JTL 201(310) _Solid State Physics-I

Instructor: Medha Dandu

Specific heat of Solids: Boltzmann, Einstein, and Debye models for heat capacity and their limitations; The Drude theory of metals: Electrons in electric and magnetic fields, Electrical and Thermal conductivity; The Sommerfeld theory of metals: Free electron model, Fermi-Dirac statistics, Fermi energy, Fermi surface, chemical potential and its relation with Fermi level, Density of states, Specific heat, thermal, and electrical conductivity, Limitations of the free electron model.

Structure of Solids: Crystal Structure, Bravais lattices, Lattices in 1D, 2D, and 3D, Unit cell, Primitive cell, Classification of Bravais lattices and crystal structures, Symmetry, Point and space groups

Reciprocal lattice and scattering by crystals: Reciprocal lattice, Brillouin Zones, Crystal planes, Miller indices, Laue equations and Bragg's law, X-ray Diffraction, atomic form factor, structure factor.

Bonding in solids: Cohesive energy, Inert gas crystals, Madelung constant, Different types of bonding, Molecular crystals.

Band theory of solids: Nearly free electron model, Tight binding chain, Energy bands, Energy gap, Bloch's theorem, Kronig-Penney model, Electrons in a periodic potential, Crystal momentum, Zone boundary, Band structure and optical properties, Van Hove Singularities

Semiconductor physics: Band gap, Electrons and holes, Equations of motion, Mobility, Effective mass, Intrinsic and extrinsic conductivity, carrier doping.

Semiconductor devices: Band structure engineering, Band diagrams, p-n junctions

Semiclassical model of electron dynamics in a periodic lattice, Carrier transport, Boltzmann transport equations, Various scattering processes

Crystal vibrations and thermal properties: Failures of the static lattice model, Vibrations of a 1D monoatomic and diatomic basis, classical and quantum theory of linear harmonic oscillators, Normal modes and phonons, phonon momentum, phonon band structure and density of states, Optical and acoustic phonons, Inelastic scattering by phonons, Elastic constants, Phonon heat capacity, Anharmonicity, Thermal expansion and conductivity

References:

Solid State Physics by C. Kittel
Solid State Physics by N.W. Ashcroft and N.D. Mermin
Solid-State Physics: An Introduction to Principles of Materials Science by H. Ibach and H. Lüth
The Oxford Solid State Basics by S.H. Simon
Principles of Semiconductor Devices by S. M. Sze and Kwok K. Ng