Grado en Ingeniería de Materiales

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

Asignatura / Subject
Materiales Compuestos
Composite Materials

ECTS	Type	Curso / Semestre	Idioma	Sylabus code	Subject Code
6	Compulsory	3 / 2	EN	04MI	45000122

Lecturers (Name)	Contact email	Office hours (Tutorials)
Javier LLorca	javier.llorca@upm.es	Monday, 9.00-10.30
Carlos González	c.gonzalez@upm.es	Monday, 9.00-10.30
Alvaro Ridruejo	alvaro.ridruejo@upm.es	Monday, 9.00-10.30

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

Criterio de evaluación

Continuum assessment.

- Exam parts 1 and 2: 20% (a mínimum of 30% is required)
- Exam part 3: 40% (a mínimum of 30% is required)
- Exam part 4: 20% (a mínimum of 30% is required)
- Laboratory practices: 20% (Compulsory)

- Final Exam

Justification and Objectives

This aim of this course is to provide the students an general vision of the field of composite materials, including processing techniques, microstructure-properties relationship, mechanical design of laminates and behavior under service conditions.

Prerequisites

Mecánica de Materiales I y 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 III

Generic competencies

CG1, CG3, CG9

Specific competencies

CE1, CE3, CE6, CE7, CE10

Bibliography

- Composite Materials Handbook, vol. 3. Department of Defense, USA.
- Composites for Aircraft design. M. C. Y. Niu
- Principles of Composite Materials Mechanics. R. F. Gibson

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**
Sem.	Tema (LM)	RP
1	Presentation (1h) Why composite materials?. Classification and typology. Present and future of composite materials Objectives and methodology of the course. Evaluation. PART 1. Fibers (3h) Classification. Natural fibers. Organic synthetic fibers. C, ceramic and metallic fibers. Discontinuous reinforcements. Structure, fabrication and properties. Mechanical behavior of isolated fibers and fiber bundles.	
2	Reinforcement architecture (2h) Particle and short fibers. Unidirectional lamina and laminates. Woven fabrics. 3D fabrics. Matrices (1h) Polymeric, metallic and ceramic materials used as matrices. Interphases (1h) Adhesion mechanisms. Mechanical characterization of interfaces.	
3	Metal-matrix composites (1h) Typology and applications. Solid-state and liquid-state manufacturing techniques. Secondary processing. Ceramic-matrix composites (1h) Typology and applications. Processing by powder metallurgy, impregnation and infiltration. C/C composites. Polymer-matrix composites (2h) Typology and applications. Processing of thermosets. Selection of manufacturing process. Consolidation of prepegs. Infiltration methods. Pultrusion. Filament winding. Processing of thermoplastics.	
4	PART 2. Micromechanics of Composites Constitutive equations (1h) Anisotropic elasticity. Elastic symmetries. Stiffness and compliance matrices. Anisotropic strength. Elastic behavior (3h) Mean-field approach. Micromechanical models	2h
5	Higro-thermal stresses (1.5h) Thermal and hygrometric expansion coefficients. Residual stresses. Thermal and electrical conductivity (1.5h)	
6	Strength and failure (3h) FIber- and matrix-dominated failure models. Micromechanical models.	
7	PART 3. Macromechanics of Composites Orthotropic lamina (3h) Plane stress assumptions. Stress-strain relations in material axis. Global-local transformations. Stress-strain relations in arbitrary axis. Reduced stiffness and compliance matrix.	2h
8	Orthotropic lamina (1h) Thermo-hygrometric effects. Elastic problem formulation of the composite lamina. Failure Criteria (2h) Failure criteria definitions. Experimental determination of strength parameters of a single lamina. Standards. Maximum stress criteria. Maximum deformation criteria. Tsai-Hill criteria. Twai-Wu criteria. Strength analysis of the composite lamina.	2h
9	Failure Criteria (1h)	2h

	Strength analysis of the composite lamina. Classical lamination theory (2h) Definition of laminates. Conventions. Kirchhoff assumptions. Stress & strain analysis of laminates. Stiffness and compliance matrix. Classification of laminates. Thermomechanical analysis of laminates. Edge effects	
10	Classical lamination theory (3h) Strength analysis of laminates. Composite beams, tubes and plates.	2h
11	PART 4. Behavior under service conditions Composite materials in applications: Understanding the requirements. Certification of composite structures. NDE and Quality procedures (4h)	
12	Damage tolerance: fatigue and impact behavior . Composites repair (3 h)	
13	Design of bonded and bolted joints (4 h)	