

S. S. Jain Subodh P. G. College, Jaipur (Autonomous)
Assignment October 2026
Programme - M.Sc. (Physics) I Sem
Paper I – Classical Mechanics

Note: Attempt any 4 questions, selecting at least one question from each unit.

UNIT - 1

1. State and explain D'Alembert's Principle?
2. Using D'Alembert's Principle, to obtain the Lagrange's equation of motion for a conservative and non-conservative holonomic system.

UNIT – 1I

3. State and explain the Hamilton's vibrational Principle and derive the Hamilton's canonical equation of motion from it.
4. Using technique of calculus of variation, Show that the curve along which a particle falling freely from rest under the influence of the gravity from a higher point to a lower point in a vertical plane taking least time is a cycloid.

UNIT – 1II

5. What is generating function? Obtain canonical transformation equation corresponding to first two types of generating functions.
6. (a) Show that the fundamental Poisson's bracket are invariant under canonical transformation.

(b) What is the phase-space? State and prove Liouville's theorem.

UNIT – 1V

7. Discuss the Lagrangian formulation of the small oscillation.
8. Derive Euler's equation of motion for a rigid body, using them discuss the force-free motion of a rigid body.

S. S. Jain Subodh P. G. College, Jaipur (Autonomous)
Assignment October 2026
Programme - M.Sc. (Physics) I Sem
Paper II – Quantum Mechanics

Note: Attempt any 4 questions, selecting at least one question from each unit.

UNIT - 1

1. (a) What are Quantum Mechanical States? How do we represent these states? Write essential postulates of Quantum Mechanics.
 (b) What are observables in Quantum Mechanics? How do we measure these observables? Explain with a suitable example.
2. (a) Write important properties of quantum mechanical amplitude. Explain about a complete set of basis states.
 (b) Explain spin dependence of quantum mechanical amplitude on position.

UNIT – 1I

3. (a) What is the time-evolution operator and show that time-evolution operator is unitary.
 (b) What do you mean by Hermiticity of Hamiltonian Matrix?
4. (a) What do you understand by Perturbative Solution? Explain with the help of an example. Find the stationary states by diagonalizing the matrix of two state system.

UNIT – 1II

5. (a) If two observables are compatible, their corresponding operators possess a set of common eigen states.
 (b) Derive transition probability for a time dependent perturbation and discuss the result.
6. (a) State and derive the Ehrenfest theorem.
 (b) Consider a general commutation between two hermitian operators $\hat{A}$ and $\hat{B}$ such that $[\hat{A}, \hat{B}] = i\hat{C}$. Prove that product of expectation value of $\Delta \hat{A}$ and $\Delta \hat{B}$. Justify the Uncertainty Principle.

UNIT – 1V

7. (a) Let $\vec{J}$ be angular momentum (It may stand for orbital $\vec{L}$, spin $\vec{S}$ or $\vec{J}$ total). Using the fact that J_x, J_y, J_z ($J_{\pm} = J_x \pm iJ_y$) satisfy the usual angular momentum commutation relations, prove

$$J^2 = J_z^2 + J_+ J_- - \hbar J_z$$
 (b) What do you understand by Symmetry Transformation of the Coordinate? Find translation operator when a coordinate function $f(x,y,z)$ translate the system along x direction.
8. (a) Calculate $[J_x^2, \hat{J}_y], [J_z^2, J_y]$ and $[J^2, J_y]$ then show $\langle j, m | J_x^2 | j, m \rangle = \langle j, m | J_y^2 | j, m \rangle$
 (b) Consider the case where $j=1$, find the matrix representation of J^2

S. S. Jain Subodh P. G. College, Jaipur (Autonomous)
Assignment October 2026
Programme - M.Sc. (Physics) I Sem
Paper III – Classical Electrodynamics –I

Note: Attempt any 4 questions, selecting at least one question from each unit.

UNIT - 1

1. State and discuss Poisson's and Laplace's equations derived from Gauss's law, and explain the concept of equipotential surfaces in visualizing electric fields.
2. Using the method of images, determine the expression for the total force acting on the point charge q placed at a distance d from the centre of an insulated, ungrounded conducting sphere of radius a carrying a net charge Q (where $d > a$).

UNIT – 1I

3. Discuss the multipole expansion of the electrostatic potential at a distant point due to a localized, arbitrary charge distribution. Explicitly derive the monopole, dipole, and quadrupole terms .
4. Explain molecular polarizability and the electric susceptibility of a medium. Derive the Clausius–Mossotti equation for molecular polarizability.

UNIT – 1II

5. State and explain the Biot–Savart law. Derive the expression for the magnetic induction produced by a circular current loop.
6. Derive the vector potential at a point due to a magnetic dipole and hence obtain the expression for the magnetic induction of the dipole.

UNIT – 1V

7. Explain the Lorentz gauge and Coulomb gauge with suitable examples. Define irrotational current and solenoidal current.
8. Explain the Poynting vector for an electromagnetic field and discuss the Poynting theorem in the case of linear dispersive media.

S. S. Jain Subodh P. G. College, Jaipur (Autonomous)
Assignment October 2026
Programme - M.Sc. (Physics) I Sem
Paper IV – Mathematical Methods in Physics

Note: Attempt any 4 questions, selecting at least one question from each unit.

UNIT - 1

1. State and prove Ricci's Theorem and Prove that Kronecker delta is a mixed tensor of rank two.
2. Define Covariant $T_{\mu\nu}$ and Contravariant $T^{\mu\nu}$ tensors. How do their indices transform under a change of coordinates.

UNIT – 1I

3. Define both isomorphism and homomorphism in the context of group theory. Discuss their significance and provide examples of each.
4. State and explain the representation theorem of finite groups. Provide an example to illustrate the theorem.

UNIT – 1II

5. Derivation of the Single- Slit Diffraction pattern using the Fourier transformation.
6. Find Fourier transform of wave train using with Gaussian amplitude.

UNIT – 1V

7. State the Convolution theorem for Laplace transforms. Use the Convolution theorem to compute the Laplace transform of the function
- $$H(t) = \int_0^t e^{\tau} \sin(\tau) d\tau$$
8. Find the Laplace transform of
- (i) $t^2 e^{-at}$ (ii) $t^2 \sin at$

S. S. Jain Subodh P. G. College, Jaipur (Autonomous)
Assignment October 2026
Programme - M.Sc. (Physics) III Sem
Paper I – Advanced Quantum Mechanics

Note: Attempt any 4 questions, selecting at least one question from each unit.

UNIT - I

1. Define differential scattering cross sections and scattering amplitude. Derive the relation between scattering cross-section area and scattering amplitude
2. Derive the Lippman- Schwinger equation and Green function approach for scattering problem.

UNIT – II

3. Derive the Klein–Gordon equation in electromagnetic (e.m.) field. Discuss the interpretation of negative probability current density and negative energy solutions of K. G. equation.
4. Explain the properties of gamma matrices and deduce orthogonality and completeness relations for Dirac spinors.

UNIT - III

5. Explain the Lorentz variance of the Dirac equation. Deduce the condition for the invariance.
6. Write short notes on –
 - (a) Zitter bewegung and
 - (b) Klein paradox.

UNIT – IV

7. What are photon states? Consider photon as a quantum mechanical excitations of the radiation field. Deduce the relations for the Hamiltonian and total momentum in terms of operators with photon states.
8. Show that differential scattering cross-section at low wavelengths varies as the inverse fourth power of wavelength for Rayleigh's scattering.

S. S. Jain Subodh P. G. College, Jaipur (Autonomous)
Assignment October 2026
Programme - M.Sc. (Physics) III Sem
Paper II – Statistical and Solid State Physics

Note: Attempt any 4 questions, selecting at least one question from each unit.

UNIT-I

1. Derive equation of state and obtain an expression for the specific heat of a perfect gas in micro-canonical ensemble
2. Derive the expression for the thermodynamic functions of canonical ensemble.

UNIT-II

3. What is Gibb's Paradox? How can it be removed? Obtain an expression for entropy which is free Gibb's Paradox.
4. Derive an expression of Translational, Rotational and Vibrational contributions to the partition function of an ideal diatomic gas.

UNIT-III

5. Discuss Drude-Lorentz theory. State its successes and its limitations and also deduce an expression for electrical resistivity of metals.
6. (a) Using Fermi-Dirac statistics obtain an expression for Thermal conductivity of metals.
(b) What do you mean by Fermi Energy? Explain its temperature dependence.

UNIT-IV

7. (a) Starting with Schrodinger Wave Equation, discuss in detail the "Kronig –Penny" model.
(b) How it was able to explain formation of energy bands.
8. (a) Discuss the Tight Binding method and calculate energy band width in simple cubic lattice.
(b) Explain the periodic character of the crystal potential.

S. S. Jain Subodh P. G. College, Jaipur (Autonomous)
Assignment October 2026
Programme - M.Sc. (Physics) III Sem
Paper III - Nuclear Physics -I

Note: Attempt any 4 questions, selecting at least one question from each unit.

Unit-I

1. Study the excited state of deuteron by using generalized form of wave equation and find out magnitude of centrifugal potential in $l = 1$ state.
2. Calculate the electric quadropole and magnetic dipole moments of the nucleus and discuss the results.

Unit-II

3. Study the effective range theory of neutron – proton scattering. Discuss how the result can be reconciled with the deuteron data.
4. (a) Explain why diprotons and dineutrons does not found in a state of stationary state.
(b)Discuss general features of two body scattering at high energy effect of exchange forces

Unit-III

5. (a) Obtain energy loss per unit length when a charged particle passes through matter.
(b)Discuss Compton Scattering and obtain Compton Absorption Coefficient.
6. Write short notes on the following:
 - (a) Pair production
 - (b) Bremsstrahlung
 - (c) Straggling

Unit-IV

7. Explain the construction, working, plateau region and counting efficiency of the G.M. counter.
8. Explain the design and principle of working of proton synchrotron.

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Assignment October 2026
Programme - M.Sc. (Physics) III Sem
Paper IV – Microwave Electronics-I

Note: Attempt any 4 questions, selecting at least one question from each unit.

UNIT-I

1. (a) Derive the wave equation for a rectangular waveguide and explain the TE and TM modes.
(b) Explain the dominant mode (TE_{10}) and discuss the choice of waveguide dimensions and methods of excitation.
2. Discuss the causes of attenuation in waveguides. Derive the expression for the attenuation constant due to wall currents and explain the quality factor (Q) of a waveguide.

UNIT-II

3. Explain the resonant modes of rectangular and cylindrical cavity resonators. Derive the expression for the quality factor (Q) and discuss excitation techniques.
4. Write short notes on: (a) YIG tuned solid-state resonators (b) Microstrip resonators (c) Dielectric resonators (d) Microwave frequency meter

UNIT-III

5. Explain the measurement of microwave parameters:
(a) Microwave power and frequency
(b) Attenuation
(c) Impedance using the Smith chart
(d) VSWR measurement using a reflectometer
(e) Directional coupler and measurement of directivity and coupling.
6. Explain microwave propagation in ferrites. Discuss Faraday rotation and explain the construction and working of isolator, circulator and gyrator.

UNIT-IV

7. (a) Explain the construction and working of Travelling Wave Tubes (TWTs). Compare O-type and M-type TWTs and discuss beam focusing.
(b) Explain the principle of velocity modulation and describe the construction, working and efficiency of Reflex klystrons.
8. Explain the construction and working of Magnetrons. Derive the relation between electric and magnetic fields, discuss the modes of oscillation and operating characteristics. Also explain the construction and field-particle interaction in Gyrotrons