Instructor: Dr. Paul Simmonds

Contact  (208) 426-3787; paulsimmonds@boisestate.edu

Note: I will respond to emails received after 5pm by 10am the next day. For emails received at the weekend, this means the following Monday.

Office  MP422 (Multipurpose Classroom Building, MPCB).

Office hours  Mondays, Wednesdays, 3:00–4:00pm; or by appointment.

Class prerequisites  PHYS 309 (Introduction to Quantum Physics).

Class time/place  Mondays/ Wednesdays, 4:30–5:45pm, MP211 (MPCB)

Class website  See Blackboard for syllabus, lecture notes and assignments.

1. Class objective

To provide an introduction to fundamental aspects and applications of the physics of different solid materials, using principles of classical and quantum physics. We will learn how the unique properties of a range of different materials arise from their physical characteristics. We will also discuss areas of on-going research.

This objective aligns with University Learning Outcome 8: “Disciplinary Lens: Natural, Physical, and Applied Sciences - Apply knowledge and the methods characteristic of scientific inquiry to think critically about and solve theoretical and practical problems about physical structures and processes.”

2. Summary

Regular classes will consist mainly of a lecture with mathematical derivations and qualitative reasoning, along with class discussions. Final grades will be based on homework, just-in-time teaching assignments, and exams. PHYS 515 students will also be graded on a class project.

Each lecture builds on previous ones. Although attendance and active participation is expected at all lectures, I also appreciate that on rare occasions people may miss a lecture for a legitimate reason (e.g. sickness). However, the onus is on you to find out from your classmates what you missed. If you don’t
catch up on missed class notes, reading or assignments, it is likely that you will find subsequent lectures difficult/impossible to follow.

In general, if you are having trouble with the course, tests, homework, anything, please let me know as soon as possible. I’m very reasonable and approachable. I want you textbfall to succeed in this class, and I know that some of the material we will cover is tough! If you have tried your best on a problem but are struggling, asking for help is not admitting defeat! Remember to take advantage of office hours to go over things that don’t make sense.

3. Accommodating disabilities

Students with disabilities needing accommodations to fully participate in this class should contact the Disability Resource Center (DRC). All accommodations must be approved through the DRC prior to being implemented. To learn more visit the DRC website.

4. University support of student wellbeing

Boise State is committed to the safety and wellbeing of students, faculty and staff. You can help identify and assist members of our campus community who may be at risk. If you are concerned about someone’s behavior or safety, or are in need of support yourself, please submit a report to the CARE Team.

5. Academic integrity

Academic integrity will be strongly enforced in this course. Any student caught cheating on any assignment or exam may fail the assignment or exam in question, or fail this course, dependent on a hearing with the course instructor. Additional disciplinary action may be pursued through the Office of the Dean of Students. All students are required to adhere to Boise State’s Student Code of Conduct, particularly Sections 4D and 7 on academic dishonesty, cheating, classroom misconduct, and plagiarism. Plagiarism (presenting other people’s work as your own) can include copying another student’s work, using exam or problem solutions from a previous semester, or solutions found on the Internet. Allowing others to copy your work will be treated the same way as plagiarism. Plagiarism will not be tolerated and could have severe consequences.

Bottom line: be honest, and contact me if you have any questions.

6. Textbooks


7. Lecture schedule and assigned reading

This schedule may change during the semester. The numbered readings correspond to page numbers in Tanner, and supplement the material presented in class. Before class, you are expected to read the required section(s) of the textbook and the class notes, and complete any JiTT assignments. Please use office hours or class to ask questions.

<table>
<thead>
<tr>
<th>Week</th>
<th>Monday</th>
<th>Topics</th>
</tr>
</thead>
</table>
| 1    | 1/11   | Motivation/Atomic bonding  
        Mon. No reading; Wed. No reading |
| 2    | 1/18   | No Class/Crystal structure  
        Mon. No reading; Wed. pp. 54–60 |
| 3    | 1/25   | Drude model: Electrical/Thermal conduction  
        Mon. pp. 1–5; Wed. pp. 6–11 |
| 4    | 2/1    | Failure of Drude model/Fermi-Dirac statistics  
        Mon. pp. 11–14; Wed. pp. 19–25 |
| 5    | 2/8    | Drude-Sommerfeld model + Review/Exam 1  
        Mon. p. 33 (+ review above); Wed. Exam 1: Feb. 10th |
| 6    | 2/15   | No Class/Nearly free electron model  
        Mon. No reading; Wed. Suplemental notes to Lecture 9 |
| 7    | 2/22   | Density of states/Refined Drude-Sommerfeld  
        Mon. pp. 25–30; Wed. pp. 33-35 and 52–54 |
| 8    | 2/29   | Reciprocal space I/Reciprocal space II  
        Mon. pp. 60–61; Wed. pp. 61–65 |
| 9    | 3/7    | Brillouin zones/Origin of energy bands  
        Mon. Supplemental notes to Lecture 13; Wed. pp. 65–69 |
| 10   | 3/14   | Band structure + Review/Exam 2  
        Mon. pp. 69–72 (+ review above); Wed. Exam 2: Mar. 16th |
| 11   | 3/21   | No Class/No Class  
        pp. 79–91 |
| 12   | 3/28   | Tight-binding model/Semiconductors  
        Mon. pp. 72–76; Wed. pp. 111–118 |
| 13   | 4/4    | Semiconductor junctions/Semiconductor devices  
        Mon. pp. 138-146; Wed. pp. 146–160 |
| 14   | 4/11   | Nanostructures/2D electron gases  
        Mon. TBD; Wed. TBD |
| 15   | 4/18   | Magnetic materials I/Magnetic materials II  
| 16   | 4/25   | Superconductivity/Review session  
        Mon. pp. 213–217 and 223–229; Wed. Review all above |
| 17   | 5/2    | Finals Week  
        Final exam Wednesday, May 4th, 3:00–5:00pm |
8 Course work

Grades will be weighted as follows:

<table>
<thead>
<tr>
<th></th>
<th>PHYS 415</th>
<th>PHYS 515</th>
</tr>
</thead>
<tbody>
<tr>
<td>JiTT questions</td>
<td>10%</td>
<td>JiTT questions 10%</td>
</tr>
<tr>
<td>Homework</td>
<td>30%</td>
<td>Homework 30%</td>
</tr>
<tr>
<td>Exam 1</td>
<td>20%</td>
<td>Exam 1 15%</td>
</tr>
<tr>
<td>Exam 2</td>
<td>20%</td>
<td>Exam 2 15%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20%</td>
<td>Final exam 15%</td>
</tr>
<tr>
<td>Class project</td>
<td>15%</td>
<td>Class project 15%</td>
</tr>
</tbody>
</table>

8.1 Just-in-time teaching (JiTT) questions JiTT is a teaching pedagogy in which students answer a small number of questions about material in an upcoming lecture. You can use any resource to answer the questions, which will usually necessitate the reading ahead of class notes, textbooks, online materials, etc. **Answers are due two hours before the beginning of class**, and I will use your responses to tailor the discussion of the relevant material during the class period. There may not be a JiTT question for each class: please check Blackboard for JiTT assignments.

**Points JiTT scoring criteria**

<table>
<thead>
<tr>
<th>Points</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Student attempts JiTT question and provides correct answer.</td>
</tr>
<tr>
<td>8</td>
<td>Student attempts JiTT question but provides incorrect answer.</td>
</tr>
<tr>
<td>0</td>
<td>Student does not answer the JiTT question.</td>
</tr>
</tbody>
</table>

JiTT questions differ from homework in that most credit goes towards effort rather than getting the answer correct.

8.2 Homework Weekly problems/due dates will be posted on Blackboard. Hand in what you have on the due date. **No late homework will be accepted.** Homework must be clearly written and easy to follow. Show all your work for full credit. Clearly mark the final result(s) in each problem. Be sure to include units of physical quantities to avoid losing points. Homework problems will form the basis of many exam problems. Review graded homework and posted solutions, to ensure you understand and can complete every assigned problem.

8.3 Exams Exams are based on textbook readings/examples, homework problems, and class notes. **All exams are counted. No make-up exams will be given.** Calculators are allowed during exams, but no other electronic equipment. Students cannot discuss the problems with other students. You may bring one 8.5” × 11” sheet of formulas for each exam.

8.4 Class Project (PHYS 515 students only) You have a choice between two projects. The first is a term paper/presentation. The second is a mini-project involving work with students from the Department of Education. To help you decide which project you would like to pursue, early in the semester we will discuss details of the two options in class.
9 Grading

Grades will be curved, according to those who turn in each assignment. Not handing in work will thus not lower the curve and will likely be quite detrimental to your final grade.

A: 88–100 %  (A−: 88–90 %; A+: 98–100 %)
B: 75–87 %  (B−: 75–77 %; B+: 85–87 %)
C: 60–74 %  (C−: 60–62 %; C+: 72–74 %)
D: 45–59 %