K23P 0503

Reg. No. : .....

Name : .....

II Semester M.Sc. Degree (CBSS – Reg./Supple./Imp.) Examination, April 2023
(2019 Admission Onwards)
PHYSICS
PHY 2C06 : Quantum Mechanics – I

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **both** the questions (Either **a** or **b**).

1. a) Obtain eigenstates and eigenvalues of angular momentum operators J^2 and J_z.

   OR

   b) Obtain the energy eigenvalues of linear harmonic oscillator by applying Schrödinger picture.

2. a) Give time independent perturbation theory and apply it to find the effect of electric field on the ground state of hydrogen atom.

   OR

   b) Discuss WKB method and apply it to find the energy levels of linear harmonic oscillator. **(2×12=24)**

SECTION – B

Answer **any four** questions (**One** mark for Part **a**, **3** marks for Part **b**, **5** marks for Part **c**).

3. a) Define Hilbert space.

   b) Explain the properties of ket and bra space.

   c) Prove that the expectation value of a Hermitian Operator is real and that of an anti-Hermitian operator is imaginary.

P.T.O.

4. a) Write any two postulates of quantum mechanics.

   b) Obtain the time derivative of the expectation value of an observable in Schrödinger picture.

   c) If the Hamiltonian of a system $H = P_x^2/2m + V(x)$, obtain the value of the commutator [x, H]. Hence find the uncertainty product $(\Delta x)\ (\Delta H)$.

5. a) What is the meaning of spin of an electron ?

   b) Discuss Pauli's spin matrices.

   c) Obtain the eigenvectors of Pauli's spin matrices S_x and S_y.

6. a) What are symmetry transformations ?

   b) List out characteristic properties of symmetry transformations.

   c) Show that conservation of linear momentum of a physical system is a consequence of the translational invariance of the Hamiltonian of the system.

7. a) Give Heisenberg's uncertainty relationship.

   b) Explain general uncertainty principle.

   c) Prove that zero-point energy of a harmonic is a consequence of uncertainty principle.

8. a) What is expectation value of an observable ?

   b) Explain variational principle.

   c) Evaluate the first order correction to the ground state energy of an anharmonic oscillator subjected to a potential $\frac{1}{2}(m\omega^2x^2) + bx^4$. **(4×9=36)**

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