UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: MATERIALS SCIENCE
Type: CORE COURSE
Degree: 351 - UNDERGRADUATE DEGREE PROG. IN MECHANICAL ENGINEERING
Center: 106 - SCHOOL OF MINING AND INDUSTRIAL ENGINEERING
Year: 2
Main language: Spanish
Use of additional languages:
Web site:

Code: 56313
ECTS credits: 6
Academic year: 2019-20
Group(s): 55 56
Duration: First semester
Second language: English
English Friendly: Y
Bilingual: N

Lecturer: **Mª TERESA CUBERES MONTSERRAT** - Group(s): **55 56**

Building/Office	Department	Phone number	Email	Office hours
2.04, Edificio Elhuyar	MECÁNICA ADA. E ING. PROYECTOS	926052849	teresa.cuberes@uclm.es	Se publicará en el tablón de anuncios del Centro a principio de curso.

2. Pre-Requisites

The student should have knowledge of mathematics, physics and chemistry from the previous course.

3. Justification in the curriculum, relation to other subjects and to the profession

Materials Science is a core subject, taught in the third Semester, common to the Industrial Branch. The engineer must know the fundamentals of Materials Science for his/her professional development.

The subject of Materials Science is directly linked to those of Physics, Chemistry and Mathematics, taught in the first course of the Degree. At the same time, it complements and serve as a base for other subjects such as Resis

4. Degree competences achieved in this course

Course competences

Code	Description
A01	To understand and have knowledge in an area of study that moves on from the general education attained at secondary level and usually found at a level that, while supported in advanced text books, also includes some aspects that include knowledge found at the cutting edge of the field of study.
A02	To know how to apply knowledge to work or vocation in a professional manner and possess the competences that are usually demonstrated by the formulation and defence of arguments and the resolution of problems in the field of study.
A03	To have the capability to gather and interpret relevant data (normally within the area of study) to make judgements that include a reflection on themes of a social, scientific or ethical nature.
A04	To be able to transmit information, ideas, problems and solutions to a specialized audience.
A05	To have developed the learning skills necessary to undertake subsequent studies with a greater degree of autonomy.
A06	Command of a second foreign language at B1 level of the Common European Framework of Refence for Languages.
A08	Appropriate level of oral and written communication.
A12	Knowledge of basic materials and technologies that assist the learning of new methods and theories and enable versatility to adapt to new situations.
A13	Ability to take the initiative to solve problems, take decisions, creativity, critical reasoning and ability to communicate and transmit knowledge, skills and abilities in Mechanical Engineering.
A14	Knowledge to undertake measurements, calculations, evaluations, appraisals, studies, give expert opinions, reports, work plans and similar tasks.
A15	Ability to work to specifications and comply with obligatory rules and regulations.
C03	Knowledge of the fundamentals of science, technology and chemistry of materials. Understanding of the relation between the microstructure, synthesis, processing and properties of materials.
CB01	Prove that they have acquired and understood knowledge in a subject area that derives from general secondary education and is appropriate to a level based on advanced course books, and includes updated and cutting-edge aspects of their field of knowledge.
CB02	Apply their knowledge to their job or vocation in a professional manner and show that they have the competences to construct and justify arguments and solve problems within their subject area.
CB03	Be able to gather and process relevant information (usually within their subject area) to give opinions, including reflections on relevant social, scientific or ethical issues.
CB04	Transmit information, ideas, problems and solutions for both specialist and non-specialist audiences.
CB05	Have developed the necessary learning abilities to carry on studying autonomously
D07	Knowledge and ability in the application of materials engineering.

5. Objectives or Learning Outcomes

Course learning outcomes

Description
The students will be able to select the most suitable material for an application in simple cases
The students will be able to identify the techniques for joining parts by welding and adhesives
The students will be able to understand and select the most appropriate hardening mechanism
The students will be able to differentiate the mechanical properties of materials, and perform mechanical tests
The students will get introduced to materials science and engineering
The students will be able to identify the metal alloys, polymers, ceramics and compounds most commonly used in the industry and their applicability.
The students will be able to understand the structure of materials and the causes of their behaviour, relating it to their microstructure and equilibrium diagrams
The students will be able to understand the relationship between the microstructure of the material and its macroscopic properties (mechanical, optical, electrical, magnetic and chemical)

Additional outcomes

To understand the structure of the materials, and the reasons of their behaviour, relating those to their microstructure and equilibrium diagrams.

6. Units / Contents

Unit 1: Introduction to Material Science. Materials for Engineering.
- **Unit 1.1** Science and Engineering of Materials
- **Unit 1.2** Materials Selection: Metals, Ceramics, Polymers and Composites

Unit 2: Microstructures of Materials. Phase Transformations.
- **Unit 2.1** Crystalline and Amorphous Conformations. Crystalline structures.
- **Unit 2.2** Optical and Electronic Microscopies. X-ray Diffraction.
- **Unit 2.3** Atomic Mobility and Temperature. Point Defects.
- **Unit 2.4** Equilibrium Diagrams. Isomorphic Alloys.
- **Unit 2.5** Equilibrium Diagrams. Eutectic Alloys.
- **Unit 2.6** Equilibrium Diagrams with Solid State Transformations.

Unit 3: Mechanical Properties and Microstructure. Microstructural Control.
- **Unit 3.1** Tensile and Hardness Testing. Elastic Deformation, Plastic Deformation and Fracture.
- **Unit 3.2** Influence of the Materials Structure on their Elastic Deformation.
- **Unit 3.3** Plastic deformation. Dislocations.
- **Unit 3.4** Strengthening mechanisms. Strain Hardening.
- **Unit 3.5** Solid Solution Strengthening. Martensite Transformation. Precipitation Hardening.
- **Unit 3.6** Reinforced Composites. Dispersion-strengthened Composites.
- **Unit 3.7** Performance in Service: Fracture, Fatigue and Creep.
- **Unit 3.8** Materials Degradation. Corrosion of metals.

Unit 4: Electrical, Magnetic and Optical Properties of Materials.
- **Unit 4.1** Electrical Properties and Microstructure. Modification of the electrical conductivity.
- **Unit 4.2** Dielectric Properties and Microstructure. Ferroelectric Materials.
- **Unit 4.3** Magnetic Properties and Microstructure. Ferromagnetic Materials.
- **Unit 4.4** Optical Properties and Microstructure. Refraction Index.

ADDITIONAL COMMENTS, REMARKS

Laboratory Practicals:

1. Metalographic Preparation and Optical Microscopy.

2. Microstructural Conformation: Solidification of a pure Metal.

3. Equilibrium Diagrams of Binary Alloys.

4. Observation of eutectic and eutectoide microstructures.

5. Tensile and Hardness Testing.

6. Strain Hardening of Copper Alloys.

7. Corrosion.

8. Electrical Conductivity Dependence on Temperature.

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	R	Description
Class Attendance (theory) [ON-SITE]	Lectures	A01 A05 A12 C03 CB01 CB02 CB03 CB04 CB05 D07	0.8	20	N	-	-	The Professor will focus the topic and explain the fundamental contents, using blackboard, audiovisual media and chair experiences.
Laboratory practice or sessions [ON-SITE]	Practical or hands-on activities	A01 A02 A03 A04 A05 A08 A12 A13 A14 A15 C03 CB01 CB02 CB03 CB04 CB05 D07	0.32	8	Y	Y	Y	Development of Laboratory Practicals in small groups.
Problem solving and/or case studies [ON-SITE]	Problem solving and exercises	A01 A02 A03 A04 A05 A06 A08 A12 A13 A14 A15 C03 CB01 CB02 CB03 CB04 CB05 D07	0.8	20	Y	N	N	Lists of problems -provided to the students in advanced - will be discussed and resolved in the classroom (collective learning). Case studies, or work of further developing concepts, might also be included.
Individual tutoring sessions [ON-SITE]	Problem solving and exercises	A01 A02 A03 A04 A05 A06 A08 A12 A13 A14 A15 C03 CB01 CB02 CB03 CB04 CB05 D07	0.32	8	N	-	-	The professor will individually attend to the students, to solve their doubts in exercises, problems or concepts, and monitor their progress.
Final test [ON-SITE]	Assessment tests	A02 A03 A04 A05 A08 A12 A13 A14 C03 CB01 CB02 CB03 CB04 CB05	0.16	4	Y	Y	Y	The students will take a final exam of the subject that will consist in short-answer questions and application problems. or issues of short answer and problems of application.
Study and Exam Preparation [OFF-SITE]	Self-study	A01 A02 A03 A04 A05 A06 A08 A12 A13 A14 A15 C03 CB01 CB02 CB03 CB04 CB05 D07	3.6	90	N	-	-	The student will revise and study his/her classroom notes, completing them with the bibliography provided by the Professor. Also, he/she will work on the resolution of the lists of problems and case studies that will be discussed in the classroom.
		Total:	**6**	**150**				
		Total credits of in-class work: 2.4						**Total class time hours: 60**
		Total credits of out of class work: 3.6						**Total hours of out of class work: 90**

As: Assessable training activity
Com: Training activity of compulsory overcoming
R: Rescheduling training activity

8. Evaluation criteria and Grading System

	Grading System		
Evaluation System	**Face-to-Face**	**Self-Study Student**	**Description**
Assessment of active participation	30.00%	30.00%	Participation in Laboratory Practicals, problem solving, case studies, and reports on further developing concepts will be considered for the grading. The actitude and involvement of the student on subject-related activities will also be taken into account.
Final test	70.00%	70.00%	The final test will be passed with a rating of 5/10. It will be necessary to achive independently a 5/10 rating in both problem solving and conceptual issues.
Total:	**100.00%**	**100.00%**	

Evaluation criteria for the final exam:
The evaluation will take into account the participation in Laboratory Practicals, problem solving, case studies, reports on further developing concepts (30%), and the final test (70%).
The assistance to the Laboratory Practicals will be a requirement to pass the subject.

Specifications for the resit/retake exam:
The evaluation will be based on the resit/retake exam.
The assistance to the Laboratory Practicals will be a requirement to pass the subject.

Specifications for the second resit / retake exam:
The evaluation will be based on the second resit/retake exam.
The assistance to the Laboratory Practicals will be a requirement to pass the subject.

9. Assignments, course calendar and important dates

Not related to the syllabus/contents

Hours	**hours**

Unit 1 (de 4): Introduction to Material Science. Materials for Engineering.

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Individual tutoring sessions [PRESENCIAL][Problem solving and exercises]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	6
Group 55:	
Initial date: 09-09-2019	**End date:** 16-09-2019
Group 56:	
Initial date: 09-09-2019	**End date:** 16-09-2019

Unit 2 (de 4): Microstructures of Materials. Phase Transformations.

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	6
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	4
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	9
Individual tutoring sessions [PRESENCIAL][Problem solving and exercises]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	31
Group 55:	
Initial date: 16-09-2019	**End date:** 28-10-2019
Group 56:	
Initial date: 16-09-2019	**End date:** 28-10-2019

Unit 3 (de 4): Mechanical Properties and Microstructure. Microstructural Control.

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	8
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	3
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	6
Individual tutoring sessions [PRESENCIAL][Problem solving and exercises]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	28.5
Group 55:	
Initial date: 28-10-2019	**End date:** 25-11-2019
Group 56:	
Initial date: 28-10-2019	**End date:** 25-11-2019

Unit 4 (de 4): Electrical, Magnetic and Optical Properties of Materials.

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	1
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	5
Individual tutoring sessions [PRESENCIAL][Problem solving and exercises]	2
Final test [PRESENCIAL][Assessment tests]	4
Study and Exam Preparation [AUTÓNOMA][Self-study]	24.5
Group 55:	
Initial date: 25-11-2019	**End date:** 23-12-2019
Group 56:	
Initial date: 25-11-2019	**End date:** 23-12-2019

Global activity

Activities	**hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	20
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	8
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	20
Individual tutoring sessions [PRESENCIAL][Problem solving and exercises]	8
Final test [PRESENCIAL][Assessment tests]	4
Study and Exam Preparation [AUTÓNOMA][Self-study]	90
Total horas:	150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Wendelin Wright, Donald R. Askeland	The Science and Engineering of Materials (7th Edition)	CENGAGE Learning Custom Publishing		9781305076761	2015	
D.R.H. Jones Michael Ashby	Engineering Materials 1:An Introduction to Properties, Applications and Design (4th Edition)	Butterworth-Heinemann		9780080966663	2011	

James F. Shackelford	Introduction to Materials Science for Engineers (8th Edition)	Pearson		9780133826654	2015
D.R.H. Jones, Michael Ashby	Engineering Materials 2. An Introduction to Microstructures and Processing (4th Edition)	Butterworth-Heinemann		9780080966694	2012
W. F. Smith, J. Hashemi	Foundations of Materials Science and Engineering (5th Edition)	Ed. McGraw Hill			2010
William D. Callister Jr., David G. Rethwisch	Materials Science and Engineering: An Introduction (10th Edition)	Wiley		978-1-119-40549-8	2018
M. F. Ashby, D. R. H. Jones	Materiales para ingeniería I: introducción a las propiedades, las aplicaciones y el diseño	Reverté	Barcelona	9788429172553	2008
W. F. Smith, J. Hashemi	Fundamentos de la ciencia e ingeniería de materiales.	Ed. McGraw Hill (5ª edición)		9786071511522	2014
Callister, William D.; Rethwisch, David G.	Ciencia e Ingeniería de Materiales 2ed	Reverté		9788429172515	2016
D. R. Askeland.	Ciencia e ingeniería de los materiales.	Thomson Paraninfo	Madrid	9788497320160	2001
J. F. Shackelford.	Introducción a la ciencia de materiales para ingenieros.	Ed. Prentice Hall (7ª edición)	Madrid	9788483226599	2010
Juan Manuel Montes Martos, Francisco Gómez Cuevas y Jesús Cintas Físico	Ciencia e Ingeniería de los Materiales	Ediciones Paraninfo		9788428330176	2014
M. F. Ashby, D. R. H. Jones	Materiales para ingeniería II: introducción a la microestructura, el procesamiento y el diseño	Reverté	Barcelona	9788429172560	2009