SEMESTER-V

PHYDSC301T

MODERN PHYSICS

Contact Hours: 60

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

Course objective: *The emphasis of course is on building basic knowledge in the field of Modern physics which have utmost importance at both undergraduate and postgraduate level. Starting from limitations of Classical Physics, it develops the idea of wave particle duality, probability interpretation, Uncertainty Relation and then discusses the formulation of Schrodinger equation along with the idea of various quantum mechanical operators and their eigen states. The topics covered in this course will also give flavours of atomic physics along with LASERs and their applications.*

Unit 1:

Inadequacy of classical mechanics with special reference to Black body radiation, Photo electric effect and Compton effect (No derivation), Planck's quantum hypothesis. Planck's radiational law: its derivation and special cases. de Broglie concept of matter wave and Wave-particle duality; Davisson-Germer's experiment as evidence of the wave property of particles; Concept of wave packet and its group and phase velocity, Complementary principle. **(12 Lectures)**

Unit 2:

Heisenberg's Uncertainty Relation and application to simple problems, a) Non-existence of electron within nucleus b) Radius and ground state energy of Hydrogen atom.

Fundamental postulates of Quantum Mechanics, Physical interpretation of wave function, Boundary conditions for a wave function, Orthogonality and normalization of wave functions. Probability and probability current densitiy. Equation of continuity. **(12 Lectures)**

Unit 3:

Time dependent & time-independent Schrödinger equation for non-relativistic particles; Expectation value of dynamical variables, Quantum mechanical Operators and their algebra, Linear operator, Eigen value and eigen function, Hamiltonian operator, Kinetic energy operator, momentum operator, angular momentum operator, Commutation relations. Hermitian operators and their properties. **(12 Lectures)**

Unit 4:

Rutherford's gold foil experiment, Derivation of Rutherford's differential scattering cross section formula, Rutherford's model of atom and its limitations. Sommerfield's atom model and explanation of fine structure of hydrogen atom. Limitations of Sommerfield atom model. Vector atom model and different quantum numbers associated with it. Gyromagnetic Ratio and Bohr Magneton. **(12 Lectures)**

Unit 5:

Lasers, spontaneous and stimulated emission of radiation, optical pumping and population inversion. Metastable states. Three level and four level lasers. Einstein's coefficients, Requisites for producing laser light, Laser rate equations, Optical resonators, He-Ne laser, Solid state laser, Gas lasers, Semiconductor lasers, Laser applications. Basic idea of MASER. **(12 Lectures)**

Expected learning outcomes: *At the end of this course the students are expected to develop a comprehensive idea of the main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and ability to discuss and interpret experiments that reveal the dual nature of matter, understand the theory of quantum measurements, wave packets and Uncertainty Principle, understand the central concepts of quantum mechanics: wave functions, various operators, the Schrodinger equation, probability density and the normalization techniques etc. Students are also expected to have the basic idea of some atomic models and applications of LASERs.*

Reference Books:

i. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.

ii. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.

iii. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.

iv. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.

v. Atomic Physics - J. B. Rajam, S. Chand & Co.

vi. Modern Physics by R. Murugesan, S. Chand & Co., Reprint, 2008.

vii. Atomic and Nuclear Physics- N. Subramaniam & Brijlal, S. Chand & Co.

PHYDSC302T

INTRODUCTION TO CLASSICAL MECHANICS AND ELECTROMAGNETIC THEORY

Contact Hours: 60

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

Course objective: *The objective of this course is to build the concepts of classical mechanics with methods of formulations of Lagrangian and Hamiltonian and their applications. The emphasis of the course is also on understanding the basic concepts of electromagnetic induction and building the required prerequisites to understand electrodynamic wave propagation.*

Unit: 1: Classical Mechanics

Dynamics of a system of particles: Centre of mass of two particle system, Velocity, acceleration and linear momentum of centre of mass of two particle system, degrees of freedom, Constraints, and their classification

Characteristics of motion under central force, Reduction of two-body central force problem to the equivalent one body problem, Central force and motion in a plane, Equations of motion and differential equation of orbit. Kepler's laws of motion and their deductions. **(12 Lectures)**