C 83628 (Pages : 2) Name.....

Reg. No.....

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SECOND SEMESTER M.Sc. DEGREE EXAMINATION, JUNE 2015

(CUCSS)

Physics

PHY 2C 05—QUANTUM MECHANICS—I (4C)

(2012 Admissions)

Time : Three Hours Maximum : 36 Weightage

Part A

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

1. What is Hilbert space ?
2. When do you say two functions are orthonormal ?
3. Outline Dirac bra and ket notation ?
4. Explain the different postulate in Quantum mechanics.
5. What are ladder operators ? Why are they called so ?
6. The definition of angular momentum given by $L = r \times p$ is not a general one. Why ?
7. What do you understand by spin of an electron ?
8. What is Slater determinant ?
9. Distinguish between Fermions and Bosons.
10. What are Partial waves ?
11. Distinguish between laboratory Coordinate system and centre of mass Coordinate system.
12. What is Phase shift ?

(12 × 1 = 12 weightage)

Part B

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

1. Discuss the problem of addition if angular momentum in quantum mechanics. Calculate the Chebsch - Gordon Coefficients for $J_1 = 1/2$ and $J_2 = 1/2$.
2. Explain the Born approximation theory for scattering and apply the same in the case of a screened Coulomb potential and arrive at the scattering cross section.
3. Explain the features of the Schrödinger picture and Heisenberg picture. Illustrate the difference between the Schrödinger and the Heisenberg pictures by applying the two methods to the solution of the problem of a linear harmonic oscillator.
4. What do you mean by identical particles ? Define symmetric and antisymmetric wave functions. Construct symmetric and antisymmetric wave functions for a system of identical particles.

(2 × 6 = 12 weightage)

Turn over

Part C

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

1. Define the commutator of two operators. Evaluate the commutators of $\left[x, \frac{d}{dx}\right]$ and $\left[\frac{d}{dx}, F(x)\right]$

2. Define a Hermitican operator. Show that the Eigenvalues of a Hermitian operator are real.

3. For a spinless particle moving a potential V(r) show that the time reversal operator T comm with the Hamiltonian.

4. Evaluate the following commutators

   a) [Lx, [Ly,Lz]) ; b) [L^2y,Lx] ; c) [L^2x L^2y].

5 .What is Probability current density vector ? Determine this quantity for a plane wave.

6. Determine the change in the Partial Phase Shift (Si) when the field V(r) is varied.

(4 × 3 = 12 weigh