

S. S. Jain Subodh P. G. (Autonomous) College, Jaipur
Academic Year 2024-25
M.Sc. (Physics) Semester-I
Paper I- Classical Mechanics
ASSIGNMENT

Note: Attempt any two questions.

UNIT- I

Q.1 Use D'Alembert's Principle to obtain the Lagrange's equation of motion for a conservative holonomic system.

Q.2 Show that the generalized velocity dependent potential for a charged particle of mass(m) and charge (q) moving with velocity \vec{v} in an electromagnetic field is given by

$$u = q\phi - q/c \vec{A} \cdot \vec{v}$$

UNIT - II

Q.3 State and prove Noether's theorem.

Q.4 State and explain Hamilton's variational principle and derive Hamilton's canonical equation of motion from it.

UNIT - III

Q.5 What is generating function? Obtain canonical transformation equation corresponding to first two types of generating functions.

Q.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 - IV

Q.7 Discuss the Lagrangian formulation of the small oscillation.

Q.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. (Autonomous) College, Jaipur
Academic Year 2024-25
M.Sc. (Physics) Semester-I
Paper II- Quantum Mechanics
ASSIGNMENT

Note: Attempt any two questions.

UNIT- I

Q.1 (a) Prove that:-

$$[\hat{A}\hat{B}, \hat{C}\hat{D}] = -\hat{A}\hat{C}\{\hat{D}, \hat{B}\} + \hat{A}\{\hat{C}, \hat{B}\}\hat{D} - \hat{C}\{\hat{D}, \hat{A}\}\hat{B} + \hat{C}\hat{A}\{\hat{C}, \hat{A}\}\hat{D}\hat{B}$$

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(b) Suppose $|i\rangle$ and $|j\rangle$ are eigenkets of some Hermitian Operator \hat{A} . Under what conditions can we conclude that $|i\rangle + |j\rangle$ is also an eigen ket of \hat{A} ?

Q.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- II

Q.3 (a) Two ket operators concerned to the physical observable of a system are given as

$$\hat{\alpha} = \begin{pmatrix} a & 0 & 0 \\ 0 & -a & 0 \\ 0 & 0 & -a \end{pmatrix} \quad \hat{\beta} = \begin{pmatrix} b & 0 & 0 \\ 0 & 0 & -ib \\ 0 & ib & 0 \end{pmatrix}$$

with a and b real. Show that $\hat{\alpha}$ and $\hat{\beta}$ commutes to each other. What do you infer from result?

(b) What do you mean by time independent perturbation of an Arbitrary System? Explain.

Q.4 (a) Discuss the states of Ammonia molecule as two state system.

(b) What is Physical meaning of Hermiticity of the Hamiltonian matrix?

UNIT- III

Q.5 (a) If two observables are compatible, their corresponding operators posses a set of common eigen states.

(b) Derive transition probability for a time dependent perturbation and discuss the result.

Q.6 (a) State and derive the Ehernfest 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 - IV

- Q.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.
- Q.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. (Autonomous) College, Jaipur
Academic Year 2024-25
M.Sc. (Physics) Semester-I
Paper III- Classical Electrodynamics-I
ASSIGNMENT

Note: Attempt any two questions.

UNIT - I

- Q.1 Explain differential form of Gauss's law for electric field. What is scalar potential?
- Q.2 Derive the induced surface charge density on conducting sphere in a Uniform Electric Field by method of Images.

UNIT - II

- Q.3 Explain Multipole expansion of the energy of a charge distribution in an external field. What is electric quadrupole moment?
- Q.4 Explain molecular polarizability and electric susceptibility of medium? Derive Clausius-Mossotti equation for molecular polarizability.

UNIT - III

- Q.5 Explain Biot and Savart law. Derive the expression for magnetic induction due to a current loop.
- Q.6 Derive vector potential a point due a magnetic dipole. Hence deduce Magnetic induction due to magnetic dipole.

UNIT - IV

- Q.7 Explain Lorentz Gauge and Coulomb Gauge with an example. What is irrotational and solenoidal current?
- Q.8 Explain Poynting Vector for electromagnetic field. Discuss about Poynting Theorem in linear dispersive media.

S. S. Jain Subodh P. G. (Autonomous) College, Jaipur
Academic Year 2024-25
M.Sc. (Physics) Semester-I
Paper IV- Mathematical Methods in Physics
ASSIGNMENT

Note: Attempt any two questions.

UNIT - I

- Q 1. Define Christoffel symbols of first and second kind. Also prove that first and second kind Christoffel symbols are symmetric with respect to their indices.
- Q2. Prove that tensor form of Maxwell equations of electromagnetic field is covariant.

UNIT - II

- Q 3.(a) Give an example of an infinite semigroup with an identity element e such that no element except e has an inverse.
- (b) Define first and second theorem of Isomorphism. Also define kernel of Homomorphism of a group G .
- Q 4. (a) what is group multiplication table? Write various properties of group multiplication.
- (b) Define symmetry operations in the point group and give examples of a point group.

UNIT - III

- Q 5. Show that the Fourier transform of Gaussian function $f(x) = e^{-\pi x^2}$ is its own fourier transform.
- Q 6. Find the Fourier sine and cosine transform $f(x) = e^{-x^2}$

UNIT- IV

- Q 7. Prove that $L(e^{at}) = 1/s-a$ and $L(\sin at) = a/s^2 - a^2$. where $s > a$
- Q 8. Find Laplace transform of $\sin^2 t$

S. S. Jain Subodh P. G. (Autonomous) College, Jaipur
Academic Year 2024-25
M.Sc. (Physics) Semester-III
Paper I- Advanced Quantum Mechanics
ASSIGNMENT

Note: Attempt any two questions.

UNIT - I

- Q.1 What is Differential and total scattering cross section? Explain the solution of scattering problem by the method of partial wave analysis with an example.
- Q.2 What is Born approximation and its validity for scattering problem. Explain Coulomb scattering problem under first Born approximation in elastic scattering.

UNIT - II

- Q.3 Derive the Klein Gordon equation for relativistic quantum mechanics. What is interpretation of negative probability current density and negative energy solution?
- Q.4 Explain properties of gamma matrices. Derive Dirac equation for relativistic quantum mechanics.

UNIT - III

- Q.5 Explain Lorentz Covariance of Dirac equation. What are Lorentz boost and rotation matrices for Dirac spinors?
- Q.6 Explain Projection operators for four momentum and spin of particle. What are CPT operators for Dirac spinors?

UNIT - IV

- Q.7 Explain Quantization of radiation oscillator. What are creation, annihilation and number operators?
- Q.8 Explain Thomson scattering. Discuss about Raman effect for quantum radiation.

S. S. Jain Subodh P. G. (Autonomous) College, Jaipur
Academic Year 2024-25
M.Sc. (Physics) Semester-III
Paper II- Statistical and Solid State Physics
ASSIGNMENT

Note: Attempt any two questions.

UNIT - I

- Q.1 Derive an expression of the entropy of a ideal gas using the microcanonical ensemble.
- Q.2 Derive perfect mono-atomic gas in canonical ensemble.

UNIT - IV

- Q.3 Discuss the translational, Rotational and Vibrational contributions to the partition function of an ideal diatomic gas
- Q.4 Drive Plank's Distribution law for radiation by B-E Statistics.

UNIT - IV

- Q.5 (a) Write Boltzmann Transport Equation for a free electron gas under steady state.
(b) Using Fermi – Dirac statistics, obtain a relation for thermal conductivity.
- Q.6 (a) Using Fermi-Dirac statistics obtain an expression for specific heat of metals. Explain why the Classical Theory has failed to explain specific heat of metals.
(b) What do you mean by Fermi Energy? Explain its temperature dependence.

UNIT - IV

- Q.7 (a) State and prove Bloch Theorem.
(b) Discuss Pseudo Potential Method.
- Q.8 (a) Starting with Schrodinger Wave Equation, discuss in detail the “Kronig – Penny” model.
(b) How it was able to explain formation of energy bands.

S. S. Jain Subodh P. G. (Autonomous) College, Jaipur
Academic Year 2024-25
M.Sc. (Physics) Semester-III
Paper III- Nuclear Physics - I
ASSIGNMENT

Note: Attempt any two questions.

UNIT - I

Q.1. Write the different expressions for the following nuclear potentials-

- (i) Central potential & Non-central potential
- (iii) Velocity dependent potential

Q.2. (i) Discuss the ground state of deuteron with quantum-mechanical equation.

- (ii) Discuss and calculate the electronic quadrupole and magnetic dipole moment for the deuteron and the D-state admixture.

UNIT - II

Q.3. Explain the p-p scattering experiments in detail with reasons to support that these are relatively easier to perform.

Q.4. Explain n-p scattering at low energy in the framework of the square well central potential.

UNIT - III

Q.5. (i) Discuss in detail the energy loss of charged particles due to ionization. Write the relation for energy loss per unit path length.

- (ii) Show that photoelectric effect cannot occur in free space.

Q.6. (i) Define the impact parameter.

- (ii) Write the Bethe- bloch formula and explain stopping power.

UNIT - IV

Q.7. Write brief notes on the following-

- (i) Surface barriers detectors
- (ii) Chrenkov detector
- (iii) Nuclear emulsion technique and its applications.

Q.8. (i) Explain the principle, design and working of proton synchrotron.

- (ii) Briefly explain the radial focusing in linear accelerators.

S. S. Jain Subodh P. G. (Autonomous) College, Jaipur
Academic Year 2024-25
M.Sc. (Physics) Semester-III
Paper IV- Microwave Electronics - I
ASSIGNMENT

Note: Attempt any two questions.

UNIT - I

- Q.1. Derive wave equation for a circular waveguide and then solve it to obtain field component for TEM mode.
- Q.2. Discuss the causes of attenuation in waveguide. Establish a formula for attenuation constant. How does quality factor of a waveguide depends on attenuation constant.

UNIT - II

- Q.3. Describe the shift of minima method to measure the dielectric constant of liquids. Draw block diagram and write relevant relations.
- Q.4. Write in brief about Faraday rotation. Show that Faraday rotation in an non-reciprocal phenomenon. Draw necessary diagram.

UNIT - III

- Q.5. Explain the construction and working of precision variable attenuator. Discuss its frequency response and reflection losses.
- Q.6. What is Smith chart? How it is used to calculate impedance on a transmission line? Explain by giving illustration.

UNIT - IV

- Q.7. Describe construction and working of a two cavity klystron. Derive expression for its efficiency. Draw necessary diagram.
- Q.8. Discuss the construction of different types of Gyrotrons.