Course guide
330511 - MATER - Materials

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: 2022 ECTS Credits: 6.0 Languages: English

LECTURER
Coordinating lecturer: Casellas Padro, Daniel
Others: Soler Conde, Marc Antoni

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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
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
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

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>90.0</td>
<td>60.00</td>
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<tr>
<td>Hours small group</td>
<td>15.0</td>
<td>10.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>45.0</td>
<td>30.00</td>
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</table>

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.
- 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
<table>
<thead>
<tr>
<th>Topic 4: Electrical and chemical properties of materials</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Dielectric, semiconductor and conductor materials.</td>
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<tr>
<td>Other electrical properties: piezoelectricity, thermocouples, etc.</td>
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<tr>
<td>Corrosion and corrosion protection.</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
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<tr>
<td>On completing the subject, students will have knowledge and understanding of the following:</td>
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<tr>
<td>Electrical conductivity, electrical behaviour of materials.</td>
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<td>Electrochemical corrosion cells.</td>
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<td>Cathode and anode corrosion reactions.</td>
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<td>Corrosion protection strategies.</td>
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<tr>
<td><strong>Related activities:</strong></td>
</tr>
<tr>
<td>Activity 6: Practice corrosion.</td>
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<tr>
<td><strong>Full-or-part-time:</strong></td>
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<tr>
<td>17h</td>
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<tr>
<td>Theory classes: 5h</td>
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<tr>
<td>Laboratory classes: 2h</td>
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<td>Self study : 10h</td>
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<tr>
<th>Topic 5: Metals</th>
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<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Ferrous metals: steels and cast iron.</td>
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<tr>
<td>Non-ferrous metals: aluminium, copper, titanium and alloys.</td>
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<td><strong>Specific objectives:</strong></td>
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<tr>
<td>On completing the subject, students will have knowledge and understanding of the following:</td>
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<tr>
<td>Metal classification by microstructure, composition and behaviour.</td>
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<td>Relationship between properties, structure and treatments of alloys.</td>
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<td><strong>Related activities:</strong></td>
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<tr>
<td>Activity 4: Practice mechanical tests.</td>
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<tr>
<td>Activity 3: Microscopy and metallography practice.</td>
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<tr>
<td><strong>Full-or-part-time:</strong></td>
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<tr>
<td>13h</td>
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<tr>
<td>Theory classes: 4h</td>
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<tr>
<td>Laboratory classes: 1h</td>
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<td>Self study : 8h</td>
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**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
Exams 80%
Activities 20%

EXAMINATION RULES.
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

Basic:

Complementary: