K20P 0351

Reg. No. : .....

Name : .....

II Semester M.Sc. Degree (CBSS – Reg./Suppl./Imp.) Examination, April 2020
(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) Explain unitary transformation and discuss its properties. If U is a transformation matrix which connects two complete and orthonormal bases $|\phi_n>$ and $|\phi'_n>$, show that U is unitary.

   OR

   b) Distinguish between Schrodinger and Heisenberg pictures in quantum mechanics. Obtain the solution of linear Harmonic oscillator using Schrodinger picture.

2. a) Derive the expressions for the energy values and wave functions of a hydrogen atom.

   OR

   b) From time independent perturbation theory, arrive at the expression to the correction in the second order, for the energy of a system subject to a small perturbation. **(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) Define commutator of two operators A and B.

   b) Explain the properties of Hilbert Space.

   c) Prove that two eigen vectors of a Hermition operator belonging to different eigen values are orthogonal.

P.T.O.

2. a) What do you meant by the matrix representation of an operator ?
   b) Show that trace of an operator is base independent.
   c) Find the eigen values and eigen vectors of a matrix.

$$A = \begin{matrix} 7 & 0 & 0 \\ 0 & 1 & -i \\ 0 & i & -1 \end{matrix}$$

3. a) What is meant by the expectation value of an operator ?
   b) Derive the general uncertainty principle.
   c) Obtain the equation of motion for the state vector in the interaction picture.
4. a) What are raising and lowering operators.
   b) Calculate $[J^2, J_x]$.
   c) Obtain the eigen value spectrum of raising and lowering operators.
5. a) What is symmetry transformation ?
   b) Prove that translational invariance of the Hamiltonian leads to the conservation of linear momentum.
   c) Show that the total energy of the system is conserved if the system is invariant under translations in time.
6. a) What do you understand by classical turning point ?
   b) Discuss the difficulties while applying WBB approximation at the classical turning point. Discuss briefly how these difficulties are overcome.
   c) Apply connection formula to obtain quantisation rule which gives the bound state energy levels for potential wells with one rigid wall. **(4×9=36)**