UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN PHYSICS

SYLLABUS WITH EFFECT FROM 2023-2024

337C6B

COURSE	**SIXTH SEMESTER – CORE COURSE-IX**
COURSETITLE	**SOLID STATE PHYSICS**
CREDITS	**3**
COURSE OBJECTIVES	To understand constituents, properties and models of nucleus. To give reason for radioactivity and study their properties.To learn about the principles of various particle detectors and accelerators. To acquire knowledge on different types of nuclear reactions and their applications.To know the reason for cosmic rays and their effect on the surface of earth and also understand the classification of elementary particles.

UNITS	COURSE DETAILS
UNIT-I	**BONDING IN SOLIDS, CRYSTAL STRUCTURE:** Types of Bonding –Ionic Bonding – Bond Energy of Nacl Molecule – Covalent Bonding – Metallic Bonding – Hydrogen Bonding – Van-Der-Waals Bonding – Crystal Lattice – Lattice Translational Vectors – Lattice with Basis – Unit Cell – Bravais' Lattices – Miller Indices – Procedure for finding them –Packing of BCC and FCC Structures – Structures of Nacl and Diamond Crystals –Reciprocal Lattice – Reciprocal Lattice Vectors – Properties – Reciprocal Lattices to SC, BCC and FCC Structures – Brillouin Zones – X-Rays – Bragg's Law(Simple Problems) – Experimental Methods: Laue Method, Powder Method And Rotating Crystal Method
UNIT-II	**ELEMENTARY LATTICE DYNAMICS:** Lattice Vibrations and Phonons: Linear Monoatomicand 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 – T3 Law (Qualitative Only)–Properties of Metals – Classical Free Electron Theory of Metals(Drude-Lorentz) – Ohm's Law – Electrical and Thermal Conductivities – Weidemann-Franz' Law – Sommerfeld's Quantum Free Electron Theory (Qualitative Only) – Einstein's Theory of Specific Heat Capacity.
UNIT-III	**MAGNETIC PROPERTIES OF SOLIDS:** Permeability, Susceptibility, Relation Between them – Classification of Magnetic Materials – Properties ofDia, Para,Ferro, Ferri and Antiferromagnetism – Langevin's theoryof Diamagnetism – Langevin'sTheory of Paramagnetism – Curie-Weiss Law – Weiss Theory of Ferromagnetism(Qualitative Only) – Heisenberg's Quantum Theory of Ferromagnetism – Domains – Discussion of B-H Curve –Hysteresis and Energy Loss – Soft and Hard Magnets – Magnetic Alloys.

UNIT-IV	**DIELECTRIC PROPERTIES OF MATERIALS:** Polarization and Electric Susceptibility –Local Electric Field of an Atom – Dielectric Constant and Polarisability – Polarization Processes: Electronic Polarization– Calculation of Polarisability – Ionic, Orientational and Space Charge Polarization –Internal Field – Clausius-MosottiRelation –Frequency Dependence of Dielectric Constant –Dielectric Loss – Effect of Temperature on Dielectric Constant – Dielectric Breakdown and its types – Classical Theory of Electric Polarisability –Normal and Anomalous Dispersion – Cauchy and SellmeirRelations – Langevin-Debye Equation – Complex Dielectric Constant -Optical Phenomena Application – Plasma Oscillations – Plasma Frequency –Plasmons.
UNIT-V	**FERROELECTRIC & SUPERCONDUCTING PROPERTIES OF MATERIALS:** **Ferroelectric Effect:**Curie-Weiss Law – Ferroelectric Domains, P-E Hysteresis Loop – Elementary Band Theory:Kronig-PennyModel – Band Gap(No Derivation) – Conductor, Semiconductor (P And N Type) and Insulator –Conductivity of Semiconductor – Mobility – Hall Effect – Measurement of Conductivity (Four Probe Method) - Hall Coefficient. Superconductivity:experimental results –critical temperature –critical magnetic field – Meissner effect –type-I and type-II superconductors – London's equation and penetration depth – isotope effect – idea of BCS theory (no derivation)
TEXT BOOKS	1. Introduction to Solid State Physics,Kittel, Willey Eastern Ltd (2003). 2. Solid state Physics, Rita John,1st edition, TataMcGraw Hill publishers (2014). 3. Solid State Physics , R L Singhal, Kedarnath Ram Nath& Co., Meerut (2003) 4. Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India 5. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill 6. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning 7. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer 8. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India 9. Solid State Physics, M.A. Wahab, 2011, Narosa Publishing House, ND
REFERENCE BOOKS	1. Puri&Babber – Solid State Physics – S.Chand&Co. New Delhi. 2. Kittel - Introduction to solid state physics, Wiley and Sons, 7th edition. 3. Raghavan - Materials science and Engineering, PHI 4. Azaroff - Introduction to solids, TMH 5. S. O. Pillai - Solid State Physics, Narosa publication 6. A.J. Dekker - Solid State Physics, McMillan India Ltd. 7. Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India

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WEBLINKS	1. https://nptel.ac.in/courses/115105099/ 2. https://nptel.ac.in/courses/115106061/

COURSE OUTCOMES:

At the end of the course, the student will be able to:

COURSE OUTCOMES	**CO1**	Classify the bonding &crystal structure also learn about the crystal structure analysis using X ray diffraction.
	CO2	Understand the lattice dynamics and thus learn the electrical and thermal properties of materials.
	CO3	Give reason for classifying magnetic material on the basis of their behaviour.
	CO4	Comprehend the dielectric behavior of materials.
	CO5	Appreciate the ferroelectric and super conducting properties of materials.

MAPPING WITH PROGRAM OUT COMES:

Map course outcomes **(CO)**for each course with program outcomes **(PO)**in the 3-point scale of STRONG(**S**), MEDIUM(**M**) and LOW(**L**).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	S	S	S	S	M	S	S
CO2	M	S	M	S	M	M	S	M	M	M
CO3	S	M	S	M	S	M	M	S	S	S
CO4	S	S	S	S	M	S	S	M	M	M
CO5	S	M	M	S	S	M	S	M	M	S