D 140701 **(Pages : 2)** **Name.....**

Reg. No.....

SECOND SEMESTER M.Sc. (CBCSS) REGULAR/SUPPLEMENTARY DEGREE EXAMINATION, APRIL 2026

Physics

PHY2C05—QUANTUM MECHANICS—I

(2019 Admission onwards)

Time : Three Hours Maximum Weightage : 30

Section A

(8 *Short questions answerable within* 7.5 *minutes)*
Answer **all** *questions, each question carries weightage* 1.

1. What are projection operators ?
2. Show that unitary equivalent observables have identical spectra.
3. Distinguish between Hermitian and skew Hermitian operators.
4. State and illustrate the Pauli Exclusion Principle.
5. Calculate the commutator $\left[J_x^2, J_y\right]$.
6. Explain the properties of Linear Vector Space.
7. Briefly explain the features of interaction picture.
8. What is the principle of indistinguishability of identical particles ?

(8 × 1 = 8 weightage)

Section B

(8 *essay questions answerable within* 30 *minutes)*
Answer any **two** *questions, each question carries weightage* 5.

9. Discuss the Harmonic oscillator problem in Schrodinger picture.
10. Derive the generalized uncertainty relation.
11. Find the Clebsch-Gordan coefficients associated with the coupling of the spins of the electron and the proton of a hydrogen atom in its ground state.
12. Describe Schrödinger equation for central potentials and hence describe hydrogen atom.

(2 × 5 = 10 weightage)

Turn over

Section C

(7 *problems answerable within* 15 *minutes)*

Answer any **four** *questions, each question carries weightage* 3.

13. Obtain the eigen value spectrum for ladder operators.
14. Explain the interaction picture. Obtain the equation of motion.
15. Find the matrices representing operators $\hat{\mathrm{J}}^2$ and J_z (given angular momentum $j = 1$).
16. Show that the total energy of the system is conserved if the system is invariant under translation in time.
17. Calculate the commutator $\left[\mathrm{J}_z^2, \mathrm{J}_y\right]$.
18. Show that $(\vec{\sigma}\cdot\vec{\mathrm{A}})(\vec{\sigma}\cdot\vec{\mathrm{B}}) = (\vec{\mathrm{A}}\cdot\vec{\mathrm{B}})\hat{\mathrm{I}} + i\vec{\sigma}\cdot(\vec{\mathrm{A}}\times\vec{\mathrm{B}})$.
19. Evaluate the x-p uncertainty product $\left\langle(\Delta x)^2\right\rangle\left\langle(\Delta p)^2\right\rangle$ for a one-dimensional particle confined between two rigid walls, $\mathrm{V} = \begin{cases} 0 & \text{for } 0 < x < a \\ \infty & \text{otherwise.} \end{cases}$

(4 × 3 = 12 weightage)