PHYDSC403T

QUANTUM MECHANICS -I

Contact Hours: 60

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *In continuation with modern physics this course gives emphasis on stationary states, Ehrenfest theorem, Dirac's bra ket notations with their operations and applications of Schrodinger equation to various quantum mechanical problems. This course gives fair idea of symmetry transformations, time-independent Perturbation theory and its applications.*

Unit 1: Wave functions, Observables and Operator

Wave functions and Operators in co-ordinate and momentum representations, Stationary states, Ehrenfest theorem. Dynamical variables and linear operators. Ladder operator, Commutation relations of various operators. Compatible and incompatible Observable. Generalized uncertainty principle and its applications. Introduction of Hilbert space. Dirac's bra and ket notation and their operations. **(11 Lectures)**

Unit 2: Applications of Schrodinger's Equation

Applications of Schrödinger Equation: Free particle in one dimensional infinite potential well and calculation of its eigen values and eigen functions, Particle in three-dimensional box - concept of degeneracy, Calculation for transmission and reflection coefficient for particle encountering step potential, Particle inside finite rectangular potential barrier - Phenomenon of quantum tunneling; Linear harmonic oscillator: Energy eigen value and eigen function of linear harmonic oscillator, ground state wave function. **(13 Lectures)**

Unit 3: Matrix Representations of operators, Operator method to Harmonic Oscillator, Hydrogen atom

Representation of states and dynamical variables, completeness and closure property. Schrödinger, Heisenberg and interaction pictures. Matrix representation of an operator, change of basis, unitary transformation. Eigen values and eigen functions of simple harmonic oscillator by operator method.

Application of Schrodinger Equation to find energy eigen value and eigen function of hydrogen atom using spherical harmonics and Laguerre polynomials. **(14 Lectures)**

Unit 4: Conservation laws and Angular Momentum Algebra

Symmetry transformations: Space – time translations and rotations, Invariance under the transformations and conservation laws. Central force problem, orbital angular momentum, angular momentum algebra, spin, Addition of angular momenta, Clebsch Gordon coefficients. **(10 Lectures)**

Unit 5: Time-Independent Perturbation Theory

Time-independent Perturbation theory (non-degenerate and degenerate) and applications to fine structure splitting, Zeeman effect (Normal and anomalous), Stark effect, and other simple cases. Variational method and applications to helium atom and simple cases. **(14 Lectures)**

Expected learning outcomes: *At the end of this course the students are expected to learn the mathematical formalism of Hilbert space, hermitian operators, eigen values, eigen states and unitary operators, which form the fundamental basis of quantum theory. Application to simple harmonic oscillators, hydrogen-like atoms and angular momentum operators will teach the students how to obtain eigen values and eigen states for such systems elegantly. Students are also expected to have fair knowledge on various symmetry transformations and time-independent Perturbation theory and its applications.*

Reference Books:

i. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
ii. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
iii. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
iv. Introductory Quantum Mechanics, Pearson Education (2006), R.L.Liboff.
v. Quantum Mechanics, Macmillan (2000), A.K. Ghatak and S. Lokanathan.
vi. Modern Quantum Mechanics, Addison-Wesley (1990), J.J. Sakurai.
vii. Quantum Mechanics, John Wiley & Sons (1999), E. Merzbacher.