

66424 - Deformation and Fracture of Engineering Materials

Syllabus Information

Academic year: 2023/24

Subject: 66424 - Deformation and Fracture of Engineering Materials

Faculty / School: 110 - Escuela de Ingeniería y Arquitectura

Degree: 536 - Master's in Mechanical Engineering

ECTS: 6.0

Year: 1

Semester: First semester

Subject type: Compulsory

Module:

1. General information

Objectives of the subject

The objective of the subject is for the student to become aware of the importance of knowing the different mechanical properties of materials based on the type of material and its microstructure. It is also important that the student knows the different mechanical tests and becomes familiar with the standards that are used. Another goal is for the student to understand the concepts of fracture mechanics so that they can identify the mechanisms of mechanical failure and understand the limitations of materials under different mechanical stresses. Likewise, the student has to learn the mathematical formalism that allows to incorporate the constitutive equations of the material behaviour in the computational simulation of the different behaviours in the elastic and plastic regime.

Sustainable Development Goals of the 2030 Agenda (<https://www.un.org/sustainabledevelopment/es/>): Goal 9: Objective 9.1; Goal 12: Objective 12.5

Recommendations to take the subject.

It is important to have knowledge of the subjects Fundamentals of Materials Engineering and Materials Technology taught in undergraduate studies.

2. Learning results

1. To understand the mechanical behaviour of metallic, ceramic, polymer and composite materials under various mechanical stresses.
2. To know and apply the theory of fracture and fatigue of materials.
3. To relate the mechanical behaviour of materials to their microstructural aspects.
4. To know the tests that characterize them and the mathematical formalism that allows to incorporate them into design and mechanical calculation.
5. To identify and solve problems by applying acquired knowledge.

3. Syllabus

Block 1. Deformation of materials for engineering.

1. Material behaviour for mechanical design
2. Mechanical tests and their standards: tensile, compression, bending and torsion tests. Experimental elements and conditions
3. Elastic behaviour: elasticity in metals and ceramics, non-linear elasticity in elastomers, viscoelasticity in polymers, superelasticity in shape memory materials.
4. Permanent deformation: plasticity and superplasticity in metals. Plasticity in polymers. Thermofluence.

Block 2: fracture of materials for engineering.

1. Fracture and fatigue: fundamentals of fracture mechanics, brittle and ductile fracture. Fatigue. Thermal creep fracture. Fatigue corrosion, stress corrosion. Wear.
2. Essays on fracture mechanics. Fatigue tests of nucleation and crack growth. Stress corrosion tests. Tribological essays.

Block 3: computational techniques.

1. Computer simulation of material behaviour through the constitutive laws of materials, such as the viscoelastic behaviour of elastomers or the plastic deformation of metals.

4. Academic activities

- Master classes and problems. 45 hours. 30 hours of master classes and 15 hours of problem solving.
- Laboratory practices. Each student will perform six practices with a total of 12 hours.
- Completion of practical work (20 hours of personal work). The student will have to carry out a project throughout the subject. It will be related to the mechanical properties of materials and their characterization.
- Tutoring. Personalized tutored sessions to review and discuss the materials and topics presented in both theoretical and practical classes, as well as to solve the doubts that may have arisen in the development of the work.
- Personal work (62 hours). In order for students to have a tool to monitor their progress and know if they are achieving the objectives of the subject, they must regularly submit solved exercises.
- Evaluation (6 hours). Set of theoretical-practical written tests and presentation of reports or works used in the evaluation of the student's learning process.

5. Assessment system

The student must demonstrate achievement of the intended learning results through the following **continuous assessment** activities:

E1: Controls (maximum 5 points in the final grade). There will be five tests throughout the term in which some theoretical-practical issues must be solved.

E2: Exercises (maximum 1.5 points in the final grade). Each week students will be proposed to work on a problem related to the concepts covered that week, which they must submit before the following week's sessions.

E3: Tutored works (maximum 1.5 points in the final grade). The objective of these works is to perform a critical analysis of scientific publications related to some of the topics covered in the subject. A joint presentation will be held at the end of the term. The evaluation will take into account the analysis of the solution proposed in the publication, as well as the quality of the oral presentation.

E4: Laboratory practices (maximum 2 points in the final grade). The evaluation of the practices will be carried out through the reports prepared and the analysis of the results obtained in them.

The student must obtain a minimum total grade of 4 out of 10 in each of the four previous sections in order to average according to the proposed weighting.

Alternatively, the student has the possibility of passing the subject through the **global evaluation** in the official calls. The evaluation will consist of two parts, a global exam (maximum of 8 points in the final grade) and a practical exam (maximum of 2 points in the final grade) and will be carried out on the dates established by the centre. The practical exam will in turn consist of two parts: a written exam and a practical laboratory exam. It will be necessary to obtain a grade higher than 4 in each of the two parts in order to average. Given that laboratory practices are considered essential, if these are performed and passed, the grade obtained will be valid for the overall evaluation.