(i) Printed Pages : 3 Roll No. .....

(ii) Questions : 9 Sub. Code : 3704

Exam. Code : 0472

M.Sc. Physics Ist Semester

1128

QUANTUM MECHANICS–I

Paper–PHY-6003

Time Allowed : 3 Hours] **[Maximum Marks : 60**

Note :– Attempt **five** questions in all taking **one** question each from Units I–IV and the compulsory question from Unit–V.

UNIT–I

1. (a) Write a note on Dirac Bra, Ket notation. 6

   (b) Given two operators A and B such that $[A, B] = iC$, show that the uncertainties in A, B in any arbitrary state are related by $\Delta A \, \Delta B \geq \frac{1}{2} < C >$. 6

2. (a) Solve simple harmonic oscillator by operator algebra, for its eigen values and eigen vectors. 8

   (b) State the properties of :

   (i) inner product

   (ii) projection operator. 2,2

UNIT–II

3. (a) Using basic commutator $[x_i, p_j] = i\hbar\delta_{ij}$, $i,j = x, y, z$, $\vec{L} = \vec{x} \times \vec{p}$ work out the commutators i) $[L_y, p_x]$, $[L_z, y]$ and $[L_x, L_y]$. 2,2,2

(b) For $\vec{J}_1 = \frac{1}{2}$, $\vec{J}_2 = \frac{1}{2}$ obtain the Clebsch-Gordon coefficients. 6

4. (a) Obtain the matrix representation for operators J^2, J_z for $J = \frac{1}{2}$. 8

(b) Find out the eigen values and eigen vectors of operator L_z. 4

UNIT–III

5. (a) Write a note on variational method. 6

(b) Write a note on degenerate perturbation theory. 6

6. (a) Develop the non-degenerate perturbation theory and obtain expression for the first order correction and second order correction expression for energy. 8

(b) Second order correction to ground state energy is always negative, in non-degenerate perturbation theory. Explain why. 4

UNIT–IV

7. Obtain the general expression for the probability of transition from one state to other, of a system under the influence of a constant time dependent perturbation ($V(t) = 0$ at $t = 0$ and constant thereafter). 12

8. (a) Explain Fermi Golden rule and its application to radiative transitions in atoms. 6

   (b) What are selection rules for emission and absorption of light? 6

UNIT–V

9. (a) Define Hilbert space. 2

   (b) State two postulates of quantum mechanics. 2

   (c) How does a quantum system evolve in Schrodinger representation and in Hiesenberg representation? 2

   (d) What are commuting operators (C.S.C.O.)? How are they useful? 2

   (e) Construct three identical particle, completely antisymmetric, normalized wave function. 2

   (f) What is the first order correction to hydrogen atom in ground state, due to Stark effect? 2