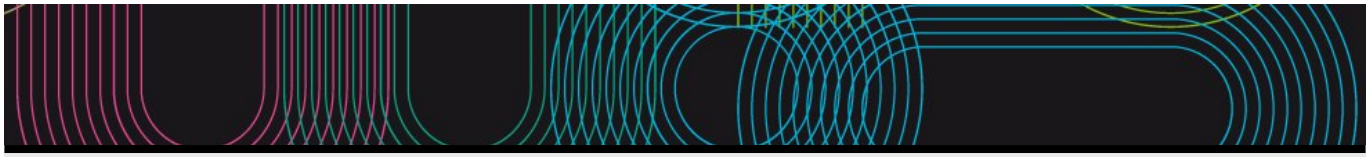

IDENTIFYING DATA				
Materials engineering				
Subject	Materials engineering			
Code	P52G381V01302			
Study programme	(*)Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Devesa Rey, Rosa			
Lecturers	Devesa Rey, Rosa González Gil, Lorena			
E-mail	rosa.devesa.rey@cud.uvigo.es			
Web	http://faitic.uvigo.es/			
General description	The subject Materials Engineering aims that the Graduated in Mechanical Engineering purchase the knowledges and the skills related with the foundations of the science, technology and chemical of materials, that allow the student to know the main material families (metallics, polymeric and ceramic) and including materials for tools and construction and all this related with their properties, behaviour in service and which basic treatments must be employed to modify them. Given the narrow relation between microstructure and properties, it will be of great importance that the student knows the main mechanisms to modify the constitution and structure of the materials and, with this, to achieve the optimisation of their properties. The learning results form part of the specifically assigned technologies to a graduated in Mechanical Engineering. When finalising this subject the student has to be able of: 1. To know the main forming and transformation processes used in the industry. 2. To know the characteristics of the materials more commonly employed in Engineering. 3. To argue the selection of a material for simple applications in the field of the industrial engineering. 4. To know the different thermal, thermochemical and thermomecanical treatments that can be applied both to materials for tools or construction. 5. To use the union processes more suitable, in function of the material.			

Competencies	
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.
B5	Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
B6	Capacity for handling specifications, regulations and mandatory standards.
B11	Knowledge, understanding and ability to apply the necessary legislation in the exercise of the profession of Industrial Technical Engineer.
C25	Knowledge and skills for engineering materials.
D5	Information Management.
D7	Ability to organize and plan.
D9	Apply knowledge.
D10	Self learning and work.
D15	Objectification, identification and organization.
D17	Working as a team.

Learning outcomes	
Expected results from this subject	Training and Learning Results

To know the main forming processes and transformation of materials used in the industry.	B3 B4	C25	D5
(*)Work the critical spirit #since a point of linguistic view and *tradutolóxico.			
To show capacity to select the prepararon process more adapted for the obtention of basic pieces from a determinate material.	B3 B4 B5	C25	D7 D9
(*)Work the critical spirit #since a point of linguistic view and *tradutolóxico.			
To know the main union processes of the materials used in the industry.	B3	C25	D9
To comprise the complex interrelationships between the properties of the materials and forming and union processes to be able to optimise the properties and the productivity in a wide margin of industrial states.	B4 B5 B6	C25	D9
To know the characteristics of the materials more usually employed in Engineering.	B3 B6	C25	D5
To know the evolution of the distinct types of materials and of the processes for his possible forming.	B3 B6	C25	D5
To know and to apply the selection criteria for the most adapted material and a concrete application.		C25	D9
To analyse and to propose operative solutions to problems in the field of materials engineering.	B4 B11		D9 D15
To interpret, analyse, synthesize and extract conclusions and results of measures and essays.	B4	C25	D7 D15
To draft texts with the suitable structure to the aims of communication. To present text to a public with the strategies and the suitable means.	B11		D5 D7 D17
To show capacities of communication and work in team.		C25	D17
To identify the own needs of information and uses the means, spaces and available services to design and execute suitable researches to the thematic field.	B4	C25	D5
To carry out to term the works entrusted from the basic orientations given by the professor, deciding the length of the parts, including personal contributions and expanding sources of information.	B4 B6	C25	D7 D10
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	C25	
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.1.- Ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses [intermediate (2)].	B4	C25	D9
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		D9
ENAEE learning outcome: ENGINEERING DESIGN: LO3.1.- Ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical societal, health and safety, environmental, economic and industrial considerations; to select and apply relevant design methodologies [basic (1)].	B4 B5		D7 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 B11		D5
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 [advanced (3)].		C25	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 [advanced (3)].		C25	D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.4.- Ability to apply norms of engineering practice in their field of study [intermediate (2)].	B6 B11		D9

ENAEE learning outcome: COMMUNICATION AND TEAM-WORKING: LO7.1.- Ability to communicate effectively information, ideas, problems and solutions with engineering community and society at large [basic (1)].	B4	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)].		D5 D7 D10 D17

Contents

Topic	
UNIT 1: MECHANICAL PROPERTIES OF MATERIALS Location and length: Weeks 1-2 [5 hours] Objective and development: This unit sims to study the main selection criteria of materials, including technological and mechanical properties. It also studied the location, extraction and concentration of metals in nature.	1.1 CRITERIA OF MATERIAL SELECTION Introduction. Parameters that influence in the selection process. Materials in the design process. Technological properties: Cost, supply and transformation. Relation with user. Interaction with the environment. 1.2 MECHANICAL PROPERTIES Introduction. Relation stress-deformation. Elastic and plastic behaviour. Ductility. Hardness. Fracture. 1.3 OBTENTION OF METALLIC MATERIALS Introduction. Abundance of metals. Metals in nature. Metallurgy: obtention of metals from one of their minerals. Concentration of ores.
UNIT 2: MATERIALS FOR TOOLS Location and length: Weeks 2-3 [4 hours] Objective and development: It is estudiad the metallurgy operations, which involve the extraction and production of steel, as well as the obtention of other relevant structural materials.	2.1 STRUCTURAL MATERIALS: METALS AND ALLOYS Introduction. Iron extraction and steel production. Recycling of steel and its environmental impact (UNE-EN 13437). Steels classification. Non-ferrous alloys. 2.2 MATERIALS FOR DEFENCE: STEELS FOR ARMOURS; ALLOYS OF ALUMINIUM, TITANIUM AND MAGNESIUM
UNIT 3: STRUCTURAL AND BUILDING MATERIALS Location and length: Weeks 3-4 [4 hours] Objective and development: This unit deepens in building materials, mainly in the technology of concrete and wood, as well as the uses of the polymers and ceramic, regarding the raw materials and degradation, among others.	3.1 THE PORTLAND CEMENT. TECHNOLOGY OF CEMENTS Raw materials (water, arids, additives) and manufacture. Reactions of hydratation and hardening. Expansion and contraction. Mechanical resistance. Inventory of emmisions. Measures in fresh and hardened concrete. Degradation of cements. 3.2 WOODS Structures, properties and main woods. Technology of woods. Degradation and recycling of woods. 3.3 POLYMERS Structures, properties and main polymers. Uses as building materials. Degradation and recycling of polymers. 3.4 CERAMICS Structure, properties and main ceramic materials. Uses as building materials. Degradation and recycling of ceramic materials.
UNIT 4: DEGRADATION OF MATERIALS. THERMAL, THERMOCHEMICAL AND THERMOMECHANICAL TREATMENTS Location and length: Weeks 4-6 [6 hours] Objective and development: This unit analyses the principles of materials corrosion, the importance of the different microstructures in steels and the thermal treatments, as well as thermochemical treatments, with and without change of composition of the material.	4.1 DEGRADATION OF MATERIALS. PROCESSES OF CORROSION Principles of corrosion. Types of corrosion. Thermodynamics and kinetics of corrosion. Protection against corrosion. 4.2 THERMAL TREATMENTS Introduction. Thermal cycle. Normalisation and annealing. Martensitic transformations: Time-Temperature-Transformation diagrams (TTT). Quenching. Isothermal treatments: austempering, martempering, isothermal annealing. Problems generated during the thermal treatments. 4.3 THERMOCHEMICAL AND SUPERFICIAL TREATMENTS Introduction. Superficial modification, without change of composition: Quenching by flame, induction or laser, hardening by transformation, superficial fusion. Superficial modification, with change of composition: carburization, nitrurization, carbonitrurization. Types of coatings: coatings by immersion, coatings by electrodeposition, annealing, ceramic coatings, physical and chemical deposition, thermal projection. Preparation of the surfaces by mechanical treatments: cleaning with dissolvent, cleaning with mechanical tools.

UNIT 5: MATERIALS SUBJECTED TO SMELTING, PLASTIC AND VISCOELASTIC DEFORMATION AND POWDER COMPACTION Location and length: Weeks 7 -9 [6 hours] Objective and development: This unit analyses the answer of different materials subjected to distinct processes of conformed, like the smelting of metals, the plastic deformation of metals, the molding, injection and extrusion of polymers and the poder metallurgy.	5.1 SMELTING Foundations of the smelting of metals 5.2 ANSWER OF THE MATERIALS SUBJECTED TO THE MAIN PROCESSES OF PLASTIC DEFORMATION 5.3 ANSWER OF THE MATERIALS SUBJECTED TO THE MAIN VISCOELASTIC PROCESSE Molding of polymers 5.4 POWDER METALLURGY
UNIT 6: UNION AND WELDING TECHNOLOGIES Location and length: Weeks 9-11 [3 hours] Objective and development: This unit analyses the main union technologies: the union by means of adhesives and the union by means of welding.	6.1 ADHESIVE MATERIALS 6.2 MATERIALS FOR WELDING

LABORATORY (14 hours)	P1. Obtention of aluminium by aluminothermy and/or electrolysis (2 hours) It is studied the concentration processes of metals from the ores by means of extraction processes. It will be employed AENOR norms (accessible database through the University of Vigo). For example, it will be proposed to research some of the following norms and the consequent resolution of questions: . Mechanical characteristics of the aluminium and its alloys (UNE-EN 683-2:2008) . Annealing of aluminium and its alloys (UNE 38019:2017) . Scrap of the aluminium and its alloys (UNE-EN 12258-3:2004). . Welding of the aluminium and its alloys (UNE-EN ISO 9692-3:2016). P2. Evaluation of building materials (concretes) (4 hours) The student manufactures concrete with different compositions and study its properties in fresh and hardened material. It is also analized the Instruction of Structural Concrete (EHE-08). Students work in groups the resolution of a more complex problem, so that its realisation need of the cooperative work of two students (or three students, exceptionally). It is included in this time the presentation and evaluation of the project. P3. Influence of corrosion in the modification of mechanical properties (2 hours) Student performs essays of corrosion in metals and study the reactions involved. P4. Superficial treatments of materials: cataphoresis and electrolytic cleaning (2 hours) Student makes treatments of surfaces recovery with painting applied by means of cataphoresis and elimination of oxides adhered with electrolytic cleaning. P5. Thermal treatments of materials: normalised, annealing and quenching (2 hours) Students test three thermal treatments on metal probes and their effects on mechanical properties. P6. Union technologies: evaluation of adhesives (2 hours) Student determine the most effective unions between materials by means of simple or hybrid unions, in different environmental conditions. They will use the AENOR norms (accessible database through the University of Vigo). For example, it will be proposed researches of some of the following norms and the consequent resolution of questions: . Self-adhesive tapes (UNE-EN 12481:2002) . Adhesives for paper, cardboard and packagings (UNE-CR 14376:2002) . Adhesives. Terms and definitions (UNE-EN 923:2016) The laboratory program may vary to adjust to the master classes or seminar sessions.
SEMINARS (7 hours)	Seminars in small groups, which will reinforce the contents of the master classes.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	38	66
Problem solving	7	14	21
Seminars	15	15	30
Laboratory practical	12	0	12
Essay questions exam	4	4	8
Problem and/or exercise solving	9	0	9
Presentation	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	In the masterclasses it will be explained the basics of each subject. Students will have in advance a summary of the Unit, in addition to the information that can be found on the course website, which contains the files with the pdf of the Unit. It is recommended to devote between half hour and an hour depending on the contents.
Problem solving	The methodology employed will be the resolution of problems and/or exercises. A series of practicas cases will be proposed to the students, so they have to solve them in pairs or small groups.
Seminars	Intensive course of 15 hours for those students that have suspended the subject in first opportunity, previous to the examination in second opportunity.
Laboratory practical	It consists in a series of laboratory practices in accordance with the Units explained in masterclasses, aiming at fixing concepts explained in masterclasses and helping the students to develope their skills to pose technical solutions.

Personalized assistance	
Methodologies	**Description**
Problem solving	The professors of the subject will attend personally the doubts and queries of the students, so much of face-to-face form, according to the schedule published in the CUD web page, as through telematic means (email, videoconference, FAITIC forums, etc.) under the modality of previous appointment.
Seminars	Tutorships in small groups with the professor.

Assessment					
	Description	Qualification	Training and Learning Results		
Problem solving	It will be evaluated: the autonomous resolution of exercises or questions, proposed by the professors, assessing, among other concepts: the proper resolution of exercises, the approach, order and delivery on time.	10	B4 B6 B11	C25	D5 D7 D9 D10 D15
Laboratory practical	It will be evaluated: the activities carried out in the laboratory, the resolution of questions made during the laboratory sessions, attitude and order in the laboratory and the resolution of questionnaires about the practices carried out, which can be done in person or through the virtual platform of the subject. They will evaluate the activities carried out in the laboratory, the resolution of questions of the script of practices, the attitude and order in the laboratory and the resolution of questionnaires about the practices made, that will be able to do *presencialmente or through the virtual platform of the subject.	10	B4 B6 B11	C25	D5 D7 D9 D10 D15
Essay questions exam	GLOBAL WRITTEN TEST: It will consist of a part of theory and a part of questions and/or problems. It is a necessary condition to pass the course by continuous evaluation obtain a minimum of 4 in each part.	40	B3 B4 B5 B6 B11	C25	D5 D7 D9 D15
Problem and/or exercise solving	INTERMEDIATE EXAMS: Two intermediate exams will be carried out (30%), in which all the topics explained so far will be evaluated.	30	B3 B4 B5 B6	C25	D5 D7 D9 D15
Presentation	EVALUATION OF LEARNING BASED IN PROJECTS: It will be evaluated the final project, taking into account criteria related to the content and format of the final memory delivered, as well as the use of the language, the quality of the presentation and the answers to questions of the professors. In the oral presentation, any member of the group has to answer to questions of the project. All have to show, therefore, deep knowledge of the product delivered, independently of the part in which they had centred their efforts.	10	B4 B6 B11	C25	D7 D9 D10 D15

Other comments on the Evaluation

Ordinary and Extraordinary Examinations In order to evaluate all the competences in the ordinary and extraordinary exams, these will include, in addition to questions of theory and part of problems, questions of the laboratory sessions. The evaluation will be considered positive when a score of 5 points out of 10 is reached.**Intensive course**Those students who have not passed the course at the first opportunity will attend an intensive course of 15 hours, in which tasks will be carried out to reinforce the main theoretical and practical contents taught in the course. At the end of such course the extraordinary examination will be carried out.**ETHICAL COMMITMENT**It is expected that students have an adequate ethical behavior. If

unethical behavior is detected (copying, plagiarism, use of unauthorized electronic devices or others), the student will be penalized with the impossibility of passing the subject by the continuous assessment modality (in which he will obtain a grade of 0.0). If this type of behavior is detected in ordinary or extraordinary exam, the student will obtain in the call a score in 0.0 points out of 10.

Sources of information

Basic Bibliography

W.D. Callister, Jr, **Introducción a la Ciencia e Ingeniería de los Materiales (I, II)**, 1, Reverté, 2012

S. Kalpakjian y S.R. Schmid, **Manufactura, Ingeniería y Tecnología 5ª Ed**, 5, Pearson Education, 2008

D.R. Askeland, **Ciencia e Ingeniería de los Materiales**, 1, Paraninfo-Thomson Learning, 2001

J.A. Puértolas Ráfales, R. Ríos Jordana, M. Castro Corella, J.M. Casals Bustos, **Tecnología de Materiales**, 1, Síntesis, 2009

M. Ashby, H. Shercliff, D. Cebon, **Materials: Engineering, science, processing and design**, 2, Butterworth-Heinemann, Elsevier, 2010

S. Barroso Herrero, J.R. Gil Bercero, A.M. Camacho López, **Introducción al conocimiento de los materiales y sus aplicaciones**, 1, Universidad Nacional de Educación a Distancia, 2008

Complementary Bibliography

Recommendations

Other comments

Students of the course Materials Engineering are recommended to review the contents of composition, structure and material properties of the Materials, Science and Technology course.

Contingency plan

Description

=== EXCEPTIONAL MEASURES SCHEDULED ===
In front of the uncertain and unpredictable evolution of the sanitary alert caused by the *COVID-19, the University of Vigo establishes an extraordinary planning that will activate in the moment in that the administrations and the own institution determine it attending to criteria of security, health and responsibility, and guaranteeing the teaching in a no face-to-face stage or partially face-to-face. These already scheduled measures guarantee, in the moment that was prescriptive, the development of the teaching of a more agile and effective way when being known in advance (or with a wide *antelación) by the students and the *profesorado through the tool normalised and institutionalised of the educational guides.

 Section 6 (CONTENTS):

The masterclasses and seminar activities may be taught in virtual classroom, keeping the distribution and contents of the face-to-face teaching. In the case of the laboratory practices, it will be proposed, when possible, the realisation of simulation practices, as well as bibliographic researches and the use of technical and/or scientific databases, ensuring in each case that student work the contents scheduled of each laboratory practice.

 Section 8 (EDUCATIONAL METHODOLOGIES): it is added the modality of synchronous virtual education and asynchronous:

Masterclasses session and/or synchronous virtual practical session: it will be employed a videoconference web plattform. Each virtual classroom contains diverse visualisation components, whose design can customise so that it adapts better to the needs of the class. In the virtual classroom, the professors (and those authorised participants) can share the screen or archives, employ a blackboard, chat, transmit audio and video or participate in online interactive activities (surveys, questions, etc.).

Masterclasses sessions and/or asynchronous virtual practical session: The recordings of the synchronous sessions will put to disposal of the students in the virtual subject, so that they can use them to review the concepts of each session.

 Section 10 (EVALUATION):
In case that they can not make evaluation in the face-to-face way, it will be proposed the combined use of the FAITIC-Moodle platform and the Remote Campus of the University of Vigo.