(i) Printed Pages: 4 Roll No. .....

(ii) Questions : 9 Sub. Code : 3704

Exam. Code : 0472

M.Sc. Physics 1st Semester

(2122)

QUANTUM MECHANICS—I

Paper : PHY-8013

Time Allowed : Three Hours] **[Maximum Marks : 80**

Note :— Attempt **FIVE** questions in all, selecting **ONE** question each from Units-I to IV and the compulsory question from Unit-V.

UNIT—I

1. (a) Define quantum system. How does a quantum system evolve in :

(i) Heisenberg representation

(ii) Schrodinger representation ?

Explain in detail. 8

(b) Explain Gram-Schmidt procedure of orthonormalization in detail. 8

2. (a) Write a note on Eigen Kets, Eigen Bras and Dirac operator approach to quantum mechanics. 8

(b) Show that for operators A, B, C satisfying $[A, B] = iC$, the following relation holds : $\Delta A \, \Delta B \geq \frac{1}{2} < C >$, where symbols have their usual meaning. 8

UNIT—II

3. (a) Obtain eigen values of L^2 operator. L is Orbital angular momentum operator. 8

(b) Given $< j'm' \mid J_{\pm} \mid jm > = \sqrt{(j \mp m)(j \pm m + 1)}\, \hbar\, \delta_{jj'} \delta_{m', m \pm 1}$. Obtain the matrix representation for J_x operator for spin $\frac{1}{2}$. 8

4. (a) For $\vec{J}_1 = \frac{1}{2}$, $\vec{J}_2 = 1$. $\vec{J} = \vec{J}_1 + \vec{J}_2$. Obtain Clebsch-Gordon coefficients. 8

(b) Using basic commutator $[x_i, p_j] = i\hbar\delta_{ij}$, $\vec{L} = \vec{r} \times \vec{p}$, find the commutators :

(i) $[L_x L_z, L_y]$.

(ii) $[L_x^2, L_z L_y]$. 8

UNIT—III

5. (a) A one dimensional quantum simple harmonic oscillator is subjected to a perturbation Cx. Find the correction to the energy of the ground state and first excited state. 8

(b) Write a note on variational method. 8

6. (a) Discuss Stark effect in the context of degenerate perturbation theory and find the correction to first two states of hydrogen atom. 8

(b) Derive Schrodinger equation using variational method. 8

UNIT—IV

7. (a) Consider the case where perturbation is constant in time, obtain the general expression for the probability of transition. 8

(b) State and explain Fermi Golden rule. 8

8. (a) Consider the case where perturbation is harmonic in time, obtain the general expression for the probability of transition. 8

(b) Write a note on Einstein coefficients. 8

UNIT—V

9. (a) State properties of Unitary operator, Hermitian operator. 2

(b) Define Hilbert Space. 2

(c) State two postulates of quantum mechanics. 2

(d) What is the relevance of Complete set of commuting operators ? 2

(e) What is the necessary condition for applicability of perturbation theory ? 2

(f) Write down the complete :

(i) Symmetric, (ii) Anti-symmetric two identical particle quantum mechanical wave functions. 3

(g) In perturbation theory, for the ground state show that the second order correction to energy is always negative. 3