

Course Information

Course Number: PHYS 617
Course Title: Solid State Physics
Time: MWF 12:40-1:30
Location: MPHY 209

Instructor Details

Instructor: Joseph Ross
Office: 448 MPHY (office upstairs in physics building) and B03 Cain (research lab)
Phone: office 979-845-3842; lab phone 979-845-7823
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Office Hours: T 1-2 & W 11-12 in 448 MPHY, M 4-6 in B03 Cain; other times are usually not a problem, but for extended questions email to arrange a time. I am also happy to answer emailed questions.

Course Description

This course covers the physics of periodic crystals and their symmetries; electronic properties and the development of band structures; lattice vibrations, phonons, and thermal properties. Also scattering of X-rays, electrons, and neutrons, electrical and thermal transport, magnetism, superconductivity, semiconductor devices, and recent developments in the physics of solids.

Prerequisites

Phys 606 (quantum mechanics) and Phys 607 (stat. mech./thermodynamics). Or, equivalent preparation with instructor approval.

Learning Outcomes

- Become familiar with symmetry properties of solids and resulting electronic effects.
- Gain an understanding of electronic properties of solids and band structures.
- Learn about vibrational properties of solids and phonon excitations.
- Develop an understanding of scattering properties of crystalline materials.
- Become familiar with magnetic and superconducting properties of materials, and recent developments in the field.

Textbooks

- "Quantum Theory of Materials", Kaxiras and Joannopoulos, 2019.
- "Solid-state physics: an introduction to principles of materials science", Ibach and Lüth, 2009 (4th ed.).

Note that the Ibach and Lüth electronic version can be read at the TAMU library website.

Grading Policy

- *Overall course grade will be based on the following scheme:*
 - *Homework (most weeks): 20%*
 - *Exam 1 & Exam 2: 25% each*
 - *Final exam: 30%*

- Assignment of final grades according to point totals calculated using the percentages above will follow the scale, 80-100 A, 70-80 B, 55-70 C, 45-55 D, <45 F.

Late Work Policy

- Late homework turned in before the solutions are given out will be awarded $\frac{1}{2}$ credit. This does not apply in the case of homework that is late due to an excused absence (approved by me).
- After solutions are posted, it will still be possible to get $\frac{1}{3}$ credit for homework turned in if I am convinced that the work was not copied from the solutions.

Course Schedule

Exams include: Exam 1 (2/21) & Exam 2 (4/11) at 7:30 PM, and the final exam, May 5 10:30 AM
 The lecture schedule is below, with sections of Kaxiras and Joannopoulos (KJ) and Ibach and Lüth (IL).
 The times spent on each topic are my best estimate and may change.

- week 1, 1-18 to 1-20: Overview; Crystals, electron gases and bonding. KJ ch. 1.
- week 2, 1-23 to 1-27: Crystal classification and symmetries, reciprocal lattices. KJ ch. 2 and 3.3, also IL 2.1-2.5.
- week 3, 1-30 to 2-3: Symmetry properties continued; x ray scattering; KJ ch. 2.
- week 4, 2-6 to 2-10: Electrons in crystals; nearly-free electrons; KJ ch. 2, also IL 6.1-6.4.
- week 5, 2-13 to 2-17: Tight-binding, band-structures, densities of states and band symmetry; KJ ch. 2-3; also see IL chapter 7.
- week 6, 2-20 to 2-24: Hartree-Fock and electron-electron interactions; density functional theory, pseudopotentials and modern band methods. KJ ch. 4.
- Exam 1: Tues. February 21, 7:30 PM**
- week 7, 2-27 to 3-3: Band-structure methods continued; screening; examples. KJ ch. 4-5.
- week 8, 3-6 to 3-10: Harmonic crystal, classical lattice vibrations; KJ ch. 7.
- week 9, 3-20 to 3-24: Quantized lattice vibrations & phonons; KJ ch. 7-8.
- week 10, 3-27 to 3-31: Phonon interactions and electrical transport properties; KJ ch. 8 continued, and IL 9.1-9.7.
- week 11, 4-3 to 4-5: Semiconductors; also physics related to devices & 2DEG's; KJ 5.5 & ch. 9.
 Reading day: April 7.
- week 12, 4-10 to 4-14: Landau Levels; topological behavior: KJ ch. 9.
- Exam 2: Tues. April 11, 7:30 PM**
- week 13, 4-17 to 4-21: Magnetic behavior of solids. KJ ch. 10.
- week 14, 4-24 to 4-28: Superconductivity. KJ 8.4, also IL ch. 10.
- week 15, 5-1 to 5-2: continuation, review.

Final Exam Friday May 5, 10:30 AM

Covid Protection

To help protect Aggieland and stop the spread of COVID-19, Texas A&M University urges students to be vaccinated and to wear masks in classrooms and all other academic facilities on campus, including labs. Doing so exemplifies the Aggie Core Values of respect, leadership, integrity, and selfless service by putting community concerns above individual preferences. COVID-19 vaccines and masking — regardless of vaccination status — have been shown to be safe and effective at reducing spread to others, infection, hospitalization, and death.

University Policies

These are the required statements and standard policies for all Texas A&M Courses:

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to [Student Rule 7](#) in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor. Please refer to [Student Rule 7](#) in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" ([Student Rule 7, Section 7.4.1](#)).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" ([Student Rule 7, Section 7.4.2](#)).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See [Student Rule 24](#).)

Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" ([Section 20.1.2.3, Student Rule 20](#)).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact the Disability Resources office on your campus (resources listed below) Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Disability Resources is located in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual

harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see [University Rule 08.01.01.M1](#)):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need. *Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with [Counseling and Psychological Services \(CAPS\)](#).*

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's [Title IX webpage](#).

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care by utilizing available resources and services on your campus

Students who need someone to talk to can contact Counseling & Psychological Services (CAPS) or call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at [suicidepreventionlifeline.org](https://www.suicidepreventionlifeline.org).