M.Sc. (PHYSICS) Part-I
(SEMESTER I & II)
SESSION: 2025-2026

Course Code	Title of Paper	Hours (Per Week)	Credits	Max Marks			Examinatio Time (Hour
SEMESTER – I				Total	Ext.	Int.	
PHY-1.1	Mathematical Methods of Physics– I	4	4	100	70	30	03
PHY-1.2	Classical Mechanics	4	4	100	70	30	03
PHY-1.3	Classical Electrodynamics	4	4	100	70	30	03
PHY-1.4	Nuclear and Particle Physics	4	4	100	70	30	03
PHY-1.5	Analog Electronics	4	4	100	70	30	03
PHY-1.6	Physics Laboratory-I	8	4	100	70	30	03
SEMESTER—II							
PHY-2.1	Mathematical Methods of Phys	4	4	100	70	30	03
PHY-2.2	Advanced Classical Mechanics Electrodynamics	4	4	100	70	30	03
PHY-2.3	Quantum Mechanics	4	4	100	70	30	03
PHY-2.4	Statistical Mechanics	4	4	100	70	30	03
PHY-2.5	Digital Electronics-	4	4	100	70	30	03
PHY-2.6	Physics Laboratory-II	8	4	100	70	30	03

Semester-I

PHY-1.1 -Mathematical Methods of Physics– I

Max Marks: 100 marks
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Credits: 04
Total Teaching Hours: 55 hrs

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

CO1: Use the Delta and Gamma functions for describing physical systems.

CO1: Use complex variables for solving definite integral.

CO3: Understand the Bessel's functions and Fourier series.

CO4: Know the concept how to solve tensors and also understand the concept of polynomials.

Instructions for the Paper Setter

The question paper will consist of three Sections: A, B and C. Section A will have four questions (from the respective section of syllabus) carrying 12 marks each, Section B will have also four questions (from the respective section of syllabus) carrying 12 marks each. Section C will consist of 11 short answer questions that will cover the entire syllabus and will be of 2 marks each.

Instructions for the Candidates

Candidates are required to attempt five questions selecting two questions from each of Section A & B and entire Section C.

SECTION-A

Gamma and beta functions: Definition of beta and gamma functions, Evaluation of -(1/2), Relation between beta and gamma functions, Evaluation of integrals using beta & gamma function

Legendre differential equation: Solution of Legendre differential equation, Legendre polynomials, Rodrigue's formula, Generating function for Legendre polynomials and recurrence relations, Orthogonality of Legendre polynomials. Associated Legendre polynomials and their properties.

Bessel functions: Definition of Bessel functions of 1st and 2nd kind, Generating function of $J_n(x)$ and their recurrence relations and orthogonality, Definition of spherical Bessel functions and their asymptotic form.

Complex variables: Elements Complex analysis, Limit and continuity, Cauchy's Riemann equations, Complex integrations, Cauchy's theorem for simply and multiply connected regions, Cauchy's integral formula, Taylor and Laurents series, Poles and singularities, Cauchy's residue theorem and its application to evaluation of definite .

SECTION B

Tensor: Cartesian tensors, Vector components and their transformation properties under three dimensional rotation in rectangular coordinates, Direct product of two and more tensors, Tensors of second and higher ranks, Symmetric and anti-symmetric tensors, Contraction and differentiation, Kronecker and alternating tensors and their isotropy property, Contra-variant and covariant tensors, Physical examples of second rank tensors.

Evaluation of Polynomials: Horner's method; Root finding; Fixed point iteration, Bisection method, Regula falsi method, Newton method, Error analysis, System of linear equations. Gauss Seidal methods, Interpolation and Extrapolation: Lagrange's interpolation, least square fitting; Differentiation and Integration: Difference operators, simpson and trapezoidal rules; Ordinary differential equation: Euler method, Taylor method.

Text Books:

1. Applied Mathematics, L.A. Pipes and Harwill, McGraw Hill Pub.
2. Mathematical Physics, G.R.Arfken, H.I. Weber, Academic Press, USA (Ind. Ed.)
3. Cartesian Tensors, H. Jeffreys, Cambridge University, Press.
4. Numerical Methods: J.H.Mathew, Prentice Hall of India, New Delhi.
5. Mathematical Methods in Physical sciences, Mary L. Boas, Wiley (2005)

Semester– I
PHY-1.2 - Classical Mechanics

Max Marks: 100 marks
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Credits: 04
Total Teaching Hours: 55

Course Outcomes: At the end of the course students will be able to:
CO1: Understand the necessity of Action, Lagrangian, and Hamiltonian formalism.
CO2: Use D'Alembert's principle and calculus of variations to derive the Lagrange equations of motion.
CO3: Describe the motion of a mechanical system using Lagrange-Hamilton formalism.
CO4: Appreciate the theory of rigid body motion which is important in several areas of physics e.g., molecular spectra, acoustics, vibrations of atoms in solids, coupled mechanical oscillators, electrical circuits, etc

Instructions for the Paper Setter

The question paper will consist of three Sections: A, B and C. Section A will have four questions (from the respective section of syllabus) carrying 12 marks each, Section B will have also four questions (from the respective section of syllabus) carrying 12 marks each. Section C will consist of 11 short answer questions that will cover the entire syllabus and will be of 2 marks each.

Instructions for the Candidates

Candidates are required to attempt five questions selecting two questions from each of Section A & B and entire Section C.

SECTION-A

Lagrangian formulation: Conservation laws of linear, angular momentum and energy for a single particle and system of particles, Constraints and generalized coordinates, Principle of virtual work, D'Alembert principle, Lagrange's equations of motion, Velocity dependent potential and dissipation function.
Problems: Lagrangian and equations of motion for systems like motion of single particle in space, on the surface of a sphere, cone & cylinder, Atwood's machine, Bead sliding on rotating wire, Simple, spherical and compound pendulums, Projectile motion and harmonic oscillator.

Variational principle: Hamilton's principle, Calculus of variations, Lagrange's equations from Hamilton principle. Generalized momentum, Cyclic coordinates Symmetry properties and Conservation theorems.
Problems: Applications of calculus of variations for geodesics of a plane and sphere, Minimum surface of revolution, Brachistochrone and harmonic oscillator-problems.

Two-body central force problem: Equivalent one body problem, Equation of motion and first integrals, Equivalent one dimensional problem, Classification of orbits, Differential equation for the orbit, Kepler's problem. Differential & total scattering cross-section, Scattering by inverse square law, Rutherford's formula. *Problems*: Application of differential equation for the orbit in the determination of force law.

SECTION - B

Rigid body kinematics: Kinematics of rotation of rigid body about a point, Orthogonal transformation and properties of transformation matrix, Euler angles and Euler theorem, Infinitesimal rotations, Rate of change of vector in rotating frame.
Problem: Components of angular velocity along space and body set of axes.

Rigid body dynamics: Angular momentum and kinetic energy of rotation of rigid body about a point, Inertia tensor and its eigen values, Principal moments, Principal axes transformation. Euler equations of motion, Heavy symmetrical top with one point fixed (analytical treatment only).

Hamiltonian formulation: Legendre transformation, Hamilton's equations of motion, Hamilton's equation from variational principle, Principle of least action.
Problems: Hamiltonian and equations of motion for system like simple and compound pendulum, Harmonic oscillator, Motion of particle in central force field, on the surface of a cone & cylinder, and near earth's surface, One-dimensional motion on a plane tangent to the earth's surface, Charged particle's motion in electromagnetic field.

Canonical transformation: Generating function, Poisson brackets and their canonical invariance, Equations of motion in Poisson bracket formulation, Poisson bracket relations between components of linear and angular momenta. *Problems*: Harmonic oscillator problem, Check for transformation to be canonical and determination of generating function

Text Book:

1. Classical Mechanics, H. Goldstein, Narosa Publishing House, New Delhi.
2. Classical Mechanics, N.C. Rana and P.S. Joag, Tata McGraw-Hill, N. Delhi, 1991

Semester-1

PHY-1.3- Classical Electrodynamics

Max Marks: 100 marks
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Credits: 04
Total Teaching Hours: 55

Instructions for the Paper Setter

The question paper will consist of three Sections: A, B and C. Section A will have four questions (from the respective section of syllabus) carrying 12 marks each, Section B will have also four questions (from the respective section of syllabus) carrying 12 marks each. Section C will consist of 11 short answer questions that will cover the entire syllabus and will be of 2 marks each.

Instructions for the Candidates

Candidates are required to attempt five questions selecting two questions from each of Section A & B and entire Section C Use of scientific calculator is allowed.

SECTION A

Electrostatics: Coulomb's law, Electric field, Evaluation of electric field due to uniformly charged sphere using Coulomb's law, Differential form of Gauss law, Dirac delta function and its properties, Representation of charge density by Dirac delta function, Equations of electrostatics, Scalar potential and potential due to arbitrary charge distribution, Discontinuities in electric field, Electric potential, Poisson and Laplace equations, Dirichlet and Neumann boundary conditions, Uniqueness theorem, Electrostatic potential energy for continuous charge distributions, Energy density.

Boundary value problems in electrostatics: Boundary value problems in one and two dimensions in Cartesian, spherical and cylindrical coordinates. Methods of images, Point charge placed near a grounded sheet and near a grounded conducting sphere.

Multipoles and dielectrics: Green's function and solution of Poisson equation, Addition theorem of spherical harmonics, Dirac delta function in spherical polar coordinates, Eigen function expansion of Green function, Solution of potential problems with spherical Green function expansion, Microscopic and macroscopic fields, Equations of electrostatic field in a dielectric, Bound charge densities.

SECTION – B

Magnetostatics: Continuity equation, Biot savart law, Differential equations of magnetostatics and Ampere's law, Vector potential and its calculation, Magnetic moment, Macroscopic equations, Boundary conditions on B and E, Magnetic scalar potential.

Time varying fields: Faraday's law of electromagnetic induction, Energy in the Magnetic field, Maxwell equations, Displacement current, Electromagnetic potential, Lorentz and Coulomb gauge. Maxwell equations in terms of electromagnetic potentials, Solution of Maxwell equations in Coulomb Gauge and Lorentz gauge by Green function.

Text Book:

1. Classical Electrodynamics, J.D. Jackson, Wiley Eastern Ltd.
2. D.J. Griffith, Introduction to Electrodynamics, Pearson Education Ltd. 2012.

Semester-I
PHY-1.4- Nuclear and Particle Physics

Max Marks: 100 marks
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Credits: 04
Total Teaching Hours: 55

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

CO1: Understand the structure and static properties of nuclei.
CO2: Compare nuclear models and explain nuclear properties using nuclear models as well as forces.
CO3: Have the knowledge of types of nuclear reactions.
CO4: Knowledge of elements of Quantization and Feynman rules.

Instructions for the Paper Setter

The question paper will consist of three Sections: A, B and C. Section A will have four questions (from the respective section of syllabus) carrying 12 marks each, Section B will have also four questions (from the respective section of syllabus) carrying 12 marks each. Section C will consist of 11 short answer questions that will cover the entire syllabus and will be of 2 marks each.

Instructions for the Candidates

Candidates are required to attempt five questions selecting two questions from each of Section A & B and entire Section C Use of scientific calculator is allowed.

SECTION A

Radiation Detectors: Interaction of radiations with matter (Charged particles and electromagnetic radiations), Gas-filled counters, Scintillation and Semiconductor detectors, Energies and intensity measurements.

Alpha Decay: Why alpha decay occurs? Basic alpha decay processes, Alpha decay systematics. Theory of alpha emission. Angular momentum and Parity in Alpha Decay.

Beta Decay: Energy Released in Beta Decay. Fermi Theory of Beta Decay. Angular Momentum and Parity Selection Rules. Comparative Half Lives and Forbidden Decays. Neutrino Physics. Non-conservation of Parity.

Gamma Decay: Energetics of gamma decay, Angular momentum and Parity selection rules, Internal conversion.

SECTION B

Particles and Forces: Classification and Properties of Hadron and Leptons and Fundamental Forces.

Conservation Laws: Parity and Isospin strangeness, charm bottom non conservation, Operations and transformations, Baryons and Leptons Conservation, Tau lepton, C,P and CP Violation in Weak Interactions, K-decays, CPT invariance (Statement and consequences).

Meson Physics: Yukawa's Hypothesis, Discovery and properties of pions and muons and Tau Lepton , Spin, parity and isospin of π mesons, Pion-proton scattering .

Strange Particles: Mass and lifetime for K-meson, Production and decay of $\frac{1}{2}^{+}$ hyperons charm and Bottom hadrons (spectres only). Relativistic kinematics, Gellmann-Nishijima Scheme, Baryons and Meson Multiplets.

Quark Model: Development, Meson Baryon construction, Colour Quantum Number. Magnetic Moments, Nucleon Structure from Scattering and Evidence of Quark Structure, Observation of New Flavors.

Theories of Fundamental Interactions: (qualitative ideas) and Grand Unified Theory. Planak scale and Recent Developments (Qualitative ideas)

Text Books:

1. Introductory Nuclear Physics: K.S. Krane, John Wiley & Sons, New York
2. Elementary Particle Physics: I.S. Hughes, Cambridge Univ.Press
3. Introductory Nuclear Physics: S.S.M. Wong, Prentice Hall of India, New Delhi.
4. Introduction to Elementary Particles: D.J. Griffiths, John Wiley & Sons.

Semester-I

PHY-1.5-Analog Electronics

Max Marks: 100 marks
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Credits 04
Total Teaching Hours: 55

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

CO1: Be familiar with the various components such as resistors, capacitor, Inductor, IC chips and how to use these components in circuit.
CO2: Understand the concept of transistor biasing.
CO3: Understand the concept of amplifiers, equivalent circuits, multistage amplifier and Op-Amp.
CO4: Have the knowledge of different types of oscillators
CO5: Have the knowledge of Communication systems.

Instructions for the Paper Setter

The question paper will consist of three Sections: A, B and C. Section A will have four questions (from the respective section of syllabus) carrying 12 marks each, Section B will have also four questions (from the respective section of syllabus) carrying 12 marks each. Section C will consist of 11 short answer questions that will cover the entire syllabus and will be of 2 marks each.

Instructions for the Candidates

Candidates are required to attempt five questions selecting two questions from each of Section A & B and entire Section C. Use of scientific calculator is allowed.

SECTION- A

Two port network analysis: Active circuit model's equivalent circuit for BJT, Transconductance model: Common emitter. Common base. Common collector amplifiers. Equivalent circuit for FET. Common source amplifier. Source follower circuit

Feedback in amplifiers: Stabilization of gain and reduction of non-linear distortion by negative feedback. Effect of feedback on input and output resistance. Voltage and current feedback.

Bias for transistor amplifier : Fixed bias circuit, Voltage feedback bias. Emitter feedback bias, Voltage divider bias method, Bias for FET.

Multistage amplifier: Direct coupled CE two stage amplifier. RC coupling and its analysis in mid- high- and low-frequency range. Effect of cascading on bandwidth. Darlington and cascade circuits.

Oscillators : Feedback and circuit requirements for oscillator, Basic oscillator analysis, Hartley, Colpitts, RC-oscillators and crystal oscillator.

SECTION B

Analog Circuits : OP AMP: IC configuration, characteristics, Differential amplifiers, CMMR, PSRR, open loop and close loop gain, inverting, non- inverting and differential amplifier, Basic characteristics with detailed internal circuit of IC Op-amp, Summing amplifier, Logarithmic and anti- logarithmic amplifiers, Current-to- voltage and Voltage-to-current converter, Electronic circuits - Phase shift oscillator, Wien-bridge oscillator, Transfer function: LP, HP, BP and BS active and passive filters.

Communication systems (Broad aspects): Review of analog modulation techniques, Analog pulse modulation techniques; PAM, PTM (PWM, PPM), Sampling theorem, Pulse code modulation (PCM), DM, ADM, DPCM, Introduction to Satellite Communication and cellular mobile communication.

Text Books:

1. Electronic Fundamentals and Applications: J.D. Ryder, Prentice Hall of India (5th Ed.), New Delhi.
2. Electronic Devices and Circuits: G.K. Mithal, Khanna Publishers
3. Digital Principles and Applications: A.P. Malvino & D.P. Leach, Tata McGraw-Hill, New Delhi
4. An Introduction to Digital Electronics: M. Singh, Kalyani Publishers, New Delhi.
5. Electronic Devices and Circuits Theory : Boylested and Nashelsky,Pearson Education, 10th Ed.2009

Semester– I

PHY-1.6-Physics laboratory-I

Max Marks: 100 marks
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Credits: 04

Instructions for Practical Examination:

Out of 100 Marks, internal assessment (based on seminar, viva-voice of experimental reports, number of experiments performed and attendance) carries 30 marks, and the final examination at the end of the semester carries 70 marks.

List of Experiments: (Perform Minimum 10 experiments)

1. Study the gain frequency response of a given RC coupled BJT, CE amplifier.
2. Study of Clipping & Clamping circuits.
3. Study of shunt capacitor filter, inductor filter, LC filter and π filter using Bridge Rectifier.
4. Find the energy gap of a given semi conductor by reverse bias junction method.
5. To calculate the temperature coefficient of Thermistor.
6. To study various Oscillators (Hartley, Colpit, RC Phase shift etc
7. To study characteristics of FET and determine its various parameter
8. Study of transistor as CE, CB and CC amplifier.
9. To study Amplitude Modulation and De-Modulation and calculate modulation index.
10. To study characteristics of FET and determine its various parameters.
11. Use of Transistor as a push pull amplifier (Class 'A', 'B' and 'AB').
12. Application of transistor as a series voltage regulator.
13. Study of biasing techniques of BJT.
14. To study Frequency Modulation and Demodulation.
15. Study of transistor as CE, CB and CC amplifier.