Grado en Ingeniería de Materiales

Department (School) / Departamento (Escuela)
Departamento de Ciencia de Materiales (ETSI Caminos Canales y Puertos)

Asignatura / Subject
Mecánica de Materiales III
Mechanics of Materials III

ECTS	Type	Curso / Semestre	Idioma	Sylabus code	Subject Code
6	Compulsory	3 / 5	EN	04MI	45000120

Lecturers (Name)	Contact email	Office hours (Tutorials)
Francisco Gálvez	f.galvez@upm.es	Tuesday and Thursday 10-00 – 12:00
Jesús Ruiz Hervías	jt@mater.upm.es	Tuesday and Thursday 10-00 – 12:00
Rafael Sancho Cadenas	rafael.sancho@upm.es	Tuesday and Thursday 10-00 – 12:00
Mikko Hokka	(Invited lecturer)	

El profesor que aparece en primer lugar es el coordinador de la asignatura

Criterio de evaluación

Continuum assessment.

Consists of two partial exams and three simulation exercises. If the student has taken part in any of the partial exams and/or simulation exercises, it is assumed that the continuum assessment method is the one chosen by the student. The mark is obtained from:

First Partial Exam (P1). Covers the general theories of the subject and practical exercises are to be solved. Additionally theoretical questions covering the theory could be included.

Second Partial Exam (P2). Covers the applications of the subject and includes practical exercises to be solved. Additionally theoretical questions covering the lectures could be included.

Three exercises of simulation are proposed during the period, and assessment range for each goes from 0 to 10 being the corresponding marks S1, S2 and S3. Each exercise has a weigh of 1/3, and the final simulation mark is computed by the following expression: S=(S1+S2+S3)/3

The final mark for the subject is computed following the following expression: CA=0.2*S+0.8*√(P1*P2)

Regular Exam (January). Covers the whole subject and only practical exercises are to be solved, giving a mark called “Jan” ranging from 0 to 10. Additionally, theoretical questions covering the subject could be included. There just one opportunity at the end of the course (January). The marks obtained from the partial exams could be considered here just to improve the mark. The final mark is computed through RE=0.2*S+0.8*Jan

The final mark will be the maximum of CA and RE. To pass the subject a minimum of 5 points is required.

Extraordinary Exam (July). Covers the whole subject and practical exercises and theory questions are to be solved. The final marl will consist on the arithmetic mean of the proposed exercises. To pass the subject a minimum of 5 points is required

Final assessment.

Only if the student has not taken part in any of the partial exams and simulation exercises. Same exam, and date as referred above for Regular Exam and the Extraordinary Exam. The exam consists on different exercises, each ranked from 0 to 10. The final mark will be the geometric mean of the exercises, excluding the lowest mark of one exercise..

Justification and Objectives

The main objective is to provide the student with the basic knowledge on the plastic behaviour of materials. The student will learn:

- The deformation mechanisms of materials in the plastic regime
- The equations describing such processes, the yielding criteria and its applicability to different materials
- The effect of temperature and time on the plastic behaviour of materials
- How to apply the theory of plasticity to the plastification of beams, plates and tubes

Prerequisites

Mecánica de Materiales II

Previous knowledge of the student
Mathematical, Physical and Mechanical foundations of Materials Science. Mechanics of Materials I, II

Contents in coordination with other subjects
Mechanics of Materials I, II and IV

Generic competencies
CG1, CG2, CG3, CG4, CG11

Specific competencies
CE2, CE5

Bibliography
Comportamiento Plástico de Materiales. Vicente Sánchez Gálvez, ETSI Caminos 2014 The mathematical Theory of Plasticity, R. Hill 1950 (Ed. 1998) Theory of Plasticity, J Chakrabarty, Elsevier 2006 Basic Engineering Plasticity. W.w.a. Reed, Elsevier 2006 Plastic Behavoiur of Materials. Francisco Gálvez / Vicente Sánchez Gálvez, Under publication

Subject contents and time distribution

LM: Lesson at room, RP: Problems Resolution, LB: Laboratory,, TI: Individual Work, TG: Group Work, DB: Debate at Room, VI: Visits, EV: Exams, OT: Other procedures

Item	Contents	Code
	P1.- Fundamentals of Plasticity	EV
P1.1	The tensile test. Engineering stress-strain. True stress-strain. Maximum load. Stress-strain empirical laws. The simple compression test. The Bauschinger effect	LM, RP
P1.2	Yield Criteria's. Isotropic materials definition. Yield of metallic materials. Geometrical representation. Tresca and Von Mises Criteria's. Non-metallic materials criteria. Coulomb Criterion. Drucker-Prager Criterion. Strain hardening effect	LM, RP
P1.3	Constitutive equations. Stress-strain relationship for isotropic materials. Stress-strain relationship for metallic materials. Hill equations. Prandtl-Reuss and Levy-Mises equations. Hencky equations	LM, RP
P1.4	Viscoplasticity. Definitions. Creep and relaxation. Logarithmic creep and Andrade. Stress and temperature effects	LM, RP
P1.5	Physics of Plasticity. Introduction to crystallography and micro-plasticity mechanisms. Thermally activated and drag controlled dislocation motion. Creep mechanisms based on diffusion and dislocation glide. Mechanical twinning and phase transformations	LM, RP
	P2.- Applications in Plasticity	EV
P2.1	Pure bending. Hypotheses. Elastic moment and plastic moment. Plastic mechanisms	LM, RP
P2.2	Plastification of beams. Analysis of the process. Isostatic and hyperstatic beams. Collapse loads. The extremum principle	LM, RP
P2.3	Plastification of plates. Analysis of the process. The failure lines method. Collapse loads	LM, RP
P2.4	Plastification of tubes. Analysis of the process. Thin wall tubes. Plastification of pipes and spheres. Instability. Maximum pressure. Thick wall tubes	LM, RP
	S.- Computational Plasticity	LB, TI
S	Fundamentals of computational plasticity. Code types. Meshes for plastic modelling. The flow rule Introduction to Abaqus Student	LM
S1	Simulation exercise A: The tensile test	LB, TI
S2	Simulation exercise B: The compression test	LB, TI
S3	Simulation exercise C: Beam under pure bending	LB, TI