

Physics 423: Contemporary Condensed Matter Physics

Syllabus as taught by M. Olmstead, Wi17

Text: *Oxford Solid State Basics*, by Stephen Simon (Oxford U. Press, 2013)

Course Goals and Content

This class covers an introduction to solid state physics, with examples taken from nanoscale physics and technology whenever appropriate. The course starts with the thermal and electrical properties that are consequences of the existence of atoms and electrons in the solid, and then adds crystalline periodicity for the development of band structure in metals, semiconductors and insulators. The course finishes with applications of this general material to the specific cases of semiconductor devices and magnetic materials.

The goal is to introduce students to the basic concepts of condensed matter physics and to give them enough vocabulary to read an article of interest in the current literature.

Lecture Topics by Week (Chapter in Simon):

1. Introduction. Specific heat of solids (Debye & Einstein) (Ch. 1-2)
2. Drude Model and Free electron Fermi gas (Ch 3-4)
3. Cohesion of solids, thermal expansion (Ch 5-8)
4. 1-D vibrations; 1D tight binding (Ch 9-11)
5. Experimental measurements and midterm (notes)
6. Crystal structure and Crystal growth (Ch 12 + notes)
7. Reciprocal lattice and diffraction (Ch 13-14)
8. Nearly-free electron gas and Band Structure (Ch 15-16)
9. Graphene, semiconductors and device physics (Ch 17-18)
10. Paramagnetism, diamagnetism, and mean-field ferromagnetism (Ch 19-21)

Grading and Requirements:

28% 9 HW sets (best 8 count). Typical assignment has 5 problems; weeks 5-9 include reading one paper from literature and explaining one figure from it.

6% Online survey for each lecture: answering one question about the topic, plus providing evidence of having completed the reading before class (best 15 count).

33% 1 midterm (on week 1-4)

33% Choice of (a) paper or (b) second exam.

(a) Paper. Choose one of the Nobel prizes awarded in physics or chemistry since 1967 on a topic related to the course and write a paper ("6 NSF-page" text + figures and references) that describes the physics underlying the research, information on the materials/techniques used, and examples of current impact, with reference to material learned in Phys 423. Students who wish W-credit must write a 10-page paper and turn in a draft for comment two weeks before the due date.

(b) Exam 2: on weeks 5-10.