

Exam. Code : 209002

Subject Code : 4807

M.Sc. Physics 2nd Semester (Batch 2021-23)

QUANTUM MECHANICS—I

Paper—Phy-451

Time Allowed—3 Hours] [Maximum Marks—100

Note :—Attempt FIVE questions in all, selecting at least ONE question from each section. The fifth question may be attempted from any section. All questions carry equal marks.

SECTION—A

1. (a) Differentiate between compatible and incompatible observable. 6
- (b) Write the orthonormalization relation, closure relation, expansion of a ket, components of a ket, closure relation, scalar product in $\{|r\rangle\}$ and $\{|p\rangle\}$ representation. Also, accomplish a change in $\{|r\rangle\}$ representation to $\{|p\rangle\}$ representation and vice versa. 14
2. (a) How are commutators and uncertainty relation related? 5
- (b) Write scalar product $\{|r\rangle\}$ and $\{|p\rangle\}$ representation. Also, accomplish a change in $\{|r\rangle\}$ representation to $\{|p\rangle\}$ representation and vice versa. 15

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(Contd.)

SECTION—B

3. (a) What are time evolution operators and how are they used in Schrodinger equation ? 10
(b) Derive and discuss Heisenberg equations of motion. 10
4. (a) What special role is played by Hamiltonian operator in Schrodinger equation ? 10
(b) State and prove the Ehrenfest's theorem. 10

SECTION—C

5. (a) What is the functional form of $V(x)$ for a potential barrier ? Solve the Schrodinger equation for this $V(x)$. 12
(b) What ratio of E/V_0 is necessary for scattering from a one dimensional step potential so that the transmission probability of the system is 50%. 8
6. Find the eigen energy and wave function for a finite and infinite potential well. 20

SECTION—D

7. (a) Give and solve Schrodinger equation for a spherically symmetric potential. 14
(b) Find the eigen values for L^2 operator. 6

8. (a) Find the total angular momentum for two particles in angular momentum state $j_1 = 1/2$ and $j_2 = 1/2$. Write the possible number of states in the total angular momentum $|J, M_J\rangle$ representation. Calculate all C.G. coefficients. 14
- (b) Using the commutation relations between r and p , find the commutation relation $[L_x, L_y]$. 6