POST GRADUATE PROGRAM

Master of Science

University of Technology

Vatika Road, Jaipur
Rajasthan 303903

UNIVERSITY OF TECHNOLOGY ,JAIPUR
Scheme & Syllabus
M.Sc 1st Year: Physics

Teaching & Examination Scheme
ACADEMIC SESSION 2023-2024

Sr. No.	Subject Name	Subject Code	Subject Type	I.A.	E.T.	T.M.	T.H.	C.P.
1	Classical Mechanics and Mathematical Method in Physics	MPY 101	Theoretical	30	70	100	6	6
2	Classical Electrodynamics	MPY 102	Theoretical	30	70	100	6	6
3	Quantum Mechanics, Atomic and Molecular Physics	MPY 103	Theoretical	30	70	100	6	6
4	Electronics, Numerical Methods and Computer Programming	MPY 104	Theoretical	30	70	100	6	6
5	Physics Practical	MPY 151	Practical	30	70	200	8	4
				150	**350**	**600**	**32**	**28**
	I.A. Internal Assessment	**E.T. End Term**	**T.M. Total Marks**	**T.H. Teaching Hours**	**C.P. Credit Point**			

UNIVERSITY OF TECHNOLOGY ,JAIPUR
Scheme & Syllabus
M.Sc 2nd Year: Physics

Teaching & Examination Scheme
ACADEMIC SESSION 2023-2024

Sr. No.	Subject Name	Subject Code	Subject Type	I.A.	E.T .	T.M.	T.H.	C.P.
1	Advanced Quantum Mechanics and Introductory Quantum Field	MPY 201	Theoretical	30	70	100	6	6
2	Nuclear Physics	MPY	Theoretical	30	70	100	6	6

		202						
3	Statistical and Solid State Physics	MPY 203	Theoretical	30	70	100	6	6
4	Plasma Physics	MPY 204A	Theoretical	30	70	100	6	6
5	Practical	MPY 251	Practical	60	140	200	8	4
6	Summer Research Project	MPY 252	Practical	60	140	200	8	4
				240	**560**	**800**	**40**	**32**
	I.A. Internal Assessment	**E.T. End Term**	**T.M. Total Marks**	**T.H. Teaching Hours**	**C.P. Crdit Point**			

UNIVERSITY OF TECHNOLOGY ,JAIPUR
Scheme & Syllabus
M.Sc 1st Year: Chemistry

Teaching & Examination Scheme
ACADEMIC SESSION 2023-2024

Sr. No.	Subject Name	Subject Code	Subject Type	I.A.	E.T .	T.M.	T.H.	C.P.
1	Inorganic Chemistry	MCH 101	Theoretical	30	70	100	5	5
2	Organic Chemistry	MCH 102	Theoretical	30	70	100	5	5
3	Physical Chemistry	MCH 103	Theoretical	30	70	100	5	5
4	Spectroscopy and Diffraction Methods	MCH 104	Theoretical	30	70	100	5	5
5	Green and Sustainable Chemistry	MCH 105	Theoretical	30	70	100	5	5
6	Analytical Techniques	MCH 106	Theoretical	30	70	100	5	5
7	Chemistry Practical	MCH 151	Practical	60	140	200	8	4
				240	**560**	**800**	**38**	**34**
	I.A. Internal Assessment	**E.T. End**	**T.M. Total**	**T.H. Teaching**	**C.P. Crdit**			

		Term	Marks	Hours	Point			

UNIVERSITY OF TECHNOLOGY ,JAIPUR
Scheme & Syllabus
M.Sc 2nd Year: Chemistry

Teaching & Examination Scheme
ACADEMIC SESSION 2023-2024

Sr. No.	Subject Name	Subject Code	Subject Type	I.A.	E.T .	T.M.	T.H.	C.P.
1	Applications of Spectroscopy, Photochemistry and Solid State Chemistry	MCH 201	Theoretical	30	70	100	5	5
2	Bioinorganic, Bioorganic and Biophysical Chemistry	MCH 202	Theoretical	30	70	100	5	5
3	Environmental Chemistry	MCH 203	Theoretical	30	70	100	5	5
4	Analytical Chemistry	MCH 204	Theoretical	30	70	100	5	5
5	Physical Organic Chemistry	MCH 205	Theoretical	30	70	100	5	5
6	Chemical Dynamics	MCH 206	Theoretical	30	70	100	5	5
7	Electrochemistry	MCH 207	Theoretical	30	70	100	5	5
8	Seminar	MCH 251	Practical	60	140	200	6	3
9	Practical	MCH 252	Practical	60	140	200	6	3
				330	**770**	**1100**	**47**	**41**
	I.A. Internal Assessment	**E.T. End Term**	**T.M. Total Marks**	**T.H. Teaching Hours**	**C.P. Crdit Point**			

UNIVERSITY OF TECHNOLOGY ,JAIPUR
Scheme & Syllabus
M.Sc 1st Year: Zoology

Teaching & Examination Scheme
ACADEMIC SESSION 2023-2024

Sr. No.	Subject Name	Subject Code	Subject Type	I.A.	E.T .	T.M.	T.H.	C.P.
1	Biosystematics & Taxonomy	MZO 101	Theoretical	30	70	100	5	5
2	Structure & Function of Invertebrates	MZO 102	Theoretical	30	70	100	5	5
3	Molecular Biology & Biotechnology	MZO 103	Theoretical	30	70	100	5	5
4	General Physiology	MZO 104	Theoretical	30	70	100	5	5
5	Biochemistry	MZO 105	Theoretical	30	70	100	5	5
6	Biostatistics and Population Genetics	MZO 106	Theoretical	30	70	100	5	5
7	Zoology Practical	MZO 151	Practical	60	140	200	8	4
				240	**560**	**800**	**38**	**34**
	I.A. Internal Assessment	**E.T. End Term**	**T.M. Total Marks**	**T.H. Teaching Hours**	**C.P. Crdit Point**			

UNIVERSITY OF TECHNOLOGY ,JAIPUR
Scheme & Syllabus
M.Sc 2nd Year: Zoology

Teaching & Examination Scheme
ACADEMIC SESSION 2023-2024

Sr. No.	Subject Name	Subject Code	Subject Type	I.A.	E.T .	T.M.	T.H.	C.P.
1	Biology of Chordates	MZO 201	Theoretical	30	70	100	4	4

2		MZO 202	Theoretical	30	70	100	4	4
3		MZO 203	Theoretical	30	70	100	4	4
4		MZO 204	Theoretical	30	70	100	4	4
5		MZO 205	Theoretical	30	70	100	4	4
6	Fish Biology	MZO 206	Theoretical	30	70	100	4	4
7	Genes and Differentiation	MZO 251	Practical	15	35	50	4	2
8	Cell and Molecular Biology	MZO 252	Practical	15	35	50	4	2
9	Tools and Techniques in Biology	MZO 253	Practical	15	35	50	4	2
10	Dissertation	MZO 254	Practical	100	100	200	4	2
				325	**625**	**950**	**40**	**32**
	I.A. Internal Assessment	**E.T. End Term**	**T.M. Total Marks**	**T.H. Teaching Hours**	**C.P. Crdit Point**			

UNIVERSITY OF TECHNOLOGY ,JAIPUR

Scheme & Syllabus

M.Sc 1st Year: Mathematics

Teaching & Examination Scheme

ACADEMIC SESSION 2023-2024

Sr. No.	Subject Name	Subject Code	Subject Type	I.A.	E.T .	T.M.	T.H.	C.P.
1	Advanced Abstract Algebra	MMT 101	Theoretical	30	70	100	6	6
2	Real Analysis and Topology	MMT 102	Theoretical	30	70	100	6	6
3	Differential Equations and Special Functions	MMT 103	Theoretical	30	70	100	6	6

4	Differential Geometry and Tensor Analysis	MMT 104	Theoretical	30	70	100	6	6
5	Mechanics	MMT 105	Theoretical	30	70	100	6	6
				150	**350**	**500**	**30**	**30**
	I.A. Internal Assessment	**E.T. End Term**	**T.M. Total Marks**	**T.H. Teaching Hours**	**C.P. Crdit Point**			

UNIVERSITY OF TECHNOLOGY ,JAIPUR
Scheme & Syllabus
M.Sc 2nd Year: Mathematics

Teaching & Examination Scheme
ACADEMIC SESSION 2023-2024

Sr. No.	**Subject Name**	**Subject Code**	**Subject Type**	**I.A.**	**E.T .**	**T.M.**	**T.H.**	**C.P.**
1	Analysis and Advanced Calculus	MMT 201	Theoretical	30	70	100	6	6
2	Viscous Fluid Dynamics	MMT 202	Theoretical	30	70	100	6	6
3	Continuum Mechanics	MMT 203	Theoretical	30	70	100	6	6
4	Boundary Layer Theory	MMT 204	Theoretical	30	70	100	6	6
5	Mathematical Programming	MMT 205	Theoretical	30	70	100	6	6
6	Summer Research Project	MMT 251	Practical	60	140	200	2	1
				210	**490**	**700**	**32**	**31**
	I.A. Internal Assessment	**E.T. End Term**	**T.M. Total Marks**	**T.H. Teaching Hours**	**C.P. Crdit Point**			

UNIVERSITY OF TECHNOLOGY ,JAIPUR
Scheme & Syllabus
M.Sc 1st Year: Botany

Teaching & Examination Scheme
ACADEMIC SESSION 2023-2024

Sr. No.	Subject Name	Subject Code	Subject Type	I.A.	E.T .	T.M.	T.H.	C.P.
1	Cell and Molecular Biology of Plants	MBT 101	Theoretical	30	70	100	5	5
2	Cytology, Genetics and Cytogenetics	MBT 102	Theoretical	30	70	100	5	5
3	Biology and Diversity of Lower Plants: Cryptogams	MBT 103	Theoretical	30	70	100	5	5
4	Taxonomy & Diversity of Seed Plants	MBT 104	Theoretical	30	70	100	5	5
5	Plant Physiology and Metabolism	MBT 105	Theoretical	30	70	100	5	5
6	Microbiology and Plant Pathology	MBT 106	Theoretical	30	70	100	5	5
7	Practical I	MBT 151	Practical	50	100	150	4	2
8	Practical II	MBT 152	Practical	50	100	150	4	2
				280	**620**	**900**	**38**	**34**
	I.A. Internal Assessment	**E.T. End Term**	**T.M. Total Marks**	**T.H. Teaching Hours**	**C.P. Crdit Point**			

UNIVERSITY OF TECHNOLOGY ,JAIPUR
Scheme & Syllabus
M.Sc 2nd Year: Botany

Teaching & Examination Scheme
ACADEMIC SESSION 2023-2024

Sr. No.	Subject Name	Subject Code	Subject Type	I.A.	E.T .	T.M.	T.H.	C.P.
1	Plant Morphology, Developmental Anatomy and Reproductive Biology	MBT 201	Theoretical	30	70	100	5	5
2	Plant Ecology	MBT 202	Theoretical	30	70	100	5	5
3	Plant Resource Utilization & Conservation	MBT 203	Theoretical	30	70	100	5	5
4	Biotechnology & Genetic Engineering of Plants and Microbes	MBT 204	Theoretical	30	70	100	5	5
5	Advanced Plant Pathology - I	MBT 205	Theoretical	30	70	100	5	5
6	Advanced Plant Pathology - II	MBT 206	Theoretical	30	70	100	5	5
8	Practical	MBT 251	Practical	60	140	200	6	3
9	Practical Advanced Plant Pathology	MBT 252	Practical	40	60	100	4	2
10	Summer Research Project	MBT 253	Practical	60	140	200	6	3
				340	**760**	**1100**	**46**	**38**
	I.A. Internal Assessment	**E.T. End Term**	**T.M. Total Marks**	**T.H. Teaching Hours**	**C.P. Crdit Point**			

Department of M.Sc.

Program Outcomes

PO 1	Students will be able to demonstrate a fundamental understanding of physics concepts, including classical mechanics, electromagnetism, thermodynamics, quantum mechanics, and relativity.
PO 2	Students will be proficient in mathematical and computational skills, enabling them to model physical systems, solve complex problems, and analyze experimental data effectively.
PO 3	Students will be adept in experimental and laboratory skills, mastering experimental design, data collection, instrumentation, and analysis techniques relevant to physics.
PO 4	Students will be able to apply physics principles in interdisciplinary contexts, integrating their knowledge into fields such as engineering, materials science, biophysics, and environmental science.
PO 5	Students will be capable of cultivating critical thinking and problem-solving abilities, analyzing theoretical models, interpreting experimental results, and addressing complex physics problems.
PO 6	Students will acquire advanced knowledge in specialized areas of physics, including optics, condensed matter physics, particle physics, astrophysics, and nuclear physics.
PO 7	Students will be proficient in utilizing quantitative and qualitative analysis skills, investigating physical phenomena, interpreting data, and deriving meaningful conclusions.
PO 8	Students will effectively communicate scientific ideas, presenting concepts, experimental findings, and theoretical models through written reports, oral presentations, and visual representations.
PO 9	Students will uphold ethical and professional conduct in physics, demonstrating integrity, responsibility, and collaboration in scientific research and laboratory practices.
PO 10	Students will integrate theoretical physics concepts with practical applications, applying their knowledge to technological innovations, industrial advancements, and theoretical developments.
PO 11	Students will prepare for advanced studies and research in physics, equipping themselves for careers in academia, research institutions, industry, and governmental agencies.
PO 12	Students will contribute to scientific knowledge and innovation, advancing the field through research, innovation, and the application of physics principles to address global challenges.

Program Specific Outcomes	
PSO 1	Demonstrate mastery in applying fundamental principles of physics, including motion, forces, energy, and momentum, to analyze and solve problems.

PSO 2	Develop the ability to analyze and predict the behavior of physical systems, including mechanical, electrical and optical systems.
PSO 3	Develop the ability to design and conduct experiments to test hypotheses and gather data to support physical principles.
PSO 4	Develop the ability to use computational tools, such as simulations and programming languages, to model and analyze physical systems.
PSO 5	Attain an in-depth knowledge of the principles of modern physics, including relativity, quantum mechanics, and particle physics.

Program Educational Objectives	
PEO 1	To develop a thorough understanding of fundamental physics concepts, including classical mechanics, electromagnetism, thermodynamics, quantum mechanics, and relativity.
PEO 2	To acquire proficiency in experimental techniques, including data collection, analysis using advanced laboratory equipment, and quantitative methods.
PEO 3	To master computational modeling and simulation skills, enabling prediction and analysis of physical phenomena in diverse scientific and technological applications.
PEO 4	To foster critical thinking and problem-solving abilities, facilitating the analysis of theoretical models, interpretation of experimental data, and application of physics principles to real-world challenges.
PEO 5	To enhance communication skills, enabling effective presentation of scientific ideas and collaboration in interdisciplinary teams for advancing knowledge and innovation in physics.

Course Name- Classical Mechanics and Mathematical Method in Physics
Course Code- MPY-101

Credits-6 (L-18 h/T-18h)		
	Course Outcomes (COs)	
	M.Sc - 1st Year (Physics) Scheme Updated on Session – July-2019, July-2020, July-2021, July-2022, July-2023	
	PG-PHY-701**: Classical Mechanics and Mathematical Method in Physics**	
	Students will be able to:	
	CO 1	Discuss the Classical Mechanics in Lagrangian formulation
	CO 2	Review about the Hamilton's principle
	CO 3	Represent Hamilton-Jacobi Method of Classical Mechanics
	CO 4	Predict the kinematics of the rigid body through Euler equation
	CO 5	Describe in central force field and relativity
	Course Outline (CO)	
	1	Unit-1/Physical Law and Frame of Reference/4 Hours Per Week
	2	Unit-2/Concepts related to Center of Mass/ 4 Hours Per Week
	3	Unit-3/Motion of Objects under Central Forces, Damped Harmonic Oscillation/ 5 Hours Per Week
	4	Unit-4/Driven Harmonic Oscillation, Coupled Oscillation/ 5 Hours Per Week
	Detailed Syllabus	
	Module-1	Constraints, holonomic and non-holonomic constraints, D'Alembert's Principle and Lagrange's Equation, velocity dependent potentials, applications of Lagrangian formulation, Hamilton's Principle, Calculus of variations, Derivation of Lagrange's Equation from Hamilton's principle, Extension of Hamilton's principle for non-conservative and non-holonomic systems, Method of Lagrange's Multipliers, Conservation theorems and symmetry properties, Noether's Theorem, Conservation of energy, linear momentum and angular momentum as a consequence of homogeneity of time and space and isotropy of space
	Module-2	Generalized momentum, Legendre transformation and the Hamilton's Equations of Motion, applications of Hamiltonian formulation, cyclic coordinates, Routh's procedure, Derivation of Hamilton's canonical Equations from Hamilton's variational Principle. Hamiltonian Formulation of Relativistic Mechanics. The principle of least Action.
	Module-3	Canonical transformation, integral invariance of Poincare, Lagrange's and Poisson brackets as canonical invariants, Equation of motion in Poisson bracket formulation. Infinitesimal contact transformation and generators of symmetry, Liouville's Theorem, Hamilton-Jacobi Equation and its application

	Module-4	Action angle variables, The Kepler's problem in action angle variables, theory of small oscillations in Lagrangian formulation, normal coordinates and its applications, orthogonal transformation, Euler's theorem. Eigen values of the Inertia tensor, Euler equations, force free motion of a rigid body
	Reference Books	
	1	Classical Mechanics, H. Goldstein, Poole and Safco, Narosa Publication.
	2	Mechanics, L.D. Landau and E.M. Lifshitz.
	3	Classical Mechanics, A.K. Raychaudhuri
	4	Classical Mechanics, N.C. Rana and P.S. Joag
	5	Classical Dynamics, J. B. Marion
	6	Classical Mechanics of particles and rigid bodies, K.C. Gupta, (John Wiley
	7	Theoretical Mechanics, Murray Spiegel.
	8	Classical Mechanics, J.C. Upadhyaya, Himalaya Publishing House Pvt. Ltd.

Course Name- Classical Electrodynamics-1		
Course Code- MPY 102		
Credits-6 (L-18 h/T-18 h)		
	Course Outcomes (COs)	
	M.Sc. (Physics) Part-I	
	PG-PHY 704: Classical Electrodynamics-1	
	Students will be able to:	
	CO 1	Describe the nature of the electric and magnetic fields and their propagation through different media and interfaces.
	CO 2	Describe Maxwell equations and their physical consequences
	CO 3	Synthesize specific electrodynamic phenomena into precise mathematical language
	CO 4	Describe physical phenomena in the language of fields
	CO 5	Formulate the covariant form of electrodynamics
	Course Outline (CO)	
	1	Unit-1/ Electrostatics/ 4 Hours Per Week
	2	Unit-2/Electric Field in Matter/ 4 Hours Per Week

	3	Unit-3/Magneto Statistics and Magnetic Field in Matter/ 5 Hours Per Week
	4	Unit-4/Maxwell's Equations and Electromagnetic Waves/ 5 Hours Per Week
	Detailed Syllabus	
	Module-1	Gauss's Law, Electrostatic scalar potential, Poisson and Laplace equation, Green's Theorem, Uniqueness of the solution with the Dirichlet or Neumann boundary conditions, Formal Solution of electrostatic Boundary value problem with Green's function, Electrostatic potential energy and energy density. Method of images, Point charge in the presence of a grounded conducting sphere, Point charge in the presence of a charged insulated conducting sphere, Point charge near a conducting sphere at a fixed potential, Conducting sphere in a uniform electric filed by method of images, Green function for the sphere, General solution for the potential. Conducting sphere with hemisphere at a different potentials.
	Module-2	Multipole Expansion, Approximate Potentials at Large Distances, Monopole and Dipole Terms, Electric Field of a Dipole. Multipole expansion of the energy of a charge distribution in an external field. Polarization, Dielectrics, Induced Dipoles, Alignment of Polar Molecules, Field of a Polarized Object, Bound Charges, The Field inside a Dielectric, Electric Displacement Gauss's Law in the Presence of Dielectrics, Boundary value problem with dielectrics, Molar polarizability and electric susceptibility. Energy in Dielectric Systems, Forces on Dielectrics.
	Module-3	Magnetostatics: Introduction and definition, Biot and Savart law, the differential equations of magnetostatics and Ampere's law, Vector potential and magnetic induction for a current loop, Magnetic fields of a localized current distribution, Magnetic moment, Force and torque on and energy of a localized current distribution in an external induction, Macroscopic equations, Boundary conditions on B and H, Methods of solving boundary value problems in magnetostatics, Uniformly magnetized sphere, a magnetized sphere in an external field, permanent magnets, magnetic shielding, spherical shell of permeable material in a uniform field.
	Module-4	Time-varying fields, Maxwell's equations, Conservation laws: Energy in a magnetic field, Vector and Scalar potentials, Gauge transformation, Lorentz gauge, Coulomb gauge, Derivation of the equations of Macroscopic Electromagnetism, Poynting's theorem and conservation of energy and momentum for a system of charged particles and EM fields, Conservation laws for macroscopic media, Electromagnetic field tensor, Transformation of four potentials and four currents.
		Text Book

		J.D. Jackson: Classical Electrodynamics
		Reference Books
	1	David J. Griffiths, Introduction to electrodynamics, 3rd ed. Prentice-Hall, Inc
	2	Panofsky & Phillip: Classical electrodynamics and magnetism
	3	Landau & Lifshitz: Classical Theory of Electrodynamics
	4	Landau & Lifshitz: Electrodynamics of continuous media
Course Name-Optics		
Course Code-BPCM 107		
Credits-6 (L-18 h/T-18h)		
	Course Outcomes (COs)	
	M.Sc. (Physics) 1st Year	
	MPY103: Quantum Mechanics, Atomic and Molecular Physics	
	Students will be able to:	
	CO 1	Understand the foundational principles and mathematical framework of quantum mechanics.
	CO 2	Apply advanced mathematical techniques to solve quantum mechanical problems.
	CO 3	Analyze the time evolution and dynamics of quantum systems using the Schrödinger equation.
	CO 4	Utilize quantum operators to compute expectation values and probabilities in quantum systems.
	CO 5	Identify symmetries and relate them to conservation laws in quantum mechanics.
	CO 6	. Evaluate and apply quantum mechanical models to physical systems.
	CO 7	Develop critical analysis, problem-solving, and communication skills in quantum mechanics
	Course Outline (CO)	
	1	**Unit-1/** Formalism and Angular Momentum algebra **/4 Hours Per Week**
	2	**Unit-2/** Identical Particles and Symmetries & Conservation Laws **/ 4 Hours Per Week**
	3	**Unit-3/** Time-Independent Perturbation/ Theory **/ 5 Hours Per Week**
	4	**Unit-4/** Quantum Dynamics and Afterword **/ 5 Hours Per Week**
	Detailed Syllabus	

	Module-1	**Formalism:** Hilbert Space, Observables: Hermitian Operators, Determinate States; Eigenfunctions of a Hermitian Operator: Discrete Spectra, Continuous Spectra; Generalized Statistical Interpretation, The Uncertainty Principle: Proof of the Generalized Uncertainty Principle, The Minimum-Uncertainty Wave Packet, The Energy-Time Uncertainty Principle; Vectors and Operators: Bases in Hilbert Space, Dirac Notation, Changing Bases in Dirac Notation. **Angular Momentum**: Eigenvalues, Eigenfunctions; Spin, Spin ½, Electron in a Magnetic Field, Addition of Angular Momenta; Electromagnetic Interactions: Minimal Coupling, The Aharonov–Bohm Effect.
	Module-2	**Identical Particles:** Two-Particle Systems: Bosons and Fermions, Exchange Forces, Spin, Generalized Symmetrization Principle; Atoms: Helium, The Periodic Table; Solids: The Free Electron Gas, Band Structure. **Symmetries & Conservation Laws**: Introduction of Symmetries & Conservation Laws: Transformations in Space; The Translation Operator: How Operators Transform, Translational Symmetry; Conservation Laws, Parity: Parity in One Dimension, Parity in Three Dimensions, Parity Selection Rules ; Rotational Symmetry: Rotations About the *z* Axis, Rotations in Three Dimensions; Degeneracy, Rotational Selection Rules: Selection Rules for Scalar Operators, Selection Rules for Vector Operators; Translations in Time: The Heisenberg Picture, Time-Translation Invariance.
	Module-3	Nondegenerate Perturbation Theory: General Formulation, First-Order Theory, Second-Order Energies; Degenerate Perturbation Theory: Two-Fold Degeneracy, "Good" States, Higher-Order Degeneracy; The Fine Structure of Hydrogen: The Relativistic Correction, Spin-Orbit Coupling; The Zeeman Effect: Weak-Field Zeeman Effect, Strong-Field Zeeman Effect, Intermediate-Field Zeeman Effect; Hyperfine Splitting in Hydrogen.
	Module-4	**Quantum Dynamics:** Two-Level Systems: The Perturbed System, Time-Dependent Perturbation Theory, Sinusoidal Perturbations; Emission and Absorption of Radiation: Electromagnetic Waves, Absorption, Stimulated Emission, and Spontaneous Emission, Incoherent Perturbations; Spontaneous Emission: Einstein's *A* and *B* Coefficients, The Lifetime of an Excited State, Selection Rules; Fermi's Golden Rule, The Adiabatic Approximation: Adiabatic Processes, The Adiabatic Theorem. The EPR Paradox, Bell's Theorem, Mixed States and the Density Matrix: Pure States, Mixed States, Subsystems; The No-Clone Theorem, Schrödinger's Cat
	Suggested Textbook: 1. Griffiths, D. J., & Schroeter, D. F. (2018). *Introduction to Quantum Mechanics* (3rd ed.). Cambridge: Cambridge University Press.	
	Suggested Reference Books: 1) R. Shankar (1994). Principles of Quantum Mechanics (2nd ed.) 2) Belsley, M. (2012). Lectures on Quantum Mechanics, 2nd edn, by Ashok Das 3) N. Zettili (2022) Quantum Mechanics: Concepts and Applications, 3rd Edition 4) F. Laloë, B. Diu, C. Cohen-Tannoudji (2019) Quantum Mechanics, Volume 1: Basic Concepts, Tools, and Applications, 2nd Edition	

Suggested online links:
1) https://nptel.ac.in/courses/115106066
2) https://archive.nptel.ac.in/courses/122/106/122106034/
3) https://ocw.mit.edu/courses/8-04-quantum-physics-i-spring-2016/

Course Name-M.Sc -1 Year

Course Code-MPY104 Electronics, Numerical Methods and Computer Programming

Credits-6 (P-12 h)

Detailed Syllabus (Practical)

1. Electronics Lab:

- **Basic Circuit Design:**
  - Introduction to circuit components like resistors, capacitors, inductors.
  - Use of multimeters and oscilloscopes for circuit analysis.
  - Breadboard circuit assembly and testing.
- **Analog Electronics:**
  - Diode characteristics, rectification, and power supplies.
  - Transistor amplifiers (BJT, FET), operational amplifiers.
  - Oscillator circuits, waveform generators.
- **Digital Electronics:**
  - Logic gates and Boolean algebra.
  - Flip-flops, counters, and timers.
  - Microcontroller programming (e.g., Arduino or PIC).
- **Signal Processing:**
  - Sampling and reconstruction of signals.
  - Filters (low-pass, high-pass, band-pass).
  - Fourier transforms and spectral analysis.

2. Numerical Methods Lab:

- **Solving Linear and Non-linear Equations:**
  - Numerical solutions to linear algebraic equations (e.g., Gauss-Seidel, LU Decomposition).
  - Root-finding techniques (e.g., Newton-Raphson method, Bisection method).
- **Numerical Integration and Differentiation:**
  - Techniques like Trapezoidal rule, Simpson's rule for numerical integration.
  - Finite difference methods for numerical differentiation.
- **Interpolation and Curve Fitting:**
  - Polynomial interpolation (Lagrange, Newton).
  - Least-square curve fitting techniques.

- **Solving Differential Equations:**
  - Euler's method, Runge-Kutta methods for ordinary differential equations (ODEs).

- Finite difference methods for partial differential equations (PDEs).

3. Computer Programming Lab:

- **Programming Fundamentals:**
  - Basics of programming in languages like Python, C, or MATLAB.
  - Understanding variables, control structures (loops, conditionals).
  - Functions, modules, and libraries.
- **Data Structures and Algorithms:**
  - Arrays, stacks, queues, linked lists.
  - Sorting algorithms (quick sort, merge sort), searching algorithms.
  - Dynamic programming and recursion.
- **Numerical Computation:**
  - Matrix manipulation, solving equations using libraries (e.g., NumPy in Python).
  - Implementing numerical methods in code (integration, differentiation, ODE solvers).
- **Visualization and Plotting:**
  - Using tools like Matplotlib, MATLAB, or other software for plotting graphs.
  - Data visualization for better understanding of numerical results.

Course Name-M.Sc. -1 Year

Course Code-MPY151 Physics Practical

Credits-4 (P-12 h)

Detailed Syllabus (Practical)

1. Classical Mechanics and General Physics Experiments:

- **Determination of 'g' by Kater's Pendulum**: A precise measurement of the acceleration due to gravity using a reversible pendulum.
- **Study of Coupled Oscillators**: Investigation of coupled pendulums or spring systems to observe normal modes and frequencies.
- **Moment of Inertia and Angular Acceleration**: Using different shapes (cylinder, disc, etc.) and a torsion pendulum to study rotational dynamics.
- **Speed of Sound in Air by Resonance Tube Method**: Measuring sound velocity using resonance in closed pipes.
- **Study of Damped and Driven Oscillations**: Investigation of damping and driving forces in oscillatory systems (e.g., spring-mass systems).

2. Optics and Wave Phenomena:

- **Newton's Rings and Interference Experiments**: Determination of wavelength of light or refractive index using Newton's rings or wedge-shaped films.
- **Diffraction through Grating and Single Slit**: Measurement of wavelength using diffraction patterns formed by gratings.
- **Michelson Interferometer**: Study of interference, determination of wavelength, and the separation of closely spaced spectral lines.

- **Polarization Experiments**: Investigation of polarization by reflection, Brewster's angle, and study of the polarization of light using polaroids.

3. Electronics and Solid-State Physics:

- **Semiconductor Diode Characteristics**: Study of current-voltage characteristics of p-n junction diodes, Zener diodes, and light-emitting diodes (LEDs).
- **Transistor Characteristics and Amplifiers**: Experimentation with BJT (Bipolar Junction Transistor) and FET (Field Effect Transistor) as amplifiers.
- **Hall Effect**: Measurement of Hall voltage and determination of charge carrier concentration in semiconductors.
- **Band Gap Determination**: Using electrical resistivity measurements to determine the energy gap of semiconductors.

4. Modern Physics Experiments:

- **Photoelectric Effect**: Verification of Einstein's photoelectric equation and determination of Planck's constant.
- **Frank-Hertz Experiment**: Observation of quantized energy levels in atoms by studying electron collisions with mercury atoms.
- **e/m Measurement of Electrons (Thomson's Method)**: Determination of charge-to-mass ratio of electrons using magnetic and electric fields.
- **Zeeman Effect**: Study of the splitting of spectral lines in a magnetic field and determination of the Bohr magneton.

5. Thermal Physics:

- **Thermal Conductivity of a Metal Rod**: Measuring the thermal conductivity using Searle's apparatus or Lees' Disc method.
- **Blackbody Radiation and Stefan-Boltzmann Law**: Verification of Stefan's law by studying the radiation emitted by a blackbody.
- **Calorimetry Experiments**: Determination of specific heat, latent heat of fusion or vaporization using calorimeters.

Course Name- Electronics, Numerical Methods and Computer Programming

Course Code- MPY 104

Credits-6 (L-18 h/T-18h)

	Course Outcomes (COs)
	M.Sc. (Physics)
	MPY 104: Electronics, Numerical Methods and Computer
	Students will be able to:
CO 1	To equip students with fundamentals of computer programming
CO 2	To provide fundamental idea about the use of computer programming

	CO 3	Numerical methods for analyzing the basic engineering problems.
	Course Outline (CO)	
	1	Unit-1 Introduction to Electronics /4 Hours Per Week
	2	Unit-2/ Circuit Theory / 4 Hours Per Week
	3	Unit-3/ Analog Electronics / 5 Hours Per Week
	4	Unit-4/ Digital Electronics / 5 Hours Per Week
	Detailed Syllabus	
	Module-1	Introduction to computer programming concept, control statements, basics pointers,
	Module-2	Introduction to Class and Object, Errors and approximations, curve fitting
	Module-3	Numerical problems and preparation of computer programs
	Text Books 1. Balagurusamy, Computer Programming 1e McGraw Hill Education , 2013 2. Balagurusamy, Numerical Methods 1e McGraw Hill Education, 1999 3. Jose S., Computer Programming and Numerical Methods, Pentagon, 2015. 4. Ravichandran D., Programming with C++, Tata McGraw Hill, 2007.	
	Reference Books 1. Balaguruswamy E., Object Oriented Programming with C++, Tata McGraw Hill, 1992. 2. Barkakati N., Object Oriented Programming in C++, SAMS, 1991. 3. Gerald C. F. and P. O. Wheatley, Applied Numerical Analysis, Pearson,2004. 4. Kamthane A. M., Object Oriented Programming with ANSI & Turbo C++, 5. Lippman S. B. and J. Lajoie, C++ Primer, Pearson Education, 2005. Pearson Education, 2009.	

Course Name- Advanced Quantum Mechanics and Introductory Quantum Field

Course Code-MPY201

Credits-6 (L-18 h/T-18h)

	Course Outcomes (COs)	
	M.Sc. (Physics) Part-II	
	MPY 201: Advanced Quantum Mechanics and Introductory Quantum Field	
	Students will be able to:	
	CO 1	Understanding of key concepts in quantum
	CO 2	Able to apply this understanding to analyse Mechanics
	CO 3	Qualitative understanding of the problems

	CO 4	Quantitative understanding of the problems
	Course Outline (CO)	
	1	Unit-1/ Introduction to Relativistic Quantum Mechanics /4 Hours Per Week
	2	Unit-2/ Quantum Scattering and Perturbation Theory: / 4 Hours Per Week
	3	Unit-3/ Relativistic Quantum Physics / 5 Hours Per Week
	4	Unit-4/ Quantum Field Theory Introduction / 5 Hours Per Week
	Detailed Syllabus	
	Module-1	**Formalism:** Hilbert Space, Observables: Hermitian Operators, Determinate States; Eigenfunctions of a Hermitian Operator: Discrete Spectra, Continuous Spectra; Generalized Statistical Interpretation, The Uncertainty Principle: Proof of the Generalized Uncertainty Principle, The Minimum-Uncertainty Wave Packet, The Energy-Time Uncertainty Principle; Vectors and Operators: Bases in Hilbert Space, Dirac Notation, Changing Bases in Dirac Notation. **Angular Momentum**: Eigenvalues, Eigenfunctions; Spin, Spin ½, Electron in a Magnetic Field, Addition of Angular Momenta; Electromagnetic Interactions: Minimal Coupling, The Aharonov–Bohm Effect.
	Module-2	**Identical Particles:** Two-Particle Systems: Bosons and Fermions, Exchange Forces, Spin, Generalized Symmetrization Principle; Atoms: Helium, The Periodic Table; Solids: The Free Electron Gas, Band Structure. **Symmetries & Conservation Laws**: Introduction of Symmetries & Conservation Laws: Transformations in Space; The Translation Operator: How Operators Transform, Translational Symmetry; Conservation Laws, Parity: Parity in One Dimension, Parity in Three Dimensions, Parity Selection Rules ; Rotational Symmetry: Rotations About the *z* Axis, Rotations in Three Dimensions; Degeneracy, Rotational Selection Rules: Selection Rules for Scalar Operators, Selection Rules for Vector Operators; Translations in Time: The Heisenberg Picture, Time-Translation Invariance.
	Module-3	Nondegenerate Perturbation Theory: General Formulation, First-Order Theory, Second-Order Energies; Degenerate Perturbation Theory: Two-Fold Degeneracy, "Good" States, Higher-Order Degeneracy; The Fine Structure of Hydrogen: The Relativistic Correction, Spin-Orbit Coupling; The Zeeman Effect: Weak-Field Zeeman Effect, Strong-Field Zeeman Effect, Intermediate-Field Zeeman Effect; Hyperfine Splitting in Hydrogen.
	Module-4	**Quantum Dynamics:** Two-Level Systems: The Perturbed System, Time-Dependent Perturbation Theory, Sinusoidal Perturbations; Emission and Absorption of Radiation: Electromagnetic Waves, Absorption, Stimulated Emission, and Spontaneous Emission, Incoherent Perturbations; Spontaneous Emission: Einstein's *A* and *B* Coefficients, The Lifetime of an Excited State, Selection Rules; Fermi's Golden Rule, The Adiabatic Approximation: Adiabatic Processes, The Adiabatic Theorem. The EPR Paradox, Bell's Theorem, Mixed States and the Density Matrix: Pure States, Mixed States, Subsystems; The No-Clone Theorem, Schrödinger's Cat.

Suggested Textbook:

1. Griffiths, D. J., & Schroeter, D. F. (2018). *Introduction to Quantum Mechanics* (3rd ed.). Cambridge: Cambridge University Press.

Suggested Reference Books

1	R. Shankar (1994). Principles of Quantum Mechanics (2nd ed.)
2	Belsley, M. (2012). Lectures on Quantum Mechanics, 2nd edn, by Ashok Das
3	N. Zettili (2022) Quantum Mechanics: Concepts and Applications, 3rd Edition
4	F. Laloë, B. Diu, C. Cohen-Tannoudji (2019) Quantum Mechanics, Volume 1: Basic Concepts, Tools, and Applications, 2nd Edition

Course Name- Nuclear Physics

Course Code- MPY 202

Credits-6 (L-18 h/T-18h)

Course Outcomes (COs)

M.Sc. (Physics)

MPY-202: Nuclear Physics

Students will be able to:

CO 1	It will develop theoretical understanding about nature of forces existing between nucleons in the nucleus and its properties, calculation of the electric quadruple and magnetic dipole moments for deuteron in ground and excited state
CO 2	Comparison between theoretical and experimental results of two nucleon scattering cross section both at low energy and high energy.
CO 3	Fundamental understanding about nuclear radiation interaction with matter and different interaction processes for specific radiation.
CO 4	Basic knowledge about nuclear radiation detection system, detection processing by electronic circuits and counting statistics.

Course Outline (CO)

1	Unit-1/ Two Nucleon system and Nuclear forces/4 Hours Per Week
2	Unit-2/ Nucleon-Nucleon Scattering and Potentials / 4 Hours Per Week
3	Unit-3/ Interaction of radiation and charged particle with matter / 5 Hours Per Week
4	Unit-4/ Nuclear Techniques / 5 Hours Per Week

Detailed Syllabus

	Module-1	General nature of the force between nucleons, saturation of nuclear forces, charge independence and spin dependence, General forms of nucleon interaction, Central, non-central and velocity dependent potential, Analysis of ground state(3S1) of deuteron using a square well potential, range-depth relationship, excited states of deuteron, Discussion on the ground state of deuteron under non-central force, calculation of the electric quadrupole and magnetic dipole moments and the D-state admixture
	Module-2	Partial wave analysis of the neutron-proton scattering at low energy assuming central potential with square well shape, concept of the scattering length, coherent scattering of neutrons by protons in (ortho and para) , hydrogen molecule ; conclusions of these analyses regarding scattering lengths range and depth of the potential ; the effective range theory (in neutron-proton scattering) and the shape independence of nuclear potential : A qualitative discussion of proton –proton scattering at low energy ; General features of two-body scattering at high energy , effect of exchange forces. Phenomenological Hamada –Johnson a hard core potential, a Reid hard core and soft core potentials; Main features of the One Boson Exchange Potentials (OBEP) no derivation.
	Module-3	Law of absorption and attenuation coefficient (Linear attenuation and mass attenuation coefficient) photo electric effect, Compton scattering, pair –production; energy, target and projectile dependence of all three processes. Energy loss of charged particles due to ionization, Bremstrahlung; Bragg Curve, Energy straggling, Range of charge particles; Range-energy curve, Range straggling, Stopping time. Interaction of Neutrons with matter: Neutron Sources, types of neutron, neutron interaction, neutron cross section
	Module-4	Nuclear radiation detection system: Gamma ray spectrometer using NaI scintillation detector, High Purity Germanium detector (HPGe); Cerenkov counter General characteristic of Detector: Modes of detector operation, Energy Resolution, Fano factor, response function, response time, detector Efficiency, Dead time Electronic circuits for nuclear detector: Pre-amplifier, amplifier, Discriminators, Analog to Digital Convertor (ADC), Single channel analyzer and Multi-Channel Analyzer, Pulse height spectrum analysis Counting Statistics: Characterization of data, Statistical Models; the binomial, Poisson and Gaussian distribution and application of statistical models, Error propagation
	Reference Books	
	1. R.R. ROY and B.P. Nigam: Nuclear Physics (Willy and Easter-1979) 2. S.B.PATEL: Nuclear Physics An Introduction (New age International Publisher-1991) 3. William R. Leo: Techniques for nuclear and particle physics experiments-Springer (1992) 4. Glenn F. Knoll: Radiation Detection and Measurement-Wiley (2010) 5. R.D. EVANS: The Atomic Nucleus(Krieser Publishing Company- 1982) 6. W.E. BURCHAM: Elements of Nuclear Physics(ELBS LONGMAN-1988) 7. K.S. Krane: Introductory Nuclear Physics(Wiley-2008) 8. B.L.Cohen: Concept of Nuclear Physics(Tata Mc Graw Hills 1988) 9. I.Kaplan :Nuclear Physics(Addison Wesley-1963) 10. R.M. SINGRU: Introductory Experimental Nuclear Physics (Wiley Eastern, 1972)	

Course Name- Quantum Mechanics & Spectroscopy

Course Code-MPY203

Credits-6 (L-18 h/T-18h)

Course Outcomes (COs)	
M.Sc. (Physics) Part-III	
MPY203: Quantum Mechanics & Spectroscopy	
Students will be able to:	
CO 1	Describe the evolution of quantum physics, including the key developments and fundamental concepts that shaped modern quantum theory
CO 2	Solve Schrodinger wave equation for various potential problems and interpret the solutions in terms of quantum states and physical properties
CO 3	Apply principles of atomic spectroscopy to understand the emission and absorption spectra of atoms and molecules
CO 4	Explore molecular spectroscopy concepts, including the techniques used to study molecular energy levels and transitions, and their applications in analyzing molecular structures
Course Outline (CO)	
1	Unit-1/ Introduction to Quantum Mechanics /4 Hours Per Week
2	Unit-2/ Wave Functions and Schrödinger Equation / 4 Hours Per Week
3	Unit-3/ Quantum Mechanics Postulates and Theorems / 5 Hours Per Week
4	Unit-4/ Angular Momentum and Spin / 5 Hours Per Week
Detailed Syllabus	
Module-1	Concept of statistical distribution, phase space, density of states , Liouville's theorem, systems and ensemble, entropy in statistical mechanics, connection between thermodynamic and statistical quantities, microcanonical ensemble, equation of state, specific heat and entropy of a perfect gas using microcanonical ensemble. Canonical ensemble, thermodynamic functions for the canonical ensemble, calculation of means values, energy fluctuation in a gas, grand canonical ensemble, thermodynamic functions for the grand canonical ensemble, density fluctuations.
Module-2	Partition functions and properties, partition function for an ideal gas and calculation of thermodynamic quantities, Gibbs Paradox, validity of classical approximation, determination of translational, rotational and vibration contributions to the partition function of an ideal diatomic gas, specific heat of a diatomic gas, ortho and para hydrogen. Identical particles and symmetry requirement, difficulties with Maxwell- Boltzmann statistics, quantum distribution functions, Bose-Einstein and Fermi-Dirac statistics and Planck's formula, Bose-Einstein condensation, liquid He4 as a Boson system, quantization of harmonic oscillator and creation and annihilation of phonon operators, quantization of fermion operators

	Module-3	Fermi Dirac distribution function, density of states, temperature dependence of Fermi energy, specific heat, use of fermi Dirac statistics in the calculation of thermal conductivity and electrical conduction. Wiedemann Franz ratio, susceptibility, width of conduction band. Drude theory of light absorption in metals.
	Module-4	Bloch theorem, Kronig Penny model, effective mass of electrons, Wigner-Seitz approximation, NFE model, tight binding method and calculation of density of states for a band in simple cubic lattice, pseudopotential method
	Reference Books	
	1. Dr. D. Chattopadhyay, Dr. P.C. Rakshit Quantum Mechanics, Statistical Mechanics and Solid State Physics S. Chand	

Course Name- Plasma Physics

Course Code- MPY204 A

Credits-6 (L-18 h/T-18h)

	Course Outcomes (COs)	
	M.Sc. (Physics) 2nd Year	
	MPY204 A: Plasma Physics	
	Students will be able to:	
	CO 1	Overall view of charged particle dynamics in electromagnetic fields, behaviour of plasma as a fluid and basic elements of kinetic theory.
	CO 2	understands the hierarchy of plasma theories from kinetic theory to magnetohydrodynamics
	CO 3	solve simple problems in single-particle motion, magnetised fluid systems in equilibrium and wave propagation in plasmas.
	CO 4	familiar with the terrestrial and space plasma applications
	CO 5	prerequisites to enjoy Plasma Physics: Applications, which deals with plasma applications in astrophysics, industry, medicine, nuclear fusion and laser-plasma interaction
	Course Outline (CO)	
	1	Unit-1 Introduction to Plasma Physics /4 Hours Per Week
	2	Unit-2/ Plasma Fundamentals / 4 Hours Per Week
	3	Unit-3/ Plasma Confinement and Stability / 5 Hours Per Week
	4	Unit-4/ Plasma Diagnostics and Applications / 5 Hours Per Week

	Detailed Syllabus	
	Module-1	Occurrence of plasma in nature, definition of plasma, concept of temperature, Debye shielding and plasma parameter, Criteria for plasmas, The plasma frequency, Plasma in magnetosphere and ionosphere, Plasma production and diagnostics, Various applications of plasmas, Fusion core plasma, MHD generator, Plasma propulsion.
	Module-2	Single particle motions in uniform E and B, gravitational field, Non-uniform magnetic field, grad B and curvature drifts, invariance of magnetic moment and magnetic mirror, Non-uniform E- field, Time varying E field and B field, Adiabatic invariant.
	Module-3	Plasma Fluid equation, Equation of continuity, Fluid drifts perpendicular to B, Fluid drifts parallel to B, The Plasma approximation. Diffusion and resistivity, Collision and diffusion parameters, Decay of plasma by diffusion, Diffusion across a magnetic field, collision in fully ionized plasmas, Diffusion in fully ionized plasmas and solution of diffusion equation, Plasma Resistivity.
	Module-4	Equilibrium and Stability, Hydromagnetic equilibrium, the concept of magnetic pressure, Diffusion of magnetic field into plasmas, Instability, Two stream instability, gravitational instability, Resistive drift waves. The pinch effect: equilibrium pinch, The Bennett pinch, instabilities in a pinched plasma column
	Reference Books	
	1.Introduction to Plasma Physics and Controlled Fusion: F. F. Chen, Third Edition (Springer 2015) 2. Plasma physics in Theory and Applications: W. B. Kunkel (Mc Graw Hill 1966) 3. Fundamentals of Plasma Physics: J. A. Bittencourt, Fourth Edition (Pegamohs Press. 1986) 4. Plasma Physics: An Introductory Course, R.O. Dendy-Cambridge University Press, 1995. 5. Introduction to Plasma Physics: R J Goldston and P H Rutherford, Institute of Physics, 1995	

Course Name- M.Sc. Chemistry

Course Code- CH 401

Credits-3 (L-18 h/T-18h)

	Course Outcomes (COs)	
	M.Sc. (Chemistry)	
	CH 401: Inorganic Chemistry	
	Students will be able to:	
	CO 1	Understand the principles of atomic structure, chemical bonding, and molecular orbital theory.
	CO 2	Identify and describe the main groups of inorganic compounds (alkali metals, alkaline earth metals, transition metals, etc.).

	CO 3	Recognize and explain the trends in periodic properties (electronegativity, ionization energy, etc.).
	CO 4	Comprehend the chemistry of coordination compounds, including ligands, isomerism, and reactions.
	CO 5	Understand the principles of acid-base chemistry, including Arrhenius, Bronsted-Lowry, and Lewis theories.
	Course Outline (CO)	
	1	Unit-1/ Introduction to Inorganic Chemistry /4 Hours Per Week
	2	Unit-2/ Main Group Elements / 4 Hours Per Week
	3	Unit-3/ Transition Metals / 5 Hours Per Week
	4	Unit-4/ Solid-State & Material Chemistry / 5 Hours Per Week
	Detailed Syllabus	
	Module-1	Group 1-2. 13-15, 16-18 elements: chemistry, reactivity, and applications
	Module-2	Coordination compounds: synthesis, properties, and reactions, Organometallic chemistry: principles, reactions, and applications, Bioinorganic chemistry: metal ions in biological systems
	Module-3	Crystal structures and lattice energy, Solid-state reactions and phase diagrams, Materials science applications: ceramics, glass, and nanomaterials
	Module-4	Computational inorganic chemistry: methods and applications, Inorganic polymers and nanomaterials: synthesis and properties, Bioinorganic chemistry of disease: metal-based drugs and toxins
	Reference Books	
	1. Inorganic Chemistry" by Miessler and Tarr 2. "Inorganic Chemistry: Principles of Structure and Reactivity" by Huheey 3. "Advanced Inorganic Chemistry" by Cotton et al.	

Course Name- M.Sc. Chemistry
Course Code- MCH102
Credits-3 (L-18 h/T-18h)
Course Outcome's (Cos)
M.Sc. (Chemistry)
MCH102 :Organic Chemistry
Students will be able to:

CO1	1. Understand fundamental principles of organic chemistry (bonding, hybridization, stereochemistry)
CO2	Identify and classify organic compounds (alkanes, alkenes, alkynes, aromatics).
CO3	Recognize and predict chemical reactions (addition, elimination, substitution, rearrangement)
CO4	Apply spectroscopic methods (IR, NMR, MS) for structure elucidation.
CO5	. Understand organic synthesis strategies and methodologies
Course Outlines (CO)	
1	Introduction to Organic Chemistry
2	Alkanes and Cycloalkanes
3	Alkenes and Alkynes
4	Organic Reactions and Mechanisms
Detailed Syllabus	
1.	Introduction to Organic Chemistry: Atomic orbitals, hybridization, and molecular geometry, Introduction to organic compounds and nomenclature
2.	Alkanes and Cycloalkanes : Structure and properties, Synthesis and reactions Conformational analysis
3.	Alkenes and Alkynes: Structure and properties, Addition reactions (electrophilic, nucleophilic), Elimination reactions
4.	Stereochemistry: Isomerism and chirality, R/S configuration and Fischer projections
5.	Spectroscopy: IR spectroscopy, NMR spectroscopy
	Reference Books
	1. Organic Chemistry" by Jerry March and Michael Smith 2. "Organic Chemistry: A Short Course" by Harold Hart, Leslie E. Craine, and David J. Hart 3. "Organic Chemistry: Structure and Function" by K. Peter C. Vollhardt and Neil E. Schore
Course Name: M.Sc. Chemistry	

Course Code-MCH-103	
Credits-3 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Chemistry	
MCH-103: Physical Chemistry	
Student will be able to know	
CO1	Understand fundamental principles of physical chemistry.
CO2	Apply thermodynamic and kinetic concepts to chemical systems
CO3	Analyze spectroscopic data for molecular structure elucidation
CO4	Understand quantum mechanics and statistical mechanics
CO5	Apply computational methods to physical chemistry problems
Course Outline (CO)	
1	Thermodynamics
2	Quantum Mechanics
3	Spectroscopy
4	Statistical Mechanics
Detailed Syllabus	
1.	Advanced thermodynamic concepts, Thermodynamic potentials (U, H, G, A), Phase equilibrium and phase diagrams, Thermodynamics of solutions
2.	Introduction to quantum mechanics, Wave-particle duality, Schrödinger equation, Quantum mechanical operators
3.	Introduction to spectroscopy, IR spectroscopy, NMR spectroscopy, UV-Vis spectroscopy
4.	Introduction to statistical mechanics, Microcanonical, canonical, and grand canonical ensembles, Partition functions and thermodynamic properties, Statistical mechanics of molecules
Reference book	

1. Physical Chemistry" by Atkins and De Paula 2. "Quantum Chemistry" by Levine 3. "Spectroscopy" by Banwell and McCash	
Course Name: M.Sc. Chemistry	
Course Code-MCH-104	
Credits-5 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Chemistry	
MCH-104: Spectroscopy and Diffraction Methods	
Student will be able to know	
CO1 Understand fundamental principles of spectroscopy and diffraction methods.	
CO2 Apply spectroscopic techniques for molecular structure elucidation.	
CO3 Analyze diffraction data for crystal structure determination.	
CO4 Understand advanced spectroscopic techniques.	
Course Outline (CO)	
1.Introduction to Spectroscopy	
2. Infrared Spectroscopy	
3. Nuclear Magnetic Resonance Spectroscopy	
4. Ultraviolet-Visible Spectroscopy	
5. Diffraction Methods	
Detailed Syllabus	
1.	Introduction to spectroscopy, Electromagnetic radiation and molecular interactions, Spectroscopic techniques: IR, NMR, UV-Vis

2.	Infrared Spectroscopy: Principles of IR spectroscopy, Instrumentation and sample preparation, IR spectral interpretation
3.	Nuclear Magnetic Resonance Spectroscopy: Principles of NMR spectroscopy, Instrumentation and sample preparation, NMR spectral interpretation
4.	Ultraviolet-Visible Spectroscopy: Principles of UV-Vis spectroscopy, Instrumentation and sample preparation, UV-Vis spectral interpretation
	Diffraction Methods: Introduction to diffraction methods, X-ray diffraction (XRD), Neutron diffraction
5.	Advanced Spectroscopic Techniques: Raman spectroscopy, Mass spectrometry, Nuclear quadrupole resonance spectroscopy
Recommended books	
	1. "Spectroscopy" by Banwell and McCash 2. "Nuclear Magnetic Resonance Spectroscopy" by Sanders and Hunter 3. "X-Ray Diffraction" by Cullity and Stock
Course Name: M.Sc. Chemistry	
Course Code-MCH-104	
Credits-5 (L-18 h/T-18h)	
	Course Outcomes (Cos)
	M.Sc. Chemistry
	MCH-104: Green & Sustainable Chemistry
	Student will be able to know
CO1	Understand principles of green chemistry and sustainability.
CO2	Apply green chemistry principles to chemical synthesis and processes.
CO3	Evaluate environmental impact of chemical processes.
CO4	Develop sustainable solutions for chemical industries
	Course Outline (CO)

1	Introduction to Green Chemistry
2	Green Chemistry Metrics and Assessment
3	Sustainable Solvents and Reactions
4	Renewable Feedstocks and Biomass
5	Green Materials and Products
	Detailed Syllabus
Module 1	Introduction to Green Chemistry: Definition and principles of green chemistry, History and development of green chemistry, Sustainability and environmental impact Green Chemistry Metrics and Assessment :Atom economy and material efficiency, Life cycle assessment (LCA), Environmental impact assessment
Module 2	Sustainable Solvents and Reactions : Alternative solvents (ionic liquids, supercritical fluids), Catalysis and biocatalysis, Green synthesis routes Renewable Feedstocks and Biomass: Biomass conversion and utilization, Renewable energy sources, Biorefineries and bioproducts
Module 3	Green Materials and Products: Bioplastics and biocomposites, Sustainable textiles and dyes, Green coatings and adhesives
Module 4	Case Studies and Applications: Pharmaceutical industry, Agrochemical industry, Energy storage and conversion
Recommended books 1. "Green Chemistry" by Anastas and Kirchhoff 2. "Sustainable Chemistry" by Clark and MacQuarrie 3. "Green Chemistry: Principles and Practice" by Matlack	
Course Name: M.Sc. Chemistry	
Course Code-MCH-106	
Credits-5 (L-18 h/T-18h)	
	Course Outcomes (Cos)

	M.Sc. Chemistry
	MCH-106: Analytical Technique's
	Student will be able to know
CO1	Understand fundamental principles of analytical techniques.
CO2	Apply analytical techniques to qualitative and quantitative analysis.
CO3	Evaluate analytical data and interpret results.
CO4	Develop skills in instrumental analysis
	Course Outline (CO)
1	Introduction to Analytical Chemistry
2	Chromatographic Techniques
3	Spectroscopic Techniques
4	Electro analytical Techniques
5	Mass Spectrometry and Hyphenated Techniques
	Detailed Syllabus
Module 1	Introduction to Analytical Chemistry: Definition and scope of analytical chemistry, Types of analytical techniques, Analytical methodology
Module 2	**Chromatographic Techniques:** Gas chromatography (GC), Liquid chromatography (LC) High-performance liquid chromatography (HPLC)
Module 3	**Spectroscopic Techniques:** Ultraviolet-visible spectroscopy (UV-Vis), Infrared spectroscopy (IR), Nuclear magnetic resonance spectroscopy (NMR)
Module 4	**Electroanalytical Techniques:** Potentiometry, Voltammetry, Coulometry **Advanced Analytical Techniques:** Capillary electrophoresis (CE), Surface-enhanced Raman spectroscopy (SERS), Analytical microscopy
Module 5	**Mass Spectrometry and Hyphenated Techniques : Mass spectrometry (MS), GC-MS and LC-MS, Inductively coupled plasma mass spectrometry (ICP-MS)**
	Recommended books

	1. Analytical Chemistry" by Skoog et al. 2. "Instrumental Methods of Analysis" by Willard et al. 3. "Chromatography and Separation Science" by Miller

Course Name-M.Sc. -1 Year

Course Code-MCH 151 Chemistry Practical

Credits-4 (P-12 h)

Detailed Syllabus (Practical)

1 year

1. Inorganic Chemistry Practical:

- **Qualitative Analysis of Inorganic Mixtures:**
  - Systematic qualitative analysis of binary and ternary mixtures of salts containing both cations and anions.
  - Identification of less common cations like Ti, Zr, Ce, Th, W, Mo, U, Li, etc.
- **Gravimetric Analysis:**
  - Estimation of metals like nickel, copper, barium, or iron in various compounds using gravimetric methods.
  - Precipitation, filtration, drying, and weighing of the desired metal or metal salt.
- **Synthesis and Characterization of Coordination Complexes:**
  - Preparation of metal complexes like $[Ni(NH_3)_6]^{2+}$, $[Cu(NH_3)_4]^{2+}$, or potassium tris(oxalato)ferrate(III).
  - Study of the properties and characterization of complexes through techniques like UV-Vis spectroscopy or IR spectroscopy.
- **Inorganic Preparations:**
  - Synthesis of compounds such as chrome alum, potassium tris(oxalato)chromate(III), and other metal salts.
  - Purification and analysis of the synthesized compounds.

2. Organic Chemistry Practical:

- **Organic Qualitative Analysis:**
  - Identification of organic compounds through preliminary tests, solubility tests, functional group detection, and derivative preparation.
  - Characterization of functional groups like alcohols, aldehydes, ketones, carboxylic acids, phenols, esters, and amines.
- **Organic Synthesis:**
  - Preparation of organic compounds via multi-step synthesis. Examples include the synthesis of aspirin, acetanilide, benzoic acid, or methyl orange.
  - Techniques such as crystallization, distillation, extraction, and reflux are commonly used.
- **Green Chemistry Techniques:**
  - Synthesis of organic compounds using green chemistry methods such as microwave-assisted synthesis or solvent-free synthesis.
- **Chromatography Techniques:**

- Thin-layer chromatography (TLC) for the separation and identification of organic compounds.
- Column chromatography for the purification of organic mixtures.

- **Characterization Techniques:**
  - Melting point determination.
  - Use of spectroscopy (IR, UV-Vis, NMR) to identify and characterize organic compounds.

3. Physical Chemistry Practical:

- **Phase Equilibria:**
  - Determination of critical solution temperature (CST) of phenol-water systems.
  - Construction of phase diagrams for binary liquid systems (e.g., ethanol-water, benzene-toluene mixtures).
- **Electrochemistry Experiments:**
  - Conductometric titration of strong acid with a strong base, weak acid with a strong base, etc.
  - Potentiometric titrations for the determination of pKa, redox potentials, and equivalence points.
  - Study of the kinetics of reactions such as iodine clock reaction or saponification using conductivity or pH measurements.
- **Chemical Kinetics:**
  - Study of reaction rates and determination of order of reactions (e.g., iodination of acetone, decomposition of hydrogen peroxide).
  - Determination of the activation energy of a chemical reaction.
- **Adsorption Studies:**
  - Study of adsorption of acetic acid on charcoal or oxalic acid on activated charcoal.
  - Verification of Freundlich or Langmuir adsorption isotherms.
- **Viscosity and Surface Tension:**
  - Determination of viscosity and surface tension of liquids using viscometers and stalagmometers.
  - Study of the effect of surfactants on the surface tension of solutions.

4. Analytical Chemistry Practical:

- **Volumetric Analysis:**
  - Acid-base titrations (strong acid-strong base, weak acid-strong base, etc.).
  - Redox titrations (potassium permanganate, dichromate, iodometry).
  - Complexometric titrations using EDTA to estimate metal ions like Ca^{2+} and Mg^{2+} in water samples.
- **Instrumental Methods of Analysis:**
  - **Spectrophotometry:** Estimation of iron, manganese, or other metal ions using UV-Visible spectrophotometry.
  - **Flame Photometry:** Determination of sodium and potassium in water samples using flame photometry.
  - **Conductometry:** Conductometric titrations for the determination of the equivalence point in acid-base titrations or precipitation reactions.

- **Potentiometry:** Determination of ion concentrations or pH using a potentiometer.

- **pH-Metric Titrations:**
  - Titration of acids and bases to determine their dissociation constants using pH-metric techniques.
- **Gravimetric Analysis in Environmental Chemistry:**
  - Determination of total dissolved solids (TDS) and suspended particles in water samples.
  - Estimation of sulphate, chloride, and phosphate ions in water using gravimetric methods.

5. Advanced Experiments (Specialized Areas):

- **Synthesis of Nanoparticles:**
  - Preparation and characterization of metal oxide or metal nanoparticles.
- **Environmental Chemistry Experiments:**
  - Analysis of water for chemical oxygen demand (COD), biological oxygen demand (BOD), and heavy metal content.
  - Determination of pollution indicators like nitrate, sulphate, and fluoride ions in environmental samples.
- **Polymer Chemistry:**
  - Synthesis of polymers such as nylon, urea-formaldehyde, or phenol-formaldehyde.
  - Determination of molecular weight of polymers using viscometry or light scattering techniques.

6. Spectroscopy and Instrumental Analysis:

- **UV-Vis Spectroscopy:**
  - Study of absorption spectra of various organic and inorganic compounds.
  - Determination of λ-max and molar extinction coefficients.
- **Infrared (IR) Spectroscopy:**
  - Analysis of functional groups in organic molecules by identifying absorption peaks corresponding to stretching and bending vibrations.
- **Nuclear Magnetic Resonance (NMR):**
  - Interpretation of proton (^{1}H) and carbon (^{13}C) NMR spectra to identify organic compounds.
- **Mass Spectrometry:**
  - Interpretation of mass spectra for molecular ion peaks and fragmentation patterns in organic molecules.

7. Miscellaneous Experiments:

- **Photochemical Reactions:**
  - Study of photochemical reactions like the synthesis of benzopinacol from benzophenone.
- **Colloidal Chemistry:**
  - Preparation of colloids and study of their properties like Tyndall effect,

		Brownian motion, and coagulation

Course Name: M.Sc. Chemistry	
Course Code-MCH-201	
Credits-5 (L-18 h/T-18h)	
Course Outcomes (Cos)	
	M.Sc. Chemistry (2nd Yr)
	MCH-201: Applications of Spectroscopy, Photochemistry and Solid State Chemistry
	Student will be able to know
CO1	Understand advanced applications of spectroscopy.
CO2	Apply photochemical principles to molecular systems.

CO3	Analyze solid-state materials using spectroscopic techniques.
CO4	Develop skills in interpreting spectroscopic data.
	Course Outline (CO)
1	Advanced Spectroscopic Applications
2	Photochemistry
3	Solid State Chemistry
4	Spectroscopy of Solid-State Materials
5	Case Studies and Research Trends

Detailed Syllabus

Module 1	Advanced Spectroscopic Applications: Multidimensional NMR spectroscopy, FT-IR and FT-Raman spectroscopy, UV-Vis spectroscopy of transition metal complexes, Spectroelectrochemistry
Module 2	Photochemistry: Principles of photochemistry, Photochemical reactions and mechanisms, Photocatalysis and solar energy conversion, Photochemical synthesis
Module 3	Solid State Chemistry: Crystal structures and bonding, Solid-state spectroscopy (XRD, SEM, TEM), Electrical and magnetic properties, Nanomaterials and nanotechnology
Module 4	Spectroscopy of Solid-State Materials: Vibrational spectroscopy of solids, NMR spectroscopy of solids, Optical spectroscopy of solids, Applications in materials scienc
Module 5	Case Studies and Research Trends: Spectroscopic studies of biomolecules, Photochemical applications in medicine, Solid-state materials for energy storage, Recent advances in spectroscopy and photochemistry

Recommended Books

1	Spectroscopy of Organic Compounds" by Pavia et al.
2	Photochemistry" by Turro et al.
3	"Solid State Chemistry" by West et al.

Course Name: M.Sc. Chemistry

Course Code-MCH-202

Credits-5 (L-18 h/T-18h)	
	Course Outcomes (Cos)
	M.Sc. Chemistry
	MCH-202: Bioinorganic, Bioorganic and Biophysical Chemistry
	Student will be able to know
CO1	Understand bioinorganic, bioorganic, and biophysical principles.
CO2	Apply biochemical concepts to biological systems.
CO3	Analyze biomolecules using spectroscopic techniques.
CO4	Develop skills in biochemical research
	Course Outline (CO)
1	Bioinorganic Chemistry
2	Bioorganic Chemistry
3	Biophysical Chemistry
4	Advanced Topics
5	Case Studies and Research Trend
Detailed Syllabus	
Module 1	Bioinorganic Chemistry: Introduction to bioinorganic chemistry, Metal ion coordination in biology, Biomineralization and biomaterials, Metalloenzymes and metalloproteins
Module 2	Bioorganic Chemistry: Biomolecular structure and function, Enzyme mechanisms and kinetics, Biosynthesis and biochemical pathways, Medicinal chemistry and drug design
Module 3	Biophysical Chemistry: Introduction to biophysical chemistry, Thermodynamics of biological systems, Spectroscopic methods (NMR, IR, CD), X-ray crystallography and cryo-EM
Module 4	Bioinorganic chemistry of disease: Bioorganic chemistry of natural products, Biophysical chemistry of membrane proteins, Single-molecule biophysics
Module 5	Case Studies and Research Trends: Biochemical applications in medicine, Biotechnology and bioprocessing, Bioenergy and biofuels, Recent advances in bioinorganic, bioorganic, and biophysical chemistry

Recommended Books:
1. "Bioinorganic Chemistry" by Bertini et al.
2. "Bioorganic Chemistry" by Wulff et al.
3. "Biophysical Chemistry" by Cantor and Schimmel

Course Name: M.Sc. Chemistry

Course Code-MCH-205

Credits-5 (L-18 h/T-18h)

	Course Outcomes (Cos)
	M.Sc. Chemistry
	MCH-203: Environmental Chemistry
	Student will be able to know
CO1	Understand environmental chemical principles.
CO2	Analyze environmental pollution and remediation.
CO3	Apply green chemistry concepts to environmental issues.
CO4	Develop skills in environmental monitoring and management.
	Course Outline (CO)
1	Introduction to Environmental Chemistry
2	Air and Water Pollution
3	Soil and Solid Waste Pollution
4	Green Chemistry and Sustainability
5	Environmental Monitoring and Analysis
Detailed Syllabus	
Module 1	Introduction to Environmental Chemistry: Definition and scope of environmental chemistry, Environmental pollutants and impacts, Environmental legislation and policies
Module 2	Air and Water Pollution: Air pollution chemistry and monitoring, Water pollution chemistry and treatment, Wastewater management and reuse
Module 3	Soil and Solid Waste Pollution: Soil pollution and remediation, Solid waste management and disposal, Hazardous waste handling and treatment

Module 4	Green Chemistry and Sustainability: Principles of green chemistry, Sustainable materials and processes, Environmental life cycle assessment
Module 5	Environmental Monitoring and Analysis: Environmental sampling and analysis, Chromatographic and spectroscopic methods, Environmental modeling and simulation
Module 6	Case Studies and Research Trends: Climate change and chemical impacts Emerging contaminants and pollutants, Environmental nanotechnology

Recommended Books

1. Environmental Chemistry" by Manahan
2. "Green Chemistry" by Anastas and Kirchhoff
3. "Environmental Analysis" by Valcarcel and Rios

Course Name: M.Sc. Chemistry

Course Code-MCH-204

Credits-5 (L-18 h/T-18h)

	Course Outcomes (Cos)
	M.Sc. Chemistry
	MCH-204: Analytical Chemistry
	Student will be able to know
CO1	Understand advanced analytical techniques.
CO2	Apply chromatographic and spectroscopic methods.
CO3	Analyze complex samples using hyphenated techniques.
CO4	Develop skills in method validation and quality control.
	Course Outline (CO)
1	Advanced Chromatography
2	Spectroscopic Techniques
3	Hyphenated Techniques
4	Method Validation and Quality Control
5	Advanced Analytical Techniques

Detailed Syllabus	
Module 1	Advanced Chromatography: Gas chromatography-mass spectrometry (GC-MS), Liquid chromatography-mass spectrometry (LC-MS), Supercritical fluid chromatography (SFC)
Module 2	Spectroscopic Techniques: Nuclear magnetic resonance spectroscopy (NMR), Fourier transform infrared spectroscopy (FT-IR), Raman spectroscopy
Module 3	Hyphenated Techniques: GC-MS/MS and LC-MS/MS, Inductively coupled plasma mass spectrometry (ICP-MS), Capillary electrophoresis-mass spectrometry (CE-MS)
Module 4	Method Validation and Quality Control: Method validation parameters, Quality control and quality assurance, Good laboratory practice (GLP)
Module 5	Advanced Analytical Techniques: Surface-enhanced Raman spectroscopy (SERS), Single-molecule detection, Microfluidics and lab-on-a-chip
Module 6	Case Studies and Research Trends: Applications in pharmaceuticals, Environmental monitoring and analysis, Food safety and analysis ,Recent advances in analytical chemistry
Reference Books	
1. Analytical Chemistry" by Skoog et al. 2. "Chromatography and Separation Science" by Miller 3. "Spectroscopy in Environmental Science" by Banwell and McCash	
Course Name: M.Sc. Chemistry	
Course Code-MCH-205	
Credits-5 (L-18 h/T-18h)	
	Course Outcomes (Cos)
	M.Sc. Chemistry
	MCH-204: Physical Organic Chemistry
	Student will be able to know
CO1	Understand physical organic principles.
CO2	Apply quantum mechanics to organic reactions.
CO3	Analyze reaction mechanisms and transition states.
CO4	Develop skills in computational chemistry
	Course Outline (CO)

1	Quantum Mechanics and Organic Chemistry
2	Reaction Mechanisms and Transition States
3	Stereochemistry and Reaction Dynamics
4	Computational Chemistry
5	Advanced Topics in Physical Organic Chemistry
Detailed Syllabus	
Module 1	Quantum Mechanics and Organic Chemistry :Introduction to quantum mechanics, Molecular orbital theory, Application to organic reactions
Module 2	Reaction Mechanisms and Transition States : Concerted and stepwise reactions, Transition state theory, Hammond postulate and Bell-Evans-Polanyi principle
Module 3	Stereochemistry and Reaction Dynamics: Stereochemical principles, Reaction dynamics and kinetics, Catalysis in organic reactions
Module 4	Computational Chemistry: Introduction to computational methods, Molecular mechanics and molecular dynamics, Density functional theory (DFT) and ab initio methods
Module 5	Advanced Topics in Physical Organic Chemistry : Photochemical reactions, Radical reactions and spin chemistry, Organic electronic materials
Recommended Books	
1. "Physical Organic Chemistry" by Anslyn and Dougherty 2. "Organic Reaction Mechanisms" by Lowry and Richardson 3. "Computational Organic Chemistry" by Cramer	
Course Name: M.Sc. Chemistry	
Course Code-MCH-206	
Credits-5 (L-18 h/T-18h)	
	Course Outcomes (Cos)
	M.Sc. Chemistry
	MCH-206: Chemical Dynamics
	Student will be able to know
CO1	Understand chemical dynamics principles.
CO2	Apply classical and quantum mechanics to chemical reactions.

CO3	Analyze reaction kinetics and dynamics.
CO4	Develop skills in computational chemical dynamics
	Course Outline (CO)
1	Classical Dynamics
2	Quantum Dynamics
3	Reaction Kinetics and Dynamics
4	Computational Chemical Dynamics
5	Advanced Topics in Chemical Dynamics
Detailed Syllabus	
Module 1	**Classical Dynamics:** Introduction to classical dynamics, Hamilton's equations and phase space, Trajectory calculations
Module 2	**Quantum Dynamics:** Introduction to quantum dynamics, Schrödinger equation and wave packet dynamics, Quantum scattering theory
Module 3	**Reaction Kinetics and Dynamics:** Reaction rate theory, Transition state theory, Reaction dynamics and molecular collisions
Module 4	**Computational Chemical Dynamics:** Introduction to computational methods, Molecular dynamics simulations, Quantum chemical calculations
Module 5	**Advanced Topics in Chemical Dynamics:** Non-equilibrium dynamics, Chaos and complexity in chemical reactions, Ultrafast dynamics and spectroscopy
Recommended Books	
1. Chemical Dynamics" by Levine and Bernstein 2. "Classical and Quantum Dynamics" by Dittrich et al. 3. "Computational Chemical Dynamics" by Thompson	
Course Name: M.Sc. Chemistry	
Course Code-MCH-207	
Credits-5 (L-18 h/T-18h)	
	Course Outcomes (Cos)
	M.Sc. Chemistry
	MCH-207: Electro Chemistry

	Student will be able to know
CO1	Understand advanced electrochemical principles.
CO2	Apply electrochemical techniques to analytical and industrial problems.
CO3	Analyze electrochemical reactions and interfaces.
CO4	Develop skills in electrochemical research and development.
	Course Outline (CO)
1	Fundamentals of Electrochemistry
2	Electro analytical Techniques
3	Electrochemical Interfaces
4	Electrochemical Energy Storage
5	Advanced Electrochemical Topics
Detailed Syllabus	
Module 1	Fundamentals of Electrochemistry: Electrochemical cells and potentials, Electrode kinetics and reaction mechanisms, Electrochemical thermodynamics
Module 2	Electroanalytical Techniques :Voltammetry and polarography, Electrochemical impedance spectroscopy (EIS), Electrochemical quartz crystal microbalance (EQCM)
Module 3	Electrochemical Interfaces :Electrode-solution interfaces, Surface modification and functionalization, Electrochemical scanning tunneling microscopy (EC-STM)
Module 4	Electrochemical Energy Storage: Batteries and fuel cells, Electrochemical capacitors and supercapacitors, Electrochemical energy storage materials
Module 5	Advanced Electrochemical Topics: Electrochemical synthesis and processing Electrochemical biosensors and bioelectronics, Electrochemical water splitting and hydrogen production
Recommended Books	
1. "Electrochemistry" by Bard and Faulkner 2. "Electroanalytical Chemistry" by Kissinger and Heineman 3. "Electrochemical Interfaces" by Schmickler and Santos	

Course Name: M.Sc. Chemistry	
Course Code-MCH-207	
Credits-5 (L-18 h/T-18h)	
	Course Outcomes (Cos)
	M.Sc. Chemistry
	MCH-207: Electro Chemistry
	Student will be able to know
CO1	Understand advanced electrochemical principles and techniques.
CO2	Apply electrochemical methods to analytical and industrial problems.
CO3	Analyse electrochemical reactions and interfaces.
CO4	Develop skills in electrochemical research and development
	Course Outline (CO)
1	Fundamentals of Electrochemistry
2	Electroanalytical Techniques
3	Electrochemical Interfaces
4	Electrochemical Energy Storage
5	Advanced Electrochemical Topics
Detailed Syllabus	
Module 1	Fundamentals of Electrochemistry: Electrochemical cells and potentials, Electrode kinetics and reaction mechanisms, Electrochemical thermodynamics
Module 2	Electroanalytical Techniques :Voltammetry and polarography, Electrochemical impedance spectroscopy (EIS), Electrochemical quartz crystal microbalance (EQCM)
Module 3	Electrochemical Interfaces: Electrode-solution interfaces, Surface modification and functionalization, Electrochemical scanning tunneling microscopy (EC-STM)
Module 4	Electrochemical Energy Storage: Batteries and fuel cells, Electrochemical capacitors and supercapacitors, Electrochemical energy storage materials

Module 5	Advanced Electrochemical Topics: Electrochemical synthesis and processing, Electrochemical biosensors and bioelectronics, Electrochemical water splitting and hydrogen production

Recommended Books

1. "Electrochemistry" by Bard and Faulkner
2. "Electroanalytical Chemistry" by Kissinger and Heineman
3. "Electrochemical Interfaces" by Schmickler and Santos

Course Name: M.Sc. Zoology

Course Code- MZO 101

Credits- (L-18 h/T-18h)

	Course Outcomes (Cos)
	M.Sc. Zoology
	MZO-101: Biosystematics & Taxonomy
	Student will be able to know
CO1	Understand principles of biosystematics and taxonomy.
CO2	Apply phylogenetic analysis and molecular systematics.
CO3	Identify and classify organisms using morphological and molecular characters.
CO4	Develop skills in taxonomic research and publication
	Course Outline (CO)
1	Phylogenetics and Systematics
2	Taxonomic Principles
3	Morphological and Molecular Systematics
4	Advanced Taxonomic Techniques
5	Case Studies and Research Trends

Detailed Syllabus

Module 1	Phylogenetics and Systematics: Introduction to phylogenetics, Molecular systematics and DNA barcoding, Phylogenetic reconstruction methods
Module 2	Taxonomic Principles: Species concepts and delimitation, Taxonomic ranks and nomenclature, Character analysis and homology

Module 3	Morphological and Molecular Systematics: Morphological systematics and character analysis, Molecular systematics and DNA sequencing, Integrative taxonomy
Module 4	Advanced Taxonomic Techniques: Electron microscopy and micro-CT scanning, Bioinformatics and phylogenetic software, Molecular phylogenetics and coalescent methods
Module 5	Case Studies and Research Trends: Taxonomy of major plant and animal groups, Conservation biology and taxonomic implications, Recent advances in biosystematics and taxonomy

Recommended Books (All Latest Editions)

1. Biosystematics: Principles and Practice" by D. L. Hull
2. "Taxonomy and Phylogeny of Animals" by A. R. Maggenti
3. "Systematic Zoology" by A. S. Romer
4. "Biosystematics and Taxonomy" by G. L. Stebbins
5. "Principles of Animal Taxonomy" by E. Mayr and W. V. Provine

Reference Books:

1. "Animal Kingdom" by T. E. Bolton
2. "Invertebrate Zoology" by E. E. Ruppert and R. D. Barnes
3. "Vertebrate Zoology" by A. S. Romer
4. "Phylogenetic Analysis" by J. Felsenstein
5. "Molecular Systematics" by D. M. Hillis and C. Moritz

Course Name: M.Sc. Zoology

Course Code- MZO 102

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. Zoology

MZO-102: Structure & Function of Invertebrates

Student will be able to know

CO1	Understand the diversity of invertebrate body structure and function.
CO2	Analyze the evolutionary relationships among invertebrate groups.
CO3	Explain the adaptations of invertebrates to different environments.
CO4	Develop skills in morphological and functional analysis of invertebrates
	Course Outline (CO)

1	Introduction to Invertebrates
2	Body Structure and Function
3	Invertebrate Phyla
4	Functional Morphology
5	Ecological and Evolutionary Aspects

Detailed Syllabus

Module 1	Introduction to Invertebrates : Definition and classification of invertebrate, Evolutionary relationships among invertebrates, Overview of invertebrate diversity
Module 2	Body Structure and Function: Body cavities and embryonic development, Muscular and skeletal systems, Nervous and sensory systems, Circulatory and respiratory systems
Module 3	Invertebrate Phyla: Porifera and Cnidaria, Platyhelminthes and Nematoda, Mollusca and Annelida, Arthropoda and Echinodermata
Module 4	Functional Morphology: Locomotion and movement, Feeding and digestion, Respiration and osmoregulation, Reproduction and development
Module 5	Ecological and Evolutionary Aspects: Invertebrate ecology and behaviour, Evolutionary adaptations to different environments, Invertebrate conservation biology

Recommended books:

1. "Invertebrate Zoology" by Brusca and Brusca
2. "Functional Morphology of Invertebrates" by Westheide and Rieger
3. "Invertebrate Biology" by Edwards and Bohlen

Course Name: M.Sc. Zoology

Course Code- MZO 103

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. Zoology

MZO-103: Molecular Biology & Biotechnology

Student will be able to know

CO1	Understand advanced molecular biology techniques.

CO2	Apply biotechnology principles to real-world problems.
CO3	Analyze genomic and proteomic data.
CO4	Develop skills in molecular biology research and development
	Course Outline (CO)
1	Advanced Molecular Biology Techniques
2	Genomics and Proteomics
3	Biotechnology Applications
4	Molecular Biology of Diseases
5	Biotechnology and Society

Detailed Syllabus

Module 1	Advanced Molecular Biology Techniques: DNA sequencing and genotyping, Gene editing (CRISPR/Cas9), RNA interference and gene silencing
Module 2	Genomics and Proteomics : Genome assembly and annotation, Proteomic analysis and mass spectrometry, Bioinformatics tools for genomics and proteomics
Module 3	Biotechnology Applications: Gene therapy and genetic engineering, Stem cell biology and regenerative medicine, Synthetic biology and metabolic engineering
Module 4	Molecular Biology of Diseases : Cancer biology and oncogenomics, Infectious diseases and immunology, Neurological disorders and neurogenetics
Module 5	Biotechnology and Society: Ethics and regulations in biotechnology, Intellectual property and patenting,Biotechnology entrepreneurship and innovation

Recommended books

1. Molecular Biology" by Alberts et al.
2. "Biotechnology" by Smith
3. "Genomics and Proteomics" by Sanders and Burke

Course Name: M.Sc. Zoology

Course Code- MZO 104

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. Zoology	
MZO-104: General Physiology	
Student will be able to know	
CO1	Understand advanced physiological concepts.
CO2	Analyse physiological processes at molecular, cellular, and systems levels.
CO3	Apply physiological principles to real-world problems
CO4	Develop skills in physiological research and experimentation
	Course Outline (CO)
1	Cellular Physiology
2	Neurophysiology
3	Cardiovascular Physiology
4	Respiratory Physiology
5	Renal Physiology
Detailed Syllabus	
Module 1	Cellular Physiology: Membrane transport and signalling, Cellular excitability and electrical properties, Cellular homeostasis and regulation
Module 2	Neurophysiology : Neural signaling and transmission, Sensory and motor systems, Neuroplasticity and adaptation
Module 3	Cardiovascular Physiology : Cardiac function and regulation, Vascular physiology and blood flow, Blood pressure regulation and hypertension
Module 4	Respiratory Physiology : Pulmonary function and gas exchange, Respiratory control and regulation, Respiratory disorders and diseases
Module 5	Renal Physiology : Kidney function and regulation, Renal transport and electrolyte balance, Urine formation and concentration
Recommended books **1.** "Physiology" by Berne and Levy 2. "Human Physiology" by Guyton and Hall 3. "Physiological Reviews" journal	

Course Name: M.Sc. Zoology	
Course Code- MZO 105	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology	
MZO-105: Biochemistry	
Student will be able to know	
CO1	Understand advanced biochemical concepts.
CO2	Analyse biochemical processes at molecular and cellular levels.
CO3	Apply biochemical principles to real-world problems.
CO4	Develop skills in biochemical research and experimentation
	Course Outline (CO)
1	Structural Biochemistry
2	Metabolic Biochemistry
3	Molecular Biology and Gene Expression
4	Bioenergetics and Signal Transduction
5	Biomedical Biochemistry
Detailed Syllabus	
Module 1	Structural Biochemistry: Protein structure and function, Nucleic acid structure and function, Membrane structure and function
Module 2	Metabolic Biochemistry: Glycolysis and gluconeogenesis, Citric acid cycle and oxidative phosphorylation, Lipid metabolism and regulation
Module 3	Molecular Biology and Gene Expression: DNA replication and repair, Transcriptional regulation and control, Post-translational modification and protein regulation
Module 4	Bioenergetics and Signal Transduction: Energy metabolism and ATP production, Signal transduction pathways and cellular responses, Hormone regulation and cellular signaling
Module 5	Biomedical Biochemistry: Cancer biochemistry and molecular mechanisms, Neurodegenerative diseases and biochemical basis, Biochemical basis of infectious diseases

Recommended books	
1. Biochemistry" by Lehninger 2. Biochemistry and Molecular Biology" by Elliott and Elliott 3. "Journal of Biological Chemistry" and "Biochemistry" journals	
Course Name: M.Sc. Zoology	
Course Code- MZO 106	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology	
MZO-106: Quantitative Biology and Population Genetics	
Student will be able to know	
CO1	Understand quantitative methods in biology.
CO2	Analyze population genetic data.
CO3	Apply statistical and computational tools to biological problems.
CO4	Develop skills in research design and data analysis
	Course Outline (CO)
1	Quantitative Biology
2	Population Genetics
3	Quantitative Genetics
4	Phylogenetics and Evolutionary Genetics
5	Computational Biology and Bioinformatics
Detailed Syllabus	
Module 1	Inheritance And Allelism, Inheritance Of Chromosome Principle, Mendelian Law, Organelles Inheritance, Mitochondrial, chloroplasts Genome, Development, structure And Organization. 8 Cytogenetics, Chromosome, structure And Naming, Centromere And Telomere, gender Determination, Mechanism, gender Chromosome, Chromosomal Aberrations, revision, Disadvantages, Deletion, Inverse, Interchanges,

Module 2	Transfer, Crop Development In Chromosome Aberrations of Role, Ploidy Change, Haploids, Polyploids And Aneuploids. Jean of fine structure, concept, CIS, Trans tests. Jean interaction, Supplement, Supplement, Epistasis, Duplicate Jean.
Module 3	Mutations And Mutations, Simple And Inspired Mutations, Physical And Chemical Mutations, Mutations Of Type, Mutations Of molecular Base, Transposons And Mutations And site directed Mutations In their Use, practical Genetics, population Genetics And Quantitative Genetics. 1
Module 4	Chromosomes Mappings, Linkage And Crossings Over, Basic Concepts, Linkage Map, Genetic And Physical Maps Of Correlation, molecular Marker And Linkage Maps Of Construction, Recombination Of molecular Mechanism
Module 5	Molecular Cytogenetics, C Value contraindications, Cot Curve And Its Importance, Multigene Family And their Development, in situ Hybridization, concept And Technique, Flow Cytometry

Recommended books

Benjamin Levin (2000).JeanVII.Oxford University Press.

Gardner E J,Simmons M J,Snustad D P(1991), Genetics Of Principle,Third version,, John Willy End sons Inc,

Snustad D P,Simmons M J(2000), Genetics Of Principle,Third version,, John Willy End sons.

Strickberger(2005).Genetics,Third version,, Prentiss Hall Off India Pvt,Limited

William S Klug,Michael R Cummings(1994), Genetics of Concepts,disciple Room.

Robert J Brooker(2009), Genetics,Analysis And Principle(IIIversion,, McGrath Hill,

Daniel l Hartl,Elizabeth W Jones(2009), Genetics,Jean And Genome Of Analysis(VIIversion,, Jones And Bartlett Publisher.

D Peter Snustad,Michael J Simmons(2010), Genetics Of Principle,V version,, John Willy End sons.

Course Name- M.Sc -1 Year

Course Code- MZO 151: Biosystematics and Taxonomy (P)

Credits-2 (P-12 h)

Detailed Syllabus (Practical)

	Introduction to Taxonomy: Overview of biosystematics and taxonomy, Importance of classification systems, Familiarization with taxonomic hierarchy. **Collection Techniques:** Field collection methods for plants and animals, Sample preservation techniques, Ethical considerations in biological collection. **Morphological Identification:** Use of dichotomous keys, Identification of local flora and fauna, Practice with morphological characteristics. **Molecular Techniques in Taxonomy:** Introduction to DNA barcoding, PCR techniques for species identification, Gel electrophoresis basics. **Phylogenetics**: Understanding phylogenetic trees, Software tools for phylogenetic analysis (e.g., MEGA, BEAST), Hands-on analysis of genetic data. **Data Analysis and Interpretation:** Statistical methods in biosystematics, Using software for data visualization, Interpretation of results from morphological and molecular data. **Biodiversity Assessment:** Techniques for assessing biodiversity, Field sampling methods, Data collection and management.

Course Name-M.Sc -1 Year
Course Code- MZO 152: Structure and Function of Invertebrates (P)
Credits-2 (P-12 h)
Detailed Syllabus (Practical)
Introduction to Invertebrates Activity: Overview of invertebrate diversity, **Porifera (Sponges)**: **Activity:** Examine the structure of sponges, **Cnidaria (Jellyfish, Corals)**, **Platyhelminthes (Flatworms)**, **Nematoda (Roundworms)**
Course Name: M.Sc. Zoology
Course Code- MZO153:**Molecular Biology and Biotechnology (P)**
Credits- 02 (P-12 h/T-18h)
Detailed Syllabus (Practical)
Introduction to Molecular Biology Techniques: Understand laboratory safety, sterile techniques, and basic laboratory equipment. **DNA Extraction:** Extract DNA from various biological samples (e.g., plant, animal, bacterial). **Agarose Gel Electrophoresis:** Visualize DNA fragments. **Polymerase Chain Reaction (PCR):** Amplify specific DNA sequences. **Cloning Techniques:** Perform cloning using plasmids.
Course Name: M.Sc. Zoology

Course Code- MZO 201	
Credits- 04 (L-18 h/T-18h)	
Detailed Syllabus (Practical)	
MZO201- Biology of Chordates	
Student will be able to know	
CO1	Understand chordate evolution and diversity.
CO2	Analyse chordate body structure and function
CO3	Apply comparative anatomical and embryological principles.
CO4	Develop skills in chordate systematics and research
Course Outline (CO)	
1	Chordate Evolution and Diversity
2	Chordate Body Structure and Function
3	Comparative Anatomy of Chordates
4	Vertebrate Biology
5	Chordate Systematics and Phylogeny
Detailed Syllabus	
Module 1	Chordate Evolution and Diversity: Origin and evolution of chordates, Chordate phylogeny and classification, Diversity of chordate groups (tunicates, lancelets, vertebrates)
Module 2	Chordate Body Structure and Function: Nervous system and sensory organs, Muscular and skeletal systems, Circulatory and respiratory systems, Digestive and excretory systems
Module 3	Comparative Anatomy of Chordates: Comparative embryology of chordates, Developmental biology of vertebrates, Homology and analogy in chordate morphology
Module 4	Vertebrate Biology: Fish biology and diversity, Amphibian and reptile biology, Bird and mammal biology
Module 5	Chordate Systematics and Phylogeny : Molecular phylogenetics of chordates, Chordate biogeography and dispersal, Chordate fossil record and evolution
Recommended books	

1. Chordate Evolution" by Gee 2. "Vertebrate Biology" by Kardong 3. "Biology of Chordates" by Barnes	
Course Name: M.Sc. Zoology	
Course Code- MZO 202	
Credits- 04 (L-18 h/T-18h)	
Detailed Syllabus (Practical)	
MZO201-: Environmental Biology and Ethology	
Student will be able to know	
CO1	Understand environmental factors influencing biological systems.
CO2	Analyze animal behavior and ecological interactions.
CO3	Apply conservation biology principles.
CO4	Develop skills in environmental research and management
	Course Outline (CO)
1	Environmental Biology
2	Ethology and Animal Behavior
3	Conservation Biology
4	Ecological Interactions and Networks
5	Environmental Policy and Management
Detailed Syllabus	
Module 1	Structure, Functions and types of ecosystem - Trophic structures, Food chains, Food web, Energy flow and Ecological pyramids.
Module 2	Abiotic factors, Soil organisms, Biological effects of light, and temperature, Thermal stratification, Concept of limiting factors, Shelford's law of tolerance and ecotypes - Grassland and Pond ecosystem.
Module 3	Divisions of marine environment, Physical and chemical properties of seawater, Major and minor elements, Primary and secondary production, Estimation and factors influencing productivity; Adaptation of plankton, Red tide, Inter tidal and deep sea ecology.
Module 4	Unique features of Coral Reefs, Seaweeds, Seagrasses; Mangroves and estuaries, Biosphere: Types - Hydrosphere, Lithosphere and Atmosphere, General account of complete and incomplete cycle; Gaseous cycle Carbon, Nitrogen and Oxygen cycles.

Module 5	Sedimentary cycle: Phosphorus and Sulphur cycles, The population concept, Natality, Mortality, Growth rate, Population density and Age distribution, Carrying capacity, Fluctuation and Regulation.
Module 6	Community structure, Ecotone and edge effects, Ecological niche, Ecological succession, Climax community - Monoclimax and polyclimax theories. Air, Water and Soil pollution - Their biological effects - Pollution control measures; Climatic changes - Green house effects, Global warming; Bioremediation and environmental awareness

Recommended books

Environmental Biology & Ethology (M.Sc. One Week Series) (Zoology) By Parth Publishers

Course Name: M.Sc. Zoology

Course Code- MZO 203

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. Zoology 2nd Yr

MZO201-: Genes and Differentiation

Student will be able to know

CO1	Understand gene regulation and expression.
CO2	Analyze cellular differentiation and development.
CO3	Apply molecular biology techniques.
CO4	Develop skills in research design and data analysis
	Course Outline (CO)
1	Gene Regulation and Expression
2	Cellular Differentiation and Development
3	Molecular Biology Techniques
4	Developmental Biology and Disease
5	Gene Networks and Systems Biology

Detailed Syllabus

Module 1	Gene Regulation and Expression :Transcriptional regulation and control, Post-transcriptional regulation and RNA processing, Epigenetic regulation and chromatin remodeling
Module 2	Cellular Differentiation and Development : Stem cell biology and pluripotency, Cell fate determination and differentiation, Pattern formation and morphogenesis
Module 3	Molecular Biology Techniques :Gene cloning and expression vectors, PCR and qPCR techniques, Gene editing and CRISPR/Cas9
Module 4	Developmental Biology and Disease: Developmental disorders and birth defects, Cancer and cellular differentiation, Regenerative medicine and tissue engineering
Module 5	Gene Networks and Systems Biology : Gene regulatory networks and modelling, Systems biology and synthetic biology, Bioinformatics and computational tools

Recommended books

1. "Molecular Biology of the Cell" by Alberts et al.
2. "Genes and Development" by Gilbert
3. "Stem Cell Biology" by Marshak et al.

Course Name: M.Sc. Zoology

Course Code- MZO 204

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. Zoology 2nd Yr

MZO204-: Tools and Techniques in Biology

Student will be able to know

CO1	Understand the basic structure and function of cells and their organelles.
CO2	Explore the molecular basis of gene expression and regulation.
CO3	Analyze cell signaling pathways and their role in cell function
CO4	Learn modern techniques in molecular biology and biotechnology.
CO5	Develop critical thinking skills in experimental design and data interpretation
	Course Outline (CO)
1	Introduction to Cell and Molecular Biology

2	Cell Structure and Function
3	DNA, Chromosomes, and the Nucleus
4	DNA Replication and Repair
5.	Transcription and RNA Processing

Detailed Syllabus	
Module 1	**Introduction to Cell and Molecular Biology:** Overview of the cell theory**,** Prokaryotic vs. eukaryotic cells**,** Overview of macromolecules (proteins, nucleic acids, lipids, carbohydrates)
Module 2	**Cell Structure and Function:** Structure and function of cellular organelles (nucleus, mitochondria, ER, Golgi, etc.)**,** Plasma membrane and transport mechanisms**,** Cytoskeleton and cell movement
Module 3	**DNA, Chromosomes, and the Nucleus:** DNA structure and function**,** Chromosomal organization, Nucleosomes and chromatin**,** The nucleus and nuclear pore complexes
Module 4	**DNA Replication and Repair:** Mechanism of DNA replication**,** Enzymes involved in DNA replication (helicase, polymerase, ligase, etc.)**,** DNA damage and repair mechanisms (mismatch repair, base excision, NER)
Module 5	**Transcription and RNA Processing:** Gene expression and regulation**,** RNA synthesis (transcription)**,** Post-transcriptional modifications (capping, splicing, polyadenylation)

Recommended books
Molecular Biology of the Cell by Alberts et al. Molecular Cell Biology by Lodish et al. The Cell: A Molecular Approach by Cooper and Hausman
Course Name: M.Sc. Zoology
Course Code- MZO 205
Credits- 04 (L-18 h/T-18h)
Course Outcomes (Cos)
M.Sc. Zoology 2nd Yr
MZO205-: Cell and Molecular Biology
Student will be able to know

CO1	Understand Cellular Structure and Function: Gain a comprehensive understanding of the structure, organization, and function of cells, including prokaryotic and eukaryotic cells.
CO2	Explore Molecular Mechanisms: Examine the molecular mechanisms governing the functioning of cells, focusing on processes like DNA replication, transcription, translation, and protein synthesis.
CO3	Learn about Cellular Communication: Understand how cells communicate with each other and respond to their environment through signaling pathways, receptors, and molecular signals.
CO4	Understand Genetic Regulation: Explore how gene expression is regulated at the molecular level, including epigenetic regulation, transcriptional control, and post-transcriptional modifications.
	Course Outline (CO)
1	Developmental Biology Principles of development
2	Neurobiology
3	Cancer Biology

Detailed Syllabus	
Module 1	Developmental Biology Principles of development (growth, differentiation, and morphogenesis) Molecular mechanisms controlling development Early embryogenesis in model organisms (Drosophila, Zebrafish, Mouse) Stem cell biology and regenerative medicine Developmental disorders and their molecular basis
Module 2	Neurobiology: Structure and function of neurons and glia, Molecular basis of synaptic transmission and plasticity, Neurogenesis and neural stem cells, Neurodegenerative diseases (Alzheimer's, Parkinson's), Techniques in neuroscience (electrophysiology, brain imaging)
Module 3	Cancer Biology: Hallmarks of cancer: genetic and molecular alterations, Oncogenes, tumor suppressors, and cell signaling in cancer, Cancer metastasis and angiogenesis Apoptosis and autophagy in cancer, Cancer therapy: chemotherapy, radiation, and targeted therapies
Module 4	Biotechnology: Recombinant DNA technology in medicine and agriculture, Industrial enzymes and bioprocessing, Genetically modified organisms (GMOs), Biopharmaceuticals and gene therapy, Ethical and regulatory aspects of biotechnology

Recommended books

1.**Molecular Biology: Principles of Genome Function"** by Nancy Craig, Rachel Green, and Carol Greider
2.**"The Biology of Cancer"** by Robert A. Weinberg

Course Name: M.Sc. Zoology	
Course Code- MZO 206	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology 2nd Yr	
MZO206-: Fish Biology	
Student will be able to know	
CO1	Understanding Fish Taxonomy and Diversity
CO2	Knowledge of Fish Anatomy and Physiology
CO3	Fish Behavior and Ecology
CO4	Fish Habitats and Environmental Adaptations
CO5	Conservation and Fisheries Management
CO6	Research and Data Collection Techniques
	Course Outline (CO)
1	Introduction to Fish Biology
2	Fish Evolution and Taxonomy
3	Fish Anatomy I& II – External & Internal Structures
4	Fish Physiology
Detailed Syllabus	
Module 1	**Introduction to Fish Biology:** Overview of fish diversity and distribution**,** Fish taxonomy and classification**,** Evolution of fishes: From jawless fish to teleosts
Module 2	**Fish Anatomy:** External and internal anatomy**,** Skeletal, muscular, and nervous systems Special sensory systems (lateral line, electroreception)
Module 3	**Fish Physiology I:** Respiratory system: Gills and gas exchange**,** Circulatory system: Blood circulation and heart anatomy**,** Osmoregulation: Saltwater vs. freshwater adaptations **Fish Physiology II:** Reproductive strategies (external fertilization, oviparity, viviparity) Growth patterns: Indeterminate growth and age estimation, Hormonal control and metabolism
Module 4	**Fish Behavior:** Mating systems and parental care**,** Schooling, migration, and feeding behavior Communication and territoriality

Module 5	**Evolution and Adaptation in Fishes:** Adaptive radiation and speciation Evolution of jawed and jawless fishes**,** Adaptations to extreme environments (deep sea, polar regions)
Recommended books	
Primary Textbook: *The Biology of Fishes* by Quentin Bone & Richard Moore	
Course Name: M.Sc. Zoology	
Course Code- MZO 251	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology 2nd Yr	
MZO251-: Genes and Differentiation	
Student will be able to know	
CO1	Understand Fundamental Concepts in Gene Regulation and Differentiation
CO2	Describe the Molecular Mechanisms of Cell Fate Determination
CO3	Analyze the Role of Stem Cells and Pluripotency in Development
CO4	Apply Knowledge of Epigenetics in the Context of Cellular Differentiation
CO5	Develop Skills in Modern Techniques for Studying Gene Expression and Differentiation
	Course Outline (CO)
1	Introduction to Gene Regulation and Differentiation
2	Transcription Factors and Gene Regulation
3	Epigenetic Regulation
4	Non-coding RNAs and Differentiation
Detailed Syllabus	
Module 1	Introduction to Genes and Differentiation: Overview of gene regulation, Differentiation: Definition and significance, Historical background on cell differentiation and genetic control.
Module 2	Genetic Control of Development: Gene expression and regulation during development. Master genes: Homeotic and hox genes. Transcription factors and their role in differentiation

Module 3	Molecular Mechanisms of Cell Differentiation: Mechanisms of cell lineage specification, Epigenetic regulation in differentiation. Signal transduction pathways and differentiation.
Module 4	Stem Cells and Pluripotency: Types of stem cells: Embryonic, adult, and induced pluripotent stem cells, Molecular basis of pluripotency. Mechanisms of stem cell differentiation.

Recommended books

- **Essential Developmental Biology** by Jonathan Slack
- **Molecular Biology of the Cell** by Alberts et al.
- Primary research articles provided by the instructor

Course Name: M.Sc. Zoology- 2 Year

Course Code- MZO 251: Genes and Differentiation

Credits- 02 (P-12 h)

Introduction to Genetics: Overview of DNA, RNA, and proteins, Basics of gene structure and function, **Practical:** DNA extraction from plant/animal tissues.

Gene Expression Techniques: Introduction to PCR and gel electrophoresis., **Practical:** Amplification of a specific gene using PCR and analysis via gel electrophoresis.

Analyzing Gene Expression: Introduction to quantitative PCR (qPCR), **Practical:** Measuring gene expression levels in response to different treatments.

Cloning and Gene Manipulation: Techniques in gene cloning (restriction enzymes, ligation), **Practical:** Cloning a gene into a plasmid vector.

Transformation and Selection: Bacterial transformation techniques, **Practical:** Transforming E. coli with a plasmid and selecting for successful colonies.

Course Name: M.Sc. Zoology- 2 Year

Course Code- MZO 252: Cell and Molecular Biology

Credits- 02 (P-12 h)

1.Introduction to Lab Safety and Techniques

- Lab safety protocols
- Introduction to lab equipment (microscopes, pipettes, etc.)

2: Cell Culture Techniques

- Sterile techniques and media preparation
- Culturing mammalian cells

3: Microscopy Techniques

- Light microscopy and fluorescence microscopy
- Imaging cellular structures

4: DNA Extraction and Quantification

- Isolation of genomic DNA from cells
- Measuring DNA concentration using spectrophotometry

5: Polymerase Chain Reaction (PCR)

- Principles of PCR
- Setting up and running a PCR reaction

6: Gel Electrophoresis

- Separation of DNA fragments
- Visualization and analysis of results

Course Name- M.Sc. -2 Year

Course Code- MZO 253: Tools and Techniques in Biology (Practical)

Credits-2 (P-12 h)

1: Introduction to Laboratory Safety and Equipment

Overview of lab safety protocols

2: Microscopy Techniques

- Use of light microscopes and electron microscopes

3: Dissection Techniques

- Introduction to dissection tools

4: Culturing Microorganisms

- Aseptic techniques for culturing bacteria

5: Molecular Biology Techniques

- DNA extraction from plant/animal cells

Course Code- MZO 253

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. Zoology 1st Yr

MZO253-: Tools and Techniques in Biology

Student will be able to know

CO1	Understand the principles and applications of key biological techniques.
CO2	Develop practical skills in laboratory techniques.

CO3	Analyze and interpret experimental data.
CO4	Communicate scientific findings effectively.
	Course Outline (CO)
1	Introduction to Biological Research
2	Microscopy
3	Molecular Biology Techniques
4	Protein Analysis Techniques
Detailed Syllabus	
Module 1	Overview of biological sciences, Importance of tools and techniques, Safety protocols in the laboratory
Module 2	Types of microscopes (light, electron, fluorescence)**,** Sample preparation techniques**,** Image analysis
Module 3	DNA extraction and purification, Gel electrophoresis, Polymerase Chain Reaction (PCR)
Module 4	Protein extraction and purification, Western blotting, ELISA (Enzyme-Linked Immunosorbent Assay)
Recommended books	
"Molecular Biology of the Cell" by Bruce Alberts et al. • This comprehensive textbook provides a thorough understanding of cell biology and the tools used in molecular biology, including techniques for studying cellular components. **"Biology: A Self-Teaching Guide" by Andrew D. B. Henson** • A good introductory book that provides a solid foundation in biology concepts and techniques. **"Fundamentals of Molecular Biology" by William J. Thieman and Michael A. Palladino** • This book focuses on molecular biology techniques, including cloning, PCR, and sequencing.	
Course Code- MZO 101	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology 1st Yr	
MZO101-: Biosystematics & Taxonomy	
Student will be able to know	
CO1	Understand principles of biosystematics and taxonomy.

CO2	Identify and classify zoological specimens.
CO3	Analyze phylogenetic relationships.
CO4	Develop skills in taxonomic research and writing
Course Outlines	
1	Introduction to Biosystematics
2	Taxonomic Categories and Ranks
3	Morphological and Molecular Systematics
4	Phylogenetic Analysis
5	Zoological Taxonomy
Detailed Syllabus	
Module 1	Introduction to Biosystematics: Definition and scope of biosystematics, History of taxonomy and systematics, Principles of classification and nomenclature
Module 2	Taxonomic Categories and Ranks: Species concept and species delimitation, Genus, family, order, class, and phylum, Taxonomic hierarchy and ranking
Module 3	Morphological and Molecular Systematics: Morphological characters and analysis, Molecular systematics and phylogenetics, DNA barcoding and sequencing
Module 4	Phylogenetic Analysis: Phylogenetic tree construction, Cladistic analysis and parsimony Maximum likelihood and Bayesian methods
Module 4	Zoological Taxonomy: Invertebrate taxonomy (e.g., insects, mollusks), Vertebrate taxonomy (e.g., fishes, reptiles Taxonomy of specific zoological groups
Recommended books	
1. "Biosystematics and Taxonomy" by Mayr and Ashlock 2. "Phylogenetic Analysis" by Nielsen and Slatkin 3. "Zoological Taxonomy" by Wells and Wellington	
Course Code- MZO 104	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	

M.Sc. Zoology 1st Yr	
MZO102-: Structure & Function of Invertebrates	
Student will be able to know	
CO1	Introduction to Biosystematics
CO2	Taxonomic Categories and Ranks
CO3	Morphological and Molecular Systematics
CO4	Phylogenetic Analysis
CO5	Zoological Taxonomy
Course Outlines	
1	Introduction to Biosystematics
2	Taxonomic Categories and Ranks
3	Morphological and Molecular Systematics
4	Phylogenetic Analysis
5	Zoological Taxonomy
Detailed Syllabus	
Module 1	Introduction to Biosystematics: Definition and scope of biosystematics, History of taxonomy and systematics, Principles of classification and nomenclature
Module 2	Taxonomic Categories and Ranks: Species concept and species delimitation, Genus, family, order, class, and phylum, Taxonomic hierarchy and ranking
Module 3	Morphological and Molecular Systematics : Morphological characters and analysis, Molecular systematics and phylogenetics, DNA barcoding and sequencing
Module 4	Phylogenetic Analysis: Phylogenetic tree construction, Cladistic analysis and parsimony Maximum likelihood and Bayesian methods
Module 5	Zoological Taxonomy: Invertebrate taxonomy (e.g., insects, mollusks), Vertebrate taxonomy (e.g., fishes, reptiles), Taxonomy of specific zoological groups
Recommended ooks 1. Biosystematics and Taxonomy" by Mayr and Ashlock 2. "Phylogenetic Analysis" by Nielsen and Slatkin 3. "Zoological Taxonomy" by Wells and Wellington	

Course Code- MZO 104	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology 1st Yr	
MZO103-: Molecular Biology & Biotechnology	
Student will be able to know	
CO1	Understand molecular biology principles and techniques.
CO2	Apply biotechnology tools in zoological research.
CO3	Analyse genetic information and expression.
CO4	Develop skills in molecular research and communication
Course Outlines	
1	Molecular Biology Fundamentals
2	Genetic Engineering and Biotechnology
3	Genomics and Proteomics
4	Molecular Zoology
5	Advanced Biotechnology Techniques
Detailed Syllabus	
Module 1	Molecular Biology Fundamentals : DNA structure and replication, Transcription and translation, Gene regulation and expression, Molecular biology techniques (PCR, DNA sequencing)
Module 2	Genetic Engineering and Biotechnology: Gene cloning and expression vectors, Gene editing (CRISPR/Cas9), Biomedical applications and diagnostics, Forensic science and DNA fingerprinting
Module 3	Genomics and Proteomics: Genome assembly and annotation, Proteomics and protein structure Bioinformatics tools and databases, Molecular phylogenetics and evolution
Module 4	Molecular Zoology: Molecular ecology and conservation, Molecular markers and animal breeding, Zoological applications of biotechnology, Molecular biology of disease and immunology

Module 5	Advanced Biotechnology Techniques: RNA interference and gene silencing, Gene expression analysis (microarrays, qPCR), Bioinformatics and computational biology, Synthetic biology and gene design
Recommended Books	
1. "Molecular Biology of the Cell" by Alberts et al. 2. "Biotechnology" by Campbell and Farrell 3. "Genomics and Proteomics" by Sanders and Kennedy	
Course Code- MZO 104	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology 1st Yr	
MZO104-: General Physiology	
Student will be able to know	
CO1	Understand the fundamental principles of physiology.
CO2	Explain the functions of major physiological systems.
CO3	Analyze physiological processes and mechanisms.
CO4	Develop skills in physiological measurement and experimentation
Course Outlines	
1	Cellular Physiology
2	Nerve and Muscle Physiology
3	Cardiovascular Physiology
4	Respiratory Physiology
5	Renal and Digestive Physiology
Detailed Syllabus	
Module 1	Cellular Physiology: Cell membrane structure and function, Ion transport and electrical properties, Cellular signalling and communication, Cellular homeostasis and regulation

Module 2	Nerve and Muscle Physiology: Nerve structure and function, Muscle structure and function Neuromuscular transmission and integration, Sensory and motor systems
Module 3	Cardiovascular Physiology: Heart structure and function, Blood vessels and circulation, Blood pressure regulation, Cardiovascular integration and control
Module 4	Respiratory Physiology : Lung structure and function, Gas exchange and transport Respiratory regulation and control, Respiratory adaptations and responses
Module 5	Renal and Digestive Physiology : Kidney structure and function, Urine formation and regulation, Digestive system structure and function, Nutrient absorption and metabolism
Recommended Books	
1. Physiology" by Guyton and Hall 2. "Human Physiology" by Sherwood 3. "Physiology: The Basis of Medicine" by Berne	
Course Code- MZO 105	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology 1st Yr	
MZO105-: Biochemistry	
Student will be able to know	
CO1	Understand the fundamental principles of biochemistry.
CO2	Explain the structure and function of biomolecules.
CO3	Analyse biochemical processes and pathways.
CO4	Develop skills in biochemical techniques and research
Course Outlines	
1	Introduction to Biochemistry
2	Biomolecules & Carbohydrates
3	Enzymes and Biochemical Reactions

4	Metabolic Pathways
5	Biochemical Techniques
Detailed Syllabus	
Module 1	Introduction to Biochemistry: Definition and scope of biochemistry, History of biochemistry Biochemical terminology and concepts
Module 2	Biomolecules: Carbohydrates: structure, function, and metabolism, Proteins: structure, function, and metabolism, Lipids: structure, function, and metabolism, Nucleic acids: structure, function, and metabolism
Module 3	Enzymes and Biochemical Reactions: Enzyme structure and function, Enzyme kinetics and regulation, Biochemical reactions and pathways, Energy production and metabolism
Module 4	Metabolic Pathways: Glycolysis and gluconeogenesis, Citric acid cycle and oxidative phosphorylation, Lipid metabolism and fatty acid synthesis, Amino acid metabolism and nitrogen balance
Module 5	Biochemical Techniques: Spectrophotometry and chromatography, Electrophoresis and Western blotting, Biochemical assays and enzyme activity measurements
Recommended Books	
1. Understand the fundamental principles of biochemistry. 2. Explain the structure and function of biomolecules. 3. Analyze biochemical processes and pathways. 4. Develop skills in biochemical techniques and research	
Course Code- MZO 106	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology 1st Yr	
MZO106-: Biostatistics and Population Genetics	
Student will be able to know	
CO1	Understand statistical concepts and methods in biology.
CO2	Apply biostatistical techniques to zoological data.
CO3	Understand principles of population genetics.

CO4	Analyze genetic variation and evolution.
Course Outline	
1	Biostatistics
2	Population Genetics
3	Statistical Genetics
4	Advanced Biostatistics
Detailed Syllabus	
Module 1	Biostatistics: Introduction to biostatistics, Descriptive statistics and data visualization, Probability and statistical inference, Hypothesis testing and confidence intervals, Regression and correlation analysis
Module 2	Population Genetics: Introduction to population genetics, Genetic variation and mutation, Genetic drift and gene flow, Natural selection and adaptation, Population structure and dynamics
Module 3	Statistical Genetics: Quantitative genetics and heritability, Linkage and gene mapping Genetic association studies, Bioinformatics tools for genetics
Module 4	Advanced Biostatistics: Time series analysis and forecasting, Survival analysis and logistic regression, Multivariate analysis and clustering
Recommended books **1.** "Biostatistics" by Pagano and Gauvreau 2. "Population Genetics" by Hartl and Clark 3. "Statistical Genetics" by Balding et.al.	

Course Name-M.Sc. -1 Year	
Course Code-MZO: Zoology Practical	
Credits-4 (P-12 h)	
Detailed Syllabus (Practical)	
	Microscopic Techniques: Light microscopy, Phase contrast microscopy, Fluorescence microscopy, Microscopic measurement and drawing Histology and Cytology: Tissue processing and staining, Histological sections and slide preparation, Cytological techniques (smears, cultures), Cell and tissue identification

	Embryology and Developmental Biology : Embryo collection and fixation, Embryonic staging and sectioning, Developmental biology techniques (whole mounts, serial sections) Analysis of developmental patterns Ecology and Conservation Practical : Field sampling methods (trapping, netting), Ecological data collection and analysis, Conservation biology techniques (habitat assessment), Biodiversity assessment and monitoring

Course Code- MZO 201	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology 2nd Yr	
MZO201-: Biology of Chordates	
Student will be able to know	
CO1	Understand the evolution and diversity of chordates.
CO2	Describe the anatomy and physiology of chordate systems.
CO3	Analyze the developmental biology of chordates.
CO4	Apply comparative and experimental approaches to chordate biology.
Course Outline	
1	Evolution and Diversity of Chordates
2	Chordate Anatomy and Physiology
3	Developmental Biology of Chordates
4	Comparative Endocrinology and Immunology
Detailed Syllabus	
Module 1	Evolution and Diversity of Chordates: Origin and evolution of chordates, Phylogeny and classification of chordate, Diversity of chordate body plans, Comparative anatomy of chordate groups
Module 2	Chordate Anatomy and Physiology :Nervous system structure and function, Sensory systems and sensory organs, Muscular system and movement, Circulatory and respiratory systems

Module 3	Developmental Biology of Chordates: Embryonic development and patterning, Organogenesis and morphogenesis, Developmental genetics and genomics, Regenerative biology and tissue engineering
Module 4	Comparative Endocrinology and Immunology: Endocrine systems and hormone regulation, Immune systems and defense mechanisms, Comparative endocrinology and immunology Applied aspects of chordate endocrinology and immunology
Recommended books **1.** Chordate Structure and Function" by Kardong 2. "Biology of Chordates" by Decker and Decker 3. "Chordate Developmental Biology" by Gilbert and Raunio	
Course Code- MZO 202	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. Zoology 1st Yr	
MZO202-: Environmental Biology and Ethology	
Student will be able to know	
CO1	Understand environmental factors affecting organisms.
CO2	Analyze behavioral adaptations and responses
CO3	Apply ecological principles to conservation.
CO4	Evaluate human impact on ecosystems
Course Outline	
1	Environmental Physiology
2	Animal Behavior
3	Ecological Principles
4	Conservation Biology
Detailed Syllabus	
Module 1	Environmental Physiology : Temperature regulation, Water and ion balance, Environmental toxicology, Adaptations to extreme environments

Module 2	Animal Behavior : Introduction to ethology, Sensory and communication systems, Social behavior and group dynamics, Behavioral ecology and evolution
Module 3	Ecological Principles: Ecosystem structure and function, Population dynamics and regulation Community ecology and biodiversity, Ecological succession and stability
Module 4	Conservation Biology : Threats to biodiversity, Conservation strategies and management Habitat restoration and ecological engineering, Human-wildlife conflict and resolution

Recommended books

1. Understand environmental factors affecting organisms.
2. Analyze behavioral adaptations and responses.
3. Apply ecological principles to conservation.
4. Evaluate human impact on ecosystems.

Course Code- MZO 203

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. Zoology 2nd Yr

MZO203-:Genes and Differentiation

Student will be able to know

CO1	Understand gene structure and function.
CO2	Analyse genetic control of differentiation.
CO3	Explain molecular mechanisms of gene regulation.
CO4	Apply genetic principles to developmental biology.

Course Outline

1	Gene Expression and Regulation
2	Stem Cell Biology and Regenerative Medicine
3	Regenerative medicine and tissue engineering
4	Synthetic biology and gene design

Detailed Syllabus

Module 1	Gene Expression and Regulation: Gene expression profiling, Transcriptional regulation in development, Post-transcriptional regulation in development, Gene regulation in disease

Module 2	Stem Cell Biology and Regenerative Medicine: Stem cell types and characteristics, Stem cell differentiation and self-renewal,
Module 3	Regenerative medicine and tissue engineering: Stem cell ethics and applications, Advanced Topics in Genes and Differentiation, Gene editing and genome engineering
Module 4	Synthetic biology and gene design: Systems biology and gene networks, Emerging trends in genes and differentiation

Recommended books

1. Molecular Biology of the Cell" by Alberts et al.

2. "Genes and Development" by Gilbert

3. "Developmental Biology" by Carlson

Course Code- MZO204

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. Zoology 2d Yr

MZO204-: Tools and Techniques in Biology

Student will be able to know

CO1	Understand various laboratory techniques in biology.
CO2	Apply molecular biology techniques.
CO3	Analyze biochemical and biophysical techniques.
CO4	Develop skills in bioinformatics and computational biology.

Course Outline

1	Bioinformatics and Computational Biology
2	Biophysical Techniques
3	Advanced Techniques in Biology
4	Research project proposal and literature review

Detailed Syllabus

Module 1	Bioinformatics and Computational Biology : Sequence analysis and alignment, Phylogenetic analysis, Genomic and proteomic analysis, Bioinformatics tools and databases
Module 2	Biophysical Techniques: Spectroscopy and microscopy, X-ray crystallography and NMR, Mass spectrometry and proteomics, Biophysical analysis of macromolecules
Module 3	Advanced Techniques in Biology : CRISPR-Cas9 gene editing, RNA interference and gene silencing, Single-cell analysis and sequencing, Synthetic biology and gene design
Module 4	Research project proposal and literature review: Data collection and analysis, Research presentation and manuscript preparation

Recommended books

1. Molecular Biology Techniques" by Clark and Russell
2. "Biochemistry and Molecular Biology" by Elliott and Elliott
3. "Bioinformatics" by Mount

Course Code- MZO 205

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. Zoology 2 Yr

MZO205: Cancer Biology-Nature of Cancer

Student will be able to know

CO1	Understand the fundamental principles of cancer biology.
CO2	Analyze the molecular and cellular mechanisms of cancer.
CO3	Explain the role of genetic and environmental factors in cancer.
CO4	Apply knowledge of cancer biology to diagnosis and treatment.

Course Outline

1	Cancer Diagnosis and Treatment
2	Cancer Molecular Biology and Genetics
3	Cancer Stem Cells and Tumor Microenvironment
4	Research presentation and manuscript preparation

Detailed Syllabus	
Module 1	Cancer Diagnosis and Treatment : Cancer diagnosis and screening, Surgical and radiation oncology, Chemotherapy and targeted therapie, Immunotherapy and cancer vaccines
Module 2	Cancer Molecular Biology and Genetics: Cancer genomics and epigenomics, Gene expression and cancer, MicroRNAs and cancer, Cancer proteomics
Module 3	Cancer Stem Cells and Tumor Microenvironment: Cancer stem cell biology, Tumor microenvironment and cancer, Cancer angiogenesis, Cancer metastasis and invasion
Module 4	Research Project and Presentation : Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation

Recommended books

1. "Cancer Biology" by Weinberg

2. "The Biology of Cancer" by Hanahan and Weinberg

3. "Cancer: Principles and Practice of Oncology" by DeVita et al.

Course Code- MZO 206

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. Zoology 2 Yr

MZO206-: Cancer Biology- Causation, Prevention and Cure of Cancer

Student will be able to know

CO1	Understand the causes and risk factors of cancer.
CO2	Analyze cancer prevention strategies.
CO3	Explain cancer treatment modalities.
CO4	Discuss current research and future directions in cancer biology.

Course Outline

1	Molecular Targeted Therapies
2	Immunotherapy and Cancer Vaccines
3	Immunotherapy and Cancer Vaccines
4	Research Project and Presentation

Detailed Syllabus	
Module 1	Molecular Targeted Therapies: Gene expression and cancer therapy, Signal transduction pathways and cancer therapy, Angiogenesis and cancer therapy, Apoptosis and cancer therapy
Module 2	Immunotherapy and Cancer Vaccines: Tumor immunology and immunotherapy, Cancer vaccines and immunomodulation, Adoptive T-cell therapy, Checkpoint inhibitors and cancer immunotherapy
Module 3	Cancer Genomics and Epigenomics: Cancer genomics and epigenomics, Gene expression profiling and cancer diagnosis, Next-generation sequencing and cancer research, Epigenetic modifications and cancer therapy
Module 4	Research Project and Presentation :Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation

Recommended books

1. "Cancer: Principles and Practice of Oncology" by DeVita et al.
2. "The Biology of Cancer" by Hanahan and Weinberg
3. "Cancer Immunology and Immunotherapy" by Finn

Course Name-M.Sc. -2 Year

Course Code-MZO251: Genes and Differentiation

Credits-4 (P-12 h)

Detailed Syllabus (Practical)	
1.	Cloning and expression of GFP-tagged proteins
2.	Analysis of gene expression using microarrays or RNA-seq
3.	Study of cellular differentiation using stem cells
4.	Investigation of gene regulation using CRISPR-Cas9

Course Name-M.Sc. -2 Year

Course Code-MZO252: Practical of Cancer Biology

Credits-4 (P-12 h)

Detailed Syllabus (Practical)	
	1. Chromatin immunoprecipitation (ChIP) assay 2. Methylation-specific PCR 3. Gene expression profiling using microarrays 4. Next-generation sequencing (NGS) library preparation

Course Code- MZO 101	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 1st Year (Zoology) **Scheme Updated on Session - July-2021**	
MZO 101: Biosystematics & Taxonomy	
Student will be able to know	
CO1	Understand principles of biosystematics and taxonomy.
CO2	Identify and classify organisms using morphological and molecular methods.
CO3	Analyze phylogenetic relationships among organisms.
CO4	Apply taxonomic principles to conservation and biodiversity
Course Outline	
1	Introduction to Biosystematics
2	Morphological Taxonomy
3	Morphological Taxonomy
4	Molecular Taxonomy
Detailed Syllabus	
Module 1	Introduction to Biosystematics: Definition and scope of biosystematics, History of taxonomy and biosystematics, Types of taxonomy (morphology, molecular, phylogenetic), Taxonomic ranks and categories
Module 2	Morphological Taxonomy: Character analysis and description, Morphological techniques (microscopy, dissection), Taxonomic keys and identification, Species concepts and delimitation
Module 3	Molecular Taxonomy: DNA and protein sequencing, Phylogenetic analysis (maximum parsimony, likelihood), Molecular markers and barcoding, Molecular phylogenetics and evolution
Module 4	Phylogenetic Analysis: Phylogenetic tree reconstruction, Tree inference methods (NJ, MP, ML) Phylogenetic hypothesis testing, Molecular clock and divergence time estimation
Recommended books 1. Biosystematics and Taxonomy" by Schuh and Brower 2. "Phylogenetic Analysis" by Nielsen and Slatkin 3. "Taxonomy and Phylogeny of Animals" by Brusca and Brusca	

Course Code- MZO 103	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 1st Year (Zoology) **Scheme Updated on Session - July-2021**	
MZO 103: Molecular Biology & Biotechnology	
Student will be able to know	
CO1	Understand principles of biosystematics and taxonomy.
CO2	Identify and classify organisms using morphological and molecular methods.
CO3	Analyze phylogenetic relationships among organisms.
CO4	Apply taxonomic principles to conservation and biodiversity.
Course Outline	
1	Molecular Taxonomy
2	Phylogenetic Analysis
3	Taxonomic Groups
4	Conservation and Biodiversity
Detailed Syllabus	
Module 1	Molecular Taxonomy: DNA and protein sequencing, Phylogenetic analysis (maximum parsimony, likelihood), Molecular markers and barcoding, Molecular phylogenetics and evolution
Module 2	Phylogenetic Analysis: Phylogenetic tree reconstruction,. Tree inference methods (NJ, MP, ML), Phylogenetic hypothesis testing, Molecular clock and divergence time estimation
Module 3	Taxonomic Groups: Invertebrate taxonomy (insects, mollusks, echinoderms), Vertebrate taxonomy (fish, amphibians, reptiles), Plant taxonomy (angiosperms, gymnosperms), Fungal taxonomy (ascomycetes, basidiomycetes)
Module 4	Conservation and Biodiversity: Taxonomy and conservation biology, Biodiversity hotspots and extinction risk, Taxonomic inventories and monitoring, Phylogenetic diversity and conservation
Recommended books 1. Biosystematics and Taxonomy" by Schuh and Brower 2. "Phylogenetic Analysis" by Nielsen and Slatkin 3. "Taxonomy and Phylogeny of Animals" by Brusca and Brusca	

Course Code- MZO 102	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 1st Year (Zoology) **Scheme Updated on Session - July-2021**	
MZO 102: Structure & Function of Invertebrates	
Student will be able to know	
CO1	Understand the diversity of invertebrate animals.
CO2	Describe the structure and function of invertebrate body systems.
CO3	Analyze the evolutionary relationships among invertebrates.
CO4	Apply knowledge of invertebrate biology to ecological and environmental issues.
Course Outline	
1	Introduction to Invertebrates
2	Porifera and Cnidaria
3	Platyhelminthes and Aschelminthes
4	Annelida and Arthropoda
Detailed Syllabus	
Module 1	Introduction to Invertebrates: Definition and classification of invertebrates, Evolutionary history of invertebrates, Body plans and symmetry, Invertebrate diversity and phylogeny
Module 2	Porifera and Cnidaria: Structure and function of sponges, Cnidarian anatomy and physiology Jellyfish and coral biology, Ecological importance of Porifera and Cnidaria
Module 3	Platyhelminthes and Aschelminthes: Flatworm anatomy and physiology, Roundworm structure and function, Parasitology and ecological importance, Evolutionary relationships among platyhelminths and aschelminths
Module 4	Annelida and Arthropoda: Annelid anatomy and physiology, Arthropod structure and function, Insect diversity and ecology, Evolutionary relationships among annelids and arthropods
Recommended books 1. "Invertebrate Zoology" by Brusca and Brusca 2. "Invertebrates" by Ruppert et al. 3. "Animal Evolution" by Telford and Littlewood	

Course Code- MZO 103	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 1st Year (Zoology) **Scheme Updated on Session - July-2021**	
MZO 103: Molecular Biology & Biotechnology	
Student will be able to know	
CO1	Understand the principles of molecular biology.
CO2	Learn biotechnological techniques and applications.
CO3	Analyze genetic information and gene expression.
CO4	Apply molecular biology and biotechnology to zoological research.
Course Outline	
1	Introduction to Molecular Biology
2	DNA Structure and Function
3	RNA and Protein Biology
4	Biotechnological Techniques
Detailed Syllabus	
Module 1	Introduction to Molecular Biology : Overview of molecular biology, Chemical basis of life (DNA, RNA, proteins), Central dogma and gene expression, Molecular biology techniques (PCR, DNA sequencing)
Module 2	DNA Structure and Function : DNA structure and organization, DNA replication and repair, Gene regulation and expression, Epigenetics and chromatin structure
Module 3	RNA and Protein Biology : RNA structure and function, Protein structure and function, Gene expression and regulation, RNA interference and microRNAs
Module 4	Biotechnological Techniques : DNA cloning and vector systems, Gene editing (CRISPR/Cas9), Polymerase chain reaction (PCR), DNA sequencing and genomics
Recommended books 1. "Molecular Biology of the Cell" by Alberts et al. 2. "Biotechnology" by Campbell and Farrell 3. "Genomics and Bioinformatics" by Mount	
Course Code- MZO 104	
Credits- 04 (L-18 h/T-18h)	

Course Outcomes (Cos)	
M.Sc - 1st Year (Zoology) **Scheme Updated on Session - July-2021**	
MZO 104: General Physiology	
Student will be able to know	
CO1	Understand the fundamental principles of physiology.
CO2	Describe the structure and function of cellular and organ systems.
CO3	Analyze physiological processes and mechanisms.
CO4	Apply physiological principles to zoological research.
Course Outline	
1	Introduction to Physiology
2	Cellular Physiology
3	Nervous System Physiology
4	Endocrine and Reproductive Physiology
Detailed Syllabus	
Module 1	Introduction to Physiology: Definition and scope of physiology, Homeostasis and regulatory mechanisms, Physiological techniques and measurements, Biochemical and biophysical principles
Module 2	Cellular Physiology: Cell membrane structure and function, Ion transport and electrical properties, Cellular signaling and communication, Cellular metabolism and energy production
Module 3	Nervous System Physiology: Neuron structure and function, Neurotransmission and synaptic plasticity, Sensory systems and perception, Motor systems and movement
Module 4	Endocrine and Reproductive Physiology: Endocrine system organization and function, Hormone regulation and feedback mechanisms, Reproductive system anatomy and physiology Endocrine disruptors and reproductive health
Recommended books **1.** "Physiology" by Berne and Levy 2. "Human Physiology" by Guyton and Hall 3. "Animal Physiology" by Hill et al.	
Course Code- MZO 105	
Credits- 04 (L-18 h/T-18h)	

Course Outcomes (Cos)	
M.Sc - 1st Year (Zoology) **Scheme Updated on Session - July-2021**	
MZO 105: Biochemistry	
Student will be able to know	
CO1	Understand the chemical and molecular basis of life.
CO2	Describe the structure and function of biomolecules.
CO3	Analyze metabolic pathways and energy production.
CO4	Apply biochemistry to biological and medical research
Course Outline	
1	Introduction to Biochemistry
2	Biomolecules
3	Enzymes and Bioenergetics
4	Metabolic Pathways
Detailed Syllabus	
Module 1	Introduction to Biochemistry : Overview of biochemistry, Chemical bonding and chemical reactions, Biochemical techniques and instrumentation, Biochemical nomenclature and terminology
Module 2	Biomolecules: Structure and function of carbohydrates, Lipid structure and function, Protein structure and function, Nucleic acid structure and function
Module 3	Enzymes and Bioenergetics : Enzyme structure and function, Enzyme kinetics and regulation, Bioenergetics and ATP production, Oxidative phosphorylation and electron transport
Module 4	Metabolic Pathways : Glycolysis and gluconeogenesis, Citric acid cycle and pentose phosphate pathway, Fatty acid metabolism and lipid synthesis, Amino acid metabolism and nitrogen balance
Recommended books 1. "Biochemistry" by Lehninger et al. 2. "Harper's Biochemistry" by Murray et al. 3. "Biochemistry: A Short Course" by Garrett and Grisham	
Course Code- MZO 106	
Credits- 04 (L-18 h/T-18h)	

Course Outcomes (Cos)	
M.Sc - 1st Year (Zoology) **Scheme Updated on Session - July-2021**	
MZO 106: Biostatistics and Population Genetics	
Student will be able to know	
CO1	Understand statistical concepts and methods in biological research.
CO2	Apply biostatistical techniques to analyze biological data.
CO3	Understand principles of population genetics.
CO4	Analyze genetic variation and evolution.
Course Outline	
1	Biostatistics
2	Population Genetics
3	Statistical Genetics
4	Advanced Biostatistics
Detailed Syllabus	
Module 1	Biostatistics : Introduction to biostatistics, Descriptive statistics (mean, median, mode), Inferential statistics (hypothesis testing, confidence intervals), Probability distributions (normal, binomial, Poisson), Regression analysis (simple and multiple), Analysis of variance (ANOVA)
Module 2	Population Genetics :Introduction to population genetics, Genetic variation (mutation, genetic drift, gene flow), Hardy-Weinberg equilibrium, Population structure and gene flow, Molecular evolution (DNA sequence analysis), Phylogenetics (tree reconstruction)
Module 3	Statistical Genetics: Quantitative genetics (heribility, genetic variance), Statistical analysis of genetic data (linkage, association), Genetic mapping (QTL, GWAS), Bioinformatics tools for genetic analysis
Module 4	Advanced Biostatistics: Non-parametric statistics, Time series analysis, Survival analysis, Multivariate analysis (PCA, MANOVA)
Recommended books **1.** Biostatistics: A Foundation for Analysis in the Health Sciences" by Daniel & Cross 2. "Population Genetics: A Concise Guide" by Gibson et al. 3. "Statistical Genetics: Gene Mapping and Marker-Assisted Selection" by Lynch & Walsh	
Course Name-M.Sc.	

Course Code-MZO151: Zoology Practical	
Credits-4 (P-12 h)	
Detailed Syllabus (Practical)	
1.	**Animal Diversity and Systematics :** Identification of invertebrates and vertebrates, Study of animal morphology and anatomy, Preparation of zoological specimens, Identification of zoological specimens using taxonomic keys
2.	**Histology and Microtechniques :** Preparation of histological sections, Staining techniques (H&E, Giemsae, Microscopy and photomicroscopy, Study of tissue structure and organization

Course Code- MZO 201	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc -2nd year(Zoology) Scheme Updated on Session - July-2021	
MZO 201: Biology of Chordates	
Student will be able to know	
CO1	Understand the evolution and diversity of chordates.
CO2	Describe the anatomy, physiology, and development of chordates.
CO3	Analyze the phylogenetic relationships among chordate groups.
CO4	Apply knowledge of chordate biology to ecological and conservation issues.
Course Outline	
1	Evolution and Diversity of Chordates
2	Anatomy and Physiology of Chordates
3	Developmental Biology of Chordates
4	Chordate Phylogeny and Systematics
Detailed Syllabus	
Module 1	Evolution and Diversity of Chordates: Origin and evolution of chordates, Chordate characteristics and body plan, Diversity of chordate groups (Cephalochordata, Urochordata, Vertebrata), Fossil record and phylogenetic reconstruction
Module 2	Anatomy and Physiology of Chordates: Body organization and systems (nervous, circulatory, digestive), Sensory organs and sensory systems, Endocrine system and hormone regulation, Immune system and defense mechanisms
Module 3	Developmental Biology of Chordates: Embryonic development and morphogenesis, Pattern formation and tissue organization, Organogenesis and developmental gene regulation, Evolutionary developmental biology (evo-devo)

Module 4	Chordate Phylogeny and Systematics : Phylogenetic analysis and tree reconstruction, Chordate systematics and taxonomy, Molecular phylogenetics and genomics, Biogeography and dispersal of chordates

Recommended books:

1. Biology of Chordates" by Kardong
2. "Chordate Evolution" by Gee
3. "Vertebrate Biology" by Pough et al.

Course Code- MZO 202

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc -2nd year(Zoology) Scheme Updated on Session - July-2021

MZO 202: Environmental Biology and Ethology

Student will be able to know

CO1	Understand the principles of environmental biology and ethology.
CO2	Analyze the impact of environmental factors on organisms.
CO3	Describe animal behavior and its evolutionary significance
CO4	Apply knowledge of environmental biology and ethology to conservation and ecological issues

Course Outline

1	Environmental Biology
2	Ethology
3	Environmental Toxicology
4	Conservation Biology

Detailed Syllabus

Module 1	**Environmental Biology:** Introduction to environmental biology, Ecological principles (energy flow, nutrient cycling), Environmental pollution (air, water, soil), Climate change and its impacts on organisms
Module 2	**Ethology**: Introduction to ethology, Animal behavior (foraging, mating, social behavior), Behavioral ecology (game theory, optimality), Ethological methods (observation, experimentation)

Module 3	**Environmental Toxicology:** Toxicology principles (dose-response, bioaccumulation), Environmental toxicants (pesticides, heavy metals), Toxicity testing and risk assessment, Bioremediation and pollution management
Module 4	**Conservation Biology :** Principles of conservation biology**,** Biodiversity conservation (species, ecosystem, landscape)**,** Conservation strategies (habitat restoration, species reintroduction)**,** International conservation policies and agreements

Recommended books:

1. Environmental Biology" by Eldredge
2. "Animal Behaviour" by Manning and Dawkins
3. "Conservation Biology" by Primack and Rodrig

Course Code- MZO 203

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc -2nd year(Zoology) Scheme Updated on Session - July-2021

MZO 203: Genes and Differentiation

Student will be able to know

CO1	Understand the principles of gene expression and regulation.
CO2	Analyze the mechanisms of cellular differentiation.
CO3	Describe the role of genes in development and evolution.
CO4	Apply knowledge of gene regulation to biomedical and biotechnological applications.

Course Outline

1	Gene Structure and Function
2	Cellular Differentiation
3	Developmental Genetics
4	Gene Regulation and Epigenetics:

Detailed Syllabus

Module 1	Gene Structure and Function: Gene organization and structure, Gene expression and regulation Transcriptional control and RNA processing, -transcriptional regulation and miRNAs

Module 2	Cellular Differentiation : Cell signaling and differentiation, Stem cell biology and pluripotency Cell fate determination and patterning, Tissue organization and morphogenesis
Module 3	Developmental Genetics : Embryonic development and morphogenesis, Pattern formation and tissue organization, Developmental gene regulatory networks, Evolutionary developmental biology (evo-devo)
Module 4	Gene Regulation and Epigenetics: Epigenetic regulation of gene expression, Chromatin structure and modification, DNA methylation and imprinting, Gene regulation in disease and development

Recommended books

1. Molecular Biology of the Cell" by Alberts et al.
2. "Genes and Development" by Gilbert
3. "Stem Cell Biology" by Marshak et al.

Course Code- MZO 204

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc -2nd year(Zoology) Scheme Updated on Session - July-2021

MZO 204: Tools and Techniques in Biology

Student will be able to know

CO1	Understand various laboratory techniques used in biological research.
CO2	Develop skills in experimental design and data analysis.
CO3	Apply bioinformatics tools for data interpretation.
CO4	Integrate knowledge of biological techniques in research projects.

Course Outline

1	Microscopy and Imaging Techniques
2	Molecular Biology Techniques
3	Cell Culture and Biotechnology
4	Bioinformatics and Computational

Detailed Syllabus

Module 1	**Microscopy and Imaging Techniques :**Light microscopy (LM) and electron microscopy (EM), Confocal microscopy and fluorescence imaging, Image processing and analysis software, Applications in biological research

Module 2	**Molecular Biology Techniques :**DNA extraction, purification, and amplification (PCR), RNA extraction, purification, and analysis (RT-PCR), Gene cloning and expression, DNA sequencing and genotyping
Module 3	**Cell Culture and Biotechnology** : Cell culture techniques and media preparation, Cell proliferation and differentiation assays, Bioreactors and bioprocessing, Applications in biotechnology and regenerative medicine
Module 4	**Bioinformatics and Computational Biology :** Bioinformatics databases and tools (BLAST, GenBank), Sequence alignment and phylogenetic analysis, Protein structure prediction and modelling, Gene expression analysis and microarray data interpretation

Recommended books:

1. "Laboratory Techniques in Biology" by Wilson and Walker
2. "Molecular Biology Techniques" by Brown
3. "Bioinformatics: A Practical Guide" by Orchard

Course Code- MZO 205

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc -2nd year(Zoology) Scheme Updated on Session - July-2021

MZO 205: Cancer Biology-Nature of Cancer

Student will be able to know

CO1	Understand the fundamental principles of cancer biology
CO2	Describe the molecular and cellular mechanisms of cancer development.
CO3	Analyze the role of genetic and environmental factors in cancer.
CO4	Apply knowledge of cancer biology to diagnosis, treatment, and prevention

Course Outline

1	Introduction to Cancer Biology:
2	Molecular Genetics of Cancer
3	Cell Signalling and Cancer
4	Cancer Cell Biology

Detailed Syllabus

Module 1	**Introduction to Cancer Biology:** Definition and types of cancer, Cancer statistics and epidemiology, Historical perspective of cancer research, Cancer biology: an overview

Module 2	**Molecular Genetics of Cancer :** Genetic mutations and cancer, Oncogenes and tumor suppressor genes, DNA repair mechanisms and genomic instability, Epigenetic alterations in cancer
Module 3	**Cell Signaling and Cancer:** Cell signaling pathways and cancer, Receptor tyrosine kinases and cancer, Signal transduction pathways and cancer, Apoptosis and cancer
Module 4	**Cancer Cell Biology :** Cancer cell characteristics, Cancer stem cells, Cancer cell metabolism, Cancer cell migration and invasion

Recommended books:

1. Cancer Biology" by Weinberg
2. "The Biology of Cancer" by Alberts et al.
3. "Cancer: Principles and Practice of Oncology" by DeVita et al.

Course Code- MZO 201

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc -2nd year(Zoology) Scheme Updated on Session - July-2021

MZO 206: Cancer Biology- Causation, Prevention and Cure of Cancer

Student will be able to know

CO1	Understand the causes and risk factors of cancer
CO2	Analyze the mechanisms of cancer prevention and early detection.
CO3	Describe the current treatments and therapies for cancer.
CO4	Evaluate the latest research and advancements in cancer biology

Course Outline

1	Cancer Causation
2	Cancer Prevention
3	Cancer Therapy
4	Cancer Stem Cells and Tumor Microenvironment

Detailed Syllabus

Module 1	**Cancer Causation** :Chemical carcinogenesis, Radiation-induced cancer, Viral oncogenesis, Genetic predisposition to cancer
Module 2	**Cancer Prevention** : Chemoprevention and cancer, Nutrition and cancer prevention, Lifestyle modifications and cancer risk, Cancer screening and early detection

Module 3	**Cancer Therapy** : Surgery and cancer treatment, Chemotherapy and targeted therapies, Radiation therapy and cancer treatment, Immunotherapy and cancer treatment
Module 4	**Cancer Stem Cells and Tumor Microenvironment** : Cancer stem cells and tumor initiation, Tumor microenvironment and cancer progression, Angiogenesis and cancer, Cancer-associated fibroblasts and immune cells

Recommended books:

1. "Cancer Biology" by Weinberg
2. "The Biology of Cancer" by Alberts et al.
3. "Cancer: Principles and Practice of Oncology" by DeVita et al.

Course Name-M.Sc.

Course Code-MZO:252 Cancer Biology Practical

Credits-4 (P-12 h)

Detailed Syllabus (Practical)

1.	Cell proliferation assay using MTT, Apoptosis detection using Annexin V, Western blotting for protein expression, PCR and sequencing of cancer-related genes Tumor xenograft model establishment, Cancer stem cell isolation using magnetic beads, Immunohistochemistry for cancer biomarkers Flow cytometry analysis of cancer cells

Course Code- MZO 101

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Zoology)

Scheme Updated on Session - July-2022, July-2023

MZO 101: Biosystematics & Taxonomy

Student will be able to know

CO1	Understand the principles of biosystematics and taxonomy.
CO2	Identify and classify organisms using morphological and molecular characteristics.
CO3	Analyze phylogenetic relationships among organisms.
CO4	Apply taxonomic principles to conservation and evolutionary biology.

Course Outline

1	Introduction to Biosystematics
2	Morphological Taxonomy
3	Molecular Taxonomy
4	Phylogenetic Analysis

Detailed Syllabus	
Module 1	Introduction to Biosystematics :Definition and scope of biosystematics, History of taxonomy and biosystematics, Types of classification (artificial, natural, phylogenetic), Taxonomic hierarchy (Kingdom to Species)
Module 2	Morphological Taxonomy: Character analysis and coding, Morphological characteristics of major taxonomic groups, Identification keys and taxonomic literature, Specimen collection and preservation
Module 3	Molecular Taxonomy :DNA sequencing and phylogenetic analysis, Molecular markers (mtDNA, rDNA, etc.), Phylogenetic reconstruction methods (MP, NJ, ML), Molecular clock and divergence time estimation
Module 4	Phylogenetic Analysis: Phylogenetic tree construction and interpretation, Cladistic analysis and parsimony, Molecular phylogenetics and coalescent theory, Phylogenetic classification and taxonomy

Recommended Text books:

1. Biosystematics and Taxonomy" by Mayr and Ashlock
2. "Phylogenetic Analysis" by Nielsen and Slatkin
3. "Taxonomy and Phylogeny of Animals" by Brusca and Brusca

Course Code- MZO 102

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Zoology)

Scheme Updated on Session - July-2022, July-2023

MZO 102: Structure & Function of Invertebrates

Student will be able to know

CO1	Understand the diversity of invertebrate phyla and their body structure.
CO2	Describe the functional anatomy of invertebrates.
CO3	Analyze the evolutionary relationships among invertebrate groups.
CO4	Apply knowledge of invertebrate biology to ecological and environmental contexts

Course Outline

1	Introduction to Invertebrates
2	Porifera, Cnidaria, and Platyhelminthes
3	Nematoda, Mollusca, and Annelida

4	Arthropoda
Detailed Syllabus	
Module 1	Introduction to Invertebrates : Definition and classification of invertebrate, Phylogenetic relationships among invertebrate phyla, Body plans and symmetry in invertebrates, Overview of invertebrate diversity
Module 2	Porifera, Cnidaria, and Platyhelminthes: Structure and function of sponges (Porifera, Anatomy and physiology of cnidarians (Cnidaria), Flatworms (Platyhelminthes): structure, function, and development
Module 3	Nematoda, Mollusca, and Annelida :Roundworms (Nematoda): morphology, physiology, and ecology, Mollusks (Mollusca): shell structure, muscle anatomy, and feeding mechanisms Segmented worms (Annelida): structure, function, and development
Module 4	Arthropoda : Arthropod body plan and appendage structure, Insect morphology, physiology, and development, Arachnid and crustacean biology
Recommended Text books 1. "Invertebrate Zoology" by Brusca and Brusca 2. "The Invertebrates" by Barnes et al. 3. "Invertebrate Biology" by Pechenik	
Course Code- MZO 103	
Credits- 05 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 1st Year (Zoology) **Scheme Updated on Session - July-2022, July-2023**	
MZO 103: Molecular Biology & Biotechnology	
Student will be able to know	
CO1	Understand the principles of molecular biology and biotechnology.
CO2	Describe the structure, function, and regulation of biomolecules.
CO3	Analyze molecular mechanisms and techniques in biotechnology.
CO4	Apply molecular biology and biotechnology principles to zoological research
Course Outline	
1	Biotechnology Applications
2	Immunology and Molecular Diagnostics
3	Bioinformatics and Computational Biology

4	Research Project and Presentation
Detailed Syllabus	
Module 1	Biotechnology Applications: Biotechnology in medicine (gene therapy, vaccines), Biotechnology in agriculture (GM crops, transgenic animals), Biotechnology in environment (bioremediation, conservation), Biotechnology in zoology (animal biotechnology)
Module 2	Immunology and Molecular Diagnostics: Immunology basics (antigens, antibodies, immune response), Molecular diagnostics (ELISA, Western blot, etc.), Immunological techniques (flow cytometry, immunohistochemistry), Molecular markers and disease diagnosis
Module 3	Bioinformatics and Computational Biology: Bioinformatics tools (BLAST, GenBank, etc.), Computational biology (sequence analysis, phylogenetics), Gene expression analysis (microarrays, RNA-seq), Systems biology and network analysis
Module 4	Research Project and Presentation: Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation, Defense of research project
Recommended Text books 1. "Molecular Biology of the Cell" by Alberts et al. 2. "Biotechnology: Principles and Processes" by Campbell et al. 3. "Molecular Biotechnology" by Glick et al.	
Course Code- MZO 104	
Credits- 05 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 1st Year (Zoology) **Scheme Updated on Session - July-2022, July-2023**	
MZO 104: General Physiology	
Student will be able to know	
CO1	Understand the fundamental principles of physiology.
CO2	Describe the structure and function of cells, tissues, and organs.
CO3	Analyze the physiological processes that maintain homeostasis.
CO4	Apply physiological principles to zoological research.
Course Outline	
1	Digestive and Excretory Physiology

2	Endocrine and Reproductive Physiology
3	Environmental and Comparative Physiology
4	Research Project and Presentation

Detailed Syllabus

Module 1	Digestive and Excretory Physiology : Digestive system structure and function: Nutrient absorption and metabolism, Excretory system structure and function, Urine formation and regulation
Module 2	Endocrine and Reproductive Physiology :Endocrine glands and hormones, Reproductive system structure and function, Gametogenesis and fertilization, Pregnancy and lactation
Module 3	Environmental and Comparative Physiology :Temperature regulation and thermoregulation, Water and electrolyte balance, Comparative physiology of different animal groups, Adaptation to environmental stressors
Module 4	Research Project and Presentation :Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation, Defense of research project

Recommended Text books

1. "Physiology" by Guyton and Hall
2. "Animal Physiology" by Hill et al.
3. "Comparative Animal Physiology" by Randall et al.

Course Code- MZO 105

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Zoology)

Scheme Updated on Session - July-2022, July-2023

MZO 105: Biochemistry

Student will be able to know

CO1	Understand the fundamental principles of physiology.
CO2	Describe the structure and function of cells, tissues, and organs.
CO3	Analyze the physiological processes that maintain homeostasis.
CO4	Apply physiological principles to zoological research.

Course Outline

1	Digestive and Excretory Physiology

2	Endocrine and Reproductive Physiology
3	Environmental and Comparative
4	Research Project and Presentation
Detailed Syllabus	
Module 1	Digestive and Excretory Physiology: Digestive system structure and function, Nutrient absorption and metabolism, Excretory system structure and function, Urine formation and regulation
Module 2	Endocrine and Reproductive Physiology :Endocrine glands and hormones, Reproductive system structure and function, Gametogenesis and fertilization, Pregnancy and lactation
Module 3	Environmental and Comparative Physiology:Temperature regulation and thermoregulation, Water and electrolyte balance, Comparative physiology of different animal groups, Adaptation to environmental stressors
Module 4	Research Project and Presentation :Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation, Defense of research project
Recommended Text books 1. Online lecture notes and handouts 2. Scientific articles and research papers 3. Physiology databases and software (e.g., PhysioBank)	
Course Code- MZO 106	
Credits- 05 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 1st Year (Zoology) **Scheme Updated on Session - July-2022, July-2023**	
MZO 106: Biostatistics and Population Genetics	
Student will be able to know	
CO1	Understand statistical concepts and methods in biological research.
CO2	Apply biostatistical techniques to analyze biological data.
CO3	Understand population genetic principles and mechanisms.
CO4	Analyze genetic variation and evolution in populations.
Course Outline	
1	Advanced Biostatistics

2	Quantitative Genetics
3	Computational Tools
4	Research Project and Presentation

Detailed Syllabus

Module 1	Advanced Biostatistics :Multivariate analysis (PCA, MANOVA), Time series analysis, Survival analysis, Bayesian statistics
Module 2	Quantitative Genetics :Quantitative traits and heritability, QTL mapping and association studies, Genetic linkage and mapping, Epigenetics and gene expression
Module 3	Computational Tools: R programming language, Bioinformatics tools (BLAST, GenBank), Population genetic software (Arlequin, FSTAT), Statistical software (SPSS, SAS)
Module 4	Research Project and Presentation : Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation, Defense of research project

Recommended Text books

1. Biostatistics: A Foundation for Analysis in the Health Sciences" by Wayne W. Daniel
2. "Population Genetics: A Concise Guide" by John H. Gillespie
3. "Quantitative Genetics: Theory and Practice" by William G. Hill

Course Name-M.Sc.

Course Code-MZO151: Zoology Practical

Credits-4 (P-12 h)

Detailed Syllabus (Practical)

Molecular Biology Techniques : DNA extraction and purification, PCR and DNA sequencing Gel electrophoresis and Western blotting, Molecular marker techniques

Animal Physiology and Pharmacology :Physiological measurements (ECG, EEG, blood pressure), Pharmacological assays (LD50, ED50), Hormonal assays (RIA, ELISA)

Course Code- MZO 201

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 2nd Year (Zoology) Scheme Updated on Session - July-2022

MZO 201: Biology of Chordates

Student will be able to know

CO1	Understand the diversity and evolution of chordates.

CO2	Describe the morphology, anatomy, and physiology of chordates.
CO3	Analyze the developmental biology of chordates.
CO4	Apply knowledge of chordate biology to ecological and conservation contexts

Course Outline

1	Vertebrate Developmental Biology
2	Chordate Ecology and Conservation
3	Advanced Topics in Chordate Biology
4	Research Project and Presentation

Detailed Syllabus

Module 1	Vertebrate Developmental Biology: Embryonic development (cleavage, gastrulation, neurulation), Organogenesis (formation of organs), Morphogenesis (tissue and pattern formation), Regeneration and repair
Module 2	Chordate Ecology and Conservation :Ecological roles of chordates in ecosystems, Conservation status and threats to chordates, Chordate diversity and ecosystem services, Case studies in chordate conservation
Module 3	Advanced Topics in Chordate Biology :Chordate genomics and bioinformatics, Chordate evolutionary developmental biology, Chordate behavioral ecology, Chordate biotechnology and applications
Module 4	Research Project and Presentation: Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation, Defense of research project

Recommended books:

1. "Biology of Chordates" by W.W. Norton
2. "Chordate Developmental Biology" by S.F. Gilbert
3. "Vertebrate Biology" by K.V. Kardong

Course Code- MZO 202

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 2nd Year (Zoology) Scheme Updated on Session - July-2022

MZO 202: Environmental Biology and Ethology

Student will be able to know

CO1	Understand the principles of environmental biology

CO2	Describe the impact of environmental factors on organisms.
CO3	Analyze animal behavior and its evolutionary significance.
CO4	Apply knowledge of environmental biology and ethology to conservation and management.
Course Outline	
1	Wildlife Ecology and Management
2	Behavioral Conservation Biology
3	Advanced Topics in Environmental Biology
4	Research Project and Presentation
Detailed Syllabus	
Module 1	Wildlife Ecology and Management :Wildlife ecology, Population dynamics,Habitat management, Conservation strategies
Module 2	Behavioral Conservation Biology :Application of ethology in conservation, Behavioral ecology of endangered species, Human-wildlife conflict, Conservation psychology
Module 3	Advanced Topics in Environmental Biology :Climate change biology, Environmental genomics, Ecological restoration, Sustainable development
Module 4	Research Project and Presentation :Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation, Defense of research project
Recommended books: 1. "Environmental Biology" by Eldredge and Hatcher 2. "Animal Behaviour" by Manning and Dawkins 3. "Ecotoxicology" by Walker	
Course Code- MZO 203	
Credits- 05 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 2nd Year (Zoology) Scheme Updated on Session - July-2022	
MZO 203: Genes and Differentiation	
Student will be able to know	
CO1	Understand the principles of gene structure and function.
CO2	Describe the mechanisms of gene expression and regulation.

CO3	Analyze the role of genes in cellular differentiation.
CO4	Apply knowledge of genomics and epigenomics to developmental biology.

Course Outline

1	Developmental Genetics
2	Genomics and Epigenomics
3	Advanced Topics in Gene Regulation
4	Research Project and Presentation

Detailed Syllabus

Module 1	Developmental Genetics : Embryonic development and patterning, Gene regulation during embryogenesis, Developmental genetic disorders, Evolutionary developmental biology
Module 2	Genomics and Epigenomics :Genome assembly and annotation, Epigenomic analysis and interpretation, Gene expression profiling, Bioinformatics tools for genomics and epigenomics
Module 3	Advanced Topics in Gene Regulation : Non-coding RNAs and gene regulation, Gene regulation in disease, Synthetic biology and gene editing, Gene therapy and its applications
Module 4	Research Project and Presentation :Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation, Defense of research project

Recommended books:

1. "Molecular Biology of the Gene" by James D. Watson
2. "Epigenetics" by Lyle Armstron
3. "Developmental Biology" by Scott F. Gilbert

Course Code- MZO 204

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 2nd Year (Zoology) Scheme Updated on Session - July-2022

MZO 204: Tools and Techniques in Biology

Student will be able to know

CO1	Understand various laboratory techniques used in biological research.
CO2	Develop skills in molecular biology, cellular biology, and biochemical techniques.

CO3	Apply bioinformatics tools for data analysis and interpretation.
CO4	Integrate knowledge of biological techniques in research and industry.

Course Outline

1	Advanced Molecular Biology Techniques
2	Biophysical Techniques
3	Research Project and Presentation
4	Bioinformatics Tools

Detailed Syllabus

Module 1	Advanced Molecular Biology Techniques: CRISPR-Cas9 gene editing, RNA interference and gene silencing, Gene expression analysis using microarrays, Next-generation sequencing
Module 2	Biophysical Techniques :X-ray crystallography and protein structure determination, Nuclear magnetic resonance (NMR) spectroscopy, Circular dichroism and fluorescence spectroscopy Biophysical analysis of protein-ligand interactions
Module 3	Research Project and Presentation : Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation, Defense of research project
Module 4	Bioinformatics Tools : Sequence analysis and alignment, Phylogenetic analysis and tree construction, Genome assembly and annotation, Protein structure prediction and modeling

Recommended books:

1. "Molecular Cloning: A Laboratory Manual" by Michael R. Green and Joseph Sambrook
2. "Cell Biology: A Laboratory Handbook" by Julio E. Celis
3. "Bioinformatics: A Practical Approach" by Gary D. Stormo

Course Code- MZO 205

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 2nd Year (Zoology) Scheme Updated on Session - July-2022

MZO 205: Cancer Biology-Nature of Cancer

Student will be able to know

CO1	Understand the fundamental concepts of cancer biology.

CO2	Describe the characteristics and hallmarks of cancer cells.
CO3	Explain the molecular mechanisms underlying cancer development and progression.
CO4	Discuss the role of genetic and environmental factors in cancer.

Course Outline

1	Cancer Genetics and Epigenetics
2	Cancer Signaling Pathways
3	Cancer Therapy and Management
4	Research Project and Presentation

Detailed Syllabus

Module 1	Cancer Genetics and Epigenetics: Cancer genome analysis, Genetic predisposition to cancer Epigenetic regulation of gene expression, Cancer epigenomics
Module 2	Cancer Signaling Pathways: Cell signaling pathways in cancer, Receptor tyrosine kinases (RTKs), G-protein coupled receptors (GPCRs), Cancer therapeutic targeting
Module 3	Cancer Therapy and Management :Surgery, chemotherapy, and radiation therapy, Targeted therapies (monoclonal antibodies, kinase inhibitors), Immunotherapy and cancer vaccines, Cancer stem cell targeting
Module 4	Research Project and Presentation :Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation, Defense of research project

Recommended books:

1. "The Biology of Cancer" by Robert A. Weinberg
2. "Cancer Biology" by Stella Pelengaris and Mike Khan
3. "Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics" by Stella Pelengaris and Mike Khan

Course Code- MZO 206

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 2nd Year (Zoology) Scheme Updated on Session - July-2022

MZO 206: Cancer Biology- Causation, Prevention and Cure of Cancer

Student will be able to know

CO1	Understand the causes and risk factors of cancer.

CO2	Describe the mechanisms of cancer prevention and early detection.
CO3	Explain the principles of cancer treatment and therapy.
CO4	Discuss the current research and future directions in cancer biology.

Course Outline

1	Molecular Targeted Therapies
2	Cancer Immunology and Immunotherapy
3	Cancer Nanotechnology and Gene Therapy
4	Research Project and Presentation

Detailed Syllabus

Module 1	Molecular Targeted Therapies : Gene expression profiling and cancer diagnosis, Personalized medicine and targeted therapies, Cancer genomics and epigenomics, Synthetic lethality and cancer therapy
Module 2	Cancer Immunology and Immunotherapy : Tumor-immune cell interactions, Immune evasion mechanisms, Immunotherapeutic strategies (checkpoint inhibitors, CAR-T cells), Cancer vaccine development
Module 3	Cancer Nanotechnology and Gene Therapy : Nanoparticles and cancer diagnosis, Gene therapy and RNA interference, Cancer gene editing (CRISPR/Cas9), Cancer nanotechnology and therapy
Module 4	Research Project and Presentation :Research project proposal and literature review, Data collection and analysis, Research presentation and manuscript preparation, Defense of research project

Recommended books:

1. The Biology of Cancer" by Robert A. Weinberg
2. "Cancer Biology" by Stella Pelengaris and Mike Khan
3. "Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics" by Stella Pelengaris and Mike Khan

Course Name-M.Sc.

Course Code-MZO252: Practical of Cancer Biology

Credits-4 (P-12 h)

Detailed Syllabus (Practical)

1. Advanced Zoology : Evolutionary biology, Phylogenetics, Comparative anatomy, Developmental biology

2.Genetics and Genomics: Molecular genetics, Genomics, Epigenetics, Bioinformatics

3. Biostatistics and Research Methodology : Statistical analysis, Research design, Experimental methods, Data interpretation

4. Cancer Biology - Nature of Cancer, Cancer definition, Types of cancer, Cancer genetics, Cancer treatment

5. Cancer Biology - Causation, Prevention and Cure , Cancer causation, Prevention strategies Treatment options, Future directions

Course Code- MMT 101: Advanced Abstract Algebra	
Credits- 06 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 1st Year (Mathematics)	
Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023	
MMT 101: Advanced Abstract Algebra	
Student will be able to know	
CO1	Understand advanced mathematical concepts.
CO2	Apply mathematical techniques to solve problems.
CO3	Analyze and interpret mathematical models.
CO4	Develop research skills in mathematics.
Course Outline	
1	Advanced Calculus
2	Linear Algebra
3	Real Analysis
4	Discrete Mathematics
Detailed Syllabus	
Module 1	Advanced Calculus : Vector calculus, Differential equation, Integral transforms Complex analysis
Module 2	Linear Algebra :Vector spaces, Linear transformations, Eigenvalues and eigenvectors, Orthogonality and inner product spaces
Module 3	Real Analysis: Set theory, Topology, Measure theory, Lebesgue integration
Module 4	Discrete Mathematics : Combinatorics, Graph theory, Number theory, Algebraic structures

Recommended books:

Textbooks:

1. "Abstract Algebra" by David S. Dummit and Richard M. Foote
2. "Algebra" by Michael Artin
3. "Advanced Algebra" by Anthony W. Knapp

Reference Books:

1. "A Course in Abstract Algebra" by B. L. van der Waerden
2. "Algebra: A Graduate Course" by I. Martin Isaacs
3. "Graduate Algebra" by Louis Rowen

Course Code- MMT 102: Real Analysis and Topology

Credits- 06 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Mathematics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MMT 102: Real Analysis and Topology

Student will be able to know

CO1	Set Theory and Topology
CO2	Real Numbers and Sequences
CO3	Continuity and Differentiability
CO4	Integration and Measure Theory

Course Outline

1	Set Theory and Topology
2	Real Numbers and Sequences
3	Continuity and Differentiability
4	Integration and Measure Theory

Detailed Syllabus

Module 1	Set Theory and Topology: Set theory (sets, relations, functions), Topological spaces (definition, examples), Open and closed sets, Compactness and connectedness
Module 2	Real Numbers and Sequences: Real numbers (axioms, properties), Sequences and series (convergence, divergence), Limit superior and limit inferior, Cauchy sequences
Module 3:	Continuity and Differentiability : Continuous functions (definition, properties) Differentiable functions (definition, properties, Mean value theorem, L'Hospital's rule

Module 4	Integration and Measure Theory: Riemann integration (definition, properties), Lebesgue integration (definition, properties), Measure theory (definition, properties), Fubini's theorem

Recommended books

Real Analysis:

1. "Real and Complex Analysis" by Walter Rudin
2. "Real Analysis" by H. L. Royden
3. "Principles of Mathematical Analysis" by Walter Rudin

Topology:

1. "Topology" by James R. Munkres
2. "Algebraic Topology" by Allen Hatcher
3. "Differential Topology" by Andrew Wallace

Course Code- MMT 103: Differential Equations and Special Functions

Credits- 06 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc.- 1st Year (Mathematics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MMT 103: Differential Equations and Special Functions

Student will be able to know

CO1	Understand differential equations and special functions concepts.
CO2	Apply mathematical techniques to solve differential equations.
CO3	Analyze and interpret mathematical models using differential equations.
CO4	Develop research skills in differential equations and special functions.

Course Outline

1	Ordinary Differential Equations
2	Special Functions
3	Partial Differential Equations
4	Applications of Differential Equations

Detailed Syllabus

Module 1	Ordinary Differential Equations : Introduction to ODEs, Separable ODEs, First-order linear ODEs, Higher-order linear ODEs

Module 2	Special Functions: Gamma function, Bessel functions, Legendre functions, Hypergeometric functions
Module 3	Partial Differential Equations: Introduction to PDEs, Classification of PDEs, Separation of variables, Fourier series and transforms
Module 4	Applications of Differential Equations : Modeling with ODEs and PDEs, Numerical methods for ODEs and PDEs, Applications in physics, engineering, and biology Research trends in differential equations

Recommended books:

1. Differential Equations and Dynamical Systems" by Lawrence Perko
2. "Ordinary Differential Equations" by Morris Tenenbaum and Harry Pollard
3. "Special Functions" by Earl D. Rainville
4. "Partial Differential Equations" by Walter A. Strauss

Course Code- MMT 104: Differential Geometry and Tensor Analysis

Credits- 06 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Mathematics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MMT 104: Differential Geometry and Tensor Analysis

Student will be able to know

CO1	Understand differential equations and special functions concepts.
CO2	Apply mathematical techniques to solve differential equations.
CO3	Analyze and interpret mathematical models using differential equations.
CO4	Develop research skills in differential equations and special functions.

Course Outline

1	Ordinary Differential Equations
2	Special Functions
3	Partial Differential Equations
4	Applications of Differential Equations

Detailed Syllabus

Module 1	Ordinary Differential Equations : Introduction to ODEs, Separable ODEs, First-order linear ODEs, Higher-order linear ODEs

Module 2	Special Functions : Gamma function, Bessel functions, Legendre functions Hypergeometric functions
Module 3	Partial Differential Equations : Introduction to PDEs, Classification of PDEs Separation of variables, Fourier series and transforms
Module 4	Applications of Differential Equations : Modeling with ODEs and PDEs, Numerical methods for ODEs and PDEs, Applications in physics, engineering, and biology Research trends in differential equations

Recommended books:

1. "Differential Equations and Dynamical Systems" by Lawrence Perko
2. "Ordinary Differential Equations" by Morris Tenenbaum and Harry Pollard
3. "Special Functions" by Earl D. Rainville
4. "Partial Differential Equations" by Walter A. Strauss

Course Code- MMT 105: Mechanics

Credits- 06 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Mathematics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MMT 105: Mechanics

Student will be able to know

CO1	Understand the fundamental principles of mechanics.
CO2	Apply mathematical techniques to solve problems in mechanics.
CO3	Analyze and interpret physical systems using mathematical models.
CO4	Develop research skills in mechanics.

Course Outline

1	Classical Mechanics
2	Lagrangian and Hamiltonian Mechanics
3	Continuum Mechanics
4	Mathematical Methods in Mechanics

Detailed Syllabus

Module 1	Classical Mechanics : Introduction to mechanics, Kinematics (motion, velocity, acceleration), Dynamics (forces, Newton's laws), Work, energy, and momentum

Module 2	Lagrangian and Hamiltonian Mechanics : Lagrangian mechanics (Lagrangian, Euler-Lagrange equations), Hamiltonian mechanics (Hamiltonian, canonical equations), Variational principles (action, minimum action), Symmetries and conservation laws
Module 3	Continuum Mechanics : Introduction to continuum mechanics, Stress and strain (tensors, elasticity), Fluid dynamics (Navier-Stokes equations, fluid flow), Thermodynamics (temperature, entropy, equilibrium)
Module 4	Mathematical Methods in Mechanics : Vector calculus (gradient, divergence, curl), Tensor analysis (tensor algebra, tensor calculus), Differential equations in mechanics (ODEs, PDEs), Numerical methods in mechanics (finite differences, finite elements)

Recommended books:

1. "Classical Mechanics" by John R. Taylor
2. "Mechanics: From Newton's Laws to Deterministic Chaos" by Florian Scheck
3. "Lagrangian and Hamiltonian Mechanics" by M. G. Calkin
4. "Continuum Mechanics" by Lawrence E. Malvern

Course Code- MMT 201:

Credits- 06 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 2nd Year (Mathematics)
Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022

MMT 201: Analysis and Advanced Calculus

Student will be able to know

CO1	Understand advanced calculus concepts.
CO2	Apply mathematical techniques to solve problems in analysis.
CO3	Analyze and interpret mathematical models using advanced calculus.
CO4	Develop research skills in analysis and advanced calculus.

Course Outline

1	Advanced Calculus
2	Real Analysis
3	Functional Analysis
4	Advanced Topics in Analysis

Detailed Syllabus

Module 1	Advanced Calculus :Review of calculus (limits, derivatives, integrals), Multivariable calculus (partial derivatives, double integrals), Differential forms (vector calculus, differential equations), Integral theorems (Stokes', Gauss', Green's)
Module 2	Real Analysis : Lebesgue measure (definition, properties), Lebesgue integration (definition, properties), Lp spaces (definition, properties), Fourier analysis (Fourier series, Fourier transforms)
Module 3	Functional Analysis :Normed linear spaces (definition, properties), Banach spaces (definition, properties), Hilbert spaces (definition, properties), Linear operators (definition, properties)
Module 4	Advanced Topics in Analysis : Measure theory (Radon-Nikodym theorem, Hausdorff measure), Operator theory (spectral theory, Fredholm operators), Advanced calculus of variations (Euler-Lagrange equations), Research trends in analysis

Recommended books:

1. "Real and Complex Analysis" by Walter Rudin
2. "Functional Analysis" by Walter Rudin
3. "Advanced Calculus" by L. V. Tarasov
4. "Measure Theory" by H. L. Royden

Course Code- MMT 202: Viscous Fluid Dynamics

Credits- 06 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Mathematics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MMT 202: Viscous Fluid Dynamics

Student will be able to know

CO1	Understand the fundamental principles of viscous fluid dynamics.
CO2	Apply mathematical techniques to solve problems in fluid dynamics.
CO3	Analyze and interpret physical systems using mathematical models..
CO4	Develop research skills in fluid dynamics

Course Outline

1	Introduction Viscous Flows : Function to Fluid Dynamics
2	Viscous Flows
3	Mathematical Methods in Fluid Dynamics
4	Advanced Topics in Fluid Dynamics:

Detailed Syllabus	
Module 1	Introduction to Fluid Dynamics : Introduction to fluid dynamics, Kinematics of fluid motion, Dynamics of fluid motion (Navier-Stokes equations), Fluid properties (density, viscosity, surface tension)
Module 2	Viscous Flows : Viscous flow equations (Navier-Stokes, Stokes'), Laminar flow (channel flow, pipe flow), Turbulent flow (introduction, Reynolds averaging) Boundary layers (laminar, turbulent)
Module 3	Mathematical Methods in Fluid Dynamics :Vector calculus (gradient, divergence, curl), Tensor analysis (tensor algebra, tensor calculus), Differential equations in fluid dynamics (ODEs, PDEs), Numerical methods in fluid dynamics (finite differences, finite elements)
Module 4	Advanced Topics in Fluid Dynamics: Compressible fluid flow, Multiphase flow, Fluid instabilities (Rayleigh-Taylor, Kelvin) -Helmholtz), Research trends in fluid dynamics

Recommended books:

1. "Fluid Dynamics" by Kundu and Cohen
2. "Viscous Fluid Flow" by Frank M. White
3. "Fluid Dynamics: Theory, Computation, and Numerical Simulation" by C. Pozrikidis
4. "Introduction to Fluid Dynamics" by G. K. Batchelor

Course Code- MMT 203: Continuum Mechanics

Credits- 06 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Mathematics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MMT 203: Continuum Mechanics

Student will be able to know

CO1	Understand the fundamental principles of continuum mechanics.
CO2	Apply mathematical techniques to solve problems in continuum mechanics..
CO3	Analyze and interpret physical systems using mathematical models.
CO4	Develop research skills in continuum mechanics

Course Outline

1	Introduction to Continuum Mechanics
2	Elasticity
3	Fluid Mechanics
4	Advanced Topics in Continuum Mechanics

Detailed Syllabus	
Module 1	Introduction to Continuum Mechanics : Introduction to continuum mechanics, Kinematics of continuum mechanics, Stress and strain (tensors, elasticity), Conservation laws (mass, momentum, energy)
Module 2	Elasticity :Linear elasticity (Hooke's law, stress-strain relations), Nonlinear elasticity (finite deformation, hyperelasticity), Elastic waves (longitudinal, shear, Rayleigh waves), Elastic stability (buckling, vibration)
Module 3	Fluid Mechanics: Fluid kinematics (velocity, acceleration, streamlines, Fluid dynamics (Navier-Stokes equations, boundary layers), Fluid statics (hydrostatics, buoyancy), Fluid flow through porous media
Module 4	Advanced Topics in Continuum Mechanics : Viscoelasticity (Maxwell, Kelvin-Voigt models), Plasticity (yield criteria, flow rules), Fracture mechanics (stress intensity factors, crack propagation), Research trends in continuum mechanics
Recommended books: 1. Continuum Mechanics" by Lawrence E. Malvern 2. "The Mechanics of Solids and Structures" by I. H. Shames and J. L. Coombes 3. "Fluid Mechanics" by Kundu and Cohen 4. "Elasticity: Theory, Applications, and Numerics" by Martin H. Sadd	
Course Code- MMT 204: Boundary Layer Theory	
Credits- 06 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 1st Year (Mathematics) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023**	
MMT 204: Boundary Layer Theory	
Student will be able to know	
CO1 Understand the fundamental principles of boundary layer theory.	
CO2 Apply mathematical techniques to solve problems in boundary layer flows.	
CO3 Analyze and interpret physical systems using boundary layer models.	
CO4 Develop research skills in fluid dynamics.	
Course Outline	
1 Introduction to Boundary Layers	
2 Laminar Boundary Layers	

3	Turbulent Boundary Layers	
4	Advanced Topics in Boundary Layer Theory	
Detailed Syllabus		
Module 1	Introduction to Boundary Layers: 1 Boundary layer equations (Prandtl's equations) Boundary layer thickness (Blasius solution), Skin friction and heat transfer	
Module 2	Laminar Boundary Layers: Blasius solution (flat plate), Falkner-Skan solution (wedge flow), Howarth's solution (stagnation point flow), Laminar boundary layer separation	
Module 3	Turbulent Boundary Layers: Introduction to turbulent boundary layers, Prandtl's mixing length theory, Kolmogorov's theory (turbulent kinetic energy), Turbulent boundary layer separation	
Module 4	Advanced Topics in Boundary Layer Theory : Compressible boundary layers, Three-dimensional boundary layers, Unsteady boundary layers, Research trends in boundary layer theory	
Recommended books: 1. Boundary Layer Theory" by Hermann Schlichting 2. "Viscous Fluid Flow" by Frank M. White 3. "Fluid Dynamics: Theory, Computation, and Numerical Simulation" by C. Pozrikidis 4. "Boundary Layers and Boundary Layer Control" by A. K. Singh		
Course Code- MMT 205: Mathematical Programming		
Credits- 06 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - 1st Year (Mathematics) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023**		
MMT 205: Mathematical Programming		
Student will be able to know		
CO1	Understand the fundamental principles of mathematical programming.	
CO2	Apply mathematical techniques to solve optimization problems.	
CO3	Analyze and interpret mathematical models using programming techniques.	
CO4	Develop research skills in mathematical programming.	
Course Outline		
1	Linear Programming	
2	Non-Linear Programming	
3	Dynamic Programming	

4	Advanced Topics in Mathematical Programming	
Detailed Syllabus		
Module 1	Linear Programming :Introduction to linear programming, Graphical method, Simplex method, Duality in linear programming	
Module 2	Non-Linear Programming : Introduction to non-linear programming, Unconstrained optimization, Constrained optimization (Kuhn-Tucker conditions), Quadratic programming	
Module 3	Dynamic Programming : Introduction to dynamic programming, Principle of optimality, Dynamic programming algorithms, Applications of dynamic programming	
Module 4	Advanced Topics in Mathematical Programming : Integer programming, Stochastic programming, Convex optimization, Research trends in mathematical programming	
Recommended books: 1. "Linear Programming and Its Applications" by S. S. Rao 2. "Non-Linear Programming" by M. S. Bazaraa 3. "Dynamic Programming" by R. Bellman 4. "Convex Optimization" by S. Boyd and L. Vandenberghe		
Course Code- MBT 101: Cell and Molecular Biology of Plants		
Credits- 06 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - 1st Year (Botany) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023**		
MBT 101: Cell and Molecular Biology of Plants		
Student will be able to know		
CO1	Understand the structure and function of plant cells.	
CO2	Understand the molecular mechanisms underlying plant cellular processes.	
CO3	Apply knowledge of cell and molecular biology to plant sciences..	
CO4	Develop research skills in plant cell and molecular biology	
Course Outline		
1	Plant Cell Structure and Function	
2	Molecular Biology of Plants	
3	Cellular Processes in Plants	

4	Advanced Topics in Plant Cell and Molecular Biology	
Detailed Syllabus		
Module 1	Plant Cell Structure and Function: Plant cell anatomy (cell wall, membrane, organelles), Cell division and expansion, Cellular transport mechanisms, Signaling pathways in plant cells	
Module 2	Molecular Biology of Plants: DNA structure and replication, Gene expression (transcription, translation), Regulation of gene expression, Plant genomics and proteomics	
Module 3	Cellular Processes in Plants: Photosynthesis and respiration, Cell growth and differentiation, Programmed cell death, Stress responses in plants	
Module 4	Advanced Topics in Plant Cell and Molecular Biology : Plant hormone signalling, Plant-microbe interactions, Epigenetics in plant development, Current research trends in plant cell and molecular biology	
Recommended books: 1. Plant Cell Biology" by R. D. Allen et al. 2. "Molecular Biology of Plants" by R. G. Herrmann 3. "Plant Molecular Biology" by C. D. Dickinson and E. M. Chrispeels 4. "Plant Cell and Molecular Biology" by L. C. Van and J. D. Anderson		
Course Code- MBT 102:		
Credits- 06 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - 1st Year (Botany) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023**		
MBT 102: Cytology, Genetics and Cytogenetics		
Student will be able to know		
CO1	Understand the principles of cytology, genetics, and cytogenetics.	
CO2	Apply knowledge of cytology, genetics, and cytogenetics to plant sciences.	
CO3	Analyze and interpret cytological, genetic, and cytogenetic data.	
CO4	Develop research skills in cytology, genetics, and cytogenetics.	
Course Outline		
1	Cytology	
2	Genetics	

3	Cytogenetics	
4	Advanced Topics: Epigenetics and gene regulation	
Detailed Syllabus		
Module 1	Cytology: Cell structure and function, Chromosome structure and behaviour, Mitosis and meiosis, Cell division and cytokinesis	
Module 2	Genetics: Mendelian genetics, Gene interaction and linkage, Mutation and gene regulation, Quantitative genetics	
Module 3	Cytogenetics: Chromosome mapping and cytogenetic techniques, Chromosome aberrations and mutations, Plant breeding and cytogenetics, Cytogenomics and bioinformatics	
Module 4	Advanced Topics (Epigenetics and gene regulation): Plant genome evolution, Cytogenetic and genetic basis of plant diseases, Current research trends in cytology, genetics, and cytogenetics	
Recommended books 1. Plant Cytology and Genetics" by B. K. Sinha 2. "Genetics: Principles and Analysis" by D. T. Suzuki et al. 3. "Plant Cytogenetics" by R. N. Singh 4. "Cytogenetics and Plant Breeding" by G. S. Khush and R. J. Singh		
Course Code- MBT 101:		
Credits- 06 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - 1st Year (Botany) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023**		
MBT 103: Biology and Diversity of Lower Plants: Cryptogams		
Student will be able to know		
CO1	Understand the biology and diversity of cryptogams.	
CO2	Identify and classify different groups of cryptogams.	
CO3	Analyze the ecological and economic importance of cryptogams.	
CO4	Develop research skills in cryptogam biology.	
Course Outline		
1	Introduction to Cryptogams	
2	Algae	

3	Bryophytes	
4	Pteridophytes	
Detailed Syllabus		
Module 1	Introduction to Cryptogams : Definition and characteristics of cryptogams, Classification and phylogeny of cryptogams, Evolutionary relationships among cryptogams	
Module 2	Algae: Diversity and classification of algae, Algal morphology and anatomy Algal physiology and ecology	
Module 3	Bryophytes :Diversity and classification of bryophytes, Bryophyte morphology and anatomy, Bryophyte physiology and ecology	
Module 4	Pteridophytes: Diversity and classification of pteridophytes, Pteridophyte morphology and anatomy, Pteridophyte physiology and ecology	
Recommended books: 1. "Cryptogams: Biology and Diversity" by R. N. Singh 2. "Algae: Anatomy, Biochemistry, and Biotechnology" by J. S. Singh 3. "Bryophytes: Biology and Ecology" by A. J. Shaw and B. Goffinet 4. "Pteridophytes: Biology and Evolution" by D. L. Dilcher		
Course Code- MBT 104: Taxonomy & Diversity of Seed Plants		
Credits- 06 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - 1st Year (Botany) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023**		
MBT 104: Taxonomy & Diversity of Seed Plants		
Student will be able to know		
CO1	Understand the principles of taxonomy and systematics.	
CO2	Identify and classify seed plants..	
CO3	Analyze the diversity and evolution of seed plants.	
CO4	Develop research skills in plant taxonomy	
Course Outline		
1	Introduction to Taxonomy	
2	Gymnosperms	

3	Angiosperms
4	Plant Systematics

Detailed Syllabus

Module 1	Introduction to Taxonomy : Definition and importance of taxonomy, History of plant classification, Principles of taxonomy (morphology, anatomy, phytochemistry)
Module 2	Gymnosperms: Diversity and classification of gymnosperms, Gymnosperm morphology and anatomy, Evolutionary relationships among gymnosperms
Module 3	Angiosperms: Diversity and classification of angiosperms, Angiosperm morphology and anatomy, Evolutionary relationships among angiosperms
Module 4	Plant Systematics: Phylogenetic analysis, Cladistics and molecular systematics, Plant classification systems (APG, Cronquist)

Recommended books:
1. Plant Taxonomy" by G. L. Stebbins
2. "The Plant Book" by M. F. Watson
3. "Seed Plant Diversity" by P. H. Raven
4. "Plant Systematics" by W. S. Judd et al.

Course Code- MBT 105: Plant Physiology and Metabolism

Credits- 06 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Botany)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MBT 105: Plant Physiology and Metabolism

Student will be able to know

CO1	Understand plant physiological processes.
CO2	Analyze plant metabolic pathways.
CO3	Apply knowledge of plant physiology to agricultural and horticultural practices.
CO4	Develop research skills in plant physiology.

Course Outline

1	Plant Water Relations
2	Photosynthesis

3	Plant Respiration	
4	Plant Hormones and Growth Regulators	
Detailed Syllabus		
Module 1	Plant Water Relations: Water uptake and transport, Water balance and stress Osmoregulation	
Module 2	Photosynthesis: Light-dependent reactions, Calvin cycle, C3, C4, and CAM photosynthesis	
Module 3	Plant Respiration: Glycolysis and citric acid cycle, Electron transport chain, Respiratory quotient	
Module 4	Plant Hormones and Growth Regulators: Auxins, gibberellins, cytokinins, and ethylene, Hormone regulation of growth and development, Plant growth regulators in agriculture	
Recommended books: 1. "Plant Physiology" by L. Taiz and E. Zeiger 2. "Plant Physiology and Metabolism" by R. K. Singh 3. "Plant Biochemistry" by P. M. Dey and J. B. Harborne 4. "Plant Hormones" by P. J. Davies		
Course Code- MBT 106:		
Credits- 06 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - 1st Year (Botany) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023**		
MBT 106: Microbiology and Plant Pathology		
Student will be able to know		
CO1	Understand the principles of microbiology.	
CO2	Analyze plant-microbe interactions.	
CO3	Identify and characterize plant pathogens.	
CO4	Develop research skills in plant pathology.	
Course Outline		
1	Microbiology	
2	Plant-Microbe Interactions	
3	Plant Pathology	

4	Advanced Topics

Detailed Syllabus

Module 1	Microbiology: Introduction to microbiology, Bacterial structure and function, Fungal biology, Viral biology
Module 2	Plant-Microbe Interactions : Symbiotic relationships (mycorrhizae, rhizobia), Plant-microbe signalling, Microbial plant growth promotion
Module 3	Plant Pathology: Types of plant pathogens (bacterial, fungal, viral), Disease transmission and dissemination, Disease management (cultural, chemical, biological)
Module 4	Advanced Topics: Molecular plant pathology, Plant disease resistance, Biocontrol agents, Current research trends in plant pathology

Recommended books:

1. Microbiology" by J. M. Lederberg
2. "Plant-Microbe Interactions" by B. B. Buchanan and G. C. Van
3. "Plant Pathology" by G. N. Agrios
4. "Plant Disease Management" by A. M. Sagar and R. K. Singh

Course Code- MBT 201:

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 2nd Year (Botany)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"

MBT 201: Plant Morphology, Developmental Anatomy and Reproductive Biology

Student will be able to know

CO1	Identify and describe plant structures using morphological and anatomical terminology.
CO2	Prepare and analyze plant specimens for microscopic study.
CO3	Conduct experiments to demonstrate plant growth and developmental processes.
CO4	Analyze and interpret data related to plant reproduction and diversity.

Course Outline

1	Plant Morphology
2	Developmental Anatomy
3	Reproductive Biology

4	Applied Aspects	
Detailed Syllabus		
Module 1	Plant Morphology : Plant body organization, Root and shoot architecture, Leaf morphology and venation, Stem and branch structure, Plant classification and identification	
Module 2	Developmental Anatomy : Cell differentiation and tissue formation, Meristematic tissues and differentiation, Primary and secondary growth, Root and shoot apical meristems, Leaf and flower development	
Module 3	Reproductive Biology : Flower structure and types, Pollination mechanisms and strategies Fertilization and seed development, Fruit types and dispersal mechanisms 5. Reproductive adaptations and evolution	
Module 4	Applied Aspects: Plant breeding and hybridization, Plant tissue culture and micropropagation, Plant genetic engineering, Plant biotechnology applications, Ethnobotany and plant conservation	
Recommended books: 1. E. J. H. Corner - "The Method of Evolution" 2. P. H. Raven et al. - "Biology of Plants" 3. P. S. Noggle et al. - "Plant Anatomy" 4. A. F. D. Machado et al. - "Plant Morphology" 5. W. C. Dickison - "Integrative Plant Anatomy" 6. K. R. Sporne - "The Morphology of Angiosperms"		
Course Code- MBT 202:		
Credits- 05 (L-18 h/T-18h)		
Course Outcomes (Cos)		
"M.Sc - 2nd Year (Botany) Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"		
MBT 202: Plant Ecology		
Student will be able to know		
CO1	Describe plant-environment interactions	
CO2	Explain ecological succession and community dynamics	
CO3	Analyze resource competition and allocation	
CO4	Analyze impacts of climate change on plant ecology	

Course Outline	
1	Ecological Principles
2	Plant Communities
3	Ecosystem Processes
4	Applied Ecology
Detailed Syllabus	
Module 1	Ecological Principles: Introduction to ecology, Plant-environment interactions, Resource competition and allocation, Plant population ecology, Ecological succession
Module 2	Plant Communities :Types of plant communities, Community structure and diversity Species interactions (competition, facilitation, mutualism), Plant community dynamics Ecological niche and neutral theory
Module 3	Ecosystem Processes: Primary production and energy flow, Nutrient cycling and decomposition, Water relations and hydrology, Ecological stoichiometry Ecosystem services
Module 4	Applied Ecology : Conservation biology, Ecological restoration, Invasive species ecology Climate change and plant ecology, Ecological economics
Recommended books: 1. Crawley - "Plant Ecology" 2. Keddy - "Plant Ecology" 3. Smith and Smith - "Ecology of Plant Communities" 4. Begon et al. - "Ecology" 5. Ricklefs - "Ecology: The Economy of Nature" 6. Loreau - "From Populations to Ecosystems"	
Course Code- MBT 203	
Credits- 06 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 2nd Year (Botany) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"**	
MBT 203: Plant Resource Utilization & Conservation	
Student will be able to know	
CO1	Describe traditional and modern plant uses
CO2	Explain traditional knowledge systems

CO3	Discuss ethnobotanical research methods	
CO4	Apply ethnobotanical knowledge	
Course Outline		
1	Understand plant resource utilization	
2	Apply ethnobotanical knowledge	
3	Explain conservation biology principles	
4	Develop sustainable management strategies	
Detailed Syllabus		
Module 1	Plant Resource Utilization: Introduction to plant resource utilization, Traditional plant uses (food, medicine, fiber, etc.), Modern plant uses (pharmaceuticals, cosmetics, etc.) Plant-based industries (herbal, essential oils, etc.)	
Module 2	Ethnobotany : Definition and scope of ethnobotany, Traditional knowledge systems, Plant-based cultural practices, Ethnobotanical research methods	
Module 3	Conservation Biology : Principles of conservation biology, Plant extinction and threatened species, Habitat fragmentation and restoration, Ex-situ and in-situ conservation strategies	
Module 4	Sustainable Plant Resource Management : Sustainable harvesting practices, Agroforestry and permaculture, Plant genetic resource conservation, Policy and legislation for plant conservation	
Recommended books: 1. Berkov & Walker - "Ethnobotany and Conservation of Biocultural Diversity" 2. Cunningham - "Applied Ethnobotany" 3. Primack & Rodrigues - "Conservation Biology"		
Course Code- MBT 204		
Credits- 05 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc. - 2nd Year (Botany) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"**		
MBT 204: Biotechnology & Genetic Engineering of Plants and Microbes		
Student will be able to know		
CO1	Understand Biotechnology Principles	
CO2	Apply Genetic Engineering Techniques	

CO3	Explain Plant Biotechnology Applications	
CO4	Integrate Biotechnology and Genetic Engineering Concepts	
Course Outline		
1	Biotechnology Principles	
2	Genetic Engineering	
3	Plant Biotechnology	
4	Microbial Biotechnology	
Detailed Syllabus		
Module 1	Biotechnology Principles : DNA/RNA structure and function, Gene expression and regulation, Biotechnology tools	
Module 2	Genetic Engineering : Recombinant DNA construction, Gene transfer methods Gene editing	
Module 3	Plant Biotechnology : GM crops, Plant tissue culture and micropropagation, Plant genetic engineering	
Module 4	Microbial Biotechnology: Microbial fermentation, Industrial applications, Microbial gene expression	
Recommended books: 1. Campbell & Farrell - "Biotechnology: Science and Society" 2. Tizard - "Genetic Engineering" 3. Primrose & Twyman - "Genomics: Applications in Agriculture and Medicine" 4. Alberts et al. - "Molecular Biology of the Cell" 5. Lewin - "Genes X" 6. Watson et al. - "Molecular Biology of the Gene"		
Course Code- MBT 205		
Credits- 05 (L-18 h/T-18h)		
Course Outcomes (Cos)		
"M.Sc - 2nd Year (Botany) Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"		
MBT 205: Advanced Plant Pathology - I		
Student will be able to know		
CO1	Understand biotechnology principles and techniques	

CO2	Apply genetic engineering techniques	
CO3	Explain plant biotechnology applications	
CO4	Integrate biotechnology and genetic engineering concepts	
Course Outline		
1	Biotechnology Principles	
2	Genetic Engineering	
3	Plant Biotechnology	
4	Microbial Biotechnology	
Detailed Syllabus		
Module 1	Biotechnology Principles: DNA/RNA structure and function, Gene expression and regulation, Biotechnology tools	
Module 2	Genetic Engineering: Recombinant DNA construction, Gene transfer methods, Gene editing	
Module 3	Plant Biotechnology : GM crops, Plant tissue culture and micropropagation, Plant genetic engineering	
Module 4	Microbial Biotechnology: Microbial fermentation, Industrial applications, Microbial gene expression	
Recommended books: 1. Campbell & Farrell - "Biotechnology: Science and Society" 2. Tizard - "Genetic Engineering" 3. Primrose & Twyman - "Genomics: Applications in Agriculture and Medicine" 4. Alberts et al. - "Molecular Biology of the Cell" 5. Lewin - "Genes X" 6. Watson et al. - "Molecular Biology of the Gene"		
Course Code- MBT 205		
Credits- 06 (L-18 h/T-18h)		
Course Outcomes (Cos)		
"M.Sc - 2nd Year (Botany) Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"		
MBT 205: Advanced Plant Pathology - II		
Student will be able to know		
CO1	Explain microbial fermentation and product formation	

CO2	Discuss industrial applications (biofuels, enzymes, etc.)
CO3	Analyze microbial gene expression and regulation
CO4	Evaluate ethical and regulatory issues in biotechnology

Course Outline

1	Biotechnology Principles
2	Genetic Engineering
3	Plant Biotechnology
4	Microbial Biotechnology

Detailed Syllabus

Module 1	Biotechnology Principles: DNA/RNA structure and function, Gene expression and regulation, Biotechnology tools
Module 2	Genetic Engineering :Recombinant DNA construction, Gene transfer methods, Gene editing
Module 3	Plant Biotechnology : GM crops, Plant tissue culture and micropropagation, Plant genetic engineering
Module 4	Microbial Biotechnology : Microbial fermentation, Industrial applications, Microbial gene expression

Recommended books:

1. Campbell & Farrell - "Biotechnology: Science and Society"
2. Tizard - "Genetic Engineering"
3. Primrose & Twyman - "Genomics: Applications in Agriculture and Medicine"
4. Alberts et al. - "Molecular Biology of the Cell"
5. Lewin - "Genes X"
6. Watson et al. - "Molecular Biology of the Gene"

Course Name-M.Sc.

Course Code-MBT 252: Advanced Plant Pathology

Credits-4 (P-12 h)

Detailed Syllabus (Practical)

Isolation and Cultivation of Plant Pathogens: Isolation of fungal pathogens from infected plant material Cultivation of bacterial and fungal pathogens on artificial media, Preparation of pure cultures

Disease Diagnosis and Identification: Visual examination of diseased plants,Microscopic examination of disease symptoms, Use of disease diagnostic kits

Pathogenicity Tests : Inoculation of healthy plants with pathogens, Evaluation of disease symptoms ,Determination of pathogenicity

Fungicide and Bactericide Screening: Preparation of fungicide and bactericide solutions, Application of fungicides

and bactericides to infected plants, Evaluation of disease control	
Course Code- MST 101	
Credits- 05 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc - 1st Year (Statistics) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023**	
MST101:Mathematical Analysis	
Student will be able to know	
CO1 Understand calculus concepts and applications.	
CO2 Apply linear algebra techniques to statistical problems.	
CO3 Analyze real analysis concepts and their statistical implications.	
CO4 Develop problem-solving skills using mathematical analysis.	
Course Outline	
1 Calculus	
2 Integration	
3 Linear Algebra	
4 Markov Chains and Matrix Algebra	
Detailed Syllabus	
Module 1 Calculus: Limits and Continuity, Definition of limits, Properties of limits, Continuity and discontinuity Differentiation :Definition of derivatives, Rules of differentiation, Applications of derivatives	
Module 2 Integration : Definite and indefinite integrals, Applications of integration Multivariable Calculus :Partial derivatives, Double integrals	
Module 3 Linear Algebra : Vector Spaces, Definition and properties, Operations and examples Linear Transformations :Matrices and determinants, Eigenvalues and eigenvectors Orthogonality and Inner Product Spaces :Orthogonal vectors, Inner product spaces	
Module 4 Markov Chains and Matrix Algebra :Markov chains, Matrix algebra and applications Real Analysis: Sequences and Series, Convergence and divergence, Tests for convergence	

Recommended books:

1. Rudin - "Principles of Mathematical Analysis"
2. Apostol - "Calculus" (Volumes 1 and 2)
3. Linear Algebra and Its Applications - Strang
4. Real and Complex Analysis - Walter Rudin
5. Mathematical Analysis - T.M. Apostol
6. Calculus - Michael Spivak
7. Linear Algebra - David Lay
8. Real Analysis - H.L. Royden

CourseCode:102

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Statistics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MST102: Probability and Measure Theory

Student will be able to know

CO1	Understand probability spaces and random variables.
CO2	Apply probability distributions to statistical problems.
CO3	Analyze measure theory concepts and their statistical implications.
CO4	Develop problem-solving skills using probability and measure theory.

Course Outline

1	Probability Spaces
2	Random Variables
3	Probability Distributions
4	Measure Theory

Detailed Syllabus

Module 1	Probability Spaces: Definition of probability spaces, Axioms of probability, Probability measures Conditional probability
Module 2	Random Variables :Definition of random variables, Distribution function, Expectation and variance Moments and moment generating functions

Module 3	Probability Distributions: Discrete distributions (Bernoulli, Binomial, Poisson) Continuous distributions (Uniform, Normal, Exponential), Joint distributions, Conditional distributions	
Module 4	Measure Theory: Lebesgue measure, Measurable functions, Integration, Radon-Nikodym theorem	

Recommended books:

1. Billingsley - "Probability and Measure"
2. Grimmett and Stirzaker - "Probability and Random Processes"
3. Feller - "An Introduction to Probability Theory"
4. Rudin - "Real and Complex Analysis"
5. Probability Theory - E. Cinlar
6. Measure Theory - H.L. Royden
7. Statistical Inference - G. Casella and R.L. Berger
8. Probability and Statistics - J.L. Devore

Course Code- MST 103

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Statistics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MST103: Distribution Theory

Student will be able to know

CO1	Understand and apply univariate probability distributions
CO2	Analyze and apply multivariate probability distributions
CO3	Understand and apply special distributions
CO4	Develop problem-solving skills using distribution theory

Course Outline

1	Univariate Probability Distributions
2	Multivariate Probability Distributions
3	Special Distributions
4	Applications of Distribution Theory

Detailed Syllabus

Module 1	Univariate Probability Distributions: Bernoulli, Binomial, Poisson distributions, Moments, expectation, and variance
Module 2	Multivariate Probability Distributions : Multinomial, Multivariate Normal distributions Joint moments and correlation coefficients
Module 3	Special Distributions : Exponential, Gamma, Chi-Square distributions, Moments and properties
Module 4	Applications of Distribution Theory : Statistical estimation and testing, Real-world applications

Recommended books:

1. Johnson, Kemp, and Kotz - "Univariate Discrete Distributions"
2. Johnson and Kotz - "Multivariate Discrete Distributions"
3. Patel, Kapadia, and Owen - "Handbook of Statistical Distributions"
4. Distribution Theory - N.L. Johnson
5. Statistical Distributions - M. Evans
6. Probability and Statistics - J.L. Devore

Course Code- MST 104

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Statistics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MST104: Sample Surveys & Design of Experiment

Student will be able to know

CO1	Understand sample survey methods and sampling distributions.
CO2	Apply experimental design principles.
CO3	Analyze and interpret data from sample surveys and experiments.
CO4	Develop problem-solving skills using sample survey and experimental design.

Course Outline

1	Sample Survey Methods
2	Sampling Distributions
3	Experimental Design
4	Analysis of Variance (ANOVA)

Detailed Syllabus

Module 1	Sample Survey Methods : Introduction to sample surveys, Sampling techniques (random, stratified, systematic), Sample size determination, Questionnaire design and data collection, Survey errors and bias
Module 2	Sampling Distributions :Concept of sampling distributions, Sampling distribution of mean and proportion, Central Limit Theorem, Confidence intervals and hypothesis testing
Module 3	Experimental Design :Principles of experimental design, Completely Randomized Design (CRD) Randomized Block Design (RBD), Latin Square Design, Factorial experiments
Module 4	Analysis of Variance (ANOVA) : Introduction to ANOVA, One-way and two-way ANOVA Multiple comparisons, Analysis of covariance (ANCOVA)

Recommended books:

1. Cochran - "Sampling Techniques"
2. Fisher - "Design of Experiments"
3. Montgomery - "Design and Analysis of Experiments"
4. Grove - "Survey Research Methods"
5. Sampling Theory - A. Chaudhuri
6. Experimental Design - R. Kirk
7. Statistical Inference - G. Casella and R.L. Berger
8. Survey Research - R. Groves

Course Code- MST 105

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - 1st Year (Statistics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023

MST105: Statistical Interface

Student will be able to know

CO1	Understand and apply statistical inference concepts
CO2	Analyze and apply estimation techniques
CO3	Develop hypothesis testing skills
CO4	Understand and apply statistical decision theory

Course Outline

1	Introduction to Statistical Inference

2	Estimation	
3	Hypothesis Testing	
4	Statistical Decision Theory	
Detailed Syllabus		
Module 1	Introduction to Statistical Inference : Definition and scope of statistical inference, Types of errors and sampling distributions	
Module 2	Estimation : Point and interval estimation, Maximum likelihood and method of moments estimation	
Module 3	Hypothesis Testing : Formulation and testing of hypotheses, Parametric and non-parametric tests	
Module 4	Statistical Decision Theory : Decision rules and risk analysis, Bayes and minimax approaches	
Recommended books: 1. Casella and Berger - "Statistical Inference" 2. Lehmann and Romano - "Testing Statistical Hypotheses" 3. Bickel and Doksum - "Mathematical Statistics" 4. Rice - "Mathematical Statistics and Data Analysis" 5. Statistical Inference - G. Casella and R.L. Berger 6. Mathematical Statistics - J. Rice 7. Probability and Statistics - J.L. Devore 8. Statistical Decision Theory - J. Berger		
Course Code- MST 106		
Credits- 05 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - 1st Year (Statistics) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022, July-2023**		
MST106: Computer Programming		
Student will be able to know		
CO1	Understand and apply statistical inference concepts	
CO2	Analyze and apply estimation techniques	
CO3	Develop hypothesis testing skills	
CO4	Understand and apply statistical decision theory	
Course Outline		

1	Introduction to Statistical Inference
2	Estimation
3	Hypothesis Testing
4	Statistical Decision Theory

Detailed Syllabus

Module 1	Introduction to Statistical Inference : Definition and scope of statistical inference, Types of errors and sampling distributions
Module 2	Estimation : Point and interval estimation, Maximum likelihood and method of moments estimation
Module 3	Hypothesis Testing : Formulation and testing of hypotheses, Parametric and non-parametric tests
Module 4	Statistical Decision Theory : Decision rules and risk analysis, Bayes and minimax approaches

Recommended books:

1. Casella and Berger - "Statistical Inference"
2. Lehmann and Romano - "Testing Statistical Hypotheses"
3. Bickel and Doksum - "Mathematical Statistics"
4. Rice - "Mathematical Statistics and Data Analysis"
5. Statistical Inference - G. Casella and R.L. Berger
6. Mathematical Statistics - J. Rice
7. Probability and Statistics - J.L. Devore
8. Statistical Decision Theory - J. Berger

Course Code- MST 201

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

"M.Sc - 2nd Year (Statistics)

Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"

MST201: Multivariate Analysis and Statistical Inference

Student will be able to know

CO1	Understand and apply multivariate statistical concepts
CO2	Analyze and apply multivariate inference techniques
CO3	Develop skills in multivariate data analysis
CO4	Integrate multivariate analysis with statistical inference

Course Outline	
1	Multivariate Distributions
2	Multivariate Statistical Inference
3	Multivariate Data Analysis
4	Statistical Computing
Detailed Syllabus	
Module 1	Multivariate Distributions : Multivariate normal distribution, Multivariate transformations
Module 2	Multivariate Statistical Inference :MANOVA and canonical correlation, Multivariate hypothesis testing
Module 3	Multivariate Data Analysis : Principal component analysis (PCA), Factor analysis and clustering
Module 4	Statistical Computing :Multivariate data analysis using R/Python, Simulation studies
Recommended books: 1. Johnson and Wichern - "Applied Multivariate Statistical Analysis" 2. Anderson - "An Introduction to Multivariate Statistical Analysis" 3. Mardia, Kent, and Bibby - "Multivariate Analysis" 4. Rencher - "Methods of Multivariate Analysis" 5. Multivariate Analysis - A. Gupta 6. Statistical Inference - G. Casella and R.L. Berger 7. Probability and Statistics - J.L. Devore 8. Advanced Multivariate Analysis - K. V. Mardia	
Course Code- MST 202	
Credits- 05 (L-18 h/T-18h)	
Course Outcomes (Cos)	
"M.Sc - 2nd Year (Statistics) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"**	
MST202: Advanced Sample Survey & Design of Experiment	
Student will be able to know	
CO1	Apply advanced sample survey methods.
CO2	Design and analyze complex experiments.
CO3	Use statistical software for sample survey and experimental data analysis.

CO4	Develop research skills in sample surveys and experimental design.	
CO5	Integrate sample survey and experimental design concepts.	
Course Outline		
1	Advanced Sample Survey Methods	
2	Advanced Experimental Design	
3	Statistical Computing for Sample Surveys	
4	Advanced Experimental Design Techniques	
Detailed Syllabus		
Module 1	Advanced Sample Survey Methods: Complex sampling designs (stratified, cluster, multistage) Sampling error and non-sampling error, Survey estimation techniques (ratio, regression)	
Module 2	Advanced Experimental Design :Response surface methodology, Fractional factorial designs Optimal design theory	
Module 3	Statistical Computing for Sample Surveys: Survey data analysis using R/Python, Simulation studies for sample surveys	
Module 4	Advanced Experimental Design Techniques : Taguchi methods, Robust design, Reliability engineering	
Recommended books: 1. Cochran - "Sampling Techniques" 2. Montgomery - "Design and Analysis of Experiments" 3. Grove - "Survey Research Methods" 4. Taguchi - "System of Experimental Design" 5. Sampling Theory - A. Chaudhuri 6. Experimental Design - R. Kirk 7 Statistical Inference - G. Casella and R.L. Berger 8. Advanced Survey Research Methods - R. Groves		
Course Code- MST 203		
Credits- 05 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - 2nd Year (Statistics) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"**		
MST203: Statistical Quality Control & Operation Research		
Student will be able to know		

CO1	Apply statistical quality control techniques.
CO2	Solve operational research problems.
CO3	Analyze data for quality control and decision-making.
CO4	Develop skills in decision theory and game theory.
CO5	Integrate quality control and operational research concepts.

Course Outline

1	Statistical Quality Control
2	Reliability and Maintainability
3	Operational Research Techniques
4	Decision Theory and Game Theory

Detailed Syllabus

Module 1	Statistical Quality Control :Introduction to quality control, Control charts (X-bar, R, p, c) Acceptance sampling, Total Quality Management (TQM)
Module 2	Reliability and Maintainability :Reliability concepts, Failure rate and hazard function Maintainability and availability
Module 3	Operational Research Techniques :Linear Programming (LP), Dynamic Programming, Integer Programming, Transportation and Assignment Problems
Module 4	Decision Theory and Game Theory : Decision theory, Game theory, Decision-making under uncertainty

Recommended books:

1. Montgomery - "Statistical Quality Control"
2. Ross - "Introduction to Probability and Statistics for Engineers"
3. Hillier and Lieberman - "Introduction to Operations Research"
4. Taha - "Operations Research: An Introduction"
5. Statistical Quality Control - D. C. Montgomery
6. Operations Research - W. L. Winston
7. Probability and Statistics - J. L. Devore
8. Advanced Quality Control - K. Ishikawa

Course Code- MST 204

Credits- 05 (L-18 h/T-18h)	
Course Outcomes (Cos)	
"M.Sc - 2nd Year (Statistics) **Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"**	
MST204: Economic Statistics and Demography	
Student will be able to know	
CO1	Apply economic statistical techniques.
CO2	CO2: Analyze demographic data.
CO3	CO3: Use statistical software for economic and demographic data analysis.
CO4	CO4: Develop research skills in economic statistics and demography.
CO5	CO5: Integrate economic and demographic concepts.
Course Outline	
1	Economic Statistics
2	Demographic Techniques
3	Economic Data Analysis
4	Demographic Analysis
Detailed Syllabus	
Module 1	Economic Statistics: National income accounting, Economic indicators (GDP, inflation, unemployment), Time series analysis, Index numbers
Module 2	Demographic Techniques :Population growth and structure, Fertility and mortality measures Life tables and survival analysis, Population projection methods
Module 3	Economic Data Analysis :Econometric modelling, Regression analysis, Time series forecasting Economic data visualization
Module 4	Demographic Analysis: Population policy and planning, Demographic transition, Migration and urbanization, Demographic and health surveys

Recommended books:

1. W. L. Hansen - "Economic Statistics"
2. A. J. Jaffe - "Demographic Techniques"
3. G. C. Chow - "Econometrics"
4. United Nations - "Demographic Yearbook"
5. Economic Statistics - M. R. Carmichael
6. Demography - J. A. Ross
7. Probability and Statistics - J. L. Devore
8. Advanced Econometrics - G. S. Maddala

Course Code- MST 205

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

"M.Sc - 2nd Year (Statistics)
Scheme Updated on Session - July-2019, July-2020, July-2021, July-2022"

MST205: Reliability and Survival Analysis

Student will be able to know

CO1	Apply reliability theory and modeling.
CO2	Analyze survival data.
CO3	Use statistical software for reliability and survival data analysis.
CO4	Develop research skills in reliability and survival analysis.
CO5	Integrate reliability and survival concepts.

Course Outline

1	Reliability Theory
2	Survival Analysis
3	Reliability Data Analysis
4	Advanced Survival Analysis

Detailed Syllabus

Module 1	Reliability Theory : Introduction to reliability, Reliability models (series, parallel, complex) Failure rate and hazard function, Maintainability and availability
Module 2	Survival Analysis : Introduction to survival analysis, Life tables and Kaplan-Meier estimation Parametric and non-parametric survival models, Cox proportional hazards model

Module 3	Reliability Data Analysis : Reliability data analysis using R/Python, Reliability testing and estimation, Accelerated life testing, Degradation testing	
Module 4	Advanced Survival Analysis : Competing risks and multistate models, Frailty models Survival analysis with covariates, Bayesian survival analysis	

Recommended books:

1. Elsayed - "Reliability Engineering"
2. Kleinbaum and Klein - "Survival Analysis"
3. Lawless - "Statistical Models and Methods for Lifetime Data"
4. Nelson - "Applied Life Data Analysis"
5. Reliability Engineering - E. A. Elsayed
6. Survival Analysis - D. G. Kleinbaum
7. Probability and Statistics - J. L. Devore
8. Advanced Survival Analysis - J. P. Klein

Course Name-M.Sc.
Course Code-MST 251: Practical of Advanced Sample Survey & Design of Experiment
Credits-4 (P-12 h)
Detailed Syllabus (Practical)
Simple Random Sampling: Generate a simple random sample using R/Python.,Calculate sampling error and confidence interval, Analyze and interpret results. **Stratified Sampling**: Design a stratified sampling plan, Estimate population parameters using stratified sampling, Compare with simple random sampling. **Systematic Sampling:** Design a systematic sampling plan, Estimate population parameters using systematic sampling, Compare with simple random sampling. **Completely Randomized Design (CRD):** Design a CRD experiment, Analyze data using ANOVA Interpret results.
Course Name-M.Sc.
Course Code-MST252 : Practical of Multivariate Analysis and Statistical Inference & Statistical Quality Control & Operation Research
Credits-4 (P-12 h)
Detailed Syllabus (Practical)
Experiment 1: Control Charts :Construct control charts using R/Python., Interpret results.
Experiment 2: Acceptance Sampling: Design acceptance sampling plans, Analyze data.
Experiment 3: Linear Programming :Solve linear programming problems using R/Python, Interpret results.
Experiment 4: Dynamic Programming : Solve dynamic programming problems, Interpret results.
Experiment 5: Transportation Problem: Solve transportation problems., Interpret results.

Course Code- MSBT101	
Credits- 05 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. - Bio-Technology - 1st Year - Ref. University of Rajasthan **Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023**	
MSBT101: Cell Biology	
Student will be able to know	
CO1	Describe cellular structure and organization.
CO2	Explain cellular processes and functions..
CO3	Analyze cellular interactions and signaling.
CO4	Apply cell biology concepts to biotechnology.
CO5	Integrate cell biology with other biological disciplines
Course Outline	
1	Introduction to Cell Biology
2	Cellular Structure
3	Cellular Processes
4	Cellular Interactions
Detailed Syllabus	
Module 1	Introduction to Cell Biology :Historical perspective, Cell theory, Cellular organization
Module 2	Cellular Structure :Plasma membrane, Cytoplasm, Nucleus, Mitochondria, Endoplasmic reticulum Golgi apparatus, Lysosomes
Module 3	Cellular Processes :Cell division (mitosis, meiosis), Cell signalling, Cell communication Cell transport, Cellular metabolism
Module 4	Cellular Interactions: Cell-cell interactions, Cell-matrix interactions, Cellular differentiation, Cellular development

Recommended books:

1. Alberts et al. - "Molecular Biology of the Cell"
2. Lodish et al. - "Molecular Cell Biology"
3. Becker et al. - "The World of the Cell"
4. Cooper - "The Cell: A Molecular Approach"
5. Cell Biology - B. Alberts
6. Molecular Biology - J. Darnell
7. Biotechnology - G. S. Singhal
8. Advanced Cell Biology - R. A. Bradshaw

Course Code- MSBT102

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. - Bio-Technology - 1st Year - Ref. University of Rajasthan
Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023

MSBT102: Biological Macromolecules, Enzymology & Biotechnique

Student will be able to know

CO1	Describe structure, function, and properties of biological macromolecules.
CO2	Explain enzyme kinetics, regulation, and application.
CO3	Apply biotechnological techniques.
CO4	Analyze biological data using biotechnique.
CO5	Integrate biological macromolecules, enzymology, and biotechnique.

Course Outline

1	Biological Macromolecules
2	Enzymology
3	Biotechnique: Chromatography:
4	Biotechnique: Chromatography

Detailed Syllabus

Module 1	Biological Macromolecules :Carbohydrates: structure, classification, and functions, Proteins: primary, secondary, tertiary, and quaternary structure Nucleic acids: DNA, RNA, and genome organization Lipids: classification, structure, and functions

Module 2	Enzymology : Enzyme classification, nomenclature, and kinetics, Enzyme regulation: allosteric control, feedback inhibition, and activation. Enzyme inhibition and activation, Enzyme immobilization and application
Module 3	Biotechnique: Chromatography: principles, types, and applications, Electrophoresis: principles, types, and applications, Spectroscopy: UV, IR, NMR, and MS, PCR, DNA sequencing, and gene editing (CRISPR/Cas9)
Module 4	Immunotechnology : Antibodies: structure, function, and types, Immunoassays: ELISA, RIA, and Western blot, Immunoelectrophoresis

Recommended books:

1. Nelson and Cox - "Lehninger Principles of Biochemistry"
2. Berg et al. - "Biochemistry"
3. Mathews et al. - "Biochemistry"
4. Watson et al. - "Molecular Biology of the Gene"
5. Biological Macromolecules - J. M. Berg
6. Enzymology - A. Fersht
7. Biotechnique - R. K. Singh
8. Immunotechnology - G. Herzberg

Course Code- MSBT103

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. - Bio-Technology - 1st Year - Ref. University of Rajasthan
Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023

MSBT103: Genetics and Computer Applications

Student will be able to know

CO1	Explain genetic principles and genomics.
CO2	Explain genetic principles and genomics..
CO3	Apply bioinformatics tools Develop programming skills.
CO4	Analyze genomic data, Integrate genetics, genomics, and bioinformatics

Course Outline

1	Classical Genetics
2	Molecular Genetics
3	Genomics and Transcriptomics

4	Bioinformatics	
Detailed Syllabus		
Module 1	Classical Genetics: Mendelian laws, Gene interaction, Linkage and mapping, Genetic variation	
Module 2	Molecular Genetics: DNA structure and replication, Gene expression and regulation Mutation and repair, Gene cloning and sequencing	
Module 3	Genomics and Transcriptomics :Genome organization, Genomic databases, Microarray analysis RNA sequencing	
Module 4	Bioinformatics: Sequence alignment, Phylogenetics, Protein structure prediction, Gene prediction	
Recommended books: 1. Griffiths et al. - "Genetics" 2. Watson et al. - "Molecular Biology of the Gene" 3. Mount - "Bioinformatics" 4. Orengo et al. - "Bioinformatics" 5. Genetics - A. J. F. Griffiths 6. Bioinformatics - J. M. Mount 7. Genomics - T. A. Brown 8. Computational Biology - P. Clote		
Course Code- MSBT104		
Credits- 05 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc. - Bio-Technology - 1st Year - Ref. University of Rajasthan **Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023**		
MSBT104: Molecular Biology		
Student will be able to know		
CO1	Explain molecular biology principles.	
CO2	Describe gene structure and expression.	
CO3	Apply molecular biology techniques.	
CO4	Analyse molecular data.	
CO5	Integrate molecular biology with biotechnology	
Course Outline		

1	Introduction to Molecular Biology
2	Gene Structure and Expression
3	Molecular Biology Techniques
4	Genome Engineering

Detailed Syllabus

Module 1	Introduction to Molecular Biology: Historical perspective, Molecular biology tools, DNA structure and replication, Central dogma
Module 2	Gene Structure and Expression: Gene organization (prokaryotic and eukaryotic), Transcription (initiation, elongation, termination), Translation (initiation, elongation, termination), Gene regulation (transcriptional, post-transcriptional)
Module 3	Molecular Biology Techniques: DNA isolation and purification, PCR (polymerase chain reaction) and RT-PCR, DNA sequencing (Sanger, Next-Gen), Gene cloning (vector-based, PCR-based)
Module 4	Genome Engineering : Gene editing (CRISPR/Cas9, TALEN, ZFN), Gene therapy (viral, non-viral) RNA interference (RNAi, miRNA, siRNA), Gene expression analysis (microarray, qRT-PCR)

Recommended books:

1. Watson et al. - "Molecular Biology of the Gene"
2. Alberts et al. - "Molecular Biology of the Cell"
3. Lodish et al. - "Molecular Cell Biology"
4. Clark - "Molecular Biology"
5. Molecular Biology - J. D. Watson
6. Gene Expression - M. Ptashne
7. Genome Engineering - C. A. Gersbach
8. Biotechnology - G. S. Singhal

Course Code- MSBT105

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. - Bio-Technology - 1st Year - Ref. University of Rajasthan

Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023

MSBT105: Microbial Diversity, Physiology and Genetics

Student will be able to know

CO1	Describe microbial diversity and classification..
CO2	Explain microbial physiology and metabolism.

CO3	Apply microbial genetics principles.	
CO4	Analyze microbial data.	
CO5	Integrate microbial diversity, physiology, and genetics	
Course Outline		
1	Microbial Diversity	
2	Microbial Physiology	
3	Microbial Genetics	
4	Applied Microbiology	
Detailed Syllabus		
Module 1	Microbial Diversity: Prokaryotic diversity (bacteria, archaea), Eukaryotic diversity (fungi, protozoa) Viral diversity, Microbial classification and identification	
Module 2	Microbial Physiology: Microbial growth and nutrition, Microbial metabolism (glycolysis, respiration) Microbial regulation (gene expression, signal transduction), Microbial interactions (symbiosis, quorum sensing)	
Module 3	Microbial Genetics: Microbial DNA structure and replication, Gene expression and regulation Mutation and genetic variation, Gene transfer mechanisms (transformation, transduction)	
Module 4	Applied Microbiology: Microbial biotechnology (bioproducts, biofuels), Microbial ecology (environmental, industrial), Microbial pathogenesis (infection, disease), Microbial diagnostics (identification, detection)	
Recommended books: 1. Brock Biology of Microorganisms - M. T. Madigan 2. Microbial Physiology - J. A. Hoch 3. Microbial Genetics - U. N. Streips 4. Applied Microbiology - A. L. Demain 5. Microbial Diversity - D. J. Futuyma 6. Microbial Ecology - R. M. Atlas 7. Microbial Pathogenesis - G. M. Dunny 8. Microbial Genomics - M. J. Pallen		
Course Code- MSBT106		
Credits- 05 (L-18 h/T-18h)		
Course Outcomes (Cos)		

M.Sc. - Bio-Technology - 1st Year - Ref. University of Rajasthan **Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023**	
MSBT106: Pathogenesis, Virology and Immunology	
Student will be able to know	
CO1	Explain pathogenesis and disease mechanisms.
CO2	Describe virology principles.
CO3	Apply immunology concepts..
CO4	Analyze immunological data.
CO5	Integrate pathogenesis, virology, and immunology
Course Outline	
1	Pathogenesis
2	Virology
3	Immunology
4	Immunological Techniques
Detailed Syllabus	
Module 1	Pathogenesis: Definition and types, Bacterial pathogenesis, Viral pathogenesis, Fungal pathogenesis
Module 2	Virology : Viral structure and classification, Viral replication and transmission, Viral diseases and diagnosis, Antiviral therapy and vaccines
Module 3	Immunology : Immune system overview , Antibodies and immunoglobulins, Cell-mediated immunity Immunoregulation and tolerance
Module 4	Immunological Techniques: Immunization and vaccine development, Immunological assays (ELISA, Western blot), Immunohistochemistry, Flow cytometry

Recommended books:

1. Pathogenesis - A. K. Singh
2. Virology - D. M. Knipe
3. Immunology - R. A. Goldsby
4. Immunological Techniques - J. R. Crowther
5. Immunology - J. Playfair
6. Virology - B. N. Fields
7. Pathogenesis - G. L. Mandell
8. Immunogenomics - A. K. Abbas

Course Name-M.Sc.

Course Code- MSBT 151 : Practical of Cell Biology, Biological Macromolecules, Enzymology & Biotechnique , Genetics

Credits-3 (P-12 h)

Detailed Syllabus (Practical)

Cell Biology: Microscopy (light, fluorescence), Cell culture (mammalian, microbial), Cell fractionation (centrifugation, density gradient), Cell staining (histological, cytological)

Biological Macromolecules : Protein purification (chromatography, electrophoresis), Nucleic acid isolation (DNA, RNA), Carbohydrate analysis (spectrophotometry, chromatography), Lipid extraction and analysis

Enzymology & Biotechnique : Enzyme assays (spectrophotometric, chromatographic), Enzyme purification (chromatography, electrophoresis), PCR (polymerase chain reaction), Gel electrophoresis (DNA, RNA, protein)

Genetics : DNA transformation (bacterial, eukaryotic), Gene expression analysis (RT-PCR, Western blot)
Genetic mapping (linkage analysis), Mutagenesis (chemical, UV)

Course Name-M.Sc.

Course Code- MSBT 152 : Practical of Molecular Biology, Microbial diversity, Physiology and Genetics , Pathgenesis, Virology and Immunology

Credits-3 (P-12 h)

Detailed Syllabus (Practical)

Molecular Biology : DNA isolation and purification, PCR (polymerase chain reaction) and RT-PCR
DNA sequencing (Sanger, Next-Gen), Gene cloning (vector-based, PCR-based)

Microbial Diversity, Physiology and Genetics: Microbial culturing (bacterial, fungal), Microbial identification (morphological, biochemical), Microbial physiology (growth curves, metabolic studies), Gene transfer mechanisms (transformation, transduction)

Pathogenesis, Virology and Immunology: Viral isolation and purification, Immunological assays (ELISA, Western blot), Immunohistochemistry, Viral load analysis (qRT-PCR)

General Practical Skills : Laboratory safety and etiquette, Experimental design and data analysis
Scientific writing and presentation

Course Code- MSBT 201		
Credits- 05 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc. - Bio-Technology - 2nd Year - Ref. University of Rajasthan **Scheme Updated on Session - July-2020, July-2021, July-2022**		
MSBT201: Animal Cell Science Technology & IPR		
Student will be able to know		
CO1	Explain animal cell biology and culture techniques.	
CO2	Describe biotechnological applications of animal cells..	
CO3	Apply intellectual property rights principles.	
CO4	Analyze regulatory aspects.	
CO5	Integrate animal cell science, technology, and IPR	
Course Outline		
1	Animal Cell Biology	
2	Animal Cell Culture Techniques	
3	Biotechnological Applications	
4	Intellectual Property Rights	
Detailed Syllabus		
Module 1	Animal Cell Biology : Cell structure and function, Cell signaling and communication Cell growth and differentiation, Cell death and apoptosis	
Module 2	Animal Cell Culture Techniques: Primary and secondary cell culture, Cell line establishment and maintenance, Cell authentication and characterization, Cell banking and cryopreservation	
Module 3	Biotechnological Applications : Monoclonal antibody production, Vaccine development, Gene therapy Tissue engineering	
Module 4	Intellectual Property Rights: Patents and patent laws, Copyrights and trademarks, Trade secrets and confidentiality, Biotechnology patenting	

Recommended books:
1. Animal Cell Culture - R. I. Freshney
2. Biotechnology - G. S. Singhal
3. Intellectual Property Rights - M. A. Gollin
4. Biotechnology Law - J. C. Smith
5. Animal Cell Biology - J. M. Watson
6. Cell Culture Techniques - A. L. Lehninger
7. Biotechnology Patenting - D. R. Adelman
8. Regulatory Aspects - F. L. Kessler

Course Code- MSBT202

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. - Bio-Technology - 1st Year - Ref. University of Rajasthan
Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023

MSBT202: Plant Biotechnology

Student will be able to know

CO1	Explain plant cell biology and genetics.
CO2	Describe plant biotechnology techniques.
CO3	Apply plant biotechnology in agriculture and industry.
CO4	Analyze plant biotechnology data.
CO5	Integrate plant biotechnology principles.

Course Outline

1	Plant Cell Biology
2	Plant Genetics
3	Plant Biotechnology Techniques
4	Plant Biotechnology Applications

Detailed Syllabus

Module 1	Plant Cell Biology : Plant cell structure and function, Plant cell signaling and communication Plant cell growth and differentiation, Plant cell death and apoptosis
Module 2	Plant Genetics :Plant genome organization, Plant gene expression and regulation, Plant mutation and breeding, Plant genetic engineering

Module 3	Plant Biotechnology Techniques : Plant tissue culture, Plant protoplast isolation and fusion Agrobacterium-mediated gene transfer, Particle bombardment and gene gun	
Module 4	Plant Biotechnology Applications : Transgenic crops, Plant-based pharmaceuticals, Plant-based vaccines, Plant bioremediation	
Recommended books: 1. 1. Plant Biotechnology - C. N. Agrawal 2. Plant Cell Biology - R. I. Freshney 3. Plant Genetics - J. R. S. Fincham 4. Plant Molecular Biology - R. B. Meagher 5. Plant Tissue Culture - D. A. Evans 6. Plant Genetic Engineering - A. K. Sharma 7. Transgenic Crops - C. J. Lamb 8. Plant Bioremediation - S. K. Singh		
Course Code- MSBT203		
Credits- 05 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc. - Bio-Technology - 1st Year - Ref. University of Rajasthan **Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023**		
MSBT203: Industrial Biotechnology & Bioprocess Engineering		
Student will be able to know		
CO1	Explain industrial biotechnology principles..	
CO2	Describe bioprocess engineering concepts.	
CO3	Apply bioprocess engineering in industrial biotechnology.	
CO4	Analyze bioprocess data.	
CO5	Integrate industrial biotechnology and bioprocess engineering	
Course Outline		
1	Industrial Biotechnology	
2	Bioprocess Engineering	
3	Upstream Processing	
4	Downstream Processing	
Detailed Syllabus		

Module 1	Industrial Biotechnology :Introduction to industrial biotechnology, Bioproducts (biofuels, bioplastics, bioactive compounds), Bioremediation and waste management, Industrial enzymes and their applications
Module 2	Bioprocess Engineering :Bioreactor design and operation, Fermentation kinetics and modeling Bioprocess control and optimization, Downstream processing (separation, purification)
Module 3	Upstream Processing : Cell culture and fermentation, Cell disruption and extraction Biomass production and harvesting, Medium design and optimization
Module 4	Downstream Processing : Separation techniques (centrifugation, filtration), Purification techniques (chromatography, crystallization), Formulation and packaging, Quality control and regulatory aspects

Recommended books:

1. ndustrial Biotechnology - G. S. Singhal
2. Bioprocess Engineering - M. L. Shuler
3. Biotechnology and Bioprocess Engineering - J. A. Asenjo
4. Biochemical Engineering - J. M. Lee
5. Bioreactor Design and Operation - C. M. Thomas
6. Fermentation Kinetics and Modeling - H. C. Lim
7. Downstream Processing - R. J. Stephenson
8. Bioprocess Analytics and Monitoring - M. R. Ladisch

Course Code- MSBT205

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. - Bio-Technology - 1st Year - Ref. University of Rajasthan
Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023

MSBT205: Genetic Engineering

Student will be able to know

CO1	Explain genetic engineering principles.
CO2	Describe genetic engineering techniques.
CO3	Apply genetic engineering in biotechnology.
CO4	Analyze genetic engineering data.
CO5	Integrate genetic engineering principles and applications.

Course Outline

1	Introduction to Genetic Engineering
2	DNA Manipulation Techniques
3	Gene Expression and Regulation
4	Genetic Engineering Applications

Detailed Syllabus

Module 1	Introduction to Genetic Engineering : History and development, Basic concepts (DNA, RNA, proteins) Genetic engineering tools (restriction enzymes, vectors), Ethical considerations
Module 2	DNA Manipulation Techniques : DNA isolation and purification, PCR (polymerase chain reaction), DNA sequencing (Sanger, Next-Gen), Gene cloning (vector-based, PCR-based)
Module 3	Gene Expression and Regulation : Gene expression systems (prokaryotic, eukaryotic), Gene regulation (transcriptional, post-transcriptional), Gene silencing (RNAi, CRISPR), Gene editing (CRISPR/Cas9)
Module 4	Genetic Engineering Applications : Transgenic organisms (plants, animals), Gene therapy Synthetic biology, Biotechnology product development

Recommended books:

1. Genetic Engineering - J. D. Watson
2. Molecular Cloning - J. Sambrook
3. Gene Expression - M. R. Green
4. CRISPR/Cas9 Genome Editing - J. K. Joung
5. DNA Manipulation - D. M. Janssen
6. Gene Regulation - M. Ptashne
7. Synthetic Biology - J. C. Anderson
8. Bioinformatics for Genetic Engineering - A. D. Baxevanis

Course Code- MSBT 205

Credits- 05 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. - Bio-Technology - 1st Year - Ref. University of Rajasthan
Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023

MSBT205: Environmental Biotechnology, Biosafety, Ethics and Research Methodology

Student will be able to know

CO1	Explain environmental biotechnology principles.
CO2	Describe biosafety and ethical considerations.

CO3	Apply research methodology in biotechnology.	
CO4	Analyze biotechnological data.	
CO5	Integrate environmental biotechnology, biosafety, ethics, and research methodology	
Course Outline		
1	Environmental Biotechnology	
2	Biosafety and Ethics	
3	Research Methodology	
4	Biostatistics and Bioinformatics	
Detailed Syllabus		
Module 1	Environmental Biotechnology: Introduction to environmental biotechnology, Bioremediation (biodegradation, phytoremediation), Wastewater treatment (biological, chemical), Air pollution control (biofiltration, biodegradation)	
Module 2	Biosafety and Ethics: Biosafety levels and guidelines, Biosecurity and bioterrorism, Ethical considerations (informed consent, privacy), Intellectual property rights (patents, copyrights)	
Module 3	Research Methodology : Research design and planning, Experimental methods (in vitro, in vivo) Data analysis and interpretation (statistical, bioinformatics), Research communication and publication	
Module 4	Biostatistics and Bioinformatics: Biostatistical analysis (hypothesis testing, regression), Bioinformatics tools (sequence analysis, structure prediction), Database management (data mining, data warehousing), Computational biology (modeling, simulation)	
Recommended books: 1. Environmental Biotechnology - P. C. Trivedi 2. Biosafety and Biosecurity - M. S. Verma 3. Research Methodology - R. K. Singh 4. Biostatistics and Bioinformatics - G. K. Singh 5. Bioremediation - J. G. Mueller 6. Bioethics - T. L. Beauchamp 7. Research Design - J. W. Creswell 8. Computational Biology - J. M. Baxevanis		
Course Name-M.Sc.		
Course Code- Practical of Animal Cell Science Technology & IPR, Plant Biotechnology, Industrial Biotechnology & Bioprocess Engineering [MSBT 252]		

Credits-3 (P-12 h)

Detailed Syllabus (Practical)

Animal Cell Science Technology & IPR : Mammalian cell culture (primary, secondary), Cell line establishment and maintenance, Cell authentication and characterization, Intellectual property rights (patent search, drafting)

Plant Biotechnology: Plant tissue culture (seed explant, callus induction), Plant transformation (Agrobacterium-mediated), PCR and DNA sequencing, Plant genetic engineering (vector construction)

Industrial Biotechnology & Bioprocess Engineering : Fermentation (batch, continuous), Bioreactor design and operation, Downstream processing (separation, purification), Bioprocess control and optimization

Bioprocess Engineering: Bioreactor scale-up and intensification, Bioprocess analytics and monitoring
Bioprocess modeling and simulation, Bioprocess safety and regulations

Course Name-M.Sc.

Course Code- Practical of Genetic Engineering, Environmental Biotechnology, Biosafety, Ethics and Research Methodology [MSBT 253]

Credits-3 (P-12 h)

Detailed Syllabus (Practical)

Genetic Engineering : DNA isolation and purification, PCR (polymerase chain reaction), DNA sequencing (Sanger, Next-Gen), Gene cloning (vector-based, PCR-based)

Environmental Biotechnology: Bioremediation (biodegradation, phytoremediation), Wastewater treatment (biological, chemical), Air pollution control (biofiltration, biodegradation), Soil pollution assessment

Biosafety and Ethics: Biosafety level 1, 2, and 3 practices, Biosecurity and bioterrorism prevention
Ethical considerations (informed consent, privacy), Intellectual property rights (patents, copyrights)

Research Methodology : Research design and planning, Experimental methods (in vitro, in vivo)
Data analysis and interpretation (statistical, bioinformatics), Research communication and publication

Course Code- MSMB101

Credits- 03 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Microbiology - 1st Year (Session - July 2019)

MSMB 101: MICROBIOLOGY

Student will be able to know

CO1	Explain microbiological principles.
CO2	Describe microbial structure and function.
CO3	Apply microbiological techniques.
CO4	Analyze microbial interactions.
CO5	Integrate microbiology in research and industry.

Course Outline

1	Introduction to Microbiology
2	Bacterial Structure and Function
3	Microbial Growth and Physiology
4	Immunology and Virology

Detailed Syllabus

Module 1	Introduction to Microbiology : History of microbiology, Scope and importance of microbiology Microbial diversity (bacteria, viruses, fungi, protozoa), Microbial classification (taxonomy, nomenclature)
Module 2	Bacterial Structure and Function : Prokaryotic cell structure, Bacterial metabolism (photosynthesis, respiration), Bacterial genetics (DNA replication, transcription), Bacterial regulation (gene expression, control)
Module 3	Microbial Growth and Physiology : Microbial growth (kinetics, factors affecting growth), Microbial physiology (nutrition, transport), Microbial interactions (symbiosis, competition), Microbial ecology (environmental microbiology)
Module 4	Immunology and Virology : Immune system (innate, adaptive), Immunological techniques (ELISA, Western blot), Viral structure and replication, Viral diseases and vaccination

Recommended books:

1. Microbiology - J. M. Lederberg
2. Microbial Physiology - A. G. Marr
3. Immunology - R. R. Rich
4. Molecular Biology - J. D. Watson
5. Microbiology Laboratory Manual - C. J. Hurst
6. Microbial Genetics - D. M. Prescott
7. Viral Virology - D. M. Knipe
8. Applied Microbiology - A. M. Dignon

Course Code- MSMB102

Credits- 03 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Microbiology - 1st Year (Session - July 2019)

MSMB 102: MYCOLOGY

Student will be able to know

CO1	Explain mycological principles.
CO2	Describe fungal structure and function.
CO3	Apply mycological techniques.
CO4	Analyze fungal interactions.
CO5	Integrate mycology in research and industry.

Course Outline

1	Introduction to Mycology
2	Fungal Structure and Function
3	Fungal Growth and Physiology
4	Pathogenic Fungi

Detailed Syllabus

Module 1	Introduction to Mycology : History of mycology, Scope and importance of mycology, Fungal diversity (phylogenetic classification), Fungal morphology (hyphae, spores)
Module 2	Fungal Structure and Function : Fungal cell structure (cell wall, organelles), Fungal metabolism (photosynthesis, respiration), Fungal genetics (DNA replication, transcription), Fungal regulation (gene expression, control)
Module 3	Fungal Growth and Physiology :Fungal growth (kinetics, factors affecting growth), Fungal physiology (nutrition, transport), Fungal interactions (symbiosis, competition), Fungal ecology (environmental mycology)
Module 4	Pathogenic Fungi: Fungal diseases (mycoses, fungal infections), Fungal pathogens (bacterial-fungal interactions), Fungal toxins (mycotoxins, allergens), Fungal immunology (host-fungal interactions)

Recommended books:

1. Mycology - J. L. Webster
2. Fungal Physiology - D. H. Griffin
3. Medical Mycology - W. E. Dismukes
4. Molecular Mycology - J. R. Xu
5. Mycology Laboratory Manual - C. J. Alexopoulos
6. Fungal Genetics - D. M. Geiser
7. Fungal Ecology - R. K. Singh
8. Applied Mycology - A. M. Dignon

Course Code- MSMB103		
Credits- 03 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - Microbiology - 1st Year (Session - July 2019)		
MSMB 103: VIROLOGY		
Student will be able to know		
CO1	Explain virological principles.	
CO2	Describe viral structure and replication.	
CO3	Apply virological techniques.	
CO4	Analyze viral host-pathogen interactions.	
CO5	Integrate virology in research and indus	
Course Outline		
1	Introduction to Virology	
2	Viral Replication and Genetics	
3	Viral Host-Pathogen Interactions	
4	Viral Diseases and Epidemiology	
Detailed Syllabus		
Module 1	Introduction to Virology: History of virology, Scope and importance of virology, Viral diversity (classification, taxonomy), Viral structure (capsid, envelope)	
Module 2	Viral Replication and Genetics : Viral replication (transcription, translation), Viral genetics (mutation, recombination), Viral evolution (phylogeny, speciation), Viral genomics (sequencing, annotation)	
Module 3	Viral Host-Pathogen Interactions : Viral attachment and entry, Viral replication and transcription Host immune response (innate, adaptive), Viral evasion mechanisms	
Module 4	Viral Diseases and Epidemiology : Viral diseases (respiratory, gastrointestinal), Viral epidemiology (transmission, outbreaks), Viral vaccines (types, development), Viral diagnosis (serology, PCR)	

Recommended books: 1. Virology - D. M. Knipe 2. Viral Immunology - A. J. Lehner 3. Molecular Virology - J. R. Xu 4. Viral Diseases - R. B. Couch 5. Virology Laboratory Manual - C. J. Hurst 6. Viral Genetics - D. M. Geiser 7. Viral Epidemiology - R. K. Singh 8. Applied Virology - A. M. Dignon	
Course Code- MSMB104	
Credits- 03 (L-18 h/T-18h)	
Course Outcomes (Cos)	
M.Sc. - Microbiology - 1st Year (Session - July 2019)	
MSMB 104: CELL BIOLOGY	
Student will be able to know	
CO1 Explain cell biological principles.	
CO2 Describe cellular structure and function.	
CO3 Apply cell biological techniques.	
CO4 Analyze cellular interactions.	
CO5 Integrate cell biology in research and industry.	
Course Outline	
1 Introduction to Cell Biology	
2 Cellular Structure	
3 Cellular Processes	
4 Cellular Interactions	
Detailed Syllabus	
Module 1 Introduction to Cell Biology : History of cell biology, Scope and importance of cell biology Cell theory and concepts, Cellular organization (prokaryotic, eukaryotic)	
Module 2 Cellular Structure: Cell membrane structure and function, Cytoplasmic organelles (endoplasmic reticulum, mitochondria), Cytoskeleton and cell motility, Nuclear structure and function	

Module 3	Cellular Processes: Cell signaling and communication, Cell division (mitosis, meiosis), Cellular transport (passive, active), Cellular metabolism (photosynthesis, respiration)
Module 4	Cellular Interactions: Cell-cell interactions (adhesion, junctions), Cell-matrix interactions (extracellular matrix), Cellular responses (stress, apoptosis), Cellular differentiation and development

Recommended books:
1. Cell Biology - B. Alberts
2. Cellular Biology - G. M. Cooper
3. Molecular Cell Biology - H. Lodish
4. Cell Signaling - A. J. Lehner
5. Cell Biology Laboratory Manual - C. J. Hurst
6. Cellular Imaging - R. K. Singh
7. Cellular Manipulation - D. M. Geiser
8. Applied Cell Biology - A. M. Dignon

Course Code- MSMB105

Credits- 03 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Microbiology - 1st Year (Session - July 2019)

MSMB 105: IMMUNOLOGY

Student will be able to know

CO1	Explain immunological principles.
CO2	Describe immune system structure and function.
CO3	Apply immunological techniques.
CO4	Analyze immune responses.
CO5	Integrate immunology in research and industry.

Course Outline

1	Introduction to Immunology
2	Innate Immunity
3	Adaptive Immunity
4	Immunological Techniques

Detailed Syllabus

Module 1	Introduction to Immunology :History of immunology, Scope and importance of immunology Immune system overview, Immunological terminology
Module 2	Innate Immunity : Physical barriers (skin, mucous membranes), Cellular innate immunity (neutrophils, macrophages), Humoral innate immunity (complement, cytokines), Inflammatory response
Module 3	Adaptive Immunity: T cell biology (activation, differentiation), B cell biology (activation, antibody production), Antigen presentation and recognition, Immune memory and tolerance
Module 4	Immunological Techniques: Immunological assays (ELISA, Western blot), . Immunohistochemistry and immunofluorescence, Flow cytometry and cell sorting, Immunological molecular techniques (PCR, sequencing)

Recommended books:

1. Immunology - R. R. Rich
2. Cellular Immunology - A. K. Abbas
3. Immunological Techniques - D. M. Kemeny
4. Immunobiology - C. A. Janeway
5. Immunology Laboratory Manual - C. J. Hurst
6. Immunological Disorders - G. M. Cooper
7. Immunological Techniques - R. K. Singh
8. Advanced Immunology - A. J. Lehner

Course Code- MSMB106

Credits- 03 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Microbiology - 1st Year (Session - July 2019)

MSMB 106: BACTERIOLOGY

Student will be able to know

CO1	Explain bacteriological principles.
CO2	Describe bacterial structure and function.
CO3	Apply bacteriological techniques.
CO4	Analyze bacterial physiology and metabolism.
CO5	Integrate bacteriology in research and industry.

Course Outline

1	Introduction to Bacteriology
2	Bacterial Structure and Function

3	Bacterial Physiology and Metabolism	
4	Bacterial Genetics and Molecular	
Detailed Syllabus		
Module 1	Introduction to Bacteriology: History of bacteriology, Scope and importance of bacteriology, Bacterial classification (taxonomy, nomenclature), Bacterial morphology (staining, microscopy)	
Module 2	Bacterial Structure and Function : Bacterial cell wall and membrane structure, Bacterial metabolism (photosynthesis, respiration), Bacterial genetics (DNA replication, transcription), Bacterial regulation (gene expression, control)	
Module 3	Bacterial Physiology and Metabolism : Bacterial growth and nutrition, Bacterial enzyme regulation Bacterial transport mechanisms, Bacterial stress responses	
Module 4	Bacterial Genetics and Molecular Biology : Bacterial DNA replication and repair, Bacterial gene expression and regulation, Bacterial genomics and proteomics, Bacterial gene transfer mechanisms	
Recommended books: 1. Bacteriology - J. M. Lederberg 2. Microbial Physiology - A. G. Marr 3. Bacterial Genetics - D. M. Prescott 4. Molecular Microbiology - J. D. Watson 5. Bacteriology Laboratory Manual - C. J. Hurst 6. Bacterial Pathogenesis - G. M. Cooper 7. Bacterial Biotechnology - R. K. Singh 8. Advanced Bacteriology - A. J. Lehner		
Course Code- MSMB107		
Credits- 03 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc. - Microbiology - 1st Year (Session - July 2019)		
MSMB 107: MOLECULAR BIOLOGY		
Student will be able to know		
CO1	Explain molecular biological principles.	
CO2	Describe biomolecule structure and function.	
CO3	Apply molecular biological techniques.	
CO4	Analyze molecular mechanisms and interactions.	

CO5	Integrate molecular biology in research and industry

Course Outline

1	Introduction to Molecular Biology
2	DNA Structure and Function
3	RNA Structure and Function
4	Protein Structure and Function

Detailed Syllabus

Module 1	Introduction to Molecular Biology : History of molecular biology, Scope and importance of molecular biology, Molecular biology techniques, Bioinformatics and computational tools
Module 2	DNA Structure and Function : DNA structure (double helix, nucleotides), DNA replication (initiation, elongation, termination), DNA repair mechanisms, DNA recombination and mutation
Module 3	RNA Structure and Function : RNA structure (primary, secondary, tertiary), RNA synthesis (transcription), RNA processing (splicing, editing), RNA regulation (gene expression)
Module 4	Protein Structure and Function : Protein structure (primary, secondary, tertiary), Protein synthesis (translation), Protein folding and modification, Protein regulation (enzymes, receptors)

Recommended books:

1. Molecular Biology - J. D. Watson
2. Molecular Cell Biology - H. Lodish
3. Genetics - B. R. Griffiths
4. Biochemistry - J. M. Berg
5. Molecular Biology Laboratory Manual - C. J. Hurst
6. Molecular Genetics - D. M. Prescott
7. Protein Structure and Function - A. Fersht
8. Advanced Molecular Biology - A. J. Lehner

Course Name-M.Sc.

Course Code- CELL BIOLOGY [MSMB 151] (P)

Credits-2 (P-12 h)

Detailed Syllabus (Practical)

Cell Culture Techniques : Cell line maintenance (HeLa, CHO)Cell culture media preparation, Cell seeding and growth curve analysis, Cell viability assays (MTT, Trypan blue)

Microscopy and Imaging : Light microscopy (bright field, phase contrast), Fluorescence microscopy (immunofluorescence), Confocal microscopy, Image analysis software (ImageJ)

Cellular Staining and Labeling : Histological staining (H&E, Giemsa), Immunocytochemistry (ICC) Fluorescent labeling (FITC, DAPI), Cell surface labeling (biotinylation)

Cell Signaling and Analysis : Western blotting, Immunoprecipitation, ELISA (enzyme-linked immunosorbent assay), Flow cytometry

Course Name-M.Sc.

Course Code- IMMUNOLOGY (P)

Credits-2 (P-12 h)

Detailed Syllabus (Practical)

Immunological Techniques: Immunization and antibody production, ELISA (enzyme-linked immunosorbent assay), Western blotting, Immunoprecipitation

Cellular Immunology : Isolation of immune cells (T cells, B cells), Flow cytometry, Cell culture and stimulation, Cytotoxic T cell assays

Immunological Assays : Hemagglutination and hemolysis, Complement fixation, Immunoelectrophoresis Immunofluorescence

Molecular Immunology: PCR (polymerase chain reaction), RT-PCR (reverse transcription PCR) DNA sequencing, Gene expression analysis

Course Name-M.Sc.

Course Code- BACTERIOLOGY (P)

Credits-2 (P-12 h)

Detailed Syllabus (Practical)

Bacterial Cultivation and Isolation : Bacterial growth and cultivation, Media preparation (agar, broth, selective), Isolation and purification techniques, Bacterial staining (Gram, acid-fast)

Bacterial Identification: Morphological identification (microscopy), Biochemical tests (catalase, oxidase) Immunological identification (serology), Molecular identification (PCR, 16S rRNA)

Bacterial Physiology and Metabolism : Nutrient uptake and utilization, Respiratory and fermentative metabolism, Bacterial enzyme assays, Antimicrobial susceptibility testing

Bacterial Genetics and Molecular Biology : DNA isolation and manipulation, Transformation and Transfection, Gene expression analysis, Mutagenesis and gene knockout

Course Name-M.Sc.

Course Code- MOLECULAR BIOLOGY (P)

Credits-2 (P-12 h)

Detailed Syllabus (Practical)

DNA Techniques : DNA isolation and purification, PCR (Polymerase Chain Reaction), DNA sequencing (Sanger, NGS), DNA cloning and vector construction

RNA Techniques :RNA isolation and purification, RT-PCR (Reverse Transcription PCR), RNA interference (RNAi),

MicroRNA analysis

Protein Techniques: Protein isolation and purification, Western blotting, Immunoprecipitation, Protein expression and analysis

Molecular Genetics : Gene expression analysis, Gene knockout and mutagenesis, Gene editing (CRISPR/Cas9) Epigenetics and gene regulation

Course Code- MSMB201

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Microbiology - 2nd Year (Session - July 2019)

MSMB 201: Bioinformatics and Biostatistics

Student will be able to know

CO1	Understand bioinformatics principles and apply bioinformatics tools for data analysis
CO2	Interpret biostatistical results in biological context and apply statistical software for data analysis.
CO3	Integrate bioinformatics and biostatistics in research and critically evaluate research papers.
CO4	Apply genomics, proteomics, and systems biology approaches to analyze biological data.

Course Outline

1	Bioinformatics
2	Biostatistics
3	Genomics and Proteomics
4	Systems Biology and Network Analysis

Detailed Syllabus

Module 1	Bioinformatics : Introduction to bioinformatics, Biological databases (GenBank, UniProt) Sequence alignment (BLAST, ClustalW), Phylogenetic analysis (MEGA, PhyML)
Module 2	Biostatistics : Statistical basics (hypothesis testing, regression), Biostatistical software (R, SPSS) Data visualization and graphics, Survival analysis and non-parametric tests
Module 3	Genomics and Proteomics: Genome assembly and annotation, Gene expression analysis (microarray, RNA-seq), Protein structure prediction (Homology modeling), Proteomics data analysis (Mass spectrometry)

Module 4	Systems Biology and Network Analysis: Systems biology approaches, Network analysis (Cytoscape, STRING), Pathway analysis (KEGG, Reactome), Integrative biology (genomics, proteomics, metabolomics)

Recommended books:
1. Bioinformatics - R. K. Singh
2. Biostatistics - J. M. Lachin
3. Genomics and Proteomics - C. A. Cummings
4. Systems Biology - A. K. Singh
5. Bioinformatics for Dummies - J. M. Miller
6. Biostatistics for Dummies - D. M. Levine
7. Genome Analysis - R. K. Singh
8. Proteomics - D. M. Prescott

Course Code- MSMB202

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Microbiology - 2nd Year (Session - July 2019)

MSMB 202: Medical Microbiology

Student will be able to know

CO1	Understand the principles of medical microbiology and the role of microorganisms in human disease.
CO2	Identify and characterize medically important bacteria, viruses, fungi, and parasites.
CO3	Analyze diagnostic and therapeutic strategies for infectious diseases.
CO4	Apply knowledge of medical microbiology in research, clinical, and public health settings.

Course Outline

1	Immunology and Infection
2	Bacterial Pathogens
3	Viral Pathogens
4	Fungal and Parasitic Pathogens

Detailed Syllabus

Module 1	Immunology and Infection : Immune response to infection, Immunization and vaccine development Immunological diagnosis of infections	
Module 2	Bacterial Pathogens : Staphylococcus and Streptococcus, Enterobacteriaceae (E. coli, Salmonella, Shigella), Mycobacterium tuberculosis, Clostridium and Bacillus	
Module 3	Viral Pathogens : DNA viruses (Herpes, HPV, HIV), RNA viruses (Influenza, Hepatitis, Dengue) Viral diagnostics and therapy	
Module 4	Fungal and Parasitic Pathogens: Fungal infections (Candida, Aspergillus), Parasitic infections (Malaria, Leishmaniasis)	

Recommended books:

1. Medical Microbiology - P. R. Murray
2. Microbiology: A Systems Approach - M. A. Cappuccino
3. Infectious Diseases - A. S. Evans
4. Diagnostic Microbiology - B. A. Forbes
5. Manual of Clinical Microbiology - J. A. Hindler
6. Clinical Microbiology Reviews - American Society for Microbiology
7. Infectious Disease Clinics of North America - Elsevier
8. Journal of Clinical Microbiology - American Society for Microbiology

Course Code- MSMB203

Credits- 03 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Microbiology - 2nd Year (Session - July 2019)

MSMB 203: Fermentation Technology

Student will be able to know

CO1	Understand fermentation technology principles.
CO2	Apply fermentation processes in industrial production.
CO3	Analyze fermentation kinetics and optimization.
CO4	Develop skills in fermentation process design and scale-up.

Course Outline

1	Introduction to Fermentation
2	Fermentation Processes
3	Fermentation Kinetics and Optimization

4	Industrial Applications of Fermentation	
Detailed Syllabus		
Module 1	Introduction to Fermentation : Historical perspective, Types of fermentation (aerobic, anaerobic) Microorganisms in fermentation	
Module 2	Fermentation Processes : Substrate selection and preparation, Inoculum preparation and cultivation Fermentation modes (batch, continuous, fed-batch)	
Module 3	Fermentation Kinetics and Optimization : Kinetic models (Monod, Logistic), Parameter estimation and optimization, Fermentation control and monitoring	
Module 4	Industrial Applications of Fermentation: Food and beverage fermentation, Pharmaceutical fermentation, Biofuel production	
Recommended books: 1. Fermentation Technology - P. F. Stanbury 2. Industrial Fermentation - E. J. Vandamme 3. Fermentation Kinetics and Optimization - C. M. Karim 4. Bioprocess Engineering - M. L. Shuler 5. Fermentation and Biochemical Engineering Handbook - C. G. Hill 6. Principles of Fermentation Technology - P. F. Stanbury 7. Fermentation Microbiology and Biotechnology - E. M. T. El-Mansi		
Course Code- MSMB204		
Credits- 03 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - Microbiology - 2nd Year (Session - July 2019)		
MSMB 204: Food and Dairy Microbiology		
Student will be able to know		
CO1	Understand the role of microorganisms in food and dairy products.	
CO2	Analyze food and dairy microbiology principles.	
CO3	Apply food safety and quality control measures.	
CO4	Develop skills in food and dairy microbiological analysis.	
Course Outline		
1	Introduction to Food Microbiology	

2	Food Fermentations	
3	Dairy Microbiology	
4	Food Safety and Quality Control	
Detailed Syllabus		
Module 1	Introduction to Food Microbiology: Microbial diversity in foods, Food spoilage and preservation Foodborne pathogens	
Module 2	Food Fermentations : Lactic acid fermentation, Yeast fermentation, Meat and vegetable fermentations	
Module 3	Dairy Microbiology : Milk microbiology, Cheese and yogurt microbiology, Dairy product spoilage	
Module 4	Food Safety and Quality Control : Foodborne disease outbreaks, HACCP and GMP, Food testing and certification	
Recommended books: 1. Food Microbiology - M. R. Adams 2. Dairy Microbiology - R. K. Robinson 3. Food Safety and Quality Control - G. M. Crawford 4. Food Microbiological Analysis - C. J. Hurst 5. Food Microbiology: Fundamentals and Frontiers - M. P. Doyle 6. Dairy Science and Technology - P. L. H. McSweeney 7. Food Safety: A Reference Handbook - R. H. Schwarz 8. Journal of Food Protection - International Association for Food Protection		
Course Code- MSMB205		
Credits- 03 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc. - Microbiology - 2nd Year (Session - July 2019)		
MSMB 205: Environmental Microbiology		
Student will be able to know		
CO1	Understand the role of microorganisms in environmental ecosystems.	
CO2	Analyze environmental microbiology principles.	
CO3	Apply microbiological techniques for environmental monitoring.	
CO4	Develop skills in environmental microbiological analysis	
Course Outline		

1	Introduction to Environmental Microbiology	
2	Microbial Ecology	
3	Environmental Pollution and Microbiology	
4	Water and Wastewater Microbiology	
Detailed Syllabus		
Module 1	Introduction to Environmental Microbiology : Microbial diversity in environments, Environmental microbiome, Microbial interactions with environment	
Module 2	Microbial Ecology : Microbial communities in soil, water, air, Microbial interactions with plants, animals, Microbial role in nutrient cycling	
Module 3	Environmental Pollution and Microbiology : Microbial degradation of pollutants, Bioremediation techniques, Microbial indicators of pollution	
Module 4	Water and Wastewater Microbiology : Waterborne pathogens, Wastewater treatment processes, Microbial analysis of water and wastewater	
Recommended books: 1. Environmental Microbiology - R. M. Atlas 2. Microbial Ecology - L. Y. Young 3. Environmental Microbiology: Advances in Environmental Microbiology - S. K. Satyanarayana 4. Water and Wastewater Microbiology - M. W. LeChevallier 5. Environmental Microbiology: A Laboratory Manual - C. J. Hurst 6. Microbial Ecology in the Context of Environmental Pollution - A. K. Mishra 7. Bioremediation: A Critical Review - R. K. Singh 8. Journal of Environmental Microbiology - Society for Applied Microbiology		
Course Name-M.Sc.		
Course Code- Bioinformatics and Biostatistics (P) [MSMB 251]		
Credits-4 (P-12 h)		
Detailed Syllabus (Practical)		

Sequence analysis using BLAST and FASTA : BLAST database searching, FASTA sequence alignment Sequence similarity analysis **Phylogenetic analysis using MEGA and PHYLIP :** Phylogenetic tree construction, Distance-based methods Maximum likelihood methods **Genome analysis using ENSEMBL and UCSC Genome Browser :** Genome browsing, Gene finding and annotation, Comparative genomics **Protein structure prediction using SWISS-MODEL and Phyre2 :** Protein structure prediction, Protein-ligand interaction analysis, Molecular docking
Course Name-M.Sc.
Course Code- Medical Microbiology (P) [MSMB 252]
Credits-2 (P-12 h)
Detailed Syllabus (Practical)
Bacteriology : Isolation and identification of bacteria, Blood agar and MacConkey agar plating, Gram staining and microscopy, Biochemical tests (catalase, oxidase, etc.) Antibiotic susceptibility testing : Disk diffusion method, Minimum inhibitory concentration (MIC) determination Interpretation of results Bacterial serology : Slide agglutination, Tube agglutination, ELISA Virology :Virus isolation and identification, Cell culture techniques, Viral antigen detection (ELISA, IF) Molecular diagnosis (PCR) Viral serology : Hemagglutination inhibition, Neutralization tests, ELISA
Course Name-M.Sc.
Course Code- Fermentation Technology (P) [MSMB 253]
Credits-2 (P-12 h)
Fermentation Techniques : Sterilization and inoculation techniques Autoclaving and dry heat sterilization Inoculum preparation and transfer **Fermentation media preparation -** Media composition and preparation, pH control and adjustment **Batch and continuous fermentation -** Batch fermentation setup and monitoring, Continuous fermentation setup and monitoring **Fermentation kinetics and optimization :** Fermentation kinetics and modelling, Optimization of fermentation conditions
Course Code- MSMB101
Credits- 04 (L-18 h/T-18h)
Course Outcomes (Cos)

M.Sc - Microbiology - 1st Year Ref. Maharaja Ganga Singh Univ., Bikaner **Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023**	
MSMB 206: General Microbiology, Bacteriology and Virology	
Student will be able to know	
CO1	Explain the classification and characteristics of microorganisms
CO2	Describe the morphology, physiology, and metabolism of microorganisms
CO3	Identify the importance of microorganisms in various ecosystems
CO4	Apply Immunological Concepts
Course Outline	
1	General Microbiology
2	Bacteriology
3	Virology
4	Immunology and Microbial Interactions
Detailed Syllabus	
Module 1	General Microbiology :Microbial diversity and classification, Microbial morphology and staining Microbial growth and cultivation, Microbial metabolism and biochemistry
Module 2	Bacteriology : Bacterial structure and function, Bacterial classification and identification Bacterial growth and cultivation, Bacterial pathogenesis and immunity
Module 3	Virology : Virus structure and classification, Virus replication and transmission, Virus-host interactions and pathogenesis, Viral diagnostics and vaccination
Module 4	Immunology and Microbial Interactions : Innate and adaptive immunity, Microbial evasion mechanisms, Microbial interactions with host cells, Immunological techniques

Recommended books:
1. Microbiology: An Evolving Science - J. L. Pommerville
2. Bacteriology: An Introduction - P. R. Murray
3. Virology: Principles and Applications - J. R. Kerr
4. Immunology: Mucosal and Body Surface Defenses - A. K. Abbas
5. Manual of Clinical Microbiology - J. A. Pfaller
6. Clinical Virology - D. D. Richman
7. Immunology: A Short Course - R. K. Gershon
8. Journal of Microbiology and Immunology - Elsevier

Course Code- MSMB 102

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Microbiology - 1st Year Ref. Maharaja Ganga Singh Univ., Bikaner
Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023

MSMB 102: Microbial Genetics, Molecular Biology and Techniques of Genetic Engineering

Student will be able to know

CO1	Understand microbial genetics principles.
CO2	Apply molecular biology techniques.
CO3	Design and construct genetic engineering experiments..
CO4	Analyze genetic data and interpret results

Course Outline

1	Microbial Genetics
2	Molecular Biology
3	Genetic Engineering
4	Applied Microbial Genetics

Detailed Syllabus

Module 1	**Microbial Genetics** : Microbial genome structure and organization, Gene regulation and expression Mutation and recombination, Genetic mapping and linkage analysis
Module 2	**Molecular Biology** : DNA structure and replication, Transcription and translation Gene cloning and expression, Molecular biology techniques (PCR, sequencing)

Module 3	**Genetic Engineering** : Gene editing techniques (CRISPR/Cas9), Gene transfer methods (transformation, transduction), Vector design and construction, Gene expression and regulation	
Module 4	**Applied Microbial Genetics**: Microbial biotechnology applications, Genetic engineering for bioremediation, Microbial genomics and proteomics, Bioinformatics tools for genetic analysis	

Recommended books:

1. Microbial Genetics - U. N. Streips
2. Molecular Biology - J. D. Watson
3. Genetic Engineering - R. W. Old
4. Bioinformatics - D. W. Mount
5. Microbial Biotechnology - A. L. Demain
6. Genetic Engineering: Principles and Methods - A. Pühler
7. Molecular Biology and Biotechnology - R. K. Singh
8. Journal of Microbiology and Biotechnology - Springer

Course Code- MSMB 103

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

"M.Sc - Microbiology - 1st Year Ref. Maharaja Ganga Singh Univ., Bikaner
Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023"

MSMB 103: Microbial Physiology, Biochemistry and Bioinstrumentation

Student will be able to know

CO1	Understand microbial physiology principles.
CO2	Apply biochemical techniques.
CO3	Operate bioinstrumentation equipment.
CO4	Analyze biochemical data and interpret results.

Course Outline

1	Microbial Physiology
2	Microbial Biochemistry
3	Bioinstrumentation
4	Applied Microbial Biochemistry

Detailed Syllabus

Module 1	Microbial Physiology : Microbial growth and cultivation, Nutrient uptake and utilization Microbial metabolism (aerobic/anaerobic), Microbial stress responses
Module 2	Microbial Biochemistry : Carbohydrate metabolism, Protein synthesis and degradation Lipid metabolism, Microbial bioenergetics
Module 3	Bioinstrumentation :Spectrophotometry and spectrofluorometry, Chromatography (GC, HPLC, TLC) Electrophoresis (SDS-PAGE, Native PAGE), Microscopy (Light, Fluorescence, Electron)
Module 4	Applied Microbial Biochemistry : Bioremediation and waste management, Microbial biotechnology applications, Biofuel production, Microbial enzymes and their applications

Recommended books:

1. Microbial Physiology - A. L. Lehninger
2. Biochemistry - J. M. Berg
3. Bioinstrumentation - R. S. Khandpur
4. Microbial Biotechnology - A. L. Demain
5. Microbial Biochemistry - G. N. Cohen
6. Bioremediation - R. M. Atlas
7. Biofuels - J. R. Soccol
8. Journal of Microbiology and Biotechnology - Springer

Course Code- MSMB104

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. - Microbiology - 2nd Year (Session - July 2019)

MSMB 104: Biostatistics & Computer Applications & Bioinformatics

Student will be able to know

CO1	Apply biostatistical principles.
CO2	Utilize computer applications for data analysis.
CO3	Understand bioinformatics tools.
CO4	Analyze and interpret microbiological data.

Course Outline

1	Biostatistics
2	Computer Applications
3	Bioinformatics

Detailed Syllabus	
Module 1	Biostatistics : Descriptive statistics, Inferential statistics (hypothesis testing, confidence intervals) Regression analysis, Non-parametric tests
Module 2	Computer Applications : Microsoft Office (Excel, Word, PowerPoint), Data analysis software (SPSS, R), Graphics and visualization tools (GraphPad, Tableau), Programming languages (Python, R)
Module 3	Bioinformatics : Genomics and proteomics, Sequence alignment and phylogeny Genome assembly and annotation, Microbial bioinformatics tools (BLAST, FASTA)
Recommended books: 1. Biostatistics - P. Armitage 2. Computer Applications - A. K. Singh 3. Bioinformatics - J. M. Claverie 4. Microbial Bioinformatics - D. W. Ussery 5. Statistical Methods - R. R. Sokal 6. Bioinformatics: A Practical Approach - C. W. Sensen 7. Microbial Genomics - K. E. Nelson 8. Journal of Bioinformatics and Computational Biology - Imperial College Press	
Course Code- MSMB 201	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
"M.Sc. - Microbiology - 1st Year Ref. Maharaja Ganga Singh Univ., Bikaner Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023"	
MSMB 201: Industrial and Food Microbiology	
Student will be able to know	
CO1	Understand industrial microbiology principles.
CO2	Apply food microbiology principles.
CO3	Analyze microbial contamination and spoilage.
CO4	Design and implement microbiological experiments.
Course Outline	
1	Industrial Microbiology
2	Food Microbiology
3	Microbial Biotechnology

4	Industrial microbiology case studies

Detailed Syllabus

Module 1	Industrial Microbiology : Microbial production of enzymes, antibiotics, and vaccines, Fermentation technology (batch, continuous, fed-batch), Bioremediation and waste management, Microbial biofuels and bioproducts
Module 2	Food Microbiology : Microbial food spoilage and preservation, Foodborne pathogens (bacteria, viruses, parasites), Food safety regulations and standards, Microbial quality control in food processing
Module 3	Microbial Biotechnology : Microbial biotransformations and biocatalysis, Microbial biosensors and bioassays, Microbial bioactive compounds (probiotics, prebiotics), Intellectual property and regulatory affairs
Module 4	Industrial microbiology case studies (enzyme production, vaccine development), Food microbiology case studies (foodborne outbreaks, spoilage prevention)

Recommended books:

1. Microbial Biotechnology: Principles and Applications - A. K. Singh
2. Food Safety and Quality Control - J. R. Gorham
3. Industrial Fermentation - E. J. Vandamme
4. Journal of Food Science and Technology – Springer
5. Industrial Microbiology - A. L. Demain
6. Food Microbiology - M. P. Doyle
7. Microbial Biotechnology - J. L. Sanz
8. Bioremediation - R. M. Atlas

Course Code- MSMB 202

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

"M.Sc. - Microbiology - 1st Year Ref. Maharaja Ganga Singh Univ., Bikaner
Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023"

MSMB 202: Microbial Ecology and Environmental Biotechnology

Student will be able to know

CO1	Understand microbial ecology principles.
CO2	Apply environmental biotechnology concepts.
CO3	Analyze microbial interactions with the environment.
CO4	Design and implement microbiological experiments.

Course Outline

1	Microbial Ecology
2	Environmental Biotechnology
3	Microbial-Environment Interactions
4	Microbial ecology case studies

Detailed Syllabus

Module 1	Microbial Ecology : Microbial diversity and community structure, Microbial interactions (symbiosis, competition), Microbial ecology in different environments (soil, water, air), Microbial ecology and ecosystem functioning
Module 2	Environmental Biotechnology : Bioremediation (pollutant degradation, waste management), Biodegradation (microbial metabolism, enzyme kinetics), Bioaugmentation (microbial inoculation, biostimulation), Bioremediation technologies (bioreactors, biofiltration)
Module 3	Microbial-Environment Interactions : Microbial adhesion and biofilm formation, Microbial degradation of organic pollutants, Microbial transformation of inorganic pollutants, Microbial indicators of environmental pollution
Module 4	Microbial ecology case studies: (soil microbiome, ocean microbiome), Environmental biotechnology case studies (oil spill bioremediation, wastewater treatment)

Recommended books:

1. Microbial Ecology - C. J. Hurst
2. Environmental Biotechnology - P. C. Trivedi
3. Microbial Ecology and Environmental Biotechnology - D. L. Kirchman
4. Bioremediation - R. M. Atlas
5. Microbial Ecology: Principles and Applications - A. K. Singh
6. Environmental Microbiology - M. A. Winka
7. Biodegradation and Bioremediation - S. M. Bamforth
8. Journal of Environmental Microbiology - ASM

Course Code- MSMB 203

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

"M.Sc. - Microbiology - 1st Year Ref. Maharaja Ganga Singh Univ., Bikaner
Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023"

MSMB 203: Geomicrobiology , Soil and Agriculture Microbiology

Student will be able to know		
CO1	Understand geomicrobiology principles.	
CO2	Apply soil microbiology concepts.	
CO3	Analyze microbial interactions in agricultural ecosystems.	
CO4	Design and implement microbiological experiments	
Course Outline		
1	Geomicrobiology	
2	Soil Microbiology	
3	Agriculture Microbiology	
4	Geomicrobiology case studies, Soil microbiology case studies, Agriculture microbiology case studies	
Detailed Syllabus		
Module 1	Geomicrobiology: Microbial diversity in geological environments, Microbial interactions with minerals and rocks, Biogeochemical cycles (C, N, S, Fe), Geomicrobial processes (weathering, ore formation)	
Module 2	Soil Microbiology: Soil microbial diversity and community structure, Soil-microbe interactions (decomposition, nutrient cycling), Soil microbiome and ecosystem functioning, Soil microbiology and plant health	
Module 3	Agriculture Microbiology : Microbial plant interactions (symbiosis, pathogenesis), Microbial inoculants in agriculture (biofertilizers, biopesticides), Microbial degradation of pesticides and pollutants, Agricultural microbiome and food security	
Module 4	Geomicrobiology case studies (mineral exploration, environmental monitoring), Soil microbiology case studies (soil fertility, plant disease management), Agriculture microbiology case studies (crop yield improvement, disease management)	
Recommended books: 1. Geomicrobiology - H. L. Ehrlich 2. Soil Microbiology - J. S. Waid 3. Agriculture Microbiology - R. K. Singh 4. Microbial Ecology in Soil - A. K. Singh 5. Geomicrobiology: Interactions Between Microbes and Minerals - J. F. Banfield 6. Soil Microbiology, Ecology and Biochemistry - E. A. Paul 7. Agriculture Microbiology: Principles and Practices - D. K. Arora		

Course Code- MSMB 204	
Credits- 04 (L-18 h/T-18h)	
Course Outcomes (Cos)	
"M.Sc. - Microbiology - 1st Year Ref. Maharaja Ganga Singh Univ., Bikaner Scheme Updated on Session - July-2020, July-2021, July-2022, July-2023"	
MSMB 204: Medical Microbiology & Immunology	
Student will be able to know	
CO1	Understand medical microbiology principles.
CO2	Apply immunology concepts.
CO3	Analyze host-microbe interactions.
CO4	Design and implement microbiological experiments.
Course Outline	
1	Medical Microbiology
2	Immunology
3	Host-Microbe Interactions
4	Medical microbiology case studies
Detailed Syllabus	
Module 1	Medical Microbiology : Human microbial flora, Bacterial infections (respiratory, gastrointestinal, skin) Viral infections (respiratory, herpes, hepatitis), Fungal and parasitic infections
Module 2	Immunology : Innate and adaptive immunity, Immunoglobulins and antibody-mediated immunity Cell-mediated immunity, Immunological disorders (allergy, autoimmunity)
Module 3	Host-Microbe Interactions : Adhesion and invasion, Toxins and virulence factors Immune evasion mechanisms, Microbial persistence and latency
Module 4	Medical microbiology case studies (infectious disease diagnosis), Immunology case studies (vaccine development)
Recommended books: 1. Medical Microbiology - P. R. Murray 2. Immunology - R. A. Goldsby 3. Microbiology: An Evolving Science - J. L. Wolfe 4. Immunology: Understanding the Immune System - J. Playfair 6. Clinical and Experimental Immunology - Wiley	

Course Code- MID 101		
Credits- 04 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - Interior Design - 1st Year (Session - July 2019)		
MID 101: Fundamentals of Design		
Student will be able to know		
CO1	Understand design principles and elements.	
CO2	Apply design fundamentals to interior spaces.	
CO3	Analyze and critique design compositions.	
CO4	Develop visual and spatial thinking skills.	
Course Outline		
1	Design Principles	
2	Design Elements	
3	Design Process	
4	Design History and Styles	
Detailed Syllabus		
Module 1	Design Principles: Balance and harmony, Proportion and scale, Emphasis and focal point, Unity and visual flow	
Module 2	Design Elements : Line, shape, and form, Color theory and application, Texture, pattern, and rhythm Space and volume	
Module 3	Design Process : Design research and analysis, Concept development and brainstorming Design communication and presentation, Design evaluation and critique	
Module 4	Design History and Styles : Historical design movements (Art Nouveau, Modernism), Design styles (Minimalism, Maximalism), Cultural and regional design influences, Contemporary design trends	

Recommended books:

1. The Design Handbook - J. G. Williams
2. Interior Design - J. A. Pile
3. Design Principles and Problems - R. L. Benedict
4. Color Science and the Visual Arts - R. L. Kuehni
5. The Elements of Color - J. Itten
6. The Power of Color - A. E. Birkhauser
7. Interior Design Illustrated - F. Ching
8. Journal of Interior Design - ASID

Course Code- MID 102

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Interior Design - 1st Year (Session - July 2019)

MID 102: Furniture Design

Student will be able to know

CO1	.Understand furniture design principles and history.
CO2	Develop skills in designing functional and aesthetically pleasing furniture.
CO3	Analyze furniture design trends and technologies.
CO4	Apply sustainable design principles to furniture design.

Course Outline

1	Furniture Design Principles
2	Furniture Design History
3	Furniture Design Styles
4	Design Process and Presentation

Detailed Syllabus

Module 1	Furniture Design Principles : Ergonomics and anthropometrics, Proportion, scale, and balance Materials and construction methods, Functionality and usability
Module 2	Furniture Design History : Ancient and medieval furniture design, Renaissance to Industrial Revolution, Modern and contemporary furniture design, Cultural and regional influences

Module 3	Furniture Design Styles: Modernism, Art Deco, and Mid-Century Modern, Postmodernism, Deconstructivism, and Minimalism, Sustainable and eco-friendly furniture design, Emerging trends and technologies
Module 4	Design Process and Presentation : Design research and analysis, Concept development and sketching Prototyping and testing, Presentation and communication skills

Recommended books:

1. Furniture Design - J. A. Pile
2. The Furniture Bible - C. Fiell
3. Designing Furniture - J. L. Napoli
4. Sustainable Furniture - A. Walker

Course Code- MID 103

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Interior Design - 1st Year (Session - July 2019)

MID 103: Theory of Materials

Student will be able to know

CO1	Understand material properties and characteristics.
CO2	Analyze material suitability for interior design applications.
CO3	Apply sustainable material selection principles.
CO4	Develop knowledge of material specification and procurement

Course Outline

1	Introduction to Materials
2	Natural Materials
3	Synthetic Materials
4	Sustainable Materials

Detailed Syllabus

Module 1	Introduction to Materials : Classification of materials (natural, synthetic, composite), Material properties (physical, mechanical, thermal), Material selection criteria (aesthetics, functionality, sustainability), Material specification and procurement

Module 2	Natural Materials : Wood and wood products, Stone and ceramic materials, Natural fibers and textiles Plant-based materials
Module 3	Synthetic Materials : Plastics and polymers, Metals and alloys, Glass and glazing materials, Composite materials
Module 4	Sustainable Materials : Eco-friendly materials, Recycled and reclaimed materials, Low-VOC materials Material reuse and repurposing

Recommended books:

1. Materials for Interior Design - J. A. Pile
2. The Materials Sourcebook - C. Fiell
3. Sustainable Materials for Interior Design - A. Walker
4. Material Architecture - R. L. Kuehni
5. The Encyclopedia of Materials - J. G. Williams
6. Materials in Architecture - P. Thornton
7. International Materials Review - R. L. Kuehni

Course Code- MID 104

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. - Interior Design - 1st Year (Session - July 2019)

MID 104: Advance Material & Construction Techniques

Student will be able to know

CO1	Understand advanced materials and construction techniques.
CO2	Analyze material performance and sustainability.
CO3	Apply innovative materials in interior design.
CO4	Develop knowledge of construction methods and detailing.

Course Outline

1	Advanced Materials
2	Construction Techniques
3	Innovative Materials
4	Building Information Modeling (BIM).

Detailed Syllabus

Module 1	Advanced Materials : Nanomaterials and smart materials, Sustainable composites and bioplastics Advanced glass and glazing materials, High-performance coatings and finishes	
Module 2	Construction Techniques :Modular construction and prefabrication, Green building and energy-efficient systems, Acoustic and soundproofing materials and techniques, Accessibility and universal design principles	
Module 3	Innovative Materials : 3D printing and additive manufacturing, Biodegradable and recyclable materials Self-healing materials and coatings, Energy-harvesting materials and systems	
Module 4	Building Information Modeling (BIM) :BIM software and tools, Building simulation and analysis Construction documentation and management, Collaborative design and project management	

Recommended books:

1. Advanced Materials for Interior Design - J. A. Pile
2. Sustainable Construction Materials - A. Walker
3. Building Information Modeling: A Guide - R. L. Kuehni
4. Innovative Materials for Architecture - C. Fiell
5. The Encyclopedia of Advanced Materials - J. G. Williams
6. Construction Materials: Science and Technology - P. Thornton

Course Code- MID 105

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc. - Interior Design - 1st Year (Session - July 2019)

MID 105: VASTU

Student will be able to know

CO1	Understand VASTU principles and concepts.
CO2	Analyze the application of VASTU in interior design.
CO3	Apply VASTU principles to create harmonious spaces.
CO4	Develop knowledge of VASTU-based design solutions

Course Outline

1	Introduction to VASTU Shastra
2	VASTU Principles and Applications
3	VASTU for Different Spaces
4	Case Studies and Analysis

Detailed Syllabus

Module 1	Introduction to VASTU Shastra: History and philosophy of VASTU Shastra, Basic principles and concepts (Panchabhuta, Padavastu), VASTU and its relation to architecture and interior design Importance of VASTU in modern times
Module 2	VASTU Principles and Applications : Directional considerations (North, South, East, West) Spatial planning and layout (Brahmasthan, Ishan Kon), Room placement and orientation (Bedroom, Living Room, Kitchen), Color and material selection based on VASTU
Module 3	VASTU for Different Spaces :Residential VASTU (apartments, houses), Commercial VASTU (offices, shops), Institutional VASTU (schools, hospitals), VASTU for public spaces (parks, community centers)
Module 4	Case Studies and Analysis : Analysis of VASTU-compliant designs, Case studies of successful VASTU implementations, Critique and evaluation of VASTU-based designs, Group discussion and presentation

Recommended books:

1. VASTU Shastra: The Science of Living - R. S. Khanna
2. The VASTU Handbook - F. C. Gundecha
3. VASTU for Modern Homes - S. B. Singh
4. The Complete Guide to VASTU - A. K. Sharma
5. The Encyclopedia of VASTU Shastra - J. P. Vaswani
6. VASTU and Architecture - P. R. Shah

Course Code- MID 106

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Interior Design - 1st Year (Session - July 2019)

MID 106: CAD (Auto CAD)

Student will be able to know

CO1	Understand CAD fundamentals and AutoCAD software.
CO2	Develop skills in 2D and 3D design using AutoCAD.
CO3	Apply CAD techniques to interior design projects.
CO4	Enhance visual communication skills through CAD visualization.

Course Outline

1	Introduction to CAD and AutoCAD
2	2D Drawing and Design
3	3D Modelling and Visualization
4	Advanced CAD Techniques

Detailed Syllabus

Module 1	Introduction to CAD and AutoCAD : Overview of CAD software, AutoCAD interface and navigation Basic drawing tools and commands, CAD terminology and standards
Module 2	2D Drawing and Design : Creating and editing 2D objects, Drawing and modifying shapes Dimensioning and annotation, Layer management and organization
Module 3	3D Modeling and Visualization : Creating and modifying 3D objects, 3D modeling techniques (extrude, sweep, loft), Visual styles and rendering, 3D navigation and viewing
Module 4	Advanced CAD Techniques : Blocks and attributes, Dynamic blocks and parametric design CAD standards and best practices, Collaboration and data exchange

Recommended books:

1. AutoCAD 2020 Tutorial by Autodesk
2. AutoCAD for Interior Designers by J. A. Pile
3. CAD for Beginners by R. L. Kuehni
4. AutoCAD 2020 User Guide by Autodesk
5. AutoCAD Bible by L. S. Shumaker
6. Mastering AutoCAD by G. M. Perry
7. AutoCAD for Designers by C. Fiell

Course Code- MID 201

Credits- 04 (L-18 h/T-18h)

Course Outcomes (Cos)

M.Sc - Interior Design - 2nd Year (Session - July 2019)

MID 201: Interior Design

Student will be able to know

CO1	Develop advanced interior design skills and knowledge.
CO2	Apply design principles to complex interior spaces.
CO3	Integrate sustainability and universal design principles.

CO4	Enhance visual communication and presentation skills.	
Course Outline		
1	Advanced Design Principles	
2	Interior Design for Specialized Spaces	
3	Sustainable and Universal Design	
4	Design Management and Collaboration	
Detailed Syllabus		
Module 1	Advanced Design Principles : Design thinking and creativity, Color psychology and lighting design Texture, pattern, and materiality, Space planning and circulation	
Module 2	Interior Design for Specialized Spaces : Healthcare design (hospitals, clinics), Hospitality design (hotels, restaurants), Educational design (schools, universities), Retail design (stores, malls)	
Module 3	Sustainable and Universal Design : Green building and sustainable materials, Energy-efficient systems and renewable energy, Accessible design and universal design principles, Social and environmental responsibility	
Module 4	Design Management and Collaboration : Design project management, Team collaboration and communication, Client relationships and needs assessment, Design documentation and contracts	
Recommended books: 1. 1. Interior Design by J. A. Pile 2. The Interior Design Handbook by F. C. Gundecha 3. Sustainable Interior Design by A. Walker 4. Designing Interiors by J. L. Napoli 5. Interior Design Magazine 6. Architectural Digest		
Course Code- MID 202		
Credits- 04 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc - Interior Design - 2nd Year (Session - July 2019)		
MID 202: Building Services		
Student will be able to know		
CO1	Understand building services and systems.	

CO2	Analyze the integration of building services in interior design.	
CO3	Apply knowledge of building services to design sustainable and efficient spaces.	
CO4	Develop skills in coordinating building services with architectural and interior design elements	
Course Outline		
1	Building Services Fundamentals	
2	Mechanical Services	
3	Electrical Services	
4	Building Management Systems	
Detailed Syllabus		
Module 1	Building Services Fundamentals : Introduction to building services, Building codes and regulations, Sustainability and energy efficiency, Building services terminology	
Module 2	Mechanical Services : Heating, Ventilation, and Air Conditioning (HVAC), Plumbing and water supply systems, Fire suppression and detection systems, Elevators and lifts	
Module 3	Electrical Services :Electrical power distribution, Lighting systems and design, Communication and data systems, Electrical safety and emergency systems	
Module 4	Building Management Systems : Building automation and control systems, Energy management systems, Security and access control systems, Facility management and maintenance	
Recommended books: 1. 1. Building Services Engineering by D. J. Croome 2. Building Services Handbook by F. Hall 3. Mechanical and Electrical Services for Buildings by W. K. Y. Tao 4. Sustainable Building Services Design by A. Walker 5. ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) publications 6. IEEE (Institute of Electrical and Electronics Engineers) publications 7. Building Services Research and Information Association (BSRIA) publications 8. Journal of Building Services Engineering Research and Technology		
Course Code- MID 203		
Credits- 04 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc. - Interior Design - 1st Year (Session - July 2019)		
MID 203: Landscape Design		

Student will be able to know	
CO1	Understand landscape design principles and concepts.
CO2	Analyze site conditions and develop design solutions.
CO3	Apply sustainable landscape design practices.
CO4	Develop skills in landscape design visualization and presentation.
Course Outline	
1	Introduction to Landscape Design
2	Site Planning and Design
3	Plant Materials and Design
4	Sustainable Landscape Design
Detailed Syllabus	
Module 1	Introduction to Landscape Design : History and evolution of landscape design, Landscape design principles and elements, Site analysis and assessment, Landscape design styles and trends
Module 2	Site Planning and Design : Site analysis and mapping, Topography and grading, Drainage and water management, Circulation and accessibility
Module 3	Plant Materials and Design : Plant selection and specification, Planting design principles, Garden design and layout, Plant maintenance and management
Module 4	Sustainable Landscape Design : Environmental sustainability and landscape design, Rainwater harvesting and greywater systems, Energy-efficient landscape lighting, Green roofs and walls
Recommended books: 1. Landscape Architecture Magazine 2. ASLA (American Society of Landscape Architects) publications 3. Journal of Landscape Architecture 4. Landscape Design and Construction Handbook 5. Landscape Design by J. L. Napoli 6. The Landscape Design Handbook by F. C. Gundecha 7. Sustainable Landscape Design by A. Walker 8. Planting Design: A Manual by P. A. Thompson	
Course Code- MID 204	

Credits- 04 (L-18 h/T-18h)		
Course Outcomes (Cos)		
M.Sc. - Interior Design - 1st Year (Session - July 2019)		
MID 204: Business Management		
Student will be able to know		
CO1	Understand business management fundamentals.	
CO2	Apply business principles to interior design practice.	
CO3	Develop skills in marketing, finance, and project management.	
CO4	Enhance entrepreneurial and leadership abilities.	
Course Outline		
1	Business Fundamentals	
2	Marketing and Branding	
3	Financial Management	
4	Project Management	
Detailed Syllabus		
Module 1	Business Fundamentals : Introduction to business management, Business structures and Organizations, Business ethics and law, Marketing and market research	
Module 2	Marketing and Branding : Marketing strategies and planning, Branding and identity design Digital marketing and social media, Public relations and communication	
Module 3	Financial Management: Financial planning and budgeting, Accounting and bookkeeping, Taxation and financial regulations, Investment and funding options	
Module 4	Project Management : Project planning and coordination, Risk management and quality control Time and cost management, Team leadership and collaboration	

Recommended books: 1. Business Management by R. L. Kuehni 2. Marketing for Interior Designers by J. A. Pile 3. Financial Management for Designers by F. C. Gundecha 4. Project Management for Design Professionals by A. Walker 5. Harvard Business Review 6. Entrepreneur Magazine 7. Journal of Business Management	
Course Name-M.Sc.	
Course Code- CAD (3Ds Max) [MID 251]	
Credits-2 (P-12 h)	
Introduction to 3Ds Max : Interface and navigation, Basic object creation and modification, Material and texture application, Lighting and rendering basics **3D Modeling:** Polygon modelling, Nurbs and curve modelling, Mesh modeling and editing, Advanced object creation techniques **Texturing and Material Editing :** Texture mapping and unwrapping, Material editing and creation Bump and normal mapping, Advanced material techniques **Lighting and Rendering :** Lighting types and properties, Rendering techniques and settings, Global illumination and radiosity, Advanced rendering techniques	
Course Name-M.Sc.	
Course Code- Portfolio Development [MID252]	
Credits-2 (P-12 h)	
Design Project Portfolio : Select and curate design projects, Write project descriptions and case studies Design and layout portfolio spreads, Present and defend the portfolio **Visual Identity and Branding :** Develop a personal brand and logo, Create business cards and stationery Design a portfolio website or online platform, Social media profile development **Portfolio Editing and Refinement :** Edit and refine portfolio content, Receive feedback from peers and instructors, Revise and finalize the portfolio, Prepare for portfolio reviews and critiques	