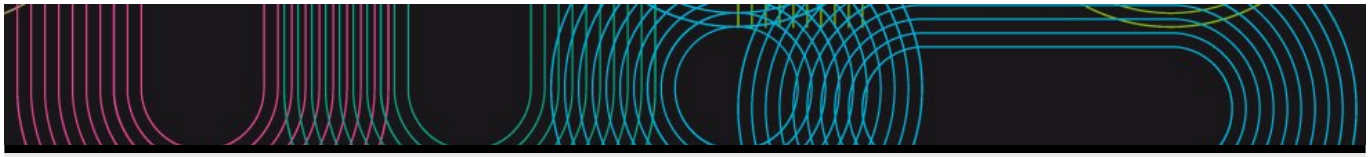

IDENTIFYING DATA				
Materials technology				
Subject	Materials technology			
Code	V09G311V01202			
Study programme	Grado en Ingeniería de los Recursos Mineros y Energéticos			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Galician English			
Department				
Coordinator	Pérez Pérez, María del Carmen			
Lecturers	Pérez Pérez, María del Carmen			
E-mail	cperez@uvigo.es			
Web	http://moovi.uvigo.gal/course/view.php?id=3281			
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 behavior. 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 skills in performing tests. 7. Analyzing the results obtained taking the corresponding conclusions. 8. Developing scientific viewpoint and experimental methodology in the approach and solution of problems related to Materials Technology.			

Training and Learning Results	
Code	
A1	That the students demonstrate to possess and understand knowledge in an area of study that is part of the general education (second level), and often found at a level that, although based on advanced textbooks, also includes some aspects that involve knowledge from the avant-garde of the field of study
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A4	That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized audience
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B7	Ability to do, within the field of mining engineering, with the knowledge acquired in accordance with section 5 of order CIN/306/2009, measurements, stakeouts, planes and maps, calculations, assessments, risk analyses, expert reports and studies, work plans, environmental and social impact studies, restoration plans, quality control systems, prevention systems, analysis and assessment of the properties of metal, ceramic, refractory, synthetic and other materials, soil and rock mass classification and other works of a similar kind.
C11	Ability to know, understand and use the principles and technology of materials.
D1	Ability to draw links between the different elements of all the knowledge they acquired, understanding them as components of a body of knowledge with a clear structure and strong internal cohesion.

D4	To foster collaborative working, communication, organization and planning skills, along with the ability to take responsibilities in a multilingual, multidisciplinary work environment that promotes education for equality, peace and respect for fundamental rights.
D5	To be familiar with the relevant sources of information, including constant updating, in order to practice one□s profession competently, accessing all the present and future tools of information search, constantly adapting to technological and social changes.
D7	Ability to organize, understand, assimilate, produce and handle all the relevant information to develop their professional work, using appropriate computing, mathematical, physics tools, etc. when these are required.
D10	To become aware of the need for continuous training and the constant improvement of quality, developing the values that are characteristic of scientific thinking, showing flexible, open and ethical attitudes in the face of different situations and opinions, particularly as regards non-discrimination on the grounds of gender, race or religion, respect for fundamental rights, accessibility, etc.

Expected results from this subject

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.	A1 A2 A3	B7	C11	D1 D5
Understanding of the relation between the microstructure and its mechanical, electric, thermal and magnetic behaviour.	A1 A2 A3	B7	C11	D5 D7
Understanding of the basics of the mechanical of the metals, ceramics, polymers, and composites.	A1 A2 A5	B7	C11	D1 D5 D7
To know the main techniques for structural characterization of materials.	A1 A4 A5	B7	C11	D1 D5
To acquire skills in the handle of diagrams and graphics.	A1 A2 A3 A4 A5	B7	C11	D5 D10
Capacity to apply standards for materials testing.	A1 A2 A5	B7	C11	D4 D5
To acquire skills for performing tests.	A1 A2 A5	B7	C11	D1 D5 D10

Contents

Topic	
CHAPTER I. INTRODUCTION	I.1. The Science and Engineering of the Material. Definitions. I.2. Types of materials. Evolution and trends. I.3. Structure - Properties - Processing relations. I.4. Introduction to the mechanical, electrical, thermal, and magnetic properties of the materials. I.5. Introduction to the concept of design and selection of materials.
CHAPTER II. CRYSTAL STRUCTURES. UNIT CELLS	II.1. Crystal / amorphous arrangements. Differences. II.2. Characteristics of the crystal structures. Metallic, ionic, and covalent crystals. II.3. Study of the metallic crystals: BCC, FCC, HCP. II.4.Crystallographic directions. Crystallographic planes (Miller indices). II.5. Resolution of the crystal structure: X-ray diffraction.
CHAPTER III. IMPERFECTION IN SOLIDS. DIFFUSION	III.1. Point defects. III.2. Linear defects (dislocations). Physical meaning of the dislocations. III.3. Surface defects. III.4. Diffusión. Mechanisms. III.5. Fick's laws (stationary and non-stationary states). III.6. Industrial application of diffusion phenomena.

CHAPTER IV. TESTING AND MECHANICAL PROPERTIES	V.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 a solid state. Dispersion strengthening. Eutectoid reaction.
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. Allowing elements and designation. VII.3. Isothermal Transformation Diagrams (TTT). Continuous Cooling Transformation Diagrams (CCT). VII.4. Heat treatment of steels: annealing, normalizing, quenching, and 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 chemical treatments of glasses. Vitroceramics. Characteristics.
CHAPTER IX. MATERIALS FOR ENGINEERING (III): POLYMERIC MATERIALS	IX.1. Polymerization. Types of polymers. IX.2. General characteristics: thermal, mechanical, and chemical behavior. 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	22	35.5	57.5
Problem solving	10	27	37
Laboratory practical	14	14	28
Case studies	4	6	10
Report of practices, practicum and external practices	0	14	14
Problem and/or exercise solving	1.5	0	1.5
Essay questions exam	1	0	1
Objective questions exam	0	1	1

*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.
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 ...)
Case studies	Analysis of an event, issue, or actual event in order to know, interpret, solve, generate hypotheses, comparing data, reflect, complete knowledge, diagnose, and training in alternative dispute resolution procedures.

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-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, Moovi 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-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, Moovi 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, Moovi forums, ...) with prior agreement
Case studies	Time that each teacher reserves to attend and solve doubts to the students in relation to aspects of the subject. Generally, In general, it will be developed individually, in-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, Moovi forums, ...) with prior agreement.

Assessment

	Description	Qualification	Training and Learning Results
Report of practices, practicum and external practices	Each laboratory session generates a report that must be done by the students individually. The expected results: the knowledge of the basis of the mechanical behaviour of the metals, ceramics, and polymers. 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 development of skills for performing tests.	10	A1 C11 D5 A2 A3 A5
Problem and/or exercise solving	These are exercises in which the contents are put into practice. theories presented in the magisterial session. They will be carried out throughout the semester, two short tests that will consist of exercises (each has a weighting of 10%). In the written exam to be held at the official date established by the center, exercises will be included (with a weighting of 25%). The results expected from this subject are: To understand the basic concepts related to bonding, structure, and microstructure of the different types of material. To understand the relationship between the microstructure and its mechanical, electric, thermal and magnetic behaviour. To know the main techniques for structural characterization of materials. To acquire skills in diagrams and graphics handling	45	A1 C11 D5 A2 A3

Essay questions exam	They consist in short questions included in the final exam. The expected results achieved are: The understanding of the basic concepts related to bonding, structure, and microstructure of the different types of materials. The understanding of the relation between the material microstructure and its mechanical, electrical, thermal and magnetic behaviour. The knowledge of the main techniques for structural characterization of materials. The acquisition of skills for handling diagrams and plots.	15	A1 A2 A3 A4	C11	D5
Objective questions exam	Tests assessing knowledge that includes closed with response alternatives questions (true/false, multiple choice, matching of elements...). Three tests will be carried out, two related to the subject taught in the master sessions and a third focused on knowledge acquired in laboratory practices. Each of them represents the 10%. The results expected from this subject are: To understand the basic concepts related to bonding, structure, and microstructure of the different types of material. To understand the relationship between the microstructure and its mechanical, electric, thermal and magnetic behaviour. To know the main techniques for structural characterization of materials. To acquire skills in diagrams and graphics handling.	30	A1 A2 A5	C11	D5

Other comments on the Evaluation

Those students who refuse to carry out continuous assessment may achieve 100% of the grade in the written exam, both at first and second chance.

On the second opportunity, the written exam will be worth 100% of the grade for all students, and will include the resolution of exercises as well as development questions and objective questions.

Exam schedule. Verify/consult updated information on the center's website:

http://minaseenerxia.uvigo.es/es/docencia/examenes

Sources of information

Basic Bibliography

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

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

Asleland, Donald R. ; Fulay, Pradeep P. ; Wright, Wendelin J., **Ciencia e Ingeniería de Materiales**, 5ª, CENGAGE Learning, 2015

Asleland, Donald R. ; Fulay, Pradeep P. ; Wright, Wendelin J., **Science and Engineering of Materials**, 7th, CENGAGE Learning, 2015

Shackelford, James F., **Introduction to Materials Science for Engineers**, 8th, Pearson Education, 2016

Shackelford, James F., **Introducción a la ciencia de materiales para ingenieros**, 7ª, Pearson Educación, S.A., 2010

Pero-Sanz, Antonio J., **Ciencia e ingenieria de materiales. Estructura, transformaciones, propiedades y selección**, 5ª, CIE-Dossat, 2000

Complementary Bibliography

Smith, W.; Hashemi, Javad, **Fundamentos de la ciencia e ingeniería de materiales**, 5ª, McGraw-Hill, 2010

Smith, W.; Hashemi, Javad, **Foundations Of Materials Science And Engineering**, 5th, McGraw-Hill Education, 2009

J.M. Montes; F.G. Cuevas; J. Cintas, **Ciencia e Ingeniería de los Materiales**, 1ª, Paraninfo, 2014

Recommendations

Subjects that are recommended to be taken simultaneously

Materials resistance/V09G311V01203

Subjects that it is recommended to have taken before

Physics: Physics I/V09G311V01102
Physics: Physics II/V09G311V01107
Chemistry/V09G311V01105