

B. Sc. III Year		BPH-E602		Semester-VI	
DSE 2		SOLID STATE PHYSICS			
Total Lectures	Time Allotted for End Semester Examination	Marks Allotted for Continuous Assessment	Marks Allotted for End Semester Examination (ESE)	Maximum Marks (MM)	Total Credits
<b>60</b>	<b>3 Hrs</b>	<b>30</b>	<b>70</b>	<b>100</b>	<b>04</b>

NOTE: The question paper shall consist of TWO sections (Sec.-A, Sec.-B). Sec.-A shall contain 10 short answer type questions of Five mark each and student shall be required to attempt any Five questions. Sec.-B shall contain 8 descriptive type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. **(12 Lectures)**

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids.  $T^3$  law. **(10 Lectures)**

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. **(12 Lectures)**

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeier relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons. **(10 Lectures)**

Elementary band theory: Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient. **(10 Lectures)**

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. (06 Lectures)

#### Reference Books

Introduction to Solid State Physics, Charles Kittel, 8<sup>th</sup> Ed., 2004, Wiley India Pvt. Ltd.

- Elements of Solid State Physics, J.P. Srivastava, 2<sup>nd</sup> Ed., 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning
- Solid-state Physics, H.Ibach and H Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

**(i) Course learning outcome:**

At the end of the course the student is expected to learn and assimilate the following.

- A brief idea about crystalline and amorphous substances, about lattice, unit cell, miller indices, reciprocal lattice, concept of Brillouin zones and diffraction of X-rays by crystalline materials.
- Knowledge of lattice vibrations, phonons and in depth of knowledge of Einstein and Debye theory of specific heat of solids.
- At knowledge of different types of magnetism from diamagnetism to ferromagnetism and hysteresis loops and energy loss.
- Secured an understanding about the dielectric and ferroelectric properties of materials.
- Understanding above the band theory of solids and must be able to differentiate insulators, conductors and semiconductors.
- Understand the basic idea about superconductors and their classifications.
- To carry out experiments based on the theory that they have learned to measure the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ to four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor.

**(ii) Broad contents of the course:**

- Crystalline and amorphous substances, lattice, unit cell, miller indices, reciprocal lattice. Brillouin zones and diffraction of X-rays by crystalline materials.
- Lattice vibrations and phonons
- Different types of magnetism
- Dielectric and ferroelectric materials.
- Band theory of solids
- Insulators, conductors and semiconductors.
- Superconductors and their classifications.

**(iii) Skills to be learned**

- Learn basics of crystal structure and physics of lattice dynamics
- Learn the physics of different types of material like magnetic materials, dielectric materials, metals and their properties.
- Understand the physics of insulators, semiconductor and conductors with special emphasis on the elementary band theory of semiconductors.
- Comprehend the basic theory of superconductors. Type I and II superconductors, their properties and physical concept of BCS theory.