Physics 155 2012 Winter Quarter
Solid State Physics UC Santa Cruz

Instructor: Gey-Hong (Sam) Gweon, ISB 249, gweon@ucsc.edu, phone: 9-1806
Course website: http://griffin.ucsc.edu/teaching/current

Lecture schedule: Tuesdays and Thursdays, 2:00 – 3:45 PM, ISB 235
Office hour schedule: Mon 2-3 PM, Wed 10-11 AM, 2-3 PM (or by appointment), ISB 249

Textbook: Introduction to Solid State Physics, by C. Kittel, eighth edition
References:
Solid State Physics, by Ashcroft and Mermin
Concepts in Solids, by Anderson

Solid state physics concerns how quantum mechanics of electrons describes our ordinary world, and is built on two fundamental theoretical frameworks. On one hand, a large part of solid state physics is built on a quantum mechanical description of **one particle in a periodic potential**. Formulating and understanding this simple problem made major contributions to our understanding of solids as well as the foundation of quantum mechanics. On the other hand, a solid is a collection of very many particles, and novel phases of matter, e.g. magnets and superconductors, emerge out of interactions between those particles. Understanding these "**emergent phenomena"** account for much of the contemporary solid state physics. These two seemingly polar-opposite theoretical frameworks are actually mutually complementary, and a good understanding of them is indispensible not only for solid state physics but also for general physics topics such as vacuum and fundamental particles. This course will cover basic concepts of solid state physics from these two important perspectives, with an emphasis made, when possible, on simple connections to contemporary activities, which will be particularly emphasized in lectures near the end. A rough plan for the course is the following.

Week	Lecture #	Date	Topic	Chapters
1	1	Jan 10	Atoms, molecules	N/A
	2	Jan 12	Crystal structure	1
2	3	Jan 17	Cells, Reciprocal lattice	1,2
	4	Jan 19	Diffraction	2
3	5	Jan 24	Diffraction, Form factors	2
	6	Jan 26	Wave number quantization	4
4	7	Jan 31	Phonons	4, 5
	8	Feb 2	Phonons, Einstein and Debye	5
5	9	Feb 7	Anharmonic effects, Umklapp scattering	5
	10	Feb 9	Free electrons	6
6	11	Feb 14	Free electrons	6
	12	Feb 16	Bloch theorem and Bragg scattering	7
7	13	Feb 21	Band theory – nearly free electron model	7
	14	Feb 23	Band theory – tight binding model	7
8	15	Feb 28	Fermi surface, Semi-classical EOM	9
	16	Mar 1	Landau levels, dHvA, SdH, hole	9
9	17	Mar 6	Exam	
	18	Mar 8	Semiconductors	8
10	19	Mar 13	Superconductors	10
	20	Mar 15	Magnetism	11,12

Grading

A rough guideline as to how your grade will be determined is the following. First, the following percentages apply: homework (30 %), quiz (20 %), midterm (30 %), final (20 %). Second, the letter grades will be determined by the absolute, not relative, quality of your work. Roughly, A- will start around 85 % and C will start around 50 %. Depending on the difficulty of exams or quizzes, any of these numbers can, and most likely will, be subject to adjustment. Excellent classroom participation, excellent discussions during office hours, or particularly excellent solutions in homework, quiz, and exams and may also be taken into account, if deemed necessary, in determining your final letter grade.

Homework

About 8-9 homework sets are expected. Each set will be due one week after it is handed out. No late homework will be accepted (however, see "emergency" below).

Quiz

There will be 5-6 short quizzes, which will usually focus on key conceptual topics that are covered in the homework solutions posted.

Exams

One conventional style exam is to be held in class, during the normal class time. The schedule of the "final exam" according to the registrar is ~~Thursday~~ Monday, March 19, 7:30-10:30 PM. The final exam will consist of a presentation of a solid state physics research topic and the submission of the presentation materials for grading. This final "exam" is intended not to be difficult, but to encourage your independent exploration into a topic related to solid state physics. Roughly, you will pick a topic, read a paper or two or equivalent (e.g. book sections), summarize what you learned in about 10 minute talk. If you already have an on-going research suitable for this presentation, you can use that. Your talk material will typically consist of 4-5 power point slides or pdf pages. Before the final exam day, you will submit your talk material to me, and on the final exam day, you will give the talk. Both the material and the presentation will be evaluated. In this evaluation, the participation itself will matter greatly. A more substantial guide to the final exam will be given later in the course. I encourage you to think about what topic you might like to pick as early as possible, and to come talk to me about it.

Emergency

If you encounter an extraordinary situation that negatively affects your work in this course, you should let me know as soon as it is convenient for you to do so. Medical emergency, activities in your research group, family emergency etc. are some examples. I will consider your individual circumstances, and, if appropriate, arrange make up opportunities.

How you can best learn:

- Read before class.
- Ask questions to yourself, me, your friend, at any time.
- Engage in discussions. *Everyone* learns in good discussions.
- If your peer asks you a question, thank him/her and try your best to explain. Teaching may be the best way to learn.
- Please know that I am here to help you learn, not "just to teach," and do not be afraid to come and talk to me.