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

PSCPHYT05 - Core Paper-V - Quantum Mechanics-I

P. Pages : 2 **GUG/W/24/11220**

Time : Three Hours * 4 3 0 8 * Max. Marks : 80

Either :

1. a) Derive time independent Schrodinger's equation. **8**

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

OR

e) Derive an expression for probability current density. Find the probability current density of wave function $\psi(x) = \frac{A}{r} e^{ikr}$ where A is constant. **8**

f) State postulates of operator formalism of quantum machanics. **8**

Either:

2. a) Explain Schrodinger picture. Obtain the time derivative of the expectation value of an observable in it. **8**

b) Define Dirac's Bra-ket notations. What is the relation between the wave function ψ and corresponding Ket notation? **8**

OR

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

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

Either :

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

b) Explain the role of L^2 operator in central force problem. **8**

OR

e) A particle of mass 'm' is moving in potential well **8**

$V(x) = V_0$ for $x < -a$

$V(x) = 0$ for $-a < x < a$

$V(x) = V_0$ for $x > a$

When energy of a particle is $E < V0$, then show that at least on bound state.

f) Obtain the energy levels for Harmonics oscillator using operator method. **8**

Either:

4. a) What are the Pouli spin matrices? Show that **8**

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

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

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

b) Derive matrices for J^2, J_z, J_y and J_x for $j = 1$. **8**

OR

e) Express the operators for angular momentum components L_x, L_y and L_z in Cartesian and in spherical polar coordinates. **8**

f) What is the Clebsch Gordan coefficient? Explain its significance. **8**

5. Attempt all the followings.

a) Discuss the Dirac delta function and write its properties. **4**

b) Show that J_+ and J_- is non Hermitian operator. **4**

c) Find the eigenfunctions and eigenvalues of the operator $\frac{d^2}{dx^2} + \frac{2}{x}\frac{d}{dx}$. **4**

d) Explain spin momentum functions. **4**

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