Reg. No. | | | | | | | | | |

PHH 452

Second Semester M.Sc. Degree Examination, Sept./Oct. 2022
PHYSICS
Quantum Mechanics II

Time : 3 Hours Max. Marks : 70

Note : *Answer **any four** questions choosing **one** from **each** Unit – **I** – **IV** and Unit – **V** is **compulsory**.*

UNIT – I

1. a) Construct and prove Schwartz inequality.

   b) Construct matrix representation of a linear operator.

   c) Check whether the vectors A = (1, 2, –1) , B = (1, 0, 1), C = (1, 1, 0) can form a linear vector space. **(5+5+5)**

2. a) State and obtain the general Heisenberg uncertainty principle.

   b) Define Hermitian Operator. Show that its eigenvalues are real using Dirac Ket and Bra notation. **(9+6)**

UNIT – II

3. a) Explain the Schrodinger and Heisenberg representation and hence obtain the equations of motion in Heisenberg picture.

   b) Deduce the commutation relations between the Pauli spin matrices. **(9+6)**

4. a) Outline the theory of addition of two angular momenta.

   b) Solve the harmonic oscillator problem using matrix method and obtain eigenvalue. **(7+8)**

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UNIT – III

5. a) Discuss in detail time dependent perturbation theory and hence deduce the Fermi golden rule.

   b) Discuss the first order degenerate perturbation theory of Zeeman effect. **(10+5)**

6. a) Evaluate the energy values of normal state of helium atom using variation Method.

   b) With suitable example explain the WKB approximation. **(9+6)**

UNIT – IV

7. a) Arrive at the Klein Gordon equation for a free particle. Obtain the equation of continuity and explain the difficulties associated with it.

   b) Derive the plane wave solutions of the Dirac equation for a particle in a central field. Explain the concept of antiparticle. **(6+9)**

8. a) Explain the term second quantization. Show that the second quantization of the one-particle non-relativistic Schrodinger equation results in a Schrodinger equation for several non-interacting particles.

   b) What are creation and annihilation operators ? Discuss their commutation and anti-commutation relations along with the significance. **(8+7)**

UNIT – V

9. Answer **any two** questions. **(2×5=10)**

   a) If A and B are two linear operators such that their simultaneous eigen states form a complete set, then show that A and B commute.

   b) If A and B are vector operators such that $[\sigma, A] = [\sigma, B] = 0$, show that $(\sigma.A)(\sigma.A) = A.B + i\sigma.(A\times B)$.

   c) Linear harmonic oscillator is perturbed by $H^1 = \frac{1}{2} bx^2$, calculate the first order corrections to its ground state.

   d) Show that creation operator for fermions is given by $a^\dagger = | n > 1 = (1 - n) | (1 - n) >$ where n = 0, 1.