

752301**Jan. 2022****M.Sc. (Physics) IIIrd SEMESTER
Advanced Quantum Mechanics (PHL-301)**

Time : 90 Minutes]

[Max. Marks : 25

Instructions :

1. *It is compulsory to answer all the questions (1 mark each) of Part-A in short.*
2. *Answer any three questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART - A

1. (a) Write Schrodinger equation for a free particle. (1)
(b) Define the zero-point energy for one-dimensional harmonic oscillator. (1)
(c) Write the Eigen values for harmonic oscillator. (1)
(d) Define the concept of Antiparticle in brief. (1)
(e) Write the wave function for normal state (100) of hydrogen atom. (1)
(f) Define the term degeneracy. (1)
(g) Write the relativistic Hamiltonian for a free particle. (1)
(h) Write the formula for D' Alembertian operator. (1)

- (i) What is Pauli's Exclusion principle? (1)
(j) What are identical particles? (1)

PART - B

2. (a) Write the Eigen functions of 1D Harmonic oscillator with the values of Hermite polynomial. (3)
(b) Draw the wave function $\psi_0(q)$ and $\psi_1(q)$ for 1D Harmonic oscillator. (2)
3. (a) Discuss the two difficulties arises in the interpretation of relativistic Schroedinger's equation. (2)
(b) Derive the Klein-Gorden equation for a free particle. (3)
4. Derive the relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field. (5)
5. (a) The energy of a linear harmonic oscillator in third excited state is 0.1 eV. Find the frequency of vibration. (3)
(b) Write the formula for complete eigen function $\psi_{nlm}(r, \theta, \Phi)$ for hydrogen atom. (2)
6. (a) Explain the Eigen values and Eigen functions of particle exchange operator. (2)
(b) Define Creation, Annihilation and number operators. (3)