M.Sc. F.Y. (Physics) Sem-II

0140 - Quantum Mechanics-I Paper-I

P. Pages : 2 **GUG/S/19/2238**

Time : Three Hours Max. Marks : 80

Note : All questions are compulsory and carry equal marks.

1. Either :

a) "A wave packet contains all the relevant information of a moving particle" – Comment. **4**

b) Discuss the concept of expectation value. Derive the expression of expectation value of momentum. **6**

c) Prove Ehrenfest's theorem. Explain its importance. **6**

OR

e) Deduce the equation of motion in momentum representation. **6**

f) Show the probability density in the momentum representation is $|\phi(p,t)|^2$. **6**

g) State the admissibility of wave function. **4**

2. Either :

a) Show that : Every eigen value of a Hermitian operator is real. **4**

b) Derive matrices for representing state vectors and operators, in an orthonormal basis. **8**

c) What are fundamental commutation relations? Derive using co-ordinate representation. **4**

OR

e) Explain how a matrix representation changes during change in basis. **6**

f) Explain Schrodinger picture. Obtain the time derivative of the expectation value of an observable. **8**

g) What is fundamental expansion postulate? **2**

3. Either :

a) Discuss the parity of wave function. **4**

b) What is parity operator? What are its eigen values. **4**

c) Solve the eigen value equation of L^2. **8**

OR

e) What do you mean by parity operator. Define even and odd parity. Shows that the parity of spherical harmonics $Y_\ell^\theta(\theta,\phi)$ is $(-1)^\ell$. **10**

f) Calculate the eigen function and eigen value of linear simple harmonic oscillator. **6**

4. Either :

a) Find the matrix elements of J^2 and J_z operators for $j = 1/2$ and 1. Also find the matrix elements J_x and J_y for $j = 1/2$. **8**

b) Explain the addition of two independent angular momenta J_1 and J_2. What is C. G. Coefficient. **8**

OR

e) Using Pauli's spin matrix representation reduce each of the operator. **8**

i) $S_x^2\ S_y S_z^2$

ii) $S_x^2\ S_y^2 S_z^2$

iii) $S_x\ S_y S_z$

iv) $S_x\ S_y S_z^3$

f) The Vector J gives the sum of angular momenta $J_1 \& J_2$, prove that : **8**

i) $\left[J_x, J_y\right] = 2iJ_z$

ii) $\left[J_y, J_z\right] = 2iJ_x$

iii) $\left[J_z, J_x\right] = 2iJ_y$

Is $J_1 - J_2$ an angular momentum?

5. All questions are compulsory.

a) What is momentum eigen function? How will you normalize the momentum eigen function using Dirac – delta normalization method? **4**

b) Explain Schwarz inequality. **4**

c) Explain importance of L^2 operators in solving central force problem. **4**

d) Show that J_+ and J_- are non Hermitian operators. **4**

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