

MSE 365 - Structure and Properties of Materials I

2012-2013 catalog description: Principles of structure and structure-property relationships in materials. [4 credits offered in Spring]

Prerequisite(s): MSE 222.

Course summary: Introductory solid-state physics concepts for materials scientists and engineers, enabling a fundamental understanding of structure-property relations of materials, with an emphasis on electronic, optical and thermal properties.

Textbooks:

1. **Electronic properties of materials**, *Rolf E. Hummel* (Required)
2. **Introduction to the physics and chemistry of materials**, *Robert J. Naumann*
3. **The physics and chemistry of solids**, *Stephen Elliott, S.R. Elliott*

Topics Covered

1 Introduction

- Mathematical concepts: complex numbers, Fourier analysis, solution to the wave equation
- elementary quantum mechanics: Solution of the Schrodinger equation for the electron in a box and hydrogen atom
- lattice structure of solids: classification, reciprocal lattices, amorphous systems, defects

2. Electronic properties of materials

- Fermi electron gas: electronic properties of simple metals
- electrons in periodic solids: Bloch wavefunctions, electronic band structure-materials classification
- semiconductors: intrinsic and extrinsic semiconductors, semiconductor devices
- electron dynamics: scattering, electrical conductivity, thermal conductivity and thermoelectric materials
- dielectric materials: capacitors, polarization, ionic materials, piezoelectricity

3. Optical properties of materials

- Drude-Lorentz models for optical properties of free-electron systems: phenomenological models for plasma oscillations
- optical properties of electrons in solids: photoluminescence, Laser, LEDs, quantum dots, photovoltaics

4. Magnetic properties of materials

- diamagnetism, paramagnetism, ferromagnetism
- molecular field model

5. Thermal properties of materials

- Phonon dispersion in periodic systems
- introductory statistical mechanics
- heat capacity: Einstein's model, Debye model
- thermal expansion
- thermal conductivity of metals and dielectrics

6. Special topic: Nano-materials

Grading:

Midterms : (2 x 20)	40%
Homework:	30%
Final:	30%