Course Title

Physics of Materials (0581-3121)

Lecturer

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Semester

1/2025

Course requirements

This is a third-year undergraduate course designed for a materials science and engineering degree. It is expected that you have been exposed to beginning-level university courses in **general physics, general chemistry, quantum mechanics, and mathematics**. The courses that the Faculty of Engineering demands as prerequisites are obviously **mandatory**.

Final grade components

Attendance: Attendance to class is not mandatory, but you get 10 points per lecture in which you are in class (no points for remote attendance), till a maximum of 100 points. It counts **5%** for your Final Grade if it is higher than your Exam Grade.

Multiple-choice Exam: 95% to **100%** of the Final Grade, depending on your Attendance Grade. Multiple-choice Homework will be provided each week, but it will not directly count for your final grade; however, it is highly recommended to do the Homework for practice towards the Exam.

Course schedule

Module	Subject and Requirements (assignments, reading materials, tasks, etc.)
1	*Everything is Made of Atoms*. We introduce this Course and its main theme through examples of classical models that work: the ideal gas law and the Dulong-Petit law.
2	*Review of the Quantum Mechanics of Atoms*. We review quantum mechanics, focusing first on the the hydrogen atom, and then on the structure of The Periodic Table.
3	*Bonding in Materials*. We analyze the main prototypes of bonding in materials: ionic, van der Waals, metallic, and covalent.
4	*The Atomic Structure of Materials*. We review the different phases in which materials can be found, and we focus our analysis in the description of crystals.
5	*Diffraction*. We discuss the physical principles of the technique that unveiled the atomic structure of crystals.
6	*Crystal Vibrations*. We introduce the physics of thermal atomic vibrations in materials, and we apply it to the study of the heat capacity of solids.
7	*Free Electron Metals*. We show how several properties of metals can be understood if

	we consider that some of their electrons behave like a very special gas.
8	*Energy Bands*. We explain the effect that the periodicity of crystals has on the electronic levels, which are grouped into bands.
9	*Semiconductors*. We learn the fundamentals of semiconductor devices, including intrinsic and extrinsic semiconductors, p–n junctions, and solar cells.
10	*Dielectrics*. We summarize the basics of how dielectrics react to electric fields; we discuss the case of piezoelectrics and ferroelectrics.
11	*Magnetic Properties of Materials*. We review how magnetic fields affect electrons and nuclei in materials, leading to macroscopic magnetic properties.
12	*Optical Properties of Materials*. We review how light affects electrons and nuclei in materials, leading to macroscopic optical properties.
13	*REVIEW*

Required course reading

There will be **Notes** created for this Course (downloadable as pdf files).

Optional course reading

The Course Notes follow in part those of *The Feynman Lectures* (https://www.feynmanlectures.caltech.edu/) that are directly related to materials science.

The level of the course is similar to the level in books such as:

- Electronic Properties of Materials, by Rolf E. Hummel, Springer (2011).
- Introduction to the Electronic Properties of Materials, by David C. Jiles, CRC (2001).

For a more advanced treatment of some of the topics, try these textbooks on solid state physics:

- Solid State Physics, by Neil W. Ashcroft and N. David Mermin, Brooks Cole (1976).
- Introduction to Solid State Physics, by Charles Kittel, Wiley (2004).
- Condensed Matter Physics, by Michael P. Murder, Wiley (2015).

Books that explain in simple language the main ideas in this subject are:

- The Nature of Solids, by Alan Holden, Dover (2011).
- Electronic Structure of Materials, by Adrian P. Sutton, Clarendon (1993).

Comments

This Course is taught in English.

The lecturer plans to **stream** and **record** each lecture.

All the material of this Course will be available in our Moodle page.