# PHYS 425 – Solid State Physics

## Fall 2025

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| **Instructor:** | Roberto Abril Valenzuela | **Time:** | MWF 2:10– 3:00 |
| **Office:** | 52-E15 | **Email:** | rabrilva@calpoly.edu |

**Office Hours:** My official office hours are MW 10am-12pm and F 1-2pm held in my office.

**Materials:** There will be no official textbook for this class but there are two resources I will highly suggest you have access to:

❏ *Solid State Physics: An Introduction* 2nd edition by Phillip Hofmann. This book is available online for free through the CalPoly library.

❏ *Modern Physics* by Randy Harris (the textbook for the modern physics series) will also be helpful to review some quantum mechanics.

Other helpful resources which are the "go-to" textbooks for solid state physics, which are great if you want a more detailed introduction to the topics:

❏ *Solid State Physics* by Ashcroft & Mermin. This book is a monster and it's essentially the solid state bible.

❏ *Introduction to Solid State Physics* by Kittel. Same detail and difficulty as Ashcroft & Mermin but with none of the fluff.

You will also ocassionally need access to a scientific non-programmable calculator.

**Prerequisites:** This course will assume that you have the appropriate mathematical background for a 400-level physics course (calculus, partial and ordinary differential equations, linear algebra, fourier analysis, etc). Phys 211 is a prerequisite so I will assume you are familiar with basic quantum mechanics, which includes: simple solutions to the Schrodinger equation such as the free particle, infinite well, finite well, simple harmonic oscillator, and hydrogen atom.

**Learning Objectives:**
By the end of the course, we aim to develop some proficiency in the following:

❏ Crystal structures and their reciprocal lattices.

❏ Phonons and their role in determining the thermal properties of solids

❏ Energy band formation in periodic lattices

❏ Classification of solids: metals, insulators and semiconductors.

❏ Effects of doping in semiconductors.

❏ Understanding simple semiconducting devices.

**Grading Policy:**

> Homework . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 30%
> Quizzes . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10%
> Exams (2) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 40%
> Final Exam . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 20%

We will be using Canvas to track grades. Please check it **regularly** and let me know if there are any issues with your grade. Don't wait until the last minute to try and fix your grade.

For the purposes of assigning a final grade, I will use a standard letter grade assignment of

$$A \geq 93\%, \quad 93\% > A- \geq 90\%,$$
$$90\% > B+ \geq 87\%, \quad 87\% > B \geq 83\%, \quad 83\% > B- \geq 80\%,$$
$$80\% > C+ \geq 77\%, \quad 77\% > C \geq 73\%, \quad 73\% > C- \geq 70\%,$$
$$70\% > D+ \geq 67\%, \quad 67\% > D \geq 63\%, \quad 63\% > D- \geq 60\%,$$
$$F < 60\%$$

This will be the worst possible letter grade you can receive but if needed I reserve the right to shift these cutoffs if I see fit.

**Homework:** I will also post a biweekly problem set that you will have to write solutions for and turn in on canvas by the due date (see schedule).

As a general policy: **Messy/unreadable work will receive a warning and I will ask you to type your solutions from then on. Otherwise you will receive no grade.**

Collaboration on the homework sets is highly encouraged but please make sure to turn in your own work. Your solutions must include some semblance of explanation and understanding of the steps required to solve. If you just turn in a bunch of math then I can't really tell if you just copied the math off of your friend.

**Quizzes:** We will have a weekly 10-minute quiz on Friday at the end of lecture. These are mostly meant to test conceptual understanding and ensure you are keeping up with the lecture material and know where you need to put more work. The lowest score will be dropped at the end of the quarter. There will be no makeups AFTER the day of a quiz. If you know you will be absent during a quiz date, it is your responsibility to let me know if you want to make it up *before* (see below).

**Exams:** Midterm exams will be non-cumulative and will roughly cover the material that we went over in lecture since the last midterm (check the schedule). Again, there will be no makeups AFTER the day of an exam. It is your responsibility to let me know if you want to make it up *before* the scheduled date.

**Exams dates:**

> Exam #1 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Fri October 17 (F Week 4)
> Exam #2 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Fri November 14 (F Week 8)
> Final Exam . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Fri December 12 1:10 - 4 PM

Please check, double check and triple check that you don't have any other plans during the specified exam dates. If you do, let me know *as soon as possible*. Makeups will only be considered if they're done **before** the official exam date. There will be no makeups after the scheduled exam date under any circumstances.

**Attendance:** I will not be teaching out of a specific textbook but I will use Hofmann as a rough guideline. This means all the required material for the homeworks, quizzes, and exams will come from what is covered in lecture. This means that attendance (while not mandatory) is very important.

**Academic Honesty:** While working in groups for homework is encouraged, everyone has to turn in their own attempt at a solution. You may also use any resource outside the textbook in order to complete your homework but please make sure you understand what you write down. During tests, cheating will not be tolerated.

**Class Citizenship:** I intend to make our lecture and lab an inclusive and safe space for everyone. Please refrain from doing or saying anything that can be considered offensive to any group of individuals and please respect the identities and space of all of your classmates.

**Accessibility:** If you have a disability that may require a special accommodation please let me know and the Disability Resource Center as soon as possible. You can reach them and browse other resources on their website: http://drc.calpoly.edu/.

**Student Academic Services (SAS):** SAS's mission is to provide access to higher education, facilitate transition to the university environment, and assist in the development of academic and personal skills, thus promoting academic success towards graduation for a diverse student population. Also offers support to students from backgrounds that have been traditionally underrepresented by income and/or disability in the California State University System. The goal of SAS is to ensure that all students at Cal Poly have equal opportunity to achieve academic success and graduation. Contact: Marie St. James, 805-756-2303, mstjames@calpoly.edu Science Bldg 52, Room E7

**Physics Tutoring:** The Cal Poly Writing and Learning Center provides free peer-to-peer tutoring with experienced physics student tutors. For more information visit the Writing and Learning Center webpage or schedule an appointment online at https://calpoly.mywconline.com/

**Private Physics Tutors:** The Cal Poly Physics Department provides this private tutor list as a service to students at all levels in the San Luis Obispo area and does not imply endorsement by the Physics Department or Cal Poly. The tutors listed are current students/employees in good standing with the University.

**Counseling and Psychological Services (CAPS):** Wherever you are in your academic and personal journey, CAPS is here to help you take steps toward emotional health and wellbeing through our clinical, educational, and consultative services. https://chw.calpoly.edu/counseling, 805-756-2511

**Basic Needs Programs:** Cal Poly's Basic Needs programs seek to ensure that all students have access to the resources needed to focus on education and success at Cal Poly. The Basic Needs Initiative is committed to fostering an equitable environment that honors the wellbeing of the Cal Poly community through intentionality and innovation. https://basicneeds.calpoly.edu/

| Week | Topics | Class Event |
|---|---|---|
| 0 (9/19) | ❏ Intro/Review | |
| 1 (9/22-9/26) | ❏ Bravais Lattice<br>❏ Crystal packing & coordination<br>❏ Reciprocal lattice & Brillouin zones | ✍ Quiz 1 on F 9/26 |
| 2 (9/29-10/3) | ❏ Structure Determination<br>❏ Bonding & Mechanics | ➢ HW 1 due F 10/3<br>✍ Quiz 2 on F 10/3 |
| 3 (10/6-10/10) | ❏ Heat capacity: Einstein & Debye<br>❏ 1D toy models (mono- & diatomic chains)<br>❏ Vibrational modes & dispersion relations | ✍ Quiz 3 on F 10/10 |
| 4 (10/13-10/17) | ❏ Drude model: Classical approach<br>❏ Free electron gas | ➢ HW 2 due F 10/17<br>☆ **MT 1 on F 10/17** |
| 5 (10/20-10/24) | ❏ LCAO & Tight binding model<br>❏ Nearly free electron model<br>❏ Periodic potentials & Bloch's theorem | ✍ Quiz 4 on F 10/24 |
| 6 (10/27-10/31) | ❏ Classification of Solids<br>❏ Optical Properties of Solids<br>❏ Effective mass and holes | ➢ HW 3 due F 10/31<br>✍ Quiz 5 on F 10/31 |
| 7 (11/3-11/7) | ❏ Intrinsic semiconductors<br>❏ Finite temperature semiconductors | ✍ Quiz 6 on F 11/7 |
| 8 (11/10-11/14) | ❏ Extrinsic semiconductors: n-type & p-type<br>❏ Doping Effects | ➢ HW 4 due F 11/14<br>☆ **MT 2 on F 11/14** |
| 9 (11/17-11/21) | ❏ p-n junctions<br>❏ Semiconducting devices | ✍ Quiz 7 on F 11/21 |
| Thanksgiving Break 9/24-9/28 | | |
| 10 (12/1-12/5) | ❏ Graphene (if time)<br>❏ Review | ➢ HW 10 due F 12/5 |
| Final Exam: Friday 12/12 1-4pm | | |