PH 408: CONDENSED MATTER PHYSICS (3-1-0:4)

Crystal Structure
Space lattice and unit cells, crystal system, symmetry operation, point groups and space groups, plane lattices and their symmetries. Miller Indices, representation of directions and planes, packing fractions, simple crystal structures. X-ray diffraction by crystals. Laue theory, interpretation of Laue equations, Bragg's law, reciprocal lattice. Ewald construction, atomic scattering factor. Brief discussion on neutron and electron diffraction.

Phonon and Lattice Vibrations
Vibrations of one-dimensional monatomic and diatomic lattices. Infrared absorption in ionic crystals (one-dimensional model). Normal modes and phonons. Frequency distribution function. Review of Debye's theory of lattice specific heat. Anharmonic effects.

Magnetic Properties of Solids
Diamagnetism, Langevin equation. Quantum theory of paramagnetism. Curie law. Hund's rules. Paramagnetism in rare earth and iron group ions. Elementary idea of crystal field effects. Ferromagnetism. Curie-Weiss law. Heisenberg exchange interaction. Mean field theory. Antiferromagnetism. Neel point. Other kinds of magnetic order. Nuclear magnetic resonance.

Free Electron Theory and Energy Bands
Energy level in one dimensions, effect of temperature on the Fermi- Dirac distribution, free electron gas in 3D, heat capacity of the electron gas, electrical conductivity and Ohm's law, motion in magnetic field, thermal conductivity of metals. Nearly free electron model, Bloch function, Kronig- Penney Model, wave equation of electron in a periodic potential, number of orbital in a band.

Semiconductor
Formation of bands, band gap, intrinsic carrier concentration, concept of a hole, impurity conductivity, Fermi level, direct and indirect band gap, p-n junction, drift current, diffusion current, thermoelectric effects, semimetals, quantum nano-structures.

Textbooks and References:

1. F. C. Phillips, "An Introduction to Crystallography", Wiley.
2. C. A. Wert and R. M. Thomson, "Physics of Solids", McGraw-Hill Book Company
3. J. P. Srivastava, "Elements of Solid State Physics", Prentice Hall India.
4. J. R. Christman, "Fundamentals of Solid State Physics", John Wiley & Sons.
5. N. W. Ashcroft and N. Mermin, "Solid State Physics", Brooks.