D 43531 (Pages : 2) Name..............................

Reg. No..............................

SECOND SEMESTER M.Sc. DEGREE EXAMINATION, JUNE 2018

(CUCSS–PG)

Physics

PHY 2C 05 – QUANTUM MECHANICS – I

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

(Total 12 questions, each answerable within 5 minutes)

Answer **all** *questions.*

Each question carries a weightage of 1.

1. What is a Hermitian operator? Show that the expectation value of Hermitian operator is real and that of an anti Hermitian operator is imaginary.
2. What is a Hilbert space? Describe its properties.
3. Find the time dependence of the expectation value of a linear operator. What is the condition for an observable to be constant of motion?
4. What is a wave packet? Distinguish between group and phase velocities of a wave packet.
5. Describe interaction picture in quantum mechanics.
6. State any *four* properties of Pauli spin matrices.
7. Find the eigen value equation for the operator J+.
8. Write down the Schrödinger equation for Hydrogen atom. Find the equation of motion for the center of mass of the atom.
9. State the condition for the Hamiltonian to be invariant under spatial translations. Illustrate.
10. Explain exchange degeneracy.
11. What is differential scattering cross section? What is its dimension?
12. Describe the validity of first order Born approximation for scattering problem.

(12 × 1 = 12 weightage)

Section B

(4 Essay questions, each answerable within 30 minutes)

Answer any **two** *questions.*

Each question carries a weightage of 6.

13. Apply commutator algebra to derive the general relation giving the uncertainty product of two operators and hence derive the Heisenberg's uncertainty relations.

Turn over

14. Find the Schrödinger equation for Harmonic oscillator problem. Discuss the energy eigen values and energy eigen states.

15. Discuss the formal theory of addition of angular momenta.

16. Discuss the method of partial waves for elastic scattering. Illustrate with spherically symmetric potential.

(2 × 6 = 12 weightage)

Section C

(6 problem questions, each answerable within 15 minutes)

Answer any **four** *questions.*

Each question carries a weightage of 3.

17. Determine the form of the momentum operator in the position representation. Also represent the position operator in momentum representation. Calculate the commutator [X, P] in the momentum representation.

18. (a) Calculate the Poisson bracket between the x and y components of the classical orbital angular momentum.

    (b) Calculate the commutator between the x and y components of the orbital angular momentum operator.

19. Find the matrix elements of the operator J_y for $j = 1$.

20. Find the Hamiltonian of a particle of mass μ and charge q moving in a central potential $V(r)$ under the influence of uniform magnetic field B.

21. Discuss the singlet and triplet state wave functions of Helium atom and hence show that the singlet state has higher energy than the triplet state.

22. Calculate the differential cross section for scattering by coulomb potential for the first Born approximation.

(4 × 3 = 12 weightage)