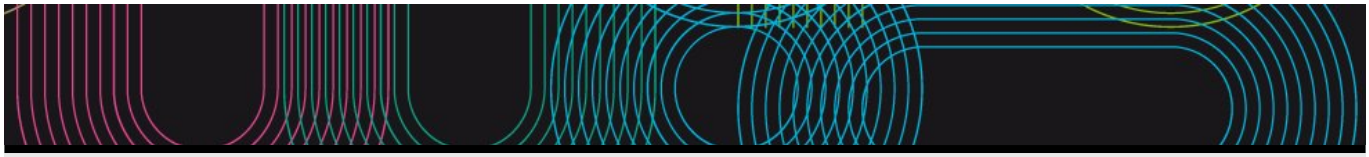

IDENTIFYING DATA				
Materials technology				
Subject	Materials technology			
Code	V09G290V01303			
Study programme	Degree in Energy Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Galician English			
Department				
Coordinator	Pérez Pérez, María del Carmen			
Lecturers	Figueroa Martínez, Raúl Pérez Pérez, María del Carmen Riobó Coya, Cristina			
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General description	Material Technology is a second-year subject with a marked technological character. It is common for all students, regardless of the specific orientation. The objective is to present the fundamentals of Materials Science and Technology in a comprehensible way to students, focusing on the relationship between internal structure - properties - processing of materials. The learning outcomes are focused on: 1. Understanding the fundamental concepts of bonds, structure and microstructure of different types of materials. 2. Understanding the relationship between the microstructure of the material and its mechanical, electrical, thermal and magnetic behaviour. 3. Knowing the main techniques of structural characterization of materials. 4. Acquiring skills in the handling of diagrams and graphics. 5. Be able to interpret and implement material testing standards. 6. Acquiring skill in performing tests. 7. Analyzing the results obtained taking the corresponding conclusions. 8. Developing scientific view point and experimental methodology in the approach andsolution of problems related to Materials Technology.			

Competencies	
Code	
C11	Capacity to learn, understand and use the principles and technologies of materials.
D1	Capacity to interrelate all the acquired knowledge and interpret it as components in a body of knowledge with a clear structure and strong internal coherence
D4	Encourage work based on cooperation, communication skills, organization, planning and recognition of responsibility in a multilingual and multidisciplinary working environment that fosters education in equality, peace and respect for fundamental rights
D5	Know what sources are available for ongoing and continual updating of all the information required to undertake their work, with access to all the current and future tools for seeking information and adapting it in the light of technological and social changes
D7	Capacity to organise, interpret, assimilate, create and manage all the information needed to organise their work, handling the I.T., mathematical, physical and other tools required
D10	Become aware of the need for training and continual improvement in quality, developing the values associated with scientific thinking and showing a flexible, open and ethical attitude towards diverse opinions and situations, particularly in matters of non-discrimination on the grounds of gender, race or religion, respect for fundamental rights, accessibility, etc

Learning outcomes	
Expected results from this subject	Training and Learning Results

To understand the basic concepts related to bonding, structure, and microstructure of the different types of materials.	C11	D1 D7
To understand the relationship between the material microstructure and its mechanical, electrical, thermal and magnetic behaviour.	C11	D1 D7
To know the basis of the mechanical behaviour of the materials.	C11	D4 D5
To know the main techniques for structural characterization of materials.	C11	D1 D4 D5 D7 D10
To acquire skills for handling diagrams and plots.	C11	D1 D4 D5 D7 D10
Capacity to apply standards for materials testing.		D4 D5
To acquire skills for performing tests.		D4 D5

Contents

Topic	
CHAPTER I. INTRODUCTION	I.1. The Science and Engineering Materials. Definitions. I.2. Type of materials. Evolution and trends. I.3. Structure - Properties - Processing relations. I.4. Introduction to the concept of design and selection of materials.
CHAPTERT II. CRYSTAL STRUCTURES. UNIT CELLS	II.1. Crystal / amorphous arrangements. Differences. II.2. Characteristics of crystals structures. Metallic, ionic and covalent crystals. II.3. Parameters of metallic structures: BCC, FCC, HCP. II.4. Crystallographic directions. Crystallographic planes (Miller indices). II.5. X-Ray diffraction: Determination of crystal structures.
CHAPTER III. IMPERFECTIONS IN SOLIDS. DIFFUSION.	III.1. Point defects. III.2. Linear defects: dislocations. Physical meaning of the dislocations. III.3. Surface defects. III.4. Diffusion: definition and mechanisms. III. 5. Fick□s laws (first and second laws). III.6. Industrial application of diffusion phenomena.
CHAPTER IV. TESTING AND MECHANICAL PROPERTIES	IV.1. Elastic deformation. Young modulus. IV.2. Plastic deformation. IV.3. The tensile test: use of stress-strain diagram. IV.4. The compression and bend tests for brittle materials. IV.5. Hardness of materials. Hardness tests. IV.6. Impact test: toughness. IV.7. Fracture toughness: fracture mechanics. IV.8. Fatigue tests.
CHAPTER V. MECHANISMS OF DEFORMATION	V.1. Slipping mechanism: dislocations and plastic deformation. V.2. Deformation by twinning. V.3. Strain hardening by cold working. V.4. Annealing: recovery, recrystallization and grain growth.
CHAPTER VI. SOLIDIFICATION AND SOLID STATE TRANSFORMATION	VI.1. Principles of solidification: pure metals. Nucleation and growth steps. VI.2. Mechanism of strengthening by grain size reduction. VI.3. Solidification in ingot casting: cast structure. VI.4. Alloys: solid solution and intermediate phases. Solid-Solution Strengthening. VI.5. Cooling curves: pure materials and alloys. VI.6. Phase diagrams (I). Total solubility (binary isomorphous systems). Microsegregation. Eutectic and peritectic systems. VI.7. Phase diagrams (II). Solid state transformations. Partial solubility in solid state. Dispersion strengthening. Eutectoid reaction. VI.8. Introduction of ternary phase diagrams.

CHAPTER VII. MATERIALS FOR ENGINEERING (I): METALLIC MATERIALS	VII.1. Ferrous alloys: steels and cast irons. VII.2. The Iron□Iron Carbide (Fe□Fe3C) Phase Diagram. VII.3. Isothermal Transformation Diagrams (TTT). Continuous Cooling Transformation Diagrams (CCT). Microstructures. VII.4. Heat treatment of steels: annealing, normalizing, quenching, tempering. VII.5. Cast irons. Types: white cast iron, gray cast iron, ductile cast iron and compacted graphite cast iron. VII.6. Nonferrous alloys. Light alloys (based on Al, Ti). Alloys based on Cu, Pb, Sn, Zn and Ni.
CHAPTER VIII. MATERIALS FOR ENGINEERING (II): CERAMIC MATERIALS	VIII: 1. Crystal structures. VIII.2. Traditional ceramics: clay products, refractories, abrasives, cement and concrete. VIII.3. Advanced ceramics. VIII.4. Glass ceramics: Characteristics, viscous deformation. VIII.5. Heat treatments and vitroceramics.
CHAPTER IX. MATERIALS FOR ENGINEERING (III): POLYMERIC MATERIALS	IX.1. Polymerization. Types of polymers. IX.2. General characteristics: thermal, mechanical and chemical behaviour. IX.3. Thermoplastic plastics: structure, crystallinity. Types. IX.4. Thermosetting plastics: structure. Types. IX.5. Elastomeric materials: structure, vulcanization. Rubbers, thermoplastic elastomers. Types.
CHAPTER X. MATERIALS FOR ENGINEERING (IV): COMPOSITE MATERIALS	X.1. Classification and general characteristics. Matrix and disperse phases. X.2. Polymer matrix composites reinforced with fiber. X.3. Metal matrix composites and ceramic matrix composites. X.4. Laminar composites and sandwich structures.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	23	33.25	56.25
Problem solving	11.5	19	30.5
Studies excursion	3	0	3
Laboratory practical	10	26.25	36.25
Essay questions exam	0.5	6	6.5
Report of practices, practicum and external practices	0	8	8
Objective questions exam	0.5	0	0.5
Problem and/or exercise solving	1.5	7	8.5
Objective questions exam	0	0.5	0.5

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Presentation by the teacher of the contents on the subject under study, theoretical and / or guidelines for a job, exercise or project to be developed by the student.
Problem solving	Activity which formulated problem and / or exercises related to the course. The student should develop appropriate solutions or right through the exercise routines, application of formulas or algorithms, application processing procedures available information and interpretation of the results. It is often used to complement the lecture.
Studies excursion	The carrying out of the "Studies excursion" activity will be organised and carried out by the Centre, taking as a starting point the proposals made by the teaching staff of the subject and related to the type of facility / company to visit.
Laboratory practical	Activities application of knowledge to specific situations and basic skills acquisition and related procedural matter under study. They are developed in specific spaces with specialized equipment (Laboratories, computer rooms, etc ...)

Personalized assistance

Methodologies	Description
Lecturing	Time devoted to attend and resolve doubts related to the main topics of the subject. In general, it will be developed individually, in the office hours, which will be provided in the presentation of the subject and it will be available to students in the online platform used by the teacher and the students. Doubts will also be solved directly in class, during the lectures. The tutorial sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) with prior agreement.

Problem solving	Time devoted to attend and resolve doubts related to the main topics of the subject. In general, it will be developed individually, in the office hours, which will be provided in the presentation of the subject and it will be available to students in the online platform used by the teacher and the students. Doubts will also be solved directly in class, during the lectures. The tutorial sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) with prior agreement.
Laboratory practical	Time devoted to attend and resolve doubts related to the main topics of the subject. Generally, students will be advised in small groups, although it can be done individually. This activity can be developed directly during laboratory activity or in office hours. Useful information (office hours) will be provided at the beginning of the course. The tutorial sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) with prior agreement.

Assessment

	Description	Qualification	Training and Learning Results
Essay questions exam	They consist in short questions included in the final exam. The learning outcomes achieved are: The understanding of the basic concepts related to bonding, structure, and microstructure of the different types of materials. The understanding of the relationship between the material microstructure and its mechanical, electrical, thermal and magnetic behaviour. The knowledge of the main techniques for structural characterization of materials and the acquisition of skills for handling diagrams and plots.	30	C11 D1 D7 D10
Report of practices, practicum and external practices	Each laboratory session generates a report that must be done by the students individually. The learning outcomes achieved are:the knowledge of the basis of the mechanical behaviour of the materials. The knowledge of the main techniques for structural characterization of materials. The acquisition of skills for handling diagrams and plots. The capacity to apply standards for materials testing and the developments of skills for performing tests.	10	C11 D4 D5
Objective questions exam	It will consist of a set of test-type questions related to the practices that were carried out in the laboratory The learning outcomes achieved are: the understanding of the basic concepts related to bonding, structure, and microstructure of the different types of materials. The understanding of the relationship between the material microstructure and its behaviour, and the capacity to apply standards for materials testing.	10	C11 D1 D4 D5 D7 D10
Problem and/or exercise solving	They will be included in the final exam. These are exercises to put into practice the contents explained in the classroom. The learning outcomes achieved are: the understanding of the basic concepts related to bonding, structure, and microstructure of the different types of material. The understanding of the relationship between the material microstructure and its behaviour. The knowledge of the main techniques for structural characterization of materials, and the development of skills for handling diagrams and plots.	40	C11 D1 D4 D5 D7 D10
Objective questions exam	Tests that assess knowledge that includes closed with response alternatives questions (true/false, multiple choice, matching of elements...). The learning outcomes achieved are: The understanding of the basic concepts related to bonding, structure, and microstructure of the different types of materials. The understanding of the relationship between the material microstructure and its mechanical, electrical, thermal and magnetic behaviour. The knowledge of the main techniques for structural characterization of materials and the acquisition of skills for handling diagrams and plots.	10	C11 D1 D7 D10

Other comments on the Evaluation

In the first call, to pass the subject a minimum mark of 40% in the official exam must be reached.

In the second call (July), the continuous assessment will not be taken into account and the final exam is worth 10 points.
For checking the exams calendar, visit the webpage od the School:http://minaseenerxia.uvigo.es/es/docencia/examenes

Sources of information

Basic Bibliography

Callister, William D.; Rethwisch, David G., **Ciencia e Ingeniería de Materiales**, 2ª Ed., Reverté, 2016

Callister, William D.; Rethwisch, David G., **Materials Science and Engineering. An Introduction**, 9th Ed., Wiley, 2014

Asleland, Donald R. ; Fulay, Pradeep P. ; Wright, Wendelin J., **Ciencia e Ingeniería de Materiales**, 6ª Ed., CENGAGE Learning, 2012

Asleland, Donald R. ; Fulay, Pradeep P. ; Wright, Wendelin J., **Science and Engineering of Materials**, 7th ed., CENGAGE Learning, 2015
Smith, W.; Hashemi, Javad, **Fundamentos de la ciencia e ingeniería de materiales**, 5ª ed., McGraw-Hill, 2010
Smith, W.; Hashemi, Javad, **Foundations Of Materials Science And Engineering**, 5th ed., McGraw-Hill Education, 2009

Complementary Bibliography

J.M. Montes; F.G. Cuevas; J. Cintas, **Ciencia e Ingeniería de los Materiales**, 9788428330176, 1ª Ed, Paraninfo 2014,
Shackelford, James F., **Introduction to Materials Science for Engineers**, 8th ed., Pearson Educación, S.A, 2016
Shackelford, James F., **Introducción a la ciencia de materiales para ingenieros**, 7ª Ed., Pearson Educación, S.A, 2010
Pero-Sanz, Antonio J., **Ciencia e ingenieria de materiales. Estructura, transformaciones, propiedades y selección**, 5ª ed., CIE-Dossat 2000, 2000

Recommendations

Subjects that are recommended to be taken simultaneously

Physics: Thermal systems/V09G290V01306
Materials resistance/V09G290V01304

Contingency plan

Description

Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

1. Semi-presential modality

Once the semi-presential teaching is required, it would mean a reduction of the capacity of the teaching spaces used in the face-to-face modality. Therefore, as the first measure of the center, the capacity of the teaching spaces would be reformulated and informed to the teachers, in order to proceed to reorganize the formative activities for the rest of the semester. It should be noted that the reorganization will depend on the moment throughout the semester in which this semi-presential modality is activated. For the reorganization of the teaching activities, the following guidelines would be followed:

Through the FaiTIC platform, all the students will be informed about the new conditions under which the formative activities and assessment tests will be carried out at the end of the semester.

The tutorial sessions will be carried out by telematic means (email, videoconference, FAITIC forums, ...) with prior agreement.

Once some of the students have carried out experimental or computer laboratory practices in the face-to-face modality, if it is possible, the rest of the students will have the possibility to perform the same or equivalent activities in the same modality.

For the rest of the activities until the end of the semester, it should be done a proper identification of those formative activities which can be done under face-to-face modality and those which will be carried out remotely.

Regarding the potential tools to be applied for the formative activities during the online mode, Campus Remoto and the FaiTIC platform will be used.

2. Online modality

In the event that the non-face-to-face teaching modality is required (suspension of all face-to-face formative and assessment activities), the tools currently available at the University of Vigo, Campus Remoto and the FaiTIC platform will be used. The reorganization will depend on the moment throughout the semester in which this online modality is activated. In the reorganization of the teaching activities, the following guidelines would be followed:

2.1. Communication

Through the FaiTIC platform, all the students will be informed about the new conditions under which the formative activities and assessment tests will be carried out at the end of the semester.

2.2. Adaptation and / or modification of teaching methodologies

As the teaching methodologies have been conceived for the face-to-face teaching modality, the teaching methodologies that would be kept and those which would be modified or replaced in the online modality are indicated below.

The teaching methodologies that would be kept, since they can be used in face-to-face and online teaching mode Lecturing and problem-solving. Both methodologies can be used through Campus Remoto platform.

The teaching methodologies that would be modified are the following
Laboratory and studies excursion. These methodologies must be modified. The use of videos that illustrate the objectives pursued with these methodologies is proposed as an alternative. As far as possible, online resources will be sought that allow student interaction with laboratory practice.

2.3. Adaptation of tutorial sessions and personalized attention
The tutorial sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) with prior agreement.

2.4. Evaluation
The short questions exam is removed and the weight of the objective questions exam is increased by up to 50%. This test may consist of several tests distributed throughout the semester, depending on the evolution of the circumstances. In the extraordinary call for July, the same qualification criteria will be maintained as in the ordinary call.
2.5. Bibliography or additional material to facilitate self-learning
Self-appraisal tests will be proposed.