TM252889Y

Reg. No :...............................

Name :.................................

MASTER'S DEGREE (C.S.S) EXAMINATION, MARCH 2025

2020, 2021, 2022, 2023 ADMISSIONS SUPPLEMENTARY

SEMESTER II - CORE COURSE

PH2C06TM20 - Quantum Mechanics - I

Time : 3 Hours **Maximum Weight : 30**

Part A

I. Answer any Eight questions. Each question carries 1 weight **(8x1=8)**

1. Compare inner and outer products of state kets.
2. Derive the similarity transformation of transformation matrix using matrix algebra.
3. Let x and p_x be the quantum mechanical operators for position and momentum in one dimension. Evaluate the commutator $[x, \exp(\frac{ip_x a}{\hbar})]$ where a is a constant.
4. Compare the behaviour of base kets in Schrodinger and Heisenberg pictures.
5. Differentiate between Schrodinger and Heisenberg pictures of quantum mechanics.
6. Form a mathematical expression of time evolution operator when Hamiltonian at different times do not commute.
7. Construct the matrix elements $\langle j', m' | J_+ | j, m \rangle$ for $j=1$.
8. Evaluate $exp(i S_z\phi/\hbar)\, S_x\, exp(-i S_z\phi/\hbar)$.
9. Show that the Clebch Gordon coefficients vanishes unless the sum of eigen values of J_{1z} and J_{2z} is equal to the eigen value of J_Z.
10. Explain the term accidental degeneracy for hydrogen atom.

Part B

II. Answer any Six questions. Each question carries 2 weight **(6x2=12)**

11. If A and B are compatible observables and the eigen values of A are nondegenerate, show that the matrix elements of B taken with respect to the eigen kets of A are diagonal. Choose the base kets as the eigen kets of A.
12. Discuss projection operator in ket space. How is it connected to measurement of dynamical observable?
13. For a system of fermions, show that the eigen values of the number operator defined by $N_k = a_k^\dagger a_k$ are 0 and 1 where $a_k^\dagger$ and a_k are creation and annihilation operators respectively.
14. Derive the matrix elements of x and p operators of linear harmonic oscillator.
15. Write a note on time dependence of expectation values of a stationary ket.
16. Find the Clebsch-Gordon coefficients for two spin ½ particles.
17. Discuss the representation of rotation operator.
18. Describe the hydrogen atom in terms of wave function, probability density, total energy, and orbital angular momentum.

Part C

III. Answer any Two questions. Each question carries 5 weight **(2x5=10)**

19. Represent the state vectors and operators of Dirac space using matrix algebra.
20. State and derive Ehrenfest's theorem.
21. Starting from angular momentum commutation relations, determine eigenvalues of J^2 and J_Z. What are Ladder operators?
22. Derive the general uncertainty principle using Schwarz inequality and properties of Hermitian and anti-Hermitian operators