

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, 10:00 – 11:45 AM, ISB 235

Office hour schedule: Tuesdays and Wednesdays 1:00 – 2:00 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

Condensed Matter Physics, by Marder

Principles of Condensed Matter Physics, by Chaikin and Lubensky

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 indispensable 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 4	Atoms, molecules (review QM)	N/A
	2	Jan 6	Crystal structure	1
2	3	Jan 11	Cells, Reciprocal lattice	1,2
	4	Jan 13	Diffraction	2
3	5	Jan 18	Diffraction, Form factors	2
	6	Jan 20	Wave number quantization	4
4	7	Jan 25	Phonons	4, 5
	8	Jan 27	Phonons, Einstein and Debye	5
5	9	Feb 1	Anharmonic effects, Umklapp scattering	5
	10	Feb 3	Free electrons	6
6	11	Feb 8	Free electrons	6
	12	Feb 10	Bloch theorem and Bragg scattering	7
7	13	Feb 15	Band theory – nearly free electron model	7
	14	Feb 17	Band theory – tight binding model	7
8	15	Feb 22	Fermi surface, Semi-classical EOM	9
	16	Feb 24	Landau levels, dHvA, SdH, hole	9
9	17	Mar 1	Exam	
	18	Mar 3	Semiconductors	8
10	19	Mar 8	Superconductors	10
	20	Mar 10	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. Quizzes will be administered after your homework is graded and returned, and will usually focus on key conceptual topics that are covered in the returned homework.

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, March 17, 4-7 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. 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.