M1PHY03-CT03: Quantum Mechanics-I

External: 80 Marks   Internal: 20 marks

Lectures: 40hrs   Tutorials : 10 hrs

Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

UNIT-I

Inadequacy of Classical Mechanics: 3L

Black body radiation, Planck' hypothesis, The photoelectric effect, Compton effect, Frank-Hertz experiment, Hamilton's principle. Schrödinger equation, Normalisation, probability interpretation of ψ, Admissible wave functions.
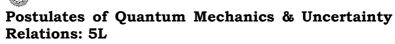
Linear Vectors Space: 5L

Vectors: Definition and properties, Examples of linear vector spaces, norm of a vector, orthonormality and linear independence, Basis and dimensions, Completeness (Closure property), Hilbert space, subspace, Inequalities and Ehrenfest theorem.

Operators: Equality, product, sum, power, function, inverse of operators, eigenvalues and eigenvectors of an operator, Positive definite, continuous and bounded operators, Linear operators, Hermitian operators, Unitary operators, Projection operators.

UNIT-II

Dirac Space and Representation Theory: 3L

Completeness of eigenfunctions, Bra and Ket notation for vectors, Dirac-Delta function, Matrix elements of change of basis, Unitary transformation. Representation theory, Coordinate and momentum representations.

Postulates of Quantum Mechanics & Uncertainty Relations: 5L

Postulates of Quantum mechanics, Uncertainty relations, States with minimum uncertainty product, Commutators, Theorem of simultaneous eigenfunctions,

UNIT –III

Quantum Dynamics: 5L

The equations of motion, Schrodinger picture, Heisenberg picture, Interaction Picture, Linear Harmonic Oscillator: Solutions from Schrodinger and Heisenberg Pictures, the method of second quantization

The Hydrogen Atom: 3L

Two body equation, Separation of variables for spherically symmetric potential, Radial wave equation, Radial wavefunctions and energy states.

UNIT –IV

Quantisation of Angular Momentum: 5L

Definition, angular momentum of a system of particles, Matrix representation, Pauli matrices, the spin eigenvectors. Orbital angular momentum: Solutions, Spherical harmonics and properties, addition theorem (no proof).

Addition of angular momenta: 3L

Clebsch-Gordan coefficients, the selection rules, properties of CG coefficients (without proof): symmetry, orthogonality and recursion relations.

UNIT –V

Perturbation Theory (Non-degenerate case): 5L

Basic formulation of the method and applications: Anharmonic oscillator (x^4), linear harmonic oscillator, infinite square well.

Degenerate case: 3L

Formulation and applications: Stark and Zeeman effects in H, Infinite cube well.

Textbook:

1. Quantum Mechanics, V.K. Thankappan, Wiley Eastern Ltd. (1986).**Reference books:**

2. Introduction to Quantum Mechanics, D.J. Griffiths, Pearson Education Inc. (2005).

3. Principles of Quantum Mechanics, R. Shankar, Plenum Press, New York (1994).

4. Modern Quantum Mechanics, J.J. Sakurai, Addison and Wesley (1994).