Course guide
240EM011 - 240EM011 - Mechanical and Rheological Performance of Materials

Last modified: 14/06/2023

Unit in charge: Barcelona East School of Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: **Academic year:** 2023 **ECTS Credits:** 4.5
Languages: Spanish

LECTURER

Coordinating lecturer: EMILIO JIMENEZ PIQUÉ - ORLANDO ONOFRE SANTANA PEREZ

Others: EMILIO JIMENEZ PIQUÉ - ORLANDO ONOFRE SANTANA PEREZ

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, experiènciea i, pràctica, amb raonament crític per a establir solucions viables 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 INFORMATI0N 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.

TEACHING METHODOLOGY

Subject in process of extinction. There is no teaching, the students that enroll it do so only with the right to an exam.

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.

STUDY LOAD

Type	Hours	Percentage
Self study	74,3	65.99
Hours small group	12,4	11.01
Hours large group	25,9	23.00

Total learning time: 112.6 h

CONTENTS

1. INTRODUCTION (6h)

Description:
Mechanical behavior of materials and the assessment of elastic and plastic responses through uniaxial testing.

Full-or-part-time: 6h
Theory classes: 6h

2.- SOLID MECHANICS, ELASTICITY THEORY, PLASTICITY THEORY (18h)

Description:
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.

Full-or-part-time: 18h
Theory classes: 18h

3.- MICROMECHANICS AND PLASTICITY IN SINGLE CRYSTALS (12h)

Description:
Introduction to dislocations and to dislocation gliding. Stress fields around dislocation. Elastic energy around a dislocation and dislocation interactions. Compact planes and computation of the resolved shear stress from the applied traction in a crystalline plane. Schmid?s law. Deformation in local scales: dislocation interaction, strain hardening and dislocation nucleation. The model of the line tension and forest hardening. Stacking fault energy and dislocation dissociation. Stress?strain curves in single crystals (Stages I, II and III). Influence of crystalline structure and chemical composition. Crystalline rotation.

Full-or-part-time: 12h
Theory classes: 12h

4.- LINEAR VISCOELASTIC BEHAVIOR (6h)

Description:
Creep. Stress relaxation. Boltzman?s superposition principle. Formal relation between creep and stress relaxation. Mechanical models. Creep- and relaxation time spectra. Dynamic mechanical measurements: complex module and complex flexibility. Relations between complex moduli and stress relaxation.

Full-or-part-time: 6h
Theory classes: 6h

GRADING SYSTEM

Subject in process of extinction. There is only one final test that corresponds to 100% of the final grade of the subject.