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

(ii) **Questions : 9** **Sub. Code :** 3 2 2 4

**Exam. Code :** 4 7 2

**M.Sc. 1st Semester**

**1125**

**PHYSICS**

**Paper -Phy-6003 : Quantum Mechanics-I**

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

**Note :–** Attempt **FIVE** questions in all taking **ONE** question from each Unit I-IV and the compulsory question from Unit-V.

## UNIT–I

1. (a) State and prove Schwarz inequality. 6

   (b) How does a quantum mechanical system evolve under Hiesenberg representation ? 6

2. (a) Explain Gram-Schmidt Orthoganlization procedure. 6

   (b) Explain the relevance of :

   (i) Unitary operators 3

   (ii) Hermitian operators in quantum physics. 3

## UNIT–II

3. (a) Obtain the eigen value of $L^2$ operator. 6

   (b) Obtain the matrix representation for $J_x$ operator for spin 1. 6

4. (a) For $\vec{J}_1 = \frac{1}{2}, \vec{J}_2 = \frac{1}{2}$ find Clebsch-Gordon coefficients. 6

(b) Using basic commutator $[x_i, p_j] = i\hbar\delta_{ij}$, work out the commutators $[x, p_x^2]$, $[L_x, L_y]$, $[L_x^2, L_z]$ 6

## UNIT–III

5. (a) Simple harmonic oscillator $H = p^2 + x^2$ is perturbed by $V = \lambda x^3 + \mu x^4$. Find the first order correction to the ground state. 8

(b) In non-degenerate perturbation theory formalism, explain why the second order correction to the energy for the ground state is always negative. 4

6. (a) Given $H = -\frac{\hbar^2}{2m}\frac{d^2}{dx^2} + Cx^4$, choose a suitable trial wavefunction and estimate ground state energy using variational method. 8

(b) Write a note on degenerate perturbation theory. 4

## UNIT–IV

7. (a) Obtain the general expression for the probability of transition from one state to another under constant harmonic time dependent perturbation. 8

(b) What are the selections rules for emission and absorption of light. 4

8. (a) State and explain Fermi Golden rule. 8

(b) What are Einstein coefficients ? 4

## UNIT–V

9. (a) State the two basic postulates of quantum mechanics. 2

(b) Define Hilbert space 2

(c) What is a :

(i) linear operator

(ii) anti-linear operator. 2

(d) Explain the role of complete set of commuting operators in describing a quantum system. 2

(e) Explain why variational method always gives an upper limit for the ground state energy of the system. 2

(f) Give the matrix representation of $S_z$ for spin $\frac{1}{2}$ particle

useful relation $\int_{-\alpha}^{\infty} x^{2n} e^{-ax^2} dx = \frac{1.3.5.....(2n-1)\sqrt{\pi}}{2^n a^{(2n+1)/2}}$. 2