2018 Project Physics

DEPARTMENT OF PHYSICS

SYLLABUS - EXPERIENTIAL LEARNING THROUGH PROJECTS

(2015-2016, 2016-2017, 2017-2018, 2018-2019)

SOLID STATE PHYSICS – I (EPH8C31)

UNIT – I

Periodic arrangements of atoms, concepts of a lattice, lattice translation vectors, Primitive lattice cell, two and three dimensional lattice types, Miller indices of crystal planes, simple crystal structures like sodium chloride type, cesium chloride type, hexagonal and face centered close packed structures, diamond structure and cubic zinc sulphie structure. Diffraction f waves by crystals: Bragg's law, Reciprocal lattice to scc, bcc and fcc lattices. Fourier analysis of the basis and structure factors of bcc and fcc lattices.

UNIT – II

Crystal Binding and Elastic constants: Inert gas crystals, ionic, covalent and metallic crystals. Hydrogen Bonds, atomic radii. Analysis of elastic strains, elastic stiffness and compliance constants. Elastic waves in cubic crystals.

UNIT – III

Vibrations of linear monoatomic and diatomic chains, quantization of elastic waves, phonon momentum. Planck distribution for a system of identical harmonic oscillators. Periodic boundaries conditions and density of states in one and two dimensions. Einstein and Debye's theories of specific heat. Anharmonicity of lattice vibrations, thermal expansion. Thermal conductivity and Umklapp processes.

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UNIT – IV

Energy levels in one dimension. Fermi Dirac distribution for a free electron gas. Periodic boundary condition and free electron gas in three dimensions. Heat capacity of the electron gas. Ohm's law, Mattheiessen's rule and Umklapp process. Hall effect, Weidman-Franz law. Nearly free electron model, and the origin and magnitude of the energy gap. Bloch functions. Motion of an electron in a periodic potential Kronig Penny model. Bloch theorem. Approximate solution near a zone boundary.

UNIT – V

Band gap in semiconductors. Equations of motion, holes and effective mass. Intrinsic mobility, Donor and acceptor states and thermal ionization of donors and acceptors. Reduced and periodic zone schemes. Construction of Fermi surfaces. Electron orbits. Tight – binding method for energy bands, Wigner – Seitz method and cohesive energy. Quantization of orbits in a magnetic field, De Hass – Van Alphen effect.

Text Books for study:

Introduction to Solid State Physics – Charles Kittel – VII Edition Chapters 1 to 9.

Books for Reference:

1. Principles of the theryof solids – J.M. Zman – II Edition (Cambridge 1972)
2. Solid State Physics – N.W. Aschroft and N.D. Mermin – Holt, Rinehart and Winston (1976)

3. Intermediate Quantum Theory of the Crystalline Solids – A.O.E. Animalu – Prentice Hall of India

4. Solid State Physics –S.O. Pillai – New Age Publications (1997)

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SOLID STATE PHYSICS – II (EPH8C41)

UNIT – I

Dielectric function of the electron gas, longitudinal plasma oscillations, Plasmons, Electrostatic screening, Screened coulomb potential, Mott transition, screening and phonons in metals, Polaritons and LST relation. Electron – electron interaction, electron – phonon interaction and polarons. Peierls instability, Kramers – Kronig dispersion relations. Frenkel and Mott-Wannier excitons. Exciton condensation, Raman effect in crystals.

UNIT – II

Superconductivity: its occurrence and its destruction by magnetic fields. Meissner effect. Heat capacity, energy gap, microwave ad infrared properties and isotope effect. Stabilization energy of a superconductor, London theory of Meissner effect, Coherence length. Basic ideas of BCS theory, flux Quantization. Type II superconductors and vortex state. Single particle tunneling DC and AC Josephson effects. Macroscopic quantum interference. High temperature super conducting (HTC) materials. Relation. Various types of polarizability. Ferro electricity; its occurrence and classification. Soft optical phonon. Landau theory of phase transitions: first and second orders.

UNIT – III

Langevin diamagnetismequation and quantum theory of diamagnetism, Quantum theory of para magnetism. Hund's rules.Crystal splitting factor. Van Vleck Temperature independent paramagnetism. Ferromagnetism: Curie point, Weiss molecular field theory, Saturation magnetization. Quantization of spin waves (magnons) and themal excitation of magnons,

Ferromagnetism and anti ferromagnetism, Neel temperature, Ferromagnetic domain walls and origin of domains – Coercivity and hysteresis.

UNIT – IV

Nuclear magnetic Resonance: Bloch equations and power absorption. Motional narrowing, Electron paramagnetic resonance and paramagnetic defects-Point defects: Schottky defects, Fresnel defects. Diffusion in metals. F centers

UNIT – V

Reconstruction and relaxation, Surface crystallography. Work function, thermionic emission, surface states and tangential surface transport. Quantunm Hall effects: IQHF and FQHE. P-N junctions; rectifications, solar cells and Photovoltaic detectors, Phenomenon of slip. Edge and Screw dislocations, Burgers vectors, stress fields of dislocations. Strength of alloys. Substitutional solid solutions – Hume – Rothery rules. Elementary theory of order. Kondo effect.

Text Book for study:

Introduction to solid state Physics (VII Edition) (1995) by Charles Kittel, John Wiley & Sons – Chapters 10 to 16, 18 to 21.

Books for Reference:

1. Principles of the theryof solids – J.M. Zman – II Edition (Cambridge 1972)
2. Solid State Physics – N.W. Aschroft and N.D. Mermin – Holt, Rinehart and Winston (1976)
3. Intermediate Quantum Theory of the Crystalline Solids – A.O.E. Animalu – Prentice Hall of India

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NANO PHYSICS(EPHJT21)

UNIT – I

Introduction – Nano and Nature – Nano particles – Properties and current appications of nano particles – Investigating and manipulating materials in the nano scale – Electron microscopes – Scanning Probe microscopes – Optical microscopes – Optical microscopes for nano science and technology – other kinds of microscopes – X – ray diffraction – Associated techniques.

UNIT – II

Nano powders and nano materials – preparation – Plasma arcing – Chemical Vapour deposition – Electro deposition – Chemical precipitation method – Ball milling – Natural nano particles – Applications of Nano materials (Insulation materials, Machine tools, Phosphors, Batteries, High power magnets, Motor vehicles and aircraft, Medical implants and other medical uses).

UNIT – III

Optics, Photonics, Solar energy – Properties of light and nano technology – Interaction of light and Nano technology - Nano holes and Photons - Imaging – New low cost energy efficient

windows and solar absorbers based on nano particles – Photonic crystals, surface wave guides and control of light paths.

UNIT – IV

Introduction to nano electronics – Birth of electronics – semiconductors and integrated circuits – Tools of micro and nano fabrication – from classical to quantum physics – Quantum electronic devices – Quantum information and quantum computers – Experimental implementation of quantum computers.

UNIT – V

Nanotechnology for future applications – Micro electro chemical systems – Robots – Ageless materials – invisible mending of atomic dislocations inside damaged materials – Nano mechanics and nano elasticity – Nano particle coatings – Nano electronic and magnetic devices and new computing systems – Opto electronic devices – Environmental applications.

Books for study:

1. Nano The essentials by T. Pradeep, McGraw Hill Company (Edition 2007) Chapters 1 and 2.
2. Nano technology by M. Wilson, K.K.G. Smith, M. Simmons and B. Raguse, Overseas Press (Edition 2005).

Books for reference:

1. Nanotechnology by Richard Booker and Earl Baysen, Wiley Dreamtech India (P) Ltd. (Edition 2005).

2. Nano Crystalline Materials – Current research and future directions _ C. Suryanarayanan and C.C. Koch, Hyperfine Interactions Journal (2000).

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