M.Sc. First Year (Physics) CBCS Pattern Semester-II

PSCPHYT05 - Core Paper-V - Quantum Mechanics-I

P. Pages : 2 **GUG/W/23/11220**

Time : Three Hours * 6 2 4 8 * Max. Marks : 80

Either :-

1. a) State and prove Ehrenfest's theorem. Explain its importance. **8**

b) State postulates of operator formalism of quantum mechanics. **8**

OR

e) Derive time dependent Schrodinger's equation. Is this equation relativistically invariant Explain. **8**

f) Explain the physical interpretation of wave function and show that the wave function Ψ leads to the continuity equation. **8**

Either:-

2. a) Explain Dirac Notation and derive expression for (i) Heisenberg equation of motion (ii) Schrodinger equation of motion. **8**

b) State and prove Schwarz inequality. Show how it leads to general uncertainty principle. **8**

OR

e) What is meant by unitary transformation? Derive equation of transformation from one orthonormal basis to another. **8**

f) Define Hermitian operator. **8**

i) Prove that the eigen values of Hermitian operator are real.

ii) Any two eigen functions of Hermitian operator that belongs to different eigen values are orthogonal.

Either:-

3. a) Obtain expression for L^2 operator in spherical polar coordinates. **8**

b) Evaluate the commutator **8**

i) $\left[x^2, P_x^2\right]$, ii) $\left[x^2, P_x^3\right]$

iii) $\left[x^2, \frac{d}{dx}\right]$ and $\left[e^{ix}, P_x\right]$

OR

e) Explain the role of L^2 operators in central force problem. **8**

f) Solve the Schrodinger equation for one dimensional harmonic oscillators and find its energy. **8**

Either :-

4. a) Obtain the Clebsch – Gordan coefficient for a system having $j_1 = 1$ and $j_2 = 1/2$ **8**

b) Find the eigen values of J^2 and J_Z **8**

OR

e) What are Pauli spin matrices? Show that **8**

i) $\left[\sigma_x, \sigma_y\right] = 2i\sigma_z$

ii) $\left[\sigma_y, \sigma_z\right] = 2i\sigma_x$

iii) $\left[\sigma_z, \sigma_x\right] = 2i\sigma_y$

f) Consider J_1 and J_2 as two independent angular momenta. Explain how they add together to obtain an angular momenta for the system. **8**

5. Attempt all the followings.

a) How that momentum operator $-i\hbar\nabla$ is a Hermitian operator. **4**

b) If the wave function for a system is an eigen function of the operator associated with the observable A, show that **4**

$\left\langle A^n \right\rangle = \langle A \rangle^n$.

c) Discuss in detail the degeneracy of hydrogen atom energy levels. **4**

d) Derive matrices for the operators J^2, J_z, J_x and J_y for j = 3/2 **4**

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