

16P206

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Name:.....

Reg. No.....

SECOND SEMESTER M.Sc. DEGREE EXAMINATION, MAY-2017
(Regular/Supplementary/Improvement)

(CUCSS - PG)

CC15P PHY2 C05 - QUANTUM MECHANICS - I

(Physics)

(2015 Admission Onwards)

Time : Three Hours

Maximum : 36 Weightage

Section A

Answer all questions

Each question has weightage of 1.

- (1) What are the postulates of quantum mechanics
- (2) Show that eigen states $\{|u_n\rangle\}$ of the unitary operators are orthonormal.
- (3) Show that trace of the matrix representing an operator in one basis is same as that of a matrix representing the same operator in the another basis.
- (4) Show that $\sum_i \Lambda_i = 1$. Where Λ_i is the projection operator.
- (5) How the wave function $\psi(x)$ is related to the state $|\psi\rangle$.
- (6) Show that time evolution operator is unitary.
- (7) Discuss the orthogonality property of C.G. - Coefficients.
- (8) What is Born approximation.
- (9) Show that time reversal operator is anti unitary.
- (10) For a free particle, show that Hamiltonian is invariant under parity operation
- (11) Show that Parity and translation in space are commuting operators.
- (12) Write down the expression for three electron wave function and show that it will satisfy Pauli's exclusion principle.

(12 × 1 = 12 weightage)

Section B*Answer any two questions**Each question has weightage of 6.*

- (13) Obtain the expression for energy levels of harmonic oscillator by using Heisenberg picture of quantum mechanics.
- (14) Obtain the expression for Pauli spin matrices.
- (15) By using partial wave analysis, obtain the expression for scattering cross section for scattering from a rigid sphere. Compare the result with classical scattering cross section.
- (16) Calculate Clebsch-Gordan coefficients for $j_1 = \frac{1}{2}$ and $j_2 = \frac{1}{2}$.

 $(2 \times 6 = 12 \text{ weightage})$ **Section C***Answer any four questions**Each question has weightage of 3.*

- (17) Show that $[\hat{q}, \hat{A}(\hat{q}, \hat{p})] = i\hbar \frac{\partial \hat{A}(\hat{q}, \hat{p})}{\partial \hat{p}}$
- (18) Obtain zero point energy of a harmonic oscillator by using uncertainty principle.
- (19) Describe different pictures of quantum mechanics. How operators and states in different pictures are related.
- (20) Show that $(\vec{\sigma} \times \vec{\sigma}) = 2i\vec{\sigma}$. Does this result is contradictory to the corresponding result for cartesian vectors.
- (21) Show that angular momentum is the generator for rotation symmetry.
- (22) Obtain the relation between scattering cross section and scattering amplitude.

 $(4 \times 3 = 12 \text{ weightage})$

 $(12 \times 1 = 12 \text{ weightage})$