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

PSCPHYT05 - Paper-V (Core-V) : Quantum Mechanics-I

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

Time : Three Hours Max. Marks : 80

Either:

1. a) Give the physical interpretation of ψ and find the expression of probability current density. **8**

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

OR

e) What are characteristic features of stationary states. **8**

f) Derive the uncertainty relations for operators A, B such that [A, B] = iC **8**

Either:

2. a) Show that the function e^{ikx} is a simultaneous eigen function of $-i\hbar\frac{\partial}{\partial x}$ and $-\hbar\frac{\partial^2}{\partial x^2}$ operators find their eigen values. **8**

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

OR

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

f) How will you express eigen value equation in matrix representation. **8**

Either:

3. a) Give the complete theory of simple harmonic oscillators using operator method. **16**

OR

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

f) Show that $En = \left(n + \frac{1}{2}\right)\hbar w$ using raising and lowering operator to $H|n>= En|n>$. **8**

Either:

4. a) Find the eigen values of J^2 and J_4 **8**

b) Derive C. G. coefficients for $j_1 = \frac{1}{2}, j_2 = 1$. **8**

OR

e) Show that **8**

i) $[J_+, J_-] = 2\hbar J_2$

ii) $[J_x^2, J_y^2] = [J_y^2, J_z^2] = [J_z^2, J_x^2]$

f) Using addition of two angular momenta, Derive the relation between $m, m_1,$ and m_2 where the symbols have their usual meanings. **8**

5. Attempt all.

a) State Bohr's correspondence principle and Ehrenfest theorem. **4**

b) Show that Hermitian operators have real eigen value. **4**

c) Find the Parity of $\gamma_\ell^m(\theta, \phi)$. **4**

d) Find matrix element of J_x for $j = 1$. **4**

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