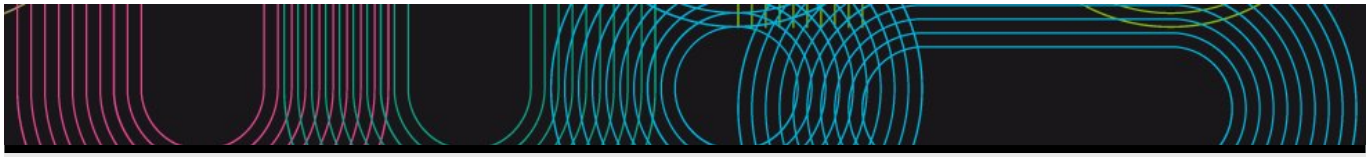

IDENTIFYING DATA				
Materials science and technology				
Subject	Materials science and technology			
Code	P52G382V01108			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	Urréjola Madriñán, Santiago Rafael			
Lecturers	Alfonsín Pérez, Víctor Ángel Urréjola Madriñán, Santiago Rafael			
E-mail	urrejola@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Currently, it is interesting to look for material properties that not only provide benefits in mechanical behavior, but also other characteristics such as appearance, shine, touch, etc., that can become important when selecting a material or another with similar mechanical characteristics. Many of these parameters are variable and could even depend on social trends. The unstoppable advance of society and the importance of some properties of materials at different scales, make their study especially relevant within the field of Engineering. The aim of this course is to introduce the main concepts of materials technology as well as to study the applications of the most common materials In addition, in this subject skills will be developed to apply theoretical and practical knowledge in order to solve problems in reference to materials from a basic and multidisciplinary point of view			

Training and Learning Results	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
B4	Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of Industrial Engineering in Mechanical specialty.
B6	Capacity for handling specifications, regulations and mandatory standards.
C9	Knowledge of the fundamentals of the science, technology and chemistry of materials. Understand the relationship between microstructure, the synthesis, processing and properties of materials.
D1	Analysis and synthesis
D5	Information Management.
D9	Apply knowledge.
D10	Self learning and work.

Expected results from this subject	Training and Learning Results		
New	B4 B6		
Knowing how the properties can be modified using mechanical processes and thermal treatments	B4	C9	D9
Knowing the basic techniques of the structural characterization of materials	B3 B6	C9	
Ability in the handling of diagrams and graphics			D1 D5
Ability in performing experiments	B6	C9	D10

To analyse the obtained results and their conclusions			D1 D9
Ability to apply standards of material testing	B6		D1 D9
ENAEE LEARNING OUTCOME. KNOWLEDGE AND UNDERSTANDING: LO1.2 - knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront. [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	B3	C9	
ENAEE LEARNING OUTCOME. KNOWLEDGE AND UNDERSTANDING: LO1.3 - Awareness of the wider multidisciplinary context of engineering [Intermediate (2)].		C9	
ENAEE LEARNING OUTCOME. ENGINEERING ANALYSIS: LO2.2.- Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical □societal, health and safety, environmental, economic and industrial □ constraints. [Intermediate (2)].	B4		D1 D9
ENAEE LEARNING OUTCOME. INVESTIGATIONS: LO4.1.- ability to conduct searches of literature, to consult and to critically use scientific databases and other appropriate sources of information, to carry out simulation and analysis in order to pursue detailed investigations and research of technical issues in their field of study. [Intermediate (2)].	B6		D5
ENAEE LEARNING OUTCOME. INVESTIGATIONS: LO4.2.- Ability to consult and apply codes of practice and safety regulations in their field of study; [Basic (1)]	B6		
ENAEE LEARNING OUTCOME. INVESTIGATIONS: LO4.3.- Laboratory/workshop skills and ability to design and conduct experimental investigations, interpret data and draw conclusions in their field of study .[Intermediate (2)].		C9	D9
ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE: LO5.1.- Understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study: [Basic (1)].			D9
ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE: LO5.2.- Practical skills for solving complex problems, realising complex engineering designs and conducting investigations in their field of study. [Basic (1)].	B4		D9
ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE: LO5.3.- Understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study. [Basic (1)].		C9	D9
ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE: LO5.4.- Ability to apply norms of engineering practice in their field of study. [Basic (1)].	B6		D9
ENAEE LEARNING OUTCOME. MAKING JUDGMENTS: LO6.1.- Ability to gather and interpret relevant data and handle complexity within their field of study, to inform judgements that include reflection on relevant social and ethical issues [Basic (1)].	B6		
ENAEE LEARNING OUTCOME.COMMUNICATION AND TEAM-WORKING: LO7.1.- ability to communicate effectively information, ideas, problems and solutions with engineering community and society at larg [Intermediate (2)].	B4		D1 D5
ENAEE LEARNING OUTCOME.COMMUNICATION AND TEAM-WORKING: LO7.2.- Ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers. [Intermediate (2)].			D10

Contents

Topic	
Introduction to materials.	Definition of material. Present, past and future of materials. What is Materials Science and Technology and its multidisciplinary nature. Importance of materials in society: Ethical-social and environmental commitment. Material properties. Material trends. Relationship between structure and properties. Selection of materials: technical-economic commitment and market value.
Types of atomic bonds and derived properties	Types of bonds. Classification of materials. Atomic bond strength and derived properties.
Structure of crystalline materials	Crystalline and amorphous materials. Main crystalline systems. Metallic crystalline structures: Cristal systems (BCC,FCC,HCP, polymorphism and alotropy). Covalent and ionic main structures. Determination of crystal structure (X-Ray diffraction)
Imperfections of crystal structure	Crystal defects: Point defects, line defects, planar defects. Importance of crystal defects in the metal and ceramic properties. Microscopic techniques for the crystal defects identificacion.
Solid atomic diffusion.	Diffusion mechanisms. Fick's laws. Diffusion factors. Industrial applications of diffusion processes:

Basic deformation characteristics	Types of deformation: elastic, anelastic, viscoelastic and plastic. Mechanisms of deformation: viscous flow, slip and crystal twinning.
Tensile test, compression and flexion	Tensile test: Standarization. Conventional tensile test curve. Mechanical properties derived. Real tensile-deformation curve. Acritude coefficient. Comparison of tensile behaviour in different materials. Compression and flexion tests: Standarizarion. Characteristics. Comparison of their behaviour between different materials.
Hardness tests	Hardness: Concept. Shore test. Macrohardness test: Brinell, Rockwell and Vickers. Microhardness test: Vickers y Knoop. Standarization. Comparison between different test procedures.
Solidification process	Nucleation and growth. Basic concepts
Equilibrium phase diagrams: Introduction. Solid state phase transformations in equilibrium	Gibbs law. Lever rule. Binary equilibrium diagrams. Types. Invariant. solidification reactions. Equilibrium solid-state transformations: Metallic and ceramic. Examples: Fe-C phase diagram. Microestructure evolution for cooling: steel and foundries. Types based on the carbon content.
Polymeric materials	Plastic composition. Properties of the most important polymers. Applications. Recycling. Adhesives.
Ceramic and composite materials	Vitreous ceramics. Clay products. Structural ceramics and porcelain. Refractory ceramics. Abrasive Ceramics. Cements and concretes. Advanced technological ceramic.
Laboratory session 1. Webquest	Introduction to materials: Search for information in order to complete sheets about different materials, which must be presented orally for evaluation. The student must use different online databases, whose use and quality will be later qualified by the teacher.
Laboratory session 2. Mechanical tests: Hardness	Hardness coefficient determination of different metallic materials: Brinell, Rockwell and Vickers. Micro-hardness profile (Vickers) of a cemented test probe. Hardness coefficient determination for different plastic materials. Shore test (A and D)
Laboratory session 3. Mechanical tests: Tensile	Introduction to tensile tests. Tensile-Elongation diagrams. Young's modulus determination and resilient modulus through Tensile-elongation diagrams.
Laboratory session 4-5. Metallographic study of metals, iron and aluminum alloys.	Introduction to metallography. Test probes preparation and optical microscope handling. Metallographic observation of test probes: monophasic-biphasic alloys, steel, iron and aluminium.
Laboratory session 6. Phase diagrams.	Development of phase diagrams for a binary alloy using the cooling curves.
Laboratory session 7. Polimeric and ceramic materials	Collaborative activity where the students use interactive videos about the synthesis and shaping processes of polymeric and ceramic materials. This activity also includes the following items: multiple choice questions, fill in the blank questions, drag and drop images, etc.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	32	60
Laboratory practical	12	6	18
Autonomous problem solving	7	7	14
Seminars	15	15	30
Objective questions exam	2	1	3
Problem and/or exercise solving	2	1	3
Essay questions exam	3	3	6
Essay questions exam	3	3	6
Essay questions exam	3	3	6
Essay	2	2	4

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

Methodologies

	Description
Lecturing	Teaching in the classroom of the key concepts and procedures for learning the syllabus contents. The students have a textbook with the contents of the subject, in addition to the information of the web that contains the file with the subject's slides. It is recommended a dedication of half hour or an hour per class period.

Laboratory practical	Application of the knowledge acquired to the resolution of problems of materials science and technology. A series of practices have been designed in accordance with the content of the subject in order to assimilate concepts explained in this class. All the practices will be carried out in the corresponding laboratories (materials, chemistry and computer) by the students in small groups (3-4 students).
Autonomous problem solving	In the seminars, the student will have to solve exercises and problems that will be corrected by the lecturer. Likewise, they will have to do exercises in individual way.
Seminars	Intensive 15-hour course for those students who have failed the subject on the first call, prior to the exam on the second call. Group tutoring with the lecturer.

Personalized assistance

Methodologies	Description
Autonomous problem solving	In the field of tutorial action, academic tutoring actions are distinguished, as well as personalized tutoring. In the first case, the students will have at their disposal hours of tutorials in which you can consult any questions related to the contents, organization and planning of the subject, etc. In the personalized tutorials, each student, individually, can discuss with the teacher any problem that is preventing him/her from properly monitoring the subject, in order to find between them some type of solution. By combining both types of tutorial action, it is intended to compensate the different learning rhythms through attention to diversity. The lecturers will answer the questions of the students, both in person, according to the schedule that will be published on the website of the center, and telematically (email, videoconference, Moovi forums, etc. .) by previous appointment.
Seminars	Academic tutoring and personalized tutoring.

Assessment

	Description	Qualification	Training and Learning Results		
Laboratory practical	Attendance, participation and periodical assignments.	15	B3 B6	C9	D1 D5 D9 D10
Objective questions exam	Several short tests consisting of theoretical questions will be carried out through the semester, with a maximum weight total of 10%	10	B3 B4 B6	C9	D1 D5 D9 D10
Problem and/or exercise solving	Two written exams (with a maximum weight total of 25%) consisting of the resolution of problems will be carried out through the semester.	25	B3 B4 B6	C9	D1 D5 D9 D10
Essay questions exam	A final continuous assessment consisting of all theoretical and practical contents will be carried out at the end of the semester. This exam will be graded over 10 points. Moreover, in this exam it will be necessary to overcome the 40% in each part (theory and problems)	40	B3 B4 B6	C9	D1 D5 D9 D10
Essay	An individual work related to the activities of seminars will be carried out (5%). In adittion, a collaborative work in groups of 2-3 students (5%) will be carried out in the last laboratory session, with the aim of having smaller groups and a longer period of time. This work is related to the contents of the subject and it evaluates the communication and the capacity for teamwork.	10	B4	C9	D1 D5 D9

Other comments on the Evaluation

CONTINUOUS ASSESSMENT:

The student must be examined of all the subject contents in the ordinary exam, if the final grade of continuous assessment is less than 5 and also in the following cases:

- The no realisation or delivery of any of the activities.
- Obtain a grade to inferior 4.0 points over 10 in any of the parts (theory and problems) of the final exam.

In the case that they do not fulfill those conditions, the maximum qualification of the student by continuous evaluation will be 4.0. In any case, the student that has passed the continuous evaluation, will have the possibility to attend to the ordinary exam to improve his/her grade.

INTENSIVE COURSE

In the case that the students do not pass the ordinary exam, they have to attend the extraordinary exam in July. The Defense University Center proposes for these students an intensive course of reinforcement during the months of June and July of 15 hours in three weeks, with the aim to prepare the exam.

ACADEMIC INTEGRITY:

Students are expected to show adequate ethical behaviour, committing to act honestly. Based on article 42.1 of the *Regulation on the evaluation, qualification and quality of teaching and the student learning process of the University of Vigo*, as well as point 6 of the fifth rule of *Order DEF/711/2022, of July 18, which establishes the requirements for evaluation, progress, and ongoing enrolment in military educational training centres for incorporation into the ranks of the Armed Forces,* **any violation of academic integrity in the assessment process, as well as the cooperation in it will result in the assignment of a failing grade to the student (zero) for the entire course in the corresponding assessment opportunity,** regardless of the percentage of importance that the test in question had in the overall continuous assessment and independently of other disciplinary actions that may be applied.

Sources of information

Basic Bibliography

Callister, William, **Introducción a la Ciencia e Ingeniería de los Materiales I y II**, Tercera, Reverté, 2003

Askeland, Donald R, **Ciencia e Ingeniería de los Materiales**, Primera, Paraninfo- Thomson Learning, 2001

Smith, William F, **Ciencia e Ingeniería de los Materiales**, Quinta, McGraw-Hill, 2014

Complementary Bibliography

Pero-Sanz Elorz, J. A., **Ciencia e Ingeniería de los Materiales: estructura y propiedades**, Cuarta, Dossat, 2006

Mangonon, P. L., **Ciencia de Materiales: selección y diseño**, Primera, Prentice Hall, 2001

Shackelford, James F, **Introducción a la Ciencia de Materiales para ingenieros**, Sexta, Prentice-Hall, 2007

Krauss, G., **Steels: heat treatment and processing principles**, Primera, ASM International, 2015

Recommendations

Other comments

In order to pass this subject, the student must remember the basic fundamentals of Physics and General Chemistry studied at High School.

In case of discrepancy in the information contained in this guide it will be understood that the edited version prevails in Spanish.