SEMESTER-VIII

PHYDSM451T

MODERN PHYSICS AND SOLID STATE 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 failure of Classical mechanics, it develops the idea of wave particle duality followed by Heisenberg Uncertainty Relation with its applications. This course also aims to introduce the basic concepts of Solid State Physics along with Radioactivity.*

Unit 1: Matter wave & Uncertainty Principle

Failure of classical Mechanics and origin of quantum mechanics, Photoelectric effect, Compton Effect, Wave-particle duality, De-Broglie concept of matter waves, De-Broglie relation, properties of matter waves. wave velocity and group velocity. Heisenberg's uncertainty principle its proof and its application in the non-existence of electrons in the nucleus, ground state energy of electron in Hydrogen atom, radius of Bohr orbit, complementary principle. **(10 Lectures)**

Unit 2: Structure of atom

Aston Mass Spectrograph. Bohr's theory of hydrogen atom, expression of radii of electrons, expression of energies and hydrogen atom spectrum. Effect of nuclear motion on atomic spectra, reduced mass, modified Rydberg constant and wave number, Evidences in favour of Bohr's theory, correspondence principle, fine structure of special lines and Sommerfield's relativistic atom model (qualitative idea). Excitation and Ionisation potentials, Frank and Hertz experiment, characteristic X-ray spectra, Moseley's law, Bragg's law. **(15 Lectures)**

Unit 3: Radioactivity

Law of successive disintegration, secular and transient equilibrium, Alpha ray spectrum, Geiger-Nuttal law. Beta ray spectrum and Pauli's neutrino hypothesis. Nuclei and their properties - charge, mass, size, density, angular momentum, nuclear magnetic moment, binding energy curve, packing fraction and nuclear stability. Nuclear fission and sustained chain reaction. Linear accelerator and cyclotron. Cosmic rays and composition, altitude effect, cosmic ray showers.

(15 Lectures)

Unit 4: Crystal Structure

Amorphous and crystalline materials, Lattice translation vectors, unit cell, primitive cell, basis, Miller indices and representation of crystal planes, interplanar spacing, symmetry consideration, symmetry group, space group, different types of crysta1 structures, classification of crystals based on nature of structures, Bravias lattice, reciprocal lattice, Theory of Laue Spots. Bragg's law, diffraction of X-ray, measurement of Lattice parameter for cubic lattices. **(10 Lectures)**

Unit 5: Lattice Vibrations

Linear monatomic chains, Acoustical and optical phonons, Qualitative description of the phonon spectrum, Brillouin Zones, Einstein and Debye theories of specific heat of solid T^3 Law. Qualitative description of free electron theory and its inadequacies with reference to Hall effect and specific heat of electrons in metals. **(10 Lectures)**

Expected learning outcomes: *At the end of this course the students are expected to develop a comprehensive idea of the introductory quantum mechanics and ability to discuss and interpret the facts that reveal the dual nature of matter and the Uncertainty Principle with its applications. Students are also expected to have the basic idea of crystal structure and physics of lattice dynamics in addition to Radioactivity covering various properties of nuclei and their decay processes.*

Reference Books:

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

ii. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill

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

iv. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, CengageLearning.

v. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan.

vi. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.

vii. Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, TataMcGraw-Hill Publishing Co. Ltd.

viii. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.

ix. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.

x. Introduction to Solid State Physics, Kittel C. 5th Ed, John Wiley.

xi. Solid State Physics by Dekker A.J., Prentice Hall.

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