UNIVERSITY OF JAMMU

(NAAC ACCREDITED 'A ++' GRADE' UNIVERSITY)
Baba Sahib Ambedkar Road, Jammu-180006 (J&K)

Academic Section
Email: academicsectionju14@gmail.com

NOTIFICATION
(25/June/Adp./11)

It is hereby notified for the information of all concerned that the Vice-Chancellor, in anticipation of the approval of the Academic Council, is pleased to authorize the adoption of the syllabi and courses of studies for **Post Graduate Programme in Zoology under NEP-2020** as per details given below:-

Two Year Post Graduate Programme under NEP-2020

Subject	Semester	For the examinations to be held in the year
Zoology	Semester-I	December 2025, 2026 and 2027
	Semester-II	May 2026, 2027 and 2028
	Semester-III	December 2026, 2027 and 2028
	Semester-IV	May 2027, 2028 and 2029

One Year Post Graduate Programme under NEP-2020

Subject	Semester	For the examinations to be held in the year
Zoology	Semester-I	December 2026, 2027 and 2028
	Semester-II	May 2027, 2028 and 2029

The Syllabi of the courses are also available on the University website: www.jammuuniversity.ac.in

DEAN ACADEMIC AFFAIRS

No. F. Acd/II/25/3521-61
Dated: 19/6/2025

Copy for information and necessary action to:

1. Dean, Faculty of Life Science
2. Convener, Board of Studies in **Zoology**
3. Director, Centre for IT Enabled services and Management, University of Jammu for information and for uploading on University Website.
4. All members of the Board of Studies
5. Joint Registrar (Evaluation/P.G. Exam.)
6. Programmer, Computer Section, Examination Wing

Syllabus of

Post Graduation (ZOOLOGY)

For one year (as per NEP-2020)

PG Syllabi 2025

S.No.	Course No.	Course Title	No. of Credits	Credits Level	Credit Points	Course Type Core/Elective /Any other	Marks Theory	Marks Practical	Nature of Course Global	National	Regional	Skill	SWAYAM /MOOC	Vocational Course	Research Project/ Summer Internship/ Dissertation
1	P1ZOTC101	Limnology and Aquatic Ecology	4	6.5	26	Core	100	-	✓	✓	✓	✓			
2	P1ZOTC102	Cell Biology and Bio-Instrumentation	4	6.5	26	Core	100	-	✓	✓	✓	✓			
3	P1ZOTC103	Applications of Microbiology	4	6.5	26	Core	100	-	✓	✓					
4	P1ZOTC104	Elementary Immunology	4	6.5	26	Core	100	-	✓	✓	✓	✓			
5	P1ZOTC105	Human Genomics and Cytogenetics	4	6.5	26	Core	100	-	✓	✓	✓	✓			
6	P1ZOPC106	Practicals based on P1ZOTC101 & P1ZOTC102	2+2	6.5	26	Core	-	100	✓	✓	✓	✓			
7	P1ZOPC107	Practicals based on P1ZOTC103 & P1ZOTC104	2+2	6.5	26	Core	-	100	✓	✓	✓				
8	P1ZOPC108	Practicals based on P1ZOTC105	2	6.5	13	Core	-	50	✓	✓					
9	P1ZOTC201	Fishery Science	4	6.5	26	Core	100	-	✓	✓					
10	P1ZOPC202	Practicals based on P1ZOTC201	2	6.5	13	Core	-	50							
11	P1ZOTE210	Nematode Biology	2	6.5	13	Elective	50	-	✓	✓	✓	✓			
12	P1ZOTE211	Aquarium and Fish Keeping	2	6.5	13	Elective	50	-	✓	✓	✓	✓			
13	P1ZOTE212	Fundamentals of Neuroscience	2	6.5	13	Elective	50	-	✓	✓	✓	✓			
14	P1ZOTE213	Basics of Bioinformatics and Biostatistics	2	6.5	13	Elective	50	-	✓	✓	✓	✓			
15	P1ZORE225	Field Visit / Industrial Training	2	6.5	13	Elective	-	50	✓	✓	✓	✓			
16	P1ZORE226	Research Project / Dissertation	16	6.5	104	Core	400	-		✓	✓	✓			✓

COURSE STRUCTURE FOR PG PROGRAMME ZOOLOGY (1 YEAR)
(ANNEXURE-1B)

CREDIT FRAMEWORK FOR SEMESTER-I

Courses	Course Code	Course Name	Credits
Major Core [20(T) + 10(P)]			
	P1ZOTC101	Limnology and Aquatic Ecology	4
	P1ZOTC102	Cell Biology and Bio-Instrumentation	4
	P1ZOTC103	Applications of Microbiology	4
	P1ZOTC104	Elementary Immunology	4
	P1ZOTC105	Human Genomics and Cytogenetics	4
	P1ZOPC106	Practicals based on P1ZOTC101 & P1ZOTC102	2+2
	P1ZOPC107	Practicals based on P1ZOTC103 & P1ZOTC104	2+2
	P1ZOPC108	Practicals based on P1ZOTC105	2
Semester Total Credits			**30**

CREDIT FRAMEWORK FOR SEMESTER-II

Courses	Course Code	Course Name	Credits
Major Core [4(T) + 2(P)]			
	P1ZOTC201	Fishery Science	4
	P1ZOPC202	Practicals based on P1ZOTC201	2
Total Core Credits			**6**
Major Elective (Any Two*) [4(T)]			
	P1ZOTE210	Nematode Biology	2
	P1ZOTE211	Aquarium and Fish Keeping	2
	P1ZOTE212	Fundamentals of Neuroscience	2
	P1ZOTE213	Basics of Bioinformatics and Biostatistics	2
Total Elective Credits			**4**
	P1ZORE225	Field Visit / Industrial Training	2
	P1ZORE226	Research Project / Dissertation	16
Semester Total Credits			**28**

OVERALL TOTAL CREDITS: 58

Programme Specific Outcomes (PSOs) – M.Sc. Zoology (As per PG Syllabus 2025)

The M.Sc. Zoology programme is structured to provide an in-depth and holistic understanding of the animal sciences, integrating theoretical foundations, laboratory skills, field-based learning, vocational exposure, and research aptitude. In alignment with the National Education Policy (NEP) 2020, the following Programme Specific Outcomes are expected:

•Develop an in-depth understanding of fundamental and advanced topics such as limnology, aquatic ecology, cell biology, microbiology, immunology, genomics, cytogenetics, and fishery science, enabling students to analyze and apply biological concepts across diverse animal taxa.

• Gain extensive practical experience through laboratory courses and hands-on sessions focusing on bio-instrumentation, microbial applications, immunological assays, molecular techniques, and fishery practices, fostering proficiency in modern biological tools and techniques.

• Train students in research methodologies including data collection, statistical analysis, experimental design, and bioinformatics, preparing them to undertake meaningful research projects, dissertations, and industrial training relevant to current challenges in zoological sciences.

• Encourage experiential and field-based learning through activities such as field visits, industrial training, and aquatic ecosystem assessments, promoting real-world understanding of biodiversity, conservation strategies, and sustainable resource management.

• Foster ecological awareness and ethical responsibility towards wildlife conservation, animal welfare, and environmental sustainability, ensuring students understand the societal and ethical implications of scientific research.

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DEPARTMENT OF ZOOLOGY
SYLLABUS FOR PG PROGRAMME ZOOLOGY (1 YEAR) AS PER NEP-2020
SEMESTER – I
(Syllabus for the examination to be held in December 2026, 2027 and 2028)

CREDIT FRAMEWORK FOR SEMESTER-I

Courses	Course Code	Course Name	Credits
Major Core **[20(T) + 10(P)]**			
	P1ZOTC101	Limnology and Aquatic Ecology	4
	P1ZOTC102	Cell Biology and Bio-Instrumentation	4
	P1ZOTC103	Applications of Microbiology	4
	P1ZOTC104	Elementary Immunology	4
	P1ZOTC105	Human Genomics and Cytogenetics	4
	P1ZOPC106	Practicals based on P1ZOTC101 & P1ZOTC102	2+2
	P1ZOPC107	Practicals based on P1ZOTC103 & P1ZOTC104	2+2
	P1ZOPC108	Practicals based on P1ZOTC105	2
Semester Total Credits			**30**

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SEMESTER – I
(Syllabus for the examination to be held in December 2026, 2027 and 2028)

Course No. P1ZOTC101 Course Title: Limnology and Aquatic Ecology

Credits: 4 Maximum Marks:100

Course Outcomes:

CO1: Students will understand the fundamental principles of limnology, including its history, scope, and relevance in the Indian context. The unit also covers the causes and consequences of dwindling freshwater availability and the importance of sustainable resource management.

CO2: Students will understand the origins and classification of lentic water bodies like lakes and ponds. They will learn about the process of eutrophication, its impacts, and various restoration methods. The unit also covers the basic concepts and management techniques associated with wetland ecosystems.

CO3: Students will understand the origins and classifications of lotic water bodies and they will learn about the management strategies specific to riverine ecosystems. The unit also introduces transitional ecosystems like estuaries and their classification.

CO4: Students will understand the key physical features and chemical characteristics of freshwater systems their significance. The unit further explores the composition and diversity of the bottom substrate and the phenomenon of thermal stratification.

CO5: Students will understand the introduction and characteristics of wetland ecosystems and various management techniques employed for their conservation. They will learn about the concepts of translocations and acidification in aquatic environments. The unit emphasizes the critical issue of dwindling freshwater resources and strategies for their conservation and management.

UNIT-I: Introduction to Limnology and Freshwater Resources **(12 hrs)**

1.1 Limnology: History and scope; Limnology in India
1.2 The Water Cycle: An overview of water movement on, above, and below the Earth's surface
1. 3 Declining Availability of Freshwater: Causes and Protection Strategies
1.4 Freshwater resource management.

UNIT-II: Lentic Ecosystems: Lakes and Ponds **(13 hrs)**

2.1 Eutrophication: Understanding its Causes and Ecological Impacts
2.2 Strategies for the Remediation of Eutrophic Water Bodies
2.3 Origins and Different Kinds of Ponds
2.4 Lake: Origin and Classification.

UNIT-III: Lotic Ecosystems: Rivers and Streams **(13 hrs)**

3.1 Rivers: Origin and Classification
3.2 Water flow and Stream channels; Physico-chemical characteristics
3.3 Biotic characteristics of flowing waters
3.4 River Management

UNIT-IV: Wetlands and Transitional Ecosystems **(10 hrs)**

4.1 Wetlands: Introduction and Characteristics
4.2 Management techniques of wetlands
4.3 Estuaries: Definition, origin and classification
4.4 Bogs and marshes: Origin, types, abiotic and biotic characteristics

UNIT-V: Physical and Chemical Characteristics of Freshwater Systems **(12 hrs)**

5.1 Light: Sources, factors affecting light penetration, measurement and its relationship with aquatic organisms
5.2 Temperature: Effect on biological processes and thermal stratification

Course No. P1ZOTC101 Course Title: Limnology and Aquatic Ecology

5.3 Dissolved oxygen and carbon dioxide: Sources, determination, distribution and significance
5.4 pH: Definition, distribution and significance

Scheme of Examination:

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

SUGGESTED BOOKS:

- Begon, M., Townsend, C.R., and Harper, J.L. 2006. Ecology: From Individuals to Ecosystems. Blackwell Publishing, UK.
- Krebs, C.J. 2009. Ecology: The Experimental Analysis of Distribution and Abundance. Pearson Education.
- Tilman, D. 1982. Resource Competition and Community Structure. Princeton University Press, USA.
- Jorgensen, S.E. 2002. Ecological Modelling: An Introduction. Elsevier, Netherlands.
- Gaston, K.J., and Spicer, J.I. 2004. Biodiversity: An Introduction. Blackwell Science, UK.
- Wilson, E.O. 1992. The Diversity of Life. Belknap Press, USA.
- May, R.M. 1974. Stability and Complexity in Model Ecosystems. Princeton University Press, USA.
- Schlesinger, W.H. 1997. Biogeochemistry: An Analysis of Global Change. Academic Press, USA.
- DeAngelis, D.L., and Waterhouse, J.C. 1987. Equilibrium and Nonequilibrium Concepts in Ecological Models. Springer-Verlag, USA.
- Scheffer, M. 1998. Ecology of Shallow Lakes. Chapman & Hall, UK.
- Sanderson, E.W., et al. 2002. The Human Footprint and the Biodiversity Crisis. BioScience, USA.
- McKinney, M.L., and Lockwood, J.L. 1999. Biotic Homogenization. Springer-Verlag, USA.
- Giller, P.S. 2005. The Ecology of Freshwater Systems. Blackwell Publishing, UK.
- Tansley, A.G. 1935. The Use and Abuse of Vegetational Concepts and Terms. Ecology, USA.
- Sharma, P.B. 2020. Fundamentals of Ecology & Environment. Dhanpat Rai Publishers, India.

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DEPARTMENT OF ZOOLOGY
SYLLABUS FOR PG PROGRAMME ZOOLOGY (1 YEAR) AS PER NEP-2020
SEMESTER – I
(Syllabus for the examination to be held in December 2026, 2027 and 2028)

Course No. P1ZOTC102 Course Title: Cell Biology and Bio-Instrumentation

Credits: 4 Maximum Marks:100

Course Outcomes:

CO1: Students will understand the fundamental structural organization of prokaryotic and eukaryotic cells, highlighting their key differences. They will learn about the intricate structure and diverse functions of the plasma membrane, including various models of organization. The unit also covers the mechanisms of transport across cellular membranes, encompassing both passive and active processes and the movement of macromolecules.

CO2: Students will understand the regulatory mechanisms that govern the progression through the cell cycle, including the stages of mitosis and meiosis. They will learn the general principles of cell communication, the roles of different cell adhesion molecules, and the function of intercellular junctions. The unit also covers the mechanisms of cell signaling through various cell surface receptors and their associated pathways.

CO3: Students will understand the process of programmed cell death (apoptosis) in mammals, including the involvement of key regulatory proteins and the intrinsic and extrinsic signaling pathways. They will learn about apoptotic pathways in model organisms like *C. elegans* and *Drosophila*. The unit also explores therapeutic strategies that target apoptosis and its role in diseases like cancer, with a focus on the p53 protein.

CO4: Students will understand the basic principles and applications of various electrophoretic techniques used for separating biomolecules. They will learn about different chromatographic methods, including thin layer, affinity, liquid, gas, paper, ion exchange, and size exclusion chromatography. The unit also covers the principles and types of centrifugation and provides an introduction to spectroscopic and structural analysis techniques.

CO5: Students will understand the principles and applications of different types of light and electron microscopy used for visualizing cellular structures. They will learn about the Polymerase Chain Reaction (PCR) and its various modifications. The unit also covers fundamental DNA sequencing methodologies and the principles behind different blotting techniques used for detecting specific biomolecules.

UNIT-I: Foundations of Cellular Architecture and Transport (12 hrs)

1.1 Eukaryotic and Prokaryotic Cell Structure: Comparative Analysis and Key Differences

1.2 The Plasma Membrane: Structural Models, Composition, and Diverse Functions

1.3 Mechanisms of Membrane Transport: Active and Passive Processes, Macromolecular Transport (Endocytosis, Exocytosis)

1.4 Intracellular Organization: Structure and Function of Major Cell Organelles (Golgi Apparatus, Mitochondria, Nucleus, Endoplasmic Reticulum)

UNIT-II: Cell Dynamics: Cycle, Communication, and Adhesion (10 hrs)

2.1 Orchestration of the Cell Cycle: Regulatory Mechanisms and Stages of Mitosis and Meiosis

2.2 Principles of Cell Communication: General Strategies, Hormonal Signaling, and Two-Component Systems

2.3 Cell Adhesion and Intercellular Junctions: Role of Adhesion Molecules, Extracellular Matrix, and Gap Junctions

2.4 Cell Surface Receptors and Initial Signaling Events: G-Protein Coupled Receptors, Ion Channel Receptors, and Enzyme-Linked Receptors

UNIT-III: Programmed Cell Death and its Significance (13 hrs)

3.1 Apoptosis in Mammals: Key Regulatory Proteins (Caspases, Bcl2 Family, IAPs) and Signaling Pathways (Intrinsic and Extrinsic)

Course No. P1ZOTC102 Course Title: Cell Biology and Bio-Instrumentation

3.2 Apoptotic Pathways in Model Organisms: Cell Death Mechanisms in *C. elegans* and *Drosophila*
3.3 Therapeutic Targeting of Apoptosis: Strategies and Applications in Disease Treatment
3.4 The Interplay of Apoptosis and Cancer: Role of Tumor Suppressor Protein p53

UNIT-IV: Fundamental Biochemical and Separation Techniques **(13 hrs)**

4.1 Electrophoretic Methods: Principles and Applications in Biomolecule Separation
4.2 Chromatographic Techniques: Exploration of Thin Layer, Affinity, Liquid, Gas, Paper, Ion Exchange, and Size Exclusion Chromatography
4.3 Principles and Categories of Centrifugation: Applications in Cellular and Molecular Biology
4.4 Spectroscopic and Structural Analysis: Introduction to Spectroscopy, Mass Spectrometry, and X-ray Crystallography

UNIT-V: Advanced Microscopy and Nucleic Acid Techniques **(12 hrs)**

5.1 Principles and Applications of Light and Electron Microscopy: Bright Field, Dark Field, Transmission, Scanning, and Fluorescence Microscopy
5.2 Polymerase Chain Reaction and its Variations: Nested, Quantitative Real-time, RT-PCR, Inverse, Anchored, and Touchdown PCR
5.3 DNA Sequencing Methodologies: Sanger Sequencing, Chemical Degradation Method, and an Overview of Next-Generation Sequencing
5.4 Blotting Techniques for Biomolecule Detection: Southern, Western, Northern, Slot, and Dot Blots

Scheme of Examination:

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II.** Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Course No. P1ZOTC102 Course Title: Cell Biology and Bio-Instrumentation

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

SUGGESTED BOOKS:

1. Korenberg, (1974). DNA Replication. W.H. Freeman and Co., San Francisco.
2. Avers, C.J. (1976). Cell Biology. D. Van Nostrand Co., New York.
3. Dewitt, (1977). Biology of the Cell - An Evolutionary Approach. Saunders Co.
4. Jones and Bartlett, (1980). Cells: Principles of Molecular Structure and Function. Prescott.
5. De Robertis, E.D.F. and De Robertis, E.M.F. (1981). Cell and Molecular Biology. Saunders International Edition.
6. Alberts,(1983) Molecular Biology of the Cell.
7. Maniatis (1983). Molecular cloning
8. Garland, A. (1983). Molecular Biology of the cell A, Bestrisetical, Garland Pub. Inc. New York.
9. Watson et al. (1987) Molecular Biology of Genes Vol I and II.
10. Gene- Watson (1987) Molecular biology.
11. Smith and E.J. Wood, Chapman & Hall., HongKong (1992) Cell Biology
12. P.K. Gupta, Rastogi Publ. Merrut. (1994). Cytogenetics, Genetics and Evolution.
13. Bruce Melacinki & Freifelder, John and Bartlett Publ. Boston. (1998) Essentials of Molecular Biology.
14. Mousami Debnath, Shashi Jain Publ. Jaipur (2008) Cell and Molecular Biology
15. Thomas .D.Pollaed et.al.(2017).Cell biology.3rd Edn.Elsiver.
16. Alberts, Bruce, Hopkins Karen and Johnson , Alexander D. (2019). Essential Cell Biology (Fifth Edition).

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SEMESTER – I
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Course No. P1ZOPC106 Practicals based on P1ZOTC101 & P1ZOTC102

Credits: 4

Maximum Marks:100

Practicals based on P1ZOTC101

1. Comparison of the physical characteristics of water from different water bodies.
2. Comparison of the physical characteristics of soil.
3. Measurement of common pollutants such as oil, grease, and fluorides in water.
4. Qualitative analysis of water samples for phytoplankton.
5. Quantitative analysis of water samples for phytoplankton.
6. Qualitative analysis of water samples for zooplankton.
7. Quantitative analysis of water samples for zooplankton.
8. Collection and identification of macrobenthic fauna.
9. Quantitative and qualitative analysis of benthic macroinvertebrates.
10. Identification of local fish species based on morphometric characteristics.
11. Estimation and comparison of FCO_2 levels in water samples.
12. Estimation and comparison of dissolved oxygen (DO) levels in water samples.
13. Estimation and comparison of carbonate and bicarbonate concentrations in water.
14. Estimation and comparison of calcium (Ca^{++}) and magnesium (Mg^{+}) concentrations in water.
15. Estimation of sulphate levels in water samples.
16. Estimation of phosphorus levels in water samples.
17. Estimation of silica levels in water samples.
18. Estimation of nitrate concentrations in water samples.
19. Sediment analysis of elements (Na, K, Ca, Mg, Phosphorus, Nitrate).
20. Study of macrophytes in aquatic environments

Practicals based on P1ZOTC102

1. Handling and operation of following apparatus and equipments: (a) Compound research microscope (b) Electrophoretic Unit (c) Thermocycler (d) Stereo-microscope
2. To study the process of mitosis from the onion root tip
3. Study of stained preparation of mitochondria and golgi bodies under the light microscope.
4. Isolation of DNA from Insect tissue
5. Quantification and qualification of DNA
6. Demonstration of polymerase chain reaction.
7. Bioinformatic tools online for analyzing DNA sequences
8. Demonstration of automated biochemical analyzer.
9. Electrophoresis of DNA.

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

Practicals			
Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
Internal Examination	100%	Continuous evaluation	50
External Examination	100%	4 hours	50
Total			100

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Course No. P1ZOTC103 Course Title: Applications of Microbiology

Credits: 4 Maximum Marks:100

CO1: Upon completion of this unit, students will be able to analyze the classification of medically significant microbes and their interaction with the human microbiota. They will understand the etiology and pathogenesis of key airborne diseases and their prophylaxis. Students will gain insight into food, water, and soil-borne diseases, identifying causative agents and methods for control and transmission.

CO2: Students will explore the principles and processes of microbial fermentation, gaining skills in product recovery and the application of microbes in food and beverage production. They will understand the synthesis of pharmaceutical compounds by microorganisms, including antibiotics and enzymes, and learn about the innovation in pharmaceuticals. Moreover, students will critically assess regulatory aspects of pharmaceutical microbiology, including drug development, intellectual property rights, and biosensor technology.

CO3: This unit will enable students to comprehend the scope and significance of agricultural microbiology, focusing on the role of microbial communities in soil health. They will learn about biological nitrogen fixation mechanisms and the essential microorganisms involved. Students will also evaluate bioremediation techniques as strategies for pollution control in various environments. Finally, they will acquire knowledge in food microbiology, including spoilage, preservation methods, and the importance of safety regulations standards.

CO4: Students will develop knowledge of knowledge of fermentation technology, including fermenter design, scale-up, and process control. They will understand the microbial production processes for primary and secondary metabolites.

CO5: Students willlearn the techniques for collection, transport, and processing of clinical specimens. They will explore and understand conventional and modern microbiological tests.

UNIT-I: Medical and Pharmaceutical Microbiology (10hrs)

1.1 Classification of Medically Important Microbes and the Human Microbiota

1.2 Etiology, Pathogenesis, and Prophylaxis of Key Airborne Diseases (Tuberculosis, Pneumonia, Diphtheria)

1.3 Causative Agents, Transmission, and Control of Select Food/Water/Soil Borne Diseases (Typhoid Fever, Cholera, Tetanus)

1.4 Viral Pathogens of Medical Significance (Hepatitis, Influenza Viruses, Encephalitis, HIV/AIDS)

UNIT-2: Industrial and Pharmaceutical Applications of Microbes (12hrs)

2.1 Microbial Fermentation: Principles, Processes, and Product Recovery

2.2 Microbial Production of Food and Beverages (Milk Products, Wine, Beer)

2.3 Synthesis of Pharmaceutical Compounds by Microbes (Antibiotics, Organic Acids, Enzymes)

2.4 Regulatory Aspects and Innovation in Pharmaceutical Microbiology (Drug Development, Intellectual Property, Biosensors)

UNIT-3: Agricultural and Environmental Microbiology (13hrs)

3.1 Introduction and Scope of Agricultural Microbiology; Microbial Communities in Soil (Rhizosphere, Phyllosphere, Mycorrhiza)

3.2 Biological Nitrogen Fixation: Symbiotic and Non-Symbiotic Mechanisms and Microorganisms

Course No. P1ZOTC103 Course Title: Applications of Microbiology

3.3 Bioremediation: Microbial Strategies for Pollution Control (Water Pollution, Oil Spills, Superbugs)
3.4 Food Microbiology: Spoilage and Preservation, Sanitation, Safety Regulations.

UNIT-4: Industrial Microbiology **(13 hrs)**

4.1 Scope and importance of industrial microbiology in biotechnology, pharmaceuticals, food, and environmental sectors
4.2 Industrially important microorganisms: bacteria, fungi, yeast, actinomycetes, algae; Types of fermentation: submerged fermentation, solid-state fermentation
4.3 Components and design of a fermenter/bioreactor, Downstream processing: cell harvesting, product recovery, purification and formulation, Biofertilizers, Biopesticides
4.4 Microbial production of biofuels (biogas, biodiesel), Probiotics and fermented foods (yogurt, cheese, sauerkraut)

UNIT-5: Diagnostic Microbiology **(12 hrs)**

5.1. Collection, transport, and processing of clinical specimens (blood, urine, sputum, swabs, CSF, stool)
5.2 Microscopy: Gram staining, acid-fast staining, fluorescent staining; Culture media and culture methods for clinical specimens
5.3 Biochemical tests for bacterial identification
5.4 Molecular diagnostic tools – PCR, RT-PCR, ELISA, sequencing, MALDI-TOF MS

Scheme of Examination:

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II: The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II.** Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests**

Course No. P1ZOTC103 Course Title: Applications of Microbiology

SUGGESTED BOOKS:

- Arora, M.P. (2005). Microbiology. Himalaya Publishing House, Mumbai.
- Crueger, W., & Crueger, A. (2005). Biotechnology: A Textbook of Industrial Microbiology (2nd Ed.). Panima Publishing Corporation, New Delhi.
- Escoll, P. (2017). Bacterial Evasion of the Host Immune System. Caister Academic Press.
- Gerard, J., Tortora, B.R., Funke, C.L., & Case, C.L. (2011). Microbiology: An Introduction (9th Ed.). Pearson Education.
- Jay, J.M. (2008). Modern Food Microbiology (6th Ed.). Aspen Publishers, Inc., Gaithersburg, Maryland.
- Joshi, V.K., & Pandey, A. (Eds.) (1999). Biotechnology: Food Fermentation (2 Vol. Set). Education Publishers, New Delhi.
- Levine, M.M., Kaper, J.B., Rappuoli, R., Liu, M.A., & Good, M.F. (2004). New Generation Vaccines (3rd Ed.). Informa Healthcare.
- Male, D., Brostoff, J., Roth, D.B., & Roitt, I. (2006). Immunology. Elsevier.
- Mitchell, R. (1992). Environmental Microbiology. John Wiley & Sons.
- Moore, L. (2019). Infectious Diseases, Microbiology, and Virology. Cambridge University Press.
- Pelczar, M.J., Chan, E.C.S., & Krieg, N.R. (1997). Microbiology: Concepts and Applications. Tata McGraw Hill.
- Rajeshwari, S., Sethi, S., & Sreekrishna, V. (2004). Biotechnology-2. New Age International Publishers, Delhi.
- Tauro, P., Kapoor, K.K., & Yadav, K.S. (1996). Introduction to Microbiology. Wiley Eastern.

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Course No. P1ZOTC104

Course Title: Elementary Immunology

Credits: 4

Maximum Marks:100

Course Outcomes:

CO1: Students will understand the foundational concepts and historical context of the immune system, differentiating between innate and adaptive immunity while identifying key immune cells and organs. They will grasp the mechanisms of B-cell and T-cell activation and the functional roles of cytokines and chemokines.

CO2: Students will explore the mechanisms of humoral immunity, including the structure and function of antibodies, the role of MHC in antigen presentation, and the implications of hypersensitivity and complement systems. They will also gain insights into advanced techniques in antibody production and applications.

CO3: Students will gain an understanding of transplantation immunology, including types of grafts and the principles of immunosuppression, along with a thorough knowledge of various immunological techniques used in research and clinical diagnostics. This will enable them to appreciate their application in both therapeutic and research settings.

CO4:Learners will critically assess the current immunotherapeutic strategies for cancer treatment, including immune checkpoint inhibitors (PD-1/PD-L1, CTLA-4), CAR-T cell therapy, and cancer vaccines.

CO5:Learners will explore the concepts of transplantation, immunosuppression, and immunosuppressive drugs, as well as immunotechniques such as ELISA, radioimmunoassay, and immunofluorescence. They will also gain practical knowledge of immunoelectrophoresis and immunoprecipitation techniques used in immune system research and diagnostics

UNIT I: Introduction to the Immune System **(10 hrs)**

1.1 Historical Background

1.2 Innate Immunity: Phagocytosis, Inflammation, Toll-Like Receptors (TLRs), etc.

1.3 Adaptive Immunity: B and T cells

1.4 Immune Cells and Organs: Primary and Secondary Tissues

1.5 B-cell and T-cell Activation, Differentiation, and Memory

1.6 General Properties and Structure of Cytokines and Chemokines

UNIT II: Humoral Immunity and Cell-Mediated Immunity **(12 hrs)**

2.1 Antigens: Antigenicity and Immunogenicity

2.2 Antibodies: Types, Structure, Function, and Generation of Diversity; Monoclonal Antibodies and Hybridoma Technology

2.3 Major Histocompatibility Complex (MHC) and Antigen Processing and Presentation

2.4 Hypersensitivity: Types and Mechanisms; The Complement System

UNIT III: Transplantation, Immunosuppression, and Immunological Techniques **(13 hrs)**

3.1 Transplantation Terminology: Autograft, Isograft, Allograft, Xenograft; Graft-Versus-Host (GVH) Reaction

3.2 Mechanisms of Immunosuppression and Overview of Immunosuppressive Drugs (e.g., Azathioprine, Cyclosporine, Cyclophosphamide, Betamethasone)

3.3 Advanced Immunological Techniques: Immunoprecipitation, Immunoassays (including RIA, ELISA), Immunofluorescence, and Luminex

3.4 Immunoelectrophoresis and its Types

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Course No. P1ZOTC104 Course Title: Elementary Immunology

UNIT-IV: Immunodeficiencies and Tumor Immunology **(13hrs)**

4.1 Primary immunodeficiencies: SCID, X-linked agammaglobulinemia, DiGeorge syndrome
4.2 Secondary immunodeficiencies: HIV/AIDS, malnutrition, therapy-induced
4.3 Tumor antigens and immune evasion
4.4 Cancer immunoediting and immune surveillance

UNIT-V: Transplantation and Immunosuppression **(12hrs)**

5.1 Transplantation terminology: Autograft, Isograft, Allograft and Xenograft; GVH reaction.
5.2 Immunosuppression: Mechanism and Immunosuppressive Drugs (Azathioprine, Cyclosporin, Cyclophosphamide)
5.3 Immunotechniques: Immunoprecipitation, Immunoassays, Radioimmunoassay, ELISA, Immunofluorescence
5.4 Immunoelectrophoresis and its types; Immunoprecipitation

Scheme of Examination:

The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

SUGGESTED BOOKS:

- Paul, W. E. (1984). Fundamental immunology.
- Kuby, J., & Osborne, B. A. (1992). Immunology.
- Abbas, A. K., & Lichtman, A. H. (2001). Basic immunology: Functions and disorders of the immune system.
- Sompayrac, L. (2001). How the immune system works.
- Helbert, M., & Nairn, R. (2002). Immunology for medical students.
- Murphy, K., Travers, P., & Walport, M. (2008). Janeway's immunobiology (7th ed.).
- Arumugan, N., & Fatima, D. (2015). Immunology. Saras Publications.
- Abbas, A. K., Lichtman, A. H., & Pillai, S. (2018). Cellular and molecular immunology. Elsevier.
- Collins, A. (2019). Transplantation immunology. Foster Academics.

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Course No. P1ZOPC107 Practicals based on P1ZOTC103 & P1ZOTC104

Credits: 4 Maximum Marks:100

Practicals based on P1ZOTC103

1. Learn about various bio-safety levels used in laboratories.
2. Understand the working principle of an autoclave.
3. Understand the working principle of laminar airflow.
4. Perform Gram staining of bacteria present in a given sample of curd.
5. Perform Gram staining of bacteria from a human throat sample.
6. Isolate and examine bacteria from a given soil sample using serial dilution, pour plate, and spread plate methods.
7. Apply different techniques of streaking in microbial culture.

Practicals based on P1ZOTC104

1. To study the different types of cells involved in the immune system of human beings.
2. To study the different types of immunoglobulins.
3. To perform hemagglutination assay for ABO blood group typing determination and Rh factor.
4. To learn the techniques of immune electrophoresis.
5. Amplification of Interleukin-28b gene using Polymerase Chain Reaction (PCR) assays.
6. Electrophoresis of Interleukin-28 gene PCR product.
7. To determine the concentration of antigen by sandwich ELISA method.
8. To determine Total Leukocyte Count (TLC) of the given sample.
9. To determine Differential Leukocyte Count (DLC) of the given sample.
10. To study the 3D structural organization of various proteins by using bioinformatics tools.
11. Electrophoresis of DNA.

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

Practicals			
Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
Internal Examination	100%	Continuous evaluation	50
External Examination	100%	4 hours	50
Total			100

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Course No. P1ZOTC105 Course Title: Human Genomics and Cytogenetics

Credits: 4 Maximum Marks:100

Course Outcomes:

CO1: Students will understand the basic principles of human genetics, Mendelian inheritance, and chromosomal theory. They will gain knowledge in human pedigree analysis, chromosome morphology, and sex chromosome structure. This includes understanding dosage compensation mechanisms. The course will also cover inheritance patterns and population genetics.

CO2: Students will learn various chromosome banding techniques and their significance in genetic analysis. They will gain expertise in advanced cytogenetic methods. Additionally, students will become proficient in human karyotyping techniques. The course will also explore the application of microscopy and computer-assisted analysis.

CO3: Students will study the structure and organization of the human genome, including the distinction between nuclear and mitochondrial genomes. They will learn about gene families, repetitive DNA, and molecular genetics processes such as DNA replication, transcription, and translation. The course will also cover mutation mechanisms and DNA repair systems.

CO4: Students will gain knowledge about chromosomal aberrations and syndromes associated with genetic disorders. They will be equipped to perform genetic disease diagnosis through DNA-based methods and biochemical tests. The course will cover prenatal diagnostics and the principles of genetic counseling and treatment for various disorders.

CO5: Students will explore the advancements of the Human Genome Project and its implications in epigenetics. They will understand gene-environment interactions and their role in complex diseases. The course will also cover stem cells, therapeutic cloning, and the ethical considerations involved. Additionally, students will study gene therapy and personalized medicine applications in treating genetic disorders.

UNIT I: Foundations of Human Genetics and Chromosome Structure (12hrs)

1.1 Overview of Human Genetics: Historical milestones, Mendelian principles, and chromosomal theory
1.2 Human Pedigree Analysis and Population Genetics: Inheritance patterns, Hardy-Weinberg equilibrium, genetic drift
1.3 Chromosome Morphology and Classification: Types, centromere positions, ISCN standards, karyotype basics
1.4 Sex Chromosomes and Dosage Compensation: X/Y chromosome structure, Lyon's hypothesis, Barr bodies

UNIT II: Human Chromosome Analysis and Cytogenetic Techniques (13hrs)

2.1 Chromosome Banding Techniques: G, Q, R, C, high-resolution banding – significance and applications
2.2 Advanced Cytogenetic Methods: FISH (Q-FISH, F-FISH), CGH, spectral and multicolor karyotyping
2.3 Human Karyotyping Techniques: Lymphocyte culture, hypotonic treatment, staining, idiogram construction
2.4 Computer-Assisted Chromosome Analysis and Microscopy: Light, fluorescence, and confocal microscopy

UNIT III: Genome Organization and Molecular Genetics (12hrs)

3.1 Human Genome Organization: Nuclear vs mitochondrial genome, gene structure, coding vs non-coding regions
3.2 Human Gene Families and Repetitive DNA: Homologs, orthologs, paralogs, contigs, transposable elements
3.3 DNA Replication, Transcription, and Translation in Eukaryotes: Key enzymes and molecular mechanisms
3.4 Mutations and DNA Repair Mechanisms: Mutation types, repair systems, and implications

UNIT IV: Genetic Disorders, Diagnosis, and Applications (10 hrs)

4.1 Chromosomal Aberrations and Syndromes: Structural, numerical, mosaicism, chimerism
4.2 Diagnosis of Genetic Diseases: DNA-based diagnostics, biochemical tests, preimplantation,population screening
4.3 Prenatal Diagnosis: Invasive (CVS, amniocentesis), non-invasive (ultrasound, fetal cells in maternal blood)
4.4 Treatment and Genetic Counseling: Management of genetic disorders, counseling approaches, eugenics and euphenics

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Course No. P1ZOTC105 Course Title: Human Genomics and Cytogenetics

UNIT V: Advances in Human Genetics and Therapeutics **(13hrs)**

5.1 Human Genome Project and Epigenetics: Goals, outcomes, ELSI, and role of epigenetic regulation
5.2 Gene and Environment Interactions: Complex disorders (diabetes, cancer, CVD), twin studies, heritability
5.3 Stem Cells and Therapeutic Cloning: Types, sources, uses in medicine, and associated ethical issues
5.4 Gene Therapy and Personalized Medicine: Pharmacogenomics, treatment strategies, and disorder-specific applications (e.g., Huntington's, Cystic Fibrosis, Thalassemia, DMD)

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II**. Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

SUGGESTED BOOKS:

- Gardner, E.J., Simmons, M. J., & Snustad, D. P. (2008). Principles of Genetics (8th ed.).Wiley-India.
- Strachan, T., & Read, A. P. (2018). Human Molecular Genetics (5th ed.). Garland Science.
- Turnpenny, P. D., & Ellard, S. (2017). Emery's Elements of Medical Genetics (15th ed.). Elsevier.
- Jorde, L. B., Carey, J. C., Bamshad, M. J., & White, R. L. (2020). Medical Genetics (6th ed.). Elsevier.
- Verma, I. C., & Agarwal, S. (2010). Principles of Medical Genetics. CBS Publishers & Distributors.
- Bhatnagar, S. (2015). Human Genetics. Pearson Education India.
- Gangane, S. D. (2021). Human Genetics (5th ed.). Elsevier India.
- Lewin, B. (2011). Genes XI. Jones & Bartlett Learning

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Course No. P1ZOPC108
Credits: 2

Practicals based on P1ZOTC105
Maximum Marks:50

1. Study of Mendelian traits in humans (e.g., tongue rolling, widow's peak, earlobe type)
2. Analysis of human pedigree charts for different inheritance patterns
3. Calculation of allele and genotype frequencies using Hardy-Weinberg equation
4. Identification of normal male and female human karyotypes
5. Identification of chromosomal abnormalities in Down, Turner, Klinefelter, Patau, and Edwards syndromes
6. Demonstration of peripheral blood lymphocyte culture technique
7. Demonstration of metaphase chromosome preparation and G-banding
8. Extraction of DNA from human buccal cells or saliva samples
9. Simulation or demonstration of agarose gel electrophoresis for DNA analysis
10. Case study analysis of single-gene and chromosomal genetic disorders
11. Observation of Barr bodies in buccal smears for sex chromatin
12. Use of online bioinformatics tools (e.g., OMIM, NCBI) to study human genes and disorders

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

Practicals			
Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
Internal Examination	100%	Continuous evaluation	25
External Examination	100%	4 hours	25
Total			50

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CREDIT FRAMEWORK FOR SEMESTER-II

Courses	Course Code	Course Name	Credits
Major Core [4(T) + 2(P)]			
	P1ZOTC201	Fishery Science	4
	P1ZOPC202	Practicals based on P1ZOTC201	2
Total Core Credits			**6**
Major Elective (Any Two*) [4(T)]			
	P1ZOTE210	Nematode Biology	2
	P1ZOTE211	Aquarium and Fish Keeping	2
	P1ZOTE212	Fundamentals of Neuroscience	2
	P1ZOTE213	Basics of Bioinformatics and Biostatistics	2
Total Elective Credits			**4**
	P1ZORE225	Field Visit / Industrial Training	2
	P1ZORE226	Research Project / Dissertation	16
Semester Total Credits			**28**

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Course No. P1ZOTC201
Credits: 4

Course Title: Fishery Science
Maximum Marks:100

Course Outcomes:

CO1: Students will understand the definition, scope, and interdisciplinary nature of fishery science. They will recognize the importance of fisheries in ensuring food security and economic growth. Students will identify and differentiate among lacustrine, riverine, and marine fisheries. They will also explore the ecological significance of plankton and benthos in aquatic systems.

CO2: Students will gain practical knowledge of measuring abiotic factors in freshwater and marine ecosystems. Learners will understand how these variables affect fish metabolism, growth, and health. They will assess the relationship between environmental conditions and fishery productivity.

CO3: Students will identify the nutritional components of fish and their role in human diets. They will understand spoilage mechanisms such as rigor mortis, oxidation, and microbial activity. Knowledge of post-harvest handling, sanitation, and hygiene will be emphasized. They will evaluate various fish preservation methods used in the fishing industry.

CO4: Students will learn the structure and hormonal regulation of fish reproductive systems. They will compare natural and artificial breeding methods, including bund and hatchery techniques. The principles and advantages of induced breeding through hypophysation will be covered

CO5: Students will differentiate between morphometric and meristic characters used in fish growth studies.They will gain skills in aquarium setup and care of ornamental fish species. Various fish diseases and their causes, symptoms, and treatments will be examined. Students will understand both traditional and modern fishing techniques.

UNIT I: Introduction to Fishery Science (13 hrs)

1.1 Definition, scope, and interdisciplinary nature of Fishery Science
1.2 Importance of Fishery Science and its role in food security and econom
1.3 Plankton and Their Classification: Definition of plankton; Characteristics and classification.
1.4 Benthos and Their Classification: Definition and characteristics; Classification of benthic organisms.

UNIT II: Aquatic Environmental Dynamics (13 hrs)

2.1 Thermal and Light Factors: Stratification, biological effects, measurement techniques
2.2 CO_2 and pH: Sources, methods of assessment, and ecological significance
2.3 Dissolved Oxygen (DO): Factors affecting levels, measurement, and role in aquatic life
2.4 Abiotic and Biotic influences on aquatic productivity and fish health

UNIT III: Nutrition, Spoilage, and Fish Processing (12 hrs)

3.1 Biochemical composition of fish – Proteins, lipids, vitamins, and minerals
3.2 Spoilage: Rigor mortis, lipid oxidation, enzymatic and microbial degradation
3.3 Post-harvest technology: Fish sanitation, handling, and hygiene
3.4 Fish processing and preservation methods: Drying, salting, smoking, refrigeration, canning

UNIT IV: Fish Reproduction and Breeding Techniques (12 hrs)

4.1 Introduction to Endocrine System: Definition, importance, comparison with vertebrates, major endocrine glands.
4.2 Structure and Function of Reproductive Organs: Male and female reproductive systems, gametogenesis, hormonal control.
4.3 Natural Breeding of Indian Major carps: Location of breeding grounds and seed collection, Factors responsible for Natural breeding
4.4 Induced breeding (Hypophysation): Principles, techniques, and benefits

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Course No. P1ZOTC201

Course Title: Fishery Science

UNIT V: Fish Growth, Disease Management, and Fishing Techniques **(10 hrs)**

5.1 Morphometric and Meristic characters – definition, types, and importance in growth studies
5.2 Aquarium management: Setup, maintenance, and common ornamental fishes
5.3 Fish diseases: Bacterial, viral, protozoan, and helminth – symptoms and treatments
5.4 Traditional and advanced fishing methods: Electric fishing, sonar, light fishing

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
TEST I (after 30 days)	20%	1 hour	10 + 10
TEST II (after 60days)	21 to 40%	1 hour	10 + 10
Theory	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
Major test (after 90 days)	100%	3 hours	60
Total			100

Test I and Test II

The Subjective Test of Test I and Test II would consist of three short answer type questions (05 marks each). Students are required to answer two questions. **No preparatory holidays shall be provided for the Test I and Test II.** Those candidates who have appeared in Test I and Test II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of two sections, Section-A and Section-B. Section-A will have one compulsory question comprising of 08 parts (minimum 01 from each unit) of 03 marks each. Section B will have 06 questions of 12 marks each to be set from the last three units (02 from each unit). In section B students are required to attempt 01 question from each unit. **In major test there should not be a gap of more than two days in between two tests.**

SUGGESTED BOOKS:

- Sinha, V. R. P., & Khanna, B. S. (1998). Fisheries Science: A Manual for Fish Farmers. Daya Publishing House.
- Pillay, T. V. R. (1990). Aquaculture: Principles and Practices. Wiley-Blackwell.
- Sahoo, L., & Sahu, S. (2008). Fisheries Ecology and Management in India. Daya Publishing House.
- Evans, D. J., Biswas, S. R. B. L. A., & Fernandis, J. C. G. Y. (Eds.). (2009). *Reproductive Biology and Phylogeny of Fish.* Science Publishers.
- Jhingran, V. G. (1982). Fish and Fisheries of India. Hindustan Publishing Corporation.
- Radhakrishnan, V. (1994). Aquaculture and Fisheries. Allied Publishers.
- King, M. (1995). Fisheries Biology, Assessment, and Management. Blackwell Publishing.
- Harris, J. E. (2003). Aquaculture Science. Cengage Learning.
- Pitcher, T. J., & Hart, P. J. B. (1997). Fisheries Ecology and Management. Blackwell Science.
- Allen, M. S., & Hightower, J. E. (2002). Fish Population Dynamics: Mortality, Growth, and Recruitment. American Fisheries Society.
- Badapanda, K. C. *(2017). Basics of fisheries science: A complete book on fisheries aquaculture* Narendra Publishing House.

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Course No. P1ZOPC202
Credits: 2

Practicals based on P1ZOTC201
Maximum Marks:50

1. Measure water temperature at different depths.
2. Measure light penetration in water using a light meter and analyze its impact.
3. Measure dissolved oxygen levels in water and analyze its ecological significance.
4. Measure carbondioxide levels in water and analyze its ecological significance.
5. Collect and identify plankton samples (zooplankton) from aquatic habitats.
6. Collect and identify benthic organisms
7. Observe and document the process of ovulation and fertilization in fish.
8. Study the stages of embryonic development in fish.
9. Study the stages of larval development and growth in fish.
10. Analyze the biochemical composition (proteins, lipids, vitamins) of fish.
11. Study fish spoilage by observing rigor mortis and enzymatic degradation
12. Measure and analyze the growth of fish using morphometric characters.
13. Study meristic characters in different fish species.

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

Practicals			
Test	**Syllabus to be covered in the examination**	**Time allotted for the examination**	**%Weightage (Marks)**
Internal Examination	100%	Continuous evaluation	25
External Examination	100%	4 hours	25
Total			50

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Course No. P1ZOTE210 Course Title: Nematode Biology

Credits: 2 Maximum Marks:50

Course Outcomes:

CO1: Students will gain a foundational understanding of nematodes, including their general characteristics, classification, and structural morphology. They will learn to identify key reproductive structures and their functions. The course enables recognition of important plant and animal parasitic nematodes, along with the diseases and symptoms they cause in hosts.

CO2: Learners will explore the ecological significance of entomopathogenic nematodes (EPNs) as biological control agents. They will understand the symbiotic relationship between EPNs and bacteria, their life cycle stages, and the development of infective juveniles. The course will also cover practical application strategies and examine real-world case studies across various plant systems.

CO3: This unit introduces students to integrated pest management (IPM) and its role in sustainable agriculture. It explains the steps involved in implementing IPM and emphasizes non-chemical methods such as traps and physical controls. Students will also evaluate the disadvantages of chemical pest control, including environmental and health concerns.

UNIT I: Introduction to Nematology and Morphology (10hrs)

1.1 General Characteristics of Nematodes: Occurrence, habit, and habitat

1.2 Classification of Nematodes up to Family Level: Major taxonomic groups

1.3 Morphology and Reproductive Structures: Size, shape, cuticle, stylet, spicules, gubernaculum, bursa

1.4 Nematode-Associated Diseases and Symptoms: Plant parasitic: Root Knot, Soybean Cyst, Lesion Nematodes - Animal/human parasitic: *Trichinella spiralis*, *Ascaris spp.*

UNIT II: Entomopathogenic Nematodes (EPNs) (10hrs)

2.1 Nematodes as Biological Control Agents: Ecological role, symbiotic relationship with bacteria

2.2 Life Cycle of EPNs: First and second-generation males/females, Infective Juveniles (IJs)

2.3 EPN Formulations and Application Strategies: Aqueous suspension, sponges, gels, clay, and powder forms

2.4 Case Studies of EPN Use: Applications in horticulture, floriculture, and medicinal plants

UNIT III: Integrated Pest Management (IPM) (10hrs)

3.1 Introduction to IPM: Concept, advantages, and disadvantages

3.2 Implementation of IPM: Steps—inspection, planning, prevention, treatment, monitoring, documentation

3.3 Non-Chemical Control Methods: Physical tools and traps—spring, sticky, pheromone, fly/wasp traps

3.4 Drawbacks of Chemical Pest Control: Resistance, environmental impact, non-target effects, health risks

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SEMESTER – II
(Syllabus for the examination to be held in May 2027. 2028 and 2029)

Course No. P1ZOTE210

Course Title: Nematode Biology

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be coveredin examination	Time allotted for Exam	% Weightage (marks)
Minor Test I	upto 20%	1 hr.	10 (5+5)
Minor Test II	21% to 40%	1 hr.	10 (5+5)
Major Test	41% to 100%	2hrs.	30

Major test will have two sections (A & B). Section A is compulsory comprising of 10 questions of 1 mark each and be spread over entire syllabus. Section B comprises of 4 questions from remaining 2 units and candidate has to attemp one question fromeach unit of 10 marks each.

SUGGESTED BOOKS:

- Sivaramakrishnan, S., & Razia, M. (2021). Entomopathogenic nematodes and their symbiotic bacteria – a laboratory manual.
- Raja, R. K., Padmanaban, K., & Sivaramakrishnan, S. (2011). Entomopathogenic nematodes: A best bio-control agent for insect pest.
- Perry, R. N., & Wharton, D. A. (2011). Molecular and physiological basis of nematode survival.
- Nguyen, K., & Hunt, D. (2007). Entomopathogenic nematodes: Systematic, phylogeny and bacterial symbionts.
- Singh, J. (2022). Technology manual: Mass production of entomopathogenic nematodes.
- Shapiro-Ilan, D. I., & Lewis, E. E. (Eds.). (2024). Entomopathogenic nematodes as biological control agents. CABI.
- Gaugler, R. (1990). Entomopathogenic nematodes in biological control (Vol. 227). H. K. Kaya (Ed.). CRC Press.
- Gaugler, R. (Ed.). (2002). Entomopathogenic nematology. CABI Publishing.
- Rajak, R. L., Muthaiyan, M. C., Kumarasamy, M., & Manickam, P. (1987). Plant parasitic nematodes: A checklist.
- Molinari, S. (2024). Plant nematode interactions.
- Bauchan, G. (2022). The systematics, morphology and molecular characterization of economically important plant parasitic nematodes.
- https://nemaindia.org.in/wp-content/uploads/2024/04/Book-of-Abstract-2024-with-Gr-Photo.pdf
- https://imanema.ugent.be/wp-content/uploads/2024/09/Introduction-to-Nematology_FULL-BOOK.pdf
- https://www.cabidigitallibrary.org/doi/10.1079/9781789246230.0010
- https://new.rlbcau.ac.in/wp-content/uploads/2024/10/APE-323-Management-of-beneficial-insects-min.pdf
- https://imanema.ugent.be/wp-content/uploads/2024/09/CHAPTER-11.-Nematodes-as-bioindicators.pdf
- https://nemaindia.org.in/wp-content/uploads/2024/08/NSI-Symposium-AGM-Proceedings_2024.pdf

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SEMESTER – II
(Syllabus for the examination to be held in May 2027. 2028 and 2029)

Course No. P1ZOTE211 Course Title: Aquarium and Fish keeping

Credits: 2 Maximum Marks:50

Course Outcomes:

CO1: Learners will understand the construction and structural aspects of aquaria, including material selection and ideal setup. They will gain practical knowledge on choosing suitable locations and maintaining optimal tank conditions. They will also become familiar with appropriate stocking densities based on fish types and tank sizes. This will enable them to design and maintain aesthetic, healthy aquarium systems.

CO2: Students will be able to evaluate key abiotic and biotic factors influencing aquarium water quality. They will learn to identify common fish diseases and recognize their symptoms effectively. Treatment and prevention strategies will be emphasized for maintaining fish health. This knowledge will help ensure the well-being of aquatic life in captive conditions.

CO3: Students will gain a biological understanding of ornamental fish species in both freshwater and marine systems. They will be able to identify species based on physical traits and learn their feeding behaviors. Knowledge of breeding and spawning will help in managing life cycles of ornamental fishes. Overall, they will be equipped to handle ornamental fish care with scientific insight and responsibility.

Unit I: Aquarium Construction and Setup (10hrs)

1.1 Aquarium Fabrication: Materials, frame types, glass size and thickness

1.2 Site Selection and Setup: Placement, environmental factors, aesthetic considerations

1.3 Stocking Capacity: Guidelines for fish load based on tank size and species

1.4 Aquarium Accessories and Decor: Heaters, filters, aerators, thermostat, and decorative elements

Unit II: Water Quality and Fish Health (10hrs)

2.1 Abiotic Components: Dissolved oxygen, pH, carbon dioxide, ammonia

2.2 Biotic Components: Aquarium plants – rooted, branched, and floating types

2.3 Common Aquarium Diseases: Symptoms of white spot, gill flukes, fin rot, mouth fungus

2.4 Fish Health Management: Preventive care and treatment strategies

Unit III: Biology of Ornamental Fishes (10hrs)

3.1 Freshwater Ornamental Fishes: Key species, characteristics, and identification

3.2 Feeding and Breeding (Freshwater): Feeding habits, reproduction, and spawning behavior

3.3 Marine Ornamental Fishes: Notable species, traits, and identification methods

3.4 Feeding and Breeding (Marine): Dietary needs and reproductive patterns

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Course No. P1ZOTE211 Course Title: Aquarium and Fish keeping

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be coveredin examination	Time allotted for Exam	% Weightage (marks)
Minor Test I	upto 20%	1 hr.	10 (5+5)
Minor Test II	21% to 40%	1 hr.	10 (5+5)
Major Test	41% to 100%	2hrs.	30

Major test will have two sections (A & B). Section A is compulsory comprising of 10 questions of 1 mark each and be spread over entire syllabus. Section B comprises of 4 questions from remaining 2 units and candidate has to attempt one question fromeach unit of 10 marks each.

SUGGESTED BOOKS:

- Swann, L. (1993). A Basic Overview of Aquaculture: Aquarium Systems. Illinois-Indiana Sea Grant Program, USA.
- Jhingran, V.G. (1991). Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
- Kumar, D. & Jena, J. (2006). Ornamental Fish Breeding and Culture. Narendra Publishing House, New Delhi.
- Natrajan, A.V. (2009). Aquarium Keeping. ICAR Publication, New Delhi.
- Das, P. & Ayyappan,S. (2000). Fish Genetics and Aquaculture Biotechnology. Narendra Publishing House.
- Ghosh, A. (2005). Introduction to Fish Biology. Emkay Publications, Delhi.
- Swain, S.K. (2013). Textbook on Ornamental Fish Culture. Kalyani Publishers, Ludhiana.
- Sharma, B.K. (2012). A Handbook of Aquarium Fish Keeping. Saraswati Publishing, Jaipur.
- Axelrod, H.R. (1996). Encyclopedia of Aquarium Fish. TFH Publications, Inc., USA.
- Mills, D. (2006). Aquarium Fish. Dorling Kindersley, London.
- Andrews, C. (2010). Manual of Fish Health. Firefly Books, Canada.

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SEMESTER – II
(Syllabus for the examination to be held in May 2027. 2028 and 2029)

Course No. P1ZOTE212 Course Title: Fundamentals of Neuroscience

Credits: 2 Maximum Marks:50

Course Outcomes:

CO1: Students will gain a deep understanding of the multidisciplinary nature of neuroscience and its application across various fields. They will explore the historical evolution and major milestones in the field of neuroscience. The course will also cover recent advances and innovations shaping modern neuroscience research. Students will appreciate how neuroscience intersects with other disciplines and its impact on society.

CO2: Students will develop an in-depth understanding of the structure, types, and functions of neurons, including their roles in neural communication. They will explore the different types of neurons and their distribution during neurulation. Knowledge of neurotransmitters, including their stimulatory and inhibitory effects, will be covered. Additionally, students will learn about synaptic transmission and its significance in neuronal functioning.

CO3:Students will analyze various neurological disorders, including brain tumors, epilepsy, and neurodegenerative diseases through case studies. They will explore structural and functional illnesses affecting the nervous system, enhancing their diagnostic and analytical skills. The course will provide insights into the latest therapeutic approaches used in treating neurological conditions. Students will learn the importance of therapeutic interventions in managing neurological disorders.

UNIT-1: Introduction to Neuroscience (10hrs)

1.1 The Multidisciplinary Nature of Neuroscience

1.2 The Scope and Key Fields of Neuroscience

1.3 Historical Milestones in Neuroscience

1.4 Recent Innovations and Advances in Neuroscience

UNIT-2: Neuronal Structure, Types, and Functions (10hrs)

2.1 Structure and Function of Neurons

2.2 Types of Neurons and Their Distribution During Neurulation

2.3 Neurotransmitters: Types and Functions (Excitatory and Inhibitory)

2.4 The Synaptic Mechanism

UNIT-3: Disorders of the Nervous System (10hrs)

3.1 Case Studies: Brain Tumors and Epilepsy

3.2 Structural and Functional Disorders of the Nervous System

3.3 Neurodegenerative Conditions and Their Impact

3.4 Therapeutic Approaches in Neurological Treatment

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SEMESTER – II
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Course No. P1ZOTE212 Course Title: Fundamentals of Neuroscience

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be coveredin examination	Time allotted for Exam	% Weightage (marks)
Minor Test I	upto 20%	1 hr.	10 (5+5)
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Major Test	41% to 100%	2hrs.	30

Major test will have two sections (A & B). Section A is compulsory comprising of 10 questions of 1 mark each and be spread over entire syllabus. Section B comprises of 4 questions from remaining 2 units and candidate has to attemp one question fromeach unit of 10 marks each.

SUGGESTED BOOKS:

1. Squire, Fundamental Neuroscience (4th Edition and latest Edition), Elsevier,2013
2. Kandel, Principles of Neural Science (5th editionand latest Edition), McGraw Hill,2013
3. Banich, Cognitive neuroscience (3rd Edition) Wordsworth,2011
4. Gazzaniga, Cognitive Neuroscience (4th Edition) Norton,2014
5. Siegel, Basic Neurochemistry (8th Edition) Academic Press,2015
6. Friefelder: Practical Biochemistry

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SEMESTER – II
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Course No.P1ZOTE213 Course Title: Basics of Bioinformatics and Biostatistics

Credits: 2

Maximum Marks:50

Course Outcomes:

CO1: Students will understand the principles of bioinformatics and its applications in biological research. They will gain proficiency in using biological databases like NCBI, EMBL, and UniProt. Sequence alignment techniques such as BLAST and FASTA will be applied in genomics and proteomics.

CO2: Students will learn fundamental biostatistical methods and their applications in biology. They will develop skills in handling different data types, calculating measures of central tendency and dispersion. Basic probability concepts will be applied in biological data analysis.

CO3: Students will gain expertise in hypothesis testing, including t-tests and Chi-Square tests, for analyzing biological data. They will develop skills in correlation and regression analysis for biological variables. Familiarity with statistical tools like MS Excel, GraphPad Prism, and R will be achieved.

UNIT-1: Introduction to Bioinformatics and Databases (10hrs)

1.1 Overview of Bioinformatics: Definition, scope, and real-world applications

1.2 Biological Databases: Exploration of key databases such as NCBI, EMBL, UniProt, and PDB

1.3 Sequence Alignment Basics: Techniques for comparing DNA and protein sequences (BLAST, FASTA)

1.4 Introduction to Genomic and Proteomic Analysis

UNIT-2: Fundamentals of Biostatistics (10hrs)

2.1 Introduction to Biostatistics: Significance and role of statistics in biological studies

2.2 Types of Biological Data: Qualitative vs. Quantitative data and sampling methods

2.3 Measures of Central Tendency and Dispersion: Understanding mean, median, mode, and standard deviation

2.4 Fundamentals of Probability: Exploring probability distributions and their biological relevance

UNIT-3: Statistical Tools and Techniques for Biological Research (10hrs)

3.1 Hypothesis Testing: Understanding concepts, t-tests, and Chi-Square tests in biological studies

3.2 Correlation and Regression Analysis: Assessing the relationship between biological variables

3.3 Introduction to Statistical Software: Basics of MS Excel, GraphPad Prism, and R for data analysis

3.4 Ethical Considerations in Data Analysis and Scientific Research

Course No.P1ZOTE213 Course Title: Basics of Bioinformatics and Biostatistics

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

MCQ on LMS + Subjective Test	Syllabus to be coveredin examination	Time allotted for Exam	% Weightage (marks)
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Minor Test II	21% to 40%	1 hr.	10 (5+5)
Major Test	41% to 100%	2hrs.	30

Major test will have two sections (A & B). Section A is compulsory comprising of 10 questions of 1 mark each and b spread over entire syllabus. Section B comprises of 4 questions from remaining 2 units and candidate has to attem one question fromeach unit of 10 marks each.

SUGGESTED BOOKS:

- Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford University Press.
- Rosner, B. (1995). Fundamentals of Biostatistics (4th ed.). Cengage Learning.
- Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis (2nd ed.). Cold Spring Harbor Laboratory Press.
- Pezzullo, J. (2013). Biostatistics for Dummies. Wiley.
- Waterman, M. S. (1995). Introduction to Computational Biology: Maps, Sequences and Genomes. Chapman & Hall.

Course No. P1ZORE225 Course Title: Field Visit/Industrial Training

Credits: 2 Maximum Marks:50

Course Outcomes: This course is designed to provide students of Zoology with practical exposure to real-world biological and ecological environments, as well as industry practices related to animal sciences. Through field visits to biodiversity-rich habitats, research institutions, zoological parks, aquaculture farms, wildlife sanctuaries, and museums, students gain firsthand knowledge of animal diversity, ecological interactions, and conservation strategies. Industrial training components may include visits to laboratories, fish hatcheries, or other zoology-related industries, helping students understand the application of zoological knowledge in various professional settings.

The course aims to bridge the gap between theoretical learning and practical application, enhance observational and recording skills, and encourage students to critically analyze biological systems in natural or applied settings.

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Course No. P1ZORE226 Course Title: Research Project/Dissertation

Credits: 16 Maximum Marks:400

Course Outcomes: The Research Project/Dissertation is designed to provide students with hands-on exposure to scientific research methodologies. It aims to develop their ability to independently design and conduct experiments, analyze data critically, interpret results, and present findings in a systematic and scholarly manner. Through this course, students gain practical experience in experimental techniques, literature review, hypothesis formulation, data collection, statistical analysis, and scientific writing.

Each student will be assigned a mentor under whose guidance they will complete a research-based project. At the end of the semester, students must submit their project report in the form of a dissertation.

Scheme of Examination: The student shall be continuously evaluated during the conduct of each course on the basis of his/her performance as follows:

	Time allotted for Examination	% Weightage		
Mid Term Appraisa	4 hours	25%		
External Examinatio	4 hours	75%	50%	Project report
			25%	Viva voce
Total				100

Distribution of Marks in Research (Dissertation/Project) in 4th Semester

Total Credits=16, Total Marks=400

Internal Evaluation = 100 Marks, External Evaluation = 300 Marks

Internal Research (Dissertation/Project) Evaluation

External Practical/ Research (thesis/project/patent) examination

External Practical/ Research examination shall be conducted by Board of Examiners consisting of Head of the Department, one/two Senior Professors of concerned department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance/dissertation of the students.