

# Course guide

## 330511 - MATER - Materials

Last modified: 04/05/2023

**Unit in charge:** Manresa School of Engineering  
**Teaching unit:** 750 - EMIT - Department of Mining, Industrial and ICT Engineering.

**Degree:** BACHELOR'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Compulsory subject).

**Academic year:** 2023    **ECTS Credits:** 6.0    **Languages:** English

### LECTURER

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**Coordinating lecturer:** Casellas Padro, Daniel

**Others:** Soler Conde, Marc Antoni

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

CE8. Knowledge of the fundamentals of science, technology and materials chemistry. Understand the relationship between microstructure, synthesis or processing and properties of materials.

CE13. Knowledge and application of production and manufacturing systems.

**Generical:**

CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.

CG4. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and skills in the field of automotive engineering.

CG7. A capacity for analysing and assessing the social and environmental impact of technical solutions.

**Transversal:**

1. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.

2. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.

**Basic:**

CB3. That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

### TEACHING METHODOLOGY

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MD1 Master class or lecture (EXP)

MD2 Problem solving and case study (RP)

MD3 Practical work in laboratory or workshop (TP)

MD5 Small-scale project, activity or assignment (PR)

MD7 Assessment activities (EV)

### LEARNING OBJECTIVES OF THE SUBJECT

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On completing the subject, students will have knowledge and understanding of the following:

- Materials classification and behaviour.
- Influence factors on materials.
- Selection criteria.



## STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Self study	90,0	60.00
Hours large group	45,0	30.00

**Total learning time:** 150 h

## CONTENTS

### Topic 1: Structure of materials

**Description:**

Atoms, bonds and materials.  
Structure of materials.

**Specific objectives:**

On completing the subject, students will have knowledge and understanding of the following:

Crystalline and amorphous materials.  
Polymorphism and isomorphism.  
Crystalline defects.  
Grain index and size.  
The relationship between crystalline defects and properties.  
The relationship between crystalline defects and alloys.

**Related activities:**

Activity 3: Microscopy and metallography practice.

**Full-or-part-time:** 10h

Theory classes: 3h  
Laboratory classes: 1h  
Self study : 6h



## Topic 2: Heat treatments

### Description:

Diffusion.  
Phase diagrams.  
Heat treatments.

### Specific objectives:

On completing the subject, students will have knowledge and understanding of the following:

Diffusion mechanisms.  
Fick diffusion laws.  
Applied diffusion processes.  
Phase diagrams.  
Annealing, quenching, tempering and precipitation hardening treatments.  
CCT and TTT diagrams.

### Related activities:

Activity 3: Microscopy and metallography practice.  
Activity 5: Practice heat treatments.

### Full-or-part-time: 18h

Theory classes: 6h  
Laboratory classes: 2h  
Self study : 10h

## Topic 3: Mechanical properties

### Description:

Properties obtained from the following:

Tensile tests.  
Fatigue tests.  
Hardness tests.  
Creep and relaxation tests.  
Wear tests.

### Specific objectives:

On completing the subject, students will have knowledge and understanding of the following:

Tensile tests: stress-strain curves, elastic modulus, yield strength, Poisson ratio, elongation, area reduction, Hollomon model of strain-hardening, anisotropy coefficient.  
Hardness: Brinell, Vickers and Rockwell scales.  
Fracture toughness, critical stress, and critical cracking.  
Fatigue: stress amplitude, mean stress, endurance limit.  
Creep, evolution of curves.

### Related activities:

Activity 4: Practice mechanical tests.

### Full-or-part-time: 23h

Theory classes: 6h  
Laboratory classes: 3h  
Self study : 14h

#### Topic 4: Electrical and chemical properties of materials

**Description:**

Dielectric, semiconductor and conductor materials.  
Other electrical properties: piezoelectricity, thermocouples, etc.  
Corrosion and corrosion protection.

**Specific objectives:**

On completing the subject, students will have knowledge and understanding of the following:

Electrical conductivity, electrical behaviour of materials.  
Electrochemical corrosion cells.  
Cathode and anode corrosion reactions.  
Corrosion protection strategies.

**Related activities:**

Activity 6: Practice corrosion.

**Full-or-part-time:** 17h

Theory classes: 5h  
Laboratory classes: 2h  
Self study : 10h

#### Topic 5: Metals

**Description:**

Ferrous metals: steels and cast iron.  
Non-ferrous metals: aluminium, copper, titanium and alloys.

**Specific objectives:**

On completing the subject, students will have knowledge and understanding of the following:

Metal classification by microstructure, composition and behaviour.  
Relationship between properties, structure and treatments of alloys.

**Related activities:**

Activity 4: Practice mechanical tests.  
Activity 3: Microscopy and metallography practice.

**Full-or-part-time:** 13h

Theory classes: 4h  
Laboratory classes: 1h  
Self study : 8h



### Topic 6: Non-metallic materials

**Description:**

Polymers: thermoplastics, thermosets and elastomers.  
Ceramic materials.  
Particles, fibre and ?sandwich? composites.

**Specific objectives:**

On completing the subject, students will have knowledge and understanding of the following:

Applications, advantages and disadvantages of polymeric, ceramic and composite materials.  
Amorphous and crystalline structure of ceramic and polymeric materials  
Design of simple fibre-reinforced composites.

**Related activities:**

Actividad 4: Práctica ensayos mecánicos.

**Full-or-part-time:** 14h

Theory classes: 6h  
Laboratory classes: 2h  
Self study : 6h

### Topic 7: Selection of materials

**Description:**

Selection of materials.

**Specific objectives:**

On completing the subject, students will have knowledge and understanding of the following:

Resolution of simple material selection problems using property maps.

**Related activities:**

Activity 2: Practice simulation.

**Full-or-part-time:** 10h

Laboratory classes: 4h  
Self study : 6h



## ACTIVITIES

### Activity 1: Finite element simulation

**Description:**

Lab

**Specific objectives:**

On completing the activity students will have knowledge and understanding of the following:

- Use finite elements software.
- Results interpretation of F.E.M. software.

**Delivery:**

Report.

**Full-or-part-time:** 7h

Laboratory classes: 2h

Self study: 5h

### Activity 2: Metallography

**Description:**

Lab

**Specific objectives:**

On completing the activity students will have knowledge and understanding of the following:

- Use the metallographic microscope.
- Microstructures identification.
- Grain size determination.

**Delivery:**

Report.

**Full-or-part-time:** 8h

Laboratory classes: 2h

Self study: 6h

### Activity 3: Mechanical tests

**Description:**

Lab

**Specific objectives:**

On completing the activity students will have knowledge and understanding of the following:

- Tensile test results determination.
- Hardness test.
- Impact test.

**Delivery:**

Report.

**Full-or-part-time:** 8h

Laboratory classes: 2h

Self study: 6h



#### Activity 4: Heat treatments

**Description:**

Lab

**Specific objectives:**

On completing the activity students will have knowledge and understanding of the following:

- Sample preparation for microstructural study.
- Heat treatment process.
- Microstructure and properties obtained from a heat treatment.

**Delivery:**

Report.

**Full-or-part-time:** 8h

Laboratory classes: 2h

Self study: 6h

#### Activity 5: Corrosion

**Description:**

Lab

**Specific objectives:**

At the end of the practice the student will be able to:

- Determine a galvanic series.
- Classify a corrosion cell.
- Calculate the theoretical weight of an electrolytic coating and the performance of a practical case.
- Calculate the corrosion rate from Faraday's law.
- Calculate a cathodic protection system.

**Delivery:**

Report.

**Full-or-part-time:** 5h

Laboratory classes: 2h

Self study: 3h

#### Activity 6: Materials selection techniques

**Description:**

Lab

**Specific objectives:**

On completing the activity students will have knowledge and understanding of the following:

- Materials selection techniques

**Delivery:**

Report.

**Full-or-part-time:** 5h

Laboratory classes: 2h

Self study: 3h



## GRADING SYSTEM

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Exams 80%  
Activities 20%

## EXAMINATION RULES.

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The activities are individual except those that are clearly specified as a group activity.  
All reports must be delivered in the ISO 9000 format.  
All reports must be original, and external information must be correctly cited.

## BIBLIOGRAPHY

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### Basic:

- Callister, William D.; Rethwisch, David G. Ciencia e ingeniería de los materiales [on line]. 2ª ed. Barcelona: Reverté, 2016  
[ Consultation : 10/06/2022 ]. Available on :  
[https://search-ebshost-com.recursos.biblioteca.upc.edu/login.aspx?direct=true&AuthType=ip,uid&db=nlebk&AN=2616389&site=ehost-live&ebv=EB&ppid=pp\\_a](https://search-ebshost-com.recursos.biblioteca.upc.edu/login.aspx?direct=true&AuthType=ip,uid&db=nlebk&AN=2616389&site=ehost-live&ebv=EB&ppid=pp_a). ISBN 9788429172515.

### Complementary:

- Smith, William F.; Hashemi, Javad. Fundamentos de la ciencia e ingeniería de materiales [on line]. 5ª ed. México: McGraw-Hill, 2014  
[ Consultation : 07/06/2022 ]. Available on :  
[https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=5732](https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=5732). ISBN 9786071511522.

- Askeland, Donald R.; Wright, Wendelin J. Ciencia e ingeniería de los materiales. 7a ed. México: Cengage Learning, 2021. ISBN 9786075260624.

- Shackelford, James F. Introducción a la ciencia de materiales para ingenieros [on line]. 7ª ed. Madrid: Pearson Educación, 2010  
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