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(Pages : 2)

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 x 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 $\left[L_k, r^2\right] = 0$; where r is the radius vector $\boldsymbol{p}$ is the linear momentum and $\boldsymbol{k}$, $\boldsymbol{l}$, $\boldsymbol{m}$ are the cyclic permutations of 1, 2, 3.

14. Show that the commutator $\left[x, \left[x, H\right]\right] = -\frac{h^2}{m}$, 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 × 2 matrix).

(4 × 3 = 12 Weightage)