Fall 2020 Teaching: PHY 555 Solid State Physics

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Instructor: Marivi Fernandez-Serra

Office: Physics B-139; office hours: Mon 4:30-6:00; Fr-9:00-10:00
The class will meet in **Javits 102, MWF 11:45 am-12:40 pm**

The meeting location is not fixed, and will depend on the number of students that the room can accommodate while maintaining social distance requirements.

Special Covid-19 Information

Everyone participating in this class, must wear a mask/face covering at all times. Any student not in compliance with this will be asked to leave the class.

Every effort will be made to avoid changing the course schedule, but the possibility exists that unforeseen events will make syllabus changes necessary. It is your responsibility to check Blackboard or this webpage for corrections or updates to the syllabus. Any changes will be clearly noted in course announcements or through Stony Brook email.

Course Delivery Mode and Structure:

This is an in person course, ready to adopt an online format at any time. I will use the Blackboard learning management system (LMS), but it is expected to consist of face-to-face meetings. In preparation for a possible full online delivery need, all assignments and office hours and beyond class interactions will utilize internet technologies. See "Technical Requirements" section for more information. In Blackboard, you will access online lessons, course materials, and resources.

How We Will Communicate:

Course-related questions should be posted in the General Questions Forum in the course Discussion board, in Blackboard, or asked directly in our in person classes. For personal/private issues, email me directly. If you use Blackboard's email tool from the course site, it will automatically include your full name, course name and section when you send me an email. Please allow between 24-48 hours for an email reply. Your Stony Brook University email must be used for all University-related communications. You must have an active Stony Brook University email account and access to the Internet. All instructor correspondence will be sent to your SBU email account. Plan on checking your SBU email account regularly for course-related messages. To log in to Stony Brook Google Mail, go to http://www.stonybrook.edu/mycloud and sign in with your NetID and password.

Regular announcements will be sent from Blackboard. These will be posted in the course site and may or may not be sent by email.

Regular communication is essential in online classes. Logging in once a day, checking the discussion board and participating with your peers ensures that you are able to remain an active member of the class and earn full points for participation.

Technical Requirements:

This course uses Blackboard for the facilitation of communications between faculty and students, submission of assignments, and posting of grades and feedback. The Blackboard course site can be accessed at https://blackboard.stonybrook.edu

If you are unsure of your NetID, visit https://it.stonybrook.edu/help/kb/finding-your-netid-and-password for more information. You are responsible for having a reliable computer and Internet connection throughout the term. Caution! You will be at a disadvantage if you attempt to complete all coursework on a smart phone or tablet. It may not be possible to submit the files required for your homework assignments.

The following list details a minimum recommended computer set-up and the software packages you will need to have access to, and be able to use:

- *PC with Windows 10 or higher (we recommend a 3-year Warranty)*
- *Macintosh with OS 10.11 or higher (we recommend a 3-year Warranty)*
- *Intel Core i5 or higher*
- *250 GB Hard Drive*
- *8 GB RAM*
- *Latest version of Chrome or Firefox; Mac users may use Chrome or Firefox. (A complete list of supported browsers and operating systems can be found on the My Institution page when you log in to Blackboard.)*
- *High speed internet connection*
- *Word processing software (Microsoft Word, Google Docs, etc.)*
- *Headphones/earbuds and a microphone*
- *Webcam (recommended)*
- *Printer (optional)*

- *Ability to download and install free software applications and plug-ins (note: you must have administrator access to install applications and plug-ins).*

Scope of the Course

A study of the fundamental principles and concepts of condensed matter physics.

Part I is dedicated to understanding basic concepts. Will introduce the modern conceptual models of a solid from the point of view of (i) interacting atoms and (ii) elementary excitations, developing a solid base on the basic elements needed to understand many of the properties of solids and the methods to calculate them.

Part II focuses on the fundamentals of electron interactions, electron dynamics and response functions. These are fundamental to understand many phenomena in in condensed matter physics. Part III will cover different phenomena that are central to modern condensed matter and materials research. I will not have time to cover all the topics in the book, but the students should have the basis to continue learning on their own with what will not be covered in the course.

By the end of the course, students should have a working knowledge of the fundamentals, sufficient to understand developments at the forefront of the field.

Syllabus

Part I: Basic Concepts: electrons and phonons: MT1

1.1 Concept of solid: introduction and overview 2 lectures

1.2 Electrons in Crystals 4 lectures

1.3 Electronic energy bands 3 lectures

1.4 Lattice vibrations and phonons 4 lectures

Part II Electron interactions, dynamics and responses (MTII)

2.1 Electron dynamics in crystals 4 lectures

2.2 Many electron interactions: the homogeneous interacting electron gas and beyond 3 lectures

2.3 Density Functional Theory (DFT) 3 lectures

2.4 The dielectric function for solids 4 lectures

Part III Optical and Transport phenomena

3.1 Electronic transitions and optical properties of solids 3 lectures

3.2 Electron-phonon interactions 3 lectures

3.3 Fundamentals of transport phenomena in solids 3 lectures

Texts

I will be mostly using the new book by Cohen and Louie (Fundamentals of Condensed Matter Physics, Cambridge University Press). You can also choose to buy other. My preferred book has always been Ashcoft, tied to Ziman's. However the new book by Cohen and Luie is superior and way more modern. Here are other good suggestions

Other Useful texts:

Ashcroft and Mermin, Solid State Physics
Ziman, Theory of Solids

Condensed Matter in a Nutshell, Gerald D. Mahan

Ibach and Luth, Solid State Physics.

Grosso and Parravicini, Solid State Physics.

Kittel, Introduction to Solid State Physics
Kittel, Quantum Theory of Solids
Madelung, Introduction to Solid State Theory

Homework Policy

Problem sets will be assigned (almost) every Friday. They will be due the following Friday and will be graded and returned the Friday after that.

Course Grading

There will be two midterms and a final exam. Midterms will be two short (1h long) exams. The MT1 will cover part 1, MT2 will cover part 2. The final exam will cover both and perhaps some topics of part 3. Exams will be very much in line with homeworks. Each exam will be only 25% of the course. Homework will be another 25% of the course. I will also give a final paper, in a journal club style (20% final grade weight) to the students. The papers will be chosen by the students from a pool of topics I will provide. Students will present the paper to the class during the two last weeks of the course.

Assignments : 25%
Midterm I : 25% (Take home Exam)

Midterm II: 25% (Take Home Exam)
Final: 25% (Take Home Exam)

Student Accessibility Support Services (SASC):

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Student Accessibility Support Center, ECC (Educational Communications Center) Building, Room 128, (631)632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential. https://www.stonybrook.edu/commcms/studentaffairs/sasc/facstaff/syllabus.php

Academic Integrity Statement:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at: http://www.stonybrook.edu/commcms/academic_integrity/index.html

Critical Incident Management Statement

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.