

PHYS6210 Syllabus

Condensed Matter Physics I, 3 Credit Hours

Fall 2026

Instructor Information

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General Course Information

Description

This course introduces the physics that explains how everyday materials—like metals, semiconductors, and superconductors—behave at a fundamental level. You will explore how the motion and interactions of electrons inside solids give rise to properties such as electrical/optical conductivity, heat flow, and superconductivity. Along the way, the course connects microscopic ideas (like atomic structure and quantum behavior) to the larger-scale properties we can measure and use in technology.

Topics include how electrons move through materials, how crystal structures shape electronic and optical behavior, and how phenomena such as quantum Hall effect and superconductivity emerge. The course also introduces modern ideas relevant to nanoscale and electronic devices, helping you see how foundational physics supports current and future technologies.

Course Learning Outcomes

Upon successful completion of this course, you should be able to:

- Explain how the microscopic behavior of electrons and atoms gives rise to the observable properties of materials, such as electrical/optical conductivity and superconductivity.
- Apply core models and concepts to analyze how electrons move through different types of materials, including metals and semiconductors.
- Describe how crystal structure influences electronic/optical behavior and material properties.

- Interpret and solve problems involving key phenomena such as energy bands, transport processes, and superconductivity.
- Connect the fundamental principles of condensed matter physics to real-world technologies, including modern electronic and nanoscale devices.

Required Course Materials

If you do not have prior coursework in undergraduate-level solid state physics (such as GT's PHYS 4262), you are strongly encouraged to review the relevant instructional videos available on this website before or during the course:

<https://podcasts.ox.ac.uk/series/oxford-solid-state-basics>.

For this course, we recommend the following reference books:

Steven M. Girvin and Kun Yang, “Modern Condensed Matter Physics”, 2019

Neil Ashcroft and David Mermin, “Solid State Physics”, 1976

Supriyo Datta, “Electronic Transport in Mesoscopic Systems”, 1995 (2003 reprint)

Grading Policy:

Final grades in this course will be determined based on a combination of participation, assignments, and exams, designed to reflect both your engagement with the material and your mastery of key concepts. Your overall grade will be calculated using the following weighting:

- Class Participation: 10%
- Homework Assignments: 50%
- Midterm Exam: 15%
- Final Exam: 25%

Letter grades will be assigned according to the standard scale: A (90–100%), B (80–89%), C (70–79%), D (60–69%), and F (below 60%).

Your final course grade will be computed as a weighted average of these components. This structure is intended to balance consistent effort throughout the semester (homework and participation) with demonstrated understanding on exams. Students are encouraged to monitor their progress regularly using posted grades and feedback, and to reach out with any questions about their standing in the course.

Description of Graded Components

- **Class Participation (10%)**
This course emphasizes active engagement. Participation will be evaluated based on your contributions to class discussions, including asking questions, offering

insights, and engaging thoughtfully with course material. A portion of this grade (5%) will also include a short mini-project later in the semester focused on visualizing crystal structures.

- **Homework Assignments (50%)**

Regular problem sets will be assigned to reinforce key concepts and develop problem-solving skills. These assignments will involve analytical calculations and conceptual questions related to course topics. While collaboration in discussing approaches is encouraged, all submitted work must be your own. Homework is a major component of the course and is intended to support steady learning throughout the semester.

- **Midterm Exam (15%)**

The midterm exam will assess your understanding of material covered in the first half of the course. It will focus on core concepts, problem-solving techniques, and the ability to apply theoretical models to physical situations.

- **Final Exam (25%)**

The final exam will be cumulative, with an emphasis on material covered after the midterm while still drawing on earlier topics. It is designed to evaluate your overall understanding of the course and your ability to integrate concepts across different areas of condensed matter physics.

Together, these components are designed to provide multiple opportunities for you to demonstrate your understanding and to build both conceptual insight and analytical skills over the course of the semester.

Course Policies

Attendance and/or Participation

Attendance will not be formally recorded in this course. However, active participation is an important component of your final grade, as outlined above. Because the course emphasizes discussion and engagement, regular attendance is strongly encouraged to support your learning and success.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review [Georgia Tech's Honor Code](#) and the student [Code of Conduct](#).

Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Core IMPACTS

[Core IMPACTS](#) is the University System of Georgia's General Education curriculum. If you are teaching a course that counts towards Core IMPACTS, you should include a syllabus statement about the Core area and associated [career competencies](#). [This resource](#) developed by the Center for Excellence in Teaching and Learning and Online Education at Georgia State University includes template syllabus statements for each of the Core IMPACTS areas that you may adapt for your course.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, [contact the Office of Disability Services](#) (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Student-Faculty Expectations Agreement

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. [The Student-Faculty Expectations](#) articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Campus Resources for Students

Undergraduate Student Academic Success Resources:

- Academic Support: Academic Success and Advising (a unit in the Office of Undergraduate Education & Student Success) provides free support for your courses. Students can attend scheduled supplemental review (PLUS) sessions, stop by Drop-In Tutoring, or schedule a one-on-one appointment through Knack. To explore what options work best for you, please visit us online at success.gatech.edu/tutoring, email us at tutoring@gatech.edu, or come see us at Clough Undergraduate Learning Commons, Suite 283.

Graduate Student Academic and Professional Success Resources:

A list of resources for graduate students is given on the [Office of Graduate and Postdoctoral Education](#) website. Specific information for [current graduate students](#) includes

- [Academic Resources](#) such as the Communications Center, Language Institute, Library, Catalog, Registrar, resources for conducting research, Advocacy and Conflict Resolution resources, and how to manage unexpected situations that may impact your academic performance;
- [Student Resources](#) such as Campus Services, Child Care/Family programs, Health & Wellness, Career Services, and the Student Resource Guide; and
- [Professional Development](#) such as the programming from the Career Center and other professional development resources and events.

Student Well-Being:

At Georgia Tech, we are concerned about your overall physical, social, and mental well-being. A [comprehensive list](#) of wellness related resources has been compiled and maintained by the Office of the Vice President for Student Engagement and Well-being [student-resource-guide \(gatech.edu\)](#).