BU Electrical & Computer Engineering

EC/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 develop an understanding of the theory of crystal structures and their determination via diffraction, as well as the thermal, electrical, optical properties of materials that arise from these structures.

Course Organization

Contact info: Professor Anna Swan
Messaging via Piazza (avoid email for class-related communication)
Office PHO828

Lectures: TR 3:30- 5:15 pm in CGS 527

Office hours: PHO 828: Thursday 12:15-1:15 pm
CGS 527527: TR 5:15-5:45 pm (half hour after class)

Contact info TA: Haoxuan Yan
Please message via piazza <hyan910@bu.edu>
Office hours TBD

Course Book **Introduction to Solid State Physics**, by Charles Kittel 8th edition, Wiley-VCH. Copies at the BU bookstore.
Lecture notes will be posted (However, a text book is strongly encouraged)

Equivalent text books (any Solid State text book will work)

- 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 The order of the material is different than in Kittel, but the topics are the same. (We are starting with crystal structure, lecture 9 in the Simon lectures)

- Solid State Physics, an introduction by Philip Hofmann 2nd edition, Wiley-VCH

Online resources can be found here: http://philiphofmann.net/book/bookhome.html

- Ashcroft and Mermin, Solid State Physics (Thomson Learning). This is a higher level book.

Prerequisites
This course does not have any graduate level prerequisites. You are expected to have an adequate undergraduate level preparation in Math (differential equations, e.g. wave equation, integrals complex variables and polar notation), Fourier transforms (much of the course relates real space and k-space), Physics (Newton's laws, Coulomb's law, Ohm's laws, waves, simple harmonic

oscillators) Modern Physics (waves, Schrödinger equation) and Chemistry (Atomic structure, bonds, periodic table).

Communication
All communication will take place via **Piazza.com,** e.g. change of class room, change of office hours, clarifications on homework, deadlines etc. You are responsible for keeping up-to-date with the course on Piazza. Please use the Piazza for questions and comment to me and your peers, i.e., do not email me a general question, instead **post questions on Piazza**. (You can sign up for email notification) http://piazza.com/bu/fall2019/ec577ms577/home
Blackboard http://learn.bu.edu will be used for posting grades and posting of certain material.

Lectures
- Preparation: The topics for each lecture is listed in the syllabus. You are expected to have read through the material before each class and have questions ready.
- Beginning of class ~ 5 minutes, will be dedicated to questions regarding previous material.
- Student presentations: Students are encouraged to present very brief "teasers" on topics relevant to the lectures. ~3-5 minute presentations. Topic will be proposed for each week. This is a great way to get a glimpse of the very rich field of solid state beyond the basics I am able to cover. Please sign up to do it. (you will get HW credit)
- Lecture will be used for a mix of theory, worked out examples, and student in-class work.
- Questions and clarifications: This course is there for you to learn. Please ask questions during lecture if concepts are not clear. If you don't find the material clear, it is likely many other students don't either.

Office hours
The office half-hour directly after class are particularly valuable to iron out lingering questions and you are strongly encouraged to use these quick and informal feedback. In addition there will be additional office hours by the instructor and TA at the posted times.

Homework
Homework problems will be posted a week ahead of the due date, and are due in class. Your solutions should have a logical progression of steps so it is easy to follow. Assumptions should be stated. Equations should use symbols until the last steps. The answer(s) should be underlined and have units, if applicable. There should be a statement on how reasonable your answer is based on what you know. The grading weight on the homeworks is not high, but practice is necessary to master the material. HW Grading: 50% for honest attempt, 100 % for correct answer(s) with units and well organized, easy-to-follow solution. Messy solution with correct answer 70- 90%, Clear solution with some mistakes, 70-90%.

Grading Policy
Homework 10% Midterm 1 15%, Midterm 2 30%, Final 45%
A student teaser presentation (max 5 minutes) is equivalent to one homework

Academic Misconduct
BU takes academic integrity very seriously. Academic misconduct is conduct by which a student misrepresents his or her academic accomplishments, or impedes other students' opportunities of being judged fairly for their academic work. Knowingly allowing others to represent your work as their own is as serious an offense as submitting another's work as your own. More information on BU's Academic Conduct Code, with examples, may be found at http://www.bu.edu/academics/policies/academic-conduct-code .

Collaboration Policy
In this class you may use any textbooks or web sources when completing your homework, and collaborator from the EC/MS577 Fall 2018 class for your homework, subject to the following conditions:

- You must clearly acknowledge all your sources (e.g. books, websites, including your collaborators) on the top of your homework.
- You must write all answers in your own words and you must be able to fully explain your answers upon demand.
- You may not use any human resource outside of class (including web-based help services, outside tutors, etc.) in doing your homework or project.

Failure to meet any of the above conditions could constitute plagiarism and will be considered cheating in this class. If you are not sure whether something is permitted by the course policy, ASK ME! (It's much more awkward to explain your actions after the fact to the college disciplinary committee). During a midterm or exam, all work has to be your own and no communication is allowed. Nor are you allowed to let other students see your work during an exam.

Syllabus Any updates to the syllabus will be posted on Piazza

EC/MS 577 Tentative syllabus Fall 2018			
date	**L#**	**Topic**	**Kittel**
3-Sep	1	Intro, Crystal lattice	Ch 1
5-Sep	2	Miller indices, Braggs law	Ch 1
10-Sep	3	Scattering and diffraction	Ch 2
12-Sep	4	Brillouin zones	Ch 2
17-Sep	5	Bonding in solids	Ch 3
19-Sep	6	Strains and mechancial proeprties	Ch 3
24-Sep	7	Review + Phonons	Ch 4
26-Sep	7	Midterm 1	Chapter 1-3
1-Oct	8	Thermal properties (phonons)	Ch 4+5
3-Oct	9	Thermal Conductivity, Expansion, melting	Ch 5
8-Oct	10	Metals; Free electron Fermigas	Ch 6
10-Oct	11	Metals; Free electron Fermigas	Ch 6
15-Oct	12	Waves, Energy bands	Ch 7
17-Oct	13	Energy bands	Ch 7
22-Oct	14	Review + Semiconductor crystals	Ch 8
24-Oct	15	**Midterm 2**	Ch 4-6
29-Oct	16	Semiconductor crystals	Ch 8
31-Oct	17	Semiconductor crystals	Ch 8
5-Nov		pn junction	Notes
7-Nov	18	Fermi Surfaces and metals	Ch 9
12-Nov	19	Fermis Surfaces and Metals	Ch 9
14-Nov	20	Light matter interactions, electron gas	Ch 14
19-Nov	21	Quasi-particles, Plasmons Polaritons	Ch 14
21-Nov	22	optoelectronic devices	
26-Nov	23	Optical excitations, Excitons	Ch 15
28-Nov		**Thanksgiving Holiday**	
3-Dec	24	Free topic, TBD	
5-Dec	25	Free topic, TBD	
10-Dec	26	Reserve and review	
TBD		**Final**	Ch 1-9, 14-15