SEMESTER - II

Paper - I : Quantum Mechanics

Max. Marks: 55
Time: 3 Hrs

Note: Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Separation of three dimensional Schrödinger equation for spherically symmetric potential into angular and radial equations, application to hydrogen atom problem, solution of radial equation and energy eigenvalues.

Matrix Mechanics : Matrix algebra preliminaries, transformation and diagonalisation of matrices, infinite matrices, unitary transformations, representation of operators and wave functions as matrices, Hilbert space, Dirac's ket and bra notation.

Time development of quantum systems, Schrodinger, Heisenberg and interaction pictures, relation with classical equation of motion, Solution of harmonic oscillator problem using matrix mechanics.

UNIT - II

Theory of Angular momentum : Representation in Cartesian and polar coordinates, commutation relations, Infinitesimal rotation operator as angular momentum operator, Eigenfunctions and eigenvalues of L^2 and L_z and connection with spherical harmonics, general angular momentum, eigenfunctions and eigenvalues of J^2 and J_z, matrix representation of angular momentum operators.

Spin angular momentum and Pauli spin matrices. Addition of two angular momenta, Clebsch Gordan (C.G.) coefficient and its properties, value of C.G. coefficient for $J_1 = 1/2$ and $J_2 = 1$.

UNIT - III

Theory of scattering : Scattering amplitude and cross section, Scattering by spherically symmetric potential, method of partial waves, optical theorem, phase shift in terms of potential, low energy scattering, sign of phase shift, scattering length. Green's function in scattering theory and expression for scattering amplitude, Born series, first Born approximation, scattering of an electron by a screened coulomb potential in first Born approximation, Validity of first Born approximation.

UNIT - IV

Time independent perturbation theory: First order and second order non-degenerate and degenerate perturbation theory. Applications: Zeeman Effect without spin, He atom (ground state), Linear Stark effect in hydrogen atom.

Time dependent perturbation theory: constant and harmonic perturbations, Golden rule for transition probability, Interaction of single electron atom with electromagnetic field (semi classical treatment only), induced absorption and emission.

Identical particles and spin: Indistinguishability of identical particles, symmetry of wave functions, spin and statistics, Pauli Exclusion Principle. Applications. Construction of spin functions for two electron systems and consequences of symmetry effects (spin and space) in the study of He atom problem (Ortho- and para-helium).

References

1. Quantum Mechanics - L.I. Schiff
2. Quantum Mechanics - J.L. Powell and B. Crasemann
3. Quantum Mechanics - Merzabacher
4. Quantum Mechanics - J.J. Sakurai
5. Quantum Mechanics - Ghatak and Loknathan
6. Quantum Mechanics - Mathews and Venkatesan
7. Quantum Mechanics - V.K. Thankappan
8. Quantum Mechanics - M.P. Khanna
9. Quantum Mechanics - B.H. Bransden and C.J. Joachain