PHYSICS COURSE-1
Course code: PPH001

UNIT-1

Crystal structure: Crystal systems, Crystal classes, Bravais lattice. Unit cell: Wigner-Seitz cell, equivalent positions in a unit cell. Notations of planes and directions. Atomicpacking: packing fraction, Co-ordination number. Examples of simple crystal structures:NaCl, ZnS and diamond. Symmetry operations, point groups and space groups.

UNIT-2

Dielectric properties of solids: Macroscopic description of static dielectric constant, Electronic, ionic and orientational polarisation, Lorentz field, expression for internal field in solids, Dielectric constant ofsolids, complex dielectric constant and dielectric losses. Theory of electronic polarisation and optical absorption. Ferroelectricity: General properties, Classification, Dipole theory and its drawbacks,Thermodynamics of ferroelectric transitions, Ferroelectric domains. Piezoelectricity. Applications.

UNIT-3

Magnetic properties of solids: Classification, Langevin theory of diamagnetism, Quantum theory of paramagnetism. Ferromagnetism: Concept of domains, thermodynamics, thickness of Bloch wall, Molecularfield concept, Weiss theory, Weiss equation for dia, para and ferromagnetic materials, B-H curve in ferromagnetic materials, soft & hard magnetic materials, applications. Heisenberg exchange interaction, Ising model, Spin waves -dispersion relation (one dimensional case), quantization of spin waves, Concept ofmagnons and thermal excitation of magnons, Bloch $T^{3/2}$ law for magnetization. Antiferromagnetism: Two sublattice model. Ferrimagnetism in the context of Iron garnets.

UNIT-4

Semiconductors: Intrinsic and extrinsic semiconductors, concept of majority and minority carriers. Statistics of electrons and holes, carrier concentration, Fermi level, electrical conductivity. Hall effect. Experimental determinations of resistivity of semiconductor by four probe method. p-n junctions, drift current, diffusion current, diffusion length and mean life time.

UNIT-5

Superconductivity: Review of basic properties, classification into type I and type II. Energy gap and its temperature dependence. Super currents and Critical currents. London's phenomenological equations, Penetration depth. Cooper pairs, Coherence length. Instability of Fermi surface and cooper pairs. BCS theory and comparison with experimental results. Ground state energy of superconductor. Quantization of magnetic flux. Josephson effects (AC and DC) and applications. High T C materials: Structure and properties, Some applications.

REFERENCE BOOKS:

1. Introduction to Solid State Physics, C. Kittel, Wiley Eastern, 6th Edition, 1986
2. Solid State Physics, A. J. Dekkar, Prentice Hall Inc.,1963
3. Solid state & Semiconductor Physics, John P. Mc Kelvey, Harper & Row Publishers,1966.
4. Solid State Physics, S. O. Pillai, New Age Publisher.
5. Semiconductor Physics, P. S. Kireev, MIR Publishers, 2nd edition, 1978.

PHYSICS COURSE-2
Course code: PPH002

UNIT-1

Crystal growth: Crystal growth from melt: Bridgemann technique, Crystal pulling by Czochralski's method, Growth from solutions, Hydrothermal method, Gel method, Zone refining method of purification.

Defects in solids: Point defects: Schottky and Frenkel defects and their equilibrium concentrations. Dislocations, edge and screw dislocations, multiplication of dislocations (Frank-Read mechanism), concept of Burger vector and Burger circuit, Plane defects: grain boundary and stacking faults.

UNIT-2

X-ray diffraction: X-ray diffraction, Bragg law. Laue equations. Atomic form factor and Structure factor. Concept of reciprocal lattice and Ewald's construction, electron density function, Fourier synthesis, Friedel's law & its breakdown, Bragg's spectrometer. Experimental diffraction methods: Laue, Rotating crystal method and Powder method.

Characterization – Photoluminescence spectroscopy, Infrared (IR) spectroscopy, Raman spectroscopy, Basic principles of working & applications.

UNIT-3

Introduction to nanotechnology: Difference between micro and nanocomposites or materials, history, definition, types, classification, Types of methods to produce nanostrucutred materials (atleast four methods to be covered), Nanorods- synthesis, properties, characterization and applications, Nanoparticles (silver nanoparticle, Al_2O_3, ZnO, TiO_2), methods fabrication polymer nanocomposites - from solution, In situ intercalative polymerization method and Melt intercalation methods; characterizations, Applications of nanostructured materials.

UNIT-4

Carbon nanotubes (CNTs): Chemistry, types, structure, properties and applications. Comparison of CNTs with graphite fibers, SWNTS & MWNTs, production of CNTs, purification, surface modification of CNTs, properties- mechanical, thermal, morphological, and electrical properties. Fullerenes - structure, properties and applications Methods of fabrication of CNT-polymer composites, properties of CNTs composites, characterizations of nanocomposites by x-ray, electrical, thermal, optical, Raman spectra and TEM. Applications of CNT-polymer nanocomposites.

UNIT-5

Solid Phases and Phase diagrams: Single and multiphase solids, Solid solutions and Hume-Rothery rules, Intermediate phase, The intermetallic and interstitial compounds, Properties of alloys: solid solutions and two component alloy systems; Phase diagram, Gibbs phase rule, Lever rule; First, second and third order phase transitions with examples; Some typical phase diagrams: Pb-Sn and Fe-Fe_2O_3; Eutectic, eutectoid, peritectic and peritectoid systems.

REFERENCE BOOKS:

1. Elements of Materials science and Engineering, L. H. Van Vlack, Addison Wesley (6 th edition, 1989).
2. Materials Science and Engineering, V. Raghavan, Prentice Hall of India, 5 th edition, 2009.
3. Materials Science and Processes, S. K. Hazra Chaudary, Indian Distr Co. (1977).
4. Introduction to Solids, L. V. Azaroff, Tata McGraw Hill education Pvt. Ltd., 1984.
5. X- ray structure determination- A Practical Guide, Stout & Jensen, 2nd edition, 1989.