



JW-003-00497003 Seat No. _____

B. Sc. / M. Sc. (Applied Physics) (Sem. VII) (CBCS)

Examination

October - 2019

Paper-II : Applied Quantum Mechanics

(New Course)

Faculty Code : 003

Subject Code : 00497003

Time : $2\frac{1}{2}$ Hours]

[Total Marks : 70

Instructions :

- (1) All questions are compulsory.
- (2) Numbers in the right margin indicate marks.

1 Attempt any seven short questions : (two marks each) **14**

- (1) What is box normalization of a wave function ?
- (2) Prove that $[x, P_x] = i\hbar$.
- (3) Evaluate : $[f(x), P_x]$.
- (4) Show that, $(\Delta A)^2 = \langle A \rangle^2 + \langle A \rangle^2$.
- (5) Prove that :
 - (i) $[A, B, C] = [A, B]C + B[A, C]$
 - (ii) $[AB, C] = A[B, C] + [A, C]B$
- (6) Explain : The azimuthal equation for a wave function of hydrogen atom.
- (7) Find the solution and discuss the radial equation for a wave function of hydrogen atom.
- (8) Show that the eigen functions of L_z form an orthonormal set.
- (9) Show that $[L^2, L_z] = 0$.
- (10) Prova that $[P_i, P_j] = 0$.

- 2 Write answer of any two : 14
- (1) (a) If \hat{x} and \hat{p} are the position and momentum operators, 3
 prove that commutator relation $[\hat{p}^2, \hat{x}] = -2i\hbar P$.
- (b) What is the operator correspondence ? Derive the 4
 Schrödinger equation for a particle subjected to forces.
- (2) What is expectation value of an operator ? Prove Ehrenfest's 4
 theorem.
- (3) Derive Schrödinger equation for a free particle in one 4
 dimension.
- (4) What are stationary states ? Derive time independent 4
 Schrödinger equation.
- 3 Write answers of any two : 14
- (1) (a) Prove that $[L_x, L_y] = i\hbar L_z$. 3
- (b) Write a detailed note : the fundamental postulates 4
 of wave mechanics.
- (2) The state of a particle in a box of length L is describe by 4
 $\psi = \sqrt{\frac{2}{L}} \sin \frac{n\pi x}{L}$; $n = 0, 1, 2, \dots$. Calculate the uncertainty
 product $\Delta x \Delta p$.
- (3) Explain in detail : the Schrödinger equation and the 4
 probability interpretation for an N particle system.
- (4) Write a detailed note : The adjoint of an operator and self 4
 adjointness of an operator.
- 4 Write answer of any two : 14
- (1) (a) Determine the eigenvalue of the parity operator P 3
 which is defined as $P\psi(r) = P\psi(-r)$.
- (b) Explain the separation of variables of partial differential 4
 equation for wave function ψ of the electron in a
 hydrogen atom.
- (2) Derive an equation of energy eigenvalue of the Schrödinger 4
 equation for a simple harmonic oscillator.
- (3) Write a detailed note : The angular momentum operator. 4
- (4) Derive partial differential equation for a wave function of the 4
 electron in a hydrogen atom.

5 Write answers of any two :

14

- (1) What is perturbation theory for discrete levels ? Derive equations in various orders to perturbation theory.
 - (2) Discuss the first order solution of perturbation theory for the non-degenerate case.
 - (3) Explain the effect of an electric field on the energy level of an atom with necessary equations.
 - (4) Explain the Hamiltonian of two electron atoms in detail and derive the equation for ground state energy.
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