PHYS422/822 Introduction to Physics and Chemistry of Solids
Spring Semester 2014

Lecture: Tues/Thurs: 11:00 am - 12:15 pm, Jorgensen Hall 245
Instructor: Xia Hong (Jorgensen Hall 310J, 472-2779, xhong2@unl.edu)
Office Hours: drop-in or by appointment

Course Goals and Objectives:

The course topics include the introduction to structural, thermal, electrical, and magnetic properties of solids, based on concepts of atomic structure, chemical bonding in molecules and electron states in solids, and principles underlying molecular design of materials and solid-state devices.

The overall learning objectives are to have you gain the ability to apply basic quantum mechanics, mechanics, electricity and magnetism concepts and techniques to solve for issues related to solid state systems. We will emphasize developing both conceptual understanding and problem-solving skills for these topics and understanding how they fit into the broader picture of science and technology.

Pre-requisites:

PHYS 213 or CHEM 481/881, and MATH 221/821, or permission. The course assumes knowledge of basic quantum mechanics, electricity and magnetism, wave motion and thermodynamics.

Textbook

Philip Hofmann, "Solid State Physics: An Introduction" (Wiley-VCH)
(Optional) *M.A.Omar*, "Elementary Solid State Physics" (Addison-Wesley)

Homework:

Homework is due a week from the day of assignment. The solutions should clearly explain all the important steps. You may discuss ideas and approaches with other students after you have spent some time thinking about these problems. However, you are required to complete all the technical steps yourself.

Homework should be handed in personally during class. Late homework will be accepted only as an exception. Homework is to be graded by a teaching assistant. If you believe your grade is incorrect or unfair please first approach the TA before you may appeal it to me.

i>Clickers:

We will be using clickers in every lecture. Please register your clicker number on BlackBoard. That will allow us to give you credit for your in-class responses.

Grade:

Class participation	10%
Homework	20%
Midterm	20%
Quizzes	20%
Final Exam	30%

Course grades will be assigned according to the following point scale (total: 100 points):

100-95	A^+
94.9-90	A
89.9-86	A^-
85.9-82	B^+
81.9-78	B
77.9-74	B^-
73.9-70	C^+
69.9-66	C
65.9-62	C^-
61.9-58	D^+
57.9-54	D
53.9-50	D^-
less than 50 points	F

Course outline

1. Crystal structure (Hofmann Ch. 2; Omar Chs. 1.1-1.8 and 2)

Crystal lattice, Basis vectors, Unit cell, Types of lattices, Index system for directions and planes, Simple crystal structures, X-ray diffraction, Reciprocal lattice, Brillouin zones.

2. Crystal Binding (Hofmann Ch. 1; Omar Chs. 1.9-1.10)

Interatomic forces, Cohesive energy, Ionic bonds, Covalent bonds, Metallic bonds, van de Waals bonds.

3. Crystal Vibrations and thermal properties (Hofmann Ch. 4; Omar Chs. 3.1-3.9)

Vibrations in a continuous media; Vibrations in monoatomic and diatomic lattices, Density of States, Acoustic and optical modes, Phonons, Heat capacity, Thermal conductivity.

4. Free electron theory and electron transport (Hofmann Ch. 5; Omar Ch. 4)

Conduction electrons, Energy levels of free electrons, Density of states, Fermi energy, Electrical conductivity, Heat capacity, Thermal conductivity, Motion in magnetic fields.

5. Band structure of solids (Hofmann Ch. 6; Omar Ch. 5)

Crystal potential, Bloch theorem, Crystal momentum, Electronic bands, Nearly-free-electron model, Classification of solids, Fermi surface, Methods for calculating band structure. Band structure of selected metals, Fermi velocity, Electron dynamics, Motion in magnetic fields

6. Semiconductors (Hofmann Ch. 7.1-7.3; Omar Ch. 6.1-6.9)

Crystal structure and bonding, Electronic structure, Electrons and holes, Effective mass, Mobility, Impurity states, Motion in magnetic fields.

7. Semiconductor devices (Hofmann Ch. 7.4-7.5; Omar Ch. 7)

P-n junctions, Diodes, Field-effect transistors, Optoelectronic devices.

8. Magnetic properties* (Hofmann Ch. 8; Omar Ch. 9)

Magnetization, Magnetic susceptibility, Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Domains

9. Dielectrics* (Hofmann Ch. 9; Omar Ch. 8)

Dipole moment, Polarization, Dielectric properties, Ferroelectricity, Piezoelectricity.

*: Depend on the course progress

Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.