K19P 0303

Reg. No. : .....

Name : .....

II Semester M.Sc. Degree (Reg./Suppl./Imp.) Examination, April 2019
(2014 Admission Onwards)
PHYSICS
PHY2C06 : Quantum Mechanics – I

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **both** questions (Either **a** or **b**) **each** question carries **12** marks.

1. a) What is an operator ? Distinguish between Hermitian and Skew-Hermitian operators. Show that the commutator of two Hermitian operators is anti Hermitian.

OR

b) Distinguish between Schrodinger, Heisenberg pictures and Interaction pictures in quantum mechanics. Outline the interaction picture. Obtain the equation of motion for the state vector in the interaction picture.

2. a) What are Clebsch Gordan Coefficients ? Deduce recursion relations for Clebsch Gordan coefficients.

OR

b) Explain the principle of WKB approximation and derive connection formula. **(2×12=24)**

SECTION – B

Answer **any four**. **Each** question carries **9** marks. **1** mark for Part – **a**, **3** marks for Part – **b**, **5** marks for Part – **c**.

1. a) Discuss unitary transformation.
   b) Explain its properties.
   c) If U is a transformation matrix which connects two complete and orthonormal bases $|\phi_n>$ and $|\phi'_n>$, show that U is unitary.

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2. a) What is Heisenberg's Uncèrtainty relationship ?
   b) Derive the general uncertainty principle.
   c) Explain the basic postulates of quantum mechanics.
3. a) Define orbital angular momentum operator.
   b) Obtain angular momentum matrices for $j = ½$.
   c) Obtain the eigenvalue spectrum of the angular momentum operators J^2 and J_z using commutation relations between them.
4. a) Write down the time dependent Schrodinger equation for the Hydrogen atom.
   b) Obtain the radial wave equation for Hydrogen atom.
   c) Solve the equation for the energy eigenvalues and normalised eigenfunctions of hydrogen atom.
5. a) What is a parity operator ?
   b) Show that an observable A is a constant of motion if the corresponding operator commutes with the Hamiltonian.
   c) Show that rotational invariance of the Hamiltonian leads to the conservation of angular momentum.
6. a) Give the principle of time independent perturbation theory.
   b) From time independent perturbation theory, arrive at the expression to the first order correction energy of a non degenerate system subject to a small perturbation.
   c) Using first order degenerate perturbation theory, calculate the energy levels of $n = 2$ states of hydrogen atom placed in an external uniform weak electric field along the positive z – axis. **(4×9=36)**
