**240EM011 - Mechanical and Rheological Performance of Materials**

**Coordinating unit:** 295 - EEBE - Barcelona East School of Engineering  
**Teaching unit:** 702 - CMEM - Department of Materials Science and Metallurgy  
**Academic year:** 2018  
**Degree:** MASTER'S DEGREE IN MATERIALS SCIENCE AND ENGINEERING (Syllabus 2014). (Teaching unit Compulsory)  
**ECTS credits:** 4,5  
**Teaching languages:** Spanish  

**Teaching staff**  
**Coordinator:** Jorge Alcalá  
**Others:** Jorge Alcalá y Orlando Santana  

**Prior skills**  
A basic knowledge is required on Mechanical Design and Elasticity.

**Degree competences to which the subject contributes**

**Specific:**  
CEMCEM-01. (ENG) Aplicar coneixements de matemàtiques, física, química, biologia i altres ciències naturals, obtinguts mitjançant estudi, experiència i, pràctica, amb raonament crític per a establir solucions viablies a problemes tècnics  
CEMCEM-04. (ENG) Realitzar estudis de caracterització, avaluació i certificació de materials segons les seves aplicacions

**Transversal:**  
06 URI N1. EFFECTIVE USE OF INFORMATION RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.

**Learning objectives of the subject**

The mechanical behavior of materials subjected to elastic and plastic deformations is studied. General concepts of continuum mechanics are introduced with the purpose of understanding mechanical responses from nano to micro to macroscopic scales. Metal plasticity is studied based on a fundamental background to the glide and interaction of linear crystalline defects (dislocations). The approach provides a solid mechanical background to assess elasto-plastic deformations of structures based on a basic knowledge of mechanics of materials. Viscous deformation in polymers is finally studied.

The course is structured in the following sections:  
(i) Overview of mechanical properties as measured in uniaxial tests. Elastic and plastic responses of materials are
covered.

(ii) Introduction to Continuum Mechanics: Main concepts in solid mechanics are studied in conjunction with elasticity theory. This discipline is applied to nano, micro and macroscopic material scales. An introduction is given to yield surfaces and continuum plasticity theory.

(iii) Micromechanics of plasticity in metals: Dislocation gliding and dislocation interaction at the atomic scale are discussed. Tools from continuum mechanics are employed to describe these phenomena. The influence of crystalline structure and chemical composition on dislocation glide and interaction is studied.

(iv) Viscoelasticity.

<table>
<thead>
<tr>
<th>Study load</th>
<th>Total learning time: 112h 30m</th>
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</thead>
<tbody>
<tr>
<td>Hours large group:</td>
<td>25h 52,2m</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
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<tr>
<td>Hours small group:</td>
<td>12h 22,8m</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
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<tr>
<td>Self study:</td>
<td>74h 15m</td>
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## Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Learning time:</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>1. INTRODUCTION (6h)</strong></td>
<td>6h</td>
<td>Mechanical behavior of materials and the assessment of elastic and plastic responses through uniaxial testing.</td>
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<tr>
<td><strong>2. SOLID MECHANICS, ELASTICITY THEORY, PLASTICITY THEORY (18h)</strong></td>
<td>18h</td>
<td>Stress tensor and deformation tensor. Traction in a crystalline plane. Linear elasticity and elastic anisotropy of single crystals. Einstein and dyadic notations in elasticity theory. Invariants of the stress tensor, pressure and stress deviator. Yield surfaces and their application to different materials. Dilatant and non-dilatant plasticities.</td>
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Qualification system

\[ NF = (0.4 \cdot EP1 + 0.3 \cdot EP2 + 0.3 \cdot EP3) \cdot 0.7 + NAC \cdot 0.3 \]

EP1 = Examen Parcial 1
EP2 = Examen Parcial 2
EP3 = Examen Parcial 3
AA = Anàlisi d'un article científic
T = Treball monogràfic d'aspectes específics del tema: Mecanismes de plasticitat de metalls (20%)
NAC = Nota d'Avaluació continuada

The curse will be graded in accordance with the following.

\[ NAC = AA \cdot 0.35 + TM \cdot 0.65 \]

If \((0.4 \cdot EP1 + 0.3 \cdot EP2 + 0.3 \cdot EP3) < 5.0\), a final exam is compulsory. In this event, the final grade is computed as:

\[ NF = EF \times 0.7 + NAC \times 0.3 \]

A "recovery" exam will be made for students whose NF < 5. In this case, the value of this exam will substitute for NF in the above calculation.

Bibliography