Course Overview and Syllabus
PHYS 424 – Solid State Physics

Meeting Times

Lectures: TR
9:30 AM – 10:45 AM
Room: Hugel Science Center 017
Office Hours: M 9:30 AM – 10:30 AM
T 11:00 AM - 12:00 PM
R 12:00 PM - 1:00 PM
**office hours will be in Hugel 028*

Contact Information

Professor: Paul Stonaha

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Phone: 610-330-3376

Course Overview

Physics 424 is an introduction to the field of solid state physics. We will cover crystal structure, reciprocal space, x-ray diffraction, crystal binding energies, lattice dynamics (phonons), free electron theory, theory of electron band structure, and magnetism. This class involves a significant amount of knowledge of quantum mechanics; it is advised that students have taken / are taking PHYS 351 (Quantum Theory) and PHYS 335 (Thermal Physics).

Course Format

The majority of this class will be taught in a flipped classroom style. This means that you will watch lectures as homework, and we will solve problems in class. Each week, I will provide a sheet with URL to the video of interest, along with a couple basic questions about the material presented. Most videos will be taken from *Solid State Physics in a Nutshell* (**http://bit.ly/2S8vk2v**). Please watch the videos. If you choose not to watch the videos *before class*, you will be doing yourself a great disservice.

Textbook and Course Materials

Required Textbook

The required textbook for this course is *Introduction to Solid State Physics* by Charles Kittel (8th ed.). The class will follow the book. Assigned readings will be listed on homework assignments. You should read the corresponding material **before** each lecture class. There's good stuff in there.

I also recommend the books *Solid State Physics* (Ashcroft & Mermin) and *Elementary Solid State Physics* (Omar).

Grading

Grading Overview

Category	Details	Percentage of overall grade
Homework	13 assignments @ various points each	40%
Exams	2 exams @ 20% each	40%
Final		20%

Homework

Homework will comprise two parts:

1) Weekly comprehension questions, derivations, and videos to watch. I will not check that you are watching the videos; that is your responsibility to yourself. However, you must complete the comprehension questions and derivations.
2) Long problems to solve. These will be drawn from the problems we solve together in class. That is, at the end of class I will review what problems we solved, and the assignment for you is to rewrite these problems and turn them in to me.

Homework will be posted to Moodle. You are expected to access these files, complete the assignments, and upload your photographs of your answers onto Moodle.

Homework is due on Thursday, 10:00 AM of each week. Homework will be accepted up to a week late for 50% credit. Homework beyond one week late will not be accepted.

Exams

I anticipate having 2 tests and a final. The final exam will focus on the last portion of the class.

Each test will be distributed to the class the week before the test is to be administered. Students may work together to solve the test problems. On the day of the examination, each student will work independently to complete the test in class. The tests will be hard, but since you'll have a week to discover how to solve all of the problems, this shouldn't be an issue.

On the day of the exam, you will be asked to solve the same problems you were given in the previous week, but you must work alone and may not use any notes, books, etc. To receive full credit, you must show all work and ***convince me that you know how to solve the problem (not just that you know what the solution is).*** This must include *written explanations* describing your reasoning.

Final Letter Grade Distribution

Letter	Minimum
A	93.5%
A-	89.5%
B+	86.5%
B	82.5%
B-	79.5%
C+	76.5%
C	72.5%
C-	69.5%
D+	66.5%
D	62.5%
D-	59.5%

Academic Honesty:

I expect that you will abide by the "Principles of Intellectual Honesty" appearing in the Lafayette College Student Handbook. Posting homework or exam questions to an external site without my permission is a violation of the Academic Honesty Policy. The Physics department also has an Academic Honesty policy for rules regarding collaboration with others. This document is available on the Moodle page for this class. Please feel free to ask if you have any questions about this policy.

Accommodations:

In accordance with Lafayette College policy, reasonable academic accommodation and support services are available to students who have a documented disability. It is your responsibility to provide me with the appropriate paperwork from the Accessibility Services Office. More information is available at https://hub.lafayette.edu/.

Covid-19 Policy:

Masks are not required for healthy, non-exposed individuals in this course section. Lafayette College is following the CDC recommended guidelines for handling cases of exposure to / illness from Covid-19:

For students ***exposed to someone who has tested positive*** for COVID-19 (close contact):

- If asymptomatic, attend classes.
- Wear a mask for a full 10 days.
- Watch for symptoms. If feeling ill, isolate immediately except to get tested at Bailey Health Center. Students may also use self-supplied, at-home test kits. A minimum of two, preferably three, negative tests taken at least 24 hours apart is recommended.

For students who ***test positive*** for COVID-19:

- Isolate for a minimum of five days.
- Mask for 10 days.
- A standard Dean's Excuse will be given and the Office of Advising & Co-Curricular Programs will be notified.

Gender Inclusion:

This is a gender-inclusive classroom. I have been provided with a class roster and your legal names. I will gladly honor any requests to be addressed by a different name or pronoun than appears on the class. Please make me aware of any preferences.

Proper Usage of Course Materials & Classroom Recordings:

At Lafayette College, all course materials are proprietary and for class purposes only. This includes posted recordings of lectures, worksheets, discussion prompts, and other course items. Reposting such materials or distributing them through any means is prohibited. Such materials should not be reposted or distributed through any means. You must request my permission prior to creating your own recordings of class materials, and any recordings are not to be shared or posted online even when permission is granted to record. If you have any questions about proper usage of course materials please ask me. Please also be in contact with me if you have any concerns with being recorded during the course.

Common Course of Study Outcomes Statement:

This course (and particularly the lab com- ponent) will promote the following outcomes for Natural Sciences (NS) within the Lafayette Common Course of Study:

- NS 1: Employ the fundamental elements of the scientific method in the physical and natural world by identifying and evaluating a testable scientific hypothesis.
- NS2: Create and evaluate descriptions and representations of scientific data via equations, graphs, tables, and/or models.

Moodle Privacy Statement:

Please note that Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

Federal Credit Hour Compliance Statement:

Student work in this course is in full compliance with the federal definition of a three-credit hour course. Please see the Registrar's Office website (https://registrar.lafayette.edu/wp-content/uploads/sites/193/2013/04/ Federal-Credit-Hour-Policy-Web-Statement.doc) for the full policy statement.

Week	Lecture	Date	Topic	Section	Reading	Homework
1	1	23-Jan	Introduction, Crystal Structure	Ch. 1		
	2	25-Jan	Crystal Systems	Ch. 1	1 - 8	
2	3	30-Jan	Bravais Lattice	Ch. 1	9 - 21	
	4	1-Feb	Reciprocal Lattice	Ch. 2	25 - 33	PS 1 due
3	5	6-Feb	Diffraction of Waves, Brillion Zones	Ch. 2	33 - 39	
	6	8-Feb	Structure Factors	Ch. 2	39 - 42	PS 2 due
4	7	13-Feb	Inert Crystals, Cohesive Energy	Ch. 3	49 - 60	
	8	15-Feb	Ionic/Covalent Crystals	Ch. 3	60 - 73	PS 3 due
5	9	20-Feb	Vibrations, First Brillion Zone	Ch. 4	91 - 95	
		22-Feb	**Exam I**	**Chs. 1-3**		PS 4 due
6	10	27-Feb	Two Atoms Primitive Basis	Ch. 4	95 - 99	
	11	29-Feb	Phonon Momentum, Inelastic Scattering, Normal Modes	Ch. 4, 5	99 - 108	PS 5 due
7	12	5-Mar	Density of States	Ch. 5	109 - 112	
	13	7-Mar	Einstein Model, Debye Model	Ch. 5	112 - 119	PS 6 due
		12-Mar	**Spring Break**			
		14-Mar				
8	14	19-Mar	Thermal Effects, Umklapp Scattering	Ch. 5	119 - 128	
	15	21-Mar	Drude Model	A&M Ch 1		PS 7 due
9	16	26-Mar	Free Electron Gas in 1-, 3-Dimensions	Ch. 6	133 - 141	
	17	28-Mar	Heat Capacity, Electrical Conductivity	Ch. 6	141 - 152	PS 8 due
10	18	2-Apr	Bloch Functions	Ch. 7	163 - 169	
	19	4-Apr	Band Structures, Nearly Free Electron Bands	Ch. 7	169 - 177	PS 9 due
11	20	9-Apr	Semiconductor Equations of Motion	Ch. 8	187 - 197	
		11-Apr	**Exam II**	**Chs. 4-6**		PS 10 due
12	21	16-Apr	Effective Mass, Holes	Ch. 8	197 - 209	
	22	18-Apr	Thermoelectrics	Ch. 8	209 - 217	PS 11 due
13	23	23-Apr	Construction of a Fermi Surface	Ch. 9	223 - 230	
	24	25-Apr	Calculations of Energy Bands	Ch. 9	230 - 242	PS 12 due
14	25	30-Apr	Measuring the Fermi Surface	Ch. 9	242 - 252	
	26	2-May	Review (Pizza?)			PS 13 due

FINAL EXAM (comprehensive): date and time TBD by the Registrar