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

(ii) Questions : 9 Sub. Code : 3704

Exam. Code : 0472

M.Sc. Physics 1st Semester

(2123)

QUANTUM MECHANICS-I

Paper—PHY-8013

Time Allowed : Three Hours] [Maximum Marks : 80

Note :—Attempt FIVE questions in all, selecting ONE question each from Unit I to IV. Unit–V is compulsory.

UNIT—I

I. (a) State and prove Schwartz inequality.

(b) Given a set of N-linearly independent vector, explain the procedure to construct ortho normal set out of them. 8,8

II. (a) Solve Simple Harmonic Oscillator by operator algebra, for its eigen values and eigen vectors.

(b) How does a quantum mechanical system evolve under Heisenberg representation ? 12,4

UNIT–II

III. (a) Show that the eigen values of L^2 operator are $\ell(\ell+1)\hbar^2$.

(b) Obtain the matrix representation of J_x operator for spin $\frac{1}{2}$. 8,8

IV. (a) Find Clebsch-Gordon coefficients for $\vec{J_1} = \frac{1}{2}$ and $\vec{J_2} = 1$.

(b) Using basic commutator $[x_i, p_j] = i\hbar\delta_{ij}$, work out the commutator :

(i) $[L_x, p_z]$ and (ii) $[L_x, L_z]$ 10,6

UNIT–III

V. (a) Write a note on degenerate perturbation theory.

(b) Choosing $\psi(x) = e^{-\alpha x^2}$ as ground state trial wave function, estimate the ground state energy of the Hamiltonian

$$H = \frac{p^2}{2m} + \frac{1}{2}mw^2x^2.$$ 8,8

VI. (a) Develop the non-degenerate perturbation theory and obtain expression for the first order correction to energy.

(b) A linear Simple Harmonic Oscillator is perturbed by the potential $V(x) = ax^3$. What is the first order correction to the ground state energy and first excited state energy ?

10,6

UNIT–IV

VII. (a) Explain Fermi-Golden rule and apply it to explain radiative transitions in atoms.

(b) Write a note on Einstein coefficients. 8,8

VIII. (a) Obtain the general expression for the probability of transition from one state to another under constant harmonic time dependent perturbation.

(b) What are the selection rules for emission and absorption of light ? 10,6

UNIT–V

IX. (a) Explain the role of complete set of commuting operators in describing a quantum system. 3

(b) Explain why the variational method always gives an upper limit for the ground state energy of the system. 3

(c) Explain the concept of degeneracy. 3

(d) When is the perturbation theory applicable ? 3

(e) What is unitary operator ? What is its relevance in physics ? 2

(f) State two postulates of quantum mechanics. 2