Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NPHC511	CONDENSED MATTER PHYSICS	3	0	0	3

Course Objective
To introduce students with fundamental physical science of solid matters; To prepare them for advanced studies in similar fields and research in materials science
Learning Outcomes
Students will learn the physics of crystalline, thermal, electronic, semiconducting, superconducting and magnetic properties of solid state materials.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Crystallography:** Elementary concepts of point and space group symmetry elements and its relevance to crystal structure. Interaction of X-rays with matter, Elastic scattering from a perfect lattice. The reciprocal lattice and its applications to diffraction techniques. The Laue, powder and rotating crystal methods; Crystal structure factor and intensity of diffraction maxima,. Introduction to quasi crystals.	8	Students will be familiarized with different types of symmetry elements and will also learn the various techniques of X-ray diffraction to analyze the crystal structures. The geometrical interpretation of Bragg's law in terms of reciprocal lattice will be very useful to understand the importance of reciprocal lattice.
2	**Defects in Crystals:** Point defects, line defects and planer (stacking) faults. Color centres. Role of defects in crystal growth and on its properties.	3	In this unit, the student will learn the cause and effects of various type of defects present in crystal structures. Students will get a clear idea about the change in various structural & optical properties of solids in presence of defects.
3	**Lattice Dynamics:** Vibration of mono-atomic and di-atomic lattice, Quantisation of lattice vibrations, Interaction of electromagnetic waves and particle waves with phonons,.Debye's theory.	4	In this topic, students will learn about the concept of coupled vibrations in mono- & di- atomic lattices. The introduction with phonon and its interaction with lattice/waves will be familiarized.
4	**Electronic Properties of Solids:** Band theory Kronig-Penney Model, Tight-binding, cellular methods. Fermi surface, Landau levels, Cyclotron resonance.	6	This topic will enable the students to understand the electronic properties of solids on the basis of quantum theory, band theory & various models and tight methods. This part will also help to understand the potential experienced by an electron in a crystal field.
5	**Semi-conductor Physics:** Degenerate and non-degenerate semiconductors, Carrier densities in undoped and doped semiconductors, Conductivity of semiconductors, Hall Effect (Classical), Semiconductor Heterostructures and Superlattices. Junction capacitance of a PN junction, Luminescence, Photo conductivity and Optical absorption.	8	Students will get a clear idea about direct/ indirect band gap, degenerate/ non degenerate, undoped/doped semiconductors. They will be able to differentiate the optical & electrical properties. Mathematical calculations of certain parameters will enable the students to understand the behavior of semiconductors as well as junction diodes.
6	**Superconductivity:** Meissner effect, Thermodynamics of superconductors, Type-I and type-II superconductors. Vortex State, London equations, Coherent length, Cooper pair, Josephson effects.	6	This unit will enable the students to understand these low temperature phenomena. The change in the properties of superconductors with magnetic field and will be understood clearly. The students will get the knowledge about the applications of superconductors in various fields.
7	**Magnetism:** Spin waves and magnons, Ferro, Ferri- and antiferro-magnetic order, Exchange interaction, Domains and Bloch-wall energy. Magnetoresistance, Giant magneto resistance; Magnetic Resonance.	7	The students will learn the various magnetic properties such as dia-, para-, ferro-, antiferro- & ferri-magnetisms of materials. The concept of magnons, dispersion relation, Heisenberg model, domains formation will enable the students to better understand the properties of ferromagnetic materials.
	Total	**42**	

Text Books:

1. Solid State Physics; Ashcroft and Mermin; Brooks/Cole; 2003.
2. Principles of Electronic Materials and Devices, S. O. Kasap, McGraw Hill Company, Inc., 2006.
3. Solid State Physics-Structure and Properties of Materials; Wahab; Narosa; 2000.
4. Solid state Physics, A J Dekker, Macmillan, 2000

Reference Books:

1. Introduction of Solids; Azaroff; Tata McGraw Hill; 1984.
2. Crystallography Applied to Solid State Physics; Verma and Srivastava; New Age; 1991.
3. Introduction to Solid State Physics; Kittel; Wiley India Pvt Ltd; 2007.
4. Element of X-ray Diffraction, B. D. Cullity, Addison-Wesley Publishing Company, Inc. Reading, MA, USA, 1956.