Reg. No. | | | | | | | | | |

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 ?
