MANGALORE UNIVERSITY

Department of Physics

MSc Physics

PHS 503 : CONDENSED MATTER PHYSICS I

(52 Hrs.)

Course outcome

CO1 On completion of this course, student will have good understanding of basics of Crystallography, point groups.

CO2 Student will have knowledge of elastic properties and thermal properties of crystals.

CO3 The candidate will have basic understanding of Dielectric and ferroelectric properties of Solids.

CO4 The student will have a broad understanding of Optical properties of Solids.

Unit I Crystallography

Symmetries elements, translations vectors – screw axes and glide plane symmetries. Space groups – illustrations, Concept of point groups, Influence of symmetry on physical properties, derivation of equivalent point positions (with examples from triclinic and monoclinic systems), experimental determination of space group.

Disordered solid structure - Amorphous solid, quasi crystal and liquid crystal.[13 hrs]

Unit II Elastic properties and thermal properties

Analysis of elastic strains and stresses, Elastic compliance and stiffness constants, Energy density, Cubic crystals and isotropic solids, Elastic waves in cubic crystals, Experimental determination of elastic constants.

Thermal properties of insulators, Normal modes of diatomic lattice, Phonon momentum, Inelastic scattering of photons and neutrons by phonons, Thermal expansion, Lattice thermal conductivity - normal and Umklapp processes. [13 hrs]

Unit III Dielectric and Ferroelectric properties of solids

Dielectric : Polarization, Dielectric susceptibility, Dielectric constant, Complex dielectric constant, Dielectric loss and loss angle. Local electric field, Polarizability, Clausius - Mossotti relation, Electronic, ionic and dipolar polarizability. Frequency dependent dielectric function, Dipole orientation in solids, Langevin function, Debye relaxation time.

Ferroelectric:Basic properties of ferroelectrics, Classification, Barium titanate, Thermodynamics of paraelectric - ferroelectric transition, ferroelectric domain, Polarization catastrophe, Antiferroelectricity. Pyroelectric, piezoelectric and ferroelectric crystals. Piezoelectricity and its applications. [13 hrs]

Unit IV Optical properties of Solids

Dielectric function of the free electron gas, Plasma optics, Dispersion relation for electromagnetic waves, Transverse optical modes in a plasma, Transparency of alkalis in the ultraviolet, Longitudinal plasma oscillations, Plasmons and their measurement; Electrostatic screening, Screened Coulomb potential, Mott metal-insulator transition, Screening and phonons in metals; Optical reflectance, Kramers-Kronig relations, Electronic inter band transitions- direct and indirect transition, Absorption in insulators; Polaritons; One-phonon absorption; Optical properties of metals, skin effect and anomalous skin effect. Excitons: Frenkel and Mott-Wannier excitons; [13 hrs]

Reference Books:

1. Cullity B D and Stock S R ‘Elements of X ray Diffraction’, III Edn. (Prentice Hall, 2001)
2. Verma A R and Srivastava O N, ‘Crystallography Applied to Solid State Physics’, II Edn. (New Age, 1991)
3. Woolfson M M, ‘An Introduction to X-ray Crystallography’ (Cambridge-Vikas, 1970)
4. Buerger M J, ‘X-ray Crystallography’ (John Wiley, 1942)
5. Brusch P : ‘Phonons : Theory & Experiments’, Vol I, II & III (Springer Verlag, 1987)
6. Kittel C, ‘Introduction to Solid State Physics’, IV Edn. (Wiley Eastern, 1974), VII Edn. (John Wiley, 1995)
7. Ashcroft N W and Mermin N D, ‘Solid State Physics’ (Harcourt, 1976)
8. Ibach H and Luth H, ‘Solid State Physics’, II Edn. (Springer, 1996)
9. Ziman J M, ‘Principles of the Theory of Solids’, II Edn. (Vikas Publ., 1979).
10. Applied Solid State Physics by Rajnikant.

11. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth.
12. Principles of the Theory of Solids (2nd edition) by J. M. Ziman