

Spring 2019 PHYSICS 440 - Introduction to Condensed Matter Physics

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Lab: SSC 108 and 110

Office Hours: After class and by appointment

Course contents

Electrons in solids
Quantum mechanics of the electron gas
Transport (electrical and thermal conductivity, etc.)
Crystal structures
Energy bands
Metals, semiconductors, and insulators
Semiconductor junctions, the diode and the transistor
Lattice vibrations (phonons)
Overview of superconductivity

Text and other materials

Required text: M. Ali Omar, *Elementary Solid State Physics*

Unfortunately, I find that there doesn't seem to exist a really good single textbook for this course level. I like the assigned one better than most others I've seen, so I want to stick with it even though it's gone out of print. Please download a PDF copy from

<https://archive.org/details/ElementarySolidStatePhysics..PrinciplesAndApplicationsM.A.Omar.compressed>

I also recommend finding an inexpensive used hard copy in an online store (the earliest printing supposedly had some typos, but basically any version should do).

Still, the book isn't perfect. Therefore the reading will jump around the text a fair amount, and there will be extra handouts and/or alternative derivations given in class. You'll be responsible for all of the above.

Several times during the semester we'll visit laboratories on campus to see how research on condensed matter is carried out in real life.

Background

Solid state physics rests on the pillars of quantum mechanics and statistical physics. To start out, a background at the level of, say, Physics 161-163 should be adequate. More advanced tools will be introduced as needed.

Grading

Your grade will be determined by your homework (35%), two midterms (35% for both), and the final (30%). The percentages are approximate; class participation also will be taken into account. The exams will be closed-book, but one sheet of notes (both sides) will be allowed.

Homework will be due *at the beginning of class* on date due. Since solutions will be handed out right away, I won't be able to accept late homework.

Please take care to prepare complete, logically laid out, and legible homework solutions. Specifically, you should:

- *Write neatly (no hurried scribbles on scratch paper, please)
- *Show all intermediate steps: it must be clear how each line and equation is connected to the rest
- *Use lots of words and explanations, not only equations. Write as if you are preparing a solutions manual and want the reader to be able to follow what you are doing
- *Box or underline the final results
- *Always make sure that your answer has the correct units. And be sure to check whether the final result makes physical sense (is the order of magnitude reasonable? does the dependence on the given variables appear logical? do the limiting cases match what you expect?).
- *Remember to staple the pages.

The purpose of insisting on the above is not only to make it easier to grade your work, but first and foremost to promote self-awareness: you can feel comfortable that you have truly mastered a problem if, and only if, you are able to explain it in detail.

The same applies to the tests. In general, *credit will be given only if the reader can easily follow the arguments.*

Physics Department Colloquium:

I encourage you to attend the department colloquium whenever possible. It's a great opportunity to hear about cutting-edge developments in physics and related fields. A good colloquium talk will be largely understood by juniors and seniors. (Admittedly and unfortunately, not all speakers turn out to be good, but most of them are.) The talks are held on Mondays at 4:15 p.m. and last about an hour. The speaker's name and the talk title and abstract are posted several days in advance in SSC, and a list is on the Physics Department web page (http://dornsife.usc.edu/cf/phys/depart_colloquium.cfm). Free coffee and cookies are served outside the room before the colloquium.

There is also a less regular Condensed Matter / Quantum Information seminar held on Friday afternoons at 2 p.m., see <http://physics.usc.edu/~shaas/cmseminar.html>

Integrity

Instructors have been asked to add a reminder of self-evident standards. Please refer to the following information: <https://sjacs.usc.edu/students/publications/> and <https://sjacs.usc.edu/students/academic-integrity/>. Furthermore, *no posting or distribution of class materials is permitted.*

Student Ombudsman

All courses in the Department of Physics & Astronomy have an assigned a Student Ombudsman to serve students as a confidential, neutral, informal, and independent resource when they wish to discuss issues concerning their course without directly confronting their instructor. The Student Ombudsman for this course is Prof. Chris Gould, <gould@usc.edu>, (213)740-1101, office SSC 204.

Important dates:

University holidays: January 21, February 18
Spring recess: March 10-17
Last day of classes: April 26
Final exam: Monday, May 6, 8-10 a.m.