Course guides
295914 - FMF - Fundamentals of Functional Materials

Unit in charge: Barcelona East School of Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2021 ECTS Credits: 6.0 Languages: English

LECTURER
Coordinating lecturer: Lloveras Muntane, Pol Marcel
Cazorla Silva, Claudio

Others: Segon quadrimestre:
CLAUDIO CAZORLA SILVA - M10
POL MARCEL LLOVERAS MUNTANE - M10
ROBERTO MACOVEZ - M10

REQUIREMENTS
Students should have attended the courses of Physical Metallurgy, Electric and Magnetic Properties of Materials, Mechanical Properties of Materials, and Optical, Thermal and Acoustic Properties of Materials.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES
Transversal:
02 SCS N3. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 3. Taking social, economic and environmental factors into account in the application of solutions. Undertaking projects that tie in with human development and sustainability.
06 URI N3. EFFECTIVE USE OF INFORMATION RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.
07 AAT N2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

TEACHING METHODOLOGY
Theory classes: the teacher introduces fundamental concepts and few proofs, complementing them with key examples and demonstrations, as well as with the discussion of some applications.
Problem solving and guided activities: the teacher carries out the resolution of representative problems; students review fundamental concepts and solve some problems under the teacher’s supervision.

LEARNING OBJECTIVES OF THE SUBJECT
At the end of the course, the student must be able to:
- describe the fundamentals of functional properties of materials, in particular related to energy, chemistry and biomedicine, and their response to applied external fields.
- possess the capability to approach the conceptual problems underlying current challenges in material science and technology.
## CONTENTS

### Item 1. Physical foundations of the thermal properties of materials

**Description:**
- Topic 1.1 Introduction to statistical physics
- Topic 1.2 Thermal properties of the ideal gas
- Topic 1.3 Thermal properties of crystals

**Full-or-part-time:** 70h  
Theory classes: 28h  
Self study: 42h

### Item 2: Solid-state phase transitions and microstructure

**Description:**
- Topic 2.1 Magnetic domains.
  - Systems of magnetic ions: Classical and quantum paramagnetism. Ferromagnetism. Ising model and micromagnetic theory.
- Topic 2.2 Structural phase transitions and microstructure.
- Topic 2.3 Magnetostructural coupling.
- Topic 2.4 Phase stability.
  - Phase equilibrium. Topological phase diagrams. Applications to pharmaceutical drugs.

**Full-or-part-time:** 28h  
Theory classes: 16h  
Self study: 12h
**Item 3. Microscopic and macroscopic properties of soft matter**

**Description:**
Topic 3.1 Introduction to disorder and molecular degrees of freedom
Orientational and conformational degrees of freedom. Introduction to mesophases. Charge transport, applications to electrochemical devices. Dynamic mechanical analysis and dielectric spectroscopy.

Topic 3.2 Structural and orientational glasses

Topic 3.3 Polymeric materials

Topic 3.4 Liquid crystals and self-assembled phases
Thermotropic liquid crystals, liquid crystal polymers and fibers. Introduction to binary systems. Polymer gels, amphiphilic molecules and block-copolymers: self-assembly, lyotropic liquid crystals. Applications (liquid crystal displays, bulletproof vests, supercapacitors, OLEDs, drug delivery) and biological relevance of organic materials.

**Full-or-part-time:** 40h
Theory classes: 16h
Self study: 24h

**GRADING SYSTEM**

The student's final mark will be calculated as a weighted average of the marks obtained from the resolution guided and autonomous exercises proposed by the instructors during the course. Percentages are:

Resolution of exercises of Item 1: 40%
Resolution of exercises of Item 2: 30%
Resolution of exercises of Item 3: 30%

**BIBLIOGRAPHY**

**Basic:**

**Complementary:**
RESOURCES

Other resources:
During the course, the teachers will provide students with study material and sometimes recommend material available online, both from general sources such as Wikipedia or from specific websites such as that of the research group of the instructors (https://gcm.upc.edu/en).