62121

Reg. No.

III Semester M.Sc. Degree Examination, March/April - 2025

PHYSICS

Quantum Mechanics - II

(CBCS New Scheme 2019-20, 2020-21 Onwards)

Paper : P- 301

Time : 3 Hours **Maximum Marks : 70**

Instructions to Candidates: **Answer All Parts.**

PART-A

Answer All questions. Each question carries 15 marks.

1. a) Set up the 3D Schrodinger equation in Cartesian coordinates for a free particle. Discuss the salient features of the wave function. Show that the eigen values are discrete in nature.

   b) Discuss the time reversal effect on time dependent Schrodinger equation **(10+5)**

(OR)

2. a) Solve the Schrodinger equation for a 3D harmonic isotropic oscillator and obtain its eigen values and eigen functions. Are the energy levels degenerate? Explain. What is the minimum uncertainty in its location in the lower state?

   b) Show that parity operator commutes with Hamiltonian operator. **(10+5)**

3. a) Discuss time independent perturbation theory for a degenerate state.

   b) Give the merits of variational principle. **(10+5)**

(OR)

4. a) Discuss the WKB approximation theory in the tunnelling region and explain Gamow's theory of alpha particle decay.

   b) State and explain Fermi's Golden rule. **(10+5)**

5. a) Using first order Born approximation, derive an expression for differential scattering cross section.

   b) Explain the concept of negative energy states. **(10+5)**

(OR)

6. a) Setup Klein-Gordon equation (KG equation) and obtain the plane wave solutions for a free particle using KG equation.

   b) Explain Dirac's relativistic equation in a covariant form. **(10+5)**

P.T.O.

PART - B

Answer any Five of the following. (5×5=25)

7. a) Comment on the statement: A conservation law necessarily implies the existence of a symmetry operation.

   b) Write a brief note on wave functions of identical bosons and fermions.

   c) Discuss the theory of harmonic perturbation.

   d) A simple harmonic oscillator of mass 'm' and angular frequency 'ω' is perturbed by an additional potential ½ b x^2. Obtain the first and second order energy corrections to the ground state energies, where 'x' is the distance and 'b' is a parameter independent of 'x'.

   e) Derive an optical theorem using scattering amplitude expression of the particle wave analysis.

   f) The dimensions of a Dirac's matrices must be even. Justify.