330511 - MATER - Materials

Coordinating unit: 330 - EPSEM - Manresa School of Engineering
Teaching unit: 750 - EMIT - Department of Mining, Industrial and ICT Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Teaching unit Compulsory)
ECTS credits: 6

Teaching staff
Coordinator: Casellas Padro, Daniel
Others: Soler Conde, Marc Antoni

Degree competences to which the subject contributes

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.

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.

General:
- 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.

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></th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total learning time:</td>
<td>150h</td>
<td></td>
</tr>
<tr>
<td>Hours large group:</td>
<td>45h</td>
<td>30.00%</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
### Content

<table>
<thead>
<tr>
<th>Topic 1: Structure of materials</th>
<th>Learning time: 10h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td>Atoms, bonds and materials.</td>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>Structure of materials.</td>
<td>Self study : 6h</td>
</tr>
</tbody>
</table>

| 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. | |

<table>
<thead>
<tr>
<th>Topic 2: Heat treatments</th>
<th>Learning time: 18h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Diffusion.</td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Phase diagrams.</td>
<td>Self study : 10h</td>
</tr>
<tr>
<td>Heat treatments.</td>
<td></td>
</tr>
</tbody>
</table>

| Related activities: | |
| Activities 3 and 5. | |

| 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. | |
## Topic 3: Mechanical properties

**Description:**
Properties obtained from the following:

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

**Related activities:**
Activity 4

**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.

**Learning time:** 23h
- Theory classes: 6h
- Laboratory classes: 3h
- Self study: 14h
### Topic 4: Electrical and chemical properties of materials

**Learning time:** 17h  
Theory classes: 5h  
Laboratory classes: 2h  
Self study: 10h

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

**Related activities:**  
Activity 6.

**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.

### Topic 5: Metals

**Learning time:** 13h  
Theory classes: 4h  
Laboratory classes: 1h  
Self study: 8h

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

**Related activities:**  
Activity 4.  
Activity 3.

**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.
### Topic 6: Non-metallic materials

**Description:**
- Polymers: thermoplastics, thermosets and elastomers.
- Ceramic materials.
- Particles, fibre and "sandwich" composites.

**Related activities:**
- Activity 4.

**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.

**Learning time:** 14h
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 6h

### Topic 7: Selection of materials

**Description:**
- Selection of materials.

**Related activities:**
- Activity 2.

**Specific objectives:**
- On completing the subject, students will have knowledge and understanding of the following:
  - Resolution of simple material selection problems using property maps.

**Learning time:** 10h
- Laboratory classes: 4h
- Self study: 6h
# Planning of activities

<table>
<thead>
<tr>
<th>Activity 1: Finite element simulation</th>
<th>Hours: 7h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 5h</td>
</tr>
</tbody>
</table>

**Description:**
Lab

**Descriptions of the assignments due and their relation to the assessment:**
Report.

**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.

<table>
<thead>
<tr>
<th>Activity 2: Metallography</th>
<th>Hours: 8h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 6h</td>
</tr>
</tbody>
</table>

**Description:**
Lab

**Descriptions of the assignments due and their relation to the assessment:**
Report.

**Specific objectives:**
On completing the activity students will have knowledge and understanding of the following:
- Use the metallographic microscope.
- Microstructures identification.
- Grain size determination.

<table>
<thead>
<tr>
<th>Activity 3: Mechanical tests</th>
<th>Hours: 8h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 6h</td>
</tr>
</tbody>
</table>

**Description:**
Lab

**Descriptions of the assignments due and their relation to the assessment:**
Report.

**Specific objectives:**
On completing the activity students will have knowledge and understanding of the following:
- Tensile test results determination.
- Hardness test.
- Impact test.
### Activity 4: Heat treatments

**Description:**
Lab

**Descriptions of the assignments due and their relation to the assessment:**
Report.

**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.

**Hours:** 8h  
Laboratory classes: 2h  
Self study: 6h

### Activity 5: Corrosion

**Description:**
Lab

**Descriptions of the assignments due and their relation to the assessment:**
Report.

**Specific objectives:**
On completing the activity students will have knowledge and understanding of the following:
- Galvanic series determination.
- Electrolytic coating elaboration and performance calculation.
- Cathodic protections systems.

**Hours:** 5h  
Laboratory classes: 2h  
Self study: 3h

### Activity 6: Materials selection tecniques

**Description:**
Lab

**Descriptions of the assignments due and their relation to the assessment:**
Report.

**Specific objectives:**
On completing the activity students will have knowledge and understanding of the following:
- Materials selection tecniques

**Hours:** 5h  
Laboratory classes: 2h  
Self study: 3h
Qualification system

Exams 80%
Activities 20%

Regulations for carrying out activities

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:


Others resources: