SIKSHA BHAVANA
(Institute of Science)

INTEGRATED SCIENCE EDUCATION AND RESEARCH CENTRE (ISERC)
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OBJECTIVES AND EXPECTED OUTCOMES OF DIFFERENT PAPERS IN FIVE-YEAR INTEGRATED M.Sc. SYLLABUS 2016

ADVANCED COMPUTING

Paper AC-3-5-1: Advanced Computing Laboratory-I
Objectives: This paper is designed to teach the basic of MATLAB programming to the students.
Learning Outcomes: Students will be able to write basic programming for numerical analysis, matrix manipulation, 2D and 3D plotting using MATLAB.

Paper AC-3-6-1: Advanced Computing Laboratory-II
Objectives: This paper is designed to teach the basic of MATHEMATICA programming to the students.
Learning Outcomes: Students will be able to write and handle loops, functions, array, matrix operation, method of solving differential and difference equation, data visualization using MATHEMATICA. They will also be able to write basic programs using the aforesaid tools in the MATHEMATICA environment.

Paper AC-4-7-1: Advanced Computing Laboratory-III
Objectives: Students will try to learn: 1. To understand how to design, implement, test, debug, and document programs that use basic data types and computation, simple i/o, conditional and control structures, string handling and functions. 2. To understand the importance of classes & objects along with constructors, arrays and vectors. 3. Discuss the principles of inheritance, interface and packages and demonstrate though problem analysis assignments how they relate to the design of methods, abstract classes and interfaces and packages. 4. To understand importance of multi-threading & different exception handling mechanisms. 5. To learn experience of designing, implementing, testing, and debugging graphical user interfaces in java using applet and awt that respond to different user events.
Learning outcomes: Students will be able to: 1. Implement object oriented programming concept using basic syntaxes of control structures, strings and function for developing skills of logic building activity. 2. Identify classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem 3. Demonstrate how to achieve reusability using inheritance, interfaces and packages and describes faster application development can be achieved. 4. Demonstrate understanding and use of different exception handling mechanisms and concept of multithreading for robust faster and efficient application development. 5. Enhance their understanding about a functional hierarchical code organization. 6. Ability to work with textual information, characters and strings. 7. To handle possible errors during program execution.

Paper AC 4-8-1: Advanced Computing Laboratory-IV
Objectives: Students will try to learn: 1. Basics of python programming 2. Decision making and functions in python 3. Object oriented programming using python 4. Files handling in python 5. Gui programming and databases operations in python 6. Network programming in python.

Learning outcomes: Students will be able to: 1. Describe the numbers, math functions, strings, list, tuples and dictionaries in python 2. Express different decision making statements and functions 3. Interpret object oriented programming in python 4. Understand and summarize different file handling operations 5. Explain how to design gui applications in python and evaluate different database operations 6. Design and develop client server network applications using python.

CHEMISTRY

Paper CH-1-1-1: Theory

Objectives: Through this course, the idea is to give basic concepts of inorganic, organic and physical chemistry. In inorganic chemistry course, students will learn atomic structure, radioactivity and some periodic properties. In organic chemistry course, students will learn basic of bonding and stereochemistry. In physical chemistry course, students will learn about kinetic theory of gases and different forces.
Learning outcomes: After the completion of the course a student should be able to know some basic concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-1-1-2: Practical

Objectives: Through this course, the idea is to learn systematically detection of elements and functional groups in organic compounds.
Learning outcomes: To develop the skill to analyze unknown organic compounds.

Paper CH-1-2-1: Theory

Objectives: The course offers the students to learn fundamentals of chemical bonding (ionic and covalent), fundamental concepts of mechanism and kinetics in organic chemistry and the basic concepts of thermodynamics and thermochemistry will be provided by physical chemistry.
Learning Outcomes: After the completion of the course a student should be able to know some basic concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-1-2-2: Practical

Objectives: Through this course, the idea is to learn systematically detection of cations and anions in inorganic compounds.
Learning Outcomes: To develop the skill to analyse unknown inorganic salts.

Paper CH-2-3-1: Theory

Objectives: Students will learn the nature and origin of weak intermolecular forces, some periodic properties and the basic concepts of redox reactions, general properties of aliphatic compounds and their reactions with reference to some name reactions, and second law of thermodynamics.
Learning Outcomes: After the completion of the course a student should be able to know important basic concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-2-3-2: Practical

Objectives: Students will learn and gather experience on quantitative analysis of solutions of inorganic compounds by performing various types of titrations.
Learning Outcomes: Students will be able to estimate different types of samples through these titrimetric methods.

OBJECTIVES AND OUTCOMES

Paper CH-2-4-1: Theory

Objectives: Students will be familiar with coordination chemistry and concepts of acids and bases and their reactions. They will be introduced to aromatic and organometallic compounds. In physical chemistry, they will learn the basics of chemical and catalytic reactions.

Learning Outcomes: After the completion of the course a student should be able to know important basic concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-2-4-2: Practical

Objectives: Students will learn to perform several experiments in physical chemistry from where they can determine partition co-efficient, viscosity, kinetics, solubility product of different systems.

Learning Outcomes: Students will be able to use different instrumental techniques to determine important parameters related to chemical reactions.

Paper CH-3-5-1: Theory

Objectives: The course offers the students to learn advanced chemical bonding, fundamental concepts of coordination complexes, their spectral and basic magnetic properties and mechanism of some organic substitution and free-radical reaction.

Learning Outcomes: After the completion of the course a student should be able to know some advanced concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-3-5-2: Theory

Objectives: The course offers the students to learn nuclear (radioactive reactions) chemistry and its various models, mechanism of some organic elimination, addition and rearrangement reactions and fundamental concepts of electrochemistry.

Learning Outcomes: After the completion of the course a student should be able to know some advanced concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-3-5-3: Practical

Objectives: Students will get experience of physical chemistry experiments using different instrumental techniques. Side by side they will also learn to prepare and characterize some inorganic compounds.

Learning Outcomes: Students will be able to learn the use of different instruments and their maintenance, and develop expertise on synthesis.

Paper CH-3-5-4: Practical

Objectives: Students will get exposure and glimpse of research world of chemical science.

Learning Outcomes: Students will be motivated to pursue research as their future career and become aware of its societal benefits.

Paper CH-3-5-5: Theory

Objectives: Students will learn in details about the theories behind the different experiments that are used in chemistry to determine the quantity and in some cases quality of various samples. Apart from that they will also learn to estimate the statistical quality of the data they obtain and handle.

Learning Outcomes: Students will not just be blindly doing the practical classes but they also know about the detail theory and reactions they are doing.

Paper CH-3-6-1: Theory

OBJECTIVES AND OUTCOMES

Objectives: Through this course, the idea is to offer basic of bioinorganic chemistry and bioorganic chemistry. This will help them to understand the role chemistry in important life processes of animal as well as the plant kingdom. Side by side they will also learn about group theory and symmetry in molecules.
Learning Outcomes: After the completion of the course a student should be able to know some important concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-3-6-2: Theory
Objectives: Through this course, the idea is to teach the students about different organometallic compounds and catalysis, including boron compounds and their properties. They will learn the method of synthesis of heterocyclic compounds and their reactions. Laws on colligative properties, their applications in real life and advanced electrochemistry in terms of galvanic cells will be introduced.
Learning Outcomes: After the completion of the course a student should be able to know some important concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-3-6-3: Practical
Objectives: Students will learn quantitative separation and estimation of a mixture of cations through titrimetry.
Learning Outcomes: Skill will be developed to estimate different cations in an unknown mixture.

Paper CH-3-6-4: Practical
Objectives: Students will get exposure of research world of chemical science and learn to make effective presentation of their work.
Learning Outcomes: Students will be motivated for take research as their future career and aware of its societal benefits.

Paper CH-3-6-5: Analytical Chemistry-II (Theory)
Objectives: Students will get exposure on different techniques/methods used in research of chemical science.
Learning Outcomes: Students will be motivated to pursue research as their future career and become aware of its societal benefits.

Paper CH-4-7-1: Theory
Objectives: Students will learn fundamentals of magnetochemistry and molecular magnetism, dyamic stereochemistry of compounds and different name reaction in organic chemistry. In physical chemistry, different aspects of colloidal chemistry and ion-solvent interaction will be introduced.
Learning Outcomes: After the completion of the course a student should be able to know some advanced concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-4-7-2: Theory
Objectives: Though this course the aim is to introduce to the students the basic ideas in solid state sciences and nanoscience. Various theories used in this field, different approaches used for their synthesis, instrumental techniques used to characterize the materials and application of such materials will be discussed.
Learning Outcomes: After the completion of the course a student should be able to know some important concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-4-7-3: Practical

Objectives: Students will learn to analyze and get the constituent elements present in some ores and alloys obtained from mineral sources.

Learning Outcomes: Skill will be developed in the students to analyze different ores used in academia and industry.

Paper CH-4-7-4: Practical

Objectives: Students will get exposure of the research world of chemical science by performing synthesis, data collection and their analysis.

Learning Outcomes: Students will be motivated to opt for research as their future career being aware of its societal benefits.

Paper CH-4-7-5: Polymer Chemistry (Theory)

Objectives: Students will learn the importance of polymer chemistry, classification, synthesis and characterization of polymers. Their structural properties will be discussed with an emphasis on the utility of specialized polymers in various practical fields of applications.

Learning Outcomes:

After the completion of the course a student should be able to know many advanced concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-4-8-1: Theory

Objectives: Students will be familiar with basic of ideas in supramolecular chemistry and their application. They will learn about rare earth elements and their properties, understand the concept and importance of asymmetric synthesis and green chemistry. In addition to that advanced idea on electrochemistry in terms of different parameters involved in an electrochemical reaction will be offered.

Learning Outcomes: After the completion of the course a student should be able to know important concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-4-8-2: Theory

Objectives: Students will learn advanced inorganic reaction mechanism, their energetics and classification. Apart from that advanced bioinorganic chemistry, photochemistry and pericyclic reactions in organic chemistry will be introduced. They will learn about different reversible/irreversible electrochemical processes and corrosion reactions involve in nature. They will also learn the basic theory of electrolyte-semiconductors junction.

Learning Outcomes: After the completion of the course a student should be able to know important concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-4-8-3: Practical

Objectives: Students will learn to determine different fundamental parameters related to chemical reactions by performing several experiments using potentiometry, conductometry and spectroscopy.

Learning Outcomes: Students will become skillful in handling sophisticated instruments.

Paper CH-4-8-4: Practical

Objectives: Students will get exposure of research world of chemical science by performing synthesis, data collection and their analysis.

Learning Outcomes: Students will be motivated to pursue research as their future career and become aware of the possibilities.

Paper CH-4-8-5: Renewable Energy: Solar, Hydrogen and Biomass Energy (Theory)
Objectives: Students will learn the chemistry behind the use of alternative energy sources which are renewable in nature. This shall include solar, hydrogen and biomass energy which are extremely relevant to the present day life as well as the environment.
Learning Outcomes: After the completion of the course a student should be able to know important concepts and prepare themselves for competitive examinations in chemical sciences.

Paper CH-5-9-1: Dissertation Paper
Objectives: Students will get the scope to do original research work as per the area of research of the supervisor(s). They will prepare schemes, execute the synthesis and characterization part and then study the properties and applications. Depending on the research group where the student shall execute it, the actual nature may vary to some extent.
Learning Outcomes: Students will become all set to start their career as a researcher with the capability to find out new problems, design experiments and work on them.

Paper CH-5-10-1: Dissertation Paper
Objectives: Students will get the scope to do original research work as per the area of research of the supervisor(s). They will prepare schemes, execute the synthesis and characterization part and then study the properties and applications. Depending on the research group where the student shall execute it, the actual nature may vary to some extent.
Learning Outcomes: Students will become all set to start their career as a researcher with the capability to find out new problems, design experiments and work on them.

EARTH AND ENVIRONMENTAL SCIENCE

Paper EES-3-5-1: Climatology and Climate Change
Objectives: The objectives of this paper are to teach the students basic ideas about climatology and climate change (weather parameters, classification of climates, etc.).
Learning Outcomes: Students will learn some elementary features about climatology and climate change (weather parameters, classification of climates, etc.).

Paper EES-3-5-2: Water Pollution
Objectives: Students will be taught several aspects of water pollution (sources and consequences, types and characteristics, etc.) and methods for waste water treatment.
Learning Outcomes: This will enable the students to study and analyze the quality of water from different sources and waste water treatment in the laboratory.

Paper EES-3-5-3: Practical
Objectives: Several water related physicochemical parameters will be taught to the students in the laboratory.
Learning Outcomes: Students will learn analysis of water related physicopchemical parameters in the laboratory.

Paper EES-3-5-4: Practical
Objectives: This is project based practical paper to encourage the students to use their idea to perform earth and environment related experiments. There is no stipulated syllabus for this paper.
Learning Outcomes: Students will learn to use basic laboratory instruments to perform earth and environment related experiments in consultation with teachers.

Paper EES-3-5-5: Principles of Soil Science
Objectives: The objectives of this paper are to teach several aspects of soil science.
Learning Outcomes: The students will have a detail understanding on soil science for applications in the laboratory.

OBJECTIVES AND OUTCOMES

Paper EES-3-6-1: Energy and Environment
Objectives: Students will be taught about different sources of energy and their impact on the environment.
Learning Outcomes: Students will learn details on how energy can be generated from various sources and their impact on the environment.

Paper EES-3-6-2: Soil Pollution and Solid Waste Management
Objectives: Various aspects of soil pollution and solid waste management will be taught to the students in detail.
Learning Outcomes: This will enable the students to analyze soils from different sources and the techniques for solid waste management.

Paper EES-3-6-3: Practical
Objectives: Several earth and environmental science related topics will be taught to the students in the laboratory.
Learning Outcomes: Students will have hands-on experience on how to analyze several parameters of soil, identification of common rocks and minerals, etc.

Paper EES-3-6-4: Practical
Objectives: This is project based practical paper to encourage the students to use their idea to perform earth and environment related experiments. There is no stipulated syllabus for this paper.
Learning Outcomes: Students will learn to use basic laboratory instruments to perform earth and environment related experiments in consultation with teachers.

Paper EES-3-6-5: Environmental Earth Science
Objectives: The objectives of this paper are to teach the students various aspects of environmental earth science.
Learning Outcomes: Students will learn details about the structure of earth, plate tectonics, mineral resources, their extraction, etc.

Paper EES-4-7-1: Remote Sensing and GIS
Objectives: Students will be taught the basic concepts of remote sensing and global positioning system (GPS).
Learning Outcomes: This will help the students to understand and apply remote sensing and GPS techniques for earth and environmental science related research works.

Paper EES-4-7-2: Environmental Toxicology
Objectives: The objectives of this paper are to teach basic principles of environmental toxicology.
Learning Outcomes: Students will learn types of toxicity, global dispersion of toxic substances, various diseases out of toxic problems, etc.

Paper EES-4-7-3: Practical
Objectives: Several earth and environmental science related topics will be taught to the students in the laboratory.
Learning Outcomes: Students will have hands-on experience on ecology, image processing, local biodiversity, etc.

Paper EES-4-7-4: Practical
Objectives: This is project based practical paper to encourage the students to use their idea to perform earth and environment related experiments. There is no stipulated syllabus for this paper.

Learning Outcomes: Students will learn to use basic laboratory instruments to perform earth and environment related experiments in consultation with teachers.

Paper EES-4-7-5: Ecology
Objectives: Students will be taught concepts of ecology in detail.
Learning Outcomes: This paper will help the students to learn various ecological cycles. Also, they will learn about the problems faced by ecoystems and their possible management.
Paper EES-4-8-1: Environmental Laws, Policies and Sustainable Development
Objectives: The objectives of this paper are to teach the details about environmental laws, policies and sustainable development.
Learning Outcomes: Students will learn different aspects of environmental laws and policies, risk assessment and management as well as sustainable development.

Paper EES-4-8-2: Environmental Management
Objectives: Students will be taught different aspects of environmental management.
Learning Outcomes: This paper will help the students to learn definition and scope of environmental management.

Paper EES-4-8-3: Practical
Objectives: Students will be assigned field visits for studying ecosystems.
Learning Outcomes: This will enable the students to gain hands-on experience about various earth and environmental related issues directly.

Paper EES-4-8-4: Practical
Objectives: This is project based practical paper to encourage the students to use their idea to perform earth and environment related experiments. There is no stipulated syllabus for this paper.
Learning Outcomes: Students will learn to use basic laboratory instruments to perform earth and environment related experiments in consultation with teachers.

Paper EES-4-8-5: Hydrology and Water Management
Objectives: The objectives of this paper are to teach basic concepts of hydrology and water management.
Learning Outcomes: Students will learn about water as a resource, different types of water flow, water quality and water management.

Paper EES-5-9-1: Dissertation Paper
Objectives: Students will get the scope to do original research work as per the area of research of the supervisor(s). Depending on the research group where the student shall execute it, the actual nature may vary to some extent.
Learning Outcomes: Students will become all set to start their career as a researcher with the capability to find out new problems, design experiments and work on them.

Paper EES-5-10-1: Dissertation Paper
Objectives: Students will get the scope to do original research work as per the area of research of the supervisor(s). Depending on the research group where the student shall execute it, the actual nature may vary to some extent.
Learning Outcomes: Students will become all set to start their career as a researcher with the capability to find out new problems, design experiments and work on them.

ENGLISH

Paper ENG-1-1-1: Functional English

OBJECTIVES AND OUTCOMES

Objectives: This paper is introduced in the beginning of the Five-Year Integrated M. Sc. programme to enhance the knowledge of the students in functional English.
Learning Outcomes: This will help students to learn basic grammer in English, written communication, creative features, etc.

LIFE SCIENCE

Paper LS-1-1-1: Molecules and Their Interaction Relevant to Biology

Objectives: Introduce students to the basics of life science to make their fundamentals strong being the first theory paper. They would be introduced to composition, structure and functions of biomolecules and various stabilizing interactions that occur among them. In addition, they are also introduced to basic concepts of bioenergetics as well as enzyme catalysis.
Learning Outcomes: Students should be able to consolidate their knowledge gained during their class XII and augment the knowledge that would prepare them for learning higher biological processes later in the course.

Paper LS-1-1-2: Practical

Objectives: As the first practical course, students would be introduced to the safety aspects in a life science laboratory, basic disinfection and sterilization procedures and good laboratory practices. In addition, simple designing of experiments for qualitative study of biomolecules would be introduced. They would also be trained in operation of instruments like autoclave, simple microscope, etc.,
Learning Outcomes: Students should be able to work in a life science laboratory following safety precautions. They would be learning basic concepts in designing experiments for simple problems, perform the experiments safely, and interpret results scientifically doing small experiments. In addition, they would be trained in using autoclaves, simple microscopes etc.

Paper LS-1-2-1: Cellular Organization

Objectives: The second paper in life science course is to make students understand the functional interactions of molecules in the making of more complex systems and their functions. Students are to learn structure and functions of cell membranes and other cellular organelles, organization of genes and chromosomes and about prokaryotic and eukaryotic cell duplication.
Learning Outcomes: Students would be able to understand and learn from molecules how more complex organelles are formed and how they function. They also learn different stages of cell division.

Paper LS-1-2-2: Practical

Objectives: This is in line with the theory paper students learn. They would be shown stages of cell division, chromosomes in addition to bacterial growth characteristics.
Learning Outcomes: Students should be able to appreciate and learn the complex processes that occur in living eukaryotic cell visually by seeing different stages of cell division. Students also learn to do staining to see bacterial cells, observe how they grow and its growth characteristics.

Paper LS-2-3-1: Fundamental Processes

Objectives: This course introduces students to the fundamental processes that occur in a living system. Students would be introduced to DNA replication, RNA synthesis and processing, protein synthesis and processing and control of gene expression.
Learning Outcomes: Students should be able to understand the basic functions of genetic material replication, information passage from genetic material for making the gene products. Understanding these processes would enable the students to understand and design or understand the experiment designs that could manipulate these processes for our advantages.

Paper LS-2-3-2: Practical

Objectives: Based on the theory course, students were introduced to genomes and transcripts in silico and its use.

Learning Outcomes: Students were able to learn different databases of genomes, retrieve a gene of interest from genomes, design primers for PCR and operational aspects of PCR machine. They were also learning alignment searches of nucleotide sequences in the databases.

Paper LS-2-4-1: Cell Communication and Cell Signaling

Objectives: In this semester with the foundation obtained from previous semesters, students are to learn cell communications and signaling. They learn host parasite interactions, endocrine systems and mechanism of hormonal action, signaling defects and diseases, cell communications and cancer.

Learning Outcomes: Students should be able to understand the different mechanisms by which chow pathogens enter, propagate and the reactions that would be elicited by the host organism or cells. They would also be able to know the signaling mechanism by hormones, signaling defects and its outcome as diseases and aberrant proliferative signaling causing cancer. They will also be able to understand how cells also try to nullify the deleterious effects of aberrant communication/signaling and thereby maintaining the healthy state of the body or cells.

Paper LS-2-4-2: Practical

Objectives: To introduce students to different pathogens, how acquiring specific genes that would impart survival advantages (by bacterial transformation with plasmids containing antibiotic resistance genes and thereby imparting antibiotic resistance), staining for bacteria, etc.

Learning Outcomes: Students would be able to understand how acquiring useful specific genes increases their survivability in adverse conditions. Gram's staining would introduce them to staining and classification of bacteria on the basis of cellular components (cell wall) and how the properties of bacteria change because of this.

Paper LS-3-5-1: System Physiology

Objectives: This paper covers plant and human organ systems and their function. In plant section, photosynthesis, nitrogen metabolism, plant hormones, sensory photobiology, solute transport and photoassimilate translocation are to be introduced. In human system, components and functions of different organ system like circulatory system, nervous sysem, sense organs (vision and hearing) and excretory system would be introduced.

Learning Outcomes: After this course students would be familiar with different plant and human system components and their functions.

Paper LS-3-5-2: Metabolism of Carbohydrates, Proteins, Lipids and Nucleic Acids

Objectives: This paper is to deal with metabolism of carbohydrate, protein, lipids and nucleic acids. Also, it deals with human digestive sysem.

Learning Outcomes: Students would familiar with metabolism of carbohydrates, proteins, lipids and nucleic acids. They would also be familiar with digestion process and various organs as well as their functions in the digestive system.

Paper LS-3-5-3: Practical-I

Objectives: To observe different plant processes like photosynthesis, transpiration and respiration experimentally, to identify the components of different human organ systems and know their functions.

Learning Outcomes: Students should able to understand the factors affecting photosynthesis, transpiration and respiration in plants. They should be able to experimentally

quantify these processes. With the human organ systems, students should be able to identify and know the functions of organs in the organ system they study in the theory papers.

Paper LS-3-5-4: Practical-II
Objectives: To provide experience in designing, performing and interpreting results of scientific projects. Students are required to take up small projects either wet lab or in silico.
Learning Outcomes: Students would gain experience in asking scientifically valid, relevant questions and addressing them experimentally.

Paper LS-3-5-5: Developmental Biology
Objectives: Aim of this paper is to familiarize students in basic aspects and the process of plant and animal development.
Learning Outcomes: Students would be able to gain knowledge in stem cells, development of gamets, fertilization, morphogenesis, organogenesis in both plants and animals (Drosophila and chick as model systems).

Paper LS-3-6-1: Inheritance Biology
Objectives: This paper aims to impart knowledge regarding Mendelian principles, concept of gene, extra chromosomal inheritance, microbial and human genetics, mutations and structural and numerical chromosomal alterations.
Learning Outcomes: Students would be able to know phenotypic characters and its expression, about alleles and their inheritance, inheritance that are extra chromosomal, mutations and chromosomal aberrations and its effects.

Paper LS-3-6-2: Ecological Principles
Objectives: This paper deals with ecology and students are to learn about environments and relationships between environments and organisms.
Learning Outcomes: Students would be able to gain knowledge about different environment types, about habitat and niche, population and interaction of different species in a population in community level. Also, they would be able to understand ecological successions, ecosystems and regarding conservation of endangered species.

Paper LS-3-6-3: Practical-I
Objectives: This practical course is based on the theory papers in this semester. Students are to do experiments to observe bacterial populations in the environment, their features, percentage of different human characteristics present in a population and measurement of various parameters in various environmental samples.
Learning Outcomes: Students would be able to identify microscopic and macroscopic communities in different ecosystems, different properties and measurement of different properties of environmental samples, prevalence of characteristics in a population etc.

Paper LS-3-6-4: Practical-II
Objectives: To provide experience in designing, performing and interpreting results of scientific projects. Students are required to take up small projects either wet lab or in silico.
Learning Outcomes: Students would gain experience in asking scientifically valid, relevant questions and addressing them experimentally.

Paper LS-3-6-5: Diversity of Life Forms
Objectives: Aim of this paper is to introduce students to principles and methods of taxonomy, levels of structural organization of living organisms, organisms of health and agricultural importance.
Learning Outcomes: Completing this paper, student should be able to classify organisms, understand levels or organization, different pathogens and useful organisms in addition to organisms that are needed to be conserved.

OBJECTIVES AND OUTCOMES

Paper LS-4-7-1: Immunology and Immunotechniques

Objectives: Aim of this paper is to make students understand components of immune system, their function and various immune-techniques.

Learning Outcomes: Students should be able to differentiate between innate and acquired immunities. functional and developmental aspects of different immune cells lie T cells, B cells, antigen presenting cells, different immune responses, and various immuno-techniques lime ELISA, RIA, Western Blot, immunoprecipitaiton, FACS, FISH, GISH, etc.

Paper LS-4-7-2: Methods in Biology-I

Objectives: This paper is designed to make students learn molecular biology and recombinant DNA methods. Techniques necessary for individual as well as large scale analyses (including comparative) of DNA, RNA, protein, carbohydrate, metabolites etc would be studied.

Learning Outcomes: After the completion of this course, students are expected to know basic molecular biology techniques like cloning, isolation and purification of nucleic acids and proteins, regarding expression of proteins and nucleic acids, about different libraries, etc. Comparative (studies both large scale and small scale) of nucleic acids and proteins from various sources and various other techniques like RFLP, RAPD and AFLP techniques would also be familiar to them.

Paper LS-4-7-3: Practical-I

Objectives: In line with various theory papers in this semester this practical course includes experiments in immunology and molecular biology that are designed to be complementary to the theory topics. These include radial immunodiffusion, immunoelectrophoresis, Oucherlony double immunodiffusion, detection of IgG and IgM antibodies, immno precipiaiton, Western blotting for immunology related experiments and restriction digestion for molecular biology.

Learning Outcomes: Students should be able to better understand various antigen antibody reactions and gain practical hands on knowledge in molecular biology.

Paper LS-4-7-4: Practical-II

Objectives: To provide experience in designing, performing and interpreting results of scientific projects. Students are required to take up small projects either wet lab or in silico.

Learning Outcomes: Students would gain experience in asking scientifically valid, relevant questions and addressing them experimentally.

Paper LS-4-7-5: Evolution

Objectives: This paper aims to impart knowledge about different evolutionary thoughts, origin of cells, paleontology, evolutionary history, molecular evolution and population genetics.

Learning Outcomes: Students would be able to know Lamark, Darwin concepts, concept of Oparin and Haldane, evolution of unicellular organisms, molecular tools in phylogeny, gene pool, gene frequency, Hardy-Weinberg Law, etc.

Paper LS-4-8-1: Applied Biology

Objectives: This paper introduces students to the advanced techniques and its uses in life science. These include transgenic technology, stem cell technology, gene correction, gene editing, gene replacements/augmentation, vaccines, diagnostics, tissue culture methods for plants and animal cells, genetic manipulation for fruit setting, ripening, herbicide resistance, bioremediation and phytoremediation, biosensors, etc.

Learning Outcomes: Students should be able to know the basis, strategies and overview of procedural steps in these techniques as well as technologies.

Paper LS-4-8-2: Methods in Biology-II

Objectives: This paper mainly introduces students mainly to various techniques used in life science as well as in bioinformatics. This includes various biophysical methods like various spectroscopy methods, radiolabeling techniques, microscopic techniques and electrophysiological Techniques.
Learning Outcomes: Students would be able to understand the principles, working and use of various techniques.

Paper LS-4-8-3: Practical-I
Objectives: Based on various theory papers in this semester, practical hands on experience is to be given in the experiments they study. Because of the lack of infrastructural facilities to conduct these experiments what they study the designing of the experiments and basic molecular biology techniques are performed. Hands on training for the application of various statistical methods students learned taking hypothetical results as well as reported studies.
Learning Outcomes: Students would be learning the in silico designing part of many experiments like making transgenic animals, gRNA for gene editing, designing shRNAs for knock down studies, in addition to bioinformatics experiments. For statistical experiments students will have some hands on experience.

Paper LS-4-8-4: Practical-II
Objectives: To provide experience in designing, performing and interpreting results of scientific projects. Students are required to take up small projects either wet lab or in silico.
Learning Outcomes: Students would gain experience in asking scientifically valid, relevant questions and addressing them experimentally.

Paper LS-4-8-5: Statistical Methods for Biology
Objectives: Introduce students to various statistical methods relevant for biology like measure of central tendency and dispersal, concept of probability and its application in biological sampling and genetics, sampling distribution, difference between parametric and non-parametric statistics, confidence interval, errors, levels of significance, concept of Regression and Correlation, T-Test, Analysis of Variance, X2 test, and basic introduction to multivariate statistics.
Learning Outcomes: After learning this course students will be able to understand the significance of statistics in experimental design and analyses of results..

Paper LS-5-9-1: Dissertation Paper
Objectives: Aim of this paper is to make students ready for research after the course. Students go to various reputed academic and research institutes where they would be carrying out research projects for the whole semester in life science or related interdisciplinary areas of science.
Learning Outcomes: Students should be able to gain experience in working with bigger research projects.

Paper LS-5-10-1: Dissertation Paper
Objectives: Aim of this paper is to make students ready for research after the course. Students go to various reputed academic and research institutes where they would be carrying out research projects for the whole semester in life science or related interdisciplinary areas of science.
Learning Outcomes: Students should be able to gain experience in working with bigger research projects.

MATHEMATICS

Paper MT-1-1-1: Mathematics-I

Objectives: In this course students will study a part of general calculus. Before studying calculus, all students have completed two years of higher secondary mathematics designed for college-bound students: courses in which they study algebra, geometry, trigonometry, analytic geometry, and elementary functions. This course include those functions that are linear, polynomial, rational, exponential, logarithmic, trigonometric, inverse trigonometric, and piecewise defined. Students must also understand the language of functions (domain and range, odd and even, periodic, symmetry, zeros, intercepts, and so on). The course emphasizes a multi representational approach to calculus, with concepts, results, and problems being expressed geometrically, analytically, and verbally. Students should see many different ways of representing functions of several variables including algebraic formulas, graphs, contour diagrams, cross sections.

In this course broad concepts and widely applicable methods are emphasized. The focus of the course is neither manipulation nor memorization of an extensive taxonomy of functions, curves, theorems, or problem types. Students should be able to work with functions represented in a variety of ways: graphical, numerical, analytical, or verbal. They should understand the connections among these representations. This course also includes the basics of tensor algebra and tensor calculus for understanding some topics related to physics course.

Learning Outcomes: Students will be able to identify areas in mathematics and other fields where calculus is useful. Students will be able to generate solutions to unfamiliar problems. Thus, although facility with manipulation and computational competence are important outcomes, they are not the core of the course.

1. Students will understand the meaning of the derivative in terms of a rate of change and local linear approximation and should be able to use derivatives to solve a variety of problems.
2. Students will understand the meaning of the definite integral and will be able to use integrals to solve a variety of problems.
3. Students will understand the relationship between the derivative and the definite integral as expressed in both parts of the fundamental theorem of calculus.
4. Students will be able to communicate mathematics both orally and in well-written sentences and should be able to explain solutions to problems.
5. Students will develop an appreciation of calculus as a coherent body of knowledge and as a human accomplishment.
6. Students will understand the tensorial representation of physical formulae which they will find in physics classes. As a prerequisite of some of the physics courses, students will find the concepts in tensor analysis.

Paper MT-1-1-2: Computing Lab-I

Objectives: The course is designed to provide almost basic knowledge of c language. The main objective is to develop logics which will help students to write programs in c. Also by learning the basic programming, they can easily switch over to any other language in future.

Learning Outcomes: On completion of the course, the student should be able to:

1. Enumerate the significant aspects of software development and problem solving technique.
2. Exhibit the various types of control flow in c language.
3. Analyze file access methods and the features of preprocessor directives.
4. Use technology to help solve problems, experiment, interpret results, and verify conclusions.
5. Able to implement the algorithms and draw flowcharts for solving mathematical and engineering problems.
6. Demonstrate an understanding of computer programming language concepts.
7. To be able to develop c programs on linux platform.
8. Develop confidence for self education and ability for life-long learning needed for computer language.

Paper MT-1-2-1: Mathematics-II

Objectives: This course is an extension of MT-1-1-1. Students would have geometric understanding of graphs of continuous functions (intermediate value theorem and extreme value theorem). They should have the idea of mean value theorem and its geometric consequences. They should have corresponding characteristics of the graphs of f, f', and f''. They should have the relationship between the concavity of f' and the sign of f'' and points of inflection as places where concavity changes. The secondary goal of this course is to familiarize the students with the notion of vectors as representing quantities that have directions as well as magnitude. For example velocity of a moving object in space is given by a vector to specify how fast and in what direction it is moving. Also, students will study two important operations involving vectors, scalar product and cross product, and their applications to linear geometry in space including equations of planes and the volume of paralellopiped. This course also includes the fourier and laplace transformations to understand their applications in physics classes. Furthermore, it is to understand how the value of a multivariable function changes as one of its independent variables is allowed to vary with all other variables fixed at constants. Hence students should study the rate of change of a multivariable function with respect to each of its independent variables, introducing the notion of partial derivatives. They will then use these partial derivatives to get various local information about the function including tangent planes and directional derivatives. Furthermore, we will develop various techniques such as the second derivative tests and Lagrange multiplier methods to and local and global maxima and minima of a multivariable function.

Learning Outcomes: On completion of the course, the student should be able to:

1. Think logically & understand the basic concepts.
2. Demonstrate problem solving for application of multiple integrals in solving engineering Problems.
3. Prepare themselves to understand the more advanced topics in partial differential equations by
Learning basics of partial derivatives.
4. Students can use laplace and fourier transforms whenever necessary.

Paper MT-1-2-2: Scientific Computing

Objectives: This course is an introduction to a broad range of numerical methods for solving mathematical problems that arise in science and engineering. The goal is to provide a basic understanding of the derivation, analysis, and use of these numerical methods, along with a rudimentary understanding of finite precision arithmetic and the conditioning and stability of the various problems and methods.

Learning Outcomes: This will help to choose, develop and apply the appropriate numerical techniques for a given problem, interpret the results, and assess accuracy. This will help to derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations. It also helps to analyze and evaluate the accuracy of common numerical methods.

Paper MT-2-3-1: Mathematics-III

Objectives: The goal is to define the double and triple integrals and to see their interpretations as average value, volume under graph, volume of a solid, area of a region, total mass from density. Students should evaluate these integrals using iterated integral. This course also includes first order differential equations including separable, homogeneous, exact, and linear. The objective is to show existence and uniqueness of solutions. In addition, it emphasizes on solving second order and higher order linear differential equations. In addition some special techniques are taught namely Bessel solution, legendre solutions and series solutions.

Learning Outcomes: On completion of the course, the student should be able to:
1. Understand the applications of multiple integrals.
2. Analyze real world scenarios to recognize when ordinary differential equations (odes) or systems of odes are appropriate, formulate problems about the scenarios, creatively model these scenarios (using technology, if appropriate) in order to solve the problems using multiple approaches, judge if the results are reasonable, and then interpret and clearly communicate the results.
3. Solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or bernoulli cases.
4. Find the complete solution of a nonhomogeneous differential equation as a linear combination of the complementary function and a particular solution.
5. Introduce the complete solution of a nonhomogeneous differential equation with constant coefficients by the method of undetermined coefficients.
6. Find the complete solution of a differential equation with constant coefficients by variation of parameters.
7. Gather knowledge of basic application problems described by second order linear differential equations with cons tant coefficients.
8. Students can apply some special solutions to the special differential equations.

Paper MT-2-3-2: Computing Lab-II

Objectives: This course is an extension of MR-1-1-2. The main objective is to teach some strategies on advanced C language and using those to write programs for mathematical problems by following solution techniques taught in MT-1-2-2.

Learning Outcomes:
1. Ability to design and develop computer programs, analyzes, and interprets the concept of pointers, declarations, initialization, operations on pointers and their usage.
2. Able to define data types and use them in simple data processing applications also he/she must be able to use the concept of array of structures.
3. Illustrate the effective usage of arrays, functions and structures in C.
4. Demonstrate the implementation of pointers in arrays, structures and functions.

Paper MT-2-4-1: Mathematics-IV

Objectives: This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of certain structures called groups, rings in addition to the theory of determinant and matrices. Abstract algebra gives to student a good mathematical maturity and enables to build mathematical thinking and skill. Another main objective is to explain base concept of a vector space and properties of vectors on the base. It also expresses row and column space of a matrix. It explains some functions defined between vector spaces. This course also expresses required conditions for a transformation in order to be a linear transformation.

Learning Outcomes: On completion of the course, the student should be able to:
1. Use and understand matrix and vector notation, addition, scalar multiplication, the dot product, matrix multiplication, and matrix transposition.
2. Use gaussian elimination to solve systems of linear equations and write the solution in parametric and vector form. Define and use the words homogeneous, nonhomogeneous, row echelon form, and reduced row echelon form.
3. Find the rank of a matrix. Determine if a collection of vectors is linearly independent. If linearly dependent, be able to write vectors as linear combinations of the preceding vectors.
4. Compute determinants, inverses, eigenvalues, and eigenvectors.
5. Illustrate with examples how a nonzero determinant is equivalent to having independent columns, an inverse, and nonzero eigenvalues. Similarly, a zero determinant is equivalent to having dependent columns, no inverse, and a zero eigenvalue.

Paper MT-2-4-2: Partial Differential Equations

Objectives: The course objective is to develop the theory of hyperbolic, parabolic and elliptic partial differential equations in connection to physical, technical and scientific problems. Main themes are well-posedness for various initial and boundary value problems and properties of solutions of the wave equation, the heat equation and the laplace equation. Important areas of application are found in numerical analysis, optimisation theory, control theory, signal processing, image analysis, mechanics, solid mechanics and quantum mechanics.

Learning Outcomes: On completion of the course, the student should be able to

1. Describe real-world systems using pdes.
2. Solve first order pdes using the method of characteristics.
3. Determine the existence, uniqueness, and well-posedness of solution of pdes.
4. Solve linear second order pdes using canonical variables for initial-value problems, separation of variables and fourier series for boundary value problems.

Paper MT-3-5-1: Discrete Mathematics

Objectives: The aim of this course is to develop logical thinking and its application to computer science (to emphasize the importance of proving statements correctly and de-emphasize the hand-waving approach towards correctness of an argument). The subject enhances one's ability to reason and ability to present a coherent and mathematically accurate argument.

Learning Outcomes: After completing this course satisfactorily, a student will:

1. Be able to construct simple mathematical proofs and possess the ability to verify them.
2. Have substantial experience to comprehend formal logical arguments.

Be skillful in expressing mathematical properties formally via the formal language of propositional logic and predicate logic.

3. Be able to specify and manipulate basic mathematical objects such as sets, functions, and relations and will also be able to verify simple mathematical properties that these objects possess.
4. Acquire ability to describe computer programs (e.g. Recursive functions) in a formal mathematical manner.
5. Be able to apply basic counting techniques to solve combinatorial problems.
6. Gain experience in using various techniques of mathematical induction (weak, strong and structural induction) to prove simple mathematical properties of a variety of discrete structures.

Paper MT-3-5-2: Analysis-I

Objectives: The objectives are:

1. Learn to work with infinite sequences and series.
2. Learn to work with infinite sequence is bounded.
3. Learn to work with an infinite sequence is monotonic.
4. Learn to work with an infinite sequence is convergent or divergent.
5. Find the sequence of partial sums of an infinite series.
6. Determine if a geometric series is convergent or divergent.
7. Find the sum of a convergent geometric series.
8. Define the real numbers, least upper bounds, and the triangle inequality.
9. Define functions between sets; equivalent sets; finite, countable and uncountable sets.
10. Recognize convergent, divergent, bounded, cauchy and monotone sequences.
11. Calculate the limit superior, limit inferior, and the limit of a sequence.
12. Recognize alternating, convergent, conditionally and absolutely convergent series.
13. Determine if subsets of a metric space are open, closed, connected, bounded, totally Bounded and/or compact.
14. Determine if a function on a metric space is discontinuous, continuous, or uniformly Continuous.

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

1. Determine if an infinite sequence is bounded.
2. Determine if an infinite sequence is monotonic.
3. Determine if an infinite sequence is convergent or divergent.
4. Find the sequence of partial sums of an infinite series.
5. Determine if a geometric series is convergent or divergent.
6. Find the sum of a convergent geometric series.
7. Determine if an infinite series is convergent or divergent by selecting the appropriate Test from the following: (a) test for divergence; (b) integral test; (c) p-series test; (d) the Comparison tests; (e) alternating series test; (f) absolute convergence test; (g) ratio test; And (h) root test.
8. Determine if an infinite series converges absolutely or conditionally.
9. Describe fundamental properties of the real numbers that lead to the formal development Of real analysis.
10. Comprehend rigorous arguments developing the theory underpinning real analysis.
11. Demonstrate an understanding of limits and how they are used in sequences, series, Differentiation and integration.
12. Construct rigorous mathematical proofs of basic results in real analysis.
13. Appreciate how abstract ideas and rigorous methods in mathematical analysis can be Applied to important practical problems.

Paper MT-3-5-3: Theory of Optimization

Objectives: This course includes both the linear programming problems and various techniques of game theory. Introduction to optimization techniques using both linear and non-linear programming. The focus of the course is on convex optimization though some techniques will be covered for non-convex function optimization too. After an adequate introduction to linear algebra and probability theory, students will learn to frame engineering minima maxima problems in the framework of optimization problems.

Learning Outcomes: By the end of the course, students should be able to:

1. Cast engineering minima/maxima problems into optimization framework.
2. Learn efficient computational procedures to solve optimization problems.
3. Verify different optimization methods.
4. Model engineering minima/maxima problems as optimization problems.

Paper MT-3-5-4: Complex Analysis

Objectives: The objective of this course is to introduce the fundamental ideas of the functions of complex variables and developing a clear understanding of the fundamental concepts of complex analysis such as analytic functions, complex integrals and a range of skills which will allow students to work effectively with the concepts.

Learning Outcomes: By the end of the course, students should be able to:

1. Represent complex numbers algebraically and geometrically,
2. Define and analyze limits and continuity for complex functions as well as consequences of continuity.
3. Apply the concept and consequences of analyticity and the cauchy-riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra,
4. Analyze sequences and series of analytic functions and types of convergence.
5. Evaluate complex contour integrals directly and by the fundamental theorem, apply the cauchy integral theorem in its various versions, and the cauchy integral formula.
6. Represent functions as taylor, power and laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

Paper MT-3-5-5: Mathematical Theory of Probability and Statistics

Objectives: The objectives are:

1. Providing students with a formal treatment of probability theory.
2. Equipping students with essential tools for statistical analyses at the graduate level.

3. Fostering understanding through real-world statistical applications.

Learning Outcomes: By the end of the course, students should be able to:

1. Develop problem-solving techniques needed to accurately calculate probabilities.
2. Apply problem-solving techniques to solving real-world events.
3. Apply selected probability distributions to solve problems.
4. Present the analysis of derived statistics to all audiences.
5. Design data collection plans, analyze data appropriately and interpret and draw conclusions from those analyses.
6. Perform statistical inference in several circumstances and interpret the results in an applied context,
7. Use mathematical tools, including calculus and linear algebra, to study probability and mathematical statistics and in the description and development of statistical procedures,

Paper MT-3-6-1: Analysis-II

Objectives: The course aims at strengthening and generalizing results that the student has already learnt from previous calculus courses, providing her or him with an adequate language

for advanced studies of mathematics, and developing skills in working with abstract concepts whose meaning are defined by various sets of axioms. This course will provide a firm foundation in topology to enable the student to continue more advanced study in this area. This course will present and emphasize those topics in order to aid the student in his future mathematical studies. Finally, this course hopes to expose the students to both mathematical rigor and abstraction, giving there an opportunity further to develop his mathematical maturity.

Learning Outcomes: By the end of the course, students should be able to:

1. Explain the various topological and metrical concepts that are introduced in the course, be able to give an account of their definitions and to use them in concrete situations. The most important of these concepts are: open and closed sets, closure, interior, boundary, dense sets, the canonical topology in a metric space, the euclidean topology, topological subspace, continuous map, homeomorphism, connectedness, compactness, separability;
2. Give an account of various set theoretic and topological constructions, such as products and factorisation of topological spaces;
3. Describe the heredity of various topological properties under continuous maps and product formation.

Paper MT-3-6-2: Advanced Modern Algebra

Objectives: This course is an extension of MT-2-4-1. This course introduces the basic concepts of modern algebra such as groups and rings. It includes some of the aspects of graph theory which will be more useful in networking analysis. The philosophy of this course is that modern algebraic notions play a fundamental role in mathematics itself and in applications to areas such as physics, computer science, economics and engineering. This course emphasizes the application of techniques. Finally, this course hopes to expose the students to both mathematical rigor and abstraction depending on their logical thinking, giving there an opportunity further to develop his mathematical maturity. For the students to formally understand and prove of theorems/lemmas and relevant results in graph theory.

Learning Outcomes: By the end of the course, students should be able to:

1. Explain the fundamental concepts of advanced algebra such as groups and rings and their role in modern mathematics and applied contexts.
2. Demonstrate accurate and efficient use of advanced algebraic techniques.
3. Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from advanced algebra.

4. Apply problem-solving using advanced algebraic techniques applied to diverse situations in physics, engineering and other mathematical contexts.
5. Find a helpful tool to quantify & simplify the many moving parts of dynamic systems.
6. Use electric circuits and computer chips form a network. The grammatical structure of languages can be modelled using graphs, for example to create translation algorithms. Graphs also have many applications in probability, game theory and financial mathematics.

Paper MT-3-6-3A: Numerical Linear Algebra

Objectives: The aim of this course is to give tools (as classical algorithms) to solve numerically problems in linear algebra. The course gives classical algorithms to solve linear systems by different methods, and to find the eigenvalues of a matrix. The course details the mathematical theory behind numerical algorithms for solution of linear systems and eigenvalue problems.

Numerical linear algebra is no longer a subtopic of numerical analysis, it has grown into an independent topic for research and teaching in recent years. The reason, is, of course, obvious. Numerical linear algebra techniques are essential ingredients in scientific computingthat are routinely used to solve practical-life problems (signal processing, control theory, heat transfer, fluid dynamics, biomedical engineering, vibration, statistics, bioscience, economics.

Learning Outcomes: After completing the course, the student will be able to

1. Derive and use the numerical techniques needed for a professional solution of a given linear algebra problem;
2. Distinguish and analyze a variety of tools that exist for solving linear systems and finding eigenvalues of these systems;
3. Evaluate when a problem should be solved using a direct or iterative method
And what the advantages, disadvantages, and costs are for these methods;
4. Demonstrate an understanding of the way in which error in data can corrupt solution and, therefore, how much confidence one can place in the obtained solution.

Paper MT-3-6-3B: Numerical Linear Algebra (Practical)

Objectives: Students will compute solutions with the help of computer for the problems taught in MT-3-6-3A using languages like C, MATLAB.

Learning Outcomes:

1. Sudents will enrich their confidence to solve the problems which are analytically difficult to solve but those can be solved numerically.
2. Students will use computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces, eigenvalues and eigenvectors, orthogonality and diagonalization.
3. Students will be able to interpret and analyze numerical data, mathematical concepts, and identify patterns to formulate and validate reasoning.

Paper MT-3-6-4: Differential Geometry

Objectives: The course introduces the fundamentals of differential geometry primarily by focusing on the theory of curves and surfaces in three space. The theory of curves studies global properties of curves such as the four vertex theorem. The theory of surfaces introduces the fundamental quadratic forms of a surface, intrinsic and extrinsic geometry of surfaces, and the gauss-bonnet theorem.

Learning Outcomes:

1. The student will be able to compute quantities of geometric interest such as curvature, as well as develop a facility to compute in various specialized systems, such as semigeodesic coordinates or ones representing asymptotic lines or principal curvatures.
2.The Student will also be introduced to the method of the moving frame and overdetermined systems of differential equations as they arise in surface theory.

3. Students will start being able to develop arguments in the geometric description of curves and surfaces in order to establish basic properties of geodesics, parallel transport, evolutes, minimal
Surfaces and consequences of the poincar{\'e} index theory.

Paper MT-3-6-5: Mathematical Modeling

Objectives: The objectives of this course are to:
1. Enable students understand how mathematical models are formulated, solved , and interpreted.
2. Make students appreciate the power and limitations of mathematics in solving practical real-life problems.
3. Equip students with the basic mathematical modeling skills.
5. Create a model that adequately describes the problem, using the appropriate technology if necessary.
6. Test the validity of the model.
7. Solve the problem using the appropriate technology if necessary.
8. Present the results orally, on computer and in a form of a written report.

Learning Outcomes: Upon successful completion of this course, the student will be able to:
1. Understand what a mathematical model is and explain the series of steps involved in a mathematical modeling process.
2. State and explain the different classifications of mathematical models stating examples in each class.
3. Explain the essential features of a good model and discuss the benefits of using a mathematical model.
4. Identify some simple real-life problems that can be solved using mathematical models, model the problem(s), solve the resulting problem, and interpret the solution.
5. Mention and discuss some applications of mathematical modeling in solving problems in engineering, physical, biological, social and behavioral sciences.
6. Acquire basic mathematical modeling skills that will enable them carry out simple modeling tasks individually or as a group.

Paper MT-4-7-1: Analysis-III

Objectives: Measure theory is the study of measures. It generalizes the intuitive notions of length, area, and volume. The earliest and most important examples are jordan measure and lebesgue measure, but other examples are borel measure, probability measure, complex measure. This course teaches to gain understanding of the abstract measure theory and definition and main properties of the integral. It helps to construct lebesgue's measure on the real line and in n-dimensional euclidean space.

Learning Outcomes: By the end of the course the student is familiar with the basic concepts and results of lebesgue measure theory (outer measure, measurable sets and connections with topology, borel sigma algebra) as well as of lebesgue theory of integrals (measurable functions/random variables, the fubini/tonelli theorem for multivariate integration). The student masters basic concepts from measure theory, including sets of measure zero, measurable functions, the lebesgue integral and lebesgue spaces. The student has an overview of the central results of the theory of lebesgue integration, including convergence theorems and fubini's theorem. Moreover, the student is familiar with applications of measure theory to probability theory. The student is able to perform operations using the lebesgue integral and lebesgue spaces. Moreover, the student is able to apply integration theory in one or several variables to formulate and solve problems in mathematics and technology, including problems involving discontinuous data.

Paper MT-4-7-2: Introduction to Continuum Mechanics

Objectives: The purpose of the course is to expose the students to the basic elements of continuum mechanics in a sufficiently rigorous manner. This course aims to introduce:

1. Notion of continuum and the length scales for the applicability of continuum mechanics,
2. Vector and tensor algebra and equip them with skills for analysis of vector and tensor valued functions.
3. Basic kinematics for a deforming body and various deformation measures and their rates.
4. Concept of stress and various stress measures as work conjugates of deformation measures,
5. Balance laws which govern the motion of a deformable continuum. Lagrangian and eulerian description.
6. Mathematical restrictions to constitutive theories, e.g. Stress strain relationship, and the notion of hyperelastic materials and their numerical implementation.

Learning Outcomes: After attending this course, the students should be able to appreciate a wide variety of advanced courses in solid and fluid mechanics.
1. Students will gain essential background on continuum mechanics.
2. They will be able to construct the kinematic relations for a deforming body in the reference and deformed configurations.

Paper MT-4-7-3: Galois Theory

Objectives: In a word, Galois theory uncovers a relationship between the structure of groups and the structure of fields. It then uses this relationship to describe how the roots of a polynomial relate to one another.

Learning Outcomes: After attending this course, the students should be able to
1. Understand the field extensions and the notion of algebraic and transcendental field extension.

2. Calculate the degree of an algebraic extension and the tower law and find examples of normal, separable and simple extensions.
3. Calculate the galois group and understand fundamental theorem of Galois correspondence, intermediate fields.

Paper MT-4-7-4: Practical-I

Objectives: This course is a laboratory based project work which include to find numerical solution of system of linear equations by different methods. Students have to train to write inhouse code.

Learning Outcomes: Students will gain the confidence to write a program in C or MATLAB language. Then can verify solutions of any system of linear algebraic equations. They will be able to compare the accuracy in different methods.

Paper MT-4-7-5: Integral Equations and Calculus of Variations

Objectives: the course is aimed to lay a broad foundation for an understanding of the problems of the calculus of variations and its many methods and techniques and to prepare students for the study of modern optimal control theory. To make the students familiar with the methods of solving integral equations.

Learning Outcomes: On successful completion of the course students will be able to recognize difference between volterra and fredholm integral equations, first kind and second kind, homogeneous and inhomogeneous etc. They apply different methods to solve integral equations. Students will have much better and deeper understanding of the fundamental concepts of the space of admissible variations and concepts of a weak and a strong relative minimum of an integral.

Paper MT-4-8-1: Analysis-IV

Objectives: The functional analysis is an important branch of the mathematics developed with the purpose to cover theoretical needs of partial differential equations and mathematical analysis. The functional analysis is related to problems arising in partial

differential equations, measure theory and other branches of mathematics. So to correlate all those under the same umbrella the basics of functional analysis have to be discussed.
Learning Outcomes: On successful completion of the course students will be able to:
1. Understand functional analysis as a methodology that is used to explain the workings of a complex system.
2. Use functional analysis in the applied sciences as well as in mathematics itself.

Paper MT-4-8-2: Numerics of Partial Differential Equations
Objectives: The objective of this course is to present the main results in the context of partial differential equations that allow learning about these models and to study numerical methods for the approximation of their solution. Analyse, synthesise, organise and plan projects in the field of study.
This course should give a platform to understand mathematics-numerics interaction, and how to match numerical method to mathematical properties. It also provides to understand correspondence between principles in physics and mathematical equations.
Learning Outcomes: On successful completion of the course students will be able to:
1. Do the stability analysis of finite diffrence formulations.
2. Use suitable techniques to have the better accuracy.
3. Handle computational fluid dynamical problems and some other real problems.

Paper MT-4-8-3: Dynamical Systems
Objectives: The objectives are to teach: discrete and continuous time dynamical systems, general solution of continuous time linear systems, Lyapunov and asymptotic stability, sensitive dependence on initial conditions (SDIC), chaotic behaviour of logistic map, etc.
Learning Outcomes: Students will learn: discrete and continuous time dynamical systems, general solution of continuous time linear systems, Lyapunov and asymptotic stability, sensitive dependence on initial conditions (SDIC), chaotic behaviour of logistic map, etc.

Paper MT-4-8-4: Practical
Objectives: The objectives are to teach laboratory based project work. Finding solution of initial and boundary value problem for ODE & PDE.
Learning Outcomes: The students will learn how to find solution of initial and boundary value problem for ODE & PDE.

Paper MT-4-8-5: Mathematical Ecology
Objectives: The objectives are to:
1. Use mathematical models to understand complexity.
2. Apply principles of physics to understanding biological organisms and communities.
3. Identify, describe and explain the theoretical concepts of mathematical modeling of ecological processes.
Learning Outcomes: On successful completion of the course students will be able to:
1. Understand population dynamics of a single species in discrete and continuous time, with and without additional structure (such as age-structure and male-female interactions).
2. Calculate limits to population growth and harvesting.
3. Use interactions of two or more species (including predator-prey, competition and symbiosis).
4. Apply dynamics in space and time (including diffusion and directed motion).
5. Gather knowledge on epidemics and travelling waves.

Paper MT-5-9-1: Dissertation Paper
Objectives: The main objecive is to introduce the students into the field of research. This training should give confidence to students for being a researcher in near future. Students go to various reputed academic and research institutes in india where they would be carrying out

research projects for the whole semester in life science or related interdisciplinary areas of science.
Learning Outcomes: After completion, students should have the confidence to do projects or research work in their academic life.

Paper MT-5-10-1: Dissertation Paper
Objectives: The main objective is to introduce the students into the field of research. This training should give confidence to students for being a researcher in near future. Students go to various reputed academic and research institutes in india where they would be carrying out research projects for the whole semester in life science or related interdisciplinary areas of science.
Learning Outcomes: After completion, students should have the confidence to do projects or research work in their academic life.

PHILOSOPHY AND HISTORY OF SCIENCE

Paper PHS-2-3-1: History of Science
Objectives: Students will be taught the history of science.
Learning Outcomes: This paper will help students to learn Aristotle's scheme of natural science, medieval physics of the Heavens, Cartesian revolution and Newtonian revolution.

Paper PHS-2-4-1: Philosophy of Science (Western, Contemporary)
Objectives: Students will be taught the western philosophy of science.
Learning Outcomes: This paper will help students to learn various concepts about western philosophy of science as well as how the laws of physics lie.

PHYSICS

Paper PH-1-1-1: Mechanics, Waves and Oscillations
Objectives: This is the first theory paper in Physics in the beginning of the academic programme. So, some important basic things are kept in the syllabus, which are already taught in the class XII level, as a continuation and upgradation of the knowledge of the students (like rotation of earth, elasticity, fluid flow, harmonic motion, waves, etc.). Also, Fourier analysis is introduced as a new concept.
Learning Outcomes: The students will be able to recapitulate and enhance their knowledge in some basic important things to understand mechanical and wave properties. The knowledge in Fourier analysis will enable them to analyze any periodic wave function (often used in electrical circuits).

Paper PH-1-1-2: Practical
Objectives: This is the first physics practical course for students. This course is designed to train the students to perform hands-on experiments related to heat, electricity, optics and basic electronics.
Learning Outcomes: In this course, student will first learn to use several basic laboratory instruments like P.O. box, CRO, spectrometer. They will understand its working principles, and next they will use these instruments to perform simple experiments.

Paper PH-1-2-1: Physical Optics
Objectives: In the class XII level, students already learn some preliminary concepts in physical optics (like interference, diffraction and polarization). The idea of this paper is to

impart deeper understandings with detail mathematical calculations on these topics. Also, some basic concepts on laser will be taught to the students.
Learning Outcomes: The students will be able to study and use different physical optics related phenomena in various optical devices frequently used in teaching as well as research laboratories. Also, the basic concepts on laser will help them to use lasers in teaching as well as research laboratories for carrying out different experiments involving lasers.

Paper PH-1-2-2: Practical
Objectives: To train the students to perform hands-on experiments related to mechanics, magnetism, optics and basic electronics.
Learning Outcomes: In this laboratory course, student will learn to measure 'g' using compound pendulum, and earth's magnetic field using Halmholtz coil. They will also learn to use spectrometer to do draw $\delta - \lambda$curve, and use of Zener diode to construct regulated power supply.

Paper PH-2-3-1: Electricity and Magnetism
Objectives: This is an elementary course on electricity and magnetism, which is designed to teach the students about fundamental laws of electrostatics and electrodynamics, different kind of circuits, and the properties of EM waves.
Learning Outcomes: Students will learn fundamental ideas of electricity and magnetism which are essential for studying advance theoretical and experimental courses in physics. They will also learn to apply basic laws of electricity magnetism to solve analytic problems.

Paper PH-2-3-2: Practical
Objectives: To train the students to perform hands-on experiments related to mechanics, electricity magnetism, optics and electronics.
Learning Outcomes: In this laboratory course, student will learn to convert galvanometer into ammeter and voltmeter which are basic measuring devices. They will learn to use spectrometer to measure dispersive power of the materials.
Paper PH-2-4-1: Quantum Mechanics and Relativity
Objectives: This paper is designed to teach the students about basic ideas of quantum mechanics and special theory of relativity. In this paper student will be given a pedagogical introduction to the quantum mechanics and special theory of relativity.
Learning Outcomes: Student will learn the inadequacy of classical mechanics to explain certain phenomenon, and understand the historical development of quantum mechanics and special theory of relativity. They will learn to solve Schrodinger equation for simple cases e.g. free particle, particle in a box. In special theory of relativity, they will learn about Lorentz transformation and use it to calculate length contraction, time dilation, energy-momentum relation etc.

Paper PH-2-4-2: Practical
Objectives: To train the students to perform hands-on experiments related to electricity magnetism, optics and basic electronics.
Learning Outcomes: In this laboratory course, student will learn to use meter bridge, to construct and study CR, LR, LCR circuits. They will also learn to use polarimeter to determine specific rotation of sugar solution. They will understand the working principle of transistor in CE mode.

Paper PH-3-5-1: Classical Mechanics
Objectives: This is an advanced course on classical mechanics. Student will learn about the Lagrangian and Hamiltonian dynamics and its applications to the central force, rigid dynamics etc. Moreover, they will also be taught advanced techniques like canonical transformations and Hamiltonian Jacobi theory.

Learning Outcomes: Students will have a comprehensive ideas about advantage and limitation of different techniques of classical mechanics like Newtonian mechanics, Lagrangian mechanics, Hamiltonian mechanics. They will also learn to apply these techniques to solve central force problem, decay and scattering processes, small oscillations and rigid dynamics.

Paper PH-3-5-2: Electronics

Objectives: This is the first and only theory paper on electronics in the academic programme for students having Physics major. So, several basic topics like semiconductors, transistors are taught along with some advanced topics like field effect transistor (FET), feedback concept, operational amplifier, adder, flip-flop, analog to digital converter (ADC), digital to analog converter (DAC), etc.

Learning Outcomes: The detail knowledge of the students on various electronic components will enable them to understand and use advanced electronics in device technology and digital circuits.

Paper PH-3-5-3: Practical-I

Objectives: This is the first advanced practical paper containing experiments from electricity magnetism, electronics and LASER.

Learning Outcomes: Students will learn to verify Thevenin's, Norton's and maximum power transfers theorem using basic circuit, to construct logic gates and adder circuits and to measure wavelengths of LASER. They will also learn the working principle and use of ballistic galvanometer.

Paper PH-3-5-4: Practical-II

Objectives: This is the project based practical paper to encourage the student to use their idea to design and perform experiments. There is no stipulated syllabus for this paper.

Learning Outcomes: Student will learn to use basic laboratory instruments to design new experiments in consultation with teachers. They will also learn to use computers and other interfacing devices (e.g. raspberry pie, arduino board) to perform their experiments.

PH-3-5-5: Statistical Mechanics

Objectives: This is a introductory course on statistical mechanics. Student will learn about the fundamental concept of classical statistical mechanics and get a very brief idea about the quantum statistical mechanics.

Learning Outcomes: Student will acquire the basic ideas of ensembles, partition functions, and will be able to apply the essential techniques to solve statistical mechanical problems. They will have clear idea about the advantages and limitations of classical statistical mechanics which leads to the development of quantum statistical mechanics.

Paper PH-3-6-1: Advanced Quantum Mechanics-I

Objectives: This is the first advanced course on quantum mechanics to teach the student about the mathematical formalism of quantum mechanics and train them to use these techniques in quantum mechanical problems.

Learning Outcomes: Student will learn about Hilbert space, Dirac's Bra-Ket formalism, Schrodinger and Heisenberg picture of quantum mechanics and angular momentum algebra. They will apply these techniques to solve LHO, Hydrogen atom problem. Moreover, they will also gain some basic ideas about different approximate methods of quantum mechanics.

Paper PH-3-6-2: Electromagnetic Theory

Objectives: This is an advanced course to teach the student about the relativistic formalism of electromagnetic theory and its application to study radiation.

Learning Outcomes: Student will learn Green's function techniques to solve boundary value problems. They will also learn about covariant formalism of electrodynamics and its

application to solve radiation problem of classical electrodynamics. They will understand the concept of retarded and advanced potentials.

Paper PH-3-6-3: Practical-I

Objectives: This is an advanced practical paper containing experiments from electricity magnetism, solid state physics and advanced electronics.

Learning Outcomes: Students will learn about LCR circuit in details, and use Anderson bridge to calculate self inductance. Moreover, they will learn to measure band-gap of solid using two different methods. They will gain hands-on experience in designing experiments (inverting, differential amplifier, flipflop) with OP-AMP and basic logic gates.

Paper PH-3-6-4: Practical-II

Objectives: This is the project based practical paper to encourage the student to use their idea to design and perform experiments. There is no stipulated syllabus for this paper.

Learning Outcomes: Student will learn to use basic laboratory instruments to design new experiments by their own or in consultation with teachers. They will also learn to use computers and other interfacing devices (e.g. raspberry pie, arduino board) to perform their experiments. Student will also gain some idea about computer simulation in order to predict the expected results of their proposed experiments.

Paper PH-3-6-5: Spectroscopy-I

Objectives: In this paper, students will be taught rotational, vibrational and electronic spectroscopy in detail. Also, fundamental concepts on radiative and non-radiative transitions involved in organic molecules in liquid media will be discussed.

Learning Outcomes: The students will be able to analyze rotational, vibrational and electronic spectroscopy often used in teaching as well as research laboratories. Also, fundamental concepts on radiative and non-radiative transitions involved in organic molecules in liquid media will help them to understand photophysical properties of organic molecules (both theoretically and experimentally).

Paper PH-4-7-1: Advanced Statistical Mechanics

Objectives: This is the advanced course on quantum statistical mechanics. It aims to teach the students about the properties of quantum gases and give an elementary idea about phase transitions.

Learning Outcomes: Student will have ideas and different characteristic properties of ideal Bose and Fermi gases. They will learn to calculate partition function of Photon gas and other Bose gases and degenerate Fermi gas. They will study Planck distribution law and Debye theory of specific heat of solid, Bose-Einstein's condensation, Degenerate Fermi gas and Chandrasekhar limits. They will also learn classification and characteristics of Phase transitions with some examples like Ising model.

Paper PH-4-7-2: Material Science

Objectives: This course is designed to give basic ideas of theoretical and experimental techniques required to study material science.

Learning Outcomes: Student will learn about the crystal structure and physical properties of solids like conductivity (electrical/thermal), magnetism. They will also learn about several experimental techniques required to produce and characterized nano-particles and nano-structures.

Paper PH-4-7-3: Practical-I

Objectives: This paper is aimed to teach the student the use of sophisticated instruments for conducting experiments. Moreover, in this paper, student will perform advanced experiments prescribed within their syllabus.

Learning Outcomes: Students will learn to use UV-visible spectrometer, Michelson's interferometer. They will perform experiment with fiber optics, Frank-Hertz experiments and determine Planck's constant by using Photo-electric effect etc.

Paper PH-4-7-4: Practical-II

Objectives: This is the project based practical paper to encourage the student to use their idea to design and perform experiments. There is no stipulated syllabus for this paper.

Learning Outcomes: Student will learn to use basic laboratory instruments to design new experiments by their own or in consultation with teachers. They will also learn to use computers and other interfacing devices (e.g. raspberry pie, arduino board) to perform their experiments. Student will also perform computer simulation in order to predict the expected results of their proposed experiments.

Paper PH-4-7-5: Spectroscopy-II

Objectives: Various concepts on the spectroscopic properties of atoms and molecules will be taught in detail. Electron spin resonance (ESR) and nuclear magnetic resonance (NMR) will be taught with some examples. Also, Mossbauer effect will be taught.

Learning Outcomes: The students will be able to carry out experiments on Zeeman effect, Paschen-Back effect, etc. in the teaching laboratory. The concepts on ESR, NMR and Mossbauer effect will help them immensely to work in related research laboratories.

Paper PH-4-8-1: Nuclear and Particle Physics

Objectives: This is a basic course on nuclear and particle physics. Basic ideas about the nuclear models, nuclear reactions, classification and properties of elementary particles are to be taught in this course.

Learning Outcomes: Student will learn about basic properties of nucleus, nuclear models e.g. liquid drop model, shell model. They will understand the physics behind nuclear reactions, alpha, beta and gamma emissions. Moreover, they will also learn about the classification and properties of elementary particles.

Paper PH-4-8-2: Advanced Quantum Mechanics-II

Objectives: This advanced course is aimed to teach the students about the advanced concepts of quantum mechanics. This course will also discuss the limitation of non-relativistic quantum mechanics and the role of basic equations of relativistic quantum mechanics to overcome the aforesaid limitations.

Learning Outcomes: Student will learn about time dependent perturbation techniques and its application, symmetries in quantum mechanics, identical particles and scattering theory. They will also acquire a brief idea about the relativistic quantum mechanics e.g. Klein Gordon equation, Dirac equations and Dirac's anti-particle theory

Paper PH-4-8-3: Practical-I

Objectives: This paper is aimed to teach the student the use of sophisticated instruments for conducting experiments. Moreover, in this paper, student will perform advanced experiments prescribed within their syllabus.

Learning Outcomes: Students will learn to use UV-visible spectrometer, Four probe method. They will perform advanced experiments like Hall effect, Electron spin resonance spectroscopy etc.

Paper PH-4-8-4: Practical-II

Objectives: This is the project based practical paper to encourage the student to use their idea to design and perform experiments. There is no stipulated syllabus for this paper.

Learning Outcomes: Student will learn to use basic laboratory instruments to design new experiments by their own or in consultation with teachers. They will also learn to use

computers and other interfacing devices (e.g. raspberry pie, arduino board) to perform their experiments. Student will also perform computer simulation in more advanced level.

Paper PH-4-8-5: Fundamentals of Laser

Objectives: The objectives of this paper are to teach students the concepts of laser in detail and to discuss some important lasers.

Learning Outcomes: The students will learn the theoretical concepts of Einstein as the beginning of laser and how the concepts are materialized in developing a real laser system. Also, ideas on some important lasers will help them in carrying out relevant research works in advanced laboratories.

Paper PH-5-9-1: Dissertation Paper

Objectives: This is basically a research based (preliminary level) course work for the whole semester in physics or relevant interdisciplinary areas of science. The students can carry out the dissertation work in any reputed educational institutions in India (including Visva-Bhatrati).

Learning Outcomes: The students will have some preliminary ideas about the research works in physics or relevant interdisciplinary areas of science presently going on in various reputed educational institutions in India (including Visva-Bhatrati). This will enable them to pursue advanced research in a better way after completion of the Five-Year Integrated M. Sc. Programme.

Paper PH-5-10-1: Dissertation Paper

Objectives: This is basically a research based (preliminary level) course work for the whole semester in physics or relevant interdisciplinary areas of science. The students can carry out the dissertation work in any reputed educational institutions in India (including Visva-Bhatrati).

Learning Outcomes: The students will have some preliminary ideas about the research works in physics or relevant interdisciplinary areas of science presently going on in various reputed educational institutions in India (including Visva-Bhatrati). This will enable them to pursue advanced research in a better way after completion of the Five-Year Integrated M. Sc. Programme

SOCIAL SCIENCE

Paper SS-1-2-1: Social Science

Objectives: The objectives of this paper are to teach students different aspects of social science, e.g., landscape, economy, women's status, peasant movement and constitution of India.

Learning Outcomes: These basic concepts on the social science related matters from Indian perspective will help students to develop their own socio-economic and cultural ideas.

D E P A R T M E N T O F S T A T I S T I C S

M.Sc. course in Statistics

Semester-I

MSC – 11

Linear Algebra and Linear Models

Course Objectives: This is also a basic and prerequisite course for the students before study the courses like multivariate analysis, linear models and stochastic process. This course is designed into four units first two units mainly devoted into vector space, matrix theory and theory of equations. Third and fourth units mainly focused on determinant, system of linear equations, rank of a matrix and eigen values. To make them understand what a linear model is and how various real-life problems can be expressed and analyzed using linear models.

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

- ☐ Analyze and solve various types of determinants, quadratic forms and system of linear equations.
- ☐ Interpret the rank related properties of a matrix and its eigen values.
- ☐ Understand and be proficient at theoretical developments in the analysis of linear models, including linear and quadratic forms, least squares, linear hypothesis testing, analysis of variance, etc.
- ☐ Apply the results from linear model theory in further advanced topics, such as nonparametric models, multivariate analysis, high-dimensional inference, etc..

MSC-12

Regression Analysis

Course Objective:

Regression Analysis is the most common statistical modeling approach used in data analysis. In this course students will learn various statistical methods for investigating functional relationships among variables. Regression analysis is an applied topic that is used in various sectors like academic, company, forecasting etc. The objective is to provide the basic and advanced idea of regression analysis, so that students can be applied this modeling to solve various real life problems and draw inferences from the data.

Learning Outcomes:

After completing the course the students will be able to:

- Analyze and fit linear, polynomial and multiple linear regression models using data.
- Detect and overcome the issues like model adequacy, multicollinearity and influential points.
- Perform various statistical inferences related to regression analysis.
- Fit the nonlinear, logistic, poisson regression model and their inferences.
- Perform all the above computation using R/ SAS.

MSC-13

Stochastic Process and Distribution Theory

Course Objective:

This course covers a vast area of advanced mathematical statistics- stretching to stochastic process and the crux of statistical distribution theory.

Learning Outcomes:

- ☐ Stability of stochastic process—stationarity and limiting distribution of a process
- ☐ Markovian model, classifications of state under discrete time Markov model
- ☐ Gambler's ruin, Random walk model
- ☐ Poisson process, death and birth process, queueing theory
- ☐ Sampling distributions under multivariate set-up—distribution of sample mean vector and sample variance covariance matrix—Wishart distribution, Hotelling's T^2
- ☐ Multivariate analysis of variance (MANOVA),
- ☐ Mahalanobis Distance

MSC-14
Statistical Inference-I

Course Objectives:

The main objective of the course is to draw statistically valid conclusions about a population on the basis of a sample in a scientific manner. This course deals with fundamental concepts and techniques of statistical inference including point and interval estimation. Parametric, Non- parametric and Bayesian Estimation methods are to be explained. Students will be accustomed with theory as well as methods of estimation in this course.

Learning Outcomes: On completion of the course, students will be able to:

- ☐ Estimate unknown parameters of a given probability distribution using standard and non- standard estimation techniques.
- ☐ Understand how to perform point and interval estimation.
- ☐ Familiar with the fundamental properties of estimators.
- ☐ Familiar with the different methods of finding out estimators of parameters.
- ☐ Familiar with loss functions, Bayes risks, prior distributions, derivation of Bayes estimates.
- ☐ Non-parametric estimates on abstract space and their properties.

Semester-II

MSC-21
Statistical Inference-II
Course Objective:

This course catches the flavor of advanced level testing of hypothesis. At the end detailed discussion on nonparametric tests is furnished.

Learning Outcome:

After completion of the course, the students will be able to understand

- Neyman-Pearson fundamental lemma
- MP test, Uniformly most powerful test, Uniformly most powerful unbiased test
- Alpha-similar tests constructions and its applications
- Invariance tests
- Test for composite null vs composite alternatives
- Construction of nonparametric tests statistic and their exact and large sample

distributions.
- Wilcoxon signed rank test, Mann Whitney test
- Goodness of fit test-Kolmogorov Smirnov test, Anderson Darling tests
- Nonparametric one way ANOVA test , Nonparametric two way ANOVA test.

MSC– 22

Applied Multivariate Analysis:

Course Objectives: To impart the concepts and applications of various multivariate statistical techniques. To make the students understand how to analyze multivariate data using statistical theories.

Learning Outcomes: After this course students should be able to

1. formulate analysis of real-life multivariate data using statistical principles along with softwares.
2. model and forecast various continuous and or discrete dependent variables depending on more than one independent variables.
3. apply various supervised and unsupervised learning methods for real-life applications.

MSC – 23

Sample Survey

Course Objective:

After the introduction of the sampling schemes like Simple random Sampling, Stratified Random Sampling and Systematic Sampling in UG, this course consists of the details of the some advanced sampling schemes like Cluster Sampling, Two-stage sampling, Double Sampling, PPS sampling etc. The randomized response techniques for the surveys regarding sensitive topics are also introduced. The objective of the course is to prepare the students for all real life survey situations.

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

(1) Conduct a randomized response based survey regarding some sensitive characteristic.
(2) Estimate the proportion of individuals having some sensitive characteristic.
(3) Understand some basics of survey design.
(4) Estimate the population mean/total as well as the variance of the estimators under different sampling schemes, viz Cluster Sampling, Two-stage Sampling, Double Sampling and PPS Sampling.

MSC– 24:

Course Objective: The objective of the course is to develop a systematic method to determine the relationship between factors affecting a process and the output of the

process. It is used to find out cause and effect relationship. This information is needed to manage process inputs in order to optimize the output.

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

(1) Analyze generalized block designs.
(2) Analyze a block design with missing observations.
(3) Understand the purpose of confounding and analyze a factorial design with some confounded effects.
(4) Construct Balanced Incomplete Block designs by different methods.
(5) Construct fractional factorials

Semester-III

MSC – 31

Real Analysis and Measure Theory:

Course Objective:

The course is spitted into two parts: Real analysis and Measure theory. The objective of this course is to provide some basic and advanced ideas of real analysis and measure theory. The real analysis part mainly develops the student's analytical thinking and some prerequisite ideas of measure theory. The measure theory part helps the student to gain the knowledge about various measures.
This part also develops the concept of probability and its related terms from the view of measure theory.

Learning Outcomes:

After completing the course the students will be able to:

- ☐ Understand various advanced ideas of real analysis like compact sets, Heine – Borel theorem etc.
- ☐ Understand sequence, series of functions and their convergence.
- ☐ Analyze the power series and related terms about its convergence.
- ☐ Know the terms related to different measures and their importance.
- ☐ Study the concept of random variables and its convergence.
- ☐ Grasp the idea of characteristic functions, law of large numbers and central limit theorem.

MSC – 32:

Categorical Data Analysis and Advanced Data Analysis Technique

Course Objectives:

In most of the applied research problems, it is a common practice to deal with categorical variables. Besides, some of the analyses are to be made on the basis of simulated data because of the lack of proper real-life data set. This particular course is designed to give some idea about the inferences on categorical data as

well as about some popular classical and Bayesian computing techniques which are appropriate in absence of proper data support.

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

1. Perform the analysis of contingency tables and fitting of generalized linear models.
2. Perform Gibbs sampling technique to simulate data from a high-dimensional posterior distribution.
3. Apply Markov Chain Monte Carlo Technique for simulation.
4. Apply Bootstrap and jackknife resampling techniques.

Module: Elective

MSE-1: Operations Research and Optimization Technique

Course Objectives:

The objective of the course is to provide basic idea about operations research and utilizing optimization techniques as its basic tools. Use of statistical and mathematical tools in operations research and their applications to decision making process is primary concern. Role of operations research under different constraint conditions are to be studied.

Learning Outcomes: On completion of the course, students will be able to:

- Formulate the problem in operations research.
- Establish the relationship between the variables and constraints by constructing the model.
- Identify the possible alternative solutions and select the optimal one.
- Install, test and establish the optimal solution.
- Learn the tools like Linear Programming Problems, Transportation, assignment, replacement and operational gamming.
- Familiar with the queuing and different inventory models.

MSE-2: Statistical Genetics

Course Objective: Statistical genetics has played a pivotal role in the discovery of genes that cause disease in humans. This module introduces the basic concepts and terms in genetics and demonstrates the use of statistical models to identify disease genes in humans. This course will provide an introduction to statistical methods for genetic studies. The basic material in statistical genetics is covered, focusing on association analysis. The emphasis of this course is on understanding basic concepts and methods and how they are applied in the health sciences.

Learning Outcomes:

Having successfully completed this module, students will be able to:

(1) Understand the basic concepts of genetics .
(2) Know how to analyze the most usual forms of genetic linkage and allelic association data.

Module: Special

MSS-1: Actuarial Statistics

Course Objectives:

The aim of Actuarial Statistics is to provide grounding in mathematical and statistical methods that are of relevance for actuarial work. It is a discipline that assesses financial risks in the insurance and finance fields. It applies the mathematics of probability and statistics to define, analyze and solve the financial implications of uncertain future events.

Learning Outcomes: On completion of the course, students will be able to:

- Equipped with knowledge of statistical distributions, methods to summarize data, the principles of statistical inference, regression models (including generalized linear models) .
- Accustomed with individual and aggregate claims and their applications.
- Utility functions and their uses in insurance.
- Life table functions and their applications.
- Life insurance, Life annuities, Net premiums, Net reserves.
- Multiple life functions and Multiple decrement functions.

MSS-2: Reliability Analysis

Course Objectives: To impart the concept of reliability and how statistical and probabilistic theories are applied to model and explain life of a mechanical component along with prediction of the same.

Learning Outcomes: After this course students will be able to

1. model and explain the operation time of a mechanical component.
2. to predict the reliability of a component, system and of a finished product.
3. explain the nature of the lifetime of an item as well.

MSS-3: Time Series Analysis

Course Objective: To impart the concept of time series and how to develop statistical models to forecast a time series for practical use/planning.

Learning Outcome: After completion of the course, students should be able to

1. Distinguish time series and cross-sectional data.
2. Model various real-life time series data and forecast them along with the forecast errors.

MSS-4: Demography

Course Objectives:

The scientific nature of demography proves the following four objectives of demography. These are to achieve knowledge about the size, composition, organization and distribution of the population. To describe the past evolution, present distribution and future changes in the population of an area.

Learning Outcomes: On completion of the course, students will be able to:

- Coverage and content errors in demographic data
- Measure of fertility, stochastic model for reproduction
- Measures of mortality.
- Life table functions and their applications.
- Population growth and population projection.
- Stochastic models for social and occupational mobility.

MSS-5: Advanced Design of Experiments

Course Objectives:

The objective of the course is to develop a systematic method to determine the relationship between factors affecting a process and the output of the process. It is used to find out cause and effect relationship. This information is needed to manage process inputs in order to optimize the output.

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

(1) Analyze factorial designs.
(2) Understand the confounding in factorial design in detail.
(3) Understand the concept of A-optimality and D-optimality.
(4) Construct Orthogonal arrays.
(5) Understand Supersaturated and Search Designs.

MSS-6: Survival Analysis

Course Objectives:

The aim of this course is to enable students to analyse data from studies in which individuals are followed up until a particular event occurs - e.g. death, cure, relapse - making use of follow-up data for those who do not experience the event, with proper attention to underlying assumptions and a major emphasis on the practical interpretation and communication of results.

Learning Outcomes:

After the successful completion of the course, students should be able to:

1. Collaborate with Health scientists.
2. Apply basic methods for estimation and statistical inference when working with censored data.

MSS-7: Clinical Trials and Bioassay

Course Objective:

Bioassays are essential tools for pre-clinical research. By revealing whether a compound or biologic has the desired effect on your biological target, bioassays can drive decision-making throughout the drug discovery process, to ultimately bring new drugs to patients.

This course will specially help the students who are interested to get involved in clinical research.

Learning Outcome:
After the completion of the course, the students should be able to:

(1) Understand the concept of basic study designs, group sequential design and adaptive designs.
(2) Understand the notion of clinical trials.
(3) Understand different types of biological assays.
(4) Get involved in medical research.

MSS-8: Statistical Ecology

Course Objectives:

Statistical ecology is a recently introduced topic that creates a bridge between statistics and ecology. Here various statical methods are used to study plenty of ecological questions throughout the world. The main objective of this course is to provide the theory as well as application of statistical techniques in various ecological contexts. Some of the topics are closely associated with real-life issues and using statistics we can draw the inferences.

Learning Outcomes:
After completing the course the students will be able to:

- Understand population dynamics and related single species and interactive models.
- Understand various ideas related to abundance estimation like capture-recapture, nearest neighbor method.
- Recognize the concept of ecological diversity through statistical approach.

MSS-9: Bayesian Inference

Course Objective:

Bayesian methods have some advantages over the classical methods, viz. these provide a natural and principled way of combining prior information with data, within a solid decision theoretical framework. These also provide inferences that are conditional on the data and are exact, without reliance on asymptotic approximation. Small sample inference proceeds in the same manner as if one had a large sample. These advanatges make these methods widely applicable to the data scientists. This course is designed to enlighten the students about the basics of Bayesian inferences.

Learning Outcomes:

1. Explain in detail the Bayesian framework for data analysis and its flexibility and be able to demonstrate when the Bayesian approach can be beneficial
2. Develop, analytically describe, and implementboth single and multiparameter probability models in the Bayesian framework.
3. Demonstrate the role of the prior distribution in Bayesian inference and be able to articulate the usage of non-informative priors and conjugate priors.
4. Show high level Interpretation of Bayesian Analysis Results and be able to readily perform Bayesian model evaluation and assessment.
5. Demonstrate the necessary skills to: fit hierarchical

models, provide thorough technical specifications for these models.

6. Perform Bayesian computation using Markov chain Monte Carlo methods using R
7. Demonstrate how Bayesian Methods can be used to solve real world problems.
8. Communicate complex statistical ideas to a diverse audience.
9. Demonstrate the necessary research skills to form a hypothesis, collect and analyse data, and reach appropriate conclusions.

MSS-10: Advanced Mathematical Techniques

Course Objectives:

This is an advanced mathematics course that is designed for the interdisciplinary research purpose. This course will also be helpful for various competitive exams like NET, SET, RET, GATE etc. The main objective of this course is to provide the theory as well as application of some applied mathematics topic. Some of the topics are very much associated with Statistics and its application.

Learning Outcomes

After completing the course the students will be able to:

- Understand various advanced techniques related to ordinary differential equations like: Existence and Uniqueness of solutions, Green's function etc.
- Understand various ideas related to partial differential equations.
- Know some basic and advanced terms related to linear algebra and numerical analysis.
- Recognize the concept of calculus of variation and linear integral equation.

Department of Environmental Studies, Siksha Bhavana, Visva–Bharati

M.Sc. Environmental Science

Objectives and Outcome

Semester	Name of the Paper	Content	Objective	Expected Outcome
Semester I	MEC 11	Fundamentals of Environmental Science	To introduce the subject to the students (including the concept and scope of Environmental Science), who usually come from various disciplines and let them understand the inter-relationships of different components of environment and how is their previous subject linked to this course.	The students will be acquainted with the various terms associated with the subjects, and understands the intricate relationships that exist among the various components of environment and what role they can play for maintaining this

				relationship ever with perfection.
	MEC 12	Climatology and Climate Change	Introduction to climate system and meteorological variables, circulation patterns in atmosphere and oceans, Role of meteorology in air quality. Cause, effect and adaption measures to climate change.	The students will appreciate the complexity in climate system involving atmosphere, ocean, land and biosphere. Will get to know how the significance of variation patterns in atmospheric temperature, pressure, wind, humidity, precipitation etc. How meteorology affect the air pollution. Compare present climate change with that of past, will know about climate forcing and feedback mechanisms.
	MEC 13	Principles of Soil Science	Basic introduction of soil science like Genesis, Nature, classification and composition of Soil. They also will introduced to various Physical, chemical biochemical properties of soil, microbial composition of soils. Moreover the environmental impacts of soil erosion, and impact on agriculture.	Have a good basic knowledge on soil formation, classification and their various physic-chemical biological properties of it.
	MEC 14	Techniques in Environmental Science	To orient and let the students understand the theoretical parts related to sampling (collection, preparation, storage and analyses) and instruments, which are key to environmental analyses and subsequent exposure and handling of sophisticated instruments.	The students will be trained to collect any environmental samples and analyse them using sophisticated instruments for assessing the environmental health (air, water, soil or other sample quality).

	MEC 15	Water Pollution	The students will be introduced to Chemistry, the health effects and remediation and control of water & water pollutants. Moreover the river Action Plans and pollution of marine, ground water and its control.	Able to understand the chemistry, health effect and strategy to control water pollutants.
	MEC 16	Practical-I	Study of microorganisms from water and soil; Study of pond biota (phytoplanktons, zooplanktons); Study of physicochemical parameters of water and soil; Plotting and interpretation of weather parameters	Have a working hand analytical knowledge on various water quality parameters and also interpreting weather parameters.
Semester II	MEC 21	Biodiversity and Conservation	Let the students be aware of about various biotic resources (biodiversity) and their significance in serving the ecosystems including human beings and also how some of our activities pose threats to their existence. Also, the various management practices and international steps taken for safeguarding these important resources are explained.	The students learned about the various biotic resources (biodiversity) and their significance in serving the ecosystems including human beings and also understood the activities that pose threats to their existence. They were also enlightened about the management practices and international steps taken for safeguarding these important resources.
	MEC 22	Air Pollution	To let the students understand atmosphere, an important component of environment, and how this component is degraded due to the release of pollutants and noise from various sources, including the chemistry of atmosphere and its constituents. To explain the students as to	The students will understand about the atmosphere and how this component is degraded due to the release of air pollutants and noise from various sources, including the atmospheric chemistry of the

			how these pollutants affect our health and wellbeing and what provisions are available for monitoring and control of this pollution in India.	chemical constituents. It will also help the students understand as to how these pollutants affect our health and wellbeing and what provisions are available for monitoring and control of air pollution in India.
	MEC 23	Environmental Earth Science	To impart students the basic geological knowledge for understanding the earth processes and management resources (mineral and water) and natural hazards (earthquake, volcanism, landslides, flood, drought etc.)	The students will know the exo-genetic and endo-genetic geological process that shapes our earth. They will learn the process of erosion, transportation and deposition and landforms developed by running water, wind glaciers and coastal water and analyse the role of human activity in modifying the natural process and their consequences. Importance of mineral Resources, their exploration and mining methods, Environmental problems associated with mining industries and how to maintain mining; Different aspects of water resource including water conservation and management methods Geology and environmental health.

	MEC 24	Energy and Environment	To make the students understood the increasing global energy needs and consumption with its impact; the principles of electricity generation in fossil fuelled power plants, hydropower and nuclear power plant and their environmental impacts. To introduce the renewable energy concepts and techniques – solar, wind, ocean wave, tides and geothermal energy; Biomass as source of energy with their advantages and limitations	The students will learn the sector wise changing trends in energy use pattern in different parts of the world. They will learn the basic principles and methods, efficiency and environmental impact of conventional energy resources such as thermal, nuclear and hydropower plants. They will also learn the principles and techniques (including recent developments) in renewable energy– solar,wind, ocean wave, tides and geothermal energy and bio-energy
	MEC 25	Soil Pollution and Solid Waste Management	Sources, behaviour and fate of soil pollutants; Sources and generation of solid wastes; Waste disposal, recycling and power generation, fly ash utilization; Management of solid wastes	Understand the basic concept, impact of various soil pollutants on environment and also develop the knowledge of impact and management of various soil wastes.
	MEC 26	Practical-II	Analyse soil and air quality parameters, Measure and analyse noise level, Computational works in Energy resources; Noise pollution; SPM, SO_2, NOx, Ozone; Chlorophyll content; Identification of common rocks and minerals; To get introduced to Toposheets and geological map;	Organic, N, P, K content in Soil; Computational works in Energy resources; Noise pollution; SPM, SO_2, NOx, Ozone; Chlorophyll content ; Identification of

			Drainage pattern assessment	common rocks and minerals; Interpretation of Toposheet and geological map; Study of Drainage pattern for water resource management
Semester III	MEE 311	Environmental Monitoring and Management	The main objective of this elective course is to orient and let the students of other departments to understand the theoretical parts related of sampling (collection, preparation, storage and analyses) and instruments, which are key to environmental analyses and subsequent exposure and handling of sophisticated instruments.	The students at least will learn to collect any environmental samples and analyse them using instruments for assessing the health of the environment (air, water, soil or other sample quality).
	MEE 312	Current Issues in Environmental Sciences	Develop the students to understand recent development in Pollution Abatement Technology, Waste management , Environmental Hazards; Conservation of Endangered and Threatened species; Traditional knowledge Movement; Environmental Law and policy; Alternative Energy sources and technology - Understanding and Solving Environmental Problems in the 21st Century.	Understand the recent development on various environment issues from sources and abatement of various pollution, biodiversity issues, environmental law and policy. So they understand how to solve the various problems in environment
	MEC 32	Ecology	Let the students be aware of about the study of ecology and ecosystems, their types and how various components are intrinsically interconnected and dependent with each other. Also, how different laws are applied as well as nutrients are recycled involving different ecosystems and their	The students will learn about the various aspects of ecology and will understand the intricate relationships that exist among various components. They will also be enlightened about the various processes of the

			continuing change and progression with time.	ecosystems and the services they provide, that help us sustaining our life..
	MEC 33	Environmental Toxicology	To introduce the students with basics of Environmental toxicology which is a multidisciplinary field of science focusing on the study of the harmful effects of various chemical, biological, and physical agents on living organisms in the ecosystems, including human. It contributes to the general knowledge of the harmful actions of chemical substances, to study their mechanisms of action, and to estimate their possible risks to humans on the basis of experimental work on biological test systems.	After completing this course, the students would be able to: Critically evaluate different advanced exposure assessment methods of chemicals Design methods for exposure assessment Understand the advantages and disadvantages of toxicological and epidemiological studies for deriving dose-response relationships Design methods for study of dose-response relations Evaluate frequently used methods for health effect measurements Gather knowledge in the risk assessment process Will learn how the risk management process works in the practical field Communicate the results and aware the public of the hazardous effects of the studied chemicals
	MEC 34	Remote Sensing & GIS	To introduce the principles and techniques of Remote Sensing and GIS in view of their increasing	Will learn the basic principles such as Electromagnetic radiation (EMR), different types of

			applications in sustainable development.	satellites and sensors and their Orbital characteristics, Remote Sensing Data types and resolutions (Spatial, Temporal, Spectral and Radiometric), Basic concept of Arial Photography, Optical, Thermal and Microwave remote sensing: Fundamentals of Digital Image Processing and Geographic Information system, Glopbal Positioning System (GPS) with Introduction to GIS and IP packages; Case studies related to Remote sensing and GIS applications in pollution monitoring; forest and vegetation mapping rural and urban land, disaster management etc
	MEC 35	Environmental Economics & Sustainable Development	To explore the proper role of government, humans, institutions, NGOs in the regulation of the environment. It will help students develop the tools to estimate the costs and benefits of environmental regulations. These tools will be used to evaluate a series of current policy issues, including: the significance of air and water pollution regulations and its effectiveness, the costs of climate change in	This course aims to provide students with sound knowledge and understanding of the major results of environmental economics. It helps to apply micro and macro-economic issues in environmental economics. It will probably convey the basics of

			India and abroad, importance of "sustainable development", method of proper uses of oil and other natural resources, energy efficiency	thorough monetary investigation proceeded with the future learns at a more significant level or investigations of ecological financial aspects.
	MEC 36	Practical-III	Ecology practical; Visual Interpretation of satellite imagery; Digital Image Processing; Bioassay methods in toxicology; Industrial tour; Local biodiversity of Santiniketan (Flora, and avifauna)	Student will be able to do various bioassays with different chemical on plants; interpret satellite maps and do ecological indices
Semester IV	MEC 41	Environmental Biotechnology	Objective is to introduce the students with basic knowledge on biotechnology like Biomonitoring, biomarker responses; Biosensors; Bioelectrodes; bioremediation; Global environmental problems and biotechnology, phytoremediation; Application of IPM technology and Ecoengineering for Sustainable Agriculture, Biofertilizers.	Students understand the basic concepts of environmental biotechnology and its utilisation of combat the various issues of pollution.
	MEC 42	Environmental Management	The course is centrally concerned with understanding deliberate efforts to translate environmental knowledge into action in order to achieve particular outcomes in the way landscapes, societies and/or natural ecosystems are used and managed. It will also consider how the objectives for land and resource use are shaped, fashioned and contested in democratic and non-democratic settings. The course will critically	After studying this course, students should be able to: Understand the usefulness of systems thinking in relation to environmental management in organisations like plan, do, check & act, describe organisations as systems like, ISO 14000, Environmental Impact Assessment (EIA)

			examine contemporary thinking on these environmental themes including: sustainable use practices, NGO and community-based approaches, social learning, and ISO 14000 systems, EIA practices.	practices and their role in environmental management. The ability to analyse environmental management in relation to the major principles of sustainable development. The student can analyse industry environment relationship by applying Environmental Auditing (EA), EIA, Life Cycle Analysis (LCA) etc.
	MEC 43	Environmental Education, Policy and Legislation	Environmental law may be the one institution standing between us and planetary exhaustion. It is a substantive understanding in the gradual evolution of pertinent themes in the environment shall be imparted so that the student is not only conversant with the overall framework of environmental law but also becomes acquainted with fundamental concepts of basic themes. The basic objective is to familiarize the concept and scope of environmental law and policy and also of its particular dominant issues so as to become a valuable addition in learning and to ignite academic/research interest, eventually. Students also enriched by aware about the social movements related to environment and role of NGO in this regard.	Learning about the significance of developments in international environmental law and the fundamental principles that have emerged, comprehending the statutory and regulatory mechanisms pertaining to the environment in India. Studying the role of international/ national environmental institutions, NGOs, civil society, and community involvement in promoting the cause of the environment. Understanding the emerging environmental issues like ozone depletion, climate change, energy

				crisis, nuclear issues, waste accumulation, marine ecology etc. and the viability of posited solutions.
	MEO 44	Optional Paper (One to be selected from four)		
	MEO 441	Ecotoxicology	Objective is to introduce the students with multidisciplinary approach to integrate toxicology, ecology, chemistry, biochemistry. Understand in details the effects of toxic chemicals on organisms at the population, community, ecosystem level.	Students understand the effects of exposure of organisms (plant / animal) and its remediation to potentially hazardous environmental chemical, biological agents up to ecosystem and community levels.
	MOE 442	Air Pollution And Health	To let the students understand atmosphere, an important component of environment, and how this component is degraded due to the release of pollutants, including the recent development in the field, and noise from various sources. To explain the students as to how these pollutants affect (at morphological, biochemical and physiological levels) our health and wellbeing and what provisions are available for monitoring and control of this pollution in India.	The students will understand about the atmosphere and how this component is degraded due to the release of air pollutants and noise from various sources, including the atmospheric chemistry of the chemical constituents. It will also help the students understand as to how these pollutants affect our health and wellbeing (at somewhat great detail) and what provisions are available for monitoring and

				control of air pollution in India.
	MEO 443	Hydrology and Water Management	To teach the basic nature and characteristics of surface and subsurface water and its movements that is important for management of water as a resource. To appreciate the significance of water security and the water management strategies.	Will learn the detailed hydrological cycle and global water balance. Principles of hydro-geomorphology and its application in watershed characteristics, runoff and sediment yield, stream flow estimation. Principles of ground water flow, Well hydraulics, ground water modelling; Will be introduced to the conflicts among stakeholders to water use rights and the laws and policies associated with them. Traditional and modern approach to water conservation and management
	MEO 444	Soil Pollution	Introduce the concept of chemical speciation, Bioavailability and ecotoxicity and various Tools to assess bioavailability; sample preparation- separation techniques; detection; risk assessments/regulations; and Bioremediation.	Students understand the concept of chemical speciation, its analysis, concept of bioavailability of pollutants for both organic and inorganic pollutants.
	MEC 45	Project Work and Presentation	Field and lab based work on various environmental issues would be done by students in the IV semester (although they start working from III semester). Major areas of their work would be air,	Students having interest in particular area will work and develop the practical based knowledge in that field and submit a project report

			soil, water pollution, biodiversity, microbiology, biogas technology, remote sensing and GIS.	which has to be defended. The students will have an extensive practical knowledge of sampling, analyses and handing various sophisticated instruments.

Ph.D Course Work in Environmental Science

Semester	Name of the paper	Content	Objective	Expected outcome
Semester I	Paper-I	Research Methodology and Techniques	To orient and let the students understand as to how to prepare report, data collection and handling and the theoretical parts related to sampling (collection, preparation, storage and analyses) and instruments, which are key to environmental analyses and subsequent exposure and handling of sophisticated instruments.	The students will be trained to collect any environmental samples and analyze them using sophisticated instruments for assessing the environmental health (air, water, soil or other sample quality).
	Paper-II (Optional, One paper has to be selected)	(Recent Advances in Environmental Science)		
	Option I	Air	To let the students understand the recent advances on atmosphere, air quality and pollution and how the pollutants affect our health and wellbeing (at morphological, biochemical and physiological levels)	Enhance knowledge base (on the current research) of the students on atmosphere, air quality, and health aspects which will help to undertake appropriate and proper research topic

			and what provisions are available for monitoring and control of the pollution in India.	for their doctoral research work.
	Option II	Water	To introduce the students with the knowledge physic-chemical properties of water, chemistry of various pollutants and the strategy to control it. They also should have a sound knowledge on Water quality parameters and its standards and Waste water treatment.	Sound knowledge on various aspects of water pollution, its chemistry and the control strategy.
	Option III	Soils and rocks	To impart basic knowledge of geomorphology and soil science so that students will be able to assess the impact of human activities on the natural geological process.	Learn about the exogenetic and endogenetic processes responsible for the shaping the surface of earth. Learn about environmental problems associated with mining activities. Nature and effects of soil pollution Problems and management of solid wastes.
	Optional-IV	Flora and fauna	To introduce the students with the knowledge of biodiversity and environmental toxicology	Learn the various aspects Biodiversity and its significance and also the basic principles of environmental toxicology, distribution & fate of toxicants
	Paper- III	Review work in the relevant field of research followed by submission of a dissertation and viva-voce	To help the students understand as to how to search and find papers on a particular area or topic of his/her research, from different sources and prepare a scientific report.	It helps the students to select and finalize his/her doctoral topic and carryout his/her research work.

B.Sc. Environmental Studies (For UG courses under CBCS system)

UGC's Ability Enhancement Compulsory Course (AECC – Environment Studies)

Semester II

Objectives: To create environmental awareness among all the undergraduate level students and make them concerned about the *environment* and its associated problems. The students will gain the knowledge and develop skills, attitudes, motivations and commitment to work individually and collectively towards solutions of current problems and prevention.
Outcome: Students will learn about the importance of natural resources (water, forest, energy, land) and the problems associated with their overexploitation; importance and need for a balanced ecosystem and biodiversity, nature, effect and control of environmental pollutions (air, water, noise, solid wastes), global environmental problems (global warming, ozone layer depletion etc.); social and legal aspects of environment etc. Students will also be made to appreciate Tagore's environmental thoughts.

DEPARTMENT OF ZOOLOGY
B.Sc. Zoology

1. Learning Outcomes based approach to Curriculum Planning

These courses are delivered in terms of concepts, mechanisms, biological designs & functions and evolutionary significance cutting across organisms at B.Sc. level. These courses are being studied by students of all branches of biology. Both chalk and board, and PowerPoint presentations are used for teaching the courses. The students are allowed to do the dissertation/ project work under practical of different courses, wherever possible. The students are expected to learn the courses with excitements of biology along with the universal molecular mechanisms of biological designs and their functions. They are being oriented from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how contributions from research and innovation have made this subject modern, interdisciplinary and application based. These courses and practical exercises will help the students to apply their knowledge in future course of their career development in higher education and research. In addition, they may get interested to look for engagements in industry and commercial activities. They may also be interested in entrepreneurship and start some small business based on their interest and experience.

SEMESTER - I

CORE COURSE - I

CC – 1: NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES

Learning outcomes
After successfully completing this course, the students will be able to:

- Develop understanding on the diversity of life with regard to protists to pseudocoelomates.
- Group animals on the basis of their morphological characteristics/ structures.
- Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.

- Understand how morphological change due to change in environment helps drive evolution over a long period of time.
- The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills. It will further enable the students to think and interpret individually due to different animal species chosen.

CORE COURSE - II
CC – 2: PRINCIPLES OF ECOLOGY
Learning outcomes
After successfully completing this course, the students will be able to:

- Know the evolutionary and functional basis of animal ecology.
- Understand what makes the scientific study of animal ecology a crucial and exciting endeavour.
- Engage in field-based research activities to understand well the theoretical aspects taught besides learning techniques for gathering data in the field.
- Analyse a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.
- Solve the environmental problems involving interaction of humans and natural systems at local or global level.

SEMESTER – II

CORE COURSE - III

CC – 3: NON-CHORDATES II: COELOMATES

About the course
The course makes a detailed comparison of the anatomy of the different taxa of non-chordates (Coelomates). It also highlights how in the taxonomic hierarchy, there is an increase in the complexity of structure and function. The course thus gives an overview of the intricate life processes and adaptive radiations in non-chordates.

Learning outcomes
After successfully completing this course, the students will be able to

- Develop an understanding of the characters used to classify besides being able to differentiate the organisms belonging to different taxa.
- Have hands on experience of materials demonstrating the diversity of Coelomates.
- Understand the relative position of individual organs and associated structures through dissection of the invertebrate representatives.
- Realize that very similar physiological mechanisms are used in very diverse organisms.
- Get a flavor of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.

CORE COURSE - IV
CC – 4: CELL BIOLOGY
Learning outcomes
After successfully completing this course, the students will be able to

- Learn different types cells, microorganisms and viruses.
- Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.

- Acquire the detailed knowledge of different pathways related to cell signaling and apoptosis, regulation of cell division and cell cycle, thus enabling them to understand the anomalies in cancer.
- Develop an understanding how cells work in healthy and diseased states.

SEMESTER – III
CORE COURSE – V
CC-5: DIVERSITY OF CHORDATES
Learning outcomes

After successfully completing this course, the students will be able to:

- Develop understanding on the diversity of life with regard to proto-chordates and chordates.
- Group animals on the basis of their morphological characteristics/ structures.
- Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
- Understand how morphological change due to change in environment helps drive evolution over a long period of time.
- The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills. It will further enable the students to think and interpret individually due to different animal species chosen.

CORE COURSE – VI
CC-6: PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS
Learning outcomes

Upon successful completion of this course, students should be able to:

- Learn different types of tissues and skeletal system.
- Learn and understand structure and function of neuron, neuro transmission, reflex action, physiology of hearing and vision.
- Develop understanding in muscle structure and contraction mechanism
- Demonstrate an understanding of the hormonal control of reproduction in males and females, processes of spermatogenesis, oogenesis.
- Understand the mechanism of hormone action, learn about hypothalamo and hypapophysial axis.
- Understand about different endocrine glands and their disorders.

CORE COURSE - VII
CC – 7: FUNDAMENTALS OF BIOCHEMISTRY

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand about the importance and scope of biochemistry.
- Understand the structure and biological significance of carbohydrates, amino acids, proteins, lipids and nucleic acids.
- Understand the structure and function of immunoglobulins.
- Understand the concept of enzyme, its mechanism of action and regulation.
- Learn the preparation of models of peptides and nucleotides.
- Learn biochemical tests for amino acids, carbohydrates, proteins and nucleic acids.
- Learn measurement of enzyme activity and its kinetics.

SEMESTER – IV

CORE COURSE - VIII
CC – 8: COMPARATIVE ANATOMY OF VERTEBRATES

Learning outcomes
After successfully completing this course, the students will be able to:

- Develop an understanding of the evolution of vertebrates thus integrating structure, function and development.
- Have an overview of the evolutionary concepts including homology and homoplasy, and detailed discussions of major organ systems.
- Understand how cells, tissues, and organisms function at different levels. The course content also provides the basis of understanding their abnormal function in animal and human diseases and new methods for treating those diseases.
- Develop an understanding of the related disciplines, such as cell biology, neurophysiology, pharmacology, biochemistry etc.
- Get a flavor of research besides improving their writing skills and making them well versed with the current trends. It will further enable the students to think and interpret individually due to different aspects chosen.

CORE COURSE - IX
CC – 9: PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

Learning outcomes
After successfully completing this course, the students will be able to:

- Understand the process of digestion and its control.
- Learn the process of respiration and transport of gases.
- Understand kidney structure and regulation of urine formation.
- Learn about blood components, hemoglobin, clotting mechanism and blood groups.
- Understand heart structure and functioning and blood pressure.

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CORE COURSE- X
CC – 10: BIOCHEMISTRY OF METABOLIC PROCESSES
Learning outcomes

After successfully completing this course, the students will be able to:

- Learn the structure and biochemical pathways of carbohydrate, lipid and protein metabolism.
- Understand the physiological regulation of the various metabolic processes.
- Learn the estimation of protein, detection of liver function enzymes and biological oxidation assay.
- Learn measurement of enzyme activity and its kinetics.

CORE COURSE- XI
CC – 11: MOLECULAR BIOLOGY
Learning outcomes
After successfully completing this course, the students will be able to:

- Develop an understanding of concepts, mechanisms and evolutionary significance and relevance of molecular biology in the current scenario.
- Get well versed in recombinant DNA technology which holds application in biomedical & genomic science, agriculture, environment management, etc. Therefore, a fundamental understanding of Molecular Biology will help in career building in all these fields.
- Apply their knowledge in problem solving and future course of their career development in higher education and research.

- Get new avenues of joining research in related areas such as therapeutic strategies or related opportunities in industry.

CORE COURSE - XII
CC – 12: PRINCIPLES OF GENETICS
Learning outcomes
After successfully completing this course, the students will be able to:

- Understand how DNA encodes genetic information and the function of mRNA and tRNA
- Apply the principles of Mendelian inheritance.
- Understand the cause and effect of alterations in chromosome number and structure.
- Relate the conventional and molecular methods for gene manipulation in other biological systems.
- Discuss and analyse the epigenetic modifications and imprinting and its role in diseases.
- Get new avenues of joining research in related areas such as genetic engineering of cells, cloning, genetic disorders, human fertility programme, genotoxicity, etc

SEMESTER VI
CORE COURSE - XIII
CC – 13: DEVELOPMENTAL BIOLOGY
Learning outcomes
After successfully completing the course, the students will be able to

- Develop critical understanding how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation and morphogenesis.
- Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions of other tissues and organisms.
- Realize that very similar mechanisms are used in very diverse organisms; and development is controlled through molecular changes resulting in variation in the expression and function of gene networks.
- Understand how the field of developmental biology has changed since the beginning of the 19th century with different phases of developmental research predominating at different times.
- Examine the evolutionary history of the taxa based on developmental affinities.
- Understand the relevance of developmental biology in medicine or its role in development of diseases.

CORE COURSE - XIV
CC – 14: EVOLUTIONARY BIOLOGY, SYSTEMATICS AND TAXONOMY

Learning outcomes
After successfully completing this course, the students will be able to:

- Acquire an in-depth knowledge on the diversity and relationships in animal world.
- Develop a holistic appreciation on the phylogeny and adaptations in animals.
- Understanding on the process and theories in evolutionary biology.
- Develop an interest in the debates and discussion taking place in the field of evolutionary biology.
- Understand the historical development of systematics from 18th century to the present.
- Understand the similarities and differences of different types of data.
- Understand the uses and limitations of phylogenetic trees.
- Appreciate the complexities and difficulties of various species concepts.
- Gain a basic grasp on the rules and philosophy of nomenclature.

- Know about the steps required to do systematic.

DISCIPLINE SPECIFIC ELECTIVE COURSES
DSE – 1A: FISH AND FISHERIES
Learning outcomes
After completing this course, the learners will be able to:

- Understand the fisheries systems.
- Understand conditioning factors and how they can be manipulated.
- Understand the environmental impacts of pisciculture.

DSE – 1B: ENDOCRINOLOGY
Learning outcomes

- Understand neurohormones and neurosecretions.
- Learn about hypothalamo and hypapophysial axis.
- Understand about different endocrine glands and their disorders.
- Understand the mechanism of hormone action.

DSE – 2A: WILD LIFE CONSERVATION AND MANAGEMENT
Learning outcomes
After successfully completing this course, the students will be able to:

- Develop an understanding of how animals interact with each other and their natural environment
- Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues
- Develop the ability to work collaboratively on team-based projects
- Demonstrate proficiency in the writing, speaking, and critical thinking skills needed to become a wildlife technician
- Gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management
- Develop an ability to analyze, present and interpret wildlife conservation management information.

DSE – 2B: ANIMAL BEHAVIOUR AND CHRONOBIOLOGY
Learning outcomes
After successfully completing this course, the students will be able to:

- Learn a wide range of theoretical and practical techniques used to study animal behaviour.
- Develop skills, concepts and experience to understand all aspects of animal behaviour.
- Objectively understand and evaluate information about animal behaviour and ecology encountered in our daily lives.
- Understand and be able to objectively evaluate the role of behaviour in the protection and conservation of animals in the wild.
- Consider and evaluate behaviour of all animals, including humans, in the complex ecological world, including the urban environment

DSE – 3A: IMMUNOLOGY
Learning outcomes
After successfully completing this course, the students will be able to:

- Identify the major cellular and tissue components which comprise the innate and adaptive immune system.
- Understand how are immune responses by CD4 and CD8 T cells, and B cells, initiated and regulated.

- Understand how does the immune system distinguish self from non-self.
- Understand the structure function relationship, mechanism of action of antigens, immunoglobulin, major histocompatibility complex and complement system.

DSE – 3B: REPRODUCTIVE BIOLOGY

Learning outcomes

Upon successful completion of this course, students should be able to:

- Explain and contrast the processes of spermatogenesis, oogenesis.
- Demonstrate an understanding of the hormonal control of reproduction in males and how this is regulated;
- Distinguish between the main stages of embryonic, foetal and neonatal development and causes of foetal disorders.
- Understand the origin and characteristics of common congenital malformations;
- Know how sexually transmitted diseases may contribute to altered neonatal or reproductive function.
- Critically assess relevant scientific literature in Human Reproductive Biology and present their argument in oral and written work.

DSE – 4A: COMPUTATIONAL BIOLOGY

Learning outcomes

After the completion of this course the learner will be able to:

- Apply the basic operations of spreadsheet applications
- Recognize advanced resources for accessing scholarly literature from internet
- Utilize bibliography management software while typing and downloading citations
- Operate various software resources with advanced functions and its open office substitutes.

DSE –4B: PARASITOLOGY

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand parasitism, host-parasite relationship.
- Learn the morphology and life cycle of parasites from different invertebrate and vertebrate groups.
- Diagnose the causative agents, describe pathogenesis and treatment for important diseases like malaria, leishmaniasis, trypanosomiasis, toxoplasmosis, schistosomiasis, cysticercosis, filariasis etc.
- Learn the incidence, prevalence and epidemiology different parasitic infections.
- Gain experience at reading and evaluating the scientific literature in the area.

GENERIC ELECTIVE COURSES

GEC-1: ANIMAL DIVERSITY

Learning outcomes

After successfully completing this course, the students will be able to:

- Develop understanding on the diversity of life with regard to protists, non-chordates and chordates.
- Group animals on the basis of their morphological characteristics/ structures.
- Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
- Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
- Understand how morphological change due to change in environment helps drive evolution over a long period of time.
- The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills.

It will further enable the students to think and interpret individually due to different animal species chosen.

GEC-2: INSECT VECTORS AND DISEASES

Learning outcomes

After successfully completing this course, the students will be able to:

- Develop awareness about the causative agents and control measures of many commonly occurring diseases.
- Develop understanding about the favourable breeding conditions for the vectors.
- Devise strategies to manage the vectors population below threshold levels, public health importance.
- Undertake measures or start awareness programmes for maintenance of hygienic conditions, avoidance of contact from vector, destruction of breeding spots in the vicinity of houses and cattle shed by public health education campaign.

GEC-3: AQUATIC BIOLOGY

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand and apply relevant scientific principles in the area of aquatic biology
- Employ scientific methodologies such as experimentation and data analysis in the area of aquatic biology
- Critically analyse, interpret and evaluate information relevant to aquatic biology
- Appreciate the multidisciplinary nature of the study of aquatic biology and engage positively with people and ideas beyond their own discipline.
- Explore some of the unique environmental problems dealing with aquatic environments.
- Develop employable skills in freshwater biological water quality analysis.

GEC-4: ANIMAL CELL BIOTECHNOLOGY

Learning outcomes

After successfully completing this course, the students will be able to:

- Develop an understanding of the fundamental molecular tools and their applications of DNA modification and cloning.
- Appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how such research and innovations have made science interdisciplinary and applied.
- Develop future course of their career development in higher education and research with a sound base.
- Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

SKILL ENHANCEMENT COURSES

SEC-1: SERICULTURE

Learning outcomes

Upon successful completion of this course, the student should be able to:

- Generation of skilled man power in the field of sericulture,
- To impart training in extension management and transfer of technology,
- To impart training in Post Cocoon Technology, and
- To provide field exposure

SEC-2: RESEARCH METHODOLOGY

Learning outcomes

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

- Understand the concept of research and different types of research in the context of biology
- Have basic awareness of data analysis-and hypothesis testing procedures
- Develop laboratory experiment related skills.
- Have basic knowledge on qualitative research techniques
- Develop competence on data collection and process of scientific documentation
- Analyze the ethical aspects of research
- Evaluate the different methods of scientific writing and reporting

Department of Zoology
M.Sc. in Zoology

2. Learning Outcomes based approach to Curriculum Planning

These courses are delivered in terms of concepts, mechanisms, biological designs & functions and evolutionary significance cutting across organisms at M.Sc. level. These courses are being studied by students of all branches of biology. Both chalk and board, and PowerPoint presentations are used for teaching the courses. The students are allowed to do the dissertation/ project work under practical of different courses, wherever possible. The students are expected to learn the courses with excitements of biology along with the universal molecular mechanisms of biological designs and their functions. They are being oriented from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how contributions from research and innovation have made this subject modern, interdisciplinary and application based. These courses and practical exercises will help the students to apply their knowledge in future course of their career development in higher education and research.

3. Learning Outcomes in Master's Degree programme in Zoology

Knowledge and Understanding

i. Demonstrate (a) in-depth knowledge and understanding about the fundamental concepts, principles and processes underlying the academic field of Zoology and its different subfields (principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, and insect, vectors and diseases) (b) skills related to specialization areas within Zoology as well as within subfields of Zoology, including broader interdisciplinary subfields (Chemistry, Physics and Mathematics).
ii. Appreciate the complexity of life processes, their molecular, cellular and physiological processes, their genetics, evolution and behaviour and their interrelationships with the environment.
iii. Study concepts, principles and theories related with animal behaviour and welfare.
iv. Understand and interpret data to reach a conclusion
v. Design and conduct experiments to test a hypothesis.

SEMESTER - I
MZCT-101 (FUNDAMENTALS OF BIOCHEMISTRY) (Theory)
Learning outcomes
After successfully completing this course, the students will be able to:

- Understand the importance of metabolic regulation in maintaining homeostasis.
- Learn the metabolic pathways involved in carbohydrate, lipid and protein metabolism.

- Understand the structure and biological function of FoF1 ATPase.
- Understand the working mechanism of regulatory enzymes.
- Describe primary, secondary, tertiary and quaternary structures of proteins.

MZCT-102 (IMMUNOLOGY) (Theory)
Learning outcomes
After successfully completing this course, the students will be able to:

- Identify the major cellular and tissue components which comprise the innate and adaptive immune system.
- Understand how are immune responses by CD4 and CD8 T cells, and B cells, initiated and regulated.
- Understand how does the immune system distinguish self from non-self.
- Understand the structure function relationship, mechanism of action of antigens, immunoglobulin, major histocompatibility complex and complement system.

MZCT-103 (CELL BIOLOGY) (Theory)

About the course
The course provides knowledge of the structure and function of cellular organelles and transport across cell membranes. It also gives a detailed account of the molecular processes of replication, transcription, translation and explains the regulation of various cellular signal transduction pathways.

Learning outcomes
After successfully completing this course, the students will be able to:

- Understand the functions of cell membrane and organelles
- Understand the mechanisms involved in the flow of genetic information from genes to proteins
- Learn cellular signaling and its regulation.

MZCT-104 (GENETICS AND MOLECULAR BIOLOGY) (Theory)

Learning outcomes
After successfully completing this course, the students will be able to:

- Understand C-value paradox and analyze genome complexity.
- Understand the chromosomal basis of human genetic disorders.
- Learn about the various lesions in DNA and how these are repaired.
- Thoroughly understand recombinant DNA technology which holds application in biomedical science, agriculture and environment management.
- Relate the conventional and molecular methods for gene manipulation in other biological systems.
- Develop interest in joining research in related areas such as genetic engineering of cells, cloning, genetic disorders.

MZCP-105 (BIOCHEMISTRY AND IMMUNOLOGY) (Practical)

Learning outcomes
After successfully completing this course, the students will be able to:

- Perform biochemical tests for blood glucose, protein, DNA and RNA.
- Learn enzyme kinetics.

- Isolate splenocytes and thymocytes
- Analyze antigen-antibody interactions.

MZCP-106 (CELL BIOLOGY, GENETICS & MOLECULAR BIOLOGY) (Practical)

Learning outcomes
After successfully completing this course, the students will be able to:

- Study the various phases of mitosis.
- Understand life cycle and mutations in *Drosophila*.
- Learn the techniques of agarose gel electrophoresis and PCR.
- Understand the applications of PCR in research, forensics and diagnostics.
- Develop keen interest in molecular biology.

SEMESTER - II
MZCT-201 (STRUCTURE AND FUNCTIONS OF ANIMAL TISSUES) (Theory)
Learning outcomes
After successfully completing this course, the students will be able to:

- Learn different tissue structures, their organization and arrangement in various organs.
- Understand different methods of tissue fixation.
- Understand and observe histological and histochemical structures and their relation to animal physiology.
- Differentiate normal and distorted tissue structures during diseased or healthy states.
- Learn different staining techniques applicable to specific tissue sections.
- Understand the applications of histochemical techniques in research, forensics and diagnostics.

MZCT-202 (THEORETICAL BASIS OF METHODS IN BIOLOGY) (Theory)

After successfully completing this course, the students will be able to:

- Understand the purpose of the technique, its proper use and possible modifications/ improvement.
- Learn the theoretical basis of technique, its principle of working and its correct application.
- Learn the construction repair and adjustment of any equipment required for a technique.
- Learn the accuracy of technique.
- Learn the maintenance laboratory equipment / tools, safety hazards and precautions.
- Understand the technique of cell and tissue culture. Learn the preparation of solution of given percentage and molarity.
- Understand the process of preparation of buffer. Learn the techniques of separation of amino acids, proteins and nucleic acids.

MZCT-203 (ECOLOGY AND CONSERVATION BIOLOGY) (Theory)

Learning Outcomes
The successful learner will be able to

- Understand the consequences of pollution and cite the incidences/cases that were occurred in the past due to pollution
- Understand the consequences of pollution and cite the incidences/cases that were occurred in the past due to pollution.
- Understand and apply knowledge to problems related to biodiversity conservation.

- Apply the basic principles of conservation biology.

MZCT-204 (ANIMAL BEHAVIOUR AND EVOLUTION) (Theory)
Learning outcomes
After successfully completing this course, the students will be able to:

- Learn a wide range of theoretical and practical techniques used to study animal behaviour.
- Develop skills, concepts and experience to understand all aspects of animal behaviour.
- Objectively understand and evaluate information about animal behaviour and ecology encountered in our daily lives.
- Understand and be able to objectively evaluate the role of behaviour in the protection and conservation of animals in the wild.
- Consider and evaluate behaviour of all animals, including humans, in the complex ecological world, including the urban environment.
- Understand the complexities of character coding.
- Understand the uses and limitations of phylogenetic trees.
- Appreciate the complexities and difficulties of various species concepts.

MZCP-205 (ECOLOGY AND ANIMAL BEHAVIOUR) (Practical)
Learning Outcomes
The successful learner will be able to

- Inculcate scientific quantitative skills, evaluate experimental design, read graphs, and analyse and use information available in scientific literature.
- Develop skills, concepts and experience to understand all aspects of animal behavior.

MZCP-206 (PREPARATION AND STUDY OF ANIMAL TISSUES) (Practical)

Learning outcomes
After successfully completing this course, the students will be able to:

- Learn different tissue structures, organization and arrangement in animal body.
- Learn methods of tissue fixation and staining techniques.
- Understand the applications of histochemical techniques in research, forensics and diagnostics.

SEMESTER - III
MZCT-301 (DEVELOPMENTAL BIOLOGY) (Theory)
Learning Outcomes
After successfully completing the course, the students will be able to

- Develop critical understanding how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation and morphogenesis.
- Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions of other tissues and organisms.
- Realize that very similar mechanisms are used in very diverse organisms; and development is controlled through molecular changes resulting in variation in the expression and function of gene networks.
- Understand the relevance of developmental biology in medicine or its role in development of diseases.

MZCT-302 (BIOLOGY OF INFECTIOUS DISEASES) (Theory)

Learning Outcomes

The successful learner will be able to

- Identify parasites, viruses and bacteria.
- Understand the process of virus and bacterial infections and how they reproduce
- Learn control strategies to prevent the diseases.
- Define and distinguish among endemic rates of disease, epidemics and pandemics.

MZCT-303 (COMPARATIVE ENDOCRINOLOGY) (Theory)
Learning Outcomes

The successful learner will be able to

- Acquire knowledge of the coordinated functioning animal body.
- Understand the relative position of individual endocrine glands and associated structures through dissection of the representative animals.
- Realize that very similar physiological mechanisms are used in very diverse organisms.
- Get a flavor of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.
- Undertake research in any aspect of invertebrate and vertebrate endocrinology in future.

MZCT-304 (COMPARATIVE ANIMAL PHYSIOLOGY) (Theory)
Learning Outcomes

The successful learner will be able to

- Develop an understanding of the characters used to classify besides being able to differentiate the organisms belonging to different taxa.
- Acquire knowledge of the coordinated functioning of different group of organisms.
- Understand the relative position of individual organs and associated structures through dissection of the invertebrate and vertebrate representatives.
- Realize that very similar physiological mechanisms are used in very diverse organisms.
- Get a flavor of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.
- Undertake research in any aspect of animal physiology in future.

MZCP-305 (DEVELOPMENTAL BIOLOGY & BIOLOGY OF INFECTIOUS DISEASES) (Practical)
Learning outcomes

After successfully completing this course, the students will be able to:

- Hands-on experience to develop critical understanding how a single-celled fertilized egg becomes an embryo through three important processes of cell division, cell differentiation and morphogenesis.
- Understand the relevance of developmental biology in medicine or its role in development of diseases.
- Identification and detection of various parasites, viruses and bacteria.

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MZCP-306 (COMPARATIVE ENDOCRINOLOGY AND PHYSIOLOGY) (Practical)
Learning outcomes

After successfully completing this course, the students will be able to:

- Understand the relative position of individual organs and associated structures

through dissection of the invertebrate and vertebrate representatives.
- Get a flavor of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.
- Undertake research in any aspect of animal physiology in future.

SEMESTER - IV
MZET-401 (POPULATION AND COMMUNITY ECOLOGY) (Theory)

Learning outcomes

After successfully completing this course, the students will be able to:

- Know about wildlife and conservation biology and how different principles are used to manage wildlife conservations and management.
- Be familiar with the laws and regulations that influence how natural resources are used and protected.
- Know about the different special projects to protect and conserve biodiversity in India.
- Develop awareness about biodiversity conservation.

MZET-401 (ENTOMOLOGY) (Theory)
Learning outcomes

After successfully completing this course, the students will be able to:
- Learn diverse groups of insects, their classification and morphological characters.
- Understand the modifications of different body parts for adaptation to their habitat.
- Understand their physiology, endocrinology and various physiological adaptations.
- Know their interactions with plants, other animal groups and human.
- Undertake research in any aspect of Entomology in future.

MZET-401 (ENVIRONMENTAL TOXICOLOGY) (Theory)

Learning outcomes

After successfully completing this course, the students will be able to:

- Know about wildlife and conservation biology and how different principles are used to manage wildlife conservations and management.

MZET-401 (FISH BIOLOGY) (Theory)
Learning outcomes

After successfully completing this course, the students will be able to:

- Learn identification of various fish species on the basis of morphological characters.
- Learn various internal organs of fish species, their physiology and endocrinology.
- Understand various morphological and physiology modifications of fish species for environmental adaptation.
- To learn about fish reproduction, maturation of eggs and hormonal regulation of fish reproduction.

MZET-401 (MOLECULAR CELL BIOLOGY & GENETICS) (Theory)

Learning outcomes

After successfully completing this course, the students will be able to:

- Know about cell cycle checkpoints and iits regulation in cancer progression.
- Develop concepts about the uniformity and differences in the regulation of gene expression in different systems.
- Relate control of gene expression with extracellular environmental signals and metabolic cues.
- Understand the biology of Cancer.
- Learn about the genes and proteins involved in carrying out apoptosis, necrosis and autophagy.
- Know the conditions inducing cell death and its role in normal physiology and in disease.

MZET-401: (PARASITOLOGY) (Theory)

Expected Learning Outcomes
The successful learner will be able to

- Know about the biology, physiology and biological roles, development of parasites and its interaction with the host.
- Develop interest in pursuing research on various aspects of parasite physiology.
- Relate the knowledge for controlling the infection and help in the welfare of mankind.

MZOT-402 (APPLIED AND THEORETICAL ECOLOGY) Theory

Learning Outcomes
The successful learner will be able to

1. Understand the changing role and value of ecosystems to humans.
2. Understand the impacts of land use and environmental management decisions on ecosystems and society.
3. Predict the consequences of human actions on both local and global ecosystems.
4. Assess problems and threat of anthropogenic practices to ecosystem health.

MZOT-402 (APPLIED ENTOMOLOGY) (Theory)

Learning Outcomes

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

- Have the knowledge of pesticide families and be able to differentiate among families based on their specific modes of activity.
- Develop appropriate pesticide management strategies by evaluating specific pest type.
- Identify the types of insect pests particularly the most common one.
- Know the methods of sampling of the pests.
- Understand the effective way of insect pest management strategy.
- Develop knowledge and awareness about the causative agents and control measures of many commonly occurring insect borne diseases.

MZOT-402 (ECOTOXICOLOGY AND ENVIRONMENTAL MANAGEMENT) (Theory)

Learning Outcomes

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

- Understand the fundamental issues of environment.
- Analyze different sources of environmental problems and methods of measurement of pollution.
- Examine economic growth and quality of life.
- Examine the microbiology of waste water treatment and its various schemes.

MZOT-402 (FISHERIES AND AQUACULTURE) (Theory)

Learning Outcomes

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

- Understand the aquaculture systems
- Understand conditioning factors and how they can be manipulated.
- Describe water depuration mechanisms.
- Understand the environmental impacts of aquaculture.

MZOT-402 (MOLECULAR GENETICS) (Theory)
Learning outcomes

After successfully completing this course, the students will be able to:

- Know about site directed mutagenesis.
- Understand DNA microarrays, chromosome painting, restriction mapping and DNA fingerprinting.
- Develop understanding about pattern formation and homeotic loci in *Drosophila.* I
- Understand the functions of oncogenes, tumour suppressor genes and their role in cancer.

MZOT-402: (PARASITOLOGY II) (Theory)

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand the experimental paradigms and can integrate the recent advances in parasite host interactions taking into account the knowledge on the physiology, behavior and activity rhythms of the different parasite for anthelmintic drug development
- Gain an in-depth knowledge of immune responses of the host on to the parasites and also understand the long period of parasite survivability in the host.
- Identify research gaps and pursue research in anthelmintic drug development or vaccine for the welfare of humankind.

MZOP-403 (ECOLOGICAL MODELLING) Practical

Learning outcomes
After successfully completing this course, the students will be able to:

- Learn quantifications of different ecological theories and principles.
- Learn computer simulation by running differential equations and matrix analysis by using ecological data.

MZOP-403 (ENTOMOLOGY) (Practical)

Learning outcomes

- Learn diverse groups of insects and identification via morphological characters.
- Understand the modifications of different body parts for adaptation to their habitat.
- Know their interactions with plants, other animal groups and human.
- Undertake research in any aspect of Entomology in future.

MZOP-403 (ENVIRONMENTAL TOXICOLOGY) (Practical)

Learning outcomes

After successfully completing this course, the students will be able to:

- Learn basic principles of signaling pathways and mechanisms of cell death.
- Understand gene-environment interactions.
- Examine the application how xenobiotics disrupt normal cellular processes of genomics, proteomics, and metabolomics data.
- Understand mechanisms of systemic and organ toxicity induced by xenobiotics.
- Learn how to analyze and interpret complex data sets in toxicological research and deliver a scientific presentation.
- Use clinical and laboratory findings in the treatment of acute toxic exposures.

MZOP-403 (FISH AND FISHERIES) (Practical)

Learning outcomes

- Learn identification of various fish species on the basis of morphological characters.
- Learn pisciculture techniques, plankton culture, water quality assessment.
- Hands-on experience in fish dissection and identification of internal organs.
- To learn the culture breeding and marketing techniques of common indigenous fishes

MZOP-403 (MOLECULAR CELL BIOLOGY & GENETICS) (Practical)

Learning outcomes

After successfully completing this course, the students will be able to:

- Isolate hepatocytes and count the living and dead cells
- Isolate DNA and learn methods to assess its purity and concentration.
- Analyze RFLP and RAPD.
- Perform SNP analysis.
- Gain expertise in working with DNA.
- Understand the applications of DNA-based techniques.

MZOP-403: PARASITOLOGY III (Practical)
Learning outcomes

After successfully completing this course, the students will be able to:

- Learn identification of different parasitic species.

- Isolation of various parasites via faecal examination, from digestive tract and other organs types and sites.
- Histology of insect organs and their observation.
- Identify research gaps and pursue research in anthelmintic drug development.

MZPW-404 (DISSERTATION & VIVA VOCE) (Project)

Learning outcomes

After successfully completing this course, the students will be able to:

- Develop concept of a particular topic by review of the available literature.
- Analyze and interpret the research data.
- Learn to write a scientific report.
- Get acquainted with citations and referencing styles.
- Gain practical experience of open presentation and discussion.