

C 42801

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Name.....

Reg. No.....

**SECOND SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY)  
EXAMINATION, APRIL 2023**

(CBCSS)

Physics

PHY 2C 05—QUANTUM MECHANICS—I

(2019 Admission onwards)

Time : Three Hours

Maximum : 30 Weightage

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

1. What is the condition for two eigen vectors to be orthogonal ?
2. Explain wave packet.
3. What are ladder operators ? Why are they called so ?
4. Explain the matrix representation of a wave function ?
5. Conservation of angular momentum is a consequence of the rotational invariance of the system. Substantiate
6. What is time reversal symmetry ?
7. What is the advantage of using spherical polar co-ordinates in the case of central potentials ?
8. What is Slater determinant ? How does it incorporate Pauli Exclusion principle ?

(8 × 1 = 8 weightage)

**Section B***4 essay questions answerable within 30 minutes.**Answer any **two** questions, each question carries 5 weightage.*

9. Discuss the matrix representation of kets and bras operators. Derive the general uncertainty relation.
10. Derive equation of motion for states and operators in Schrodinger and interaction pictures.

**Turn over**

11. Obtain Eigenvalue problem for angular momentum operators  $J^2$  and  $J_z$ . Enumerate their matrix representations.
12. Describe the concept of symmetry and conservation laws with specific reference to displacement in space and time.

(2 × 5 = 10 weightage)

### Section C

*7 problems answerable within 15 minutes.*

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

13. Show that  $[L_k, r^2] = 0$ ; where  $r$  is the radius vector  $\mathbf{p}$  is the linear momentum and  $\mathbf{k}, \mathbf{l}, \mathbf{m}$  are the cyclic permutations of 1, 2, 3.
14. Show that the commutator  $[x, [x, H]] = -\frac{\hbar^2}{m}$ , where H is the Hamiltonian operator.
15. With creation and annihilation operators solve linear harmonic oscillator problem.
16. State and prove the continuity equation.
17. An electron has a speed of 500 m/s with an accuracy of 0.004 %. Calculate the certainty with which we can locate the position of the electron.
18. Discuss the fundamental commutation relations of angular momentum.
19. Show that Pauli spin matrices satisfy  $\sigma_i \sigma_j + \sigma_j \sigma_i = 2I \delta_{ij}$  (I is a  $2 \times 2$  matrix).

(4 × 3 = 12 Weightage)