BU Electrical & Computer Engineering

EC 577/MS 577
Electrical, Optical and Magnetic Properties of Materials

This course provides an introduction to the rich field of solid state physics as it pertains to materials science and electrical engineering applications. Students will encounter thermal, mechanical, ectronical, optical and magentic properties of crystaline materials, Tools and concepts that are common for multiple phenomena, in particular wave and quantization phenomena will be studied. Students will be encouraged to explore a broader array of topics through brief minipresentations each lecture.

Prerequisites This course does not have any graduate level prerequisites, but require an adequate undergraduate level preparation in several related areas: **Math:** differential equations such as wave equation, integrals, complex variables, especially Euler's
equations to express sine and cosine in polar notation. **Fourier transforms:** much of the course relates real space and k-space, and familiarity with FT are helpful. **Classical Physics:** Newton's laws, Coulomb's law, Ohm's laws, waves, simple harmonic oscillators. **Modern Physics:** Waves, Schrödinger equation, quantum harmonic oscillators, particle-wave duality. **Chemistry:** Atomic structure, bonds, periodic table. **Thermodynamics/stat-mech:** Heat-energy, heat-capacity, kinetic gas theory, equipartition theorem, Fermion- and Bose-Einstein statistics.

Course Organization

Contact info:	Instructor: Professor Anna Swan swan@bu.edu use Piazza for messaging (avoid email for class related communication) Course TAs: Erik Schiferle and Xinyi Wang. Please contact via piazza.
Lectures:	TR 3:30- 5:15 pm in CAS226, 685-725 Commonwealth Avenue
Office hours:	Swan TR 5:15-5:45 pm (half hour after class) **More hours TBD** Eric TBD, Xinyi TBD
Course Book	The The Oxford Solid State Basics by Steven Simon, Oxford University Press. There are lectures posted online by Steven Simon that are very good, and you are encouraged to listen to them. https://podcasts.ox.ac.uk/series/oxford-solid-state-basics (Any Introductory Solid state book will cover the same material)
Companion book:	Solid State Physics, an Introduction by Philip Hofmann 2nd edition, Wiley-VCH for mechanical properties, Chapter 3. Online resources can be found here: http://philiphofmann.net/book/bookhome.html
Other books	Kittel, Introduction to Solid State Physics (Wiley and Sons- 8th Ed.) (more topics than covered in this course) Ashcroft and Mermin, Solid State Physics (Thomson Learning) (more advanced, but starts out with classical models, like Simon, and goes deeper in several stages.)

Communication platforms

Piazza This term we will be using Piazza for class discussion, questions and clarifications on homework, deadlines etc. The system is highly catered to getting you help fast and efficiently from classmates, the TAs, and myself. Rather than emailing questions to the teaching staff, post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com. You are responsible for keeping ajour with the course on Piazza.
Find our class page at: https://piazza.com/bu/fall2021/ec577ms577/home

Blackboard: The blackboard platform will be used for posting grades. **http://Learn.bu.edu**

Communication and participation
Despite having most students participate in person, a few students will still be in a remote learning situation due to VISA delays. It is important to establish efficient and inclusive ways for everyone to be heard and have access to materials and partcipate in a learning community.

Lectures: Each lecture will have 2 students assigned to take notes on main ideas and questions that came up. These notes should be entered on Piazza in the folder "lectures" and in the specific subfolder, e.g. L1 (lecture 1) , L4 (lecture 4) etc. Anyone can add to the notes
In additon to classroom disucsusions we will use Piazza as a discussion board.

Homework groups: The homeworks are one of the best tools to learn the material in the course. You will work in a HW group and meet/connect 1-3 times a week to discuss the material and work on HW solutions. You are welcome to discuss all aspects, including specific answers, but DO NOT COPY each other.

Questions, information and suggestions: We will use piazza as the communications platform. If something is unclear to you or you found some great (online) resource, it is likely that many students will benefit from knowing the answer. If you have a question about the course, please post your question and other inputs *to the whole class* on piazza. If you have a question/comment of a personal nature, you can post to a specific instructor.

Your input is welcome to improve the class.

Homework and homework groups
You will have ~10 homeoworks during the semester. Your attention to learning and understanding from the homework is an essential part of the course, and is going to give you a working knowledge of the subject.
You will be in a study groups, 3 students in each group. Please enter your info in this google sheet. Decide if you want to be put in a HW group by me, or self organize a group of three (second and third page)
The expectations is that you should meet ~ twice a week to make sure everyone understands the questions and have an idea of the path towards solving it and compare and discuss solutions. If you are ahead of the people in your group, you will solidify your understanding by explaining it; if you are confused, you will learn from your peers. If there is a topic that you think merits further discussion, bring to Piazza (or class) for discussion.

Homework grading: One person in each HW group will be randomly chosen to be graded. All members of the HW group will get the same grade. The accumulated homework grades will max out at 70% of the max points. This is domne so that a mistake by a member will not jeoprdize everyones grade. The point of the homework grops and the grading is to get everyone to help each other; in the groups and in the class. Collaborate, learn more, and have more fun.

Google spreadsheet for forming homework groups. Please fill out this informations as soon as possible, and before Aug 29.
https://docs.google.com/spreadsheets/d/1Jxijo4Xq31gbdZkrxgzUW2OUT4V3rq2mB_mC9SQCgCA/edit?usp=sharing

Grading
Homework 10%
Midterms 60%
Final 30%
Minipresentations (<5 minutes): Extra points: 2.5 in September, 2 in October, 1.5 in November, and 1.0 extra points for December presentations. MAX 2 presentations per lecture.

Academic conduct
Please see the university policy on proper academic conduct and what constitutes academic misconduct. In the case of academic misconduct in this class, established academic discipline procedures will be followed. http://www.bu.edu/ceit/university-policies/academic-conduct/
Midterms and exams: No help from other sources than authorized material is allowed. Helping someone else also is considered cheating.
Homework and Study Collaboration: Discussion with your peers and instructors of homework and projects are encouraged. However, homework solutions has to be your own work; copying a homework solution is cheating.

Syllabus (Subject to change)

date	L#	Topic	Chapter	Comment
2-Sep	1	Introduction	Ch 2	
7-Sep	2	Specific heat	Ch 2	
9-Sep	3	Metals, Drude theory	Ch 3	
14-Sep	4	Metals, Sommerfeld theory	Ch 4	
16-Sep	5	Structure of materials	Ch 5-7	
21-Sep	6	1D model: sound, thermal	Ch 8	
23-Sep	7	1D: vibrations	ch 9	
28-Sep	8	1D: di-atomic vibrations	Ch 10	
30-Sep	9	Mechanical properties	Hoffman	Ch 3 from Hoffman
5-Oct	10	Crystal Structure	Ch 12	
7-Oct	11	MIDTERM 1		Ch 2-10 + Hoffman
12-Oct		Monday schedule		
14-Oct	12	Reciprocal Lattice, diffraction	Ch 13	
19-Oct	13	Electron, X-ray and neutron diffraction	Ch 14	
21-Oct	14	Nearly free electron model	Ch 15	
26-Oct	15	reserve, review		
28-Oct	16	MIDTERM 2		Chapter 12-14
2-Nov	17	Fermi surfaces	Notes	
4-Nov	18	Insulator, SC or metal	Ch 16	
9-Nov	19	Semiconductor physics	Ch 17	
11-Nov	20	Semiconductor devices	Ch 18	
16-Nov	21	Optical Properties	Notes	
18-Nov	22	MIDTERM 3		Ch 15- 18
23-Nov	23	Magnetism	Ch 19	
25-Nov		Thanksgiving		
30-Nov	24	Magnetism	Ch 20	
2-Dec	25	Magnetism	Ch 21	
7-Dec	26	TBD		
9-Dec	27	TBD		