# Material physics and technologies

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***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The course will provide students with the conceptual framework to access the realm of novel technologies based on the exploitation of materials properties. A survey of the basic physical properties is provided to help classifying materials according to possible applications. Devices developed on the basis of selected materials will be presented, focusing on working principles and their outcome on the marketplace. In particular, materials related to nanotechnologies will be considered, including smart materials, materials for energy harvesting and generation, materials for ICT, for biomedical applications, and environmental remediation.

At the end of the course, students will be able to:

* Understand the working principles, at the basis of the most important every-day technologies;
* Capture the possible technological impact of the outcomes of fundamental and applied research in the fields of materials science, electronics, optoelectronics, ICT, energy harvesting, optics, nanotechnologies, biomedical;
* Demonstrate operational knowledge in the field of application of innovative and disruptive technologies.

***COURSE CONTENT***

The course will cover the following topics:

*Module 1 (1st quarter)*

1. The structure of matter. Basic physical properties.

2. Reactions, transformations, and phase diagrams.

3. Materials classification: metals and metallic alloys, insulators, semiconductors, polymers, composites.

4. Mechanical, optical, magnetic, thermal and electrical properties of materials

*Module 2 (2nd quarter)*

5. Introduction to semiconductors and electronics

6. Introduction to optics, photonics and lasers

7. Devices and applications: electronic devices, photonics, photovoltaics, energy harvesting, sensing.

8. Nanomaterials, nano- and quantum-technologies.

***READING LIST***

Text book:

W.D. Callister Jr.-D.G. Rethwisch, *Materials Science and Engineering. An Introduction,* John Wiley & Sons, Inc. This text book mainly covers Part 1 to 4 of the program and will be completed by lecture slides (to be downloaded from Blackboard). For Part 5 and 6 additional reading materials will be provided before lectures and will be posted on Blackboard.

***TEACHING METHOD***

The teaching method is mainly based on frontal lectures and case-studies discussions. Expert testimonials on specific subjects will be possibly invited during the course.

***ASSESSMENT METHOD AND CRITERIA***

The final exam will aim to assess the acquired knowledge, in a simple form, of the physical principles behind the many different technologically relevant device/material classes discussed during the course.

The final assessment will be based on a written exams divided into two parts, one for each module. Each of the two parts of the exam will consist in a multiple choice test (13 questions, corresponding to 26/30 maximum marks) and the open discussion of a case-study on a technologically relevant device/material class (4/30 maximum marks), to be chosen among a portfolio of topics previously discussed. The marks obtained in the two parts will be averaged to attribute the final marks, which can range from 18/30 to 30/30. Full marks cum laude will be attributed to outstanding cases in which the student demostrates a clear independence in the application of the concepts learned by presenting the case-study in a personal and original way.

***NOTES AND PREREQUISITES***

Considering the introductory nature of the course, no specific pre-requisites are requested.