Phys 440 Solid State Physics I
Fall 2010
Time: MWF 12:30-1:20
Place: WAT 417A
Instructor: Prof. Klaus Sattler (956-8941), email: sattler@hawaii.edu
Office Hours: W 12:00-1:00 pm
Text: Charles Kittel, Introduction to Solid State Physics, 8th edition (Wiley)
Pre-requisites: Phys 274 and Phys 350(or consent).

Course Outline:
Chapter 1: Crystal Structure
Chapter 2: Wave Diffraction and the Reciprocal Lattice
Chapter 3: Crystal Binding
Chapter 4: Phonons I. Crystal Vibrations
Chapter 5: Phonons II. Thermal Properties
Chapter 6: Free Electron Fermi Gas
Chapter 7: Energy Bands
Chapter 8: Semiconductor Crystals
Chapter 9: Fermi Surfaces and Metals
Chapter 10: Superconductivity

Exams: We will have two in-class midterm exams and the final examination.

Course grade will be based on grade scale:
A (85 – 100), B (70 – 84), C (50 – 69), D (35 – 49), F(< 35)

SYLLABUS: The syllabus describes the intended progression of the course. The syllabus and homework assignments will be revised as needed. Changes to the syllabus and the homework assignments will be announced in class.

Student Learning Outcomes (SLOs):

General student learning outcomes will be:

(1) explains and interprets physical situations as stated in a word problem
(2) identify the physical laws appropriate to the physical situation at hand
(3) predict the behavior of representative physical systems using mathematics/physical laws as a tool.
(4) interpret the outcome of a physical system .
(5) represent physical systems in multiple representations: i.e., mathematically, pictorially, graphically, etc.

Course Specific Learning Outcomes:

Students should be able to:

- Describe the elementary models for bonding of atoms and molecules and the consequential classifications used in solid state physics; relate the general properties (electrical, thermal and optical) for each class, including details of the expected crystal structures, to the mechanical properties.
- Describe, and perform simple calculations involving, the hexagonal close-packed structure and various cubic structures, which are commonly found in nature.
- Explain how the problem of elastic scattering by a crystal is treated using the concept of the reciprocal lattice and how calculations separate factors which depend on the lattice and on the basis, *i.e.* yield the Laue equations and a structure factor; solve problems relating to representative solid state materials.
- Give a detailed description of the features of the vibrations of monatomic and of diatomic linear chains and explain the significance of dispersion curves in three dimensions.
- Discuss in an informed manner the scattering of phonons, and in particular the occurrence of Umklapp scattering of phonons near the Brillouin zone edge.
- Describe the free electron model and apply it in calculations involving: the dispersion relation, the effective mass, the density of states, the Fermi distribution.
- Use the nearly free electron model to account for the occurrence of energy gaps at the Brillouin zone edges, and the consequent behaviour of the group velocity and effective mass of the electrons.
- explain qualitatively band theory;
- compare the strengths and weakness of free electron and nearly free electron theories;
- state Bloch Theorem;
- draw E-k diagrams;
- describe the concepts of Brillouin zone, Density of States, Fermi energy, effective mass and holes;
- describe the basic optical transitions in semiconductors;
- describe an acceptor and donor;
- distinguish between extrinsic and intrinsic properties of semiconductors;
- define drift, diffusion and thermal conduction and the relations between them for metals, semiconductors and degenerate semiconductors;
- distinguish an insulator, semiconductor and metal
- develop the basic skills of problem solving and critical thinking.