18P208 (Pages: 2) Name……..…….

Reg. No…….……..

SECOND SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2019

(Regular/Supplementary/Improvement)

(CUCSS - PG)

(Physics)

CC17P PHY2 C05 - QUANTUM MECHANICS I

(2017 Admission onwards)

Time: Three Hours Maximum: 36 Weightage

Part A

Answer ***all*** questions. Each question carries 1 weightage.

1. Briefly explain when the wavelength of microscopic systems approaches zero, the wave-like properties of the system disappear.
2. Explain the importance of Unitary Operators in quantum mechanics.
3. Explain some of the Observables and their equivalent Operators in Quantum mechanics.
4. Define and explain the Ehrenfest Theorem.
5. Discuss the validity of the statement, " Interaction picture is suitable for solving dynamical problems".
6. Explain why there is no state with zero energy for a square well potential.
7. Explain the Properties of the Spherical Harmonics.
8. Discuss the properties of Pauli spin Matrices.
9. Briefly explain Space inversion and time reversal.
10. Distinguish between Bosons and Fermions.
11. Express the situation in which how Phase shift is evolved in partial wave analysis.
12. Write a short note on Hilbert space.

(12 × 1 = 12 Weightage)

Part B

Answer any ***two*** questions. Each question carries 6 weightage.

13. Set up the integral equation of scattering and obtain an expression for the scattering amplitude in the Born approximation.
14. Construct the symmetric and antisymmetric wave for a system of two identical, noninteracting particles. Obtain the Slater determinant for a system for N electrons.
15. Express matrix representation of Kets, Bras, and Operators in linear vector space.
16. Define Clebsch-Gordon coefficient and explain its basic properties. Solve the resultant angular momentum when its components are $j_1 = \frac{1}{2}\ and\ j_2 = \frac{1}{2}$

(2 × 6 = 12 Weightage)

Part C

Answer any ***four*** questions. Each question carries 3 weightage.

17. Find the eigen values and the eigen functions of the operator $\hat{A} = -\frac{\partial^2}{\partial x^2}$. Restrict the eigen functions to those complex functions vanish everywhere except in the region $0 < x < a$
18. Solve one dimensional harmonic oscillator in the Heisenberg picture and obtain the matrices for ***H, x*** and ***p*** the symbols have their usual meaning.
19. Using the principle of indistinguishability of identical particles, evaluate the ground state of the helium atom.
20. Using the partial wave analysis, show that imaginary part of the complex index of refraction is related to the absorption cross-section for light in the medium.
21. Consider a mass *M* is in an attractive square well potential

    $V_r = -V_0,\ r < a$

    $= 0,\ r > a$

    consider the cases $0 < r < a$ and $r > a$ separately. Express the time-independent Schrödinger equation for this particle and also its energy states.
22. Consider a system with total angular momentum $j = 1$. Evaluate the angular momentum operators $\widehat{J_x}$, $\widehat{J_y}$ and $\widehat{J_z}$

(4 × 3 = 12 Weightage)

****