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MSH 451

II Semester M.Sc. Examination, Sept./Oct. 2022
(CBCS)
MATERIALS SCIENCE
Quantum Mechanics – I

Time : 3 Hours

Max. Marks : 70

Instructions : 1) *Scientific calculator may be **allowed**.*
2) *Answer **all** questions.*

1. a) Define expectation value of an operator. State and prove Ehrenfest's theorem.
b) Show that the expectation value of energy for a particle in a square box of side L is equal to $\hbar \omega$. **(14+6)**

OR

2. Set up the Schrodinger equation for a particle in a one-dimensional potential well of finite depth and obtain the energy spectrum. **20**
3. a) Write the Schrodinger equation for hydrogen atom in spherical polar coordinates.
b) Solve the radial part and show that the maximum probability of finding the electron is at a distance equal to the first Bohr radius. **(4+16)**

OR

4. Discuss the motion of 1-dimensional simple harmonic oscillator and determine the energy eigenvalue spectrum. Write down the first four wave functions. Compare the results with classical results. **20**
5. a) Show that the coordinate and momentum representations are Fourier transforms of each other.
b) Define Bra, Ket vectors. Represent inner product using Bra and Ket vectors. **(14+6)**

OR

6. Discuss the motion of a simple harmonic oscillator using matrix mechanics. Arrive at the matrices for creation, annihilation, number, position, momentum and Hamiltonian operators. **20**

P.T.O.



7. Answer **all** the following questions :

(2×5=10)

- a) Find out the de Broglie wavelength of an electron accelerated by a potential of 600 volts.
- b) What are the canonically conjugate variables ?
- c) What type of operators are used for representing physical variables ? Why ?
- d) Distinguish between Schrodinger and Heisenberg pictures.
- e) If operators, a and a^+ act on the ground state $|0\rangle$ of a harmonic oscillator, what do you expect ?
