

D 140701

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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 $[J_x^2, J_y]$.
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{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 $[J_z^2, J_y]$.
18. Show that $(\vec{\sigma} \cdot \vec{A})(\vec{\sigma} \cdot \vec{B}) = (\vec{A} \cdot \vec{B})\hat{I} + i\vec{\sigma} \cdot (\vec{A} \times \vec{B})$.
19. Evaluate the x - p uncertainty product $\langle(\Delta x)^2\rangle\langle(\Delta p)^2\rangle$ for a one-dimensional particle confined between two rigid walls, $V = \begin{cases} 0 & \text{for } 0 < x < a \\ \infty & \text{otherwise.} \end{cases}$

(4 × 3 = 12 weightage)