# Course guides
# 295710 - PME - Mechanical Propieties of Materials

**Last modified:** 19/06/2020

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

**Degree:** BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Compulsory subject).

**Academic year:** 2020 **ECTS Credits:** 6.0 **Languages:** Spanish

## LECTURER

**Coordinating lecturer:** ORLANDO ONOFRE SANTANA PEREZ

**Others:**

Primer quadrimestre:
FERHUN CEM CANER - M21
VIOLETA DEL VALLE GARCÍA MASABET - M21
MAGALI KLOTZ - M21
LUIS MIGUEL LLANES PITARCH - M21
ERICA ROITERO - M21
ORLANDO ONOFRE SANTANA PEREZ - M21

Segon quadrimestre:
FERHUN CEM CANER - M21
VIOLETA DEL VALLE GARCÍA MASABET - M21
MAGALI KLOTZ - M21
LUIS MIGUEL LLANES PITARCH - M21
ERICA ROITERO - M21
ORLANDO ONOFRE SANTANA PEREZ - M21

## PRIOR SKILLS

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

**Specific:**
CE9. Knowledge of science, technology and materials' chemistry fundaments. Understanding the relation between microstructure, synthesis or processing and materials' properties.
CEM1. Knowledge on several types of materials' structure, as well as analysis characterisation and techniques of materials.
CEMT-20. Knowledge of the mechanical, electronic, chemical and biological behaviour of materials, and the ability to apply it in designing, calculating and modelling aspects of elements, components and equipment.

**Transversal:**
04 COE N2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

## TEACHING METHODOLOGY

Lectures on theoretical and problem-solving issues are given thorughout the course. Evaluation is done on the basis of written exams and oral presentations of proposed activities.

## LEARNING OBJECTIVES OF THE SUBJECT

The main objective of the course is that student understands the importance of structure - mechanical property correlation in the material selection process regarding structural applications, according to service conditions requirements. In doing so, basic concepts are given on mechanical response of materials, elastic deformation and plasticity, strengthening mechanisms, fracture, fatigue, and enviromental effects. In all the cases special emphasis is done on critical design parameters and selection of specific materials for each service condition.

## STUDY LOAD

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

**Total learning time:** 150 h

## CONTENTS

### 1. Introduction

**Description:**
Introduction: mechanical integrity, durability and reliability issues in structural applications. Mechanical response of structural materials: basic concepts of elasticity and plasticity.

**Full-or-part-time:** 8h
Theory classes: 3h
Practical classes: 1h
Self study : 4h

### 2. Deformation of materials

**Description:**
Theory of dislocations. Plastic deformation of single-crystals and poly-crystals. Mechanisms of deformation. Strengthening mechanisms: solid solution, aging, cold work, microstructural refinement, reinforcement through second phases (particles, fibers)

**Full-or-part-time:** 24h
Theory classes: 6h
Practical classes: 4h
Guided activities: 2h
Self study : 12h

### 3. Fracture of materials

**Description:**
Fracture of materials. Types of fracture. Fractography. Fracture mechanics. Stress intensity factor. Fracture toughness. Evaluation of fracture toughness. Microstructural effects.

**Full-or-part-time:** 28h
Theory classes: 8h
Practical classes: 4h
Laboratory classes: 2h
Self study : 14h

### 4. Fatigue of materials

**Description:**
Fatigue. Cyclic deformation and crack nucleation. Fatigue crack propagation. Design criteria against fatigue

**Full-or-part-time:** 28h
Theory classes: 8h
Practical classes: 4h
Laboratory classes: 2h
Self study : 14h

### 5. Enviromental effects on the mechanical response of materials

**Description:**
Environmental assisted cracking. Corrosión fatigue. Case studies.

**Full-or-part-time:** 12h
Theory classes: 2h
Practical classes: 2h
Guided activities: 2h
Self study : 6h

### 6. Mechanical properties and fracture behavior of polymers and composites

**Description:**
Mechanisms of plastic deformation in polymers. Curves stress - strain and relation with polymer's structure. Viscoelasticity in polymers. Impact testing of polymers. Fracture mechanics applied to polymers. Mechanical properties of polymer-matrix composites.

**Full-or-part-time:** 20h
Theory classes: 6h
Practical classes: 2h
Laboratory classes: 2h
Self study : 10h

## GRADING SYSTEM

50% Final Exam + 30% Short (midterm) Tests + 10% Lab Reports + 10% Guided Activities.
If mean qualification of short tests is above 5, final exam becomes optional.
In case the student fails the course, it is possible to do a re-assessment test, in a date fixed by the School (July). The students will be able to access the re-assessment test that meets the requirements set by the EEBE in its Assessment and Permanence Regulations (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf)

The re-assessment grade will be calculated as follows
NF= 80% Re-assessment test + 10% Lab Reports + 10% Guided Activities.
Qualifications for Lab Reports and Guided Activities will be those obtained during the regular course.

## BIBLIOGRAPHY

**Basic:**
- Ward, IM ; Sweeney, J. An introduction to the mechanical properties of solid polymers. 2nd ed. Chichester: John Wiley & Sons, cop. 2004. ISBN 047149626X.
- Suresh S. Fatigue of materials. 2nd ed. Cambridge: Press Syndicate of the University of Cambridge, 1998. ISBN 0521578477.
- Alcalá, J. ; Llanes, L. M. ; Mateo, A. M. ; Salán, M. N. ; Anglada, Marc. Fractura de materiales [on line]. Barcelona: Edicions UPC, 2002 [Consultation: 09/06/2020]. Available on: http://hdl.handle.net/2099.3/36175. ISBN 8483015927.
- Dieter, GE ; Bacon, D. Mechanical metallurgy. SI Metri ed. / adapted by David Bacon. London: McGraw-Hill Book Company, cop. 1988. ISBN 0071004068.
- Hertzberg, Richard W. Deformation and fracture mechanics of engineering materials. 5th ed. New York: John Wiley & Sons, cop. 2013. ISBN 9780470527801.

**Complementary:**
- Young, Robert Joseph; Lovell, P. A. Introduction to polymers [on line]. 3rd ed. Boca Raton: CRC Press, cop. 2011 [Consultation: 09/06/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1460729. ISBN 9780849339295.
- Meyers, M. A. ; Armstrong, R. W. Mechanics and materials: fundamentals and linkages. New York: John Wiley & Sons, 1999. ISBN 0471243175.
- With, Gijsbertus de. Structure, deformation, and integrity of materials. Weinheim: Wiley-VCH, cop. 2006. ISBN 3527314261.
- McCrum, N.G. ; Buckley, C.P. ; Bucknall, C.B. Principles of polymer engineering. 2nd ed. Oxford, [etc.]: Oxford University Press, 1997. ISBN 0198565267.

## RESOURCES

**Other resources:**
Material docente disponible en ATENEA