

Physics 47003: Selected Topics in Physics: Solid State Physics
Spring 2009
MWF 10:00 - 11:00 AM
Room: CNS 206

Professor: Matthew C. Sullivan
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Office Hours: M/W/Th 11 AM - 12 PM
and by appointment

Textbook: **Solid State Physics**, 2nd ed., Hook and Hall (required)
Introduction to the Physics of Electrons in Solids, Brian K. Tanner
(suggested)
Introduction to Solid State Physics 8th ed. Kittel (suggested)
Solid State Physics, Ashcroft and Mermin (suggested)

Website: <http://departments.ithaca.edu/physics/facstaff/mcsullivan/ph470/>

Course Objectives:

My goals for this course (and the focus of my exams!) are:

- To introduce students to solid state physics and more broadly the physics of materials
- To help students become better and more organized problem solvers using solid state physics as a tool to that end.
- To help students become better abstract and critical thinkers, using solid state physics as a tool to that end.
- To familiarize students with current topics in solid state physics.

Grading Philosophy:

An advanced level course such as Solid State Physics will not work unless students actively participate in their learning. This is a seminar-style course, as such, I will help facilitate your learning, but you must take final responsibility for understanding the material. This responsibility includes: Class participation, homework, the final report, and (not to be forgotten) ASKING QUESTIONS! Please ask questions in class, or during office hours, or in an email... My goal is to help you learn, and you are the best judge of how much you truly understand.

I feel that doing Physics is the best way to learn physics, thus, homework will be weighted accordingly in the grading scheme. The rest of the course will consist of two exams and a final report. The scheme is as follows:

Participation:	5%
Homework:	35%
In-class midterm:	20%
Take-home midterm:	20%
Final Report and Presentation:	20%

The IC grading scale is as follows: A: 90-100, B: 80-89, C: 70-79, D: 60-69, F: <60.

Homeworks:

I will assign a homework set roughly two-thirds of the weeks. Homework will be due every **Wednesday** at the **beginning** of class. *Late homework will not be accepted.* I recognize that students will get overworked at certain points during the semester, so every student gets 2 five-day extensions: You may have an extension until the next Monday at the start of class. The only catch: You have to ask for the extension by noon Tuesday – you cannot show up to class and expect to get an extension.

Regarding homework, I encourage you to work together when trying to understand a problem, but the work you hand in must be your own. I suggest you work out the problem in groups, then write your solution up neatly at home. This will reinforce the problem, and will make it clear if there are any gaps in your understanding.

Homework problems will be worth 10 points. You will be graded on the concepts as well as your ability to solve the problem mathematically. Also, three of the points will be awarded as follows: 2 points for neatness and clarity, and 1 point for drawing a picture or a schematic of the situation. The beauty of physics is that we have a real, physical problem we are trying to solve, so draw the picture of that problem! And writing legible solutions that I can follow is excellent practice for the exams.

Matlab is a useful tool in solid state physics, and will allow us to model several of the systems we will discuss in class. MatLab will not be a focus in this course, but MatLab exercises will be included as homework problems in roughly every problem set.

Exams:

There will be two exams in this course. The first will be open notes, open book, and in the evening at 6 PM. Please be aware that open book exams are not necessarily easier than closed book exams! In fact, this has a tendency to make the exams seem more difficult as students spend much of their time searching the book for just the right equation. Do not succumb to this temptation! This exam will consist of several problems similar in nature to the homework problems.

The second exam will be a take-home exam. This exam will also be open notes and open book (or books, the suggested books are also allowed resources). You will have 48 hours to complete the exam. You are not allowed to discuss the exam with anyone except me. You are not allowed to use the internet as a resource. You will be on your honor to complete this exam by yourself, using only your notes and books. Essentially, there is no good way to test your knowledge in a 2-hour period for a class at this level, hence the need for a take-home exam.

Physics teaches students how to think analytically. To this end, often the way one approaches a problem is at least as important as the answer. I will give partial credit on homeworks and exams based on work shown. Clarity is important – homeworks/exams that are difficult to follow will receive a lower score. Use English to explain steps where appropriate. It is also possible to receive no credit on a homework/exam problem even when the answer is correct if I cannot follow your logic as to how you got the answer.

Please note that both exams have been scheduled, so plan your semester accordingly.

Final Report and Presentation:

At the end of the semester, all students will complete a final report and presentation. The report will be to research a topic of current interest in solid state physics (or condensed matter physics, if you are really interested in superfluids), and prepare a four-page, single-spaced, two-column report that summarizes the background of the topic and the current work on the subject, as well

as results they hope to find. Use of \LaTeX formatting is **strongly** suggested.

During our final exam time each student will give a 15-minute presentation to the entire class on their report. The students in the audience will give each speaker a grade based on a grading rubric, and those grades will be incorporated into the Presentation grade.

The report and presentation are both due at the start of our final exam time. However, the final report topic is due to me by Apr. 24. The topic should include a rough outline of what you will research and a general idea of the results that you gleaned from the most reliable source of information anywhere: Wikipedia. A rough draft of the report is due on the last day of class. This should be a *completed report* that only needs polishing and editing. Both the topic and the rough draft are boolean: full credit or no credit. Late submissions are not allowed.

Final report Grading:

Topic and Outline:	2%
Rough draft:	2%
Report:	10%
Student evaluations of presentation:	4%
Professor's evaluation of presentation:	6%
Total	20%

There are any number of possible topics for your final report. Here is a list off the top of my head: giant magnetoresistance, quantum Hall effect, fractional quantum Hall effect, high-temperature superconductivity, superconductivity in iron arsenides, spintronics, and superfluidity, just to name a few.

Attendance:

I will not be lecturing strictly from the book (nor lecturing in the traditional sense much at all), and I hope to cover some topics not in the book at all this semester. For these reasons, I expect you to attend class.

Academic Honesty:

Students are expected to adhere to Ithaca College's Code of Conduct (see http://www.ithaca.edu/attorney/policies/vol7/Volume_7-70104.htm). Any students caught cheating (whether they are currently enrolled in this class or not) will be disciplined according to Ithaca College guidelines.

We have had problems with students cheating off each other as well cheating from the web. No one benefits from this. I have sent students to Academic Justice office for these offenses in the past, and if you are caught, I will discipline you also.

Your own Advice:

Here is some advice from other students in my courses. The advice students give to future students is remarkably uniform for all of my classes, so please heed their advice!

- Start the homework early
- Be prepared to attend class every day and work hard
- Work with others on HW
- Do the reading assignments
- Read HW problems as soon as they are assigned, they will be discussed in class
- Go in for help as soon as you're having trouble or it will accumulate
- Listen to the advice from previous students that they give you in the syllabus

Other notes:

- Accommodations will be made for students with documented learning or physical disabilities
- Students performing below a C will be asked to meet with the professor to discuss a course of action that will bring the student's grade up.
- I will send out occasional emails to the entire class to their *Ithaca College* email addresses, so you must check them regularly.
- Final grades are FINAL – no work may be handed in for additional credit after the final exam.

Course Outline:

Below is a rough outline of the course. There will be modifications to this outline depending on how fast we cover the material. The readings are taken from Hook and Hall.

No	Week of	Reading	Topic	Homework due
1	Jan 19	No reading	Drude/Sommerfeld free electron model	No homework due
2	Jan 26	Ch. 3	Quantum Mechanical free electron model	Problem Set 1
3	Feb 2	Ch. 2	Crystal Dynamics and Phonons	Problem Set 2
4	Feb 9	Ch. 1	Crystal Structure: Lattices, Bragg Diffraction	Problem Set 3
5	Feb 16	Ch. 3	Free electrons and the lattice	Problem Set 4
6	Feb 23	Ch. 4	Nearly free electrons, energy bands	
!→	Feb 25		First Midterm, 6 PM	
7	Mar 2	Ch. 4	Tight binding model	Problem Set 5
	Mar 9		Spring Break	
8	Mar 16	Ch. 5	Semiconductors and holes	Problem Set 6
9	Mar 23	Ch. 5	More semiconductors	Problem Set 7
10	Apr 2	Ch. 6	Semiconductor devices	Problem Set 8
11	Apr 13	Ch. 7	Diamagnetism and paramagnetism	Problem Set 9
12	Apr 20	Ch. 8	Ferromagnetism	Problem Set 11 Final Report outline due Apr.24
13	Apr 27	Ch. 10	Superconductivity	
!→	Apr 29		Second Midterm	Pickup Apr. 29, return May 1.
14	May 4	Ch. 10	Superconductivity	Problem Set 12 Final Report Rough Draft

Final Presentations will be:

Wednesday May 6, 4:30 PM - 7 PM, CNS 204.

Last revised on January 22, 2009.