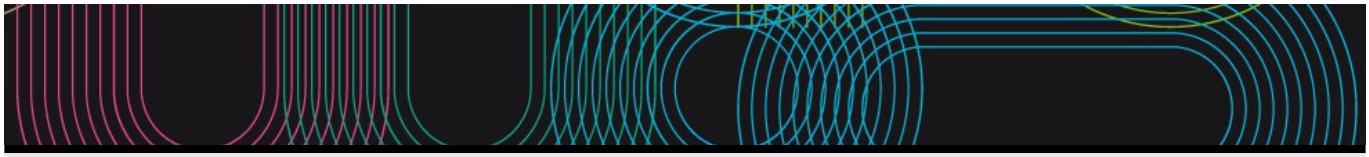

IDENTIFYING DATA				
Materials engineering				
Subject	Materials engineering			
Code	V12G363V01502			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	English			
Department				
Coordinator	Díaz Fernández, Belén			
Lecturers	Díaz Fernández, Belén			
E-mail	belenchi@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject combines the scientific fundamentals that prove the relation structure-properties-performance with technological aspects such as the manufacturing processes and the service conditions.			

Skills	
Code	
B3	CG3 Knowledge of basic and technological subjects that enable students to learn new methods and theories, and to adapt to new situations.
B4	CG4 Ability to solve problems through initiative, decision-making, creativity, critical reasoning, and to communicate and transmit knowledge, skills and abilities in the field of industrial engineering.
B5	CG5 Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
B6	CG6 Capacity for handling specifications, regulations and mandatory standards.
B11	CG11 Knowledge, understanding and ability to apply the legislation relating to industrial installations.
C19	CE19 Knowledge and skills for engineering materials.
D1	CT1 Analysis and synthesis.
D5	CT5 Information Management.
D7	CT7 Ability to organize and plan.
D9	CT9 Application of knowledge.
D10	CT10 Self learning and work.
D15	CT15 Objectification, identification and organization.
D17	CT17 Working as a team.

Learning outcomes	
Expected results from this subject	Training and Learning Results

Knowledge of the main manufacturing and transformation processes used in the industry	B3	C19	D1
Probe the ability to select the most suitable forming process for each material	B4		D5
Knowledge of the joining processes used in the industry	B5		D7
Understand the complex relations between the properties of materials and the forming and joining processes in order to improve properties and to increase productivity	B6		D9
	B11		D10
Knowledge of the characteristics of the materials used in engineering			D15
Knowledge of the several types of materials and processes for their forming			D17
Knowledge of the criteria for the selection of the most suitable material for an specific application			
Propose operative solutions for the most common problems in the materials engineering field			
Analyse conclusions and results of tests and measurements			
Write with a suitable structure. Make a presentation with the available media			
Show the aptitude of communication and working in teams			
Identify the need of information and use the available media and services to design and perform a suitable search in the subject area			
Perform the assigned projects following the indications given by the lecturer			

Contents

Topic	
Unit I: In-service materials performance.	Lesson 1. Fatigue Definition and importance. Fracture surface characteristics. S-N curve. Fatigue crack propagation and service life prediction. Cumulative fatigue damage: Palmgren-Miner□s rule. Influence of the mean stress: Goodman and Gerber criteria. Factors that influence on fatigue. Lesson 2. Fracture mechanics. Griffith and Irwin theories. Linear elastic fracture mechanics. Stress distribution at the crack tip: plain stress and plain strain. Plain strain fracture toughness. Lesson 3. Creep. Influence of temperature on strength. The creep curve: creep rate, creep strain, temperature and stress. Creep tests for metals and plastics. Influence of stress and temperature. Prediction of long-time properties. Development of creep resistant alloys. Materials selection. Deformation mechanisms. Lesson 4. Fundamentals of corrosion. Economic and social importance. Electrochemical corrosion. Thermodynamic analysis. Electrode potential and Pourbaix diagrams. Kinetic analysis. Corrosion rate. Polarization phenomena. Passivation. Corrosion control strategies: design, change of material and/or exposure environment, protective layers, cathodic and anodic protection.
Unit II: Metal-casting and forming processes, heat treatments and joining processes.	Lesson 5: Fundamentals of metal casting: especial casting methods. Castability: fluidity, no cavities and resistance to hot cracking. Casting alloys. Directional solidification, casting for single-crystal components and metallic glasses. Squeeze casting. Semi-solid forming (rheocasting and thixocasting). Lesson 6: Plastic forming of metals: cold working and hot forming. Strain hardening. Characteristics of cold working. Annealing of a cold-worked piece. Hot forming: dynamic recovery and dynamic recrystallization. Characteristics of hot forming. Benefits of hot forming for cast structures. Lesson 7. Heat treatments and thermomechanical treatments. Quench and hardenability. Tempering. Martempering and austempering. Thermomechanical treatments: definition and types. Controlled rolling, ausforming, isoforming and marforming. Lesson 8. Welding metallurgy. Classification of welding processes according to AWS. Thermal cycle: influencing factors. Weld zone: epitaxial and competitive growth. Heat affected zone. Solid solution strengthened alloys. Work-hardened alloys. Precipitation hardened alloys. Transformation hardening alloys. Post-welding treatments.

Unit III: Structural materials.	Lesson 9. Structural steels and stainless steels. Hot-rolled steels for general purposes. Microalloyed steels. Atmospheric corrosion resistant steels. Steels for quench and tempering. Low-temperature applications steels. Stainless steels. Passive layer characteristics. Classification. Lesson 10. Aluminum alloys. Strengthening of aluminum alloys. Classification of the aluminum alloys. Cast and wrought aluminum alloys. Lesson 11. Composite materials. Definition: advantages and drawbacks. Types of composite materials. Fiber-reinforced plastics: properties and fabrication. Laminated structures. Metallic and ceramic matrix composite materials.
Laboratory contents	Laboratory 1. Fractography and fatigue testing. Macroscopic and microscopic features of the fracture surfaces. Scanning Electron Microscope. Practical examples. Fatigue: general concepts. Fatigue testing: Wöhler curve. Factors that influence on fatigue. Examples. Laboratory 2. Corrosion technology. Corrosion protection. Electrochemical techniques for the corrosion assessment. Metallographic analysis. Assessment of protective layers. Thickness and adherence. Assessment of failure mechanisms. Laboratory 3. Metallography I: forming techniques. Cast structures: influence of cooling rate and alloying elements. Cold worked and hot formed structures. Laboratory 4. Metallography II: heat-treated alloys. Steels and Al alloys. Laboratory 5. Hardenability. Jominy test. Jominy curve. Objective and applications. Jominy test and results designation. Laboratory 6. Liquid penetrating and magnetic particles testing. Definition, objectives and applications. Testing methodology and report. Laboratory 7. Radiography and ultrasounds (I) Radiography: definitions, objectives and applications. Testing. Ultrasounds: through-transmission (transmitter-receiver) and pulse-echo modes. Ultrasonic inspection: calibration and thickness assessment. Laboratory 8. Ultrasonic inspection (II) Inspections of metallic pieces with a contact transducer. In-situ assessment of concrete structures. Sclerometer test: surface hardening and strength relationship. Ultrasonic inspections with the direct transmission mode. Ultrasonic pulse velocity in concrete: indirect mode. Ultrasonic pulse velocity and strength relationship. Laboratory 9. Exposition of projects. Each student will participate in the exposition of his/her group and will answer the questions posed either by the lecturer and/or by students from other groups.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	33	56	89
Problem solving	4	8	12
Seminars	3	3	6
Laboratory practical	13	19	32
Mentored work	0	11	11

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

Methodologies	
	Description
Lecturing	Presentations given by the lecturer of the main contents of the subject

Problem solving	Proposal of a set of problems/exercises that students must resolve by themselves. Guidelines, required formulas and common routines will be given in the classroom. Some problem will be resolved at the classroom, by the lecturer or by a student.
Seminars	Additional explanations to solve the main difficulties about the subject contents
Laboratory practical	Activities for application of the theoretical knowledge to particular situations and for the acquisition of basic skills and procedures related to the subject. Students will use the laboratories with the suitable equipment and devices.
Mentored work	Students, individually or in group, elaborate a document or presentation about some important topic related to the subject. Student can be asked to prepare a seminar, a short research, a summary of a document or conference...

Personalized assistance

Methodologies	Description
Mentored work	Personalized attention, the lecturer will guide the preparation of the project. Any difficulty/doubt will be attended. This support can be provided either in person or electronically (email, videoconference, campus remoto ...) after being formally requested.
Seminars	Personalized attention, time devoted to help students with any difficulty or doubt. IThis support can be provided either in person or electronically (email, videoconference, campus remoto ...) after being formally requested.

Assessment

	Description	Qualification	Training and Learning Results	
Lecturing	The assessment will be completed with two written exams of short questions, tests or exercises. The purpose is to assess the level of knowledge achieved along the course. One of the tests will be done during the teaching period (20%) and the other in the date established by the school	70	B3 B4 B5 B6 B11	D5 D7 D9 D10 D15
Laboratory practical	The laboratory activities will be assessed through the students attendance and participation, preparation of reports and a final test at the end of the teaching period	15		D5 D9 D10 D15 D17
Mentored work	It will be assessed by the handed reports and/or the exhibition in the classroom of the prepared project.	15	B3 B4 B11	D9 D10 D15

Other comments on the Evaluation

FIRST ATTEMPT:

The continuous assessment will be followed during the teaching period of the subject according to the criteria established in the previous section. In the final exam, a minimum mark of 2 out of 5 is required in the own written exam to pass the subject. The mark will be the sum of the mark achieved in the final exam plus the mark achieved in the continuous assessment.

In case this minimum mark was not achieved, the whole mark will be that corresponding to the maximum achieved mark, either in the continuous assessment or in the final exam.

Students have the right to renounce to the continuous assessment system. This option must be formally asked. In this situation, the final exam will include the totality of the contents of the subject, and its qualification is 100%. The date of the exam will be fixed by the school and can be checked at http://eei.uvigo.es.

SECOND ATTEMPT (exam in July):

The qualification obtained from the continuous assessment will be kept, unless the student request to be cancelled in due course. In this situation, the totality of the contents of the subject (those given in the classroom and in the laboratory) will be included in this final exam and the student could achieved 100% of the qualification (the minimum mark to pass the exam will be 5 out of 10).

The date of the exam will be fixed by the school and can be checked at http://eei.uvigo.es.

EXTRAORDINARY CALL: the exam (questions, tests and/or exercises) will include the totality of the contents and the qualification will be 100%.

Ethical commitment: student is expected to show an ethical behaviour. In the case a non ethical behaviour is detected (copy, plagiarism, use of forbidden electronic devices, or others), the student will failed with a qualification of 0%.

Sources of information

Basic Bibliography

Kalpakjian, S. and Schmid, S. R.,, **Manufacturing Engineering and Technology**, Pearson/Prentice Hall,

Mikell P. Groover, **Fundamentals of Modern Manufacturing: Materials, Processes, and Systems**, John Wiley & Sons,

Dieter, G. E., **MECHANICAL METALURGY**, McGraw-Hill Book Company,

Complementary Bibliography

Reina Gómez, M., **Soldadura de los aceros, aplicaciones.**, Gráficas Lormo,

Sindo Kou, **Welding Metallurgy**, John Wiley & Sons,

Krauss, G., **Steels: Heat Treatment and Processing Principles**, ASM International,

Brooks, CH., **Principles of the Surface Treatment of Steels.**, Inc. Lancaster,

Randall, M. G., **Sintering: Theory and Practice**, John Wiley & Sons,

Beeley, P., **Foundry Tecnology**, Butterworth-Heineman, Ltd.,

Recommendations

Subjects that continue the syllabus

Fundamentals of manufacturing systems and technologies/V12G363V01402
Mechanics of materials/V12G363V01404
Manufacturing engineering/V12G363V01604

Subjects that it is recommended to have taken before

Materials science and technology/V12G363V01301