Roll No.
500 -/-/15/20

DS-203

November – December 2019
M. Sc. Ist Semester Examination

PHYSICS
PAPER III : QUANTUM MECHANICS

Time 3 Hours] [Max. Marks : Regular 85 / Private 100
[Min. Marks : Regular 28 / Private 33

Note : This question paper is meant for all Regular and Private students. Answer all five questions. All questions carry equal marks. The blind candidates will be given 60 minutes extra time.

1. State and prove Ehrenfest's Theorem.

OR

A beam of particles with energy E is incident on a potential barrier with potential function :

$$V(x) = \begin{cases} 0 & \text{for} \quad x < 0 \\ V_0 & \text{for} \quad 0 < x < a \\ 0 & \text{for} \quad x > a \end{cases}$$

Show that there is a finite probability of transmission even if $E < V_0$.

2. Derive Heisenberg's Uncertainty Principle by the help of Quantum Mechanical Operators.

OR

Discuss the representation of wave functions and operators in matrix form. How a basic set of wave functions is changed into another by unitary transformation in Hilbert Space ?

3. Establish Schrödinger equation for a linear harmonic oscillator and solve it to obtain its eigen values and eigen functions.

OR

Solve the radial part of Schrödinger's equation for the hydrogen atom to obtain its eigen value and eigen functions.

4. Deduce the commutation relation for the components L_x, L_y, L_z of orbital momentum and show that all three components commute with L^2.

OR

Explain why Pauli introduced a set of 2×2 spin matrices. If σ_x, σ_y and σ_z are Pauli spin matrices and $\vec{A}$ and $\vec{B}$ any constant vector, show that :

$$(\vec{\sigma} \cdot \vec{A})(\vec{\sigma} \cdot \vec{B}) = \vec{A} \cdot \vec{B} + i\,\vec{\sigma}\,(\vec{A} \times \vec{B}).$$

5. Write short notes on any two of the following :
   (a) Postulates on Quantum Mechanics.
   (b) Bra and Ket Vectors.
   (c) Schrödinger equation in spherical polar coordinates.
   (d) CG-Coefficients.
