GALGOTIAS UNIVERSITY

ADMISSION NUMBER												

School of Basic Sciences

Master of Science in Physics
Mid Term Examination - Nov 2023

Duration : 90 Minutes
Max Marks : 50

Sem I - C1PO102T - Quantum Mechanics-I

General Instructions
Answer to the specific question asked
Draw neat, labelled diagrams wherever necessary
Approved data hand books are allowed subject to verification by the Invigilator

1) Interpret Hilbert Space. K2 (2)

2) Why wave function should be normalised? K1 (3)

3) Interpret acceptable characteristics of wave function. K2 (4)

4) Why the following wave function for any value of x are good acceptable wave function? (a) 2sin x (b) exp (-x2) K2 (6)

5) Consider an ensemble of 100 identical systems, each in state $|\psi\rangle = \frac{2}{\sqrt{5}}|\phi_0\rangle - \frac{1}{\sqrt{5}}|\phi_1\rangle$. Here $|\phi_0\rangle$ and $|\phi_1\rangle$ are the normalized eigenfunctions in ground and excited state respectively. If measurements are done, how many systems will be found in the ground state and excited state? K3 (6)

6) Consider a system which is described by the state K3 (9)

$$\psi(\theta, \varphi) = \sqrt{\frac{3}{8}}Y_{11}(\theta, \varphi) + \sqrt{\frac{1}{8}}Y_{10}(\theta, \varphi) + AY_{1,-1}(\theta, \varphi),$$

where A is a real constant

(a) Calculate A so that $|\psi\rangle$ is normalized.
(b) Find $\hat{L}_+\psi(\theta, \varphi)$.
(c) Calculate the expectation values of $\hat{L}_x$ and $\hat{L}^2$ in the state $|\psi\rangle$.

7) Calculate the commutation relation: [y, Ly] K4 (8)

8) K4 (12)

At time t=0, a particle is represented by:

$$\psi(x,0)=\begin{cases} Ax/a & if \quad 0\le x\le a \\ A\left(\dfrac{b-x}{b-a}\right) & if \quad a\le x\le b \\ 0 & otherwise \end{cases}$$

Here A, a and b are constants.

(a) What is normalized value of Ψ?
(b) Sketch Ψ (x,0) as a function of x.
(c) Where is the particle most likely to be found at t=0?
(d) Probability of finding the particle left of a. what is probability if b=a and b=2a?

OR

Consider a wave function: K4 (12)

$$\psi(x,t)=Ae^{-\lambda|x|}e^{-i\omega t}$$

Find the value of A (b) Determine expectation value of x and x^2. (c) Plot $|\Psi|^2$