Full Syllabus

Course Title

Physics of Materials

Lecturer

Dr Oswaldo Diéguez

Semester

1/2020

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

100% multiple-choice Exam (multiple-choice Homework will be provided each week and graded through Moodle, but it will not directly count for your final grade; however, the Exam questions are variations on the Homework questions, so it is highly recommended to practice with the Homework).

Course schedule

Class no. / Date	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	*SUMMARY*

Required course reading

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

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Optional course reading

If you want to expand your reading beyond our Course Notes, have in mind that those Notes were written in the spirit of those of *The Feynman Lectures* (https://www.feynmanlectures.caltech.edu/) that are directly related to materials science.

If you want to find out more about a particular topic you can consult the following references.

The level of the course is similar to the level in books such as these:
- Electronic Properties of Materials, by Rolf E. Hummel, Springer (2011).
- Introduction to the Electronic Properties of Materials, by David C. Jiles, CRC (2001).

If you get really interested on these topics, and you are looking for a more advance treatment of some of them, you can try upper undergraduate 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.

In 2020/2021 the Course will be taught remotely through a combination of recorded videos on the topics and videoconferencing to answer questions you might have in real time. All the material of this Course (including links to those videos and to zoom virtual rooms) will be available in the Moodle page of the Course: https://moodle.tau.ac.il/course/view.php?id=581312101