Physics of Materials (PHYS-0431)

This course is meant for science majors only. Comprehensive knowledge of HS level mathematics and some basic knowledge of quantum mechanics is needed.

1.Crystal Binding and structure: [5]

Classification of solids by binding forces, Group theory and crystallography, some typical crystal structure, Miller indices. Bragg and von Laue diffraction. Structure determination. Neutron and electron diffraction in crystals.

2. Electrons in periodic potentials and Energy Bands in solids: [6]

One electron model, the Kroning Penney model, band structure, metal, insulator and semiconductor. Effective mass, DOS, concept of holes.

3. Lattice Vibration and Thermal Properties: [5]

Elastic waves, DOS of a continuous medium. Specific heat-models of Einstein and Debye. Thermal conductivity. Microwave ultrasonic. Lattice optical properties in the infrared.

4. Electrical, Magnetic and superconducting Properties of Materials: [12]

The free electron model-electrical and thermal conductivity in metals. The AC conductivity and optical properties. Semiconductors-carrier concentration, impurity states, electrical conductivity and mobility. Optical properties and absorption processes in semiconductors. Dielectric and optical properties of solids-sources of polarizibility,piezoelectricity and ferroelectricity. Magnetic properties-magnetic susceptibility, classification of materials. Dia, para and ferromagnetism. Ferrites. Super conductivity-zero resistance, Meissner effect, the critical field, electrodynamics of super conductors, Transition temperature, High T_C superconductors.

5. Defects in solids: [5]

Important defects in solids, shallow and deep impurity levels in semiconductors, colour centers, diffusion, edge and screw dislocations, cold-field emission.

6. Non-crystalline materials: [6]

Microstructure and imperfections. Diffusion in solids. Non-crystalline and glassy materials-structure, thermodynamics, glass transition and related models. Amorphous semiconductors-electrical and optical properties, magnetic properties, switching and device applications.

7. Soft Condensed Matter: [5]

Liquid Crystals-classification, orientation order and intermolecular forces, elasticity, magnetic effects, optical properties & applications. Polymers – effect of temperature, mechanical and electrical properties.

8. Nano-materials: [6]

Properties of individual nanoparticles, quantum wells, wires and dots. Preparation and characterization of nanomaterials. Carbon nanotubes and fullerenes.