CLASSICAL MECHANICS (Theory)
[As per Choice based Credit System (CBCS) Scheme]
Semester-I (M.Sc. Physics)

Course Code	20PCM11	Maximum Marks (CIE)	50
Number of Lecture (H/W)	04	Maximum Marks (SEE)	50
Total Number of Lectures	48	Exam Hours	03
CREDITS – 04			

Objectives of the Course:

- Review of Newtonian formulation.
- How to use conservation of energy and linear and angular momentum to solve dynamics problems.
- How to represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.
- Increase mathematical and computational sophistication. Learn and apply advanced mathematical techniques and methods of use to physicists in solving problems.
- Develop some capabilities for numerical/computational methods, in order to obtain solutions to problems too difficult or impossible to solve analytically.

Module-1 [10 hours]

Newtonian mechanics: Single and many particle system- Conservation laws of linear momentum, angular momentum and energy, Application of Newtonian mechanics, Limitations of Newtonians formulation, One body central force problem, scattering due to central force fields, Kepler's laws of planetary motion.

Module-2 [10 hours]

Lagrangian formulation: Constraints in motion, Generalized co-ordinates, Virtual work and D'Alembert's principle, Lagrangian equations of motion, Symmetry and cyclic co-ordinates, Hamilton variational principle; Lagrangian equations of motion from variational principle, Simple application.

Module-3 [10 hours]

Hamiltonian formalism: Hamilton's equations of motion - from Legendre transformations and the variational principle, Simple applications, Canonical transformations, Poisson brackets-Canonical equations of motion in Poisson bracket notation, Comments on Hamilton equations.

Module-4 [10 hours]

Motion of Rigid body: Euler's Theorem, Angular momentum & Kinetic energy, The inertia tensor, Euler's equation of motion, Euler's angles, Motion of symmetric top**.**

Module-5 [08 hours]

Relativistic mechanics: Relativistic mechanics: Four-dimensional formulation-four-vectors, four-velocity, four-momentum and four-acceleration, Lorentz co-variant form of equation of motion.

Course Outcome

After Successful completion of course students will

CO1: Understand Newtonian formulation And Basic concepts of Classical Mechanics i.e., applying the basic laws of physics in the areas of classical mechanics, Newtonian gravitation, Types of forces: Force of gravitation, Lorentz force and fundamental forces of nature.

CO2: Describe the use of conservation of energy and linear and angular momentum to solve dynamic problems.

CO3: Understand the equations of motion for complicated mechanical system using the Lagrangian and Hamiltonian formulations of classical mechanics to solve Lagrange's equation.

CO4: Develop some capabilities for numerical, computational methods in order to obtain solutions to problems that are too difficult or impossible to solve analytically.

CO5: Understand an intermediate classical mechanics topic such as coordinate transformations and oscillatory motion.

CO6: Define and understand basic mechanical concepts related to constraint motion and to study virtual work and D'Alembert's principle Lagrangian equation of motion and its application.

CO7: Describe and understand the motion of a mechanical system using Lagrange-Hamilton formalism and understanding Relativistic Mechanics.

CO8: To apply Rotating coordinates system and to Derive the Coriolis's force from Lagrangian formulation.

References

1. Classical Mechanics: H. Goldstein, (Addison-Wesley, 1950).
2. Introduction to Classical Mechanics: R G Takawale and P S Puranik (TMH, 1979).
3. Classical Mechanics: N C Rana and P S Joag (Tata mcGraw, 1991).
4. Mechanics: Landau L D and Lifshitz E M (Addition-Wesley,1960).

ELECTRODYNAMICS (Theory)
[As per Choice based Credit System (CBCS) Scheme]
Semester-I (M.Sc. Physics)

Course Code	**20PED12**	**Maximum Marks (CIE)**	**50**
Number of Lecture (H/W)	**04**	**Maximum Marks (SEE)**	**50**
Total Number of Lectures	**48**	**Exam Hours**	**03**
CREDITS – 04			

Objectives of the Course:

- Students are expected to have a reasonable background in electrodynamics.
- Primarily learn how to solve the Maxwell's equations for various boundary conditions
- The main objective is to introduce the fundamental theory and methods of electrodynamics based on the Maxwell's theory of electromagnetic fields.
- Learn theory of EM wave generation and propagation

Module-1 [10 hours]

Electrostatics: Introduction, Electric Charge**,** Properties of Electric Charge, Coulomb’s law, Electric Field, Electric field Intensity, Electric field lines. Electric flux, Gauss’s law: Integral and differential form, Applications of Gauss’s law: Electric field due to a uniformly charged hallow sphere, Electric field due to a uniformly charged solid sphere, Electric dipole, the dipole in an uniform and non uniform external field, Electrostatic potential: Electrostatic Potential, Relation between electric field and potential, The electric potential and fields due to monopole, dipole and quadrupole, Potential due to multipoles, Electrostatic energy, Dielectric polarization.

Module-2 [10 hours]

Magnetostatics: Magnetic field, Lorentz force, Magnetic flux, Biot-Savart law for current carrying conductor and for two closed circuits and Ampere’s law, Applications of Biot-Savart law: Magnetic field due to infinity long straight wire carrying current, Magnetic field on the axis of a circular loop carrying current, The magnetostatic field laws, The magnetic scalar and vector potentials, Potential and field of a circular current element- magnetic dipole.

Module-3 [10 hours]

Magnetic properties of Matter: Magnetization, Magnetic moment and angular momentum-Bohr Magneton, Classifications of magnetic materials, Field of a magnetized object, magnetic field inside matter, Torque & potential energy of magnetic dipole in magnetic field, Effects of magnetic field on atomic orbital’s.

Module-4 [10 hours]

Electromagnetics: The non-steady currents and charges, magnetic flux, Lorentz force law and Faraday’s law of induction, Lenz’s law, Integral & differential form of Faraday’s law, Inductors and Inductance and classification, Maxwell’s equations- Fundamental equations of electromagnetic field, The macroscopic equations and boundary conditions, Potentials of electromagnetic fields, Energy in the electromagnetic field, Poynting’s theorem and energy momentum conservation.

Module-5 [08 hours]

Electromagnetic waves: Displacement current, Transverse nature of electromagnetic waves, The wave equation, Plane Waves in free space, waves in non-conducting media, Electromagnetic waves in conducting media, Electromagnetic waves in bounded media; Reflection and refraction of waves, Energy flux in a plane wave, Relativistic Electrodynamics, The principle of invariance-Lorentz transformations.

Course Outcome

After Successful completion of course students will

CO1: Understand Gauss law and its applications to obtain the electric field for different cases.

CO2: Describe and explain the relationship between the electric field and the electrostatic potential.

CO3: Understand the Lorentz force on a point charge moving in a magnetic field.

CO4: State Biot and Savart's law and amperes circuital law to describe and explain the generation of magnetic field by electrical current.

CO5: Analytical skills and the realization of the regular electromagnetic phenomena are developed studying the electromagnetic waves.

CO6: Understand the magnetic properties of matter and their classification.

CO7: Understand the origin of Maxwell's equations in magnetic and dielectric media.

CO8: Derive the electromagnetic wave solutions and propagation in dielectric and other media and understand the transport of energy and Pointing theorem.

CO9: Understand the symmetries of Maxwell's and Lorentz transformations and applications of Lagrangian field.

CO10: Understand the motion of charge in EM field.

References

1. Introduction to Electrodynamics: D J Griffith (Prentice-Hall, 1981).
2. Classical Electromagnetic Radiation: J B Marion (Academic, 1968).
3. Classical Electrodynamics: C D Jackson (Wiley Eastern, 1978).
4. Electromagnetics: B B Laud (Wiley Eastern, 1987).
5. The Feynman Lectures on Physics-II: R P Feynman (Addison Wesley, 1964).
6. Classical Electricity and Magnetism: W Panofsky & M Philips (Addison Wesley, 1962).

QUANTUM MECHANICS (Theory)
[As per Choice based Credit System (CBCS) Scheme]
Semester-I (M.Sc. Physics)

Course Code	**20PQM13**	**Maximum Marks (CIE)**	**50**
Number of Lecture (H/W)	**04**	**Maximum Marks (SEE)**	**50**
Total Number of Lectures	**48**	**Exam Hours**	**03**
CREDITS - 04			

Objectives of the Course:

- Schrödinger equation description of the hydrogen atom and how it differs from Bohr's model of the hydrogen atom.
- Be able to discuss and interpret experiments displaying wavelike behavior of matter, and how this motivates the need to replace classical mechanics by a wave equation of motion for matter (the Schrödinger equation).

Module-1 [10 hours]

Physical basis of quantum mechanics: Experimental background. Inadequacy of classical physics, basic postulates of quantum mechanics. Wave function, Uncertainty Principle, complimentarity, Principle of superposition, Wave-particle duality. Development of wave equation: One-dimensional and three dimensional cases for a free particle subject to forces.

Module-2 [10 hours]

Some exactly solvable eigen value problems: Eigen value problem- degeneracy, eigen values and eigen functions- Physical interpretation. One dimensional eigen value problems: square well, rectangular step potentials, rectangular barrier and simple harmonic oscillator.

Module-3 [10 hours]

Expectation value and Ehrenfest's theorem: Separation of wave equation, boundary and continuity condition. Three dimensional eigen value problems: Particle in a box, particle in a spherically symmetric potential. Eigen values and eigen functions of hydrogen and hydrogen like atoms. Optical theorem.

Module-4 [10 hours]

General formalism: Hilbert space, observables, quantum mechanical operators- definition and properties, eigen values and eigen vectors of an operator; Hermitian operator, unitary and projection operators and Commuting operators. Bra and ket notation for vectors. Quantum dynamics**:** Equations of motion. Schrodinger, Heisenberg and Interaction pictures.

Module-5 [08 hours]

Approximation methods for stationary states: Time independent perturbation theory- Variation method, eigen values in the first approximation. Application to anharmonic oscillator and to the ground state of Helium atom. WKB method: Application to barrier penetration.

COURSE OUTCOMES

After Successful completion of course students will

CO1: Understand the central concepts and principles of quantum mechanics: the Schrödinger equation, the wave function and its physical interpretation.

CO2: Discuss stationary and non-stationary states, time evolution and expectation values.

CO3: Interpret and discuss physical phenomena wave particle duality of the uncertainty relation.

CO4: Schrödinger equation description of the hydrogen atom and how it differs from Bohr's model of the hydrogen atom.

CO5: Understanding the concept the quantum states, Hilbert space and vector space.

CO6: Defining the quantum mechanical operators.

CO7: Solve the problems in one dimensional and three dimensional by the application of Schrodinger equation.

CO8: Develop a knowledge and understanding of perturbation theory.

CO9: Apply the Perturbation theory to the ground state of helium atom.

CO10: Application of barrier penetration by WKB Approximation method.

References

1. Quantum Mechanics: L I Schiff [McGraw-Hill, NY, 1968].
2. A Text book of Quantum Mechanics: P M Mathews and K Venkateshan [TMH,1994].
3. Quantum Mechanics: V K Thankappan [Wiley Eastern, 1980].
4. Quantum Mechanics: Theory and Applications: A K Ghatak & S Loknathan [MacMillan India Ltd., 1984].
5. Modern Quantum Mechanics: Sakuraj J J and Tuan S F [Addison Wesley 1999].
6. Introduction to Quantum Mechanics: L Pauling and E B Wilson [McGraw Hill 1935].
7. Quantum Mechanics by R. Shankar.

MATHEMATICAL PHYSICS (Theory)
[As per Choice based Credit System (CBCS) Scheme]
Semester-I (M.Sc. Physics)

Course Code	**20PMP14**	**Maximum Marks (CIE)**	**50**
Number of Lecture (H/W)	**04**	**Maximum Marks (SEE)**	**50**
Total Number of Lectures	**48**	**Exam Hours**	**03**
CREDITS – 04			

Objectives of the Course:

- Provides the mathematical skills needed by physics students to develop well in their career. It consists of Special functions of mathematical physics such as the gamma function, hyper-geometric functions, Legendre functions, Bessel functions and Hermite.
- Introducing students to the use of mathematical methods to solve physics problems; and providing students with basic skills necessary for the application of mathematical methods in physics

Module-1 [10 hours]

Differential Equations: Definition, Order and degree of differential equation, Ordinary differential equations: First & Second Order homogeneous and non-homogeneous equations with constant and variable coefficients, Partial differential equations: Classifications, Methods of solutions of partial differential equation.

Special functions: Power series method for ordinary differential equations, Legendre's equation, and its solution, Bessel's equation and its solution, Hermite equation and its solution**.**

Module-2 [10 hours]

Matrices: Definition, Types of matrices, Algebra of matrices: Addition, Subtraction, Multiplication and inverse of matrices, Rank of a matrix, Symmetric matrix orthogonal Matrix Hermitian Matrix and unitary Matrix, Eigen value and Eigen vectors, Eigen values and Eigen vectors of matrix, Diagonalization of a real symmetric matrix, Matrix Representation of linear operators.

Module-3 [10 hours]

Fourier Series and Laplace transforms: Fourier Series: Fourier's theorem, Change of interval, Fourier transform: Transform of sine and cosine function, Convolution theorem, Laplace transforms: Transforms of some simple functions, Convolution theorem, inverse Laplace transform, some physical applications.

Module-4 [10 hours]

Tensors and Groups: Tensors: Definition of tensors, tensors in physics, notation and conventions, Covariant vector, contravariant vector, tensors of higher rank, Algebra of tensors: addition, subtraction, outer product, inner product; contraction of tensor; symmetric and anti-symmetric tensors; Quotient law. Group: Basics concept of a group, Examples of finite group, Groups, subgroups, classes, Homomorphism and isomorphism, Group representation.

Module-5 [08 hours]

Elements of complex analysis: Taylor series, Cauchy reside theorem, Cauchy integral theorem and formula, Greens functions: Green's function method of solving boundary value problems, Greens functions for one dimensional problem.

COURSE OUTCOME

After Successful completion of course students will

CO1: Explain fundamental concepts of a special topic in mathematical physics.
CO2: Define accurate and efficient use of specific mathematical physics techniques.
CO3: Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from mathematical physics.
CO4: Different techniques to solve differential and integral equations**.**
CO5: Demonstrate a detailed physical and mathematical understanding of a variety of systems and processes in a range of advanced topics in physics.
CO6: Study of Fourier series theorem and convolution theorem.
CO7: Understand the basic concepts in group theory.
CO8: Approach and solve new problems in a range of advanced topics in physics.
CO9: Understand the expression of Taylor series, Cauchy's reside theorem.
CO10: Undertake independent research in a physical or mathematical field.

References

1. Mathematical methods for Physicists: G Arfken
2. Mathematical Physics by P K Chattopadhyay, Wiley Eastern
3. Matrices and tensors in Physics: A W Joshi
4. Methods of Mathematical Physics: R K Bose and M C Joshi
5. Introduction to Mathematical Physics by C Harper, PHI.
6. Elements of Group Theory for Physicists: A. W. Joshi

PRACTICAL PAPERS (Practical)
[As per Choice based Credit System (CBCS) Scheme]
Semester-I (M.Sc. Physics)

Sl. No.	NAME OF THE EXPERIMENT
Paper: 20POPL15:- Optics and Photonics Lab-I (CREDITS – 02)	
01	Wavelength of laser by using Grating element.
02	Diffraction holes.
03	Planks constant by photocell.
04	Study of Spectrometer
Paper: 20PEL16:- Electronics Lab-I (CREDITS – 02)	
01	Logic gates
02	Transistor characteristics
03	Determination of resonance frequency of LCR series and parallel circuit
04	Digital to analog converter
05	Determination of k/e using a transistor
Paper: 20PSNL17:- Solid State and Nuclear Physics Lab-I (CREDITS – 02)	
01	Study of G. M. counter
02	Resistivity of a semiconductor
03	Specific heat of solids
04	Linear & mass attenuation co-efficient of aluminum for Beta source
05	Verification of inverse square law.
06	Thermal diffusivity of brass.

* **Note:** Experiments shall be added as and when available or developed

PROJECT PAPER (Practical)
[As per Choice based Credit System (CBCS) Scheme]
Semester-I (M.Sc. Physics)

Course Code: 20PHYP18
(CREDITS – 02)

Compulsorily each student must carry out a project work under the supervision of a staff member or faculty of any research center. The topic for project work can be theoretical or experimental or computational in nature. A group of students or individual students can work under supervisor on a single topic for a project. However, each student must submit his/her own independently written original project report and face examination independently.

A maximum of two credits are given for the project work. On completion of the project work and at the end of the Semester I, a project report (certified by both supervisor and Chairman/Head of the Department) based on the project work carried out must be submitted to the Department. Project work will be valued at a maximum of 100 marks (CIE 50 marks and SEE 50 marks).