

Theory of Solids I 33-783 (12 units)

Fall 2020 Syllabus

Instructor: Prof. Sara Majetich
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Meeting time and place:

MWF 2:40 – 3:30 PM, via Zoom

Learning Objectives: The goal is to prepare graduate students in physics and related fields so that they can apply their knowledge of solid state physics in their research areas. This course includes two components: 1) An overview of the basic concepts and phenomena of solid state physics, with readings covered in standard texts, and 2) an introduction to the current solid state physics literature. At the conclusion of the course, students will have a basic knowledge of solid state physics (crystal structure, electronic structure, and thermal, transport, optical and magnetic properties). They should also be able to apply them as they read and analyze articles in the solid state physics research literature.

Course Motivation: In a world filled with lasers, cell phones, and hard disc drives, there is no need to stress the practical importance of solid state devices. The overview component of the course will cover the basics of crystal and electronic structure, and the main classes of materials -- metals, semiconductors and two-dimensional materials, insulators, magnetic and spintronic materials, and superconductors. The literature component serves several purposes. There is a considerable gap in the level of difficulty between standard graduate texts in physics, and the physics literature. Reading and summarizing these articles will help to make the transition and prepare for independent reading in their research areas. Students will learn how to approach journal articles, which unlike textbooks will not contain a lot of background information. They will gain experience in analyzing the scientific content of journal articles, and practice in synthesizing new information with their solid state physics background. Finally, they will learn more about some of the problems and issues of greatest interest to solid state physicists today.

Learning Resources: Neil W. Ashcroft and N. David Mermin, Solid State Physics, Saunders College Publishing, ISBN 0-03-083993-9 plus supplemental readings to be distributed in class.

Prerequisites: 33-756 or instructor permission.

Course Activities: The basic course material will be presented as lectures. There will be two take-home exams to test students' mastery of this material. In addition there will be a journal article to read (~8 over the course of the semester) related to a hot topic in solid state physics. Each student will write a two-page summary for each article, and all will participate in the discussion of the article. The summaries will be turned in after class. At the end of the semester each student will submit a final paper (10 pages, single spaced, plus references) that is an extended analysis of a single solid state physics article, clearly explaining the underlying solid state physics. Students will be judged on both their understanding of the physics and on their

ability to communicate. Effective communication does not require perfect English; non-native English speakers will not be penalized for small grammatical errors. However, it is important to be able to analyze, understand and convey scientific ideas in English, and this is what is meant by the “ability to communicate”. The level should be appropriate so that other students in the class could understand the interesting solid state physics of the paper, not just the instructor or experts in the field.

Grading: Grades will be determined based on several components, listed in order of importance: 1) Written Summaries of journal articles, 2) Take-Home Exams, 3) Final Paper, and 4) Participation in discussions of journal articles.

Course Web Site: The course website can be reached through Canvas. Visit the course web site often for announcements, course information such as this syllabus, an outline of the topics covered, instructor contact information, supplementary lecture notes, assignments, solutions to assignments, and your grades.

Class Attendance: You are expected to attend all classes (via Zoon), and to be on time. Regular class attendance is the easiest way to keep up with the material. If you are unable to attend, you should notify the instructor as quickly as possible and explain why. This also helps to alleviate difficulties that arise when a student has an extended absence due to illness, etc.

Lectures and Reading Assignments: While you are not asked to study new material before it is covered in lecture, *you may find it helpful to preview the material for the next lecture.* The lecture covers the high points of the new material, and you are expected to go back over this material in the textbook in detail, to help fix the new concepts in your mind. The best approach is to study a little bit between each lecture, and to ask questions when you don’t understand.

Academic Integrity: Cheating will not be tolerated at any level, whether it be copying on a take-home exam, or plagiarizing material for an article summary or the final paper. CMU is a high pressure environment, and we understand that the temptation exists. This zero tolerance policy aims to protect the large majority of students who are honest and work hard to earn their grades.

Office Hours: By appointment. For quick response, send email or see the instructor just before or just after lecture to schedule.

Accommodations: Please make the instructor aware as soon as possible if any accommodations need to be made, and provide the supporting documentation from the Office of Disability Resources. Their office can be contacted at access@andrew.cmu.edu.

Wellness: Do your best to maintain a healthy lifestyle this semester. If you or anyone you know experiences any academic stress, difficult life events, or difficult feelings like anxiety or depression, we strongly encourage you to seek support. Consider reaching out to a friend, faculty or family member you trust for assistance connecting to the support that can help. Counseling and Psychological Services (CaPS) is here for you: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Over 25% of students reach out to CaPS some time during their time at CMU.

Respect for Diversity: It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.