Exam.Code:0472
Sub. Code: 3704

2031
M.Sc. (Physics)
First Semester
PHY-8013: Quantum Mechanics – I

Time allowed: 3 Hours | Max. Marks: 80

***NOTE**: Attempt <u>five</u> questions in all, including Question No. 9 (Unit-V) which is compulsory and selecting one question each from Unit I - IV.*

x-x-x

UNIT-I

1. (a) Describe the evolution of a quantum mechanical system evolve in i) Hiesenberg picture, ii) Schrödinger picture. (8)
(b) Given two operators A and B such that $[A, B] = iC$, show that the uncertainties in A ,B in any arbitrary sate are related by $\Delta A\ \Delta B \geq \frac{1}{2} < C >$ (8)

2 (a). Solve one dimensional quantum simple harmonic oscillator by operator algebra, for its eigen values and eigen vectors (8)
(b) State and explain Schwarz inequality (8)

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)$[L_y, p_z]$, ii) $[L_z, x]$, iii) $[L_z, L_y]$ and iv) $[x, p_x^2]$ (2,2,2,2)
(b)For $\vec{J}_1 = 1,\ \vec{J}_2 = \frac{1}{2}$ obtain the Clebsch-Gordon coefficients (8)

4.(a) Obtain the matrix representation for operators J_z, J_y for $\vec{J} = \frac{1}{2}$ (8)
(b) Obtain the eigen vectors eigen values of L^2 operator (8)

UNIT-III

5.(a) Describe variational method using an example. (8)
(b)Develop the non-degenerate perturbation theory and obtain expression for the first order correction to the energy and first order correction to wave function. (8)

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6. (a) Write a note on degenerate perturbation theory. (8)
(b) Derive Schrödinger equation using variational method (8)

UNIT-IV

7.(a) Obtain the general expression for the probability of transition from one state to other, of a system under the influence of a periodic time dependent perturbation. (10)
(b)State and explain Fermi Golden rule and its application to radiative transitions in atoms. (6)

8.(a)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). (10)
(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) Show that momentum operator is Hermitian. (2)
(d) Show that eigen values of a Hermitian operator are always real. (2)
(e) Construct two identical particle, i) completely antisymmetric, ii) completely antisymmetric normalized wave function. (2)
(f) What are C.G coefficients? (2)
(g)What is an unitary operator, what is its relevance in physics? (2)
(h)Second order correction to ground state energy is always negative, in non-degenerate perturbation theory. Explain why? (2)

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