

January, 2017

QUANTUM MECHANICS - I

Time : Three Hours]

[Maximum Marks : 80

Answer from both the Sections as directed. The figures in the right-hand margin indicate marks.

SECTION-A

1. Answer any four of the following : 4×4

- (a) Define scalar product of vectors and explain their properties.
- (b) Discuss the Schmidt method of orthogonalization.
- (c) Define time evolution operator and explain its properties.
- (d) Show that $[L_z, L_+] = \hbar L_+$.
- (e) Define Pauli spin matrices and explain their properties.
- (f) Show that the product of two unitary operators is also a unitary operator.

OR

(2)

2. Answer all questions from the following : 2×8
- (a) Define unitary operators.
 - (b) What do you mean by minimum uncertainty wave packet?
 - (c) What do you mean by Quantum States?
 - (d) Define interaction picture.
 - (e) Prove the operators L_x and L_y do not commute.
 - (f) Define orbital angular momentum operator.
 - (g) Give the importance of spin.
 - (h) What is quantization of field?

SECTION-B

Answer all questions : 16×4

3. (a) What are Hermitian Operators? Explain the physical interpretation and its properties. Show that eigen values of Hermitian Operators are real.

OR

- (b) Discuss the completeness and closure properties of the basis set. Explain the properties of unitary transformations of basis vectors.

(3)

4. (a) Distinguish between the Schrodinger picture and Heisenberg picture of quantum mechanics. Obtain the equation of motion in Heisenberg picture.

OR

- (b) Solve the Schrodinger equation for a harmonic oscillator using operator method. Explain the time evolution of creation and annihilation operators.

5. (a) Obtain the commutation relations for angular momentum operator and derive the expression for L_x operator in spherical polar co-ordinate system.

OR

- (b) Derive the eigen values and eigen functions of L_x and L^2 using operator method. Explain the matrix representation of L_x .

6. (a) What are spin $\frac{1}{2}$ particles? Obtain the eigen values and eigen functions for spin $\frac{1}{2}$ particles.

OR

- (b) Discuss the addition of two angular momenta. Explain the properties of C. G. coefficients and obtain the C. G. equation in the case of $J_1 = \frac{1}{2}$ and $J_2 = \frac{1}{2}$.