PH-511/PH-521/PH-611 **Material Science**

L	T	P	C
3	0	2	4

Course Outcomes:

After successful completion of the course, the students should be able to

CO1: Recognize common crystal structures and describe their symmetries.

CO2: Understand motion of electron in crystalline solid under period potential and able to differentiate materials on basis of band theory.

CO3: Describe Nanomaterials based on their dimensionality.

CO4: To analyze the dielectric and magnetic properties of materials

CO5: Understand the phenomenon of superconductivity and their properties in order to their applications.

CO/PO Mapping S-strong, M-medium and W-weak indicate the strength of correlation												
COs	Programme outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	W	W	M	S	W	S	S	S
CO2	S	W	S	S	S	W	M	W	M	M	M	M
CO3	S	S	M	S	M	M	M	W	M	S	S	M
CO4	S	M	M	S	M	S	M	M	S	M	S	S
CO5	S	S	M	S	M	S	M	W	M	M	S	S

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UNIT-I

Elements of crystallography

A brief Introduction to material science, Space lattices, Unit cell, primitive cell, Bravais lattice, Atomic packing factor, Miller Indices, directions and planes in crystal lattice (cubic and hexagonal only), distribution of atoms in lattice planes (in cubic crystal only), Important structures (NaCl, CsCl, Diamond and ZnS), structure determination; X-ray diffraction, Neutron and electron diffraction. **(10 Hrs)**

Imperfections in crystals

Point imperfections, Frenkel, and Schottky defects and their equilibrium concentration determination, Color centres, types of color centres, generation of color centres, Edge and screw dislocation, Burger vector, Surface defects. **(4 Hrs)**

Band theory of solids

Free electron theory, Concept of energy bands, Bloch theorem, Electron in a periodic field of crystal (The Kronig–Penny Model) distinction between metal, semiconductor and insulator, effective mass of an electron, Hall Effect. **(6 Hrs)**

UNIT-II

Dielectric materials

Introduction of dielectric materials, Polarization, Different types of polarization, Electronic, ionic, orientational and space charge polarization, polarizability, Clausius-Mossotti relation, temperature and frequency dependence of polarizability, dielectric breakdown, measurement of dielectric properties, Dielectric constant, Dielectric loss, ferroelectric and piezoelectric materials, examples of materials and their applications. **(5 Hrs)**

Magnetic materials

Terminology and classification of engineering materials, Type of magnetism (dia, para, ferro, ferri and anti ferromagnetisms), Theory of para, dia and ferromagnetic materials, magnetic anisotropy and magnetrostriction, magnetic domains, hard and soft magnetic materials, ferrites and their applications. **(5 Hrs)**

Superconductivity

Introduction, type I & type II superconductors, Meissner‘s effect, isotope effect,effects of magnetic field, London‘s equations, penetration depth, specific heat, BCS theory (electron-lattice-electron interaction, Cooper-pair, coherence length, energy gap), high temperature superconductors, applications of superconductivity. **(6 Hrs)**

Nano-materials

Fundamentals of nonmaterial’s and nanotechnology, nanoparticles, properties of nanonmaterials, synthesis and characterisation, applications of nanomaterials.

(4 Hrs)

Total : (40 Hrs)

Recommended Books:

1. Raghvan, Materials Science
2. Srinivasan & Srivastava, Science of Engineering Materials
3.Callister J.R., Materials Science and Engg.: An Introduction
4. Askeland & Phule, The Science and Engineering of Materials

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List of Experiments (PH-511/PH-521/PH-611)

Course Outcomes:

After successful completion of the course, the students should be able to

CO1: Differentiate between macro and microstructure in the materials.
CO2: Specify the microstructure of an alloy from phase diagrams
CO3: Understand type of charge carrier, mobility and carrier concentration and band gap of semiconductor.
CO4: Understand thermal and mechanical properties of material.
CO5: To analyze the electric, dielectric and magnetic properties and related phenomenon of materials

CO/PO Mapping S-strong, M-medium and W-weak indicate the strength of correlation												
COs	Programme outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	W	W	M	S	W	S	S	S
CO2	S	W	S	S	S	W	M	W	M	M	M	M
CO3	S	S	M	S	M	M	M	W	M	S	S	M
CO4	S	M	M	S	M	S	M	M	S	M	S	S
CO5	S	S	M	S	M	S	M	W	M	M	S	S

1. To prepare a metallic sample and measure the grain size using the metallurgical microscope.
2. To study the creep nature in metallic wires at room temperature.
3. To find the mobility and carrier concentration in a semiconductor sample using Hall Effect experiment.
4. To study the B-H curves of different materials.
5. To determine the Stefan's constant.
6. To determine the resistivity and energy band gap by four probe method
7. To find the Curie temperature of the given ferrite material.
8. To find the Curie temperature of the given ferroelectric material.
9. To calculate the dielectric constant of the given dielectric material.
10. To find the capacitance and permittivity of the given material.
11. To study the cooling curve and phase diagram of Pb-Sn alloy.
12. Dispersion relation of monoatomic and diatomic lattice