Course Code	Course Name	Credits
26PH007	SOLID STATE PHYSICS	04

Course Objectives

- Understand the fundamental concepts of crystal structures, including lattice translation, Bravais lattices, and X-ray diffraction techniques.
- Analyse lattice dynamics and phonon behaviour, and apply Einstein and Debye theories to understand the thermal properties of solids.
- Explore the electrical properties of materials, focusing on band theory, semiconductors, and the role of doping in determining material behaviour.
- Investigate the magnetic properties and superconducting behaviour of materials, including magnetic susceptibility, the Meissner effect, and the BCS theory of superconductivity.

Learning Outcomes

Upon successful completion, students will have the knowledge and skills to:

- Appraise the significance and value of condensed matter physics
- Understand various crystallography methods.
- Gain knowledge in the context of a topic related to condensed matter physics: magnetic and dielectric
- Gain and apply discipline-specific knowledge of various theories on thermal properties of solid.

Unit 1 - Crystal Structure (12 Hrs.)

Solids: Amorphous and Crystalline. Lattice translation vectors, unit cell, and basis. Symmetry operations – Point group and space group (Definition). Types of Lattices – Bravais lattices in three dimensions. Miller indices. Laue equations, Bragg's Law, and X-ray diffraction in crystals using the powder method.

Unit 2 – Elementary Lattice Dynamics (12 Hrs.)

Lattice vibrations and phonons: Vibrations in one-dimensional monoatomic and diatomic lattices – Acoustical and Optical modes. Phonons: momentum and inelastic scattering. Specific heat of solids: Einstein and Debye theories. Debye's T^3 law.

Unit 3 - Electrical Properties Of Materials (12 Hrs.)

Elementary band theory of solids. Effective mass of electrons and concept of holes. Energy band diagrams and solid classification. Law of mass action. Insulators and semiconductors. Direct and indirect band gaps. Intrinsic and extrinsic semiconductors – ptype and n-type doping. Hall effect in semiconductors.

Unit 4 – Magnetic Properties Of Materials (12 Hrs.)

Magnetic intensity, magnetization, and susceptibility. Relation between μr and χm. Types of magnetic materials: Dia, Para, Ferro, and Ferri. Langevin's theory of diamagnetism and paramagnetism. Curie's law and Weiss's theory of ferromagnetism. B-H curve, domains, and hysteresis.

Unit 5 - Superconductivity (12 Hrs.)

Critical temperature and magnetic field. Meissner effect. Thermodynamics of superconducting transitions. Type-I and II superconductors. London equations and penetration depth. Isotope effect. BCS theory idea (no derivation), Cooper pairs, and energy gap variation. AC/DC Josephson effect (no derivation).

Reference Books:

1. M.A. Wahab, Solid State Physics, 2nd edition, Narosa Publications, 2011.
2. R.K. Puri and V.K. Babbar, Solid State Physics, 1st edition, S. Chand & Co, 2018.
3. C. Kittel Introduction to Solidstate Physics, Wiley India Edition, 2019, 8thEdn.
4. M. Arumugam, Materials Science, Anuradha Publishers, 2004.
5. S.O. Pillai, Solid State Physics, New Age International (P) Ltd, 2018.
6. Crystallography Applied to Solid State Physics, ARVerma and ON Srivastava, 2nd edition, New Age International Publishers, 2001.
7. Solid State Physics, AJ Dekker, Macmillan India Ltd., Bangalore, 1981.

Websites and eLearning Sources:

1. https://nptel.ac.in/courses/115106127
2. https://youtu.be/BjVTdZ_htu8?si=JdiMkRHbAwkFUd5M
3. https://youtu.be/CjAVfW_6juw?si=uiyDvahHCrE3Zyc6

COs and Bloom's Taxonomy Mapping – 26PH007		
Course Outcomes	**On successful completion of this course, students will be able to**	**BTL**
CO1	Recall and describe crystal structures, lattice systems, and fundamental solid-state concepts.	K1, K2
CO2	Apply diffraction and band theory to analyze properties of solids.	K3
CO3	Analyze electrical, thermal, and magnetic properties of materials using theoretical models.	K4
CO4	Evaluate the behavior of semiconductors and superconductors in practical applications.	K5
CO5	Develop models and solutions related to material properties and solid-state devices.	K6

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

Relationship Matrix – 26PH007													
Course Outcomes	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**						**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	
CO1	3	2	1	1	1	1	3	2	1	1	1	1	1.50
CO2	3	3	2	2	1	1	2	2	3	3	2	1	2.08
CO3	3	3	3	1	1	1	2	3	3	1	3	2	2.25
CO4	3	2	3	1	2	1	2	2	3	2	3	2	2.17
CO5	2	2	3	1	2	2	2	2	3	2	3	3	2.17
												Total	2.03

Mean Score: 3- High, 2- Medium/Moderate, 1-Low