

Roll No. _____

25/2394**M.Sc. (First Semester) Examination, 2025****PHYSICS****Paper : Fourth****(Quantum Mechanics)***Time : Two Hours]**[Maximum Marks : 75***Note :** Attempt **all** sections as per instructions.**Section-A****(Very Short Answer Type Questions)****Note :** Attempt all the **(05) five** questions.Each question carries **02 (two)** marks and answer of each question should notexceed **50** words. $5 \times 2 = 10$

1. ~~(a)~~ Briefly explain Heisenberg's uncertainty principle.

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- ~~(b)~~ Explain briefly the degenerate and non-degenerate systems.
- ~~(c)~~ Write Pauli's spin matrices for the electron.
- (d) Explain Stark effect.
- ~~(e)~~ Explain Dirac's Bra and Ket notations.

Section-B**(Short Answer Type Questions)**

Note : Attempt any **05 (five)** questions out of the **08 (eight)** questions. Each question carries **05 (five)** marks and answer of each question should not exceed **100** words. $5 \times 5 = 25$

2. (a) An electron has a speed of 1.05×10^4 m/sec within accuracy of 0.01%. Calculate uncertainty in position of electron.
- ~~(b)~~ Write down the Schrödinger equation for a particle in a box.

- (c) Explain projection operator.
- (d) Show that for Pauli spin matrices
 $\sigma^2 = \sigma_x^2 + \sigma_y^2 + \sigma_z^2 = 3$
- (e) Discuss perturbation theory for non degenerate levels.
- (f) Explain stark effect of a plane rigid rotator.
- (g) State Ehressfest's theorem.
- (h) Write the differential form of 'Momentum' and 'Energy' operators.

Section-C

(Long Answer Type Questions)

Note : Attempt any **02 (two)** out of **04 (four)** questions. Each question carries **20 (twenty)** marks and the answer of each question should not exceed **400** words.

$$2 \times 20 = 40$$

3. (a) Explain Schrödinger equation for the hydrogen atom and discuss the radial wave function.

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- (b) Explain Schrödinger equation for linear harmonic oscillator and obtain its eigen values and eigen function. What is the zero point energy?
- (c) Describe Pauli Spin matrices for electron. Write down the commutation relation between σ_x , σ_y and σ_z . Show that

$$[\sigma^2, \sigma_x] = [\sigma^2, \sigma_y] = [\sigma^2, \sigma_z] = 0$$
- (d) Give the general formulation of the time independent perturbation theory. Explain the first and second order corrections.

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