**19P207** (Pages: 2) Name……………………….

Reg. No………..….………..

**SECOND SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2020**

(CUCSS - PG)

**CC19P PHY2 C05 - QUANTUM MECHANICS I**

(Physics)

(2019 Admissions - Regular)

Time: Three Hours Maximum: 30 Weightage

**Section A**

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

1. Briefly explain the 'one –to- one' correspondence between ket space and bra space.
2. "A measurement always causes the system to jump into an eigenstate of the dynamical variable that is being measured" What does this statement means?
3. What is the physical significance of Hermitian operator in quantum mechanics?
4. Compare State Kets and Observables in the Schrodinger and the Heisenberg Pictures.
5. Prove that $[L_x, L_y] = i\hbar L_z$ Where, $L_x , L_y \; and \; L_z$ are components of orbital angular-momentum operators.
6. Define Pauli's spin matrices and to explain its properties.
7. Space inversion sometimes called as parity operation. Why?
8. Write a short note on Slater determinant.

**(8 x 1 = 8 Weightage)**

**Section B**

Answer any ***two*** questions. Each question carries 5 weightage.

9. Explain the Position-Space Wave Function and Momentum-Space Wave Function. Then discuss the Momentum Operator in the Position Basis.
10. Construct the simultaneous eigen kets and energy eigen values using simple harmonic oscillator problem by using the operators $\boldsymbol{a} \; and \; \boldsymbol{a}^{\dagger}$ . Also derive the matrix elements of the position and momentum operators.
11. Discuss the Angular momentum commutation relations and the ladder operators. Then evaluate the eigen values of $J^2$ and $J_z$.
12. What are space-time symmetries? Discuss about the operators and conservation laws that are associated with space-time symmetries.

**(2 x 5 = 10 Weightage)**

## Section C

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

13. Evaluate the Energy eigen values of an 3-dimensional Isotropic harmonic oscillator.
14. Discuss the free particle problem in three dimension using infinite spherical well evaluated by using spherical symmetry and angular momentum.
15. Prove the following properties of a Hermitian operator (a) The eigen values are real (b) Eigen vectors belonging to different eigen values are orthogonal.
16. Show that $\frac{\partial^2}{\partial x^2}$ is a linear Operator.
17. Prove that the operator equation, $(\hat{\sigma}.\hat{A})(\hat{\sigma}.\hat{B}) = (\hat{A}.\hat{B}) + i\hat{\sigma}(\hat{A} \times \hat{B})$
18. Suppose Consider a particle subject to a one-dimensional simple harmonic oscillator potential. Put t=0 and the state vector is given by $exp\left(\frac{-ipa}{\hbar}\right)|0\rangle$ where, $p$ is a momentum operator $a$ is some number with dimension of length. Using Heisenberg picture, evaluate the expectation value $\langle x \rangle$ for $t \geq 0$
19. ‘Classical mechanics can be derived from quantum mechanics, but the opposite is not true’ verify the statement on the light of Schrödinger picture.

**(4 x 3 = 12 Weightage)**

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