Semester	**VI**
Course	**Major**
Paper Code	
Paper Title	**Solid State Physics**
No. of Credits	**4**
Theory / Practical / Composite	**Theory**
Minimum No. of preparatory hours per week a student has to devote	2+2
Number of Modules	2
Syllabus	**Module A** **[24 L]** Crystal structure: Solids: Amorphous and Crystalline Materials, Lattice Translation Vectors, Lattice with a Basis – Central and Non-Central Elements, Unit Cell, Types of Lattices (2D & 3D), Miller Indices, Packing fraction, Reciprocal Lattice, Brillouin Zone, Diffraction of X-rays by Crystals - Bragg's Law, Laue's equation, equivalence between the two approaches, Atomic scattering factor & Structure factor. **[9 lectures]** Elementary lattice dynamics: Lattice Vibrations: Linear Monoatomic and Diatomic Chains, Acoustical and Optical Phonons, Qualitative Description of the Phonon Spectrum in Solids, Density of states, Specific Heat of Solids, Dulong & Petit's Law, Einstein and Debye theories - T^3 law. **[9 lectures]** Dielectric Properties of Materials: Polarization, Local Electric Field at an Atom, Depolarization Field, Electric Susceptibility, Polarizability, Clausius-Mossotti Equation, Classical Theory of Electric Polarizability, Normal and Anomalous Dispersion, Complex Dielectric Constant (basic ideas). **[6 lectures]** **Module B** **[24 L]** Drude model: Free electron gas in metals, drift current, mobility, electrical & thermal conductivity, Hall effect in metals. Wiedemann-Franz law, Lorenz number. **[3 lectures]**

	Elementary band theory: Bloch's theorem (proof) and Kronig Penney model, Band Gap, Effective mass, Conductor, Semiconductor and insulator, Semiconductor – Conductivity, mobility, Hall Effect in semiconductors. **[8 lectures]** Magnetic Properties of Matter: Dia-, Para- and Ferromagnetic Materials, Classical Langevin Theory of dia– and Paramagnetic Domains, Quantum theory of paramagnetism, Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains, exchange interaction, Heisenberg's theory, Curie-Weiss law, Explanation of B-H curve from ferromagnetic domain, Energy Loss in hysteresis. **[8 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, Basics of BCS theory (No derivation). **[5 lectures]**
Learning Outcomes	**Module A** CO1: The students will become familiar with different types of Bravais lattice. They will also know about the packing fraction, Miller indices, reciprocal basis, Brillouin zone and x-ray diffraction. CO2: They will learn about elementary lattice vibration. They will gain knowledge about phonons and the density of states. In this part, they will also learn about classical and quantum theory of specific heats of solids. CO3: They will learn about dielectric properties of materials that include depolarizing field, dielectric susceptibility, polarizability,

	Clausius-Mosotti relation. They will also learn about the complex dielectric constant, normal and anomalous dispersion. **Module B:** CO4: The students will learn the free electron theory and Drude model, Hall effect and Wiedermann-Franz law. CO5: The students will learn the elementary band theory and will be able to distinguish between metal, semiconductor and insulator. CO6: The students will learn about magnetic properties of matter and will be able to distinguish between diamagnets, paramagnets, and ferromagnetic materials. CO7: The students will learn about superconductivity. Elementary features, e.g. Meissner effect, critical temperature, etc. will be introduced.
Reading/Reference Lists	**References for Module A & B**: 1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd. 2. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning. 3. Solid State Physics, A J Dekker, 1st Edition (2000). Pan McMillan. 4. Elementary Solid State Physics: Principles and Applications, by Ali Omar. Pearson Education 1st Ed. (2002) 5. Solid State Physics: An Introduction to Principles of Materials Science, Ibatch and Luth, 2011 Edition. Springer India Pvt Ltd.
Evaluation	CIA 30 (2 x 10 + 5 Assignment +5 Attendance) SEM Exam 70
Paper Structure for Theory Semester Exam	For each module of 35 Marks: 15 marks from 3 mark questions (5 / 7) 20 marks from 10 mark questions (2 / 3)