voce, Projects, Surveys, Field visits, Tutorials, Assignment, Group Discussion, open book test etc (on approval of the head of the centre)

ATKT Rules:

- Minimum number of credits required to take admission to Second Year of B. Sc.: 22
- Minimum number of credits required to take admission to Third Year of B.Sc.: 44

Completion of Degree Course:

- A student who earns 140 credits, shall be considered to have completed the requirements of the B. Sc. degree program and CGPA will be calculated for such student.

F. Y. B.Sc. Microbiology Titles of Papers and Scheme of Study Evaluation

Semester I

Code	Course title	Credits	Hours/ week	CIA	ESE	Total
Disciplinary Major Mandatory						
24MIC11101	Introduction to Microbiology 2(Cr)(T)	2	02	20	30	50
24MIC11102	Practical based on Introduction to Microbiology 2(Cr)(P)	2	04	20	30	50
OE (For Arts and Commerce faculty)						
24MIC11303	Microbiology in day to day life 2(Cr)(T)	2	02	20	30	50
SEC						
24MIC11404	Good laboratory practices 2(Cr)(P)	2	04	20	30	50

Semester II

Code	Course title	Credits	Hours/week	CIA	ESE	Total
Disciplinary Major Mandatory						
24MIC12101	Microbial biochemistry and growth 2(Cr)(T)	2	02	20	30	50
24MIC12102	Practical based on Microbial biochemistry and growth 2(Cr)(P)	2	04	20	30	50
OE (For Arts and Commerce faculty)						
24MIC12303	Practical based on Microbiology in day to day life 2(Cr)(P)	2	04	20	30	50
SEC						
24MIC12404	Basic Laboratory Skills 2(Cr)(P)	2	04	20	30	50

S. Y. B.Sc. Microbiology Titles of Papers and Scheme of Study Evaluation

Semester III

Semester	Code	Course title	Credits	Hours/week	CIA	UE	Total
	Disciplinary Major Mandatory						
III	24MIC23101	Bacterial physiology and Agricultural Microbiology (T)	2	02	20	30	50

	24MIC23102	Environmental Microbiology (T)	2	02	20	30	50
	24MIC23103	Practical based on Bacterial physiology and Agricultural Microbiology and Environmental Microbiology	2	04	20	30	50
	24MIC23104	Indian Traditional Microbiology knowledge system (T)	2	02	20	30	50
Minor
	24MIC23205	Microbial ecology (T)	2	02	20	30	50
	24MIC23206	Practical based on Microbial ecology	2	04	20	30	50
OE (For Arts and Commerce faculty)
	24MIC23307	Human Health and Diseases (T)	2	02	20	30	50
VSEC and FP
	24MIC23408	Cultivation of Microorganisms and Special staining techniques (P)	2	04	20	30	50
	24MIC23409	Field Project (P)	2	04	20	30	50

S.Y. B.Sc. Microbiology Semester IV

Semester	Code	Course title	Credits	Hours/week	CIA	UE	Total
IV	**Disciplinary Major Mandatory**						
	24MIC24101	Bacterial Genetics (T)	2	02	20	30	50
	24MIC24102	Industrial Microbiology (T)	2	02	20	30	50
	24MIC24103	Food and Dairy Microbiology (T)	2	02	20	30	50
	24MIC24104	Practicals based on Bacterial genetics, Industrial Microbiology, Food and dairy microbiology	2	04	20	30	50
	Minor						
	24MIC24205	Introduction to Industrial Microbiology (T)	2	02	20	30	50
	24MIC24206	Practical based on Introduction to Industrial Microbiology	2	04	20	30	50
	OE (For Arts and Commerce faculty)						
	24MIC24307	Practicals based on Human health and diseases	2	04	20	30	50
	SEC and CEP						
	24MIC24408	Advancements in Sustainable Agriculture: Production of	2	04	20	30	50

8

		Biofertilizers, Biopesticides, and Nanoparticle Biosynthesis. 2(Cr)(P)					
	24MIC24409	CEP (P)	2	04	20	30	50

Semester III
Major
24MIC23101: Bacterial physiology and Agricultural Microbiology
[2 Credits; 30 Lectures] [1 credit=15 lectures x 60 mins]

Course Outcomes

After learning this course students will be able to -

CO1: Explain various systems of bacterial classification.

CO2: Describe the components of holoenzyme, nomenclature and classification of enzymes, models of catalysis and effect of various parameters on enzymes.
CO3: Explain various glucose metabolic pathways with details such as structures and names of metabolites, names of enzymes and cofactors
CO4: Discuss plant growth improvement with respect to disease resistance, environment tolerance.
CO5: Correlate stages of plant disease development, epidemiology, symptoms based classification, control methods.
CO6: Elaborate the importance of microorganisms in sustainable agriculture

Unit No.	Topic	No. of lectures
Unit I	**Bacterial systematics**	2
	Nomenclature and Classification of Microorganisms: a. Binomial Nomenclature b. Whittaker's five kingdom system c. Carl Woese's three domain classification based on 16S rRNA	
Unit II	**Bacterial physiology**	13
1	**Enzymes** i. Introduction to Enzymes: Properties of enzymes, Nature of active site, Structure of active site, commonly occurring amino acids at active site. Ribozymes, coenzymes, apoenzymes, prosthetic group and cofactors. ii. Nomenclature and classification as per IUB (up to class level). iii. Models for catalysis– a) Lock and key b) Induced fit c) Transition state. iv. Effect of pH and temperature, substrate concentration, activators and inhibitors on enzyme catalyzed reactions.	6

2	i. Definitions of Metabolism, catabolism, anabolism, respiration and fermentation ii. Metabolic pathways (with structures) a) Embden-Meyerhof-Parnas pathway (Glycolysis). Entry of fructose and lactose in glycolysis. Substrate level phosphorylation. b) Hexose monophosphate pathway c) Entner-Doudoroff pathway d) Phosphoketolase pathway (Hexose) e) TCA cycle (with emphasis on amphibolism) and Glyoxylate bypass	7
Unit III	**Agricultural Microbiology**	**15**

	1. **Plant growth improvement and Stages in development of a disease**
	
	   a. Plant growth improvement with respect to disease resistance
	
	   b. Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogens and perennation
		3

	2. **Classification of disease based on symptoms** with one example of each. Citrus Canker. Concepts of monocyclic, polycyclic and polyetic diseases. Disease triangle.	3

	3. **Methods of plant disease control**
	
	   a. Eradication
	
	   b. Chemical control
	
	   c. Biological control (employing bacterial and fungal cultures)
	
	   d. Integrated pest management
	
	   e. Genetic engineering for disease resistant plants -RNAi, BT crops.
		6

	4. **Role of microorganisms in plant nutrition and growth**
	   i. Mechanism of diazotrophy,
	   ii. Phosphate solubilization,
	   iii. Potassium mobilization
	   iv. Micronutrient availability
		3

References:
1. Arora D. K. (Editor). (2003). Fungal Biotechnology in Agriculture, Food and Environmental Applications (Mycology). CRC Press. ISBN 9780824747701.
2. Bahadur B., Venkat rajam M., Sahijram L. and Krishnamurthy K.V. (2012). Plant Biology and Biotechnology. Vol II: Plant Genomics and Biotechnology. Springer Publications.
3. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part A: Introductory Essays. Garrity G. editor. Springer. ISBN 978-0- 387-24143-2
4. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part B: The Gammaproteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24144-9
5. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part C: The Proteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24145-6

6. Bergey's Manual of Systematic Bacteriology. (2009). Volume Three: The Firmicutes. Part C: The Proteobacteria. Vos, P., Garrity, G., Jones, D., Krieg, N.R., Ludwig, W., Rainey, F.A., Schleifer, K.-H., Whitman, W. (Eds.). Springer. ISBN 978-0-387-

7. Conn E. E., Stumpf P. K., Bruening G., Doi R. Y. (1987). Outlines of Biochemistry. 5th Edition, John Wiley and Sons, New Delhi. (Unit I & II)

8. Dube. H.C. and Bilgrami. K. S. (1976). Text book of modern pathology. Vikas Publishing House. New Delhi.

9. George N. Agrios. Plant pathology. Fifth Edition

10. Husain F. H. and Ahmad I. (2017). Biofilms in Plant and Soil Health. Germany: Wiley. ISBN: 9781119246374

11. Johnson D. V., Al-Khayri J. M. and Jain S. M. (2016). Advances in Plant Breeding Strategies: Breeding, Biotechnology and Molecular Tools. Germany: Springer International Publishing. ISBN: 9783319225210,

12. Jones D. J. (Editor). (2013). The Epidemiology of Plant Diseases. Netherlands: Springer Netherlands. ISBN: 9789401733021

13. Jones J. B., Jr. (2012). Plant Nutrition and Soil fertility. Manual 2nd Edition. CRC Press. ISBN-13:978-1-4398-1610-3 (ebook-pdf)

14. Kashyap P. L., Srivastava A. K. and Srivastava M. (2021). The Plant Microbiome in Sustainable Agriculture. United Kingdom: Wiley. ISBN: 9781119505167

15. Lakshamana V., Selvaraj G.and Bais H. P. (2021). Functional Soil Microbiome: below Ground solutions to above ground problems, https://plantphysiol.org.

16. Martin Alexander. (1962). Introduction to Soil Microbiology. John Wiley and Sons. Inc. New York.

17. Mehrotra R. S. (1994). Plant Pathology. Tata McGraw-Hill Limited.

18. Moat A. G. and Foster J. W. (1988). Microbial Physiology. 2nd Edition. John Wiley and Sons New York.

19. Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry. 8th edition, W.H. Freeman and Company. ISBN: 978-1-319-22800-2

20. Peter K. (2018). Genetic Engineering of Horticultural Crops. United Kingdom: Elsevier Science. ISBN: 9780128104408

21. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Private Limited., New Delhi.

22. Singh R. S. (1998). Plant Diseases Management. 7th edition. Oxford and IBH, New Delhi.

23. Stewart C. N. (2008). Plant Biotechnology and Genetics: Principles, techniques and applications. John Wiley and Sons. Inc. New York.

24. Thind B. (2019). Phytopathogenic Bacteria and Plant Diseases. United Kingdom: CRC Press. ISBN: 9780429512506

25. Voet D. and Voet J. G. (1995). Biochemistry. 2nd Edition. John Wiley &sons. New York. ISBN 0-471-58651-X

Major

24MIC23102: Environmental Microbiology

[2 Credits; 30 Lectures] [1 credit=15 Lectures x 60 mins]

Course Outcomes:
After learning this course students will be able to -

CO1: Describe habitats of microorganisms and microbial interactions.
CO2: Draw carbon and nitrogen cycles and explain role of microorganisms.
CO3: Explain fresh water microbiology and test potability of water.
CO4: Describe management of solid and liquid waste.

Unit No.	Topics	No. of Lectures
1	**Microorganisms and their Habitats** Terrestrial Environment: Soil profile and soil microflora, rhizosphere, role of rhizosphere microorganisms Microbial succession in decomposition of plant organic matter, Humus and humus formation Aquatic Environment: Microflora of fresh water and marine habitats Atmosphere: Aeromicroflora and dispersal of microbes	5
2	**Microbial Interactions** Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non symbiotic interactions Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria	6
3	**Biogeochemical Cycling** Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction	3
4	**Waste Management** Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment	10
5	**Water Potability** Treatment and safety of drinking (potable) water, CPCB and WHO guidelines for bacteriological standards of water potability, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique, Indicators of fecal contamination of water and their significance.	6

References:

1. Aithal S. C. and Kulkarni N. S. (2015). Water microbiology ~ an Indian perspective. Published by Himalaya Publishing House, IstEdition. ISBN: No.: 978-93-5202-129-1.
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition.
3. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA.Benjamin/Cummings Science Publishing, USA
4. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
5. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
6. Dubey H. C. and Bilgrami K. S. (1976). Textbook of modern pathology. Vikas publishinghouse. New Delhi.
7. Dubey R. C. and Maheswari D.K. Textbook of Microbiology. S. Chand Publishing. ISBN:9788121926201
8. Frobisher M. (1974). Fundamentals of Microbiology. 9th Edition. Saunders, MichiganUniversity Press. ISBN: 9780721639222
9. Ingraham C. A. and Ingraham J. L. (2000). Introduction to Microbiology. United Kingdom:Brooks/Cole.
10. Lim D. V. (1989). Microbiology. 2nd Edition. West Publishing Company. ISBN:9780314262066
11. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial
12. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition.
13. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
14. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc.NewYork & London.
15. MPCB, CPCB, BIS and WHO websites guidelines for drinking water quality New York
16. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer,
17. Pawar C. B. and Daginawala H.F. (1982). General Microbiology. Vol. I and II. 1st Edition.Himalaya Publishing House, Mumbai. ISBN: 9789350240892and ISBN9789350240908
18. Pelzar M. J., Chan E. C. S. and KriegN. R. (1986). Microbiology. 5th Edition. McGraw-HillPublication
19. Prescott L. M., Harley J. P. and Klein D. A. (2006). Microbiology. 6th Edition. McGraw Hill Publication
20. Salle A. J. (1971). Fundamental Principles of Bacteriology.7th Edition. Tata MacGraw Publishing Co.
21. Schlegel H. G. (1993). General Microbiology. 8thEdition. Cambridge University Press
22. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave MacmillanLimited.
23. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press,
24. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
25. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An introduction 12thEdition, Pearson. ISBN-13: 9780321929150

Major

24MIC23103: Practical Course based on
24MIC23101: Bacterial Physiology and Agricultural Microbiology
And
24MIC23102: Environmental Microbiology

[2 Credits: 60 hours]

12 Practicals = 60 hours

COURSE OUTCOMES:

After learning this course students will be able to -

CO1: Isolate and identify soil bacteria and characterize them by Gram staining, motility, cultural and biochemical tests

CO2: Study PGPR activity of *Azotobacter* and *Rhizobium* and prepare a bioinoculant.
CO3: Estimate the diversity of microorganism in air by statistical analysis.
CO4: Determine potability of drinking water using MPN test and membrane filtration technique.

CO5: Determine BOD of wastewater

Expt. No.	Topics	No. of Practicals
1	Enzyme detection – Gelatinase, Catalase, Oxidase	2
2	Isolation and identification of bacteria from rhizosphere (Characterization of rhizosphere bacteria- Pseudomonas and *Bacillus*) : Tests for Biochemical characterization of bacteria a. Gram staining & motility, b. Cultural and Biochemical characteristics i. Sugar utilization test, ii. Sugar fermentation test, iii. Triple Sugar iron agar, Oxidative-fermentative test [Baird Parker's modification of Hugh and Leifson's oxidative- fermentative (OF) basal medium for Gram Positive and Hugh and Leifson's oxidative- fermentative (OF) basal medium for Gram negative; Public Health England, 2019]	4
3	Enrichment, Isolation and bioincoculant preparation : *Azotobacter*	2
4	Air Flora: a. Diversity determination Simpson index. b. Determination of sedimentation rate	2

5	Bacteriological tests for potability of water
	
	  a. Presumptive test, Determination of MPN, Confirmed and Completed test.
	  b. Membrane filter technique (Demonstration)
	
	Identification of *E. coli* from water sample as fecal indicator
	
	  i. IMViC test
		4

6	Determination of BOD of waste water sample.	1
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References:

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India

2. Atlas R. M. (1986; Digitized 2007). Basic and Practical Microbiology. United Kingdom: Macmillan. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India

3. Cappuccino, J.G. and Sherman, N. (2002) Microbiology: A Laboratory Manual. 6th Edition, Pearson Education Inc., San Francisco, 15-224.

4. Goldman E. and Green L. H. (2008). Practical Handbook of Microbiology. United States: CRC Press.

5. Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International (P) Limited New Delhi, India

6. Mukherjee K. L. (2013). Medical Laboratory Technology. Second Edtion. Volume III. McGraw-Hill Companies, India.

7. Nollet L. M. L. and De Gelder L. S. P. (2013). Handbook of Water Analysis, Third Edition. United States: Taylor and Francis.

Major
24MIC23104: IKS- Indian Traditional Microbiology knowledge system
[2 Credits; 30 Lectures] [1 credit=15hrs x 60 mins]

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the contribution of Indian scholars in medicine.

CO2: Describe concepts of microbiology discussed in ancient literature.

CO3: Discuss preparation of traditional fermented products.

Unit No.	Topics	No. of lectures

I	**Microbiology in ancient India**
	  a. Scholars: Charak, Sushrut, Vagbhat and Madhavakar and their contribution.
	  b. Concept of bacteria and viruses in Ayurveda
	  c. Microbial diseases: symptoms and treatment, Epidemic
	  d. Methods of disinfection
	  e. 'Prakriti' and gut microbiome
	  f. Antimicrobial Resistance and Ayurveda
	  g. Ayurvedic medicines as alternative treatment approach.
	  h. Ayurveda as lifestyle, concept of personalized medicine.
		15

II	**Traditional applications of microorganisms**
	  a. Concept of fermentation- alcoholic and lactic fermentation.
	  b. Fermented foods
	  c. Fermented feeds
	  d. Fermented beverages
	  e. Fermented dyes
	  f. Ayurvedic medicines Arishtqas and asavas
	  g. Ayurvedic alcoholic beverages
	  (Discuss two examples each of traditional applications from subpoints b to g)
		15

	Total	30

References

1. Apoorva Jnana, Thokur Sreepathy Murali, Kanive Parashiva Guruprasad, Kapaettu Satyamoorthy, (2020) Prakriti phenotypes as a stratifier of gut microbiome: A new frontier in personalized medicine?, Journal of Ayurveda and Integrative Medicine, Volume 11, Issue 3, Pages 360-365, ISSN 0975-9476, https://doi.org/10.1016/j.jaim.2020.05.013.
2. Chaudhari, D., Dhotre, D., Agarwal, D. *et al.* Understanding the association between the human gut, oral and skin microbiome and the Ayurvedic concept of *prakriti*. *J Biosci* 44, 112 (2019). https://doi.org/10.1007/s12038-019-9939-6
3. Deogade, M. S., & Kethamakka, S. R. P. (2019). Krumi (microorganisms) in ayurveda-A critical review. *International journal of ayurvedic medicine*, *10*, 297-300.

4. Dinesh, K. S., Krishna, S., Chitra, S., George, M. J., & Patel, A. (2020). Concept of human gut microbiome in health and disease–an ayurveda perspective.

5. https://www.bdu.ac.in/schools/biotechnology-and-genetic-engineering/biotechnology/sekardb.htm

6. Jyotirmoy, S., & Rekha, S. D. (2016). Concept of epidemic diseases in ayurveda. *IJHRMLP*, *2*(01), 24.

7. Kukkupuni, S. K., Shashikumar, A., & Venkatasubramanian, P. (2015). Fermented milk products: probiotics of ayurveda. *Journal of Medical Nutrition and Nutraceuticals*, *4*(1), 14.

8. Nagar, J., & Rao, M. V. (2021). A review study on the concept of disinfection in Ayurveda.

9. Sharma, C., Singh, C., Sharma, L. N., Purvia, R., & Adlakha, M. (2014). Antibiotic resistant organism: An emerging public health problem and role of ayurveda (an overview). *Int. J. Ayurveda Pharm. Res*, *2*, 17-29.

10. Shubhashree, M. N., Naik, R., Doddamani, S., & Bhavya, B. (2020). Preventive strategies to combat infections–a review of traditional practices and Ayurveda concepts. *Int J Complement Alternate Med*, *13*(3), 125-129.

11. Wallace, R. K. (2020). The microbiome in health and disease from the perspective of modern medicine and ayurveda. *Medicina*, *56*(9), 462.

Minor

24MIC23205: Microbial Ecology

[2 Credits; 30 Lectures] [1 credit=15 Lectures x 60 mins]

Course Outcomes:
After learning this course students will be able to -

CO1: Describe habitats of microorganisms and microbial interactions.
CO2: Draw carbon and nitrogen cycles and explain role of microorganisms.
CO3: Explain fresh water microbiology and test potability of water.
CO4: Describe management of solid and liquid waste.

Unit No.	Topics	No. of Lectures
1	**Microorganisms and their Habitats** Terrestrial Environment: Soil profile and soil microflora, rhizosphere, role of rhizosphere microorganisms, Humus formation. Aquatic Environment: Microflora of fresh water and marine habitats Atmosphere: Aeromicroflora and dispersal of microbes.	6
2	**Microbial Interactions** Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non symbiotic interactions Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria	8
3	**Biogeochemical Cycling** Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction	4
4	**Waste Management** Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD), Primary, secondary (oxidation ponds, trickling filter and septic tank) and tertiary sewage treatment	6
5	**Water Potability** Treatment and safety of drinking (potable) water, CPCB and WHO guidelines for bacteriological standards of water potability, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique, *E. coli* as Indicator organism.	6

References:

1. Aithal S. C. and Kulkarni N. S. (2015). Water microbiology ~ an Indian perspective. Published by Himalaya Publishing House, Ist Edition. ISBN: No.: 978-93-5202-129-1.

2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Pearson, ISBN-10 : 0805306552

3. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA.Benjamin/Cummings Science Publishing, USA

4. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

5. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

6. Dubey H. C. and Bilgrami K. S. (1976). Textbook of modern pathology. Vikas publishinghouse. New Delhi.

7. Dubey R. C. and Maheswari D.K. Textbook of Microbiology. S. Chand Publishing. ISBN:9788121926201

8. Frobisher M. (1974). Fundamentals of Microbiology. 9th Edition. Saunders, MichiganUniversity Press. ISBN: 9780721639222

9. Ingraham C. A. and Ingraham J. L. (2000). Introduction to Microbiology. United Kingdom:Brooks/Cole.

10. Lim D. V. (1989). Microbiology. 2nd Edition. West Publishing Company. ISBN:9780314262066

11. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial

12. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition.

13. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.

14. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc.NewYork & London.

15. MPCB, CPCB, BIS and WHO websites guidelines for drinking water quality New York

16. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer,

17. Pawar C. B. and Daginawala H.F. (1982). General Microbiology. Vol. I and II. 1st Edition.Himalaya Publishing House, Mumbai. ISBN: 9789350240892and ISBN9789350240908

18. Pelzar M. J., Chan E. C. S. and KriegN. R. (1986). Microbiology. 5th Edition. McGraw-HillPublication

19. Prescott L. M., Harley J. P. and Klein D. A. (2006). Microbiology. 6th Edition. McGraw Hill Publication

20. Salle A. J. (1971). Fundamental Principles of Bacteriology.7th Edition. Tata MacGraw Publishing Co.

21. Schlegel H. G. (1993). General Microbiology. 8thEdition. Cambridge University Press

22. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave MacmillanLimited.

23. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press,

24. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

25. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An introduction 12thEdition, Pearson. ISBN-13: 9780321929150

Minor

24MIC23206: Practical based on Microbial Ecology

[2 Credits: 60 hours]

12 Practicals = 60 hours

COURSE OUTCOMES:

After learning this course students will be able to -
CO1: Study of microorganisms in water and rhizosphere.
CO2: Estimate the diversity of microorganism in air by statistical analysis.
CO3: Determine potability of drinking water using MPN test and membrane filtration technique.
CO4: Determine BOD of wastewater

Expt. No.	Topics	No. of Practicals
1	Observation of microbial diversity in pond water sample.	2
2	Isolation of marine microorganism and their morphological and cultural characterization..	3
3	Isolation of rhizosphere bacteria and their morphological and cultural characterization.	3
4	Air Flora: 1. Diversity determination Simpson index. 2. Determination of sedimentation rate	2

5	Bacteriological tests for potability of water
	
	    a. MPN, Confirmed and Completed test.
	    b. Membrane filter technique (Demonstration)
	Identification of *E. coli* from water sample as fecal indicator
	
	    ii. IMViC test
		4

6	Determination of BOD of waste water sample.	1
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References:

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India

2. Atlas R. M. (1986; Digitized 2007). Basic and Practical Microbiology. United Kingdom: Macmillan. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited,

New Delhi, India

3. Cappuccino, J.G. and Sherman, N. (2002) Microbiology: A Laboratory Manual. 6th Edition,Pearson Education Inc., San Francisco, 15-224.

4. Goldman E. and Green L. H. (2008). Practical Handbook of Microbiology. United States: CRCPress.

5. Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International (P)Limited New Delhi, India

6. John Harley (2010). Prescott's Microbiology Lab Manual, 8th Edition, McGraw-Hill Education.

7. Mukherjee K. L. (2013). Medical Laboratory Technology. Second Edtion. Volume III.McGraw-Hill Companies, India.

8. Nollet L. M. L. and De Gelder L. S. P. (2013). Handbook of Water Analysis, Third Edition.United States: Taylor and Francis.

Open Elective
24MIC23307: Human health and diseases 2 Cr (T)

COURSE OUTCOMES:
At the conclusion of this course the students will be able to
CO1: Explain airborne and water borne, and vector borne diseases , MPN and antibiotic sensitivity test.
CO2: Describe physiological metabolic disorders

CO3: Explain types of immunity, disease prevention and treatment

Unit 1	Health and microbial diseases	15 lectures
	1. Introduction to Health, hygiene and Diseases: Normal flora of human body, pathogens, opportunistic pathogens. **2. Types of Diseases**: communicable and non-communicable **3. Air borne diseases** (causative agent and symptoms)**:** a. Viral: Chickenpox, Influenza, Common cold (Adenovirus, Rhinovirus), Coronavirus Disease 2019 (COVID-19), Measles, Mumps. b. Bacterial- *Streptococcus pneumoniae*, Tuberculosis, *Bordetella pertussis*, Diptheria. c. Fungal- Aspergillosis. d. Air sanitation **4**. **Water borne diseases** (causative agent and symptoms)**:** a. Bacterial- Cholera, diarrhea, typhoid, b. Protozoal- amebiasis, giardiasis c. Viral- Polio, hepatitis, Rotavirus. d. Potable water, water purification 5. **Food borne diseases** (causative agent and symptoms) **6. Vector borne diseases** (causative agent and symptoms)**:** a. Viral: Chikungunya, Dengue, Japanese encephalitis b. Protozoal: Lymphatic filariasis, Malaria	
Unit 2	Physiological and Metabolic disorders and immunity	15 lectures

	1. Physiological/ Metabolic disorders: detection and prevention: diabetes, hypertension, hypotension, anemia.
	 2. **Health and Immunity:**
	 a. Types of Immunity:
	    i. Innate and Acquired
	    ii. Concept of antigen and antibody-Formation of Antigen Antibody complex
	 b. Concept of blood group -antigens on blood cells
	
	 4. Treatment and prevention of diseases
	 a. Antibiotics, their mode of action; drug resistance	

References:
1. Ather B, Mirza TM, Edemekong PF. Airborne Precautions. [Updated 2023 Mar 13]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK531468/
2. Godkar, P. B., & Godkar, D. P. (2003). *Textbook of medical laboratory technology*. Bhalani.
3. https://asm.org/getattachment/2594ce26-bd44-47f6-8287-0657aa9185ad/Kirby-Bauer-Disk-Diffusion-Susceptibility-Test-Protocol-pdf.pdf
4. https://www.biodiamed.gr/wpcontent/uploads/2017/06/Manual_on_Antimicrobial_Susceptibility_Testing.pdf

5. https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases
6. Kanungo R. (2017). Ananthanarayan and Paniker's Textbook of Microbiology. 10th edition. Universities Press, Hyderabad, India
7. Salle, A. J. (1948). Fundamental principles of bacteriology. Fundamental Principles of Bacteriology., (Edn 3).
8. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: an Introduction. Twelfth edition. Pearson, London.

Vocational Skill Enhancement Course
24MIC23408: Cultivation of microorganisms and Special staining techniques 2(Cr)(P)

COURSE OUTCOMES:

At the conclusion of this course the students will be able to -

CO1: Describe the growth characteristics of different groups of microorganisms.

CO2: Stain various components of bacterial cells using special staining methods.

CO3: Stain, observe and describe morphological features of fungi in stained preparations.

Expt. No.	Topics	No. of Practicals
1	Preparation of Nutrient broth, Mac Conkey's broth, PDA, BG11 medium.	2
2	Cultivation and Observing growth of bacteria, fungi, actinomycetes and algae in liquid culture and solid medium	5
3	Bacterial Cell wall staining	1
4	Demonstration of Capsule	1
5	Endospore staining.	1
6	Flagella staining	2
7	PHB and metachromatic granules.	2
8	Mounting of fungus in lactophenol cotton blue	1
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References:
1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology And Biotechnology. New Age International, New Delhi, India
2. Brown, A., & Smith, H. (2014). Benson's Microbiological Applications, Laboratory Manual in General Microbiology, Short Version. McGraw-Hill Education.
3. Cappuccino J. and Welsh C. (2019). Microbiology: A Laboratory Manual, Loose Leaf Edition. United Kingdom: Pearson Education.
4. Chance, H. L. (1953). A Bacterial Cell Wall Stain1. *Stain Technology*, *28*(4), 205-207. https://www.tandfonline.com/doi/abs/10.3109/10520295309105600
5. Fathima, Nabila & Krishnaswamy, Veenagayathri. (2017). Isolation and Screening of PHB Producing Halotolerant Bacterial Strains from A Saline Environment. Journal of Biotechnology and Biomedical Science. 1. 34-45. 10.14302/issn.2576-6694.jbbs-17-1783.
6. Goldman, E., & Green, L. H. (Eds.). (2015). Practical handbook of microbiology. CRC press.
7. Harley J. P. and Prescott L. (2020). Laboratory Exercises in Microbiology. Independently Published.
8. https://biologyease.com/cell-wall-staining/
9. https://microbeonline.com/albert-stain-principle-procedure-results-uses/

Semester IV
Major
24MIC24101: Bacterial Genetics
[2 Credits; 30 Lectures] [1 credit=15 hrs x 60 mins]

Course Outcomes:

At the end of the course students will be able to**:**

CO1: Explain how the nature of genetic material was discovered and comprehend the structure of Nucleic acids

CO2: Comprehend the modes, rules and steps of DNA replication

CO3: Explain various types of mutations, types of mutagenic agents and their mechanism of action

CO4: Discuss overview of gene expression and plasmid genetics

Unit I	Topics	No. of lectures

1	**Understanding DNA:**
	
	  i. Experimental evidence for nucleic acid as genetic material.
	
	  a. Discovery of transforming material (hereditary material):
	
	  b. Griffith's experiment
	
	  c. Avery and MacLeod experiment
	
	  d. Gierer and Schramm
	
	  e. Fraenkel-Conrat and Singer experiment (TMV virus)
	
	  f. Hershey and Chase experiment
		6

	ii. Types of nucleic acids (DNA and RNAs)	1

	iii. Structure of DNA
	
	  a. Structure of Nitrogen bases, Nucleoside, Nucleotide and polynucleotide chain
	
	  b. Bonds involved in DNA structure
	
	  c. Different forms of DNA
		2

2	**iv. Prokaryotic DNA replication** a. Models of DNA replication (Conservative, semi-	6

	conservative and Dispersive) b. Meselson and Stahl's experiment (semi-conservative) c. Basic mechanism of DNA replication d. Enzymes, proteins and other factors involved in DNA replication. e. Modes of DNA replication Rolling circle mechanism, theta and linear DNA replication	
Unit II	**Topics**	15
1	**i. Gene expression** a. Concept of Genetic code and its properties b. Concept of transcription and translation c. Levels of genome organization in prokaryotes d. Levels of genome organization in eukaryotes	3

2	**ii. Mutations and reversions**
	 a. Concept of Mutation and Types of mutations: Nonsense, Missense, Silent, Conditional lethal-temperature sensitive, Amber, Reverse, suppressor
	
	 b. Spontaneous Mutation
	     i. Mechanism of spontaneous mutation
	
	 c. Concept of Induced Mutations
	     i. Base pair substitution (Transitions, Transversions), Insertions and deletions-Frame / Phase shift mutations
	     ii. Physical Mutagenic agent: UV and X-ray
	     iii. Chemical mutagenic agents
	     iv. Base analogues (2 amino purine, 5 bromouracil) –Keto and Enol forms of Nitrogen bases.
	     v. HNO_2, Alkylating agents
	     vi. Intercalating agents (EtBr, acridine orange)
		8

3	**Plasmid genetics** a. Types and properties of plasmids. b. Concept of plasmid incompatibility, plasmid curing and amplification. c. Plasmid replication Importance of plasmids in recombinant DNA Technology and other fields.	4

References:

1. Alberts B., Johnson A., Lewis J., Raff M., Roberts K. and Walter P. (2008). Molecular Biology of the Cell. 5th Edition. Garland Science. Taylor and Francis. ISBN: 978-0-8153- 4105-5. .

2. Brooker R. J. (2012). Genetics: Analysis and Principles. 4th edition. McGraw- Hill- Publication

3. Gardner E. J., Simmons M. J. and Snustad D. P. (2006). Principles of Genetics. 8th edition. John Wiley and Sons Publication. ISBN-13: 9788126510436

4. Hayes W. (2nd Edition). (1968). Genetics of Bacteria and their Viruses. Oxford-Edinburgh:Blackwcll Scientific Publications.

5. Krebs J., Kilpatrick S. T., Goldstein E. S. (Editors). Lewin's GENES X (2011). 10th Edition.Sudbury, Mass: Jones and Bartlett, c2011

6. Lodish H., Berk A., Kaiser C. A., Krieger M., Bretscher A., Ploegh H., Martin K. C., Yaffe

7. M. and Amon A. (2021). Molecular Cell Biology, 9th Edn. Macmillan Learning. ISBN: 9781319208523

8. Malacinski G. M. (2005). Freidfelder's Essentials of Molecular Biology. 4th Edition. Jones and Bartlett Publishers, Inc.

9. Pawar and Daginawala. General Microbiology. Vol. I and vol II. 1st Edition.Himalaya Publishing House, Mumbai

10. Primrose S. B. (2002) .Principles of Gene Manipulation. 6th Edition. Oxford: BlackwellScientific Publications

11. Russel P. J. (2010). iGenetics: A Molecular Approach. 3rd Edition. Benjamin Cummings.ISBN: 9780321569769

12. Russel P. J. (2000). Fundamentals of Genetics. Publisher: Benjamin/Cummings. ISBN:9780321036261

13. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave MacmillanLimited.

14. Strickberger M. W. (2012). Genetics. 3rdEdition. New Delhi: PHI Learning Gardne

15. Watson J.D., Baker, T.A., Bell, S.P., Gann A., Levine M. and Losick R. (2014). Molecular Biology of the gene. 7th edition. Pearson. ISBN: 9780321762436

Major

24MIC24102: Industrial Microbiology

[2 Credits; 30 Lectures] [1 credit=15hrs x 60 mins]

Course Outcomes

At the end of the course students will be able to**:**

CO1: Describe application of fermentation technology, screening, selection and maintenance of microbialstrains.

CO2: Explain design of fermenters and fermentation media, types of fermentations and working of fermenters.

CO3: Explain culture isolation and strain improvement techniques for fermentation processes.

CO4: Describe optimization and sterilization of fermentation media.

CO5: Diagrammatically explain the scale up of fermentation process.

Unit	Topics	No. of Lectures (30)
	a. Concept of fermentation technology i. Microbial biomass- based fermentation (Biofertilizer, biopesticide and Probiotics) ii. Production of Primary metabolites (Organic acids, amino acids, vitamins andenzymes) iii. Production of Secondary metabolites (Antibiotics) iv. Production of recombinant products (insulin and growth hormones) v. Production of Fermented food products (Cheese, yoghurt) vi. Microbial biotransformation (Steroid transformation)	2
Unit I	**b. Strains of industrially important microorganisms:** i. Desirable characteristics of industrial strain ii. Principles and methods of primary and secondary screening iii. Master, working and seed culture; development of inoculum iv. Preservation and maintenance of industrial strains.	3
	c. Strain Improvement: 1. Objectives of strain improvement 2. Methods for strain improvement: i. Types of mutants used in strain improvement (altered cell permeabilitymutants, auxotrophs, analogue resistant mutants, revertants) ii. Selection of different types of mutants (replica plate method, filtrationenrichment, penicillin enrichment method, gradient plate technique)	4

	iii. Application of rDNA technology (significance, technique for commercial recombinant products like insulin)	
Unit II	**Design of a Fermenter (typical CSTR Continuous stirred Tank Reactor):** Different parts and their working	2
	Monitoring of different fermentation parameters (Temperature, pH, aeration, agitation, foam)	2
	Types of fermentations: Batch, continuous and dual	2
Unit III	**1.Media for industrial fermentations:** Constituents of media (Carbon source, nitrogen source, amino acids, vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors andinducers)	2
	2. Media optimization a. Objectives of media optimization b. Methods of media optimization: i. Classical approach – One factor at a time, Full factorial design ii. Plackett and Burman Design (with example) (Numerical problems ofPBD can be discussed using software)	4
	3. Sterilization of Media: a. Methods of sterilization a. Batch sterilization and Continuous sterilization (direct and indirect methods) b. Concept and derivation of Del factor c. Filter sterilization of liquid media	4
	4. Scale-up and Scale-down: a. Objectives of scale-up b. Levels of fermentation (laboratory, pilot-plant and production level – flow sheet to explain scale up) c. Criteria of scale-up for critical parameters [Aeration (kLa Volumetric Mass transfer coefficient), Agitation (P/V ratio, N_{Re} Reynolds number, N_p Power number, N_{Fr} Froudes number), Sterilization and broth rheology (Newtonian and non Newtonian fluids - bacterial and mycelia fungal fermentations)] Scale-down (example of anyone commercial fermentation)	4

	5.Contamination: Sources, precautions and consequences	1

References:

1. Aiba S., Humphrey A. E. and Millis N.F. (1977). Biochemical Engineering. AcademicPress,New York,

2. Bailey J. A., Bailey J. E., Bailey J., Simpson R. J. and Ollis D. F. (1986). Biochemical Engineering Fundamentals. 2nd Edition. McGraw-Hill. Chemical Engineering Series.McGraw-Hill Publisher. ISBN: 0070032122, 9780070032125

3. BIOTOL series. (1992). Bioreactor Design and Product Yield. Butterworths- Heinemann (Publisher). ISBN-13: 978-0750615082

4. BIOTOL series. (1992). Operational Modes of Bioreactors. Butterworths-Heinemann.ISBN-13: 978-0750615082

5. British Pharmacopeia. (2021). The Stationery Office Ltd (TSO), PO Box 29, Norwich,NR3 1PD. https://www.pharmacopoeia.com/Catalogue/Products

6. Casida L. E. J. R. (2016). Industrial Microbiology. New Age International Private Limited.ISBN-9788122438024

7. Flickinger M. C. (2010). Encyclopedia of Bioprocess Technology. Seven Volume Set.Wiley-Interscience, New Jersey. ISBN: 978-0-471-79930-6

8. Indian Pharmacopeia. (2018- Addendum 2021): https://www.indianpharmacopoeia.in/index.php

9. Lydersen B. K., D' Elia N. A. and Nelson K. L. (Eds.). (1994). Bioprocess Engineering:Systems, Equipment and Facilities. Wiley. ISBN: 978-0-471-03544-2

10. Meshram S. U. and Shinde. G. B. (2009). Applied Biotechnology. I K InternationalPublishing House. ISBN-13: 978-93-80026-56-5, ISBN: 93-80026-56-0

11. Moo-Young M. (2019). Comprehensive biotechnology. Third edition. Volume 1: Scientific Fundamentals of Biotechnology. Volume 2: Engineering Perspectives in Biotechnology. Volume 3: Industrial Biotechnology and Commodity Products. Volume 4: Agricultural and Related Biotechnologies. Volume 5: Medical Biotechnology and Healthcare. Volume 6: Environmental and Related Biotechnologies. Pergamon Press Limited, England. ISBN: 978- 0-444-64047-5

12. Patel A. H. (2016). Industrial Microbiology. Trinity Press (Publisher).ISBN-13- 9789385750267

13. Patel. A. H. (2016). Industrial Microbiology. Trinity Press (Publisher). ISBN-13-9789385750267

14. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume 1: Microbial Processes. Academic Press, New York. ISBN: 978-0-12-551501

15. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume II: Fermentation Technology (2nd Edition). Academic Press. ISBN: 9781483268279

16. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume 1: MicrobialProcesses. Academic Press, New York. ISBN: 978-0-12-551501-6

17. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume II: Fermentation Technology (2nd Edition). Academic Press. ISBN: 9781483268279

18. Prescott L. M., Harley J. P. and Klein D. A. (2005). Microbiology. 6thEdition. Mac Graw Hill Companies Inc. (Unit II)

19. Reed G. (Editor). (1982). Prescott and Dunn's Industrial Microbiology. Westport, CT, AVI PublishingCo Inc.

20. Reed G. (Editor). (1982). Prescott and Dunn's Industrial Microbiology. Westport, CT, AVI Publishing Co Inc.

21. Stanbury P. F., Whitaker A. and Hall S. J. (2016). Principles of FermentationTechnology.3rd Edition.Butterworth-Heinemann. ISBN: 9780080999531

22. Stanbury P. F., Whitaker A. and Hall S. J. (2016). Principles of Fermentation Technology.3rd Edition. Butterworth-Heinemann. ISBN: 9780080999531

Major

24MIC24103: Food and Dairy Microbiology

[2 Credits; 30 Lectures] [1 credit=15 lectures x 60 mins]

Course Outcomes:

After learning this course students will be able to -

CO1: Describe food classification based on their perishability, intrinsic and extrinsic factors affecting the growth of microbes in foods.

CO2: Distinguish between various types of food spoilage and describe prevention of food borne diseases.

CO3: Apply principles of sanitation, heat treatment, irradiation, modified atmosphere,antimicrobial preservatives and combination of method (hurdle concept) to control microbial growth with emphasis on HACCP guidelines.

CO4: Explain prospects of dairying at commercial marketing.

CO5: Describe steps involved in processing of milk and dairy products.

CO6: Explain quality control tests in dairy industry.

CO7: Describe production of dairy products of commercial significance with emphasis to local and global market demand.

Unit No.	Topics	No. of lectures
	Food Microbiology:	**(15)**
	Introduction to properties of food and spoilage of food: a. Definition of food b. Classification of food- Perishable, non-perishable, and semi-perishable	1
	Food Spoilage : Chemical and physical properties of food affecting microbial growth, Sources of food spoilage causing microorganisms, Spoilage of Meat and Poultry products, Bread, Fruits and Vegetables, Sea foods and Canned foods.	5
I	**Food preservation:** Principles of food preservation, Thermal destruction of bacteria - use of low temperature and high temperature. Determination of TDP, TDT values. Use of chemicals and antibiotics, radiations, additives in preservation of food.	4
	Food borne infections and intoxications: Food poisoning -*Clostridium botulinum* Food infection-*Salmonella typhimurium*	2
	Concept of Prebiotic and Probiotic and fermented food: Definition, Health effects, side effects and risk. Potential applications of Prebiotic, Probiotic and fermented food	2
	Food sanitation and regulatory authorities : ISO, FDA, FSSAI, WHO	1

	Dairy Microbiology	**(15)**
II	**Milk Chemistry and Constituents** i. Definition and Composition of milk, Difference between colostrum and milk, ii. Physico-Chemical properties of milk iii. Types of milk: whole, toned, double toned, homogenized, skimmed milk and dehydrated milk iv. Microflora associated with milk	5
	Spoilage of Milk i. Sources of contamination of raw milk ii. Types of spoilage: Stormy fermentation, ropiness, sweet curdling iii. Color and flavor defects iv. Milk borne diseases	3
	Preservation of Milk and Milk products i. Physical method: pasteurization, sterilization, irradiation ii. Chemical agents iii. Food grade bio preservatives (GRAS), Bacteriocin of LAB iv. Naturally occurring preservative systems in milk like LP system, Lactoferin etc.	5
	Microbiological aspects of quality control and quality assurance in production of milk and milk products i. Good Manufacturing Practices ii. Total quality management and application of HACCP program in dairy industry.	2

References:

1. Alias A K., Paliyath G. and Bhat R. (2012). Progress in Food Preservation. United Kingdom: Wiley. ISBN: 9780470655856

2. Banwart G. J. (1989). Basic Food Microbiology. 2nd edition. Chapman and Hall. International Thompson Publishing.

3. Banwart G. J. (1989). Basic Food Microbiology. 2nd edition. Food Science and

4. Bozoglu T. F. and Erkmen O. (2016). Food Microbiology. 2 Volume Set: Principles into Practice. United Kingdom: Wiley. ISBN: 9781119237761

5. Bullock D. (2019). Dairy Microbiology. ED-Tech Press. E-Book. ISBN: 9781788821629

6. Coles R. and Kirwan M. J. (2011). Food and Beverage Packaging Technology. Germany: Wiley. ISBN: 9781444392173

7. De Sukumar. (2001). Outlines of Dairy Technology. Oxford University Press. Delhi.

8. Early R. (2012). Guide to quality management for the food Industry. Blackie Academic andProfessional. ISBN-13: 978-1461358879 edition. Food Science and Nutrition. Springer. ISBN 978-0-387-23413-7.

9. Food Safety and Standards Act. 9th edition. Commercial Law Publishers (India) Private Limited.

10. Frazier W. C., Westhoff D. C. and Vanitha N. M. (2013). Food Microbiology. 5th edition.McGraw Hill education, India.

11. Garbutt J. (1997). Essentials of Food Microbiology. Taylor and Francis. ISBN:9780340677018

12. Gupta V. (2017). The food safety and standards act 9th edition. Commercial Law Publishers

13. James J. M., Loessner M. J. and Golden D. A. (2005). Modern Food Microbiology. 7th

14. Jay J. M. (2012). Modern Food Microbiology. Netherlands: Springer Netherlands. ISBN: 9789401164818

15. Jay J. M. and Loessner M. J. (2005). Modern Food Microbiology. 7th edition. Springer. ISBN 978-0-387-23413-7

16. Joshi V. K. (2019). Indigenous Fermented Foods of South Asia. CRC Press. ISBN

17. Mahindru S. N. (2010). Encyclopedia of Food Analysis. 3 Volumes. APH PublishingCorporation. ISBN-13: 9788131308806

18. Mahindru S. N. (2010). Encyclopedia of Food Analysis. APH Publishing Corporation,

19. Makun H. A. (2016). Significance, Prevention and Control of Food Related Diseases. Croatia:IntechOpen. ISBN: 9789535122777

20. Marth E. H. and Steele J. (2001) Applied Dairy Microbiology. 2nd Edition. CRC

21. Mathews G. (2018). Food and Dairy Microbiology. Scientific e-Resources, Scientific 9780367377076

22. Palmiro Poltronieri. (2017). Microbiology in Dairy Processing: Challenges and

23. Parihar P. and Parihar L. (2008). Dairy Microbiology. Agrobios, Jodhpur, India. ISBN

24. Peñas. E., Frias J. and Villaluenga C. M. (2016). Fermented Foods in Health and DiseasePrevention. Netherlands: Elsevier Science. 9780128025499

25. Preedy V. R. (2015). Probiotics, Prebiotics, and Synbiotics: Bioactive Foods in Health Promotion. Netherlands: Elsevier Science. ISBN: 9780128023716

26. Ray B. (2019). Food Biopreservatives of Microbial Origin. United States: CRC Press. ISBN: 9781351080514

27. Robinson R. K. (2012). Modern Dairy Technology. Volume 2. Springer. ISBN-13:

28. Sharma K.S. (2021). Chemistry of Milk. AgriMoon.com. e-Krishi Shiksha. Online 9788177542738

29. Singh S. (2013) Dairy Technology: Volume -01: Milk and Milk Processing. New India

30. Sivasankar B. (2009). Food processing and preservation. PHI Learning Pvt. Limited

31. Varnam A. H. and Jane P. (2012). Milk and Milk Products: Technology, Chemistry

Major
24MIC24104: Practical Course based on
24MIC24101: Bacterial Genetics and 24MIC24102: Industrial Microbiology and
24MIC24103: Food and Dairy Microbiology
[12 Practicals = 60 hours]

Course outcomes:
At the end of the course students will be able to**:**
CO1: Detect ability of microorganisms to produce enzymes, antibiotics and organic acids
CO2: Demonstrate screening of organic acid/ antibiotic and amylase producing microorganisms**.**
CO3: Demonstrate the quality of food and dairy products.
CO4: Demonstrate the use of physical and chemical mutagen to isolate mutants.

Expt .No	Topics	No. of Practicals
1	Primary screening of industrially important organisms: 1. Screening and isolation of antibiotic and organic acid producing organism from soil by Crowded plate and Giant colony method. 2. Microorganisms producing industrially important enzyme- Isolation of amylase producer and plate assay.	2
2	Study of parts of fermenter and their function.	1
3	i. UV- survival curve ii.Induction of mutation by using physical mutagen (e.g. U V rays) iii. Isolation of auxotrophic mutants by Replica Plate	2
4	Food Microbiology i. TVC of food product. ii. Food preservation-To study the Effect of sodium benzoate and potassium sorbate on various categories of food/ food products. iii. Food Adulteration detection tests	3
5	Microbiological quality control tests for milk: i. Dye reduction tests (MBRT/Resazurin) ii. Phosphatase test iii. Milk Adulteration detection test	2
6	HACCP guidelines for dairy and food industry (activity based).	1
7	Project based activity: Analysis of packaged food and local samples.	3
8	Visit to fermentation/Food/Dairy industry	1
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References:

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology andBiotechnology. New Age International, New Delhi, India

2. Banwart G. J. (1989). Basic Food Microbiology. 2nd edition. Food Science and Nutrition.Springer ISBN   978-1-4684-6453-5

3. Bisen P. S. (2014). Laboratory Protocols in Applied Life Sciences. United Kingdom:CRC Press.

4. Bullock D. (2019). Dairy Microbiology. ED-Tech Press. E-Book. ISBN:9781788821629

5. Cappuccino, J.G. and Sherman, N. (2002) Microbiology: A Laboratory Manual. 6thEdition, Pearson Education Inc., San Francisco, 15-224.

6. Cox C. C. and Wathes C. M. (2020). Bioaerosols Handbook. United States: CRC Press.

7. De Sukumar. (2001). Outlines of Dairy Technology. Oxford University Press. Delhi. ISBN-13 978-0195611946

8. Frazier W. C., Westhoff D. C. and Vanitha N. M. (2017) Food Microbiology. 5thedition.McGraw Hill education, India. ISBN-10 -9781259062513

9. Gunasekaran P. (2007). Laboratory Manual In Microbiology. New Age International(P)Limited New Delhi, India

10. John Harley (2010). Prescott's Microbiology Lab Manual, 8th Edition, McGraw-Hill Education

11. John Harley (2010). Prescott's Microbiology Lab Manual, 8th Edition, McGraw-HillEducation

12. Marth E. H. and Steele J. (2001) Applied Dairy Microbiology. 2nd Edition. CRC Press.ISBN 9781138367609

13. Mathews G. (2018). Food and Dairy Microbiology. Scientific e-Resources, Scientific e-Resources. ISBN 1839472545, 9781839472541

14. Nakatsu C. H., Yates M. V., Miller R. V. and Pillai S. D. (2020). Manual ofEnvironmental Microbiology. United States: Wiley.

15. Parihar P. (2008) Dairy Microbiology. Agrobios, AbeBooks Seller, India.ISBN:9788177542738, 8177542737

16. Parihar P. and Parihar L. (2008). Dairy Microbiology. Agrobios, Jodhpur, India. ISBN 13:9788177542738

17. Pepper I. L., Brendecke J. W. and Gerba C. P. (2011). EnvironmentalMicrobiology: A Laboratory Manual. Netherlands: Elsevier Science.

18. Robert Cruickshank, Duguid J.P., Marmilon B.P. and Swain R.H.A. (1975). Medical Microbiology, the Practice of Medical Microbiology. Churchill Livingstone, EdinburghLondon and New York.

19. Robinson R. K. (2012). Modern Dairy Technology. Volume 2. Springer. ISBN-13: 978-1468481747

20. Sharma K.S. (2021). Chemistry of Milk. AgriMoon.com. e-Krishi Shiksha. Online Courses.

21. WHO Guidelines for Indoor Air Quality: Dampness and Mould. (2009). Philippines: WHO.

Minor

24MIC24205: Introduction to Industrial Microbiology

[2 Credits; 30 Lectures] [1 credit=15hrs x 60 mins]

Course outcomes

At the end of the course students will be able to**:**

CO 1: Draw flow sheet for production of fermentation products.

CO 2: Explain strain improvement.

CO3: Describe Optimization of Fermentation media.

CO4: Discuss the design and operation of fermenter

Unit No.	Topics	No. of lectures

I	**a. Concept of fermentation technology**
	  i. Microbial biomass- based fermentation (Biofertilizer, biopesticide and Probiotics)
	  ii. Production of Primary metabolites (Organic acids, amino acids, vitamins and enzymes)
	  iii. Production of Secondary metabolites (Antibiotics)
	  iv. Production of recombinant products (insulin and growth hormones)
	  v. Production of Fermented food products (Cheese, yoghurt)
	  vi. Microbial biotransformation (Steroid transformation)
	
	b. Strains of industrially important microorganisms:
	  i. Desirable characteristics of industrial strain
	  ii. Principles and methods of primary and secondary screening
	  iii. Master, working and seed culture; development of inoculum
	  iv. Preservation and maintenance of industrial strains.
	
	c.Strain Improvement:
	  i. Objectives of strain improvement
	  ii. Methods for strain improvement:
	  iii. Types of mutants used in strain improvement (altered cell permeability mutants, auxotrophs, revertants)
	  iv. Selection of different types of mutants -replica plate method, gradient plate technique.
		15

II	a. **Design of a Fermenter** (typical CSTR Continuous stirred Tank Reactor): Different parts and their working b. **Monitoring of different fermentation parameters** (Temperature, pH, aeration, agitation, foam) c. **Types of fermentations**: Batch, continuous and dual d. **Media for industrial fermentations**: Constituents of media (Carbon source, nitrogen source, amino acids, vitamins, minerals, water, buffers, antifoam	15

	agents, precursors, inhibitors andinducers)	
	e. Media optimization	
	i. Objectives of media optimization	
	ii. Methods of media optimization: Classical approach – One factor at a time	
	f. Contamination: Sources, precautions and consequences	

References:

1. Aiba S., Humphrey A. E. and Millis N.F. (1977). Biochemical Engineering. AcademicPress,New York,

2. Arora D. K. (Editor). (2003). Fungal Biotechnology in Agriculture, Food and Environmental Applications (Mycology). CRC Press. ISBN 9780824747701.

3. Bailey J. A., Bailey J. E., Bailey J., Simpson R. J. and Ollis D. F. (1986). Biochemical Engineering Fundamentals. 2nd Edition. McGraw-Hill. Chemical Engineering Series.McGraw-Hill Publisher. ISBN: 0070032122, 9780070032125

4. BIOTOL series. (1992). Bioreactor Design and Product Yield. Butterworths- Heinemann(Publisher). ISBN-13: 978-0750615082

5. BIOTOL series. (1992). Operational Modes of Bioreactors. Butterworths-Heinemann.ISBN-13: 978-0750615082

6. Casida L. E. J. R. (2016). Industrial Microbiology. New Age International Private Limited.ISBN-9788122438024

7. Flickinger M. C. (2010). Encyclopedia of Bioprocess Technology. Seven Volume Set. Wiley-Interscience, New Jersey. ISBN: 978-0-471-79930-6

8. Lydersen B. K., D' Elia N. A. and Nelson K. L. (Eds.). (1994). Bioprocess Engineering:Systems, Equipment and Facilities. Wiley. ISBN: 978-0-471-03544-2

9. Meshram S. U. and Shinde. G. B. (2009). Applied Biotechnology. I K InternationalPublishing House. ISBN-13: 978-93-80026-56-5, ISBN: 93-80026-56-0

10. Moo-Young M. (2019). Comprehensive biotechnology. Third edition. Volume 1: Scientific Fundamentals of Biotechnology. Volume 2: Engineering Perspectives in Biotechnology. Volume 3: Industrial Biotechnology and Commodity Products. Volume 4: Agricultural andRelated Biotechnologies. Volume 5: Medical Biotechnology and Healthcare. Volume 6: Environmental and Related Biotechnologies. Pergamon Press Limited, England. ISBN: 978- 0-444-64047-5

11. Patel. A. H. (2016). Industrial Microbiology. Trinity Press (Publisher). ISBN-13- 9789385750267

12. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume 1: MicrobialProcesses. Academic Press, New York. ISBN: 978-0-12-551501-6

13. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume II: Fermentation Technology (2nd Edition). Academic Press. ISBN: 9781483268279

14. Reed G. (Editor). (1982). Prescott and Dunn's Industrial Microbiology. Westport, CT, AVIPublishing Co Inc.

15. Stanbury P. F., Whitaker A. and Hall S. J. (2016). Principles of Fermentation Technology.3rd Edition. Butterworth-Heinemann. ISBN: 9780080999531

16. Van Damme E. J. (1984) Biotechnology of Industrial Antibiotics. Marcel Dekker Inc. New York. ISBN-13: 978-0824770563

17. Wiseman A. (1983) Topics in Enzyme and Fermentation – Biotechnology. Volume 7. Ellis Horwood Limited, Publishers: Chichester. John Wiley and sons,New York

Minor

24MIC24206: Practicals based on Introduction to Industrial Microbiology

[2 credits=60h][12 Practicals =60h]

Course outcomes:

At the end of the course students will be able to**:**
CO1: Observe bacterial motility.
CO2: Explain concept of enrichment, pure culture, isolation and maintenance of microbial cultures
CO3: Factors affecting microbial growth.

Expt. No.	Topic	No. of Practicals
1	Preparation of Nutrient broth, Starch broth, PDA.	1
2	Cultivation and Observing growth of bacteria, fungi and actinomycetes in liquid culture and solid medium.	2
3	Primary screening of industrially important organisms: 1.Screening and isolation of antibiotic and organic acid producing organism from soil by Crowded plate and Giant colony method 2. Microorganisms producing industrially important enzyme-amylase. Detection of amylase by plate assay.	4
4	i. Induction of mutation by using U V rays ii. Isolation of auxotrophic mutants by Replica Plate	2
5	Study of parts of fermenter and their function.	1
6	Enrichment, Isolation and bioincoculant preparation :*Azotobacter*	3
7	Lab scale production of organic acids using fungi and titrimetric estimation.	2
	Total	15

Note: Students should learn to perform minimum 12 practicals from the course.

References:

1. Atlas R. M. (2005). Handbook of Media for Environmental Microbiology. United States: Taylor and Francis.

2. Cappuccino J. and Welsh C. (2019). Microbiology: A Laboratory Manual, Loose Leaf Edition. United Kingdom: Pearson Education.

3. Goldman, E., & Green, L. H. (Eds.). (2015). Practical handbook of microbiology. CRC press.

4. Harley J. P. and Prescott L. (2020). Laboratory Exercises in Microbiology. Independently Published.

5. Jacquelyn G Black, Laura J. Black, Microbiology: Principles and Explorations, 10th Edition, Wiley Publications

6. Klein D. A., Harley J. P. And Prescott L. (2001). Microbiology. United Kingdom: McGraw-Hill Higher Education.

7. Miller A. D. and Tanner J. (2013). Essentials of Chemical Biology: Structure and Dynamics of Biological Macromolecules. Germany: Wiley.

8. Pelczar M. J. Jr., Chan E.C.S. and Krieg N. R. (2010). Microbiology: An Application based Approach. McGraw-Hill Education (India) Private Limited, New Delhi, India.

9. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave Macmillan Limited.

10. Talaros, Foundations in Microbiology, MacGrew Hill Publication

11. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An Introduction.

Open Elective
24MIC24307: Practical based on Human health and diseases 2 Cr (P)

[2 Credits: 60 hours]

12 Practicals = 60 hours

COURSE OUTCOMES:
At the conclusion of this course the students will be able to -
CO1: Understand the safety measures to be followed in a Microbiology laboratory.
CO2: Describe construction and working of common instruments used in Microbiology laboratory.
CO3: Explain use of various glassware used in microbiology experiments.
CO4: Handle and use compound microscope to observe microorganisms.
CO4: Perform MPN and antibiotic sensitivity test.
CO 5: Identify protozoal pathogens form permanent slides, blood cell types
CO 6: Determine blood pressure and sugar level and blood group.

Expt. No.	Topics	No. of Practicals
1	Introduction to Health, hygiene and Diseases Importance of normal flora of skin a. Determination of load of microorganisms before and after washing of hands.	**1**
2	Air borne diseases a. Prevention of spread-Disinfection of air by filtration, uv radiation and chemicals. b. Determination of load and types of microorganisms in the air by settle plate technique.	**2**
3	Water/ food borne diseases: a. Demonstration of Water potability testing: MPN b. Observing permanent slides of protozoa such as *Entamoeba sp.*, *Giardia sp.* c. Prevention of spread: Disinfection of water by filtration, uv radiation and chemicals.	**2**
4	Vector borne diseases: a. Prevention of spread. b. Observing permanent slides of malarial parasite.	**2**
5	Physiological/ Metabolic disorders: a. Determination of blood/urine sugar level use of glucometer and Colorimetry. b. Measurement of blood pressure. c. Demonstration of hemoglobin estimation	**3**
6	Study of blood and its components: 1. Demonstration/ Observation of blood smear (types of Blood cells: RBCs, WBCs)	**3**

	2. Determination of Blood groups (ABO, Rh)	
7	Antibiotics, their mode of action; drug resistance: 1. Demonstration of Antibiotic sensitivity testing using disc diffusion and mic by turbidometric method	**2**
	TOTAL	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References;

1. Ather B, Mirza TM, Edemekong PF. Airborne Precautions. [Updated 2023 Mar 13]. In: StatPearls
2. https://www.ncbi.nlm.nih.gov/books/NBK531468/
3. Godkar, P. B., & Godkar, D. P. (2003). *Textbook of medical laboratory technology*. Bhalani.
4. https://asm.org/getattachment/2594ce26-bd44-47f6-8287-0657aa9185ad/Kirby-Bauer-Disk-
5. https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases
6. Salle, A. J. (1948). Fundamental principles of bacteriology. Fundamental Principles of Bacteriology., (Edn 3).
7. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: an Introduction. Twelfth edition.Pearson, London.
8. https://www.biodiamed.gr/wpcontent/uploads/2017/06/Manual_on_Antimicrobial_Susceptibility_Testing.pdf[

SEC

24MIC24408: Advancements in Sustainable Agriculture: Production of Biofertilizers, Biopesticides, and Nanoparticle Biosynthesis.
2 (Cr) (P)

[2 Credits: 60 hours]

12 Practicals = 60 hours

COURSE OUTCOMES:
At the conclusion of this course the students will be able to -
CO1: Isolate Azotobacter and Rhizopbium and prepare bioinoculant

CO2: Production of algal biofertilizers, biopesticide

CO3: Synthesis and characterization of nanoparticles using plant extracts, fungi/ bacteria

Expt. No.	Topics	No. of Practicals
1	Enrichment, Isolation and bioincoculant preparation a. *Azotobacter* b. *Rhizobium* species c. Tests for PGP activity: i.Ammonia production, ii. IAA production	5
2.	Lab scale Production of algal biofertilizer	1
3.	Solid state fermentation for production of *Trichoderma sp.* Preparation of liquid formulation and Determination of antifungal activity	3
4	Synthesis of copper nanoparticles using plant extract and their characterization by spectrophotometry.	3
5	Synthesis of zinc nanoparticles using bacterial/ fungal culture and characterization of nanoparticles and determination of antibacterial activity	3
	Total	**15**

Note: Students should learn to perform minimum 12 practicals from the course.

References:

1. Casida L. E. J. R. (2016). Industrial Microbiology. New Age International Private Limited. ISBN-9788122438024
2. Chokriwal A., Sharma M. M. and Singh A. (2014). Biological synthesis of nanoparticles using bacteria and their applications. American Journal of PharmTechResearch. 4(6):38-61.
3. Das R. K., Pachapur V. L., Lonappan L., Naghdi M., Pulicharla R., Maiti S. and Brar S. K. (2017). Biological synthesis of metallic nanoparticles: plants, animals andmicrobial aspects. Nanotechnology for Environmental Engineering. 2(1): 1-21.
4. Fariq A., Khan T. and Yasmin, A. (2017). Microbial synthesis of nanoparticles and their potential applications

in biomedicine. J. Appl. Biomed. 15: 241–248

5. Li X., Xu H., Chen Z. S. and Chen G. (2011). Biosynthesis of nanoparticles by microorganisms and their applications. Journal of Nanomaterials. 2011.

6. Mohd Yusof H., Mohamad R., Zaidan U. H. and Rahman N. A. A. (2019). Microbial synthesis of zinc oxide nanoparticles and their potential application as an antimicrobial agent and a feed supplement in animal industry: a review. J Animal SciBiotechnol. 10(57): https://doi.org/10.1186/s40104-019-0368-z

7. Patel A. H. (2016). Industrial Microbiology. Trinity Press (Publisher).ISBN-13- 9789385750267.

8. Salame P. H., Pawade V. B. and Bhanvase B. A. (2018). Characterization tools and techniques for nanomaterials. Nanomaterials for Green Energy: 83–111. doi:10.1016/b978- 0-12-813731-4.00003-5

9. Yan S., He W., Sun C., Zhang X., Zhao H., Li Z., Zhou W., Tian X., Sun X., Han X. (2009).The biomimetic synthesis of zinc phosphate nanoparticles. Dyes and Pigments. 80(2): 254– 258

****

Progressive Education Society's

Modern College of Arts, Science and Commerce,

Ganeshkhind, Pune – 411 016 (Autonomous)

Affiliated to SPPU

B.Sc. (Physics)

(Three Years Integrated Degree Program)

S. Y. B. Sc. Physics

NEP Version II

From

Academic Year 2025-26

Board of Studies in Physics

Modern College of Arts, Science and Commerce (Autonomous) Ganeshkhind, Pune – 411016

Structure of the Course

S. Y. B.Sc.

<div style="border:1px solid black">

NEP II- S.Y.B.Sc. (Physics) (SEM-III and IV)

</div>

Subject Code	Subject	Subject Type	Credits	Th	Pr	Total Workload
		Semester III				
24PHY23101	Mathematical Methods in Physics -I	Major	2	2	-	2
24PHY23102	Heat and Thermodynamics	Major	2	2	-	2
24PHY23103	Physics Laboratory 2A	Major Practical	2	2	-	2
24PHY23104	Major specific IKS	Major Specific IKS	2	-	4	4
24PHY23205	Electronics	Minor- Th	2	2	-	2
24PHY23206	Practical Based on Electronics	Minor -Pr	2	-	4	4
24PHY23307	Weather Studies	OE	2	2	-	2
24PHY23408	Instrumentation	VSEC	2	-	4	4
24PHY23609	Field Project	FP	2	2	-	2
		Semester IV				
24PHY24101	Applied Optics	Major	2	2	-	2
24PHY24102	Nuclear Physics	Major	2	2	-	2
24PHY24103	Physics Laboratory 2B	Major Practical	2	-	4	4
24PHY24204	Optics	Minor- Th	2	2	-	2
24PHY24205	Practical Based on Optics	Minor -Pr	2	-	4	4
24PHY24306	Physics in Toy Technology	OE	2	-	-	-
24PHY24407	Laser and its Applications	VSEC	2	-	4	4
24PHY24408	Python Programming	SEC	2	-	4	4
24PHY24609	Community Engagement Project	CEP	2	2	-	2

Course code and title: 23-PHY-231: Mathematical Methods in Physics-I

Total Lectures: 36   **(Credits-02)**

Learning Outcomes: After the completion of this course students will be able to

- Understand the complex algebra useful in physics courses.
- Understand the concept of partial differentiation.
- Understand the role of partial differential equations in physics.
- Understand vector algebra useful in mathematics and physics.
- Understand the concept of singular points of differential equations.

1. Complex Numbers   (9L)

1.1 Introduction to complex numbers

1.2 Rectangular, polar and exponential forms of complex numbers

1.3 Argand diagram

1.4 Algebra of complex numbers using Argand diagram

1.5 De-Moivre's Theorem (Statement only)

1.6 Power, root and log of complex numbers

1.7 Trigonometric, hyperbolic and exponential functions

1.8 Applications of complex numbers to determine velocity and acceleration in curved motion.

1.9 Problems.

2. Partial Differentiation   (9L)

2.1 Definition of partial differentiation

2.2 Successive differentiation

2.3 Total differentiation

2.4 Exact differential

2.5 Chain rule

2.6 Theorems of differentiation

2.7 Change of variables from Cartesian to polar co-ordinates

2.8 Problems.

3. Vector Algebra   (6L)

3.1 Introduction to scalars and vectors, dot product and cross product of two vectors and their physical significance. (Revision)

3.2 Scalar triple product and its geometrical interpretation

3.3 Vector triple product and its proof

3.4 Scalar and vector fields

3.5 Problems.

4. Vector Analysis and its applications (12L)

4.1 Differentiation of vectors with respect to scalar

4.2 Vector differential operator and Laplacian operator

4.3 Gradient of scalar field and its physical significance

4.4 Line Integration, Surface Integration and Volume Integration

4.5 Divergence of scalar field and its physical significance

4.6 Gauss' Diversions Theorem

4.7 Curl of vector field and its physical significance.

4.8 Stokes Theorem, Maxwell's Equation of Electrodynamics: Differential and Integral Forms

4.9 Vector Identities.

    a. $\nabla \times (\nabla \Phi) = 0$

    b. $\nabla \cdot (\nabla \times V) = 0$

    c. $\nabla \cdot (\nabla \Phi) = \nabla^2 \Phi$

    d. $\nabla \cdot (\Phi A) = \nabla \Phi \cdot A + \Phi(\nabla \cdot A)$

    e. $\nabla \times (\Phi A) = \Phi (\nabla \times A) + (\nabla \Phi) \times A$

    f. $\nabla \cdot (A \times B) = B \cdot (\nabla \times A) - A(\nabla \times B)$

4.10 Problems.

Reference Books:

1. Methods of Mathematical Physics by Laud, Takwale and Gambhir.

2. Mathematical Physics by B.D.Gupta.

3. Mathematical Physics by Rajput and Gupta.

4. Mathematical Methods in Physical Science by Mary and Boas.

5. Vector analysis by Spiegel and Murrey.

6. Mathematical Methods for Physicists by Arfkenand Weber. (5th Edition)

7. Fundamentals of Mathematical Physics by A.B.Gupta.

8. Vector Analysis by Seymour Lipschutz and Dennis Spellman.

S.Y.B.Sc. (Physics)

24PHY23102: Heat and Thermodynamics

Lectures: 30   (Credits-02)

Unit 1: Fundamentals of Thermodynamics   (8 Lectures)
Concept of thermodynamic state, Equation of state, Van der Waal's equation of state, Thermal equilibrium, Zeroth law of thermodynamics, Thermodynamic processes: Adiabatic,Isothermal, Isobaric and Isochoric changes, Indicator diagram, Work done during isothermalchange, Adiabatic relations, Work done during adiabatic change, Internal energy, Internalenergy as state function, First law of thermodynamics, Reversible and Irreversible changes, Problems.

Unit 2: Applied Thermodynamics: (7 Lectures)
Conversion of heat into work and it's converse, Second law of thermodynamics, Concept of entropy, Temperature - entropy diagram, T-dS equations, Clausius - Clapeyron latentheat equations, Problems.

Unit 3: Heat Transfer Mechanisms   (8 Lectures)
Carnot's cycle and Carnot's heat engine and its efficiency, Heat Engines: Otto cycle &its efficiency, Diesel cycle & its efficiency, Refrigerators: General principle and coefficient of performance of refrigerator, Simple structure of Vapour compression refrigerator, Air Conditioning: Principle and it's applications, Problems.

Unit 4: Thermometry   (7 Lectures)
Concept of heat & temperature, Principle of thermometry, Temperature scales & inter- conversions, Principle, Construction and Working: (Liquid thermometers, Liquid filled thermometers, Gas filled thermometers, Bimetallic thermometers, Platinum resistancethermometer, Thermocouple), Problems.

Reference Books:
1. Concept of Physics: H. C. Verma, BharatiBhavan Publisher.
2. Heat and Thermodynamics: Brijlal, N. Subrahmanyam, S. Chand and Company Ltd.
3. Heat and Thermodynamics: Mark W. Zemansky, Richard H. Dittman, 7th Edition, Mc-GrawHill International Edition.
4. Thermodynamics and Statistical Physics: J. K. Sharma, K. K. Sarkar, Himalaya Publishing House.
5. Thermal Physics (Heat and Thermodynamics): A. B. Gupta, H. P. Roy books and Allied (P)Ltd. Calcutta.

6. Instrumentation:Devices & Systems, Rangan, Mani, and Sarma.

<center>**S.Y.B.Sc. (Major Pr)**</center>

<center>**24PHY23101:   Physics Laboratory 2A**</center>

Lectures: 60   **(Credits-2)**

Practical Based on Mathematical Methods in Physics and Heat and Thermodynamics

Sr No	Title of the experiment
1	Interpretation of Isothermal and Adiabatic curve on P-V diagram and theoretical study of Carnot's cycle by drawing graphs of Isothermal and Adiabatic curves
2	Study of temperature coefficient of Thermistor.
3	Study of Thermocouple and determination of inversion temperature
4	Study of thermal conductivity by Lee's method
5	Study of specific heat of Graphite
6	Study of Solar constant
7	Determination of calorific values of different fuels
8	Use of MS Excel to perform Vector addition/ subtraction/ multiplication operations
9	Use of MS Excel to determine imaginary part of a complex number, and addition and multiplication of complex numbers
10	Use of MS Excel to solve problems in complex numbers
11	Use of MS Excel to solve partial differential equations

No. of Lectures:30   **(2 Cr Theory Course)**

Introduction:

- Physics is a natural science called as Natural Philosophy in ancient times has developed as a main branch of Science.

- Indian Philosophers and scientists have contributed to the development of this subject.

- This is subject which seeks to understand how everything operates at its most fundamental level.

- Physicists try to understand the fundamental mathematical relationships that control natural occurrences and then apply that knowledge to fascinating situations.

- This paper will give an idea about the contribution of Indian Scientist and the sttaus of development in present times.

Course Outcome:

Students will know about the glorious contribution of Indian Physicist from Ancient times
They will also know about contribution of women physicists
Present scenario of physics research
Our contribution to Astronomical research

Unit 1: Ancient Period   **(4 L)**

- Information about work of Maharshi Kanada

- Buddhist Atomists Dharmakirti and <u>Dignāga</u>

- Pakhuda Kaccayana- 6th Century Philpsopher- Concept of Paramanu

- Aaryabhatta and his work Aryabhatia

- Vedic Period

Unit 2: Research after Ancient Period   **(8 L)**

- Astronomer Keḷallur Nilakantha Somayaji

- Satyendranath Bose and the Concept of Light Quantum

- Chandrasekhara Venkata Raman: Verifying the Light Quantum

- Meghnad Saha: Applying the Light Quantum

- Research in Nanotechnology

- Work on Computers

Unit 3: Research in Astronomy and Astrophysics   **(8 L)**

This section will elaborate on work of Astrophysicist and Astronomical Institutes/ Observatories in India

- Vikram Sarabhai- ISRO
- Jayant Naralikar- IUCAA
- Meghnad Saha
- Subramanayam Chandrashekhar
- Vainu Bappu Observatory- Vellore
- Girawali Observatory- IUCAA
- Mount Abu Infrared Observatory
- Allahabad Observatory and NPL- Indian Standard Time

Unit 4: Contribution of Women Physicist   **(4 L)**
- Dr. Rohini Godbole
- Ritu Karidhal
- Amruta Gadge
- Radha Balakrishnan.
- Archana Bhattacharyya.
- Dr. Anna Mani

Unit 5: Research Institutes in India   **(6 L)**

- TIFR
- BARC
- National Chemical Laboratory (NCL)
- Indian Institute of Science Education and Research
- C MET
- DRDO
- DIAT
- IMD

Reference Books:
- History of Science in India - Physics, Mathematics and Statistics (Volume I, Part - I) published by the national Academy of Science, India and Ramakrishna Mission
- The Making of Modern Physics in Colonial India by Somaditya Banerjee Routledge and CRC Press

24PHY23205: Electronics

Total Lectures: 30   **(Credits-02)**

Learning outcomes:

On successful completion of this course the students will be able to

• Apply different theorems and laws to electrical circuits.

• Understand the relations in electricity.

• Understand the parameters, characteristics and working of transistors.

• Understand the functions of operational amplifiers.

• Design circuits using transistors and applications of operational amplifiers.

• Understand the Boolean algebra and logic circuits.

1. Network Theorem   **(6L)**

    1.1 Krichhoff's Law

    1.2 Voltage and Current Divider Circuit

    1.3 Thevenin's Theorem

    1.4 Norton's Theorem

    1.5 Superposition Theorem

    1.6 Maximum Power transfer theorem (With proof)

    1.7 Problems

2. Study of Transistor   **(10 L)**

    2.1 Bi-junction Transistor

    a) Electronic components, Metals, semiconductors (intrinsic and extrinsic), insulators and their applications, P-n junction diode.

    b) Revision of Bipolar Junction Transistor, Types, Symbol and Basic action.

    c) Configuration (Common Base, Common Emitter and Common Collector)

    d) Current Gain Factors (α and β) and their relations

    e) Input, Output and transfer Characteristic of CE Configuration

    f) Biasing method and Voltage Divider

    g) DC Load line (CE), Operating Point (Q- point)

    h) Transistor as a switch

    2.2 Uni-Junction Transistor

    a) Symbol, Types, Construction, Working Principle, I-V characteristics, Specifications and

Parameters of Uni-Junction Transistor (UJT)

   b) UJT as a relaxation Oscillator.

2.3 Problems.

3. Operational Amplifiers and Application (10 L)

   3.1 Operational Amplifiers

      a) Introduction

      b) Ideal and practical Characteristics

      c) Operational Amplifier: IC741- Block Diagram and Pin diagram

      d) Concept of Virtual Ground

      e) Inverting and Non-inverting operational amplifiers with concept of gain

      f) Operational amplifier as an adder and subtractor

   3.2 Oscillators

      a) Concept of Positive and negative feed back

      b) Barkhausein Criteria for an oscillator

      c) Construction, working and application of phase shift oscillator using IC741

   3.3 Problems

4. Number System and Logic Gates (4 L)

   4.1 Number System: Binary, Binary coded Decimal (BCD), Octal, Hexadecimal

   4.2 Addition and Subtraction of binary numbers and binary fractions using one's and two's complement

   4.3 Basic Logic gates (OR, AND, NOT)

   4.4 Derived gates: NOR, NAND, EXOR, EXNOR, with symbols and truth table

   4.5 Boolean Algebra

   4.6 De Morgan's theorem and its verification

   4.7 Problems

Reference Books-

1. **Electronic Principles**, Malvino, 7th Edition Tata Mc-Graw Hills publication.

2. **Principles of Electronics**, V.K. Mehta, S. Chand publication.

3. **Op-amp and Linear Integrated Circuit**, Ramakant Gaikwad, Prentice Hall of India publication.

4. **Integrated Circuit,** Botkar, Khanna Publication, New Delhi.

5. **Digital Principles and Application**, Malvino and Leech, Tata Mc-Graw Hills publication.

Course code and title: 23-PHY-232: Electronics

Total Lectures: 36   **(Credits-02)**

N.B: This course is for students **who have not taken Electronic Science as one of the subjects at F. Y. B. Sc.**

Learning outcomes:

On successful completion of this course the students will be able to

• Apply different theorems and laws to electrical circuits.

• Understand the relations in electricity.

• Understand the parameters, characteristics and working of transistors.

• Understand the functions of operational amplifiers.

• Design circuits using transistors and applications of operational amplifiers.

• Understand the Boolean algebra and logic circuits.

3. Network Theorem (6L)

3.1 Krichhoff's Law

3.2 Voltage and Current Divider Circuit

3.3 Thevenin's Theorem

3.4 Norton's Theorem

3.5 Superposition Theorem

3.6 Maximum Power transfer theorem (With proof)

3.7 Problems

4. Study of Transistor (12L)

4.1 Bi-junction Transistor

i) Electronic components, Metals, semiconductors (intrinsic and extrinsic), insulators and their applications, P-n junction diode.

j) Revision of Bipolar Junction Transistor, Types, Symbol and Basic action.

k) Configuration (Common Base, Common Emitter and Common Collector)

l) Current Gain Factors (α and β) and their relations

m) Input, Output and transfer Characteristic of CE Configuration

n) Biasing method and Voltage Divider

o) DC Load line (CE), Operating Point (Q- point)

p) Transistor as a switch

4.2 Uni-Junction Transistor

c) Symbol, Types, Construction, Working Principle, I-V characteristics, Specifications and Parameters of Uni-Junction Transistor (UJT)

d) UJT as a relaxation Oscillator.

2.3 Problems.

4. Operational Amplifiers and Application   (12 L)

4.1 Operational Amplifiers

g) Introduction

h) Ideal and practical Characteristics

i) Operational Amplifier: IC741- Block Diagram and Pin diagram

j) Concept of Virtual Ground

k) Inverting and Non-inverting operational amplifiers with concept of gain

l) Operational amplifier as an adder and subtractor

4.2 Oscillators

d) Concept of Positive and negative feed back

e) Barkhausein Criteria for an oscillator

f) Construction, working and application of phase shift oscillator using IC741

3.4 Problems

5. Number System and Logic Gates   (6 L)
5.1 Number System: Binary, Binary coded Decimal (BCD), Octal, Hexadecimal

4.8 Addition and Subtraction of binary numbers and binary fractions using one's and two's complement

4.9 Basic Logic gates (OR, AND, NOT)

4.10 Derived gates: NOR, NAND, EXOR, EXNOR, with symbols and truth table

4.11 Boolean Algebra

4.12 De Morgan's theorem and its verification

4.13 Problems

Reference Books-

6. **Electronic Principles**, Malvino, 7th Edition Tata Mc-Graw Hills publication.

7. **Principles of Electronics**, V.K. Mehta, S. Chand publication.

8. **Op-amp and Linear Integrated Circuit**, Ramakant Gaikwad, Prentice Hall of India publication.

9. **Integrated Circuit,** Botkar, Khanna Publication, New Delhi.

10. **Digital Principles and Application**, Malvino and Leech, Tata Mc-Graw Hills publication.

Open Elective: Weather Studies
Course Code: 24PHY23307

Lectures: 30   **(Credits-2)**

Course Description:
The concepts of atmospheric temperature, pressure, humidity, wind and how these factors are measured. Investigation of the physical processes of the atmosphere in such areas as heat transfer, condensation and precipitation. Study of atmospheric circulation and weather changes. Course includes essentials of climatology.

Objectives:
Upon successful completion of this course, the student will be able to do the following:
1. identify and manipulate basic metric measurements
2. relate the major events in the history of meteorology
3. identify the composition, structure, and layering of the atmosphere
4. discuss the earth/sun relationship and the energy received from the sun as seasons.
5. list and discuss the effects of pressure, density and wind on weather phenomena
6. discuss clouds and precipitation, atmospheric circulation systems and mid-latitude low pressure systems
7. identify and discuss unusual or extreme weather phenomena

Unit 1: Introduction to Meteorology   **(4 Lectures)**

1.1 Introduction
1.2 TV Weather Report
1.3 Science of Meteorology

Unit 2: Atmospheric composition and Structure   **(4 Lectures)**

2.1 Origin of the Earth's Atmosphere
2.2 Composition of the Atmosphere
2.3 Layers of the Atmosphere
2.4 Ozone Layer

Unit 3: Solar Radiation and Energy   **(6 Lectures)**

3.1 Solar Radiations
3.2 Earth and Sun
3.3 Cause of the Seasons
3.4 Solar Energy
3.5 Greenhouse Effect
3.6 Energy Budget of the Earth

Unit 4: Temperature and Heat   **(6 Lectures)**

4.1 Temperature measurement and Scales, types of thermometers

4.2 Heat transfer Mechanisms: Conduction, Convection and Radiation
4.3 Temperature variations and Control
4.4 El Niño and La Niña
4.5 Introduction to digital sensors

Unit 5: Moisture, Air Pressure and Wind   **(5 Lectures)**

5.1 Humidity due point and relative humidity
5.2 Clouds and precipitation formation
5.3 Atmospheric pressure and its measurement
5.4 Wind: Causes and Effects
5.5 Cyclones, Thunderstorm and Tornadoes

Unit6: Study of Weather forecasting techniques   **(5 Lectures)**

6.1 Weather data collection and observation
6.2 Use of weather maps and models
6.3 Long term and short-term forecasting Methods

Reference Books:
1. Prakrutik Bhuvidnyan, Prof. S. P. Date, Anirudha Publication
2. Prakrutik Bhuvidnyan, Dr. Shrikant Karlekar, Raghunath Publishing
3. Physical Geography, Prakrutik Bhuvidnyan, Dr. Arun Kumbhare, Payal Publication
4. Bharatacha Bhugol, Part I, Musmade and More, Nirali Prakashan
5. Causes of Climet Change, Ashok Malik, Rajat Publications
6. Textbook of Physical Geography, R.N. Chauhan, ABD Publications
7. Elements of Climetology and Oceanography, Dr. Shrikant Karlekar,

Total Lectures: 30   **(Credits-02)**

After successful completion of this course, the student will be able to

- Understand the concept of measurement.
- Understand the performance of measuring instruments.
- Design experiments using sensors.

1. Fundamental of measurement, Calibration and Error Analysis   **(8L)**

1.1 Aims of measurement

1.2 Functional elements of typical measurement system (Block diagram and its explanation).

1.3 Standards of measurement and its classification. (International, primary or national, secondary and working standards).

1.4 Calibration

1.5 Static characteristics: Accuracy, Precision, Sensitivity, Linearity, Resolution, Drift and Hysteresis.

1.6 Dynamic characteristics: Types, First and Second order instruments, Examples of first order: Resistance thermometer and thermal element, Example of 2nd order: U–tube Manometer.

1.7 Errors in measurement and its classifications.

1.8 Problems

2. Introduction to Transducers   **(12L)**

2.1 Classification of Transducers and its characteristics

2.2 Displacement Transducer
  a) Resistive Type: Linear and Angular (Rotary) Potentiometer, Strain Gauge: Bonded and Unbonded

  b) Capacitive Type

  c) Inductive Type: Self inductive: Variable number of turns, Variable Reluctance, MutualInductive: LVDT

  d) Piezoelectric Type: Quartz Crystal

2.3 Temperature Measurement

Scales for temperature: Celsius, Kelvin and Fahrenheit

Temperature Measurement Techniques

a) Thermistor: PTC and NTC with characteristics

b) Thermocouple: Seebeck effect and Peltier effect,

2.4 Elastic Transducer- Diaphragm, Corrugated Diaphragm, Bellows, Bourdon Tube

2.5 Problems.

3. Measurement of Pressure (8L)

3.1 Unit of pressure, Concept of vacuum, Absolute gauge and differential pressure,

3.2 Vacuum pumps, Rotary and Diffusion type

3.3 Flow measurement, Electromagnetic flow

3.4 Problems

4. Signal Conditioning and Processing (8L)

4.1 Current to voltage, Voltage to current convertors, buffer amplifier, S/H Amplifier and Characteristics, Acquisition time, Aperture time, Drop rate

4.2 Filters: First order LPF and HPF with design,

4.3 Instrumentation Amplifier (Using 3 op-amp)

4.4 Photodiode , Photomultiplier

4.5 Problems

Reference Books:

1. **Instrumentation Device and System**, Rangan,Mani and Sarma, Tata Mc Graw Hill

2. **Instrumentation Measurement and Analysis**, Nakra, Choudhari, Tata Mc Graw Hill India publication.

3. **Sensors and Transducers**, D. Patranabis, PHI publications.

4. **Op-Amps and Linear Integrated Circuits**, by Ramakant A. Gayakwad, Pearson India publications.

5. **Process control Instrumentation Technology**, C.D. Johnson, PHI publications.

Semester IV

S.Y.B.Sc. (Physics) (Sem- IV)
Major (Theory)
24PHY24101 : Applied Optics

Lectures: 30   **(Credits-02)**

Unit 1: Geometrical Optics   **(6L)**

    1.1 Introduction to lenses and sign conventions, Thin lenses: lens equation for convex lens

    1.2 Lens formula and Lens maker equation (Only Formula)

    1.3 Concept of magnification, deviation and power of thin lens

    1.4 Equivalent focal length of two thin lenses

    1.5 Concept of cardinal points

    1.6 Total Internal Reflection

    1.7

    1.8 Problems.

Unit 2: Wave Optics: Interference and Diffraction   **(10 L)**

    (a) Interference:

    2.1 Introduction to interference- constructive and destructive interference

    2.2 Phase change on reflection (Stokes treatment)

    2.3 Interference due to wedge shaped film

    2.5 Newton's ring (to calculate wavelength)

    2.6 Michelson Interferometer

    2.7 Problems

    (b) Diffraction:

    2.8 Introduction to diffraction

    2.9 Types of diffraction (only discussion)

    2.10 Fraunhoffer's diffraction due to single slit (only qualitative discussion)

    2.11 Plane transmission grating and grating equation (only principal maxima)

    2.12 Rayleigh criterion for resolution (only qualitative discussion)

    2.13 Problems

    Unit 3: Polarization   **(6L)**

    3.1 Introduction to polarization

3.2 Brewster's law

3.3 Law of Malus

3.4 Polarization by double refraction.

3.5 Optical Activity

3.6 Polarimeter, Polaroid (Only construction and working)

3.7 Nicol's Prism

3.8 Application of polarization

3.9 Problem

Unit 4: Holography and Fibre Optics: (8 L)

4.1 Introduction and Theory of Holography

4.2 Importance of coherence and Principle of holography

4.3 Coaxial holography, off axis holography, holograms

4.4 Applications of Holography

4.5 Introduction to Fibre Optics

4.6 The Optical Fibre: Principle and Structure

4.7 Fibre Optics: Numerical aperture and Acceptance angle, Pulse dispersion and Calculation of pulse dispersion

4.8 Types of Optical Fibres: Concept of Mode, Multimode and Single mode fibre

4.9 Attenuation in optical fibers, single mode and multimode fibers

4.10 Fibre Optic communication system: Fiber optical telecommunication system

4.11 Advantages of Fibre Optics

4.12 Problems

Reference Books:
(1) Ghatak Ajoy, Optics 3rd Edition, The McGraw Hill companies.
(2) N. Subrahmanyam, A textbook of Optics, S. Chand publications.
(3) Optical Fiber and Fiber Optic communication System, S.K Sarkar S. Chand.
(4) Practical Optics, Naftaly Menn, Academic press (2004)
(5) M. Born and E. Wolf, Principles of Optics, Cambridge University Press
(6) F. A. Jenkins, H.E White, Fundamental of Optics, McGraw companies

S.Y.B.Sc. (Physics) (Sem-IV)
Major (Theory)

24PHY24102 : Nuclear Physics

Lectures: 30   **(Credits-02)**

1: Nuclear Structure, Properties and Radioactivity: **(9 L)**
   Basic Concept of Nucleus:

1.1 Composition, charge, size, density of nucleus (Revision)

1.2 Nuclear Angular momentum,

1.3 Nuclear magnetic dipole moment

1.4 Electric Quadrupole moment, Parity & symmetry,

1.5 Mass defect and Binding energy, packing fraction,

1.6 Classification of nuclei,

1.7 Stability of nuclei (N Vs Z Curve) .

1.8 Problems

2: Particle Accelerator and Radiation Detectors: **(06 L)**

Particle Accelerators:

2.1 Introduction and Classification

2.2 Linear Accelerator (electron/proton LINAC)

2.3 Cyclic Accelerator (Cyclotron)

2.4 Particle Accelerators in India (Discussion only)

Radiation Detectors:

2.5 Classification of Nuclear Detectors

2.6 Gas filled Detectors (G. M. counter)

2.7 Solid state detectors (scintillation counter)

2.8 Problems

3: Nuclear forces and Nuclear Models: (09 L)

3.1 Classification of Nuclear Forces

3.2 Meson theory of nuclear forces,

3.3 Properties Of nuclear forces, properties of deuteron system,

3.4 Elementary particles,

3.5 Quarks model for elementary particles

3.6 Shell Model: Assumptions, Evidences, and Spin and Parity limitations.

3.7 Liquid drop model: Assumptions

3.8 Semi-empirical B.E. formula

3.9 Problems

4: Nuclear Reactors: (06 L)

4.1 Nuclear fission, nuclear fusion stellar energy, chain reaction and critical mass

4.2 Nuclear reactor and its basic components

4.3 Homogeneous and heterogeneous reactors

4.4 Power reactor, fast breeders

4.3 Nuclear Reactors in India (Discussion only)

4.4 Problems.

Reference books:
1. Dr. S. N. Ghoshal, Nuclear Physics, Revised Edition, S. Chand Publication, 2014
2. D. C. Tayal, Nuclear Physics, Revised Enlarged Edition, Himalaya Publishing House.
3. K.S. Krane, Introductory Nuclear Physics, Wiley, India, 1988
4. B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill
5. I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989
6. S.B. Patel, Nuclear Physics: An Introduction, New Age International, 1991

S.Y.B.Sc. (Major Pr)

24PHY24103 : **Physics Laboratory 2B**

Lectures: 60 **(Credits-2)**

Practical Based on Optics and Nuclear Physics

Sr No	Title of the experiment
1	Characteristics of G.M. tube
2	e/m by Thomson method
3	Determination of Planck's constant
4	Study of Gaussian distribution by G. M. tube
5	Determination of the diameter of a thin wire using a laser beam.
6	Study of diffraction using a transmission/reflection grating (metal ruler)
7	μ' By total internal reflection of light
8	Newton's Ring: Determination of wavelength of monochromatic light source (λ).
9	Dispersive power of glass prism.

10	Double refracting prism.
11	Study of Interference of light by using Biprism

S.Y.B.Sc. (Physics)
Minor Theory
24PHY24204: Optics

Total Lectures: 30   **(Credits-02)**

Learning Outcomes:

On successful completion of this course the students will be able to

- Acquire the basic concept of wave optics.

- Describe how light can constructively and destructively interfere.

- Explain why a light beam spread out after passing through an aperture

- Summarize the polarization characteristics of electromagnetic wave

- Understand the operation of many modern optical devices that utilize wave optics

- Understand optical phenomenon such polarization, diffraction and interference in terms ofthe wave model

- Analyze simple example of interference and diffraction.

Unit 1: Geometrical optics
(4 L)

1.9 Introduction to lenses and sign conventions, Thin lenses: lens equation for convex lens

1.10 Lens formula and Lens maker equation (Only Formula)

1.11 Concept of magnification, deviation and power of thin lens

1.12 Equivalent focal length of two thin lenses

1.13 Concept of cardinal points

1.14 Total Internal Reflection

1.15 Problems.

Unit 2: Lens Aberrations
(4 L)

2.1 Introduction to aberrations: Monochromatic and Chromatic

2.2 Types of monochromatic aberrations

2.3 Spherical aberration and its reduction

2.4 Chromatic aberration

2.5 Achromatism: lenses in contact and separated by a finite distance

2.6 Problem

Unit 3: Optical Instruments
(6 L)

3.1 Introduction to optical instruments

3.2 Types of optical instruments: Simple Microscope, Compound Microscope and
Astronomical telescope (only construction and working)

3.3 Eyepiece: Ramsden's eye piece (Expression), Huygens eye piece and Gauss's
eyepiece (only construction and working)

3.4 Problems

Unit 4: Wave Optics: Interference and Diffraction (10 L)

(b) Interference:

4.1 Introduction to interference- constructive and destructive interference

4.2 Phase change on reflection (Stokes treatment)

4.3 Interference due to wedge shaped film

4.5 Newton's ring (to calculate wavelength)

4.6 Problems

(b) Diffraction:

4.7 Introduction to diffraction

4.8 Types of diffraction (only discussion)

4.9 Fraunhoffer's diffraction due to single slit (only qualitative

   discussion)

4.10 Plane transmission grating and grating equation (only principal maxima)

4.11 Rayleigh criterion for resolution (only qualitative discussion)

4.12 Problems

Unit 5: Polarization   (6L)

5.1 Introduction to polarization

5.2 Brewster's law

5.3 Law of Malus

5.4 Polarization by double refraction.

5.5 Optical Activity

5.6 Polarimeter, Polaroid (Only construction and working)

5.7 Nicol's Prism

5.8 Application of polarization

5.9 Problems

Reference Books:

1. **Optics** by A. R. Ganesan, IVth edition, Pearson Education, E. Hetch.

2. **A Textbook of Optics** by N Subhramanyam, Brijlal, M. N. Avadhanulu, S. Chand Publication

3. **Physical Optics** by A.K. Ghatak, McMillan, New Delhi

4. **Fundamental of Optics** by F. A. Jenkins, H. E. White Mc Graw-Hilll International edition

5. **Principles of Optics**, by D. S. Mathur, Gopal Press, Kanpur.

Open Elective: Physics in Toy Technology

Course Code: 24PHY24306

Lectures: 30   **(Credits 2)**

Introduction:

- Brief overview of the interdisciplinary nature of toys and physics

- Explanation of how physics principles apply to various toys

- Importance of understanding physics in optimizing performance and enhancing techniques in different toys

- The students will understand the physics laws through practical sessions.

Objective of the Course:

- To provide students with a fundamental understanding of physics concepts as they apply to toys

- To explore the relationship between physics principles and design of toys

- To explore basic principles of mechanics, electromagnetism, thermodynamics and fluid mechanics

- To enable students to analyze and evaluate the physical aspects of toys

Learning Outcomes:

By the end of the course, students should be able to:

1. Explain and apply key physics concepts used in toys.

2. Demonstrate an understanding of how different toys utilize physics principles.

3. Critically evaluate the role of physics in research and development of toys.

Unit 1: Introduction to Sports and Physics   (2 L)

- Interdisciplinary nature of toys and physics

- Overview of physics principles in toys

Unit 2: Motion and Mechanics   (4 L)

- Newton's laws of motion and their application in toys

- Projectile motion and its use in toys

- Conservation of momentum and collisions

- Analyzing toy cars and ramps

- Impact of friction, gravity, and air resistance on toys

- Torque and angular momentum

- Spinning top

Unit 3: Energy and work   (4 L)

- Kinetic and Potential energy

- Conservation of energy

- Springs and potential energy in toys

- Energy transfer and efficiency in sports

Unit 4: Fluid Dynamics   (4 L)

- Properties of fluids

- Bernoulli's principle and flight

- Water rockets

Unit 5: Electromagnetics   (4 L)

- Electric circuits and magnetism

- Motors and Generators

- Simple electric toys like electric cars, magnetic trains, Drones

- Electromagnetic waves and communication

- Remote control cars

Unit 6: Thermodynamics   (4 L)

- Heat transfer and thermodynamic principles

- Drinking bird

- Heat engine and thermal toys

Unit 7: Waves and Sound   (4 L)

- Properties of Waves

- Sound Production

- Musical toys

Unit 8: Optics   (4 L)

- Reflection, Refraction, Mirrors and Lenses

- Optical toys like Kaleidoscope, Periscope

Reference Books:

1. Basic Concepts of Physics, Beiser, Addison Wesley
2. Fundamentals of Physics, Halliday & Resnick, Wiley
   3. Concepts of Modern Physics: A Beiser (6 th ed., McGrawHill,2003)
4. A text book of Optics by N. Subhramanyam, Brijlal, M.N. Avadhanaulu, S. Chand Publication
5. A text book of Sound by N. Subhramanyam, Brijlal Vikas Publishing House

Vocational Skill Enhancement Course: 2 Credit (Practical Course)
Course Title: Lasers and its Applications
Course Code: 24PHY24407

No. of Lectures:60   **No. of Credits: 2**

Objectives: It helps in understanding the theoretical and mathematical development of the subject and to create interest in the subject. To give the students, information about construction and characteristics of Lasers. To make the students aware of the commercial applications of Lasers.

Course Description: This course gives basic theory about generation of a laser beam, its characteristics and Construction of a commercial laser. Also some demonstration and laboratory experiments can give them idea about uses of laser.

Topic	Details
Theory	Introduction to Lasers, Brief History, Three basic process: Absorption, spontaneous emission and stimulated emission. Light Amplification
	Laser Action, Pumping Schemes, Components of a laser, Optical Pumping and population inversion, Properties of Laser, Types of Lasers, Application of Lasers
Practical	1) Total Internal Reflection of laser beam
	2) Beam divergence
	3) Measurement of diameter of a thin wire
	4) Measurement of wavelength of Laser beam using plane diffraction grating.
	5) To study the interference of light using optical fibres
	6) Determination of Angle of prism (Pin and drawing paper)
	7) Study of Lissajous figures using diode Laser and mirrors

Reference books:

1. An introduction to Lasers - Theory and applications, M.N. Avadhanulu, S. Chand and Co. New Delhi
2. Experiments with He-Ne Laser by Sirohi
3. Optical fibre and Laser - Principle and applications, Anuradha De, New Age International Publishers,

T.Y.B.Sc. (Physics) (Sem-V)
24PHY24408: Python Programming

Lectures: 30   **(Credits-02)**

Pre-requisite	: Basic mathematics (XII-Science)
Version of python	: 3.4
Proposed IDE	: Spider, Py Charm or Jupyter

Python Programming:

Python is one of the top ten popular programming languages. Python is a general purpose and high level programming language. You can use Python for developing desktop GUI applications, websites and web applications. Also, Python, as a high level programming language, allows you to focus on core functionality of the application by taking care of common programming tasks. The simple syntax rules of the programming language further makes it easier for you to keep the code base readable and application maintainable. There are also a number of reasons why you should prefer Python to other programming languages.

Advantages of Python Programming

- i.) Readable and Maintainable Code
- ii.) Multiple Programming Paradigms
- iii.) Compatible with Major Platforms and Systems
- iv.) Robust Standard Library
- v.) Many Open Source Frameworks and Tools
- vi.) Simplify Complex Software Development
- vii.) Adopt Test Driven Development

Objectives:

- i.) To build foundation for understanding Python environment to enhance computational skills.
- ii.) Understand variables, input and output functions in python and To Apply computational skill in problem solving approach of Physics
- iii.) Get exposure to arithmetic, assignment, relational, logical and Boolean operators.
- iv.) Be familiar with Python modules and Libraries

Course outcomes:

After completion of this course student will be able

- i.) To write code for complex scientific computational requirement.
- ii.) Use Libraries like NumPy for numeric computation
- iii.) Use Library SciPy for scientific and technological calculations
- iv.) Use Library Matplotlib for plotting of graph and its visualization.
- v.) Develop own functions for Physics or mathematics.

Syllabus

a) Python Programming:

Unit No.	Topic	Lectures
1	**Introduction to Computers :** History of Computers: first to fifth generations ,Characteristics of computers ,Classification of Computers, flowcharts symbols ,Brief about : Translators ,Compiler, Interpreter ,Assembler .Computer memory ,Representation of data.	03
2	**Introduction to Python Programming Language**: Introduction to Python Language, • Strengths and Weaknesses, • IDLE, Dynamic Types, • Naming Conventions, • String Values, • String Operations, • String Slices, • String Operators, • Numeric Data Types, • Conversions, • Built In Functions	05
3	**Data Collections and Language Component:** • Introduction, • Control Flow and Syntax, • Indenting, • The if Statement, • Relational Operators, • Logical, • Operators, • True or False, • The while Loop, break and continue, • The for Loop, Lists, Tuples, Sets, Dictionaries, • Sorting Dictionaries, • Copying Collections.	05
4	**Functions and Modules :** • Introduction • Defining Your Own Functions Parameters • Function Keyword and Optional Parameters • Passing Collections to a Function • Variable Number of Arguments Scope • Functions Passing Functions to a Function • Mapping Functions in a Dictionary • Modules • Standard Modules – math • Standard Modules – time • The dir Function	05

Sr. No.	Practical/Demonstration to Communicate Concepts and Application in Physics, Electronics, Statistics and Mathematics
1	Write python program to read and print values of variables of different data types.
2	Write python program to find prime numbers etc
3	Write python program to store data in list and perform matrix operation
4	Write python program to calculate the distance between two points.
5	Write python program to calculate area of a circle.
6	Write python program to find greatest number from three numbers
7	Write python program to find whether the given number is even or odd
8	Write python program to enter a binary number and convert it into decimal.
9	Write python program using For loop to calculate factorial of a number
10	Write python program to find smaller of two numbers using lambda function.

Reference books:

- Python Programming: Using Problem Solving Approach. By Reema Thareja.
- Think Python By Allen Downey
- Problem Solving and Python Programming By Balguruswami McGrow Hill
- Let Us Python By Aditya Kanetkar
- Learning with Python By Allen Downey
- Data Analytics By Bharti Motwani

c) **Scientific Data Analysis**

Unit No.	Topics	Lectures
I	**Data Structures, modules and Importing Datasets** Lists: Creating list, accessing list elements, functions for lists, programming with lists Tuples: Creating Tuples, accessing list elements, functions for Tuples, programming with Tuples Dictionary: Creating Dictionary, accessing list elements, functions for Dictionary, programming with Dictionary. In Built modules : Math module, random Module, Array module, string Module etc	6
II	**Core libraries in Python** NumPy Library for Arrays Pandas Library for Data Processing Basics of data frames, create, adding/ deleting of rows, columns to data frames Import of data, functions of data frames Data Normalization Sets, data extraction using relational, logical operators. Group by functionality, missing values	6
III	**Summarizing the Data Frame and visualization** Matplotlib Library for visualization: Line chart using plot function, Pie chart, violin plot, bar chart, area plot. Seaborn Library for Visualization: Box plot, point plot, count plot, strip plot, scatter plot	6

Practicals : Perform any 5 practicals   **Lectures- 18**

Sr. No.	Practical/Demonstration to Communicate Concepts and Application in Physics, Electronics, Statistics and Mathematics
1	Write python program to remove all duplicates from a list
2	Write python program that convert a list of temperature in Celsius into fahrenheit
3	Write python program to modify an item in the dictionary
4	Write python program using functions on numpy array
5	Write python program to draw Line chart , Pie chart using Matplotlib Library
6	Write python program to draw violin plot, bar chart using Matplotlib Library
7	Write python program to draw Box plot, point plot using Seaborn Library
8	Write python program to draw violin plot, bar chart using Seaborn Library
9	Write python program to draw strip plot, scatter plot using Seaborn Library

Reference Books:

- Python Programming: Using Problem Solving Approach- Reema Thareja.
- Let us Python - Aditya Kanetkar
- Problem Solving and Python Programming By Balguruswami McGrow Hill
- Think Python By Allen Downey
- Learning with Pythob - Allen Downey

Data Analytics - Bharti Motwani

COURSE STRUCTURE OF THE COURSE:

Structure of the course for the second year and the pattern of examination is as specified below:

Sem.	Paper	Paper	Paper title	No. of credits	Marks		
					CIA	ESE	Total
III	Major DSC (Vertical 1) 25STA23101	I	Continuous probability distributions and Statistical Techniques I	4	40	60	100
	Major DSC (Vertical 1) 25STA23102	II	Practical III (based on Theory paper) (Manual and using MS-Excel)	2	20	30	50
	Major IKS (Vertical 1) 25STA23103	III	Indian Statistical knowledge system	2	20	30	50
	Major VSEC (Vertical 4) 25STA23404	IV	Introduction to C language	2	20	30	50
	Minor (Vertical 2) 25STA23205	I	Continuous probability and Statistical Techniques I	2	20	30	50
	Minor (Vertical 2) 25-STA-23206	II	Practical III (based on Theory paper) (Manual and using MS-Excel)	2	20	30	50
IV	Major DSC (Vertical 1) 25STA24101	I	Continuous Probability distributions and Statistical Techniques II	4	40	60	100
	Major DSC (Vertical 1) 25STA24102	II	Practical IV (based on Theory paper) (Manual and using MS-Excel)	2	20	30	50
	Major VSEC (Vertical 4) 25STA24403	IV	Introduction to Python	2	20	30	50
	Minor (Vertical 2) 25STA24204	I	Continuous Probability distributions and Statistical Techniques II	2	20	30	50
	Minor (Vertical 2) 25STA24205	II	Practical IV (based on Theory paper) (Manual and using MS-Excel)	2	20	30	50

Evaluation Scheme:

Sr. No,	Type of Examination	Description of Marking System	Marks
1	Theory (4 Credits)	End Semester Examination (ESE) At the end of each Semester	40
		Continuous Internal Assessment (CIA) Continuous throughout Semester	60
	Total Marks		100
2	Practical (2 Credits)	End Semester Examination (ESE) At the end of each Semester 1) On Line Examination(Excel) (Q1 compulsory) 2) Using Calculator: (Attempt any two questions out of Q2, Q3, and Q4.	5 25
		Total Marks	30
		Continuous Internal Assessment (CIA) Continuous throughout Semester 1) Journal Day to day work 2) Viva 3) Small Project in group	10 5 5
		Total Marks	20
	Total Marks		50

Preparation by Internal Examiner for Section I (Online examination):

➢ Keep at least 15 **computers** with latest configuration ready with battery backup and necessary software, printers, scientific calculators, necessary statistical tables, normal probability paper at the examination laboratory.
➢ Appropriate data sets for time series: linear, quadratic, exponential trend fitting, exponential smoothing be entered in spreadsheet.
➢ Any other type of data required as per slip also be entered in computer spreadsheet.

Instructions to Examiners:

➢ Students are not expected to fill data items at the time of examination. They are expected to use $Ms - EXCEL$ and R −commands (whichever is applicable) to operate on the data set which are already fed.
➢ The questions on section I (On line examination Using $Ms - EXCEL$ / R−commands (whichever is applicable)) are compulsory and there is no internal option.
➢ The slips made available for Section I shall be allotted to the candidates at random so that the total marks of all asked commands will be exactly 05.

Instruction for Examination:

- ➢ The theory question paper for each paper shall cover all the topics in the pertaining syllabus with proportional weightage to the number of hours of instruction prescribed.
- ➢ The practical are to be conducted in batches as per the University norms for the faculty of science.
- ➢ Medium of Instruction: English.

Examination:

- • Pattern of examination: Semester wise.
- • Standard of passing : As per norms of University

Bloom's Taxonomy:

Sr. No.	Particular
B6	Create
B5	Evaluate
B4	Analyze
B3	Apply
B2	Understand
B1	Remember

Create — Use Existing Information to make something new. Invent, Develop, Design, Compose, Generate, Construct

Evaluate — Make judgments based on sound analysis. Assess, Judge, Defend, Prioritize, Critique, Recommend

Analyze — Explore relationships, causes, and connections. Compare, Contrast, Categorize, Organize, Distinguish

Apply — Use existing knowledge in new contexts. Practice, Calculate, Implement, Operate, Use, Illustrate

Understand — Grasp the meaning of something. Explain, Paraphrase, Report, Describe, Summarize

Remember — Retain and recall information. Reiterate, Memorize, Duplicate, Repeat, Identify

SEMESTER – III

Theory Paper–I (Major DSC Vertical 1)

25-STA23101: Continuous probability distributions and Statistical

Techniques I

[NO. OF CREDITS=04   NO. OF HOURS = 60]

COURSE OUTCOMES (COS): At the end of the course student will be able to:

CO1) Differentiate between discrete and continuous random variable.

CO2) Find moments of a continuous random variable

CO3) Understand vital events in the human life cycle and their importance,

CO4) Understand the technique of queuing modelling.

CO5) Fit multiple linear regression model to real life data.

CO6) Simulate (Realize) queueing model (M/M/1)

COURSE CONTENT:

Unit1: Introduction (Uni-variate Continuous random variable) [14 Hours]

- Continuous sample space:
  - ✓ Definition.
  - ✓ Illustrations.
- Continuous random variable:
  - ✓ Definition.
  - ✓ Probability density function (p. d. f.).
  - ✓ Probability distribution of function of r. v.: $Y = g(X)$ using) Jacobian of transformation for $g(.)$ monotonic function and one-to-one, on to functions.
  - ✓ Cumulative distribution function (c. d. f.), properties of c. d. f. (without proof). Distribution function for $Y = X^2$,   Y = |X| etc.
  - ✓ Probabilities of events related to random variable.
  - ✓ Expectation of continuous r. v., expectation of function of r. v. [(X)].
  - ✓ Mean, geometric mean, harmonic mean.
  - ✓ Mode.
  - ✓ Partition values: quartiles (Q_1, Q_2, Q_3), deciles, percentiles.
  - ✓ Raw and central moments, variance.
  - ✓ Skewness, kurtosis.
  - ✓ Mean deviation about mean.
- Moment generating function (MGF):
  - ✓ Definition, properties.
  - ✓ M.G.F. of (X).
  - ✓ Cumulant generating function (CGF): Definition.

Unit2: Introduction (Bi-variate Continuous random variable)   [16 Hours]

- Continuous bivariate random vector or variable (X, Y):
  - ✓ Joint p. d. f.,

4

- ✓ Joint c. d. f., properties (without proof), probabilities of events related to random variables (events in terms of regions bounded by regular curves, circles, straight lines).
- ✓ Probability distribution of transformation of bivariate r. v. $U = \phi_1(X,Y), V = \phi_2(X,Y)$.
- ✓ Marginal and conditional distributions.
- Expectation of r. v. (X, Y), expectation of function of r. v.
  - ✓ $[(X,Y)]$, joint moments, c (X,Y), $Corr(X,Y)$.
  - ✓ Conditional mean, conditional variance.
  - ✓ $E[E(X|Y=y)] = E(X)$ & $E[E(Y/X=x) = E(Y)$,
  - ✓ $r$egression as a conditional expectation.
  - ✓ Theorems on expectation:
    1) $E(X + Y) = E(X) + E(Y)$.
    2) $\text{E}(XY) = \text{E}(X)\,\text{E}(Y), if\ X\ and\ Y$ are independent.
    3) Generalization to k variables. $(aX + bY + c), Var(aX + bY + c)$ (statement only proof not expected).
- Moment generating function (MGF): $M_{X,\text{F}}(t_1, t_2)$:
  - ✓ Definition.
  - ✓ Properties, MGF of marginal distribution of random variables (r. v. s.),
  - ✓ properties:
    1) $M_{X,\text{Y}}(t_1, t_2) = M_X(t_1, 0)\, M_\text{F}(0, t_2)$ if X and Y are independent r. v. s.
    2) $M_{X+\text{Y}}(t) = M_{X,\text{Y}}(t, t)$
    3) $M_{X+y} = M_X(t)\, M_\text{Y}(t)$ if X and Y are independent r. v. s.

Unit3: Multiple linear regression model   [12 Hours]

- Multiple regression coefficient:
  - ✓ Definition of multiple correlation coefficient $R_{\text{Y}.X_1 X_2}$
  - ✓ Derivation of the expression for multiple correlation coefficient.
  - ✓ Properties of multiple correlation coefficient.
    1) $0 \le R_{\text{Y}.X_1 X_2} \le 1$
    2) $R_{\text{Y}.X_1 X_2} \ge \min\{r_{yx_1}, r_{yx_2}\}$.
  - ✓ Interpretation of coefficient of multiple determination $R^2{}_{\text{Y}.X\ X}$ as explained by linear proportion of variation explained by the linear regression
  - ✓ Properties:
    1) $\underline{R^2_{Y.X_1 X_2}=0}$
    2) $\underline{R^2_{Y.X_1 X_2}=1}$
- Partial correlation coefficient:
  - ✓ Definition
  - ✓ derivation of partial correlation coefficient $r_{yx_1.x_2}$ and $r_{yx_2.x_1}$
  - ✓ Property of partial correlation coefficient
- **Multiple linear regression:**
  - ✓ Notion of multiple linear regression.
  - ✓ Yule's notation (trivariate case) (statement only).
  - ✓ Fitting of regression plane of Y on X_1 and X_2, $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$

by the method of least squares; obtaining normal equations, solution of normal equations.

✓ Definition and interpretation of partial regression coefficients β_1 and β_2. (relations between partial regression coefficients and multiple correlations on are not expected).

✓ Residual: Definition, order, derivation of variance, properties.

Unit4: Demography   [10 Hours]

- Vital events, vital statistics, methods of obtaining vital statistics, rates of vital events, sex ratios, dependency ratio.
- Death/Mortality rates: Crude death rate, specific (age, sex etc.) death rate, standardized death rate (direct and indirect), infant mortality rate.
- Fertility/Birth rate: Crude birth rate, general fertility rate, specific (age, sex etc.) fertility rates, total fertility rate.
- Growth/Reproduction rates: Gross reproduction rate, net reproduction rate. .(Numerical examples with heavy computations are to be asked preferably in practicals).
- Interpretations of different rates, uses and applications.
- Trends in vital rates as revealed in the latest census.

Unit5: Queuing Model   [08 Hours]

- Introduction to quening model (M/M/1) as an application of exponential distribution, Poisson distribution and geometric distribution.
- Some concepts used in queuing theory like calling population, queue discipline, queue length, number of customers in queue.
- Kendall's notation
- Little's formulae

SEMESTER – III

Practical Paper–III (Major DSC Vertical 1)

25-STA23102: (Based on Theory Paper) (Manual and using Excel)

[NO. OF CREDITS=02   NO. OF HOURS = 60]

Objectives:

- ➢ To fit various discrete and continuous probability distributions and to study various real life situations.
- ➢ To identify the appropriate probability model that can be used.
- ➢ To use forecasting and data analysis techniques in case of univariate and multivariate data sets.
- ➢ To use statistical software packages.
- ➢ To test various hypotheses of significance like means, proportions, independence of attributes, variance etc. included in theory (using calculators, software).
- ➢ To compute probabilities of discrete and continuous probability distributions using MS-Excel and/or R software (whichever is applicable).
- ➢ To study applications of statistics in the field of demography etc.

[NO. OF CREDITS=02   NO. OF PRACTICALS = 15]

Sr. No.	Title of the experiment	No. of Practical
1	Checking the validity of probability model (checking the conditions of pdf)	2
2	Calculation of cumulative distribution function, Sketching of cdf, checking the validity of cdf	2
3	Calculation of measures for continuous data	1
4	Bivariate continuous distribution (checking the conditions of pdf, calculation of marginal, conditional pdf)	1
5	Measures on the basis of bivariate continuous distribution	1
6	Fitting of Multiple regression (Manual and Using Excel)	1
7	Demography	2
8	Queuing model	2
9	Case study	3
	Total	15

Notes:
- ➢ For case study, a group of maximum 8 students will be allowed.
- ➢ All the students in a group should be given equal marks for project.
- ➢ Different data sets from newspapers, internet, and magazines may be collected and students will be asked to use Statistical techniques/tools which they have learnt.

> Students must produce at the time of practical examination, the laboratory journal alongwith the completion certificate signed by the Head of the Department.

SEMESTER – III

(Major IKS Vertical 1)

25-STA23103: Indian Statistical Knowledge System

[NO. OF CREDITS=02   NO. OF HOURS = 30]

COURSE OUTCOMES (COS): At the end of the course student will be able to:
CO1) Understand how the statistics was used in Ancient days.
CO2) Understand the development of Statistics
CO3) Find different institutes in India.

COURSE CONTENT:

Unit1: History of Statistics used in India in Ancient days   [08 Hours]
Unit2: Introduction of different institutes in India   [12 Hours]
Unit3: Introduction of different techniques used in ancient Indian and new era   [10 Hours]

SEMESTER – III

(Major VSEC Vertical 4)

25-STA23104: Introduction to C language

[NO. OF CREDITS=02   NO. OF PRACTICALS = 15]

Sr. No.	Title of the experiment	No. of Practical
1	Introduction of different types of variables, and Introduction of printf(), scanf(),	1
2	Simple C programs 1. Simple arithmetic operations (addition, subtraction, multiplication,division 2. Calculation of area of i) Triangle ii) Circle 3. Conversion of degree celcius to Faherenheit and Fahrenheit to degree celcius 4. Finding maximum and minimum of two numbers and three numbers using conditional operator ?:	2
3	Measures of central tendency and dispersion for raw data using for loop statement.	2
4	To initiate array (one dimensional and two dimensional array), to arrange the array in increasing/decreasing order.	2
5	1. To check the palindrome. 2. To write number in reverse order	2
6	Solving 1. two simple linear equations in two variables. 2. Quadratic equation in two variables	2
7	Introduction to while statement and use of it to solve transcendental equation.	1
8	Introduction to switch() function and use of it to find area	1
9	To find correlation coefficient and to fit line of regression.	1
10	Introduction to pointer	1
	Total	15

.

➤ Students must produce at the time of practical examination, the laboratory journal alongwith the completion certificate signed by the Head of the Department.

SEMESTER – IV

Theory Paper–II (Major DSC Vertical 1)

25-STA24101: Continuous probability distributions and Statistical

Techniques II

[NO. OF CREDITS=02   **NO. OF HOURS = 60]**

COURSE OUTCOMES (COS): At the end of the course student will be able to:

CO1) Understand different standard continuous probability distributions.

CO2) Find moments of standard continuous random variable

CO3) Understand new technique "Testing of Hypotheses".

CO4) Understand the technique of "Regression".

COURSE CONTENT:

Unit1: Some Standard Probability distributions   [30 Hours]

- Uniform distribution: **[02 Hours]**
  - ✓ Definition.
  - ✓ Probability density function.
  - ✓ Cumulative distribution function.(Partition values), Distribution of $\frac{X-a}{b-a}$, $\frac{b-X}{b-a}$, F(x)
  - ✓ Expected value. (Mean, variance, Central moments)
- Exponential distribution: **[04 Hours]**
  - ✓ Definition.
  - ✓ Probability density function. (Nature of density curve)
  - ✓ Cumulative distribution function.(Partition values), Distribution of min(X, Y), max(X, Y).
  - ✓ Expected value. (Mean, variance, Central moments).
  - ✓ Moment generating function.
  - ✓ Cumulant generating function
  - ✓ Properties
- Gamma distribution: [**04 Hours]**
  - ✓ Definition.
  - ✓ Probability density function. (Nature of density curve)
  - ✓ Expected value. (Mean, variance, Central moments).
  - ✓ Moment generating function.
  - ✓ Cumulant generating function
  - ✓ Properties
- Normal distribution: **[08 Hours]**
  - ✓ Definition.
  - ✓ Probability density function. (Nature of density curve)
  - ✓ Expected value. (Mean, variance, Central moments).
  - ✓ Moment generating function.
  - ✓ Cumulant generating function ₁₁

- ✓ Properties
- Chi square distribution: **[04 Hours]**
    - ✓ Definition.
    - ✓ Probability density function. (Nature of density curve)
    - ✓ Expected value. (Mean, variance, Central moments).
    - ✓ Properties
- Student's t distribution: **[04 Hours]**
    - ✓ Definition.
    - ✓ Probability density function. (Nature of density curve)
    - ✓ Expected value. (Mean, variance, Central moments).
    - ✓ Properties
- Snedecor's F distribution: **[04 Hours]**
    - ✓ Definition.
    - ✓ Probability density function. (Nature of density curve)
    - ✓ Expected value. (Mean, variance, Central moments).
    - ✓ Properties
    - ✓ Interrelation between chi-square, t and F distribution

Unit2: Testing of hypothesis   [20 Hours]
- Introduction   **[04Hours]**
    - ✓ Concept of testing of hypotheses
    - ✓ Definitions and types of hypothesis
    - ✓ Concept of Statistics, Test Statistic, Parameter, Sampling Distribution
    - ✓ Acceptance and Rejection region: Definition, Criterion of deciding
    - ✓ Level of significance
- Approximate test: **[04Hours]**
    - ✓ For population mean
        1) Single population mean
        2) Two population means
    - ✓ For population proportion
        3) Single population proportion
        4) Two population proportions
- Exact test: t test   **[05 Hours]**
    - ✓ t test for:
        1) Single population mean
        2) Two population means (independent, paired)
    - ✓ Chi square test for: **[04 Hours]**
        1) Single population variance
        2) Independence of attributes
        3) Fitting of distribution
    - ✓ F test for equality of two independent population variances. **[02 Hours]**

Unit3: Time Series   [10 Hours]
- Meaning and utility of time series, components of time series: trend, seasonal variations, cyclical variations, irregular (error) fluctuations or noise

12

- Exploratory data analysis: Time series plot to (i) check any trend and seasonality in the time series (ii) identify the nature of trend.
- Methods of trend estimation and smoothing: (i) moving average, (ii) linear, parabolic, exponential, Parato curve fitting by least squares principle (iii) exponential smoothing.
- Choosing parameters for smoothing and forecasting.
- Forecasting based on exponential smoothing.
- Measurement of seasonal variations: i) simple average method, ii) ratio to moving average method, iii) ratio to trend where linear trend is calculated by method of least squares.(Numerical examples with heavy computations are to be asked preferably in practical).
- Fitting of autoregressive model *AR* (I)
- Case studies of real life Time Series: Price index series, share price index series, economic time series: temperature and rainfall time series, wind speed time series, pollution levels.

SEMESTER – IV

Theory Paper–IV (Major DSC Vertical 1)

25-STA24102: (Based on Theory Paper) (Manual and using R software)

[NO. OF CREDITS=02   NO. OF PRACTICALS = 15]

Sr. No.	Title of the experiment	No. of Practical
1	Fitting of Normal distribution, exponential distribution	2
2	Application of Distributions(Uniform, Normal, Exponential)	3
3	Graphical representation of different distributions	1
4	Approximate tests	2
5	Exact test for population mean	2
6	Chi square tests	2
7	Moving averages(3 yearly, 5 yearly, 4 yearly), graph of original and moving average series	1
8	Exponential smoothing	1
9	Seasonality Calculation(ratio to trend)	1
10	Report	2
	Total	15

14

SEMESTER – IV

(Major VSEC Vertical 4)

25-STA24403: Introduction to Python

[NO. OF CREDITS=02   NO. OF PRACTICALS = 15]

Sr. No.	Title of the experiment	No. of Practical
1	Different data types used in python	1
2	Introduction to various directories used in python	1
3	Simple mathematical calculations in python	1
4	Simple statistical calculations in python	1
5	Diagrammatic representation of data(pie chart, simple/ multiple bar diagram, subdivided bar diagram)	2
6	Graphical representation of data	1
7	Fitting of linear regression model in python	2
8	Testing of hypotheses	1
9	Introduction to high level statistics using python Part 1	2
10	Introduction to high level statistics using python Part 2	2
	Total	14

Notes:

- For case study, a group of maximum 8 students will be allowed.
- All the students in a group should be given equal marks for project.
- Different data sets from newspapers, internet, and magazines may be collected and students will be asked to use Statistical techniques/tools which they have learnt.

Students must produce at the time of practical examination, the laboratory journal alongwith the completion certificate signed by the Head of the Department

1. .

Reference Websites:
1. www.stats.unipune.ac.in (100 Data sets for Statistics Education by Dr. Anil P. Gore,Dr. Mrs. S. A. Paranjape and Madhav B. Kulkarni available in ISPS folder).
2. www.freestatistics.tk(National Statistical Agencies)
3. www.psychstat.smsu.edu/sbk00.htm(Onlinebook)
4. www.bmj.bmjournals.com/collections/statsbk/index.shtml
5. www.statweb.calpoly.edu/bchance/stat-stuff.html
6. www.amstat.org/publications/jse/jse-data-archive.html(International journal onteaching and learning of statistics)
7. www.amstat.org/publications/chance(Chancemagazine)
8. www.statsci.org/datasets.html(Datasets)
9. www.math.uah.edu/stat(Virtual laboratories in Statistics)
10. www.amstat.org/publications/stats(STATS : the magazine for students of Statistics)
11. www.stat.ucla.edu/cases(Case studies in Statistics).
12. www.statsoft.com
13. www.statistics.com
14. www.indiastat.com
15. www.unstat.un.org
16. www.stat.stanford.edu
17. www.statpages.net
18. www.wto.org
19. www.censusindia.gov.in
20. www.mospi.nic.in
21. www.statisticsofindia.in

Books Recommended:

1. Brockwell P.J.and Davis R.A. (2003), Introduction to Time Series and Forecasting (Second Edition), Springer Texts in Statistics.
2. Chatfield C. (2001), The Analysis of Time Series An Introduction, Chapman and Hall / CRC, Texts in Statistical Science .
3. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
4. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .
5. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
6. Gupta, S. P. (2002), Statistical Methods (Thirty First Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.
7. Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), Introduction to Mathematical Statistics (Tenth Impression), Pearson Prentice Hall.
8. Kulkarni, M. B., Ghatpande, S. B. and Gore, S. D. (1999), Common Statistical Tests, Satyajeet Prakashan, Pune 411029
9. Medhi, J., Statistical Methods, Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi – 110002.
10. Meyer, P. L., Introductory Probability and Statistical Applications, Oxford and IBH Publishing Co. New Delhi.
11. Mood, A. M., Graybill F. A. and Bose, F. A. (1974), Introduction to Theory of Statistics (Third Edition, Chapters II, IV, V, VI), McGraw - Hill Series G A 276
12. Mukhopadhya Parimal (1999), Applied Statistics, New Central Book Agency, Pvt. Ltd. Kolkata
13. Purohit S. G., Gore S. D. and Deshmukh S. R. (2008), Statistics using R, Narosa Publishing House, New Delhi.
14. Ross, S. (2003), A first course in probability (Sixth Edition), Pearson Education publishers , Delhi, India.
15. Walpole R. E., Myers R. H. and Myers S. L. (1985), Probability and Statistics for Engineers and Scientists (Third Edition, Chapters 4, 5, 6, 8, 10), Macmillan Publishing Co. Inc. 866, Third Avenue, New York 10022.
16. Weiss N., Introductory Statistics, Pearson education publishers

COURSE STRUCTURE OF THE COURSE:

Structure of the course for the second year and the pattern of examination is as specified below:

Sem.	Paper	Paper	Paper title	No. of credits	Marks		
					CIA	ESE	Total
III	Minor (Vertical 2) 25STA23205	I	Continuous probability and Statistical Techniques I	2	20	30	50
	Minor (Vertical 2) 25-STA-23206	II	Practical III (based on Theory paper) (Manual and using MS-Excel)	2	20	30	50
IV	Minor (Vertical 2) 25STA24204	I	Continuous Probability distributions and Statistical Techniques II	2	20	30	50
	Minor (Vertical 2) 25STA24205	II	Practical IV (based on Theory paper) (Manual and using MS-Excel)	2	20	30	50

Evaluation Scheme:

Sr. No,	Type of Examination	Description of Marking System	Marks
1	Theory (2 Credits)	End Semester Examination (ESE) At the end of each Semester	20
		Continuous Internal Assessment (CIA) Continuous throughout Semester	30
		Total Marks	50
2	Practical (2 Credits)	End Semester Examination (ESE) At the end of each Semester 1) On Line Examination(Excel) (Q1 compulsory) 2) Using Calculator: (Attempt any two questions out of Q2, Q3, and Q4.	5 25
		Total Marks	30
		Continuous Internal Assessment (CIA) Continuous throughout Semester 1) Journal Day to day work 2) Viva 3) Small Project in group	10 5 5
		Total Marks	20
		Total Marks	50

Preparation by Internal Examiner for Section I (Online examination):

- ➤ Keep at least 15 **computers** with latest configuration ready with battery backup and necessary software, printers, scientific calculators, necessary statistical tables, normal probability paper at the examination laboratory.
- ➤ Appropriate data sets for time series: linear, quadratic, exponential trend fitting, exponential smoothing be entered in spreadsheet.
- ➤ Any other type of data required as per slip also be entered in computer spreadsheet.

Instructions to Examiners:

- ➤ Students are not expected to fill data items at the time of examination. They are expected to use $Ms - EXCEL$ and R −commands (whichever is applicable) to operate on the data set which are already fed.
- ➤ The questions on section I (On line examination Using $Ms - EXCEL$ / R−commands (whichever is applicable)) are compulsory and there is no internal option.
- ➤ The slips made available for Section I shall be allotted to the candidates at random so that the total marks of all asked commands will be exactly 05.

Instruction for Examination:

- ➤ The theory question paper for each paper shall cover all the topics in the pertaining syllabus with proportional weightage to the number of hours of instruction prescribed.
- ➤ The practical are to be conducted in batches as per the University norms for the faculty of science.
- ➤ Medium of Instruction: English.

Examination:

- Pattern of examination: Semester wise.
- Standard of passing : As per norms of University

Bloom's Taxonomy:

Sr. No.	Particular
B6	Create
B5	Evaluate
B4	Analyze
B3	Apply
B2	Understand
B1	Remember

Create	**Use Existing Information to make something new** Invent, Develop, Design, Compose, Generate, Construct
Evaluate	**Make judgments based on sound analysis** Assess, Judge, Defend, Prioritize, Critique, Recommend
Analyze	**Explore relationships, causes, and connections** Compare, Contrast, Categorize, Organize, Distinguish
Apply	**Use existing knowledge in new contexts** Practice, Calculate, Implement, Operate, Use, Illustrate
Understand	**Grasp the meaning of something** Explain, Paraphrase, Report, Describe, Summarize
Remember	**Retain and recall information** Reiterate, Memorize, Duplicate, Repeat, Identify

SEMESTER – III

Theory Paper–I (Minor Vertical 2)

25-STA23205: Continuous probability and Statistical Techniques I

[NO. OF CREDITS=02   NO. OF HOURS = 30]

COURSE OUTCOMES (COS): At the end of the course student will be able to:

CO1) Differentiate between discrete and continuous random variable.

CO2) Find moments of a continuous random variable

CO3) Understand vital events in the human life cycle and their importance,

CO4) Understand the technique of queuing modelling.

COURSE CONTENT:

Unit1: Introduction (Uni-variate Continuous random variable) [07 Hours]

- Continuous sample space:
    - ✓ Definition.
    - ✓ Illustrations.
- Continuous random variable:
    - ✓ Definition.
    - ✓ Probability density function (p. d. f.).
    - ✓ Probability distribution of function of r. v.: $Y = g(X)$ using) Jacobian of transformation for g (.) monotonic function and one-to-one, on to functions.
    - ✓ Cumulative distribution function (c. d. f.), properties of c. d. f. (without proof). Distribution function for $Y = X^2$, $Y = |X|$ etc.
    - ✓ Probabilities of events related to random variable.
    - ✓ Expectation of continuous r. v., expectation of function of r. v. $[(X)]$.
    - ✓ Mean, geometric mean, harmonic mean.
    - ✓ Mode.
    - ✓ Partition values: quartiles (Q_1, Q_2, Q_3), deciles, percentiles.
    - ✓ Raw and central moments, variance.
    - ✓ Skewness, kurtosis.
    - ✓ Mean deviation about mean.
- Moment generating function (MGF):
    - ✓ Definition, properties.
    - ✓ M.G.F. of (X).
    - ✓ Cumulant generating function (CGF): Definition.

Unit2: Introduction (Bi-variate Continuous random variable)   [08 Hours]

- Continuous bivariate random vector or variable (X, Y):
    - ✓ Joint p. d. f.,
    - ✓ Joint c. d. f., properties (without proof), probabilities of events related to random variables (events in terms of regions bounded by regular curves, circles, straight lines).

3

- ✓ Probability distribution of transformation of bivariate r. v.
  $U = \phi_1(X, Y), V = \phi_2(X, Y)$.
- ✓ Marginal and conditional distributions.
- Expectation of r. v. (X, Y), expectation of function of r. v.
  - ✓ $[(X, Y)]$, joint moments, c (X, Y), $Corr(X, Y)$.
  - ✓ Conditional mean, conditional variance.
  - ✓ Examples on expectation:
    1) $E(X + Y) = E(X) + E(Y)$.
    2) $E(XY) = E(X)E(Y), if\ X\ and\ Y$ are independent.
    3) Generalization to k variables. $(aX + bY + c), Var(aX + bY + c)$
       (statement only proof not expected).

Unit3: Multiple linear regression model [06 Hours]
- **Multiple linear regression:**
  - ✓ Notion of multiple linear regression.
  - ✓ Yule's notation (trivariate case) (statement only).
  - ✓ Fitting of regression plane of Y on X_1 and X_2, $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$
    by the method of least squares; obtaining normal equations, solution of normal equations.
  - ✓ Definition and interpretation of partial regression coefficients β_1 and β_2.
    (relations between partial regression coefficients and multiple correlations on are not expected).
  - ✓ Residual: Definition, order, derivation of variance, properties.
  - ✓ Computation of R^2 and R^2_{adj} and its interpretation.

Unit4: Demography [05 Hours]
- Vital events, vital statistics, methods of obtaining vital statistics, rates of vital events, sex ratios, dependency ratio.
- Death/Mortality rates: Crude death rate, specific (age, sex etc.) death rate, standardized death rate (direct and indirect), infant mortality rate.
- Fertility/Birth rate: Crude birth rate, general fertility rate, specific (age, sex etc.) fertility rates, total fertility rate.
- Growth/Reproduction rates: Gross reproduction rate, net reproduction rate.
  .(Numerical examples with heavy computations are to be asked preferably in practicals).
- Interpretations of different rates, uses and applications.
- Trends in vital rates as revealed in the latest census.

Unit5: Queuing Model [04 Hours]
- Introduction to quening model. as an application of exponential distribution, Poisson distribution and geometric distribution.
- Some concepts used in queuing theory like calling population, queue discipline, queue length, number of customers in queue
- Kendall's notation
- Little's formulae

4

SEMESTER – III

Practical Paper–III (Minor Vertical 2)

25-STA23206: (Based on Theory Paper) (Manual and using Excel)

[NO. OF CREDITS=02   NO. OF HOURS = 60]

Objectives:
- To fit various discrete and continuous probability distributions and to study various real life situations.
- To identify the appropriate probability model that can be used.
- To use forecasting and data analysis techniques in case of univariate and multivariate data sets.
- To use statistical software packages.
- To test various hypotheses of significance like means, proportions, independence of attributes, variance etc. included in theory (using calculators, software).
- To compute probabilities of discrete and continuous probability distributions using MS-Excel and/or R software (whichever is applicable).
- To study applications of statistics in the field of demography etc.

[NO. OF CREDITS=02   NO. OF PRACTICALS = 15]

Sr. No.	Title of the experiment	No. of Practical
1	Checking the validity of probability model	2
2	Calculation of cumulative distribution function	2
3	Measures	1
4	Bivariate distribution	1
5	Measures on the basis of bivariate distribution	1
6	Fitting of Multiple regression	2
7	Demography	2
8	Queuing model	2
9	Case study	2
	Total	15

Notes:
- For case study, a group of maximum 8 students will be allowed.
- All the students in a group should be given equal marks for project.
- Different data sets from newspapers, internet, and magazines may be collected and students will be asked to use Statistical techniques/tools which they have learnt.
- Students must produce at the time of practical examination, the laboratory journal alongwith the completion certificate signed by the Head of the Department.

SEMESTER – IV

Theory Paper–II (Major DSC Vertical 1)

25-STA24204: Continuous probability distributions and Statistical

Techniques II

[NO. OF CREDITS=02   NO. OF HOURS = 60]

COURSE OUTCOMES (COS): At the end of the course student will be able to:

CO1) Understand different standard continuous probability distributions.

CO2) Find moments of standard continuous random variable

CO3) Understand new technique "Testing of Hypotheses".

CO4) Understand the technique of "Regression".

COURSE CONTENT:

Unit1: Some Standard Probability distributions   [20 Hours]

- Uniform distribution: **[02 Hours]**
    - ✓ Definition.
    - ✓ Probability density function.
    - ✓ Cumulative distribution function.(Partition values), Distribution of $\frac{X-a}{b-a}$, $\frac{b-X}{b-a}$, F(x)
    - ✓ Expected value. (Mean, variance, Central moments)
- Gamma distribution: [**05 Hours]**
    - ✓ Definition.
    - ✓ Probability density function. (Nature of density curve)
    - ✓ Expected value. (Mean, variance, Central moments).
    - ✓ Moment generating function.
    - ✓ Cumulant generating function
    - ✓ Properties
    - ✓ Exponential distribution as a special case of Gamma distribution, special property of Exponential distribution
    - ✓ Chi-square distribution as a special case of Gamma distribution, special property of Exponential distribution
- Normal distribution: **[05 Hours]**
    - ✓ Definition.
    - ✓ Probability density function. (Nature of density curve)
    - ✓ Expected value. (Mean, variance, Central moments).
    - ✓ Moment generating function.
    - ✓ Cumulant generating function
    - ✓ Properties
- Student's t distribution: **[04 Hours]**
    - ✓ Definition.
    - ✓ Probability density function. (Nature of density curve)
    - ✓ Expected value. (Mean, variance, Central moments).

✓ Properties
- Snedecor's F distribution: **[04 Hours]**
    ✓ Definition.
    ✓ Probability density function. (Nature of density curve)
    ✓ Expected value. (Mean, variance, Central moments).
    ✓ Properties
    ✓ Interrelation between chi-square, t and F distribution

Unit2: Testing of hypothesis   **[10 Hours]**
- Introduction   **[03Hours]**
    ✓ Concept of testing of hypotheses
    ✓ Definitions and types of hypothesis
    ✓ Concept of Statistics, Test Statistic, Parameter, Sampling Distribution
    ✓ Acceptance and Rejection region: Definition, Criterion of deciding
    ✓ Level of significance
- Large Sample test: **[02Hours]**
    ✓ For population mean
        1) Single population mean
        2) Two population means
    ✓ For population proportion
        3) Single population proportion
        4) Two population proportions
- Small Sample test: t test   **[02 Hours]**
    ✓ t test for:
        1) Single population mean
        2) Two population means (independent, paired)
    ✓ Chi square test for: **[02 Hours]**
        1) Single population variance
        2) Independence of attributes
        3) Fitting of distribution
    ✓ F test for equality of two independent population variances.   **[01 Hours]**

- Fitting of autoregressive model AR (p), where $p = 1,2$.
- Case studies of real life Time Series: Price index series, share price index series, economic time series: temperature and rainfall time series, wind speed time series, pollution levels.

7

SEMESTER – IV

Theory Paper–IV (Major DSC Vertical 1)

25-STA24102: (Based on Theory Paper) (Manual and using R software)

[NO. OF CREDITS=02   NO. OF PRACTICALS = 15]

Sr. No.	Title of the experiment	No. of Practical
1	Fitting of Normal distribution, exponential distribution	1
2	Application of Distributions	3
3	Graphical representation of different distributions	2
4	Large sample test	2
5	Small sample test for population mean	2
6	Chi square tests	2
7	Moving averages	1
8	Exponential smoothing	1
9	Seasonality Calculation	1
10	Report	2
Total		15

Reference Websites:
 1. www.stats.unipune.ac.in (100 Data sets for Statistics Education by Dr.

Anil P. Gore,Dr. Mrs. S. A. Paranjape and Madhav B. Kulkarni available
in ISPS folder).

2. www.freestatistics.tk(National Statistical Agencies)
3. www.psychstat.smsu.edu/sbk00.htm(Onlinebook)
4. www.bmj.bmjournals.com/collections/statsbk/index.shtml
5. www.statweb.calpoly.edu/bchance/stat-stuff.html
6. www.amstat.org/publications/jse/jse-data-archive.html(International
   journal onteaching and learning of statistics)
7. www.amstat.org/publications/chance(Chancemagazine)
8. www.statsci.org/datasets.html(Datasets)
9. www.math.uah.edu/stat(Virtual laboratories in Statistics)
10. www.amstat.org/publications/stats(STATS : the magazine for students of Statistics)
11. www.stat.ucla.edu/cases(Case studies in Statistics).
12. www.statsoft.com
13. www.statistics.com
14. www.indiastat.com
15. www.unstat.un.org
16. www.stat.stanford.edu
17. www.statpages.net
18. www.wto.org
19. www.censusindia.gov.in
20. www.mospi.nic.in
21. www.statisticsofindia.in

Books Recommended:

1. Brockwell P.J.and Davis R.A. (2003), Introduction to Time Series and Forecasting
   (Second Edition), Springer Texts in Statistics.
2. Chatfield C. (2001), The Analysis of Time Series An Introduction, Chapman and Hall /

CRC, Texts in Statistical Science .

3. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.

4. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .

5. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.

6. Gupta, S. P. (2002), Statistical Methods (Thirty First Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.

7. Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), Introduction to Mathematical Statistics (Tenth Impression), Pearson Prentice Hall.

8. Kulkarni, M. B., Ghatpande, S. B. and Gore, S. D. (1999), Common Statistical Tests, Satyajeet Prakashan, Pune 411029

9. Medhi, J., Statistical Methods, Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi – 110002.

10. Meyer, P. L., Introductory Probability and Statistical Applications, Oxford and IBH Publishing Co. New Delhi.

11. Mood, A. M., Graybill F. A. and Bose, F. A. (1974), Introduction to Theory of Statistics (Third Edition, Chapters II, IV, V, VI), McGraw - Hill Series G A 276

12. Mukhopadhya Parimal (1999), Applied Statistics, New Central Book Agency, Pvt. Ltd. Kolkata

13. Purohit S. G., Gore S. D. and Deshmukh S. R. (2008), Statistics using R, Narosa Publishing House, New Delhi.

14. Ross, S. (2003), A first course in probability (Sixth Edition), Pearson Education publishers , Delhi, India.

15. Walpole R. E., Myers R. H. and Myers S. L. (1985), Probability and Statistics for Engineers and Scientists (Third Edition, Chapters 4, 5, 6, 8, 10), Macmillan Publishing Co. Inc. 866, Third Avenue, New York 10022.

16. Weiss N., Introductory Statistics, Pearson education publishers

MODERN COLLEGE OF ARTS, SCIENCE
AND COMMERCE GANESHKHIND, PUNE-16
(AUTONOMOUS)

SYLLABUS OF SECOND YEAR ZOOLOGY

S.Y.B.Sc (SEMESTER III AND IV)

To be implemented from

Academic Year 2025-2026

FRAMED BY

BOARD OF STUDIES IN ZOOLOGY

Progressive Education Society's
MODERN COLLEGE OF ARTS, SCIENCE AND COMMERCE,
GANESHKHIND, PUNE- 16
(AUTONOMOUS)

Preamble:

Zoology is one of the major subjects of Basic Sciences and deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. A zoology student needs to gain understanding of many areas of the subject to keep pace with advancements in Life Sciences.

This under-graduate degree program has been designed by the Board of Studies in Zoology of Savitribai Phule Pune University with a substantial component of what is needed from a zoologist as a skilled career and what zoologists needs to pursue for post-graduation and further academic studies. It follows the guidelines laid down by the University Grants Commission, New Delhi. This newly designed curriculum is a perfect blend of the classical aspects in Zoology with the advanced and more specialized areas.

This degree offers Discipline Specific Core Courses **[CC]** in Animal Systematics, Animal Ecology, Animal Cell biology, Applied Zoology, Pest Management, Histology, Biological Chemistry, Genetics, Developmental Biology, Parasitology, Medical & Forensic Zoology, Animal Physiology, Molecular Biology, Entomology, Techniques in Biology and Evolutionary Biology.

In addition to the Core Courses, Ability Enhancement Compulsory Courses **[AECC]** have been added in the second year i.e. Semester III and Semester IV of the undergraduate course. In the third year i.e. Semester V and Semester VI, Discipline specific Elective Courses **[DSEC]** and Skill Enhancement Courses **[SEC**] have been offered. The students, therefore, have an opportunity to take courses in Environment Awareness, Language & communication, English / Marathi, Aquarium Management, Poultry Management and Environmental Impact Assessment. In Semester VI the students also have a course dedicated to Project work.

The syllabus has been framed in such a way that the student gains each year, a broader perspective of the subject as he progresses towards completion of the degree program. Field visits, Educational visits and the Project work have been included for the student to experience the applications of the theory learnt in the classroom.

After completion of the program, it is expected that students will understand and appreciate: animal diversity, few applications of Zoology, the structure, functions and life processes at cellular, tissue, organ and system level, significance of evolution, and basic concepts of human health. The students

would also gain an insight into laboratory and field work through the practical course, field work and the project.

The new course will be effective from the academic year 2025- 2026 and will follow the Choice Based Credit System in a Semester mode. It has been primed keeping in view the distinctive requirements of B. Sc. Zoology students. The contents have been drawn-up to accommodate the widening prospects of the discipline of Life Sciences. They reflect the changing pre requisites of the students. This graduate program has been introduced with 144 credits for the subject group while 08 credits to earn from any of the 08 groups offering a range of curricular, co-curricular and extracurricular activities. This pattern has been specially aimed towards the overall development of the students.

The calculation of credits and CGPA will be as per the guidelines of the University. The B. Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent thinking and problem solving skills. The Syllabus has been revised with the following aims -

• To foster curiosity in the students for Zoology,

• To create awareness amongst students for the basic and applied areas of Zoology,

• To orient students about the importance of abiotic and biotic factors of environment and their conservation,

• To provide an insight to the aspects of animal diversity,

• To inculcate good laboratory practices in students and to train them about proper

handling of lab instruments.

Instructions for the Students:

The students seeking admission to S.Y.B.Sc Zoology course is hereby informed that they are supposed to adhere to the following rules:

1.   A minimum of 75 % attendance for lectures / practical is the pre-requisite for grant of term.

2.   There shall be tutorial / practical / surprise test / home assignment / referencing of research papers / seminar / industrial visits/Field Visit / training course/viva-voce as a part of internal assessment in each semester. The students are supposed to attend all the tests. The students should note that re-test will not be permitted to the student absent for the test/s unless the case is considered by competent authority.

3.   The students opting for dissertation course shall follow the rules framed for the same.

4.   The students are supposed to attend all the Industrial Workshops / Laboratory Workshops / Training Programme/ symposia/ seminar/ field visit / study tour organized by the department/ college. The students shall attend these programmes at their own cost.

Examination

[A]   Pattern of Examination Evaluation of Students:

1)   The In-semester and End-Semester examinations will be of 20 marks each for 2 credits and 40 marks for 4 credits and for End-semester 30 marks for 2 credits and 60 marks for 4 credits.

2)   Student has to obtain minimum of 40 % passing separately in both the In-Semester and End- Semester.

3)   Internal marks remain unchanged and internal assessment cannot be repeated. If student remain absent during internal assessment examination, he/she will have second chance with the permission of the competent authority. But it will not be right of the student. It will be under the discretion of the competent authority and internal departmental assessment committee. In case he/she wants to repeat Internal, he/she can do so only by registering for the said courses.

5) There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

i.   In-semester Examination:

Internal assessment for each course would be continuous and dates for each tutorials/practical tests etc. will be pre-notified in the time table for teaching or placed separately as a part of time table. Department / College Internal Assessment Committee will coordinate this activity.

a)   Theory Courses:

Students should be encouraged to participate in various academic activities. A teacher must select a variety of the procedures for conducting internal assessment suggested as follows.

a)   Multiple choice questions

b)   Combination of objective and subjective questions.

c)   Open book test (concerned teacher will decide the allowed books)

d)   Tutorial

e)   Surprise test specified topics in a given notified period

4

f)   Oral

g)   Assignments

h)   Review of research paper

i)   Seminar presentation

j)   Journal/Lecture/Library notes Student has to preserve the documentation of the internal assessment except midterm test answer script. It is the responsibility of the student to preserve the documents.

b) Practical Courses:

It is a continuous evaluation process. Practical courses will be evaluated on the basis of the following:

1.   Performance assessment of each experiment on the basis of attendance, punctuality, journal completion, practical skills, results, oral and analysis.

2.   Assessment on practical course be conducted before the end-semester examination.

3.   Assessment of each experiment shall be done for each practical weekly.

4.   Assessment of the Activity will be based on any one of the following (per practical course).

i.   Special training programs in recognized research institutes such as NCL, NIO, NIV, ZSI, BNHS, etc.

ii.   Project on Research Methodology

iii.   Industrial/Institution Visit report

iv.   Field visit report/ study tour repor.

The student strength of practical batch should be 12

Project Course: Project will be evaluated by the examiner/s in consent with the project guide if required.

ii.   End-Semester Examination:

The End-semester examination programme will be scheduled as per the notifications and guidelines issued by the Examination section of University of Pune.

[B]   Standard of Passing

Student has to obtain 40% marks separately in In-Semester and End-Semester assessment.

Program outcomes (POs):

After successfully completing the S.Y.B.Sc Zoology program students will be able to:

PO1. Zoology knowledge: Apply the knowledge of Zoology, Life Sciences and allied subjects to the understanding of complex life processes and phenomena.

PO2. Problem analysis: Identify, review research literature, and analyse complex situations of living forms.

PO3. Design/development of solutions: Design processes/strategies that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge andresearch methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in real situations.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources,and ICT tools for understanding of the subject.

Programme Specific outcomes

PSO1: Understand the impact of the natural and anthropogenic activities in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. Identify a range of invertebrates and vertebrates and justify their conservation.

PSO2: Apply ethical principles and commit to professional ethics and responsibilities andnorms of the work/research practice.

PSO3: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

REVISED NEP COURSE STRUCTURE (As per GR dated 23rd March, 2024)

Course Structure: **Course Structure with Credit Distribution of the Undergraduate Science Program in Zoology- B.Sc in Zoology (S.Y.B.Sc)**

		S.Y. B. Sc			
Course Type	**Course Code**	**SEMESTER III**	**Course Code**	**SEMESTER IV**	**Credits**
Major DSC	24ZOO23101	Cell Biology and Genetics (4C) (T)	24ZOO24101	Mammalian Histology and Physiology (4C) (T)	4+4
Major DSC	24ZOO23102	Practicals in Cell Biology and Genetics (2C) (P)	24ZOO24102	Practicals in Mammalian Histology and Physiology (2C) (P)	2+2
Major Specific IKS	24ZOO23103	Indian Natural History- Animal Kingdom (2C) (T)			2+0
Minor	24ZOO23204	Environment Impact Assessment (2C) (T)	24ZOO24203	Human health, hygiene and Nutrition (2C) (T)	2+2
Minor	24ZOO23205	Practicals in Environmental Impact Assessment (2C) (P)	24ZOO24204	Practicals in Food and Nutrition (2C) (P)	2+2
OE	24ZOO23306	Fascinating world of Animals (2C) (T)	24ZOO24305	Ethology (2C) (T)	2+2
VSEC	24ZOO23407	Practicals in Clinical Hematology (2C) (P)	24ZOO24406	Practicals in Public Health and hygiene (2C) (P)	2+2
SEC		-	24ZOO24407	Practicals in Good Laboratory Practices (2C) (P)	2
AEC		By College (2C) (T)		By College (2C) (T)	2+2
FP	24ZOO23608	Field project (2C) (P)			2
CEP			24ZOO24608	Community Engagement program (2C) (P)	2
CC		By College (2C) (P)		By College (2C) (P)	2+2

				Total credits	**44**

Subject Code: -   24ZOO23101
Subject Name -: Cell Biology and Genetics
No. of credits: 04

Year : II			Semester : III			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	04	60	02	40	60	100

Course Outcomes:

After successfully completing this course, students will be able to:

1. The learner understand the meaning, branches, scope and importance of Cell Biology.

2. To understand the structure and function of various cell organelles present in a cell.

3. To understand the basics the concept of Mendelian & non - Mendelian genetics.

4. Concept and characteristics of multiple alleles, ABO blood group system, Inheritance of Rh antigen, Erythroblastosis foetalis and their medico-legal importance.

5. Understand the structure of chromosomes, chromatin and its types, giant chromosomes and chromosomal aberrations.

6. Successfully solve genetic problems using Punnett squares, probability calculations and pedigree analysis.

7. Recognize and explain the inheritance patterns and molecular basis of common genetic disorders, including both Mendelian and complex traits.

Sr. No.	Name of the Topic	No of lectures allotted

1	**Unit 1: Cell as Basic unit of Life**	(04L)
	1.1 Introduction to Cell and Cell theory.	
	1.2 Prokaryotic and Eukaryotic cells.	
	1.3 Structure of Prokaryotic cell.	
	1.4 Structure of Eukaryotic cells (Animal and Plant cell).	
2	**Unit 2: Plasma Membrane**	(06L)
	2.1 Structure of plasma membrane: Fluid mosaic model.	
	2.2 Transport across membranes: Active and Passive transport, Facilitated transport, endocytosis, exocytosis.	
	2.3 Cell – Cell Junction: Structure and function, Tight junctions, Adherent junctions, Gap junctions, Desmosomes and Hemi-desmosomes.	
	2.4 Functions of Plasma membrane.	
3	**Unit 3: Cell organelles: Structure and functions-**	
	3.1 Nucleus and nuclear pore complex.	(15L)
	3.2 Endoplasmic Reticulum.	
	3.2 Golgi Complex.	
	3.3 Lysosomes.	
	3.4 Ribosome.	
	3.5 Peroxisomes.	
	3.6 Mitochondria.	
4	**Unit 4: Cell Division:**	(05L)
	4.1 Cell Cycle.	
	4.2 Mitosis.	
	4.3 Meiosis.	
5	**Unit 5: Recapitulation of Mendelian Genetics:**	(05L)
	5.1 Mendel's work: Selection of experimental plant.	
	5.2 Mendelian Inheritance: Laws of heredity and their practical applications.	

	(Monohybrid cross and Dihybrid cross).	
	5.3 Test cross and back cross.	
6	**Unit 6: Non-Mendelian Genetics:**	(08L)
	6.1 Concept of Gene Interaction.	
	6.2 Intra-allelic interactions-Dominance.	
	6.3 Inter-allelic interactions: Co-dominance and incomplete dominance (concept of epistasis, complimentary factors (9 : 7), supplementary factors (9: 3 : 4), inhibitory factors (13 : 3), duplicate dominant genes (factors) (15 : 1).	
	6.4 Lethal genes in *Mus musculus*.	
7	**Unit 7: Multiple alleles**	
	7.1 Concept and characteristics.	(03L)
	7.2 ABO blood group system, Inheritance of Rh antigen, Erythroblastosis foetalis and their medico-legal importance.	
8	**Unit 8: Chromosomes**	(06L)
	8.1 Introduction: Morphology and types of chromosomes (based on the position of centromere and involvement in sex determination).	
	8.2 Chromatin, its structure and its types (Euchromatin and Heterochromatin).	
	8.3 Giant chromosomes (Polytene chromosome and Lamp brush chromosomes).	
	8.4 Chromosomal Aberrations: Structural (Deletion, duplication, inversion and translocation) and Numerical (Euploidy, monoploidy, polyploidy - autopolyploidy & allopolyploidy and aneuploidy - monosomy, nullisomy, trisomy).	
9	**Unit 9: Sex Determination**	(04L)
	5.1 Genetically controlled sex determination: (Heterogametic males: XX - XY & XX - XO systems, Heterogametic females: ZZ - ZW system), Genetic balance system in Drosophila.	
	5.2 Parthenogenesis and Gynandromorphism.	

10	**Sex-linked Inheritance:**	(04L)
	6.1 Sex-linked inheritance: Characteristics, types (X - linked, Y - linked, and XY - linked).	
	6.2 Examples of Sex-linked inheritance: Haemophilia, Colour blindness and Hypertrichosis.	
	6.3 Linkage-Complete and Incomplete linkage with example.	
	Total Lectures	60

REFERENCES :

1. Cell Biology: Verma, P. S. And Agrawal, V. K., S. Chand and Co., New Delhi.
2. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J. D., Molecular
3. Biology of the Cell, Gerl and Publ. Inc., New York, 2008.
4. 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.
5. Cooper, G. M. and Hausman, R. E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D. C.; Sinauer Associates, M. A.
6. De Robertis, E. D. P. and De Robertis, E. M. F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
7. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
8. Powar, C. B.: Cell Biology, Himalaya Publishing House, Bombay, 1999. Genetics: Verma, P. S. and Agrawal, V. K., S. Chand and Co., New Delhi.
9. Fundamentals of Genetics: B. D. Singh, Kalyani Publishers, New Delhi.
10. Principle of Genetics: Sinnott, Dunn and Dobzhansky, Tata McGraw Hill Edition, New Delhi.
11. Genetics: Gupta, P. K., Rastogi Publication, Meerut.
12. Genetics: Sarin, C., Tata McGraw Hill, New Delhi.
13. Principles of Genetics: Gardner, E. J., Simmons, M. J. and Snustad, D. P., John Wiley and Sons.
14. Cytology and Genetics: Dyan Sagar V. R., Tata McGraw Hill Pub. Co. Ltd., New Delhi.

Subject Code: - 24ZOO23102
Subject Name -: Practicals in Cell Biology and Genetics
No. of credits: 02

Year : II	Semester : III

Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	Semester End Exam	Total
Mandatory Major	02	30	01	20	30	50

Course Outcomes:

After completion of this course, students should be able to :

CO1: Understand principles and workings of simple and compound microscopes.

CO2: Acquire the skills to accurately measure microscopic objects using micrometry.

CO3: Learn to visualize plant and animal cells under microscope.

CO4: Learn to study various stages of mitosis and meiosis.

Sr. No.	Name of the Practical	Practical allotted
1	Study of principle and working of simple and compound microscope.	1P
2	Measurement of microscopic objects using micrometry.	1P
3	Identification of ultrastructure of different cell organelles from electron micrographs / photographs/video.	1P
4	Staining and visualization of mitochondria by Janus green stain.	1P
5	Preparation of temporary stained squash of onion root tip to study various stages of mitosis.	1P
6	Preparation of temporary stained squash of onion root tip/Grasshopper testis to study various stages of meiosis.	1P

7	Experiments on monohybrid, dihybrid cross ratio and deducing the applicability of Mendelian laws (three examples of each ratio).	1P
8	Experiments on test cross and back cross ratio and deducing the applicability of Mendelian laws (three examples of each ratio.	1P
9	Study of Mendelian genetic traits in human beings (tongue rolling, widow's peak, attachment of ear lobes, colour blindness (Isihara chart) and PTC tasters / non-tasters) using collected data from a limited population/photographs.	1P
10	Study of facultative heterochromatin from humans: Barr body (buccal cells) /Drumstick (Neutrophils).	1P
11	Study of polytene chromosomes from Drosophila / Chironomous larva. (E)	1P

REFERENCES :

1. Cell Biology: Verma, P. S. And Agrawal, V. K., S. Chand and Co., New Delhi.
2. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J. D., Molecular
3. Biology of the Cell, Gerl and Publ. Inc., New York, 2008.
4. 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.
5. Cooper, G. M. and Hausman, R. E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D. C.; Sinauer Associates, M. A.
6. De Robertis, E. D. P. and De Robertis, E. M. F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
7. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
8. Powar, C. B.: Cell Biology, Himalaya Publishing House, Bombay, 1999. Genetics: Verma, P. S. and Agrawal, V. K., S. Chand and Co., New Delhi.

Fundamentals of Genetics: B. D. Singh, Kalyani Publishers, New Delhi

Subject Code: - 24ZOO23103
Subject Code: - 24ZOO23103
Subject Name -: Indian Natural History- Animal Kingdom
No. of credits: 02

Year : II	Semester : III

Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Major Specific IKS	02	30	02	40	60	100

Course Outcomes :

After completion of this course, students should be able to :

CO1: Students will be able to learn most of the essential aspects of Evolutionary Biology in detail which will help them in acquiring better understanding regarding the subject.

CO2: Explain important processes, principles and concepts and critically evaluate theories and empirical research within evolutionary biology

CO3: Apply evolutionary theory and concepts to address empirical and theoretical questions in evolutionary biology.

CO4: Independently investigate evolutionary questions using literature and analyses of empirical data.

CO5: Communicate the principles, theories, problems and research results associated with questions that lie within the evolutionary framework to students.

Sr. No.	Name of the Topic	No. of lectures allotted
1	**Unit 1:** The origin of earth and life	(02L)
2	**Unit 2: Theories of evolution** 2.1 Darwinism and Neo-Darwinism.	(04L)

	2.2 Lamarckism.	
	2.3 Modern synthetic theory.	
3	**Unit 3:** Tools and methods used in evolutionary biology.	(03L)
4	**Unit 4: Geological time scale**	(03L)
	4.1 Eons, Eras, Periods, Epochs and Age.	
5	**Unit 5: Life in the Precambrian**	(02L)
	5.1 The Cambrian explosion.	
6	**Unit 6: Age of the Tetrapods**	(06L)
	6.1 Amniotes and attainment of full territoriality.	
	6.2 Carboniferous period.	
	6.3 Devonian period- Age of Fishes.	
	6.4 Mesozoic era- Golden Age of reptiles.	
	6.5 Life in the Jurassic and Triassic.	
7	**Unit 7: Zoogeographical Realms**	(04L)
	Palearctic, Nearctic, Neotropical, Ethiopian, Australian, Oriental realms with unique fauna.	
8	**Unit 8: Indian Natural History Museums,** IKS Centre for Animal Science	(02L)
9	**Unit 9: Antiquity of Man:**	(04L)
	Stages in Human evolution- Australopithecus, Kenyapithecus, Homo habilis, Homo erectus, Cromagnon, Neanderthal, Homo sapiens.	

REFERENCES:

1. Mark Ridley. Evolution. 3rd Edition. Blackwell Publishing. (2004).

2. Mathur, Tomar, Singh. Evolution and Behaviour. Rastogi Publication, Merrut.

3. Mohan P. Arora. Evolutionary Biology, Himalaya Publishing House, Bombay.

4. P. S. Vermin and V. K. Agarwal. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Revised Edition. S. Chand Publication (2004).

5. Strickberger. Evolution. Prentic Hall. (2002).

6.   Theodore H., Jr Eaton. Evolution. 1st Edition. W. W. Norton Publication. (1970). Organic Evolution, Richard Swann Lull, Light & Life Publishers.

<table>
<tr><td colspan="7" style="text-align:center">Subject Code: - 24ZOO23204
Subject Name -: Environmental Impact Assessment (Minor)
No. of credits: 02</td></tr>
<tr><td colspan="4" style="text-align:center">Year : II</td><td colspan="3" style="text-align:center">Semester : III</td></tr>
<tr><td colspan="4" style="text-align:center">Teaching Scheme</td><td colspan="3" style="text-align:center">Evaluation Scheme</td></tr>
<tr><td>Course Type</td><td>Credits</td><td>Number of Teaching hours</td><td>Lectures per week</td><td>Internal Assessment</td><td>Semester End Exam</td><td>Total</td></tr>
<tr><td>Minor</td><td>02</td><td>30</td><td>02</td><td>20</td><td>30</td><td>50</td></tr>
</table>

Course Outcomes:

After completion of this course, students should be able to :

CO1: Describe the branches and scope of Environmental biology, emphasizing its environmental importance.

CO2: Understand impact of pollution on wildlife, natural resources and development..

CO3: Understand concept of sustainable development.

CO4: Students understand the Environment protection acts, environment impact assessment process and agencies associated with it.

Sr. No.	Name of the Topic	No of lectures allotted
1	**Unit 1: Environment** 1.1 Definition. 1.2 Divisions. 1.3 Importance.	(02L)
2	**Unit 2: Pollution** 2.1 Definition and types. 2.2 Impact on wildlife, natural resources, development.	(03L)
3	**Unit 3: Sustainable development:**	(02L)

	3.1 Definition and need.	
	3.2 Exploitation of natural resources.	
	3.3 Concept of carrying capacity.	
	3.4 Three pillars of Sustainability.	
	3.5 UN 17 Sustainable Development Goals (SDGs).	
4	**Unit 4: Overview of Environmental Protection acts:**	(05L)
	4.1 The Air (Prevention and Control of Pollution) Act 1981.	
	4.2 The Water (Prevention and Control of Pollution) Act 1974.	
	4.3 The Environment Protection Act 1986.	
	4.4 The National Green Tribunal Act 2010.	
	4.5 Biological Diversity Act 2002.	
5	**Unit 5: Environmental Impact Assessment (EIA):**	(05L)
	5.1 Definition, need and importance of EIA.	
	5.2 EIA notification 2006 - key elements, History and Evolution of EIA.	
	5.3 Categories of Industries / establishments requiring EIA, Types of EIA - strategic EIA, regional EIA, sectoral EIA, project level EIA and life cycle assessment.	
	5.4 Rapid and comprehensive EIA.	
6	**Unit 6: EIA Process:**	(05L)
	6.1 Screening, Scoping and consideration of alternatives.	
	6.2 Baseline data collection, Impact analysis, Mitigation, Reporting, Public hearing.	
	6.3 Review of EIA.	
	6.4 Decision-making, monitoring clearance conditions.	
	6.4 Case study based on EIA.	
7	**Unit 7: Stakeholders in EIA process:**	(03L)
	7.1 Project proponent, Environmental consultant.	
	7.2 CPCB / MPCB.	
	7.3 Public, EIA agency (IAA).	

8	**Overview of Scheme for Accreditation of EIA Consultant Organizations (NABET / QCI):** 8.1 Eligibility and benefits. 8.2 EIA coordinator (EC), Functional area experts (FAEs). 8.3 Functional area associate (FAA) and team members: Role, educational qualification, experience and functions.	(05L)
	Total Lectures	30

REFERENCES:

1. Fundamentals of Ecology - M C Dash, Tata Mcgraw-Hill Publishing Co. Ltd.1998

2. Concepts of Ecology - Edward J. Kormondy, Prentice-Hall Of India Pvt. Ltd.1996

3. Ecology - Mohan P. Arora, Himalaya Publishing House, 2004

4. Environmental Biology-Biswarup Mukherjee, Tata Mcgraw-Hill Publishing Co.Ltd,1996

5. Fundamentals of Ecology-Eugene P. Odum, Natraj Publishers, 199.

6 Environmental Education - Nagarajan and Sivakumar. P, Ram Publishers, Chennai, (2002). 7.

A text book of Environment - Agarwal. K. M. Sikdar. P. K. and Deb. S. C, Mac Miller India

Ltd., Calcutta, (2002).

Subject Code: - 24ZOO23205 **Subject Name -: Practicals in Environmental Impact Assessment** **No. of credits: 02**	
Year : II	Semester : III
Teaching Scheme	**Evaluation Scheme**

Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	Semester End Exam	Total
Minor	02	30	01	20	30	50

Course Outcomes:

After completion of this course, students should be able to :

CO1: Describe the need and importance of environmental monitoring in environmental engineering field and problems associated with it.

CO2: Acquire the skills to use different sampling techniques.

CO3 Prepare different solutions during analytical procedures for determination of water and air pollutants content.

CO4: The students will be exposed to various standard protocols used in environmental monitoring.

Sr. No.	Name of the Practical	Practical allotted
1	Study of a simple ecosystem (Suggested Habitats: Pond/ Grassland/ Forest) And Description of The Biotic And Abiotic Components of The Ecosystem	1P
2	Study of effects of human interaction with Natural Environment	1P
3	Survey of vegetation, birds, insects and other animals in an area	1P
4	Study of any environmental problem of your locality and suggest corrective measures for the same.	1P
5	Identifying the sources of pollution in water obtained from different sources.	1P
6	Study of physiochemical properties of water & soil sample.	1P
7	Study of role of biological indicators in an ecosystem.	1P
8	To determine the biological oxygen demand of the given water sample.	1P
9	To determine the dissolved oxygen content of the given water sample.	1P
10	Study of biodiversity indices (Shannon/Simpson).	1P
11	Study of insects by pitfall trap.	1P

142	Visit to an ecosystem and assessment of biodiversity using quadrat method (line or belt transect method).	2P

REFERENCES:

1. Radojevic M. and Valdimir N.B. (2006) Practical Environmental Analysis, RSC publishing.

2. APHA (1980) Standard Methods for the Examination of Water and Wastewater Published by American Public Health Association, 15th ed.

Suggested readings

1. Kim Y.J. and Platt U. (Eds.) (2008) Advanced Environmental Monitoring, XXII, 420 p. Springer.

2. Laboratory Analytical Techniques Series (LATS), published by CPCB.

3. Roa M. (2008) Environmental Science Activities Kit, Jossey-Bas.

4. Wagner T.P. and Robert S. (2009) Environmental Science: Active Learning Laboratories and Applied Problem Sets, 2nd Edition, Wiley.

5. Wells E. (2009) Lab Manual for Environmental Science, Cengage Learning

Case studies

<table>
<tr><td colspan="7" align="center">Subject Code: - 24ZOO23306

Subject Name -: Fascinating World of Animals
No. of credits: 02</td></tr>
<tr><td colspan="3" align="center">Year : II</td><td colspan="4" align="center">Semester : III</td></tr>
<tr><td colspan="4" align="center">Teaching Scheme</td><td colspan="3" align="center">Evaluation Scheme</td></tr>
<tr><td>Course Type</td><td>Credits</td><td>Number of Teaching hours</td><td>Lectures per week</td><td>Internal Assessment</td><td>Semester End Exam</td><td>Total</td></tr>
<tr><td>Open Elective</td><td>02</td><td>30</td><td>02</td><td>40</td><td>60</td><td>100</td></tr>
</table>

Course outcomes:

After successfully completing this course, students will be able to:

CO1: Define the basic information about differences between the vertebrate and invertebrate world.

CO2: Understand the interesting facts about the invertebrate animals.

CO3: Knowledge of the interesting features of the vertebrate animals.

CO4: Apply the knowledge of animals in the real world.

Sr. No.	Name of the Topic	No. of lectures allotted
1	**Unit 1: Amazing facts of the invertebrate world -I** 1.1 World in a drop of water. 1.2 Use of bath sponge/ Portuguese man of war.	(02L)
2	**Unit 2 : Amazing facts of the invertebrate world -II** 2.1 Budding in Hydra. 2.2 Stinging in Jellyfish. 2.3 Coral reefs. 2.4 Bioluminescence in Ctenophora. 2.5 Earthworms- friend of farmers.	(04L)
3	**Unit 3: Amazing facts of the invertebrate world -III** 3.1 Use of Honey bees for honey, wax, royal jelly, propolis, pollinators. 3.2 Harvesting of silkworms in making silk garments. 3.3 World of butterflies. 3.4 Use of insects as bioindicators and in Forensic Science. 3.5 Web formation in spiders/ venomous scorpions and spiders.	(04L)
4	**Unit 4: Amazing facts of the invertebrate world -IV** 4.1 Octopus as Devilfish. 4.2 World under water- Shells and pearls.	(02L)
5	**Unit 5: Amazing facts of the invertebrate world -V** 5.1 Regeneration in Starfish and Planaria. 5.2 Types of Parasites and diseases.	(03L)
6	**Unit 6: Amazing facts of the vertebrate world -I** 6.1 World of fishes.	(04L)

	6.2 Nesting behaviour in Turtles.	
	6.3 Venomous and non venomous snakes.	
	6.4 Camouflage in Chameleon.	
7	**Unit 7: Amazing facts of the vertebrate world -II**	(02L)
	7.1 Winter sleep and summer sleep in frogs and bear.	
	7.2 Parental care in Animals.	
8	**Unit 8: Amazing facts of the vertebrate world -III**	(03L)
	8.1 Migration in birds and fishes.	
	8.2 Nest building behaviour in birds.	
	8.3 Echolocation in bats.	
9	**Unit 9: Amazing facts of the vertebrate world -IV**	(02L)
	9.1 Porpoising in penguins.	
	9.2 Exciting facts about whales, dolphins and walruses.	
10	**Unit 10: Amazing facts of the vertebrate world -V**	(02L)
	10.1 Interesting features of Animals as pets.	
	10.2 Police dog squad- K9 dog.	
	10.3 Facts about big cats.	
11	**Unit 11: Amazing facts of the vertebrate world -VI**	(02L)
	11.1 Animal Human coexistence with suitable example.	
	11.2 Similarities between monkeys, apes and man.	
	Total no. of lectures	30

REFERENCES:

1.Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The

Invertebrates: a Synthesis, Blackwell Publishing.

2. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.

3. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.

4. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw- Hill.

5. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S.and Nelson.

6. Integrated Principles of Zoology, Eleventh Edition, Hickman CP, Roberts LS & Larson A. International Edition ISBN 0–07–118077–X, The McGraw-Hill Companies, Inc.,

Course Code: 24ZOO23407						
Course Title: Practicals in Clinical Hematology						
Year : II				Semester : III		
Teaching Pattern				Evaluation Pattern		
Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	End Semester Exam	Total
VSEC	02	30	02	20	30	50

Course Outcomes :

After the completion of the course, students should be able to :

CO1: Students will gain knowledge about lab techniques.

CO2: Students will be able to use the technique in diagnosing various diseases.

CO3: Students will know about various components of blood and their normal levels.

CO4: Students will get knowledge about histology.

Sr. No.	Name of the Practical	Practical allotted
1	Study of human blood composition	1P
2	Estimation of blood glucose by anthrone method.	1P
3	Estimation of bleeding time and clotting time	1P
4	Differential Leucocyte Count.	1P
5	Study of normal reference range of blood.	
6	Estimation of Serum urea/creatinine	1P

7	Determination of normal and abnormal constituents of blood	1P
8	Reticulocyte count and its clinical significance.	1P
9	Study of ABO and Rh system and its significance	1P
10	Estimation of haemoglobin percentage by using haemoglobinometer	1P
11	Visit to a pathology lab to understand the analysis of blood samples to detect various pathological conditions in humans.	2P
12	Study based on clinical reports.	1P

REFERENCES:

1. Dondelinger, Robert M. "Spectrophotometers." Biomedical Instrumentation & Technology 45.2 (2011): 139-143.

2. Ridley, John W. Fundamentals of the study of urine and body fluids. Basel, Switzerland: Springer, 2018.

3. Törnqvist, M., et al. "Protein adducts: quantitative and qualitative aspects of their formation, analysis and applications." Journal of Chromatography B 778.1-2 (2002): 279-308.

4. Lagier, Jean-Christophe, et al. "Current and past strategies for bacterial culture in clinical microbiology." Clinical microbiology reviews 28.1 (2015): 208-236.

5. Rawat, Sonu, et al. "Urine Analysis for Abnormal Urine in Pathology Laboratory."

6. Pan, Chen-Wei, Dharani Ramamurthy, and Seang-Mei Saw. "Worldwide prevalence and risk factors for myopia." Ophthalmic and Physiological Optics 32.1 (2012): 3-16.

7. Practical Clinical Biochemistry: Methods and Interpretations By Ranjna Chawla (2014)

8. Pathology Practical Book By Harsh Mohan (2007)

9. Oxford Handbook of Clinical Pathology (2012) https://doi.org/10.1093/med/9780199591633.001.0001

Course Code: 24ZOO23608	
Course Title: Field Project (FP)	
Year : II	**Semester : III**

Teaching Pattern				Evaluation Pattern		
Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	End Semester Exam	Total
VSEC	02	30	02	20	30	50

SEMESTER IV

Subject Code: - 2 4 ZOO24101 Subject Name -: Mammalian Histology and Physiology No. of credits: 04						
Year : II			Semester : IV			
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
Mandatory Major	04	60	04	40	60	100

Course Outcomes:

After the completion of the course, students should be able to :

CO1: The students will be able to identify, understand and classify the different types of tissue.

CO2: The students will understand the complexity of various tissues in an organ.

CO3: The students will understand the concept of energy requirements.

CO4: The students will be able to understand various aspects of Digestive and excretory

physiology.

CO5: The students will be able to develop understanding in Structure and functions of muscles.

CO6: The students will gain knowledge about the process of formation of gametes and function

of endocrine glands.

25

Sr. No.	Name of the Topic	No. of lectures allotted
1	**Unit 1:- Introduction to Histology** 1.1 Definition and Scope of Histology. 1.2 Introduction to Fixation and Staining- Types of Fixatives and Stains. 1.3 Introduction to microtechniques- Microtome and Cryotome.	(01L)
2	**Unit 2: Definitions and Review of Types of Tissues:** 2.1 Epithelial tissue. 2.2 Connective tissue. 2.3 Nervous tissue. 2.4 Muscular tissue.	(03L)
3	**Unit 3: Histological study of following mammalian organs**: 3.1 V.S of Skin 3.2 V.S. Tooth 3.3 C.S. of Tongue with reference to mucosa papillae and taste buds.	(05L)
4	**Unit 4: Histological study of Alimentary canal and Liver:** 4.1 T.S. of Oesophagus 4.2 T.S of Stomach 4.3 T.S. Duodenum 4.4 T.S. Rectum 4.5 C.S. of Liver	(06L)
5	**Unit 5: Histological study of Respiratory organs:** 5.1 T.S. of Trachea 5.2 C.S of Lung	(02L)
6	**Unit 6:-** : **Histological study of Excretory organs:** 6.1 Kidney (L. S.). 6.2 Juxtaglomerular complex.	(03L)
7	**Unit 7: Histological study of Reproductive and Endocrine organs**	(04L)

	7.1 T.S of Testis with reference to Seminiferous Tubules and Cells of Leydig.	
	7.2 C.S of Ovary	
	7.3 L.S. of Pituitary gland.	
	7.4 T.S. of Thyroid gland.	
	7.5 T.S. of Adrenal gland.	
	7.6 C.S. of Pancreas including both exocrine and endocrine components.	
8	**Unit 8: Nutrition and Digestion:**	(06L)
	8.1 Nutritional requirement & balanced diet.	
	8.2 Digestion and absorption of carbohydrates, proteins and lipids.	
	8.3 Vitamins - outline of fat soluble and water-soluble vitamins; dietary sources and deficiency disorders.	
9	**Unit 9: Respiration**	(06L)
	9.1 Characteristics of respiratory tissue.	
	9.2 Types of respiration: Internal and External.	
	9.3 Mechanism of respiration: Regulation of ventilation in lungs, exchange of gases at respiratory surface.	
	9.4 Haemoglobin and Transport of gases : O2 and CO2 transport.	
10	**Unit 10: Circulation**	(05L)
	10.1 Blood: Definition and its constituents, functions of blood.	
	10.2 Heart: Structure of human heart, Pace maker, Cardiac Cycle.	
	10.3 Origin and conduction of heart beat.	
11	**Unit 11: Excretion**	(04L)
	11.1 Structure of Uriniferous tubule.	
	11.2 Mechanism of urine formation.	
	11.3 Normal and abnormal constituents of urine, Elementary idea of dialysis.	
12	**Unit 12: Muscle physiology**	(03L)
	12.1 Structure of smooth, skeletal and cardiac muscles.	
	12.2 Mechanism of muscle contraction by Sliding filament theory.	

13	**Unit 13: Reproduction and Endocrine Glands**	(06L)
	13.1 Structure of sperm and spermatogenesis, Physiology of male reproduction.	
	13.2 Structure of ovum and oogenesis, Physiology of female reproduction.	
	13.3 Hormones and functions of pituitary, thyroid, parathyroid, pancreas and adrenal glands.	
	Total no. of lectures	60

REFERENCES:

1. A Text Book of Histology, 2014, 5th Edn. Krishna Garg, Indira Bahl & Mohini Kaul CBS Publication & Distributors, Delhi.

2. Histology, 1987, 9th Edn., Arthur W. Ham, David H. Cormack, J. B. Lippincott Co. Philadelphia.

3. Histology, 1977, 4th Edn., R. O. Greep and L. Weiss, McGraw Hill Int. Book Co., New York.

4. Hand Book of Histo-pathogical & Histo-chemical Techniques, 1983, 3rd Edn. reprint, Butterworth & Co. (Publishers) Ltd, UK.

5.Textbook of Medical Physiology, Guyton A. C. & Hall J. E., 2006, 11th Edition, Hercourt Asia Pvt. Ltd. / W. B. Saunders Company

6. Principles of Anatomy & Physiology, 2006, 11th Edition, Tortora G. J. & Grabowski S., John Wiley & sons, Inc.

7. Haematology: De Gruchi.

8. Human physiology, Vol. I & II, 1980, 12th Edn. Dr. C. C. Chatterjee, Medical Applied Agency, Kolkata

9. Text book of Animal Physiology, 2008, 2nd Edn. Nagabhushanam, S. V. S. Rana, S. Kalavathy, Oxford University Press, India.

10. Animal Physiology: Adaptation and Environment, 1997, Schmidt-Nielsen, Knut, Cambridge University Press.

11. General and Comparative Physiology, 1983, 3rd Edn., Hoar W. S., Prentice Hall, UK.7.

12. Medical Physiology, 2006, Asis Das, Books and Allied Pvt. Ltd., Kolkata.

<table>
<tr><td colspan="7" style="text-align:center">Subject Code: - 2 4 ZOO24102
Subject Name -: Practical in Mammalian Histology and Physiology
No. of credits: 02</td></tr>
</table>

Subject Code: - 2 4 ZOO24102		

Subject Code: - 2 4 ZOO24102
Subject Name -: Practical in Mammalian Histology and Physiology
No. of credits: 02

Year : II				Semester : IV		

Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Mandatory Major	02	30	01	20	30	50

Course Outcomes:

After the completion of the course, students should be able to :

CO1: To understand the classification of various types of basic tissues.

CO2: To study structure & functions of various tissues in organ system.

CO3: To understand histological structure of various glands and its functions.

CO4: To acquaint students with the principles and basic facts of Animal Physiology

CO5: To acquaint students with some of the laboratory techniques and equipment used in the gaining of physiological facts

Sr. No.	Name of the Practical	Practical allotted
Section I: Practicals in Mammalian Histology	
1	Study of the different types of tissues with the help of permanent slides – Epithelial tissue, Connective tissue, Muscular tissue and Nervous tissue.	1P
2	Study of permanent histological slides of T. S. of skin, V. S. of tooth and C. S. of tongue.	1P
3	Study of permanent histological slides of digestive parts – T. S. of Stomach, T. S. of Duodenum, T. S. of Rectum, C. S. of Liver.	1P
4	Study of permanent histological slides of glands - T. S. of Pituitary gland, T. S. of Thyroid gland, T. S. of Adrenal gland, C. S. of Pancreas.	1P
5	Study of permanent histological slides of reproductive organs- T. S. of Testis,	1P

	C. S. of Ovary.	
6	Temporary mounting of smooth / skeletal muscle fibre	1P
Section II: Practicals in Mammalian Physiology		
1	Measurement of blood pressure and oxygen saturation level in humans.	1P
2	Effect of exercise on breathing rate.	1P
3	Estimation of cholesterol from the given sample.	1P
4	Determination of vital capacity of lungs by respirometer.	1P
5	To study the total count of Leucocytes.	1P
6	To study the total count of RBC.	1P
7	Estimation of lactic acid in muscles/blood.	1P

REFERENCES:

1. Histology, 1977, 4th Edn., R. O. Greep and L. Weiss, McGraw Hill Int. Book Co.,
New York.

2. Hand Book of Histo-pathogical & Histo-chemical Techniques, 1983, 3rd Edn. reprint,
Butterworth & Co. (Publishers) Ltd, UK.

3. Principles of Anatomy & Physiology, 2006, 11th Edition, Tortora G. J. & Grabowski S., John
Wiley & sons, Inc.

4. Haematology: De Gruchi.

5. Human physiology, Vol. I & II, 1980, 12th Edn. Dr. C. C. Chatterjee, Medical Applied Agency,
Kolkata

Subject Code: - 24 ZOO24203							
Subject Name -: Human Health Hygiene & Nutrition							
No. of credits: 02							
Year : III				**Semester : IV**			
Teaching Scheme				**Evaluation Scheme**			
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**	
Minor	**02**	**30**	**02**	**20**	**30**	**50**	

Course Outcomes:

After the completion of the course, students should be able to :

CO1: Understand the relationship between nutrition, health, and fitness.

CO2: Have a knowledge of the life style related diseases.

CO3: Analyse the good indicators of health.

CO4: Understand the indicators of Good health.

Sr. No.	Name of the Topic	No. of lectures allotted
1	**Unit 1: Concept of health** 1.1 Definition and concept of health (WHO). 1.2 Major nutritional Deficiency diseases- (kwashiorkor and marasmus), Deficiency disorders, their causes, symptoms, treatment, prevention and government programmes,	(05L)
2	**Unit 2: Life style related diseases** 2.1 Life style related diseases- hypertension, diabetes mellitus, 2.2 Atherosclerosis and obesity- their causes and prevention through dietary and lifestyle	(05L)

	modifications.	
	2.3 Social health problems- smoking, alcoholism, drug.	
3	**Unit 3: Indicators of Good Health** 3.1 Pulse rate, Blood Pressure, Temperature, Respiratory rate, weight. 3.2 Body Mass Index (BMI) Cholesterol (lipid profile) ,Blood sugar (HbA1c) Complete blood count (CBC). 3.3 Liver Test, Thyroid test.	(05L)
4	**Unit 4: Food and infections** 4.1 Bacterial infection: typhoid fever, dysentery. 4.2 Viral infection: Hepatitis, Poliomyelitis. 4.3 Protozoan infection: amoebiasis, giardiasis. 4.4 Parasitic infection: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention. 4.4 Brief account of food spoilage: Causes of food spoilage and their preventive measures.	(05L)
5	**Unit 5: Human Nutrition** 5.1 Nutrition and Balanced diet. 5.2 Carbohydrates: Type, Source, Function, Dietary requirements and physiological significance. Glycaemic index of foods. 5.3 Proteins: Type, Source, Function, Dietary requirements. Evaluation methods and improvement of protein quality.	(05L)
6	**Unit 6: Vitamins** 6.1 Types and Source of Fat soluble and Water soluble vitamins. Function, Dietary requirements, Deficiency and Toxicity of Fat soluble and Water soluble vitamins.	(02L)
7	**Unit 7: Role of Minerals** 7.1 Role of Minerals: Macro minerals: calcium, phosphorus, magnesium, sodium, potassium and chloride. 7.2 Micro minerals: Iron, copper, zinc, manganese, iodine, fluoride. Trace minerals: selenium, cobalt, chromium.	(03L)

REFERENCES:

1) Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2012; New Age International Publishers

2) Park and Park Park's Textbook of Preventive and Social Medicine, Book by K. Park

3) Mudambi, SR, Rao SM and Rajagopal, MV. Food Science; Second Ed; 2006; New Age International Publishers

4) Srilakshmi B. Nutrition Science; 2012; New Age International (P) Ltd.

5) Srilakshmi B. Food Science; Fourth Ed; 2010; New Age International (P) Ltd.

6) Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.

7) Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd

. 8) Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.

9) Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.

10) Manay MS, Shadaksharaswamy. Food-Facts and Principles; 2004; New Age International (P) Ltd.

Subject Code: - 24ZOO24204
Subject Name -: Practicals in Food and Nutrition
No. of credits: 02

Year : II	Semester : IV

Teaching Scheme				Evaluation Scheme		
Course Type	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Minor	02	30	01	20	30	50

Course Outcomes:

After completion of this course, students should be able to :

CO1: Describe the need and importance of assessment of food adulterants

CO2: Build competent professionals in the field of food industry, health care sector to address societal & national needs.

CO3: Understand chemical function and properties of major food components.

CO4: Know the effects of chemical reactions of food components on the quality of food.

Sr. No.	Name of the Practical	Practical allotted
1	Study of disorders caused due to protein and energy malnutrition	1P
2	Study of anthropometry (measuring of height, weight and upper arm circumference)	1P
3	Prepare diet plan for healthy and malnourished persons	1P
4	Study of therapeutic diet plans (diabetes, hypertension, renal diseases)	1P
5	To detect the presence of adulterants in fat oil and butter.	1P
6	To detect the presence of adulterants in sugar/milk/paneer.	1P
7	To detect the presence of adulterants in sample of chilli powder, turmeric powder and pepper.	1P
8	Analysis of macro and micronutrients from the given food material.	1P
9	Study of different food preservatives and their analysis.	1P
10	Study of common food preservation techniques.	1P
11	Visit to food safety laboratory	2P

REFERENCES:

1. Mudambi, S.R. and Rajagopal, M.V. (2007). Fundamentals of Foods, Nutrition andDiet Therapy; Fifth Ed;; New Age International Publishers

2. Srilakshmi, B. (2002). Nutrition Science; New Age International (P) Ltd.

3. Srilakshmi, B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.

4. Swaminathan, M. (1986). Handbook of Foods and Nutrition; Fifth Ed; BAPPCO.

5. Bamji, M.S.; Rao, N.P. and Reddy, V. (2009). Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.

6. Wardlaw, G.M. and Hampl, J.S. (2007). Perspectives in Nutrition; Seventh

Ed;McGraw Hill.

7. Lakra, P. and Singh M.D. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.

8. Manay, M.S. and Shadaksharaswamy, M. (1998). Food-Facts and Principles; New Age International (P) Ltd.

Subject Code: - 24ZOO24305						
Subject Name -: Ethology						
No. of credits: 02						
Year : II				**Semester : IV**		
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**Semester End Exam**	**Total**
Open elective	02	30	02	20	30	50

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Understand the meaning, branches, scope and concept of Ethology.

CO2: Know the basic principles of Ethology.

CO3: Analyse the scientific methods in studying animal behaviour.

CO4: Evaluate the advancements and applications in the field of Ethology.

Sr. No.	Name of the Topic	No. of lectures allotted
1	**Unit 1: Introduction to the study of Animal Behaviour** 1.1 Definition and Meaning of Ethology. 1.2 History of Ethology. 1.3 Branches of Ethology 1.4 Scope of Ethology.	(04L)

2	**Unit 2: Concepts of Ethology**	(06L)
	2.1 Motivation.	
	2.2 Fixed Action Patterns (FAP).	
	2.3 Sign or key stimulus or Releasers.	
	2.4 Innate Releasing Mechanism (IRM).	
	2.5 Physiological basis.	
	2.6 Imprinting.	
	2.7 Evolution of behaviour.	
3	**Unit 3: Methods of studying behaviour**	(06L)
	3.1 Introduction to methods of studying behavior.	
	3.2 Methods of studying behaviour in Laboratory and Wild.	
	3.3 Identification, Naming and Locating of Individuals in Wild.	
4	**Unit 4: Learning and Memory**	(05L)
	4.1 Definition and meaning of learning and memory.	
	4.2 Types of learning.	
	4.3 Theories and laws of learning.	
5	**Unit 5: Hormones and behavior**	(05L)
	5.1 Definition and meaning of hormones.	
	5.2 Hormones of Gonads.	
	5.3 Hormones of Adrenal gland.	
	5.4 Hormones of Pituitary gland.	
	5.5 Effects of hormones on different behavioral patterns.	
	5.6 Paternal-Maternal behavior; Parent-young one bond.	

6	**Unit 6: Social Organisation, Social behavior and Communication**	(04L)
	6.1 Introduction- Definition and meaning of social organization, social behaviour and communication.	
	6.2 Social organization in Honey bees, termites, monkeys and Lion; Altruism, Kin-selection.	
	Total Lectures	30

REFERENCES :

1."Animal Behavior: An Evolutionary Approach" by John Alcock.

2."The Behavior of Animals: Mechanisms, Function And Evolution" by Luc–Alain Giraldeau and Johan Bolhuis.

3. "Animal Behaviour": A textbook by Reena Mathur.

4. Animal Behaviour : A textbook by S. Chand.

Subject Code: - 24ZOO24406						
Subject Name -: Practicals in Public Health and Hygiene						
No. of credits: 02						
Year : II			**Semester : IV**			
Teaching Scheme				**Evaluation Scheme**		
Course Type	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**Semester End Exam**	**Total**
VSEC	02	30	01	20	30	50

Course Outcomes:

After completion of this course, students should be able to :

      CO1: Define and describe the concepts of hygiene and sanitation.

      CO2: Explain the concepts of health and the parameters used for assesment.

      CO3: Analyse different methods to examine the different types of disease causing agents.

CO4: Get an exposure to various standard measures used in understanding the epidemiology of a disease.

Sr. No.	Name of the Practical	Practical allotted
1	Determination of individual overall health level.	1P
2	Assess the nutritional status by weight and height of a person (BMI).	1P
3	Calculate Ideal Body Weight (IBW), Total energy expenditure, physical activity level (PAL), etc.	1P
4	Collection and interpretation of local data on diseases prevalence.	1P
5	Case study on recent disease outbreak.	1P
6	Demonstration of medically important entomological specimens.	1P
7	Preparation and examination of peripheral blood smear.	1P
8	Microscopic examination of Fungi.	1P
9	Microscopic examination and staining techniques for bacterial strains.	1P
10	Visit to a clinic/ pathological laboratory/local hospital.	1P
11	Visit to a local surrounding community and preparation of health card of volunteers.	1P

REFERENCES:

1.Bamji, M.S., K. Krishnaswamy & G.N.V. Brahmam (2009) Textbook of Human

Nutrition(3rd edition) Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

2.Swaminathan (1995)Food & Nutrition(Vol I, Second Edition) The Bangalore Printing

&Publishing Co Ltd., , Bangalore

3.Vijaya Khader (2000)Food, nutrition & health, Kalyan Publishers, New Delhi

4.Srilakshmi, B., (2010)Food Science, (5th Edition) New Age International Ltd., New Delhi

India Institute of Hygiene and Public Health: http://aiihph.gov.in/healthin-india-2016

5. Park, K. (2009). Preventive and Social Medicine. Jabalpur: M/s Banarsidas Bhanot. − ¬Park, W. H. (2019).

7. Introduction to Community and Public Health. USA: John Wiley & Sons. − Swachh Bharat Mission: http://swachhbharatmission.gov.in/sbmcms/index.htm

Subject Code: - 24ZOO24407							
Subject Name -: Practical in Good Laboratory Practices							
No. of credits: 04							
Year : II				**Semester : III**			
Teaching Scheme				**Evaluation Scheme**			
Course Type	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**Semester End Exam**	**Total**	
SEC	02	30	01	20	30	50	

Course outcomes:

After completion of this course, students should be able to :

CO1: Understand the basic calibration and handling of instrumentation in laboratory.

CO2: Safely practice, basic laboratory procedures and protocols in the laboratory.

CO3: Maintain laboratory records, complaints with current industry standards.

CO4: Have a knowledge of the maintenance of the audit records.

Sr. No.	Name of the practical	Practical allotted
1.	Introduction to Good laboratory practices and Standard operating procedures.	2P
2.	Protocols for Lab safety measures.	1P
3	Precaution and Safety in handling of chemicals, Laboratory tools, Glassware and instruments.	2P
4	Use of safety symbols: meaning, types of hazards and precautions.	1P
5	Waste disposal management and segregation of wastes based on OECD principles.	
6	Log Book Maintenance, Basic SOPs for instrument handling and Maintenance.	1P

7	Calibration of Instruments.	2P
8	Use of Microsoft word, Excel. (For Data entry, calculation and graphical representation).	2P
9	Keeping data records, its analysis by using statistical and mathematical tools. Result analysis and its interpretation.	2P

Subject Code: - 24ZOO24608 Subject Name -: Community Engagement Program No. of credits: 02						
Year : II			**Semester : IV**			
Teaching Scheme				**Evaluation Scheme**		
Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	Semester End Exam	Total
CEP	02	30	01	20	30	100

Chairman, BOS   **Principal**