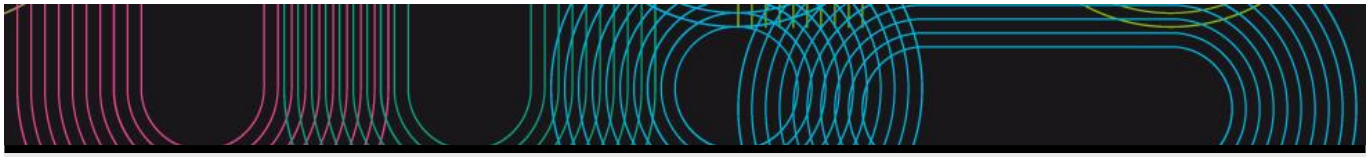

(*)Centro Universitario da Defensa da Escola Naval Militar de Marín

Grado en Ingeniería Mecánica

Subjects

Year 2nd

Code	Name	Quadmester	Total Cr.
P52G381V01201	Mathematics: Calculus II and differential equations	1st	6
P52G381V01202	Materials science and technology	1st	6
P52G381V01203	Thermodynamics and heat transfer	1st	6
P52G381V01204	Resistance of materials	1st	6
P52G381V01205	Fundamentals of electrical engineering	2nd	6
P52G381V01206	Mechanism and machine theory	2nd	6
P52G381V01207	Environmental technology	2nd	6
P52G381V01208	Fluid mechanics	2nd	6
P52G381V01209	English I	2nd	6

Year 3rd

Code	Name	Quadmester	Total Cr.
P52G381V01301	Electronic technology	1st	6
P52G381V01302	Materials engineering	1st	6
P52G381V01303	Elasticity and additional topics in resistance of materials	1st	6
P52G381V01304	Graphic engineering	1st	6
P52G381V01305	Fluid machines	2nd	6
P52G381V01306	Basics of business management	2nd	6

Year 4th

Code	Name	Quadmester	Total Cr.
P52G381V01401	Fundamentals of automation	1st	6
P52G381V01402	Fundamentals of manufacturing systems and technologies	1st	6
P52G381V01403	Thermal engineering I	1st	6

P52G381V01404	Theory of structures and industrial constructions	1st	6
P52G381V01405	Machine design	2nd	6
P52G381V01406	English II	2nd	6
P52G381V01407	Manufacturing engineering and dimensional quality	2nd	6
P52G381V01408	Radio-communication systems	2nd	6
P52G381V01409	Naval engines and machines	2nd	6
P52G381V01410	Basics of topography	2nd	6

Year 5th

Code	Name	Quadmester	Total Cr.
P52G381V01501	Technical Office	1st	6
P52G381V01502	Naval sensors	1st	6
P52G381V01503	Basics of computer networks	1st	6
P52G381V01504	Theory of the ship and shipbuilding	1st	6
P52G381V01505	Automobiles	1st	6
P52G381V01506	Complementary training	2nd	6
P52G381V01991	Final Year Dissertation	2nd	12

IDENTIFYING DATA

Mathematics: Calculus II and differential equations

Subject	Mathematics: Calculus II and differential equations			
Code	P52G381V01201			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Alvarez Hernandez, Maria			
Lecturers	Alvarez Hernandez, Maria González Coma, José Pablo			
E-mail	maria.alvarez@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The aim of this course is for students to learn the basic techniques of integral calculus in several variables, vector calculus, ordinary differential equations and their applications.			

Skills

Code	
CG3	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.
CG4	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.
CE1	Ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and partial differential equations, numerical methods, numerical algorithms, statistics and optimization.
CT1	Analysis and synthesis
CT2	Problems resolution.
CT3	Oral and written proficiency
CT6	Application of computer science in the field of study.
CT9	Apply knowledge.
CT15	Objectification, identification and organization.
CT16	Critical thinking.

Learning outcomes

Learning outcomes	Competences		
Understanding of the basic concepts of integral calculus in several variables.	CG3	CE1	CT1
Knowledge of the main techniques of integration of functions of several variables.	CG3 CG4	CE1	CT1 CT2 CT9
Knowledge of the main results of vector calculus and its applications.	CG3 CG4	CE1	CT1 CT2 CT9
Understand the importance of integral calculus, vector calculus and differential equations for the study of the physical world.		CE1	CT9 CT16
Apply knowledge of integral calculus, vector calculus and differential equations.		CE1	CT2 CT6 CT9 CT16
Acquisition of the ability to use this knowledge to solve questions, exercises and problems manually and by computer.		CE1	CT1 CT2 CT3 CT6 CT9 CT15 CT16
Acquire the basic knowledge for solving linear differential equations and systems.	CG3	CE1	

ENAEE LEARNING OUTCOME: KNOWLEDGE AND UNDERSTANDING: LO1.1 - Knowledge and understanding of mathematics and other basic sciences inherent to his/her engineering specialisation, at a level that allows the acquisition of the rest of the competences of the degree [development level (basic (1), adequate (2) and advanced (3)) of this sub-outcome: Adequate (2)].	CG3	CE1	
ENAEE LEARNING OUTCOME: ENGINEERING ANALYSIS: LO2.2 - The ability to identify, formulate and solve engineering problems in their speciality; to choose and apply established analytical, computational and experimental methods appropriately; to recognise the importance of social, health and safety, environmental, economic and industrial constraints [Adequate (2)].	CG4	CE1	CT1 CT2 CT9 CT16
ENAEE LEARNING OUTCOME: RESEARCH AND INNOVATION: LO4.3 - Ability and skill to design and carry out experimental investigations, interpret results and draw conclusions in their field of study [Adequate (2)].			CT9

Contents

Topic	
Integration in several variables	Curves and surfaces. Integration in the plane. Integration in space. Geometric and physical applications of the multiple integral.
Vector Calculus	Integration of fields along a curve. Integration of fields over a surface. Classical theorems of vector calculus. Applications.
Differential equations	General concepts. Methods for solving first-order ordinary differential equations. Second order linear differential equations. Systems of linear differential equations.
Numerical methods for initial value problems	Euler and Runge-Kutta methods.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	28	56
Problem solving	10	10	20
Mentored work	7	0	7
Practices through ICT	3	2	5
Seminars	15	13	28
Problem and/or exercise solving	4	4	8
Laboratory practice	1	1	2
Essay questions exam	9	15	24

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

Methodologies

	Description
Lecturing	The lecturer will expose in the theoretical classes the contents of the course. Students will have basic reference texts for the monitoring of the subject.
Problem solving	The lecturer will solve problems and exercises and the student will have to solve similar exercises to acquire the necessary capabilities.
Mentored work	The student will have to solve exercises and problems that will be corrected by the professor. Those exercises will be tackled in groups and will work on them.
Practices through ICT	The lecturer will solve problems and exercises through the use of the Matlab tool and the student will have to solve similar exercises to acquire the necessary abilities
Seminars	Intensive course of 15 hours for those students who have failed the subject in the first exam, prior to the exam at the second call.

Personalized assistance

Methodologies	Description
Problem solving	The faculty will personally answer the students' questions and queries, according to the timetable that will be published on the center's website, and by telematic means (e-mail, videoconference, Moovi forums, etc.) by appointment. In the sessions for problem solving, the professor will answer the questions raised by the students in a personalised manner.
Practices through ICT	In the sessions devoted to the accomplishment of informatics practices, the lecturer will answer the questions raised by the students.
Mentored work	In group tutorials, the lecturer will personally answer the questions of the students, will do complementary exercises or other activities.

Assessment

	Description	Qualification	Evaluated Competencess

Problem solving	A complementary activity will be carried out consisting of resolution of exercises.	15	CG3 CG4	CE1	CT1 CT2 CT3 CT6 CT9 CT15 CT16
Problem and/or exercise solving	There will be two mid-term exams on Topics 1 and 2.	30	CG3 CG4	CE1	CT1 CT2 CT3 CT9 CT15 CT16
Laboratory practice	A practical problem-solving exercise will be carried out with Matlab.	15	CG3 CG4	CE1	CT2 CT6 CT9
Essay questions exam	There will be a final continuous assessment exam on the contents of the whole subject.	40	CG3 CG4	CE1	CT1 CT2 CT3 CT9 CT15 CT16

Other comments on the Evaluation

GENERAL OBSERVATIONS ON THE CALCULATION OF THE MARK:

The continuous assessment will consist of two written tests, for the first two themes, with a weight of 15% each, a Matlab laboratory practical, with a weight of 15%, and a hand-in of exercises to be developed, with a weight of 15%, being the weight of the final exam of 40%.

Students will have to take the ordinary exam of all the contents of the course, which will be 100% of the grade, in the following cases:

- Failure to complete or hand in any of the above points.

- Obtaining a mark of less than 4 points out of 10 in the final continuous assessment exam.

- Obtaining a mark lower than 5 points in the continuous assessment.

In the circumstances described in the first two sections of the above list, the continuous assessment mark would be assigned as the minimum value between a 4.5 and the mark calculated according to the weightings described above.

In any case, students who have passed the continuous assessment will have the possibility of taking the ordinary exam in order to obtain a higher mark. The assessment of students in the second and successive examinations will consist of an exam about the contents of the subject which will account for 100% of the mark.

ETHICAL COMMITMENT:

Students are expected to behave ethically. If unethical behaviour is detected (cheating, plagiarism, use of unauthorised electronic devices or other) will be automatically penalised with a grade of 0.0 in the current session.

Sources of information

Basic Bibliography

E. Marsden, A.J. Tromba, **Cálculo Vectorial**, Pearson-Addison Wesley, 2004

G.F. Simmons, **Ecuaciones diferenciales con aplicaciones y notas históricas**, Mc-Graw Hill, 1993

Complementary Bibliography

A. Quarteroni, F. Saleri, **Cálculo científico con Matlab y Octave**, Springer, 2006

Recommendations

Other comments

In case of discrepancies, the Spanish version of this guide shall prevail.

IDENTIFYING DATA				
Materials science and technology				
Subject	Materials science and technology			
Code	P52G381V01202			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Alfonsín Pérez, Víctor Ángel			
Lecturers	Alfonsín Pérez, Víctor Ángel Devesa Rey, Rosa Urrejola Madriñán, Santiago Rafael			
E-mail	valfonsin@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			

Skills	
Code	
CG3	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.
CG4	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.
CG6	Capacity for handling specifications, regulations and mandatory standards.
CE9	Knowledge of the fundamentals of the science, technology and chemistry of materials. Understand the relationship between microstructure, the synthesis, processing and properties of materials.
CT1	Analysis and synthesis
CT5	Information Management.
CT9	Apply knowledge.
CT10	Self learning and work.

Learning outcomes	Competences		
Understanding the mechanical behavior of metallic, ceramic, plastics and composites materials	CG4 CG6		
Knowing how the properties can be modified using mechanical processes and thermal treatments	CG4	CE9	CT9
Knowing the basic techniques of the structural characterization of materials	CG3 CG6	CE9	
Ability in the handling of diagrams and graphics			CT1 CT5
Ability in performing experiments	CG6	CE9	CT10
To analyse the obtained results and their conclusions			CT1 CT9
Ability to apply standards of material testing	CG6		CT1 CT9
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)].	CG3	CE9	
ENAEE LEARNING OUTCOME. KNOWLEDGE AND UNDERSTANDING: LO1.3 - Awareness of the wider multidisciplinary context of engineering [Intermediate (2)].		CE9	

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)].	CG4		CT1 CT9
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)].	CG6		CT5
ENAEE LEARNING OUTCOME. INVESTIGATIONS: LO4.2.- Ability to consult and apply codes of practice and safety regulations in their field of study; [Basic (1)]	CG6		
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)].		CE9	CT9
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)].			CT9
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)].	CG4		CT9
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)].		CE9	CT9
ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE: LO5.4.- Ability to apply norms of engineering practice in their field of study. [Basic (1)].	CG6		CT9
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)].	CG6		
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)].	CG4		CT1 CT5
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)].			CT10

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: synthesis, doping of semiconductors.
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
Problem solving	7	7	14
Seminars	15	10	25
Objective questions exam	1	2	3
Problem and/or exercise solving	1	2	3
Report of practices, practicum and external practices	0	6	6
Essay questions exam	3	4	7
Essay questions exam	3	2	5
Essay questions exam	3	2	5
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).
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

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	Evaluated Competencess		
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	CG3 CG4 CG6	CE9	CT1 CT5 CT9 CT10
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	CG3 CG4 CG6	CE9	CT1 CT5 CT9 CT10
Report of practices, practicum and external practices	Attendance, participation and reports that will be delivered periodically	15	CG3 CG4 CG6	CE9	CT1 CT5 CT9 CT10
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	CG3 CG4 CG6	CE9	CT1 CT5 CT9 CT10
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	CG4	CE9	CT1 CT5 CT9

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.

ETHICAL COMMITMENT:

It is expected that students have an adequate ethical behaviour:

- If is detected an unethical behaviour (cheating, plagiarism, use of unauthorised electronic devices or others) during written exams, the student will be penalized with the impossibility to pass the course by the modality of continuous assessment, obtaining a qualification of 0.0.
- If this kind of behaviour is detected in ordinary or extraordinary exam, the student will obtain a qualification of 0.0.

- In the case of the practices reports, the total or partial copy in a report (according to the opinion of the lecturers), will be penalized in the final note of the practices with a qualification of 0.0.

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.

IDENTIFYING DATA				
Thermodynamics and heat transfer				
Subject	Thermodynamics and heat transfer			
Code	P52G381V01203			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	González Gil, Lorena			
Lecturers	Eiras Barca, Jorge González Gil, Lorena			
E-mail	lorena.gonzalez@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The aim of this subject is to train future graduates in Bachelor Degree in Mechanical Engineering with the ability to apply the principles of Thermodynamics and Heat Transfer required in almost all industrial processes and domestic installations. The knowledge of these principles is basic in Thermal Engineering, for instance, to carry out an energy analysis (determining the energy and exergy efficiency) of power systems for electricity generation (combined cycle with steam and gas turbine), a mechanical power cycle, a heat pump cycle, etc. The knowledge of whether a thermodynamic process can occur in reality is essential for the design of new processes, as well as the knowledge of the maximum benefits that can be obtained by the different devices present in an energy installation, and the causes hindering those maximum benefits. Furthermore, the study of the thermodynamic properties of the working fluids that circulate through the devices, water, air, refrigerants, gases and gas mixtures, is essential to analyse the behaviour of thermal systems. Likewise, studying the procedure needed for the energy analysis of refrigeration, air conditioning and in combustion processes is of great interest. On the other hand, it is essential for students to know the heat transfer mechanisms, focusing on determining the way and rate of the energy exchanged. Thus, at the end of the course, students are expected to be able to properly state and solve heat transfer engineering problems and to perform a basic design of heat exchangers.			

Skills	
Code	
CG4	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.
CG5	Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
CG6	Capacity for handling specifications, regulations and mandatory standards.
CG7	Ability to analyze and assess the social and environmental impact of the technical solutions.
CG11	Knowledge, understanding and ability to apply the necessary legislation in the exercise of the profession of Industrial Technical Engineer.
CE7	Knowledge of applied thermodynamics and heat transfer. Basic principles and their application to solving engineering problems.
CT2	Problems resolution.
CT7	Ability to organize and plan.
CT9	Apply knowledge.
CT10	Self learning and work.
CT17	Working as a team.

Learning outcomes	Competences		
Capacity to know, understand and use the principles and fundamentals of applied thermodynamics	CG4 CG5 CG6 CG7	CE7	CT2 CT7 CT9 CT10 CT17
Ability to know and understand the principles and fundamentals of heat transmission	CG5 CG6 CG7 CG11	CE7	CT2 CT7 CT9 CT10 CT17

Ability to know and understand the principles and fundamentals of thermal equipment and generators	CG4 CG6 CG7 CG11	CE7	CT2 CT7 CT9 CT10 CT17
Analyze the operation of thermal systems, such as heat pump systems, refrigeration cycles or power cycles, identifying components, as well as the cycles used to obtain high performance.	CG4 CG5 CG6 CG7 CG11	CE7	CT2 CT7 CT9 CT17
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- Knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [Level of achievement (Basic (1), Intermediate (2) and Advanced (3)) for this learning outcome: [Advanced (3)].		CE7	
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 [Advanced (3)].	CG4 CG7		CT2 CT9
ENAEE learning outcome: RESEARCH AND INNOVATION: 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. [Basic (1)].	CG6 CG11		
ENAEE learning outcome: RESEARCH AND INNOVATION: LO4.2.- Ability to consult and apply codes of practice and safety regulations in their field of study [Basic (1)].	CG6 CG7 CG11		
ENAEE learning outcome: RESEARCHING AND INNOVATION: LO4.3.- Ability to design and conduct experiments, interpret data and draw conclusions [Intermediate (2)].		CE7	CT9
ENAEE learning outcome: ENGINEERING PRACTICE LO5.4.- Ability to apply norms of engineering practice in their field of study [Basic (1)].	CG6 CG7 CG11		CT9
ENAEE learning outcome: ENGINEERING PRACTICE LO5.5- Awareness of non-technical -societal, health and safety, environmental, economic and industrial implications of engineering practice [Basic (1)].	CG7		
ENAEE learning outcome: MAKING JUDGEMENTS LO6.1.- Ability to gather and interpret relevant data and handle complex concepts within their field of study, to make judgements that involve reflection on ethical and social issues [Basic (1)].	CG6 CG7 CG11		

Contents	
Topic	
BLOCK 1 (B1): Properties of pure, simple and compressible substances	B1-1. Review of basic concepts and definitions - Systems definition - Description of the systems and their behaviour - Temperature measurement. Zero Law of Thermodynamics - Heat and specific heat - Phase change and latent heat - Ideal gas. State equations - The First Law of Thermodynamics - Thermodynamic transformations of an ideal gas - The Second Law of Thermodynamics B1-2. Properties of a pure, simple and compressible substance - Definition of the thermodynamic state - The p-v-T relationship - Calculation of thermodynamic properties - The ideal gas model - Internal energy, enthalpy and specific heats of ideal gases - Calculation of internal energy and enthalpy changes in ideal gases - Polytropic processes of an ideal gas

BLOCK 2 (B2): Energy analysis of systems according to the First and Second Law	B2-1. Energy analysis of control volumes - Conservation of mass - Conservation of energy - Steady state analysis - Transient analysis B2-2. The Second Law of Thermodynamics - Using the 2nd law - Formulations of the 2nd law - Identification of irreversibilities - Application of the 2nd low to thermodynamic cycles - The Kelvin temperature scale - Maximum efficiency measurements for cycles operating between two heat sources - The Carnot cycle B2-3. Entropy and its use - Clausius inequality - Definition of entropy change - Obtaining entropy values - Entropy change in internally reversible processes - Entropy balance for closed systems - Entropy balance for control volumes - Isentropic processes - Isentropic efficiencies of turbines, nozzles, compressors and pumps B2-4. Exergy analysis - Definition of exergy - Exergy balances - Exergy efficiency (second law)
BLOCK 3 (B3): Introduction to thermodynamic analysis of thermal motors and machines	B3-1. Power production facilities - Introduction to power production facilities - Vapor power production: the Rankine Cycle - Gas turbine power production facilities: the Brayton cycle - Combined cycle B3-2. Gas cycles in reciprocating internal combustion engines - Otto cycle - Diesel cycle B3-3. Refrigeration cycles - Refrigerators - Heat pumps

BLOCK 4 (B4): Fundamental concepts and principles in heat transfer	B4-1. Introduction to heat transfer - Fundamental concepts in heat transfer - Mechanisms of heat transfer: conduction, convection and radiation - Fourier's law. Thermal conductivity and diffusivity - Newton's law of cooling. Convection coefficient - Stefan-Boltzmann law. Emissivity and absorptivity B4-2. Heat transfer by conduction - General heat conduction equation - One-dimensional conduction in steady state. Plane walls - Thermal resistance. Thermal resistance network - Global heat transfer coefficient - Stationary conduction with thermal energy generation - Conduction in radial systems: cylinders and spheres B4-3. Heat exchangers - General considerations - Classification of heat exchangers. Characteristics and selection criteria - Parallel, countercurrent and cross flow temperature distribution - Considerations for the design of heat exchangers - Heat flow exchanged - Logarithmic mean temperature difference (DTML) method - Efficiency method-number of transfer units (E-NUT) B4-4. Heat transfer by convection - Movement of a fluid. Laminar and turbulent flows - Boundary layers of convection: hydraulic and thermal - Dimensionless numbers - Free and forced convection - Empirical correlations for external and internal flows B4-5. Heat transfer by radiation: general principles - Fundamental concepts. Electromagnetic spectrum. Thermal radiation - Blackbody radiation. Planck's Law. Wien's Law - Definitions: radiation intensity, irradiance, emissivity - Surface absorptivity, reflectivity and transmissivity - Kirchhoff's Law

PRACTICAL CONTENTS	The seven practices proposed aim to consolidate and deepen the knowledge acquired in the theoretical classes while developing research skills: design of experiments, analysis and collection of experimental data, discussion of results using appropriate sources of information, etc. PL 1. Mechanical equivalent of heat This practice aims to determine the mechanical equivalent of heat, that is, the relationship between the energy unit (Joule) and the heat unit (calorie). Through this practical experience, it is highlighted the large amount of mechanical energy that needs to be transformed into heat to significantly increase the temperature of a small mass. PL 2. Linear thermal expansion of solids Study of linear thermal expansion in iron, brass and aluminum thin tubes. Estimation and comparison of the coefficients of expansion of these materials. The implications of the materials expansion on structural safety will be evaluated, as stated in the Technical Building Code (CTE). PL 3. Introduction to thermographic techniques It is intended to initiate students in the use of thermographic cameras as a tool applied to the study of insulation in buildings and predictive maintenance. The environmental implications of their use will be analysed. The importance of emissivity in this technique will be studied. PL 4. Thermal conductivity of metals It will be determined the heat flux that occurs through U-shaped metal bars whose ends are immersed in hot and cold water. It will be proved that the heat flux depends on the composition of the material, as well as its cross section and length. PL 5. Determination of insulation properties It is intended to observe the thermal properties of different insulating materials for the management and understanding of concepts such as thermal insulation, thermal conductivity and heat capacity. PL 6. Heat exchanger The aim is to better understand the operation of heat exchangers, establish energy balances and determine the effectiveness and the integral coefficient of heat transfer as a function of the direction and flow of the fluids. Likewise, the DTLM and ε-NUT methods will be validated and the dimensionless numbers will be applied to estimate the theoretical heat transfer coefficients. PL 7. Alternative energies. Study of a solar collector. It is intended to initiate students in the study of a solar collector, analyse the energy received by radiation and make an energy balance of the energy used for domestic hot water, thus being able to meet the requirements of the CTE. Different configurations of the equipment will be tested in order to understand its operation and find the one that maximizes energy use.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	37	65
Laboratory practical	14	7	21
Problem solving	7	7	14
Seminars	15	12	27
Problem and/or exercise solving	0	4	4
Objective questions exam	4	4	8
Essay questions exam	3	2	5
Essay questions exam	6	0	6
*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. In addition to the information published on the online teaching platform Moovi, which contains the file with the lesson slides, the students have in the recommended bibliography the contents of each leasson with a more detailed development.
Laboratory practical	Application of the knowledge acquired in the lectures to the resolution of practical problems. A series of practices have been designed in accordance with the content of the subject in order to fix the explained concepts, so that the the student develops his creativity and his ability to propose technical solutions
Problem solving	The student must solve exercises and problems related to the subject individually.
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. The lecturer briefly reviews theoretical concepts of the subject and proposes problems to be solved, while individually supervising the work of each student. An active learning methodology is promoted.

Personalized assistance

Methodologies	Description
Lecturing	Assistance in groups of approximately 40 students. To complement the personalized assistance, a tutorial action will be carried out. In the scope of the tutorial action, it can be distinguished between academic tutoring actions (in group or individually) and personalized tutoring. Both types of tutorial action are combined to compensate for the different learning rhythms and thus paying attention to diversity. The lecturers of the subject will solve the questions and queries of the students in person or online (via email, videoconference, Moovi forums, etc.) at the time scheduled on the website of the center or by appointment.
Laboratory practical	Assistance in groups of 20 students. It is complemented with academic and personalized tutoring.
Problem solving	Assistance in groups of 10 students. It is complemented with academic and personalized tutoring.
Seminars	Continuous tutorng action, with constant support by the lecturer to the student's learning process. Students receive personalized assistance in small groups. It is complemented with academic and personalized tutoring.

Assessment

	Description	Qualification	Evaluated Competencess
Laboratory practical	The assessment will be carried out through deliverables and a questionnaire (ECP). The questionnaire will be loaded in Moovi and it will assess the knowledge acquired in the lectures and in the laboratory related to the practices. On the other hand, the deliverables of each practice evaluate the quality of the experimental data collection, the understanding of the practice, synthesis capacity, logical reasoning, teamwork and the search for appropriate sources of information that help to understand the problem under study and to contrast the results obtained. The mark of each deliverable and the questionnaire will be out of 10 points. The global grade of practices will be the average of the mark of all the deliverables and the questionnaire.	20	CG4 CE7 CT2 CG5 CT7 CG6 CT9 CG7 CT10 CG11 CT17
Problem and/or exercise solving	During the semester different tasks (TE) will be proposed, some will be individual and others may be in group. The objective of these tasks will be to promote the understanding of the theoretical/practical contents and to delve into other key aspects of the subject, such as the management and application of regulations such as the Technical Building Code in matters of energy saving. These activities will be compulsory and scored, each one of them, out of 10 points.	10	CG4 CE7 CT2 CG5 CT7 CG6 CT9 CG7 CT10 CG11 CT17
Objective questions exam	Mid-term exams (PP) Their objective is to evaluate the theoretical contents and the ability to solve problems acquired during part of subject, since two mid-term exams will be conducted (weighting 15% each). These tests will consist of a series of questions and exercises that prioritize conceptual and logical reasoning, in order to verify the intellectual maturity of the students to obtain conclusions from contents presented in lectures. Both test will be compulsory and scored on 10 points each.	30	CG4 CE7 CT2 CG5 CT7 CG7 CT9 CG11 CT10
Essay questions exam	Final Exam (EF) Its objective is to evaluate the theoretical contents and the ability to solve problems acquired during the whole subject in the lectures and seminars. This test will consist of a series of questions and exercises that prioritize conceptual and logical reasoning, in order to verify the intellectual maturity of the students to obtain conclusions from contents presented in lectures. This test will be compulsory and scored on 10 points.	40	CG4 CE7 CT2 CG5 CT7 CG7 CT9 CG11 CT10

Essay questions exam	Ordinary and Extraordinary Exam If the students do not pass the continuous evaluation, they will have an ordinary exam after the final exam. In this exam the students will be evaluated of all the contents taught in the lectures, seminars and practical sessions. This exam will represent 100% of the final grade of the student. It will be necessary to obtain a grade higher than 5 points out of 10 to pass the exam. If the students do not pass the ordinary exam, they would go directly to the second call in July. In the extraordinary exam the student will be examined of all the theoretical/practical contents taught in the subject during the ordinary course.	100	CG4 CG5 CG6 CG7 CG11	CE7	CT2 CT7 CT9 CT10

Other comments on the Evaluation

Sources of information

Basic Bibliography

Çengel, Yunus y Boles, Michael, **Termodinámica**, 9ª, McGraw-Hill, 2019

Moran M.J. y Shapiro H.N., **Fundamentos de Termodinámica Técnica**, 2ª, Reverté, 2015

Çengel Y.A., y Ghajar A.J., **Transferencia de Calor y Masa. fundamentos y aplicaciones**, 6ª, McGraw-Hill, 2020

Incropera F.P. y DeWitt D.P, **Fundamentos de transferencia de calor**, 4ª, Pearson Education, 2000

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Wark, K. y Richards, D.E., **Termodinámica**, 6ª, McGraw-Hill, 2001

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Çengel Y.A., **Introduction to Thermodynamics and Heat Transfer**, McGraw-Hill, 2008

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Segura, J, **Termodinámica Técnica**, Reverté, 1988

Baehr, H. D, **Tratado moderno de termodinámica**, Tecnilibro, S.L, 1987

Holman, J. P, **Transferencia de Calor**, 8ª, Mc Graw-Hill, 1998

Agüera Soriano, J, **Termodinámica Lógica y Motores Térmicos**, Ciencia 3, S.A.,

Alarcón Aguín, J. M.; Granada Álvarez, E.; Vázquez Alfaya, M. E., **SISCECT, Simulación y cálculo de ciclos termodinámicos**, Bellisco, 1999

Chapman A.J., **Transmisión de calor**, 3ª, Bellisco, 1990

Lienhard IV J.H., Lienhard V J.H., A, **A heat transfer textbook**, Phlogiston Press, 2005

Segura J., y Rodriguez J, **Problemas de Termodinámica Técnica**, Reverté, 1993

Lacalle, Nieto, **Problemas de Termodinámica Técnica**, 3ª, Dextra, 2017

Corrochano Sánchez, C.; Muñoz Antón, J,; Ortiz Gómez, A.; Fernández Benítez, J.A., **Problemas de transferencia de calor**, Dextra, 2014

Recommendations

Subjects that continue the syllabus

Thermal engineering I/P52G381V01403

Other comments

To successfully complete this subject, the student must have the following skills:

- Written and oral comprehension.
- Abstraction, basic calculation and synthesis of information.

IDENTIFYING DATA				
Resistance of materials				
Subject	Resistance of materials			
Code	P52G381V01204			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Regueiro Pereira, Araceli			
Lecturers	Regueiro Pereira, Araceli Suárez García, Andrés			
E-mail	regueiro@cud.uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	Introduction to linear elastic materials, and analysis of internal loadings, stress and strain relationships. Study of the fundamentals of mechanics of materials and particularization for shafts and beam structures.			

Skills	
Code	
CG3	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.
CG4	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.
CE14	Knowledge and use of the principles of strength of materials.
CT1	Analysis and synthesis
CT2	Problems resolution.
CT9	Apply knowledge.
CT10	Self learning and work.
CT16	Critical thinking.
CT17	Working as a team.

Learning outcomes	Competences		
Know the differences between rigid and elastic solids.	CG3 CG4	CE14	CT1 CT2 CT9 CT10 CT16 CT17
Apply the acquired knowledge to maximum stress calculation at a point in a deformable solid.	CG3 CG4	CE14	CT1 CT2 CT9 CT10 CT16 CT17
To know the basic principles governing Strength of Materials.	CG3 CG4	CE14	CT1 CT2 CT9 CT10 CT16 CT17
To know the relationships between the different stresses and the stresses they cause.	CG3 CG4	CE14	CT1 CT2 CT9 CT10 CT16 CT17

Apply the acquired knowledge to the determination of stresses.	CG3 CG4	CE14	CT1 CT2 CT9 CT10 CT16 CT17
Apply the acquired knowledge of stresses to their estimation in bar elements.	CG3 CG4	CE14	CT1 CT2 CT9 CT10 CT16 CT17
To know the fundamentals of the deformations of bar elements.	CG3 CG4	CE14	CT1 CT2 CT9 CT10 CT16 CT17
Apply the knowledge acquired to the dimensioning of busbar elements.	CG3 CG4	CE14	CT1 CT2 CT9 CT10 CT16 CT17
ENAEE LEARNING OUTCOME: KNOWLEDGE AND UNDERSTANDING. LO 1.2: Knowledge and understanding of the engineering disciplines specific to their speciality, at the level necessary to acquire the rest of the competences of the degree, including notions of the latest developments. Level of development: Adequate (2). NOTE: The possible values for the level of development are: Basic (1), Adequate (2) and Advanced (3).	CG3	CE14	
ENAEE LEARNING OUTCOME: ENGINEERING ANALYSIS. LO 2.2: The ability to identify, formulate and solve engineering problems in their speciality; to choose and apply established analytical, computational and experimental methods appropriately; to recognise the importance of social, health and safety, environmental, economic and industrial constraints. Level of development: Adequate (2).	CG4		CT1 CT2 CT9 CT16
ENAEE LEARNING OUTCOME: RESEARCH AND INNOVATION. LO 4.3: Ability and skill to plan and carry out experimental research, interpret results and reach conclusions in their field of study. Level of development: Basic (1).		CE14	CT9

Contents	
Topic	
Topic 1. Statics	- Concept of the elastic solid - Vector. Dot Product and Cross Product - Moment of a force - Static balance. Equations - Moments and products of inertia - Static balance and elastic balance - Requests on a section in elastic regime
Topic 2. Basic concepts of Strength of Materials	-Object and purpose of strength of materials - Tensions and deformations. - Tension state. Stress matrix. Mohr's circle - Principle of relative stiffness and superposition - Elastic balance - Reactions in ligatures. Types of supports - Isostatic and hyperstatic systems - Security coefficient. Admissible tension
Topic 3. Traction-Compression	- Normal effort - Tensile deformations - Statically determinate problems - Hyperstatic problems - Monoaxial traction or compression caused by thermal variations or assembly defects
Topic 4. Fundamentals of buckling	- Definition - Critical load. Euler's formulation - Application limits of the Euler formulations

Topic 5. Bending and shear	- Beams. Deformation and classes. Forces applied to beams - Shear stress and bending moment - Relations between shear stress, bending moment and load - Diagram of shear forces and bending moments - Types of bending. Assumptions and limitations - Normal tensions. Navier's Law - Concept of resistant module. Optimum sections - Analysis of deformations: turns and arrows. Moment-curvature relationship. Elastic equation. Theorems for the calculation of deformations - Hyperstatic flexion
Topic 6. Failure criteria	- Limit state - Ductile material - Fragile material - Security factor
Laboratory Session 1: Tensile test	The student will play with tensile test, as well as the normative that describe them.
Laboratory Session 2: F-Tool software practice (I)	The student will calculate tensile and shear stress values in different assumptions by using a structural calculation software.
Laboratory Session 3: Compression test	The student willl play with compression test, as well as the normative that describe them. You will make different more and less slender prototypes and calculate the critical force. The grip must be the same for all of them, implying a sudden change of section. The normal stress diagram will also be calculated.
Laboratory Session 4: Shear test	The student willl play with shear test, as well as the normative that describe them.
Laboratory Session 5: Bending test	The student willl play with bending test, as well as the normative that describe them. Analyze different configurations: bi-embedded, bi-articulated and bi-supported beam. Calculate the bending moment and the deflection associated with each of them.
Laboratory Session 6: Modulus of elasticity	This practice will focus on the calculation of the experimental modulus of elasticity. The student will use the data collected by the student in the previous laboratory sessions. For this, the association of the elastic modulus and the tensions in each test carried out will be reviewed.
Laboratory Session 7: F-Tool software practice (II)	Student will analyze bar structures of increasing complexity, obtaining tensile, shear and bending stresses, as well as the deformation under different types of load.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	28	56
Laboratory practical	14	14	28
Seminars	7	0	7
Essay questions exam	13	26	39
Laboratory practice	15	5	20

*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 lectures, the fundamentals of each topic are explained. Students will have the slides of the lectures at their dispossal
Laboratory practical	In laboratory sessions, the concepts taught in lectures will be applied. A series of practices have been designed to show the concepts explained in lectures and develop the student ability to propose technical solutions.
Seminars	In the seminars, a series of problems are analysed and proposed to be carried out. Students must solve exercises and problems under the supervision of the lecturer

Personalized assistance

Methodologies	Description

Lecturing	In the personalized assistance, a distinction is made between academic and personalised assessment. In the academic assessment, students will have at their disposal tutoring sessions in which they can ask any question related to the contents, organisation and planning of the subject. In the personalised assessment, each student, individually, will be able to discuss with the lecturer any problem that is preventing him/her from following the course properly, in order to find some kind of solution between them. By combining both types of assessment, the aim is to compensate for the different learning rhythms through attention to diversity. Both will be scheduled by appointment

Assessment

	Description	Qualification	Evaluated Competencess		
Essay questions exam	Final Test (PF) which represents 40% of the continuous assessment (EC). 2 Theoretical-Practical Controls (PT) representing: 2x15%=30% of EC.	70	CG3 CG4	CE14	CT1 CT2 CT9 CT10 CT16
Laboratory practice	Practice Reports (PL) which represent 20% of the EC. Questionnaires and Tests (CT) representing 10% of EC.	30	CG3 CG4	CE14	CT1 CT2 CT9 CT16 CT17

Other comments on the Evaluation

Continuous assessment

The continuous assessment (EC) method will assess the results achieved by students in the different activities carried out throughout the course, grouped into four parts: Final Exam (PF), Theoretical-Practical Controls (PT), Laboratory Practices (PL) and Deliverable Reports (PE). The weights for each part will be: PF 40 %, PL 30 %, PE 20 % and CT 10 %.

There will be two evaluation controls of theoretical-practical knowledge (PT1 and PT2) throughout the course. Each of them will account for 15 % of the final continuous assessment mark. These controls will be interspersed with the theory sessions. The PT FINAL grade will be the arithmetic mean of PT1 and PT2.

The student will be assessed for each laboratory session carried out (PL1 to PL7). Each practice will account for 3% of the final continuous assessment grade, except for PL2 and PL7, which will be 2.5%. This evaluation will be carried out by reports or questionnaires. It could be the case that a report and a questionnaire could be requested simultaneously for the assessment of a single session. The delivery of the reports and the completion of the questionnaires will be carried out telematically through the MOOVI platform. In addition, during seminar and/or theory class hours, students will be asked to complete and submit different exercises (PE).

The final continuous assessment test (PF) will include all the contents of the subject and will have a weight of 40% in the final continuous assessment mark.

The continuous assessment mark (NEC) will be the result of applying the weighted arithmetic average of the marks for each of the parts (PF, PT, PL and PE), as shown in the following equation:

NEC=0.4 PF+0.3 PT+0.2 PL+0.1 CT

In order to pass the continuous assessment, two conditions must be met: having a NEC≥5 and a PF≥4. If the latter condition is not met, the PL grade will be ignored, and the student will obtain a failing grade in the continuous assessment of the subject, with a score equal to the minimum of 4.0 and the weighted average of PF and PT.

Ordinary exam

Those students who do not manage to pass the subject by the continuous assessment method must do the ordinary exam, where all the competences of the subject will be assessed. The results of this exam will account for 100% of the student's final mark. A mark greater than 5 is a requirement for passing the course. Finally, it is worth highlighting that all students have the option to raise their NEC. In other words, students who have passed the subject by continuous assessment will have the possibility of taking the ordinary exam to improve their mark.

Extraordinary exam

Students who have not passed the course in the ordinary exam will sit an extraordinary exam which will have the same format and the same requirements as the ordinary exam.

Ethical commitment

As both a member of the military and a student of the University of Vigo, the student is subject to the obligations derived from both institutions. As far as university students are concerned, the University Student Statute, approved by Royal Decree 1791/2010 of 30 December, establishes in article 12, point 2d, that university students have the duty to "refrain from using or cooperating in fraudulent procedures in assessment tests, in the work carried out or in official university documents". Likewise, the Law 39/2007 on Military Careers, in its article 4 concerning the rules of behaviour of the military, states in its fifteenth rule that the military "shall perform their duties and obligations with accuracy, motivated by a sense of honour, [...]".

Therefore, the student is expected to behave ethically. If unethical behaviour is detected during the course (cheating, plagiarism, use of unauthorised electronic devices or other), the student will be penalised with a grade of "0.0" on the written test or deliverable and will have an NEC of "0.0" at the end of the term.

Sources of information

Basic Bibliography

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Complementary Bibliography

Hibberler, R.C., **Mecánica de materiales**,

Ferdinand P. Beer, E. Russel Johnson, JR., David F. Mazurek & Elliot R. Eisenberg, **Mecánica vectorial para ingenieros**,

Recommendations

Other comments

The subject Strength of Materials is the study of the behaviour of real materials in relation to their strength, stiffness and stability. This course requires the necessary conceptual basis for its correct understanding. For this reason, in order to successfully complete it, the student must have:

- Ability of written and oral comprehension.

- Ability of abstraction, basic calculation and synthesis of information.

IDENTIFYING DATA				
Fundamentals of electrical engineering				
Subject	Fundamentals of electrical engineering			
Code	P52G381V01205			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Falcón Oubiña, Pablo			
Lecturers	Falcón Oubiña, Pablo González Prieto, José Antonio Val García, Jesús del			
E-mail	pfalcon@cud.uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	The knowledge of electricity, its use and its protections is basic for the development of any kind of engineer, regardless of his branch. That is why Fundamentals of Electrical Engineering represents one of the most important pillars of the knowledge of the future technician, and given its broad spectrum, it will contain a theoretical part and a further part eminently practical. The main objective of this course is to transmit the fundamental concepts of the Theory of Circuits and Electrical Machines for application in the design of electrical distribution systems and electronic circuits. These concepts represent the basis of electrical engineering which brings together different aspects and technical sciences such as, among others, Electronics, Power Electronics, Control and Regulation, Automation Systems and Electrical Machines. All this forms the basis of the current field of action of industrial electricity.			

Skills	
Code	
CG3	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.
CE10	Knowledge and use of the principles of circuit theory and electrical machines.
CT1	Analysis and synthesis
CT2	Problems resolution.
CT6	Application of computer science in the field of study.
CT10	Self learning and work.
CT14	Creativity.
CT16	Critical thinking.
CT17	Working as a team.

Learning outcomes			
Learning outcomes	Competences		
To understand the basics of the operation of circuits and electrical machines	CG3	CE10	
Familiarisation with current techniques for the analysis of electrical circuits		CE10	CT6
Know the techniques of measure of electrical circuits			CT6 CT10
To acquire skills on the process of analysis of electrical circuits			CT1 CT2 CT6 CT10 CT14 CT16 CT17
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	CG3		
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.3.- awareness of the wider multidisciplinary context of engineering [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].		CE10	

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 [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	CT2 CT16
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 [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	CT6
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 [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	CT10 CT17

Contents	
Topic	
Unit 1. Direct current circuits	This topic aims to study the techniques of analysis and resolution of basic DC circuits. 1.1 Introduction and general concepts. Common measurement units. 1.2 Electrical circuit. Elementary components. 1.3 Kirchhoff's Laws. 1.4 Voltage and current sources. Font conversion. 1.5 Voltage and current dividers. 1.6 Serial and parallel association. 1.7 Analysis of circuits by nodes and meshes. 1.8 Theorems of Thévenin and Norton.
Unit 2. Alternating current circuits	The objective of this topic is to study the techniques of analysis and resolution of basic alternating current circuits. 2.1 Periodic waveforms and associated parameters. 2.2 Phasorial representation. 2.3 Impedance and admittance concept. Elements of the circuit: Resistance, Capacitor and Inductor. 2.4 Active, reactive and apparent power. Triangle of powers. Power factor 2.5 Analysis of alternating circuits
Unit 3. Three-phase current circuits	This topic aims to study the techniques of analysis and resolution of basic circuits in three-phase current. 3.1 Definition and origin of three-phase systems. 3.2 Star-delta connection. 3.3 Balanced three-phase systems. 3.4 Power in three-phase systems. Measuring systems. 3.5 Power factor. Definition, use and correction.
Unit 4. Direct current machines	The objective of this topic is to understand the operation, parameters basic and utilities of a DC machine. 4.1 Basic constituent elements and operating principle. 4.2 Switching. Reaction of the armature. 4.3 Power balance and losses. 4.4 Excitation and equivalent circuits. Torque-speed curves. 4.5 Inversion of the direction of rotation and speed regulation.
Unit 5. Transformers	This topic aims to understand the operation, basic parameters and uses of a transformer. 5.1 Principle of operation of transformers and main parts 5.2 Real transformer. Equivalent circuit. 5.3 Running regime. 5.4 Open and short circuit tests. 5.5 Losses and performance. 5.6 Excitation and connection current. 5.7 Constructive characteristics.

Unit 6. Asynchronous machines	This topic aims to understand the operation, parameters and utilities of an asynchronous machine. 6.1 Principle of operation. Fundamental parts. 6.2 Equivalent circuit. 6.3 Open and short circuit tests. 6.4 Power balance. Rotational torque and maximum torque. 6.5 Start-up. Speed regulation
Unit 7. Synchronous machines	This topic aims to understand the operation, parameters and utilities of a synchronous machine. 7.1 Principle of operation. Fundamental parts. 7.2 Types of excitation. 7.3 Linear and non-linear analysis. Equivalent circuit. 7.4 Alternator. Characteristics and applications. 7.5 Active and reactive power. 7.6 Balance of power, performance and torque. 7.7 Starting a synchronous motor
Practices Block I	Practices related to electrical circuits The aim of this group of practices is that the student understands the basic concepts of continuous, alternating and three-phase circuits, as well as a methodology for solving them. To do this, electronic instrumentation equipment will be used, as well as basic circuits assembled on prototyping boards. In the practices of this block it will be proposed the assembly and analysis of electrical diagrams whose operation is not known a priori. Practice 1: Dangers of electric current. Protection measures. Introduction to the handling of instrumentation equipment and assembly of basic DC circuits. This practice has a double objective. In a first part, the student will be taught the precautions to be taken when handling electrical circuits, making him aware of the dangers related to electric current, presenting him the basic electrical safety measures, the operation of protection and safety devices, and teaching him how to manage the danger. In the second part of the practicum, the student will be familiarized with the instrumentation equipment of the Electrical Engineering Laboratory by assembling basic DC circuits on a prototyping board (or breadboard). These circuits will include basic assemblies for measuring voltages in series and parallel, as well as voltage and current dividers. Practice 2: Assembly of direct current circuits This practice aims to make more advanced circuits and aims to have the student experiment with resistive elements and sources on a prototype board. The student will check concepts seen in theory like Ohm's law, Thevenin's theorem, Boucherot's theorem, etc. Practice 3: Assembly and measurement of alternating current circuits In this practice, the assembly of alternating current circuits is carried out in prototyping board, as well as learning how to use the functions and make measurements with the oscilloscope. Practice 4: Simulation of PSIM circuits in alternating current The student will learn how to analyze a circuit in AC by means of the PSIM circuit simulation software. Practice 5: Three-phase energy systems The objective of this practice is to introduce students to the use of real three-phase systems. The sources in the lab will be used to feed passive loads and measure their consumption parameters with three-phase measuring equipment.

Practices Block II	The purpose of this group of practices is for the student to understand the basic concepts of motors and electric machines. Panels with different electrical machines will be used, as well as simulation software. In the practices of this block, tests or assemblies of machines without previous assembly guide will be proposed. Practice 6: Dangers of electrical machines. Protection measures. Tests on single-phase transformer. The objective of this practice is twofold. In the first part, the student will be taught the precautions to be taken when working with electrical machines, explaining the basic safety measures, the operation of the protection and safety devices, and teaching him how to manage the danger. In the second part of the practical, the student will learn the main characteristics of a single-phase transformer. For this purpose, he/she will experimentally determine the parameters that govern its operation, using the so-called open and short-circuit tests. The student must be able to carry out the appropriate assembly for the realization of these tests, measuring voltages, currents and powers. From the result of the measurements, the student must be able to interpret the obtained data and get from them the necessary information to know and quantify the different power losses in a real transformer. With these data the student must construct the equivalent model of a real transformer. Practice 7: Three-phase asynchronous motor. The objective of this practice is the assembly of a three-phase asynchronous motor in star and delta. The student must reason and select the correct configuration for the power source available in the laboratory and perform the perform the start-up of the motor. The values obtained for speed and consumption will be compared with the values provided by the manufacturer.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	38	66
Laboratory practical	14	7	21
Seminars	7	3	10
Seminars	15	15	30
Essay questions exam	13	10	23
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Participatory master classes. In these sessions, the basic theoretical contents of the programme will be explained in detail, giving explanatory examples with which to deepen the understanding of the subject. Computer presentations and blackboard will be used. A copy of the slides will be given to the students prior to the exhibition, focusing lecturer's and student's efforts in the understanding of the topics. Anyway, the paper reproductions of slides should never be considered as substitutes for texts or notes, but as complementary material.
Laboratory practical	Practical set-ups corresponding to the contents seen in the classroom will be carried out in the laboratory, or complementary aspects not covered in the theoretical classes will be treated. The methodology used consists of the lecturer supervising the work carried out by the different groups into which the students are divided. The laboratory practices are aimed at reinforcing the theoretical concepts covered in the classroom sessions.

Seminars	Since the tutorial action is approached as a group support action to the learning process of the student, these sessions, carried out in seminars and under the format of small group meetings, will serve to solve questions and to raise problems and exercises that will be solved by the students themselves. As far as possible, the problems will have a realistic orientation, trying to bring them closer to solving real situations involving other engineering disciplines such as traction/propulsion, industrial processes, production and manufacturing, etc. In this way, students will have a more transversal vision of the subject and will see how it can help to solve problems of other disciplines.
Seminars	Intensive course that is carried out as preparation for the extraordinary exams.

Personalized assistance

Methodologies	Description
Lecturing	Personalized answers to questions related to the exhibition by the teacher of the contents of the subject matter, theoretical bases and/or guidelines of a work or exercise that the student has to develop.
Seminars	In the field of tutorial action, there are academic tutoring actions as well as tutorial personalized actions. In the first case, students will have at their disposal tutorials to solve any question related to the contents, organization and planning of the subject, development of projects, etc. Tutorials can be individualized, but group tutoring is encouraged to solve problems related to the activities to be carried out in a group, or simply to inform the lecturer about the evolution of collaborative work. In the personalized tutorials, each student, individually, will be able to comment with the lecturer any questions he may have, problems that are preventing him from following up on the subject properly, in order to find some kind of solution. The aim of combining both types of tutorial action is to compensate the different learning rates through attention to diversity. The lecturers of the course will personally answer the questions and queries of the students, according to the timetable that will be published on the centre's website, and through telematic means (e-mail, videoconference, Moovi forums, etc.) by appointment.
Laboratory practical	Individual attention will be given to the implementation activities of the knowledge in a given context and the acquisition of basic and procedural skills on the subject.

Assessment

Description	Qualification	Evaluated Competencess

Lecturing	The final grade will be determined from the grades obtained in: 1. Continuous evaluation, through the assessment of practical work and activities proposed throughout the course. 2. Final evaluation, by means of examinations carried out in the calls and dates set by the University and the Centre. In the framework of the continuous evaluation, it will be a first theoretical partial examination of the contents seen so far (circuits of direct and alternating current). This test will account for 15% of the total grade final of continuous assessment, there being no minimum score on this test. Before the final exam of the course, a second exam will be taken with contents related to three-phase systems and electrical machines seen up to that point. This test will account for 15% of the total the final mark for continuous assessment, there being no minimum mark in this proof. Throughout the four-month period, they will take place at different times, short questionnaires to check follow-up and commitment to subject by the students. The tests will be carried out with the support of the platform for the subject's tele-education. These tests will involve in total 10% of the final mark for continuous assessment, with no minimum mark. At the end of the four-month period, a final exam will be taken that will cover the all the contents of the course, both theoretical and practical, and which may include multiple choice tests, reasoning questions, resolution of problems and development of case studies. The examination, which will account for 40 per cent of the final continuous assessment score, will be based on the assessment of problem-based learning by the parties to the Block I: Circuit Theory (Direct Current, Alternating Current and three phase) and Block II: Electrical Machines. It will be distributed in trouble and/or theoretical questions, which can be about the theory and seminars seen in the classroom or about the practices seen in the laboratory. In order to pass the course, a mark of 5.0 points out of 10 will be required in the computation of the final Continuous Evaluation Note (NEC). Additionally is required: - A minimum of 40% of the score assigned to Block I (Theory of Circuits) - A minimum of 40% of the score assigned to Block II (Machines Electrical) Those students who do not reach the minimums established in any of the two parts, must be submitted to the Ordinary Examination. In this case, your the final continuous evaluation note (NEC) will be calculated as: NEC = min {4.0, NEC}	80	CG3 CE10	CT1 CT2 CT14 CT16
Laboratory practical	Laboratory practical will be evaluated on the basis of the work done by the student during the practice sessions and by evaluating the technical reports produced at the end of each one. The grade for this block of practices will represent 20% of the total grade end of continuous evaluation. The student must reach 40% of the score assigned to the practices of each of the blocks of the subject.	20	CG3 CE10	CT1 CT6 CT10 CT16 CT17

Other comments on the Evaluation

Qualification Assurance Plan

Recovery plan of the final qualification in the First Call

This plan consists of the right to take a new exam, called the Ordinary exam, on the dates set by the centre, which will replace, if it is higher, the score previously obtained and will count for all purposes in the calculation of the final grade of the first call. This exam will be open to those students who:

- Have not passed the subject during the Continuous Assessment (NEC < 5.0)
- Wish to improve the grade obtained by the Continuous Assessment method.
- Have not fulfilled the ethical commitment that is developed below.

The ordinary examination will be based on the evaluation of problem-based learning in the parts of Block I: Circuit Theory (direct current, alternating current and three-phase current) and Block II: Electrical Machines. The practice part will also be

evaluated with a test based on the circuit and machine simulation tool that will be used during the course.

The ordinary examination will contain a theoretical part and a practical part. The student will pass the course when the Note of the Ordinary Examination (NEO) is greater or equal to 5.0 points out of 10, being also necessary to overcome the minimums established in the following table:

Minimum Score		
Theory (T) 80%	Block I	40%
	Block II	40%
Practice(P) 20%	Blocks I+II	40%

Once the minimums for each of the parts are exceeded, the NEO will be calculated as:

NEO = 0.8-T + 0.2-P

If the minimums are not passed, the score of the ordinary examination will be calculated as:

NEO = min {4.0, NEO}

Finally, the corresponding First Call Note (NPC) will be calculated from the Note of the Ordinary Examination (NEO) and the Note of the Continuous Evaluation Examination (NEC) as

NPC = max {NEC, NEO}

Recovery plan of the final qualification in the Second Call

Students who have not passed the subject during the first call have the right again to a second exam, called Extraordinary or Second Call, on the dates set by the centre. It is understood that the mark obtained in the exam replaces, if it is higher, the mark obtained in the ordinary or first call exam. This exam will contain a practical part, in addition to the theoretical part. The evaluation system will be governed by the same scales and weightings as those established for the ordinary exam, so that the student will pass the subject when the score of the Extraordinary Examination (NEE) is greater than or equal to 5.0 points out of 10. Once the minimums for each of the parts have been passed, the Extraordinary Examination Note (NEE) will be calculated as:

NEE = 0.8-T + 0.2-P

If the minimums are not passed, the score of the extraordinary examination will be calculated as:

NEE = min {4.0, NEE}

Plan to improve the final rating

Each and every student can access a plan to improve their final grade. The improvement plan consists of the right to take a new exam, coinciding with the ordinary or first call exam, on the dates set by the centre, whose grade will replace the one previously obtained, as long as it is higher than the one already obtained, and will count for all purposes as the only reference in the calculation of the final grade. It is understood that the mark obtained in the exam, in the event that it is higher than the mark obtained through the continuous assessment of the subject throughout the four-month period, replaces the aggregation of the marks of the partial tests of continuous assessment, the practice marks, the marks of the short questionnaires and the final exam of the subject.

Ethical commitment

If unethical behavior (cheating, plagiarism, use of unauthorized electronic devices or others) is detected, either during a written test or in the completion of practice reports, you will be penalized as follows:

- *Continuous evaluation*: Given the diverse teaching methodology followed to evaluate each of the two blocks that make up the subject, different considerations will be taken into account. In this way:
- *Scoring tests (partial exams, short questionnaires and final exam)*: All points obtained up to this point will be automatically eliminated, without the possibility of recuperation, and will be excluded from the continuous assessment method. The student must pass the subject in the ordinary exam.

Practice reports: all students involved in copying all or part of a report (at the discretion of the subject's teachers) will be penalized in the final grade of the practice block with a mark of 0.0.

Ordinary exam: A grade of 0 will be given in all parts of the exam, and students must take the extraordinary exam.

Extraordinary exam: A grade of 0 will be given in all parts of the exam.

Sources of information

Basic Bibliography

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Carlson, A. Bruce, **Teoría de circuitos: ingeniería, conceptos y análisis de circuitos eléctricos lineales**, 1ª, Thomson-Paraninfo, 2002

Conejo, A, **Circuitos eléctricos para la ingeniería**, 1ª, McGraw-Hill, 2004

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Duncan Glover, J. y Sarma, M., **Sistemas de Potencia. Análisis y Diseño**, 3ª, Cengage Learning Editores S.A., 2003

Kosow, I.L., **Máquinas Eléctricas y Transformadores**, 1ª, Pearson Educación, 1993

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Recommendations

Subjects that continue the syllabus

Electronic technology/P52G381V01301
Fundamentals of automation/P52G381V01401
Naval engines and machines/P52G381V01409

Other comments

The subject Fundamentals of Electrical Engineering has no associated prerequisites. However, in order to take this course successfully, the student must have:

- Written and oral comprehension skills
- Ability of abstraction, basic calculation and synthesis of information
- Skills for group work and group communication
- At least basic notions acquired in the subjects of Physics II and Mathematics.

The most common learning difficulties are linked to a lack of such knowledge, but it can be overcome with a little effort and the means of this Centre

IDENTIFYING DATA				
Mechanism and machine theory				
Subject	Mechanism and machine theory			
Code	P52G381V01206			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Pérez Vallejo, Javier			
Lecturers	Cacabelos Reyes, Antón González Gil, Arturo Pérez Vallejo, Javier			
E-mail	jvallejo@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The main objective of the subject will be to provide students with knowledge of the principles of the Theory of Machines and Mechanisms, collecting such competence from the Ministerial Order CIN/351/2009 that establishes the requirements for the verification of the degrees that enable for the exercise of the profession of Industrial Technical Engineer. This subject will develop said competence, allowing the knowledge acquired to develop subsequent competences in other subjects.			

Skills	
Code	
CG3	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.
CG4	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.
CE13	Knowledge of the principles of the theory of machines and mechanisms.
CT2	Problems resolution.
CT6	Application of computer science in the field of study.
CT9	Apply knowledge.
CT10	Self learning and work.
CT16	Critical thinking.

Learning outcomes	Competences		
Know the basic foundations of the Theory of Machines and Mechanisms and their application in Mechanical Engineering to solve the problems related with said matter in the field of Industrial Engineering.	CG3 CG4	CE13	CT2 CT9 CT10 CT16
Know, understand, apply and practice the concepts related to the Theory of Machines and Mechanisms.		CE13	CT2 CT9 CT10 CT16
Know and apply the techniques of kinematic and dynamic analysis of mechanical systems.		CE13	CT2 CT9 CT10 CT16
Know and use mechanism analysis software effectively.		CE13	CT2 CT6 CT9 CT10 CT16
ENAEE learning outcome: 1. KNOWLEDGE AND UNDERSTANDING. 1.2.- 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).	CG3	CE13	

ENAEE learning outcome: 2. ENGINEERING ANALYSIS. 2.2. 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. Level of achievement: Advanced (3).	CG4	CT2 CT9 CT16
ENAEE learning outcome: 3. ENGINEERING DESIGN. 3.1. 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. Level of achievement: Basic (1).	CG4	CT2 CT9
ENAEE learning outcome: 5. ENGINEERING PRACTICE. 5.3. Understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study. Level of achievement: Basic (1).		CT6 CT9

Contents	
Topic	
Unit 1: Introduction to the topology of mechanisms.	- Basic concepts: link, kinematic pair, kinematic chain, mechanism, machine. - Types of mechanisms. - Degrees of freedom. - Four bar mechanisms. Theorem of Grashof.
Unit 2: Analysis of positions and displacements.	- Graphic method. - Grafic-analytical method. - Analytical method: closed-loop equations.
Unit 3: Analysis of velocities.	- Elementary movements: rotation and translation. - Analysis of relative velocities. - Calculation of instantaneous centres of rotation. - Graphic method. - Analytical method.
Unit 4: Analysis of accelerations.	- Elementary movements: rotation and translation. - General movement with relative velocity, acceleration of Coriolis. - Relation between the acceleration of two points of the same element. - Graphic method. - Analytical method.
Unit 5: Analysis and synthesis of real mechanisms.	- Schematization of mechanisms. - Inversions. - Mechanical advantage.
Unit 6: Statics.	- Foundations. - Reduction of systems of forces to a point.
Unit 7: Dynamics of planar motion.	- Dynamically equivalent systems. - Inertia forces in planar motion, D'Alembert's principle.
Unit 8: Dynamics of rotary motion.	- Static balancing. - Dynamic balancing. - Balancing analysis.
Unit 9: Dynamic regulation of mechanisms: the flywheel.	- Analysis of machines with cyclic operation. - The flywheel as a control system of cyclic motion. - The flywheel as an energy storage system.
Unit 10: Cams.	- Cam and follower mechanism: types. - Displacement diagram and bond curves. - Kinematic analysis of the movement. - Graphic design of cam profiles.
Unit 11: Gears.	- Transmission mechanisms: generalities. - Types of gears and applications. - Main parameters of the spur gear geometry. Normalisation. - Fundamental law of gearing and gear ratio. - Strengths and power transmission of the spur gears. - Gear trains.

Laboratory practices (PL).	PL1.- Analysis of machinery. PL2.- Assembly and kinematic analysis of basic mechanisms. PL3.- Kinematic analysis of real mechanisms by means of simulation software. PL4.- Dynamic analysis of basic mechanisms by means of simulation software. PL5.- Defence of the project on design of a mechanism. PL6.- Kinematic analysis and design of cams. PL7.- Assembly and analysis of gear trains.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	35	63
Laboratory practical	14	7	21
Seminars	7	7	14
Problem solving	15	15	30
Mentored work	3	9	12
Essay questions exam	10	0	10

*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 lecture sessions, the foundations of each topic are explained. The students can access to the topic information in the bibliography books or the lecture slides uploaded in the subject repository.
Laboratory practical	In the laboratory sessions, the students apply the theory to problem resolution. A series of practices are proposed in accordance with the topic to settle the concepts. Hence, the creative proposal of solutions is promoted.
Seminars	In the seminar sessions, a series of applied exercises are proposed for the students to solve, either individually or in groups, under the supervision of the lecturer.
Problem solving	Intensive course for those students who have failed the subject in ordinary call, prior to the exam in extraordinary call. Group tutoring with the lecturer. Assessment tasks and reinforcement hours.
Mentored work	The students will have to make and expose a group project on the design of a mechanism.

Personalized assistance

Methodologies	Description
Seminars	In the scope of the tutorial action, we distinguish actions of academic tutoring and personalised tutoring. The students will have at their disposal hours of academic tutoring in which they will be able to ask any question related to the contents of the subject, its organisation, evaluation, etc. These tutorials can be individualised or in a group. Notwithstanding, group tutorials will be encouraged for solving problems or clarifying different contents of the subject. In addition, the lecturer will be available for the student to comment or ask for advice on any circumstance that prevents him/her from adequately following the subject (personalised tutorials). With the combination of these two types of tutorial action, we aim to achieve an academic-personal balance that allows the student to achieve their goals in the most effective way. The faculty of this subject will be available for tutorials in the schedule published on the website of the centre, as long as the students confirm in advance by email their interest in attending them. However, the students may arrange a tutorial with the lecturer at any time (not necessarily in this schedule). Finally, the teaching staff will be able to answer the students' questions by telematic means (email, videoconference, forums on the online teaching platform, etc.).

Assessment

	Description	Qualification	Evaluated Competencess		
Laboratory practical	Practice Reports (MP): Reports to be delivered for each laboratory practice (if the practice is carried out in a group, only one group memory will be delivered). Each report will be scored out of 10 points. The MP grade will be the average value of the grades obtained in each report delivered and will represent 10% of the continuous evaluation grade.	10	CG3 CG4	CE13	CT2 CT6 CT9 CT10 CT16
Seminars	Assessable Exercises (EE): Resolutions of problems to be delivered that will be proposed along the course (in particular in the seminar hours). Each exercise will be scored out of 10 points. The EE grade will be the average value of the grades obtained in each exercise delivered and will represent 10% of the continuous evaluation grade.	10	CG3 CG4	CE13	CT2 CT9 CT10 CT16

Mentored work	Group Project (TG): Common project consisting of the delivery of a report and an oral presentation. The project will be scored out of 10 points. The TG grade will represent 10% of the continuous assessment grade.	10	CG3 CG4	CE13	CT2 CT6 CT9 CT10 CT16
Essay questions exam	Partial Tests (PP): Two written tests (theoretical questions and problems) that evaluate the contents taught to date. These tests will be interspersed with theory sessions during the quadmester. Each test will be scored out of 10 points. The PP1 (15%) and PP2 (15%) grades will represent 30% of the continuous assessment grade. Final Test (PF): Written tests (theoretical questions and problems) that evaluate the entire subject. This test will take place at the end of the quadmester. The final test will be scored out of 10 points. The note PF will represent 40% of the continuous assessment grade.	70	CG3 CG4	CE13	CT2 CT9 CT10 CT16

Other comments on the Evaluation

The student will have two calls to pass the subject: the ordinary and the extraordinary call. In the ordinary call, two options are considered to pass the subject: passing by continuous assessment or passing a final exam (ordinary exam), which will include all the contents of the subject. In case of failing the first call, the student will be able to pass the subject by passing the extraordinary exam, which will also include all the contents of the subject.

A numerical grading system with values between 0 and 10 will be used, according to the current legislation (R.D. 1125/2003 de 5 de septiembre, B.O.E. nº224 de 18 de septiembre).

Ordinary call: continuous assessment

The continuous assessment method (EC) will assess the results achieved by students in the different activities carried out throughout the course, grouping into five parts: Final Test (PF), Partial Tests (PP), Practice Reports (MP), Assessable Exercises (EE), and Group Project (TG). The grade of each part will be calculated as the arithmetic mean of the items made up to the moment of the evaluation in that part.

There will be two Partial Tests (PP) throughout the course. These continuous assessment tests will be interspersed with theory sessions during the quadmester. The student must present a report for each laboratory practice if indicated during the session, which will be evaluated in item MP. In the seminar and/or theoretical class hours, the student may be offered the completion and delivery of different exercises, which will be evaluated in item EE. In the event that a student cannot attend a session in which an evaluable exercise is carried out due to force majeure, he or she must notify the teachers by email so that it is recorded and this circumstance is taken into account at the assessment time. In addition, students must carry out and present a group project on the design of a mechanism (see laboratory practice PL5) that will be assessed in item TG. The final continuous assessment test (PF) will include all the contents of the subject and will have a weight of 40% in the final grade of continuous assessment.

The grade of the continuous evaluation (NEC) will be the result of applying the weighted arithmetic mean of the grade of each of the parts (PF, CT, MP, EE and TF), as reflected below:

$NEC = 0,40 \cdot PF + 0,15 \cdot PP1 + 0,15 \cdot PP2 + 0,10 \cdot MP + 0,10 \cdot EE + 0,10 \cdot TG$

To pass the subject by continuous assessment, three conditions must be met: i) having carried out all the evaluable tasks (except in duly justified cases); ii) having a score of at least 4 points out of 10 in the final continuous assessment test (PF); iii) having a value of NEC greater than or equal to 5. In case of breaching any of the first two conditions, the student's grade will be the minimum between their NEC and a 4, then obtaining a failure grade in the continuous assessment of the subject.

Ordinary call: ordinary exam

Those students who do not pass the subject through the continuous assessment method must take the ordinary exam, where all the competences of the subject will be assessed. The results of this exam will represent 100% of the student's final grade, being an essential requirement to pass the course to obtain a grade greater than or equal to 5 points out of 10. Finally, it should be noted that all students have the option of improving their grade obtained by continuous assessment (NEC) taking the ordinary exam.

Extraordinary call

Students who have not passed the subject in the ordinary call will take an extraordinary exam that will have the same format and the same requirements as the ordinary exam.

Ethical commitment

In their double condition of military and student of the University of Vigo, students are subject to the obligations derived from both institutions. As regards a university student, the University Student Statute, approved by Real Decreto 1791/2010 de 30 de diciembre, establishes in its article 12, point 2d, that the university student has the duty to abstain from using or cooperation in fraudulent procedures in assessment tests, in the work carried out or in official university documents. Likewise, the LCM, in its article 4 concerning the rules of behavior of the military, establishes in its fifteenth rule that the latter will carry out his duties and obligations exactly, driven by the feeling of honor, ...

Therefore, the student is expected to have adequate ethical behavior. If during the course unethical behavior is detected in the performance of any evaluable test or exercise (cheating, plagiarism, use of unauthorized electronic devices or others), the student in question will not pass the subject by continuous evaluation (in which he will obtain a rating of 0.0). Likewise, if this type of behavior were detected in the ordinary exam or in the extraordinary exam, the student would obtain a grade of 0.0 in such call.

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Recommendations

Other comments

The student is required to have skills in the field of differential calculus, vector calculus and kinematics and dynamics calculus of the point and the solid. The knowledge acquired will in turn be necessary to properly study other subsequent subjects of the same Degree, such as Machine Design.

IDENTIFYING DATA				
Environmental technology				
Subject	Environmental technology			
Code	P52G381V01207			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Maceiras Castro, María del Rocío			
Lecturers	González Gil, Lorena Maceiras Castro, María del Rocío			
E-mail	rmaceiras@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This syllabus collects the competencies that the students must acquire in this course, the calendar of planned educational activities, the contents and its distribution, an estimate of the volume of work of the student and the specific criteria of assessment. The aim of this subject is to form future graduates in Bachelor Mechanical Engineering with the ability to identify the environmental impacts of industrial and human activities, with the aim to minimize, prevent and solve them. In fact, the increase in legal requirements related to environmental protection, together with the interest of society in the application of more environmentally friendly technological solutions enhance the need for professionals capable of solving environmental problems within multidisciplinary contexts. To achieve this, in this subject it is carried out an approach to Environmental Engineering in combination with other knowledge fields, such as Mechanical Engineering (equipment design), Chemistry (study of pollutants and their behavior), Biology (biotechnological processes) and Process Engineering (design of physical, chemical and biological processes to mitigate contamination). More specifically, in this subject some technical and practical knowledge about environmental pollution in different ecosystems and their flows of matter and energy will be needed, to later study all the vectors of pollution and evaluate the most appropriate technologies to minimize them, complying whit the current legislation. Lastly, basic knowledge is given on the main policies, tools and indicators developed within the framework of environmental management for the prevention of industrial pollution.			

Skills	
Code	
CG7	Ability to analyze and assess the social and environmental impact of the technical solutions.
CE16	Basic knowledge and application of environmental technologies and sustainability.
CT1	Analysis and synthesis
CT2	Problems resolution.
CT3	Oral and written proficiency
CT9	Apply knowledge.
CT10	Self learning and work.
CT12	Research skills.
CT17	Working as a team.
CT19	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources.

Learning outcomes		
Learning outcomes	Competences	
To know the available environmental technologies for control of gaseous pollutants	CE16	CT2 CT3 CT10
To know the basic processes for the conditioning of water and wastewater treatment	CE16	CT2 CT3 CT10
To know the performance of wastewater treatment plants	CE16	CT2 CT3 CT10
To know the integrated process of industrial waste treatment	CE16	CT2 CT3 CT10 CT19

To know and be able to apply the different tools for preventing industrial pollution		CE16	CT1 CT2 CT3 CT9 CT10 CT12 CT17 CT19
Ability to analyze and determine the social and environmental impact of the technical solutions to environmental problems	CG7		CT1 CT3 CT9 CT10 CT17 CT19
ENAEE LEARNING OUTCOME. KNOWLEDGE AND UNDERSTANDING LO1.3.- awareness of the wider multidisciplinary context of engineering (level of development this sub-resulted of learning: Intermediate (2))		CE16	
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))	CG7		CT1 CT2 CT9 CT19
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 (Intermediate (2))	CG7		CT2 CT9 CT19
ENAEE LEARNING OUTCOME. INVESTIGATIONS LO4.2.- ability to consult and apply codes of practice and safety regulations in their field of study (Intermediate (2))	CG7		
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 (Intermediate (2))			CT9 CT12
ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE LO5.4.- ability to apply norms of engineering practice in their field of study (Basic (1))	CG7		CT9
ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE LO5.5- awareness of non-technical societal, health and safety, environmental, economic and industrial implications of engineering practice (Intermediate (2))	CG7	CE16	CT19
ENAEE LEARNING OUTCOME. MAKING JUDGEMENTS 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 (Intermediate (2))	CG7		CT19

Contents	
Topic	
LESSON 1: INTRODUCTION: IMPORTANCE OF ENVIRONMENTAL TECHNOLOGY IN SOCIETY	1. Pollution and environmental impacts 2. Milestones in environmental protection 3. Environmental catastrophes
LESSON 2: MAIN UNIT OPERATIONS USED IN ENVIRONMENTAL TECHNOLOGY	1. Introduction to the unit operations: concept and classification 2. Separation operations controlled by mass transfer 3. Separation operations controlled by heat transfer 4. Separation operations controlled by heat and mass transfer 5. Separation operations controlled by fluid mechanics 6. Membrane separation processes
LESSON 3: MASS BALANCES IN ENVIRONMENTAL ENGINEERING PROCESSES	1. Mass balances in steady state with and without chemical reaction 2. Mass balances in unsteady state with and without chemical reaction
LESSON 4: ATMOSPHERIC POLLUTION	1. Introduction 2. Types of pollutants 3. Effects of the atmospheric pollution 4. Technical solutions to air emission control
LESSON 5: WATER POLLUTION	1. Introduction 2. Types of pollutants 3. Indicators of water pollution 4. Wastewater treatment technologies
LESSON 6: SOIL POLLUTION	1. Introduction 2. Types of polllutants 3. Remediation techniques

LESSON 7: INTRODUCTION TO SOLID WASTE TREATMENT	1. Introduction 2. Types of solid waste 3. Solid waste treatment technologies
LESSON 8: ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT	1. Introduction to the tools for evaluating the environmental impact 2. Life cycle assessment 3. Environmental management system 4. Prevention and control of the industrial pollution: IPPC directive and PRTR regulation
Practice 1. Sedimentation	The objective of this practice is to determine the sedimentation rate of particles contained in a wastewater in order to design a sedimentation tank.
Practice 2: Coagulation - Flocculation	To improve sedimentation efficiency during wastewater treatment, in many cases, it is necessary to previously perform coagulation followed by flocculation. These processes are optimized in the laboratory.
Practice 3: Analysis of the main pollutants in wastewaters	In this practice, some of the key parameters in the contamination of a water are experimentally measured, such as the chemical oxygen demand and the concentration of sulfates, phosphates and chlorides.
Practice 4: Determination of the solids content of a water	The objective of the previous practice is complemented determining the solid content of a wastewater.
Practice 5: Extraction with solvents	This solid-liquid extraction practice is carried out in order to get the student familiarized with the chemical processes used to separate contaminants from a soil.
Practice 6: Introduction to the simulation software DWSIM	In this practice, it is used the chemical process simulator DWSIM (open source). The student will become familiar with the simulation tool and will carry out different examples such as conversion reactors, balance reactors, condensers and simple distillation columns.
Practice 7: Classification and labeling of solid waste	In this practice, the students familiarize with the regulations related to the classification and labeling of both hazardous and non-hazardous solid waste. In addition, it is addressed the importance of waste classification for worker safety and health and for society in general.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	31	59
Laboratory practical	14	7	21
Problem solving	7	7	14
Seminars	15	15	30
Objective questions exam	4	0	4
Essay	0	5	5
Problem and/or exercise solving	0	2	2
Essay questions exam	3	2	5
Essay questions exam	3	2	5
Essay questions exam	3	2	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	Teaching in the classroom of the key concepts and procedures for learning the syllabus contents. In addition to the information published on the online teaching platform, which contains the file with the lesson slides, the students have in the recommended bibliography the contents of each leasson with a more detailed development.
Laboratory practical	Application of the knowledge acquired to the resolution of problems of environmental technology. A series of practices have been designed in accordance with the content of the subject in order to fix concepts explained in this class.
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
Laboratory practical	Academic tutoring and personalized tutoring.

Lecturing	In the scope of the tutorial action, it can distinguished between academic tutoring actions and personalized tutoring. Both types of tutorial action are combined to compensate for the different learning rhythms and thus paying attention to diversity. The lecturers of the subject will solve the questions and queries of the students in person or online (via email, videoconference, MOOVI, forums, etc.) at the time scheduled on the website of the center or by appointment.
Seminars	Academic tutoring and personalized tutoring.
Problem solving	Academic tutoring and personalized tutoring.

Assessment

	Description	Qualification	Evaluated Competencess
Laboratory practical	Evaluation of the work in the laboratory and of the summary report with the data obtained in the practices, its analysis and discussion. At the end of each practice, the student must prepare a detailed report including aspects such as: objectives and theoretical fundaments of the practice, experimental procedure, materials used, the results obtained and their discussion. In addition, the comprehension of the practice, the student's synthesis capacity, the writing style and the presentation of the report, as well as the student's personal contribution, are evaluated. These reports will be compulsory and rated, each of them, on 10 points, and represent 10% of the continuous assessment. In addition, an exam corresponding to laboratory practices (5%) will be carried out.	15	CG7 CE16 CT1 CT3 CT9 CT12 CT17 CT19
Objective questions exam	The theoretical and practical knowledge acquired by the student during the masterclasses and seminars will be monitored. There will be two continuous assessment tests of theory and problems (P1 and P2), with a weight of 15% each. Such tests will be compulsory and scored on 10 points.	30	CG7 CE16 CT1 CT2 CT3 CT9 CT10 CT12 CT17
Essay	The students, in pairs or groups of 3, will carry out a written essay on contents related to Topic 8 "Environmental impact assessment and management" or on key aspects of other lessons that it is appropriate to further study. Part of the work will focus on seeking the real application of the addressed topic in different industrial or social fields, evidencing the multidisciplinary application of environmental engineering. Moreover, the students will have to reflect on the ethical and social implications of the studied content. Finally, each group will present their work orally and the peer-assessment among students will be encouraged.	5	CE16 CT1 CT3 CT9 CT10 CT12 CT17 CT19
Problem and/or exercise solving	During class hours, individual tasks (TI, 5%) and activities to promote the student learning (TO, 5%), that may be individuals or in groups and they will be proposed in order to monitor the contents taught. These activities will be compulsory and scored, each of them, on 10 points.	10	CE16 CT1 CT3 CT9 CT10 CT12 CT17 CT19
Essay questions exam	Final Exam (FE) At the end of the course, the knowledge acquired by the student will be evaluated by means of a written test with theoretical contents (4 points) and problems (6 points). Such exam will be compulsory and scored on 10 points.	40	CG7 CE16 CT1 CT2 CT3 CT9 CT10 CT12 CT17
Essay questions exam	Ordinary Exam If the students do not pass the continuous evaluation, they will have an ordinary exam after the final exam. In this exam the students will be evaluated of all the contents taught, both theoretical and practical. It will be necessary to obtain a grade higher than 4 points out of 10 in each of the parts (theory and problems) in such exam. Besides, there will be a test related to the laboratory practices (with a weight of 5%).	100	CG7 CE16 CT1 CT2 CT3 CT9 CT10 CT12 CT17
Essay questions exam	Extraordinary Exam The student will be examined of all the theoretical / practical contents taught in the subject during the ordinary course. In addition, it will be necessary to obtain a grade higher than 4 points out of 10 in each of the parts (theory and problems) evaluated in such exam. Besides, there will be a test related to the laboratory practices (with a weight of 5%).	100	CG7 CE16 CT1 CT2 CT3 CT9 CT10 CT12 CT17

Other comments on the Evaluation

Minimum requirements to pass the continuous evaluation: the student must obtain a minimum of 5 in his/her total grade. In addition, the students will have to attend to the ordinary exam to pass the course in the following cases:

- The non-completion or delivery of any of the proposed tests/activities.
- If the obtained grade is lower than 4 points out of 10 in some of the parts (theory and problems) of the Final Exam.

Those students that do not fulfil any of the previous requirements will have a maximum grade of 4.0 in the continuous evaluation. All those students that have passed the continuous evaluation, but wish to improve their qualification, could attend to the ordinary exam.

ETHICAL COMMITMENT:

It is expected that the students have an adequate ethical behaviour.

- If it is detected an unethical behaviour (cheating, plagiarism, use of unauthorised electronic devices or others) during the final or partial exams, the student will be punished with the impossibility to pass the subject by the modality of continuous evaluation, obtaining a qualification of 0.0.
- If this type of behaviour is detected in the ordinary or extraordinary exam, the student will obtain a qualification of 0.0.
- In the case of the documents delivered to evaluate the laboratory practices, the total or partial copy in the report (according to the opinion of the teachers of the subject), will be penalized in the final grade of the practices with a qualification of 0.0.

INTENSIVE COURSE:

In the case that the students do not pass the ordinary exam, they have to do the extraordinary examn in July. The CUD-ENM proposes for these students an intensive course during the months of June and July of 15 hours during three weeks to prepare this exam. It will be elaborated a specific educational guide for such course. In the extraordinary exam, the student will be evaluated of all the practical/theoretical contents taught in the subject during the ordinary course. In addition, it will be necessary to obtain a grade higher than 4 points out of 10 in each part (theory and problems) of the exam.

Sources of information

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Recommendations

Other comments

It recommends to the students have surpassed the subjects of Physical I, Physical II and Chemistry.

IDENTIFYING DATA				
Mecánica de fluídos				
Subject	Mecánica de fluídos			
Code	P52G381V01208			
Study programme	Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2	2c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín			
Coordinator	Febrero Garrido, Lara			
Lecturers	Febrero Garrido, Lara Regueiro Pereira, Araceli			
E-mail	lfebrero@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	A materia de Mecánica de Fluídos ten un carácter básico, onde se aplican os principios fundamentais da física e a mecánica á materia fluída. Trátase de que os alumnos da titulación de grao en enxeñaría mecánica adquiran os coñecementos e ferramentas necesarias para saber analizar e comprender problemas fluídos de distinta categoría, para servir de apoio a outras materias do plan de estudos relacionadas coas propiedades e o movemento dos fluídos, de carácter tanto básico como máis orientadas a problemas reais no campo da enxeñaría. Foméntase así mesmo o desenvolvemento de habilidades e competencias xenéricas como o traballo en equipo e a aprendizaxe autónoma. A Mecánica de Fluídos describe os fenómenos físicos relevantes do movemento dos fluídos, describindo as ecuacións xerais dos devanditos movementos. Este coñecemento proporciona os principios básicos necesarios para analizar calquera sistema no que o fluído sexa o medio de traballo. O campo de aplicacións da Mecánica de Fluídos en enxeñaría é moi amplo: transporte de fluídos en condución, aeronáutica, motores, barcos, fluxos biolóxicos, etc. Os principios da Mecánica de Fluídos son necesarios para campos tan diversos como: - Deseño de maquinaria hidráulica. - Lubricación. - Sistemas de calefacción e ventilación, calor e frío. - Deseño de sistemas de tubaxes. - Medios de transporte: transmisión, climatización, sistema de escape, aerodinámica e hidrodinámica, refrixeración, etc. - Aerodinámica de estruturas e edificios - Centrais térmicas e de fluídos de produción de enerxía convencionais e renovables			

Competencias	
Code	
CG4	Capacidade de resolver problemas con iniciativa, toma de decisións, creatividade, razoamento crítico e de comunicar e transmitir coñecementos, habilidades e destrezas no campo da Enxeñaría Industrial na especialidade de Mecánica.
CG5	Coñecementos para a realización de medicións, cálculos, valoracións, taxacións, peritaxes, estudos, informes, planes de labores e outros traballos análogos.
CE8	Coñecementos dos principios básicos da mecánica de fluídos e a súa aplicación á resolución de problemas no campo da enxeñaría. Cálculo de tubaxes, canais e sistemas de fluídos.
CT2	Resolución de problemas.
CT9	Aplicar coñecementos.
CT10	Aprendizaxe e traballo autónomos.

Resultados de aprendizaxe			
Learning outcomes	Competences		
Entender os principios básicos do movemento de fluídos	CG4 CG5	CE8	CT2 CT9 CT10
Capacidade para calcular tubaxes e canles	CG4 CG5	CE8	CT2 CT9 CT10
Capacidade para manexar medidores de magnitudes fluídas	CG4 CG5	CE8	CT2 CT9 CT10
Capacidade para coñecer e dominar as ferramentas coas que se abordan os problemas de fluxos de fluídos.	CG4 CG5	CE8	CT2 CT9 CT10

RESULTADOS DE APRENDIZAXE ENAEE: 1. COÑECEMENTO E COMPRENSIÓN: Subresultado: 1.2 Coñecemento e comprensión das disciplinas de enxeñaría propias da súa especialidade, no nivel necesario para adquirir o resto de competencias do título, incluíndo nocións dos últimos adiantos. Nivel de desenvolvemento: Adecuado (2)		CE8	
RESULTADOS DE APRENDIZAXE ENAEE: 2. ANÁLISE EN ENXEÑARÍA: Subresultado: 2.1 A capacidade de analizar produtos, procesos e sistemas complexos no seu campo de estudo; elixir e aplicar de forma pertinente métodos analíticos, de cálculo e experimentais xa establecidos e interpretar correctamente resultados de devanditas análises. Nivel de desenvolvemento: Adecuado (2)	CG4		CT2 CT9
RESULTADOS DE APRENDIZAXE ENAEE: 2. ANÁLISE EN ENXEÑARÍA: Subresultado: 2.2 A capacidade de identificar, formular e resolver problemas de enxeñaría na súa especialidade; elixir e aplicar de forma adecuada métodos analíticos, de cálculo e experimentais xa establecidos; recoñecer a importancia das restricións sociais, de saúde e seguridade, ambientais, económicas e industriais. Nivel de desenvolvemento: Adecuado (2)	CG4		CT2 CT9
RESULTADOS DE APRENDIZAXE ENAEE: 3. PROXECTOS DE ENXEÑARÍA: Subresultado: 3.1 Capacidade para proxectar, deseñar e desenvolver produtos complexos (pezas, compoñentes, produtos acabados, etc.), procesos e sistemas da súa especialidade, que cumpran cos requisitos establecidos, incluíndo ter conciencia dos aspectos sociais, de saúde e seguridade, ambientais, económicos e industriais; así como seleccionar e aplicar métodos de proxecto apropiados. Nivel de desenvolvemento: Básico (1)	CG4 CG5	CE8	CT2 CT9
RESULTADOS DE APRENDIZAXE ENAEE: 3. PROXECTOS DE ENXEÑARÍA: Subresultado: 3.2 Capacidade de proxecto utilizando algún coñecemento de vangarda da súa especialidade de enxeñaría. Nivel de desenvolvemento: Adecuado (2)	CG4 CG5		
RESULTADOS DE APRENDIZAXE ENAEE: 4. INVESTIGACIÓNS E INNOVACIÓN. Subresultado: 4.3 Capacidade e destreza para proxectar e levar a cabo investigacións experimentais, interpretar resultados e chegar a conclusións no seu campo de estudo. Nivel de desenvolvemento: Adecuado (2)		CE8	CT9
RESULTADOS DE APRENDIZAXE ENAEE: 5. APLICACIÓN PRÁCTICA DA ENXEÑARÍA. Subresultado: 5.2 Competencia práctica para resolver problemas complexos, realizar proxectos complexos de enxeñaría e levar a cabo investigacións propias da súa especialidade. Nivel de desenvolvemento: Adecuado (2)	CG4 CG5		CT2 CT9
RESULTADOS DE APRENDIZAXE ENAEE: 5. APLICACIÓN PRÁCTICA DA ENXEÑARÍA: Subresultado: 5.3 Coñecemento de aplicación de materiais, equipos e ferramentas, tecnoloxía e procesos de enxeñaría e as súas limitacións no ámbito da súa especialidade. Nivel de desenvolvemento: Básico (1)			CT9
RESULTADOS DE APRENDIZAXE ENAEE: 7. COMUNICACIÓN E TRABALLO EN EQUIPO. Subresultado: 7.2 Capacidade para funcionar eficazmente en contextos nacionais e internacionais, de forma individual e en equipo e cooperar tanto con enxeñeiros como con persoas doutras disciplinas. Nivel de desenvolvemento: Adecuado (2)			CT10
RESULTADOS DE APRENDIZAXE ENAEE: 8. FORMACIÓN CONTINUA: Subresultado: 8.1 Capacidade de recoñecer a necesidade da formación continua propia e de emprender esta actividade ao longo da súa vida profesional de forma independente. Nivel de desenvolvemento: Básico (1)			CT10
RESULTADOS DE APRENDIZAXE ENAEE: 8. FORMACIÓN CONTINUA: Subresultado: 8.2 Capacidade para estar ao día nas novidades en ciencia e tecnoloxía. Nivel de desenvolvemento: Básico (1)			CT10

Contidos	
Topic	
UD I. INTRODUCIÓN	I.1. Conceptos fundamentais. Concepto de fluído I.2. O fluído como medio continuo I.3. Características dos fluídos I.4. Propiedades termodinámicas dun fluído. Fluídos newtonianos e non newtonianos I.5. Viscosidade e outras propiedades secundarias
UD II. FLUIDOESTÁTICA	II.1. Presión e gradiente de presión II.2. Equilibrio dunha partícula fluída II.3. Distribución de presións en hidrostática II.4. Forzas hidrostáticas sobre superficies planas II.5. Forzas hidrostáticas sobre superficies curvas II.6. Flotación e estabilidade II.7. Distribución de presións en movemento como sólido ríxido II.8. Medidores de presión

UD III. FUNDAMENTOS DO MOVEMENTO DE FLUÍDOS	III.1. Propiedades do campo de velocidade. Método Euleriano e Lagranxiano III.2. Patróns de fluxo: liñas de corrente, sendas e liñas de traza III.3. Clases de fluxos III.3.1. Segundo condicións cinemáticas III.3.2. Segundo condicións xeométricas III.3.3. Segundo condicións mecánicas de contorno III.3.4. Segundo condicións do movemento interno III.3.5. Segundo forma de reaccionar ante obstáculos III.4. Sistemas e volume de control III.5. Integrais estendidas a volumes fluídos III.5.1. Teorema do transporte de Reynolds
UD IV. RELACIÓNS INTEGRAIS PARA UN VOLUME DE CONTROL	IV.1. Conservación da masa IV.2. Conservación da cantidade de movemento IV.3. Teorema do momento cinético IV.4. Ecuación da enerxía IV.5. Fluxo sen fricción: a ecuación de Bernoulli
UD V. RELACIÓNS DIFERENCIAIS PARA UNHA PARTÍCULA FLUÍDA	V.1. O campo de aceleracións dun fluído V.2. Ecuación diferencial de conservación da masa V.3. Ecuación da cantidade de movemento en forma diferencial V.4. Ecuación diferencial do momento cinético V.5. Ecuación diferencial da enerxía V.6. Condicións de contorno para as ecuacións básicas V.7. A función de corrente V.8. Vorticidade e irrotacionalidade V.9. Fluxos irrotacionales non viscosos
UD VI. ANÁLISE DIMENSIONAL E SEMELLANZA	VI.1. Parámetros adimensionais VI.2. Natureza da análise dimensional VI.3. Teorema Pi de Buckinghan. Aplicacións VI.4. Grupos adimensionais de importancia na Mecánica de Fluídos VI.4.1. Significado físico dos números adimensionais VI.5. Semellanza VI.5.1. Semellanza parcial VI.5.2. Efecto de escala VI.6. Medidores en fluídos
UD VII. MOVEMENTO LAMINAR CON VISCOSIDADE DOMINANTE	VII.1. Introdución VII.2. Movemento laminar permanente VII.2.1. Correntes de Hagen-Poiseuille VII.2.2. En condutos de sección circular VII.2.3. Outras seccións VII.3. Efecto de lonxitude finita do tubo VII.4. Perda de carga VII.4.1. Coeficiente de fricción VII.5. Estabilidade de corrente laminar.
UD VIII. MOVEMENTO TURBULENTO	VIII.1 Réximes en función do número de Reynolds VIII.2 Modelización da turbulencia VIII.3 Fluxos internos e fluxos externos VIII.4 Perda de carga en fluxos turbulentos en condutos. VIII.4.1. Diagrama de Nikuradse VIII.4.2. Diagrama de Moody VIII.5 Noción de capa límite VIII.6 Fórmulas empíricas para fluxo en tubaxes
UD IX. INTRODUCCION Á CAPA LÍMITE	IX.1 Noción da capa límite IX.2 Ecuacións da capa límite bidimensional incompresible IX.3 Espesor da capa límite
UD X. MOVEMENTOS DE LIQUIDOS EN CONDUTOS DE SECCION VARIABLE	X.1. Introdución X.2. Perdas locais X.2.1. Perda á entrada dun tubo X.2.2. Perda nun tubo á saída X.2.3. Perda por contracción X.2.4. Perda por ensanche X.2.5. Perda en cóbados X.3. Tubaxes ramificadas X.4. Tubaxes en serie X.5. Tubaxes en paralelo X.6. Redes de tubaxes

PRACTICAS DE LABORATORIO	Práctica PL1. Principio de Arquímedes Obxectivos: Determinar o empuxe que sofren os corpos mergullados en líquidos. Práctica PL2. Medición da presión hidrostática Obxectivos: Medición da presión hidrostática cun manómetro en U. Práctica PL3. Ecuación de Bernoulli Obxectivos: Estudo da presión en tubaxe con treitos de diámetro variable e constante pola que flúe líquido. Os tubos verticais indican a presión estática. Práctica PL4. Demostración da medición de fluxos Obxectivos: Comparación da medida do fluxo por medio de diferentes fluxómetros. Medición do caudal de paso con boquilla/diafragma. Medición do caudal de paso con venturímetro. Medición do caudal de paso con fluxómetro flotador. Calibración de fluxómetros Práctica PL5. Demostración de perdas en tubaxes e conectores Obxectivos: Estudo das perdas de presión en tubaxes e accesorios. Determinación do efecto da velocidade de fluxo na perda de presión. Determinación das perdas de presión e liñas características de apertura dos órganos de peche. Determinación dos índices de resistencia. Estudo do funcionamento e principio de diferentes métodos de medición do caudal. Práctica PL6. Traballo tutelado Obxectivos: A partir de problemas expostos polos propios alumnos, seguindo as directrices establecidas polo profesor, os alumnos divididos en grupos deberán realizar un traballo baseado nun persoal preestablecida baseada no Traballo Fin de Grao. Preténdese que se familiaricen con estrutúraa tipo dun artigo científico, o traballo con formatos, referencias, índices, etc., así como a distribución de tarefas, traballo en equipo, etc. Ademais das sesións de prácticas ás que se alude neste punto, tamén se utilizará tempo de sesións de teoría como complemento para o desenvolvemento do traballo. As prácticas de laboratorio ou de aula de informática programadas poderán variar en contidos e en orde dependendo do material dispoñible para a súa realización, así como das necesidades organizativas do curso académico.

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	28	28	56
Prácticas de laboratorio	14	14	28
Exame de preguntas de desenvolvemento	5	7	12
Traballo	15	12	27
Exame de preguntas de desenvolvemento	6	7	13
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente	
	Description
Lección maxistral	Nestas sesións, explicaranse detalladamente os contidos teóricos básicos do programa, expondo exemplos aclaratorios cos que profundar na comprensión da materia. Utilizaranse presentacións informáticas e a pizarra. Na medida do posible, proporcionarase copia das diapositivas aos alumnos con anterioridade á exposición, centrando o esforzo do profesor e do alumnado na exposición e comprensión dos coñecementos. De todos os xeitos, as reproducións en papel das diapositivas nunca deben ser consideradas como substitutos dos textos ou apuntamentos, senón como material complementario.

Prácticas de laboratorio	Nas clases prácticas aplicaranse os conceptos desenvolvidos en cada tema á realización de prácticas de laboratorio. Deseñáronse unha serie de prácticas (PL1 a PL5) acorde co desenvolvemento da materia de teoría co fin de fixar conceptos explicados nesa clase. Metodoloxías integradas Aprendizaxe baseada en proxectos. Algunhas sesións prácticas (PL6: Traballo tutelado) dedicaranse ao seguimento dos traballos expostos aos diversos grupos nos que se divide o alumnado. Proporcionarase sempre material e bibliografía, aínda que tamén se pretende fomentar a capacidade de procura de información, capacidade de síntese, etc.

Atención personalizada

Methodologies	Description
Lección maxistral	Cada alumno, de maneira individual, poderá comentar co profesor calquera problema que lle estea impedindo realizar un seguimento adecuado da materia, co fin de atopar entre ambos algún tipo de solución.
Prácticas de laboratorio	Cada alumno, de maneira individual, poderá comentar co profesor calquera problema que lle estea impedindo realizar un seguimento adecuado da materia, co fin de atopar entre ambos algún tipo de solución.

Avaliación

	Description	Qualification	Evaluated Competencess
Prácticas de laboratorio	A avaliación das prácticas de laboratorio (PL1-PL5) levará a cabo mediante cuestionarios expostos a través de Moodle onde se avaliará ao alumno sobre os coñecementos adquiridos en clase e no laboratorio. A nota das memorias de prácticas (MP) será a media das notas de todos os cuestionarios de prácticas realizados.	15	CG4 CE8 CT2 CG5 CT9 CT10
Exame de preguntas de desenvolvemento	Proba final (PF): A proba PF ten como obxectivo a avaliación da aprendizaxe de todos os contidos teóricos seleccionados para a materia. Confeccionaranse para xulgar o que o alumno sabe de toda a materia. En segundo lugar, debe consistir nunha serie de cuestións que primen o razoamento conceptual e lóxico, a fin de verificar a madurez intelectual dos alumnos para obter conclusións a partir das nocións ou as teorías expostas en clase. A proba final de avaliación continua realizarase na semana de avaliación e valorarase sobre 10 puntos. Será necesario obter unha nota maior ou igual a 4 puntos sobre 10 no exame final de avaliación continua para poder optar ao aprobado por avaliación continua.	40	CG4 CE8 CT2 CG5 CT9 CT10
Traballo	Dado que o traballo tutelado debe ser avaliado de maneira que se garanta a exigibilidade individual e a interdependencia positiva (isto é, todos os membros do grupo deben traballar e contribuído ao produto final e deben dominar, minimamente, todos os aspectos do traballo), na sesión de presentación oral e defensa, intervirán todos os membros do grupo e, calquera membro do grupo debe poder responder a preguntas do traballo, independentemente da parte na que estaba especializado. Todos deben demostrar, por tanto, coñecemento profundo do produto entregado, independentemente da parte na que centrasen os seus esforzos.	15	CG4 CE8 CT2 CG5 CT9 CT10
Exame de preguntas de desenvolvemento	Probas parciais (P1 e P2): As probas parciais P1 e P2 teñen como obxectivo a avaliación da aprendizaxe de todos os contidos teóricos seleccionados para a materia. Confeccionaranse para xulgar o que o alumno sabe dunha parte da materia. En segundo lugar, deben consistir nunha serie de cuestións que primen o razoamento conceptual e lóxico, a fin de verificar a madurez intelectual dos alumnos para obter conclusións a partir das nocións ou as teorías expostas en clase. Realizaranse duas (2) probas parciais de avaliación continua. Cada control suporá un 15% na nota de avaliación continua.	30	CG4 CE8 CT2 CG5 CT9 CT10

Other comments on the Evaluation

Para superar a materia por Avaliación Continua a nota final (NEC) deberá ser maior ou igual a 5 e calcularase do seguinte modo:

NEC = 0,40·PF +0,15·P1 +0,15 P2+ 0,10·TT+0,10·ES + 0,10·MP
O alumno deberá presentarse ao exame ordinario de todos os contidos da materia, que suporá o 100% da nota, si a nota final de avaliación continua é menor que 5 puntos sobre 10.Tamén terá que presentarse ao exame ordinario nos seguintes supostos:
- A non realización ou entrega dalgún dos puntuables anteriores.
- Obter unha nota inferior a 4 puntos sobre 10 no exame final de avaliación continua.- Obter menos dun 5 sobre 10 na avaliación do traballo tutelado.
En calquera destes supostos, a cualificación da avaliación continua será o mínimo da nota de avaliación continua e 4 puntos (o alumno neste caso obterá como máximo 4 puntos). En calquera caso, o alumno que supere a avaliación continua, terá a posibilidade de presentarse ao exame ordinario para subir nota.
COMPROMISO ÉTICO No caso de que se detecte fraude académica por parte dun alumno ou grupo de alumnos seguiranse as seguintes normas:- Si a fraude académica prodúcese nalgunha das memorias de prácticas, a nota total de prácticas será cero independentemente da obtida no resto das mesmas.- Si a fraude académica prodúcese nalgunha das probas intermedias de control ou no exame de avaliación continua, o alumno suspenderá a avaliación continua cun cero e deberá presentarse directamente á convocatoria ordinaria.- Si o alumno comete a fraude académica nunha convocatoria oficial (ordinaria ou extraordinaria) suspenderá dita convocatoria cun cero.

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Recomendacións

Other comments

Para cursar con éxito esta materia o alumno debe seguir as seguintes recomendacións:
- Asistencia regular e activa ás clases, tanto teóricas como prácticas.
- Manter un estudo diario mínimo.

En caso de discrepancias, prevalecerá a versión en castelán desta guía.

IDENTIFYING DATA				
English I				
Subject	English I			
Code	P52G381V01209			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	English			
Department				
Coordinator	Douglas , Heidi Jennifer Diane			
Lecturers	Douglas , Heidi Jennifer Diane Gómez Garrido, Sandra Hawthorne , Kaye Louise Muradás Sanromán, Macarena			
E-mail	externo.hdouglas@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	In this subject, students are expected to improve their mastery of the four basic skills of English (listening, speaking, reading, writing) at B1+ Level CEFR (Common European Framework of Reference for Languages) in order to foster the use of the language in the professional military environment.			

Skills	
Code	
CG10	Ability to work in a multidisciplinary and multilingual environment.
CE34	CITN4 To promote, through speaking and writing in Spanish and English, communication skills to ease the transmission and understanding of orders, ideas and concepts.
CT4	Oral and written proficiency in a foreign language.
CT5	Information Management.
CT7	Ability to organize and plan.
CT8	Decision making.
CT9	Apply knowledge.
CT15	Objectification, identification and organization.
CT17	Working as a team.
CT18	Working in an international context.

Learning outcomes	Competences		
OVERALL ORAL PRODUCTION To sustain a straightforward description of one of a variety of subjects within his/her field of interest, presenting it as a linear sequence of points. SUSTAINED MONOLOGUE: DESCRIBING EXPERIENCE To give straightforward descriptions on a variety of familiar subjects within his/her field of interest. SUSTAINED MONOLOGUE: PUTTING A CASE To develop an argument well enough to be followed without difficulty most of the time. ADDRESSING AUDIENCES To give a prepared straightforward presentation on a familiar topic within his/her field which is clear enough to be followed without difficulty most of the time, and in which the main points are explained with reasonable precision. To take follow up questions, but s/he may have to ask for repetition if the speech was rapid. OVERALL SPOKEN INTERACTION To communicate with some confidence on familiar routine and non-routine matters related to his/her interests and professional field. To exchange, check and confirm information, deal with less routine situations and explain why something is a problem. To express thoughts on more abstract, cultural topics such as films, books, music, etc.	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18

OVERALL WRITTEN PRODUCTION To write straightforward connected texts on a range of familiar subjects within his/her field of interest, by linking a series of shorter discrete elements into a linear sequence. REPORTS AND ESSAYS To write short, simple essays on topics of interest. To summarise, report and give his/her opinion about accumulated factual information on familiar routine and non-routine matters within his/her field with some confidence.	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18
OVERALL LISTENING COMPREHENSION To understand straightforward factual information about common everyday or job related topics, identifying both general messages and specific details, provided speech is clearly articulated in a generally familiar accent. UNDERSTANDING CONVERSATION BETWEEN NATIVE SPEAKERS To generally follow the main points of extended discussion around him/her, provided speech is clearly articulated in standard dialect. LISTENING AS A MEMBER OF A LIVE AUDIENCE To follow a lecture or talk within his/her own field, provided the subject matter is familiar and the presentation straightforward and clearly structured. LISTENING TO ANNOUNCEMENTS AND INSTRUCTIONS To understand simple technical information, such as operating instructions for everyday equipment. LISTENING TO AUDIO MEDIA AND RECORDINGS To understand the information content of the majority of recorded or broadcast audio material on topics of personal interest delivered in clear standard speech.	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18
OVERALL READING COMPREHENSION To read straightforward factual texts on subjects related to his/her field of interest with a satisfactory level of comprehension. READING FOR ORIENTATION To scan longer texts in order to locate desired information, and gather information from different parts of a text, or from different texts in order to fulfil a specific task. READING INSTRUCTIONS To understand clearly written, straightforward instructions for a piece of equipment.	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18
ENAEE Learning Outcome: KNOWLEDGE AND UNDERSTANDING: LO1.3.- Critical awareness of the wider multidisciplinary context of engineering [Intermediate (2)].	CG10		
ENAEE Learning Outcome: INVESTIGATIONS: LO4.1.-Ability to conduct searches of literature, to consult and critically use databases and other appropriate sources of information, to carry out simulation in order to pursue detailed investigations and research of technical issues in their field of study [Intermediate (2)].			CT5
ENAEE Learning Outcome: COMMUNICATION AND TEAM-WORKING: LO7.1.- Ability to communicate effectively information, ideas, problems and solutions within the engineering community and society at large [Intermediate (2)].		CE34	CT4 CT18
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)].		CE34	CT4 CT7 CT8 CT17 CT18
ENAEE Learning Outcome: LIFELONG LEARNING: LO8.1.- Ability to recognise the need for and to engage in independent lifelong learning [Basic (1)].			CT8
ENAEE Learning Outcome: LIFELONG LEARNING: LO8.2.- Ability to follow developments in science and technology [Basic (1)].			CT8

Contents	
Topic	
Unit 1	1.1. Questions and answers 1.2. It's a mystery
Unit 2	2.1. Doctor, doctor 2.2. Act your age
Unit 3	3.1. Fasten your seat belts 3.2. A really good ending?
Unit 4	4.1. Stormy weather 4.2. A risky business

Unit 5	5.1. I'm a survivor 5.2. Wish you were here

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	22	20	42
Mentored work	22	20	42
Essay questions exam	33	21	54
Essay	0	4	4
Oral exam	4	4	8

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

Methodologies	
	Description
Lecturing	The communicative approach is based on the idea that language learning successfully comes through interspersing different didactic methods. Theory lessons will consist of checking the theoretical knowledge students have and, consequently, teaching the contents designed for completing the knowledge students have previously acquired.
Mentored work	Theory lessons will be completed with practical sessions in which different activities will be done in order to develop students' competence in the four linguistic skills and, therefore, reach the abovementioned goals.

Personalized assistance	
Methodologies	**Description**
Mentored work	The teachers will answer their students' questions themselves, both in the office, at the time published on the website of the college, and through the use of web-based technology (e-mail, videoconferences, MooVi forums, etc.) on appointment.
Tests	**Description**
Oral exam	

Assessment					
	Description	Qualification	Evaluated Competencess		
Essay questions exam	Taking into account both the methodologies and the different activities done throughout the whole term (whose main objective is the acquisition of the learning outcomes), the following is the percentage of the global mark corresponding to each part of the exam: Reading - 20% Listening - 20% Writing - 30% Speaking - 30% Global - 100% Exams (2 per term) 70% Exam 1 - 30% Exam 2 - 40%	70	CG10	CE34	CT4 CT8 CT9 CT15 CT17 CT18
Essay	Activity 1 (15%)	15	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18
Oral exam	Activity 2 (15%)	15	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18

Other comments on the Evaluation

The main goal of the subject is to assess the learning of all of the contents. Exams must be complete, i. e., they will cover all of the contents, since the main goal is to assess what students know about the subject in general, not about a part of it. The mid-term exam will be worth 30% of the overall mark of the continuous assessment, and the final exam will be worth 40% since the latter covers all of the contents taught throughout the term. Moreover, in the final exam, it will be necessary to fulfil the following condition:

1. Obtain at least 40% on each of the four parts of the exam, corresponding to the four linguistic skills.
If the student does not fulfil the abovementioned requirement, the mark of the part of the exam where the student has got the highest mark will become the mark of the final exam and, therefore, of the continuous assessment. This mark will never be higher than 3/10 (3 out of 10) since this is the highest possible mark in each of the two parts of the exam whose marks are the highest (writing and speaking). To pass the subject via continuous assessment, the student should get at least 5 points as a whole.
Ordinary and/or extraordinary exam
In order to pass this exam, it will be necessary to fulfil the following condition:
1. Pass (get at least half of the points on) each of the four parts of the exam, corresponding to the four linguistic skills.
If the student does not fulfil the abovementioned requirement, the mark of the part of the exam where the student has got the highest mark will become the mark of the exam and, therefore, of the assessment. This mark will never be higher than 3/10 (3 out of 10) since this is the highest possible mark in each of the two parts of the exam whose marks are the highest (writing and speaking).
Both in the exams which make up the continuous assessment (mid-term exam and final exam) and in the ordinary and extraordinary exams, all of the students, independently of the class group (1, 2, 3 or 4) they belong to, are being assessed of the same compulsory subject of the Degree in Mechanical Engineering of the Defense College, English I. Consequently, for the speaking part of the exam, students will be grouped by following objective and consistent criteria. Although, if possible, the grouping of students to do the abovementioned part of the exam will aim to be similar to class groups, this will not be compulsory.
IMPORTANT NOTES:1. During the time students are sitting exams, they will be banned from using electronic devices (except the student on duty, who will put her/his mobile on the desk, in sight of the teachers invigilating the exam at issue). If the teachers invigilating the exam realise that a student (except the student on duty, who will be allowed to have the regulatory mobile) has, handles or uses an electronic device, her/his mark will be 0 in the exam as a whole and, if they do so during the ordinary/extraordinary exam, their mark will be 0 in the assessment as a whole. Under no circumstances will there be any special permission to allow the students to have electronic devices during the time they will be sitting exams.
2. The organisation of exam procedures, which is published both on the "orden diaria" and the virtual platform of the subject, will be only and exclusively designed by the coordinator of the subject, who will have reached an agreement with the governing body of the Defense College. Under no circumstances will there be any changes derived from decisions made by people different from the coordinator or the members of the governing body of the Defense College. The mark of those students who do not fulfil the abovementioned requirements will be 0 on the exam and, if they do not fulfil the above mentioned requirements during the ordinary/extraordinary exam, their mark will be 0 on the assessment as a whole.

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The UK Foreign and Commonwealth Office,
The British Army,
The Royal Air Force,
The British Forces Broadcasting Service,
US Department of Defence Dictionary of Military and Associated Terms,
US-based military English website,
Military definitions,
The National Army Museum,
Airforce magazine,

Recommendations

Subjects that continue the syllabus

English II/P52G381V01406

Other comments

To take this subject, students are highly encouraged to have taken the subject English Language of the Naval College. Both the knowledge and skills acquired once students have taken the subject will allow them to be able to succeed in subjects taken later, because at the end of the academic year students are expected to be able to acquire CEFR Level B1+.
Therefore, to be able to succeed, it is advisable to have the following skills:
-Reading and listening skill
-Writing and speaking skill
-Skill to think abstractly and summarise information
-Skills for group work and communication

IDENTIFYING DATA				
Electronic technology				
Subject	Electronic technology			
Code	P52G381V01301			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Troncoso Pastoriza, Francisco Manuel			
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General description	The objective of this course is to provide the students with the theoretical and practical fundamental knowledge in electronics' five main areas: analog electronics, digital electronics, industrial sensors, power electronics and communications electronics. In case of any discrepancy between this translation of the guide and the Spanish version, the valid one is the Spanish version.			

Skills	
Code	
CG3	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.
CE11	Knowledge of the fundamentals of electronics.
CT2	Problems resolution.
CT9	Apply knowledge.
CT10	Self learning and work.
CT17	Working as a team.

Learning outcomes			
Learning outcomes		Competences	
To know of the operation of electronic devices.	CG3	CE11	CT2 CT9 CT10 CT17
Know conditioning and data acquisition electronic systems and devices.		CE11	CT10
To identify different types of industrial sensors.		CE11	CT10
To know the basics of a digital electronic system.		CE11	CT2 CT9 CT10 CT17
To know basic electronic circuits for data communications.	CG3	CE11	CT9 CT10
ENAEE LEARNING OUTCOME: KNOWLEDGE AND UNDERSTANDING LO 1.3 Be aware of the multidisciplinary context of engineering. (level of development of this sub-learning outcome: Basic (1))		CE11	
ENAEE LEARNING OUTCOME: ENGINEERING ANALYSIS LO 2.2 Ability to identify, formulate and solve engineering problems within an specialty; choose and apply properly analytical methodologies; recognize the importance of social, health and safety, environmental, economic and industrial restrictions. (Medium (2))			CT2 CT9
ENAEE LEARNING OUTCOME: COMMUNICATION AND TEAMWORK LO 7.2 Ability to operate properly within national and international contexts, both individually and as a team, and cooperate with engineers and/or people from other disciplines. (Medium (2))			CT10 CT17
ENAEE LEARNING OUTCOME: CONTINUOUS EDUCATION LO 8.1 Ability to realize the need for continuous training and undertake this activity throughout their professional life on their own. (Medium (2))			CT10

Contents	
Topic	
Digital Electronics	- Basic concepts - Logical values: positive and negative logic - Logical families: TTL, ECL, CMOS - Binary functions and basic logic blocks - Truth table - Karnaugh maps - Basic integrated circuits - Design of basic combinational digital systems
Operational Amplifiers	- Basic concepts - Differential amplifier and operational amplifier - The op. amp.: terminals, feedback, virtual shortcut - Op-Amp circuits with closed-loop and negative feedback: inverting and non-inverting amplifiers, summing amplifier, differential amplifier, integrator, differentiator,... - Design of analog systems based on operational amplifiers
The diode	- Basic concepts - Semiconductors - The diode - The zener diode - Other diodes: LED, photodiode, etc. - Applications
The Bipolar Junction Transistor (BJT)	- Structure - BJT operation - Polarization, load line analysis and operating point (Q) - Applications
Field-Effect Transistor (JFET)	- Structure - Families of FET transistors - Polarization - Applications
Small-Signal Amplifiers	- Amplifier gain: voltage amplifier, current amplifier - Input impedance - Output impedance - Small-signal model for BJT - Small-signal model for JFET
Applications	- Data acquiring systems - Sensors and actuators - Analog to digital converter - Design of digital and analogical electronic systems - Industrial communications
Practice 1: Digital Electronics	This practice introduces the student to digital combinational circuits by assembling basic circuits within a protoboard.
Practice 2: Operational Amplifiers	The goal of this practice is introducing the closed-loop operation of these types of amplifiers, by assembling different circuits within a protoboard.
Practice 3: Simulation of digital and analog circuits	The goal of this practice is to introduce the simulation software PSIM and "Digital Electronic Simulator" to the student, in order to understand the importance of a proper simulation.
Practice 4: Basic electronic circuits with diodes	This practice shows the student different circuits for diodes (rectifiers, trimmers, ...), by assembling them in a protoboard and testing them with different input signals.
Practice 5: Simulation of electronic circuits with diodes and transistors	With this practice the student will learn to solve different circuits conformed by diodes and/or transistors with the simulation software PSIM.
Practice 6: Basic electronic circuits with transistors	This practice shows basic circuits with transistors (mainly BJT) in order to show the polarization concepts shown in theory.
Practice 7: Multistage amplifier design	This practice tries to merge all the concepts learned during the course for analog devices by designing a simple multistage amplifiers conformed by a small-signal amplifiers followed by one (or more) stages of high power amplifiers (wit op-amps).

Planning	Class hours	Hours outside the classroom	Total hours

Lecturing	28	42	70
Laboratory practical	14	14	28
Seminars	22	0	22
Problem and/or exercise solving	7	13	20
Problem and/or exercise solving	1.5	2	3.5
Problem and/or exercise solving	1.5	2	3.5
Laboratory practice	3	0	3

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

Methodologies

	Description
Lecturing	They will consist in an oral explanation by the lecturer of the most important parts of the course, all related with the materials that the student had to work previously. This is intended to favor the active participation of the students, that will have occasion to rise doubts and questions during the sessions. Active participation is desired during all the sessions.
Laboratory practical	During these sessions, in the classroom, interleaved with the lectures, the lecturer will proceed to solve examples and/or exercises that properly illustrate the problems to solve. As long as the number of participants in the classroom allows, active participation will be promoted.
Seminars	Previous preparation of the theoretical sessions: Prior to the start of the theoretical sessions, the students will have available a series of materials that have to prepare, as the sessions will relay on them. Previous preparation of the laboratory sessions: It is mandatory that the students make all the assigned previous tasks prior to access the laboratory. These task are intended to greatly improve the laboratory knowledge acquisition. The achieved report will be taken into account when the laboratory session is to be evaluated. This section includes the intensive course designed for preparing the extraordinary exam.

Personalized assistance

Methodologies	Description
Seminars	In the scope of tutorial action, academic tutoring actions and personalized tutoring are distinguished. Within the first option, students will have tutoring hours where they can ask questions related to the subject contents, organization and/or planning. In personalized tutoring hours, each student, individually, can discuss with the lecturer any problem regarding his/her understanding of the subject. Both tutorial actions aim to compensate the different learning rhythms through attention to diversity. The lecturers of the subject will personally answer the questions and queries of the students, according to the schedule that will be published on the website of the center, such as through telematic means (email, videoconference, MOOVI forums, etc.) under the modality of previous appointment.

Assessment

	Description	Qualification	Evaluated Competencess		
Problem and/or exercise solving	Final exam to evaluate the global knowledge acquired of the subject, due at the end of the semester.	40	CG3	CE11	CT2 CT9 CT10
Problem and/or exercise solving	First assessable test of the knowledge acquired up to that moment (due date: around the 5th week of the semester).	15	CG3	CE11	CT2 CT9 CT10
Problem and/or exercise solving	Second assessable test, corresponding to themes 3, 4 and 5 (approximate date: 9th week of the semester).	15	CG3	CE11	CT2 CT9 CT10
Laboratory practice	Laboratory exam where the ability to understand, ensemble and simulate basic electronic circuits are tested (due date: at the end of the semester).	30	CG3	CE11	CT2 CT9 CT10 CT17

Other comments on the Evaluation

The student evaluation and qualification criteria proposed for this subject are set out. Given the peculiarities of the Centro Universitario de la Defensa, where this subject will be taught, and taking into account that the students are in a boarding school, only evaluation criteria for assistants are proposed.

Ordinary call:

Continuous evaluation

In the ordinary call, a process of continuous evaluation is carried out in which the weight of the different parts in which the subject is structured over the final mark is as follows:

- Knowledge of theory (T): 70%
- Practical knowledge (L): 30%

Knowledge of theory:
The theory knowledge part is evaluated by combining two scoring tests and a final exam as follows:

- Partial exam 1 (P1):
    - A test of approximately 1 hour and a half in length and preferably located at the end of themes 1 and 2 of the subject.
    - Weight: 15% of the continuous assessment score (NEC).
    - It is qualified with 10 points.
    - Made individually.
    - It can take the form of a multiple choice questionnaire, short answer questionnaire, problem solving or some combination of the above.
    - There is no minimum qualification.

- Partial Exam 2 (P2):
    - A test of approximately 1 hour and a half, preferably located at the end of themes 3 and 4 of the course.
    - Weight: 15% of the continuous assessment score (NEC).
    - It is qualified with 10 points.
    - Made individually.
    - It can take the form of a multiple choice questionnaire, short answer questionnaire, problem solving or some combination of the above.
    - There is no minimum qualification.

- Final exam (EF):
    - Exam to be taken on the evaluation dates.
    - Weight: 40% of the continuous assessment score (NEC).
    - It is qualified with 10 points.
    - Made individually.
    - They can be in the form of a multiple choice questionnaire, short answer questionnaire, problem solving or some combination of the above.
    - A minimum qualification of 4.0 is required.

Practical knowledge:

The practical part of the course is assessed by means of a practical laboratory test, as follows:

- Practical laboratory exam (L2):
    - This is a test to evaluate the ability acquired by the student to assemble electronic circuits and to check their operation with the instruments used in the practices.
    - The realization of the test is individual.
    - Weight: 30% of the continuous evaluation score (NEC).
    - It is qualified with 10 points.
    - A minimum score of 4.0 points is required.

Final mark and minimum requirements to pass the course through continuous assessment:

To ensure that the student has acquired the minimum skills in each of the aspects of the subject, students will be required to achieve a minimum score of 4.0 out of 10 in the final exam of theory (EF), and a minimum score of 4.0 out of 10 in the

practical part (L1 and L2).

In this way, the final mark in continuous assessment (NEC) is calculated using the following formulas, a minimum mark of 5.0 in the NEC being necessary to pass the course:

NEC = 0.15*P1 + 0.15*P2 + 0.4*EF + 0.3*L
In the event that the minimum mark required in any of the parts is not reached, the final mark for continuous assessment will be calculated as:

NEC = min(4.0, NEC)
The student who does not pass the course in continuous evaluation must take the ordinary exam.
Ordinary exam

- Knowledge of theory (T): 70%
- Practical knowledge (L): 30%

Theory:

Consists of:

- A single exam, of approximately 3 hours, to be performed within the course calendar.
- It is qualified with 10 points (T).
- Individual.
- It can include tests, short questions and/or problems or a combination of them.

Laboratory:

Consists of:

- A single practical exam, of approximately 45 min, at the laboratory, related to the practical contents of the subject.
- It is qualified with 10 points (L).
- Individual.

Final mark and minimum requirements to pass the subject:

The final mark (NEO) will be computed following the next equation:

NEO = 0.7 * T + 0.3 * L

A minimum of 4.0 out of 10 points are required for the T exam, and a minimum of 4.0 out of 10 points are required for the L exam. Once obtained these minimums, a punctuation equal or higher than 5.0 points over 10 in the total computation of NEO is mandatory to pass the subject.

Extraordinary exam:

The students that did not pass the subject on first convocatory must attend the second convocatory (or extraordinary exam), that will have the same structure, exam duration, percentages and minimum points required than in the ordinary exam.

Code of Honor:During exames, the use of non-allowed electronic devices, notes or books is forbidden.Exams lacking some of the sheets will not be graded.
All the results obtained must be properly justified, in any of the exams or activities. None of the numerical results will be considered if no explanation is given about the methodology used to obtain them.

It is expected that all the students abide to these considerations. If a non-ethical behaviour is detected, the student will automatically be graded with a 0.0 at the current convocatory.

Sources of information
Basic Bibliography
Malvino, Albert; Bates, David J., **Principios de Electrónica**, 7ª,
E. Mandado, **Sistemas Electrónicos Digitales**, 9ª,
Complementary Bibliography
R. Pallás Areny, **Sensores y acondicionadores de señal**, 4ª,

J. Millman, **Microelectrónica. Circuitos y sistemas analógicos y digitales**, 4ª,
N. R. Malik, **Circuitos Electrónicos. Análisis, simulación y diseño**, 1ª,
T. L. Floyd, **Fundamentos de Sistemas Digitales**, 9ª,

Recommendations

Subjects that it is recommended to have taken before

Fundamentals of electrical engineering/P52G381V01205
Mathematics: Calculus II and differential equations/P52G381V01201

IDENTIFYING DATA				
Materials engineering				
Subject	Materials engineering			
Code	P52G381V01302			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Pérez Rial, Leticia			
Lecturers	Maceiras Castro, María del Rocío Pérez Rial, Leticia			
E-mail	leticia@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The subject Materials Engineering aims that the Graduated in Mechanical Engineering acquire 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), 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.			

Skills	
Code	
CG3	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.
CG4	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.
CG5	Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
CG6	Capacity for handling specifications, regulations and mandatory standards.
CG11	Knowledge, understanding and ability to apply the necessary legislation in the exercise of the profession of Industrial Technical Engineer.
CE25	Knowledge and skills for engineering materials.
CT5	Information Management.
CT7	Ability to organize and plan.
CT9	Apply knowledge.
CT10	Self learning and work.
CT15	Objectification, identification and organization.
CT17	Working as a team.

Learning outcomes	Competences		
To know the main forming processes and transformation of materials used in the industry.	CG3 CG4	CE25	CT5
To show capacity to select the most appropriate manufacturing process for the obtention of basic pieces from a given material.	CG3 CG4 CG5	CE25	CT7 CT9
To know the main union processes of the materials used in the industry.	CG3	CE25	CT9
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.	CG4 CG5 CG6	CE25	CT9
To know the characteristics of the materials more usually employed in Engineering.	CG3 CG6	CE25	CT5

To know the evolution of the distinct types of materials and of the processes for his possible forming.	CG3 CG6	CE25	CT5
To know and to apply the selection criteria for the most adapted material and a concrete application.		CE25	CT9
To analyse and to propose operative solutions to problems in the field of materials engineering.	CG4 CG11		CT9 CT15
To interpret, analyse, synthesize and extract conclusions and results of measures and essays.	CG4	CE25	CT7 CT15
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.	CG11		CT5 CT7 CT17
To show capacities of communication and work in team.		CE25	CT17
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.	CG4	CE25	CT5
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.	CG4 CG6	CE25	CT7 CT10
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)].	CG3	CE25	
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)].	CG4	CE25	CT9
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)].	CG4		CT9
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)].	CG4 CG5		CT7 CT9
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)].	CG6 CG11		CT5
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)].		CE25	CT9
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)].		CE25	CT9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.4.- Ability to apply norms of engineering practice in their field of study [intermediate (2)].	CG6 CG11		CT9
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)].	CG4		CT5
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)].			CT5 CT7 CT10 CT17

Contents
Topic

UNIT 1: MECHANICAL PROPERTIES OF MATERIALS Location and length: Weeks 1-2 [5 hours] Objective and development: This unit aims 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 3-4 [4 hours] Objective and development: Once metallurgy operations have been studied, the extraction and production of steel is studied as well as the obtention of other relevant structural materials.	2.1 STRUCTURAL MATERIALS: METALS AND ALLOYS Introduction. Iron extraction and steel production. Steels classification. Non-ferrous alloys. 2.2 MATERIALS FOR DEFENCE: STEELS FOR ARMOURS; ALLOYS OF ALUMINIUM, TITANIUM AND MAGNESIUM 2.3 RECYCLING OF STEEL AND ITS ENVIRONMENTAL IMPACT (UNE-EN 13437).
UNIT 3: STRUCTURAL AND BUILDING MATERIALS Location and length: Weeks 5-6 [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 and recycling 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 6-8 [5 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 8-10 [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 PROCESSES Molding of polymers 5.4 POWDER METALLURGY

UNIT 6: UNION AND WELDING TECHNOLOGIES Location and length: Weeks 11-12 [4 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)	Practice 1. 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. Practice 2. 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 searches related to aluminum technology. 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). Practice 3. Union technologies: evaluation of adhesives (2 hours) Student determines 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 or updates) . Adhesives. Terms and definitions (UNE-EN 923:2016) . Adhesives for wood (UNE-EN 14292:2005) . Structural adhesives for metals and plastics (UNE-EN 13887:2004) Practice 4, 5 and 6. Evaluation of building materials (concretes) (6 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 (project), 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. Practice 7. Public presentation of the project (2 hours) The last practice session will be reserved for the students' oral presentation of the project carried out on the evaluation of construction materials (concrete). 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	28	56
Problem solving	7	14	21
Seminars	15	15	30

Laboratory practical	12	10	22
Essay questions exam	13	6	19
Presentation	2	0	2

*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 topic. 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 practical 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 failed the subject by continuous evaluation, previous to the examination in first 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 propose technical solutions.

Personalized assistance

Methodologies	Description
Problem solving	The lecturers of the subject will answer personally the questions 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, Moovi forums, etc.) under the modality of previous appointment.
Seminars	Tutorships in small groups with the professor.

Assessment

	Description	Qualification	Evaluated Competencess		
Problem solving	It will be evaluated: the autonomous resolution of exercises or questions, proposed by the lecturers, assessing, among other concepts: the proper resolution of exercises, the approach, order and delivery on time.	10	CG4 CG6 CG11	CE25	CT5 CT7 CT9 CT10 CT15
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.	10	CG4 CG6 CG11	CE25	CT5 CT7 CT9 CT10 CT15
Essay questions exam	INTERMEDIATE EXAMS: Two intermediate exams will be carried out (30%), in which all the topics explained so far will be evaluated. GLOBAL EXAM (40%): It will consist of a theory part and a problem part. It is a necessary condition to pass the subject by continuous evaluation to obtain a minimum of 4 in each part.	70	CG3 CG4 CG5 CG6 CG11	CE25	CT5 CT7 CT9 CT15
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 lecturers. 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	CG4 CG6 CG11	CE25	CT5 CT7 CT9 CT10 CT15 CT17

Other comments on the Evaluation

In case of not exceeding any of the minimums indicated above, the maximum mark of the student for continuous evaluation will be 4 points, having to take the ordinary exam to pass the subject.

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 ordinary examination will be carried out.

ETHICAL COMMITMENT

It is expected that students have an adequate ethical behavior. If unethical behavior is detected (cheating, 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 the student 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

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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 subject.

IDENTIFYING DATA				
Elasticity and additional topics in resistance of materials				
Subject	Elasticity and additional topics in resistance of materials			
Code	P52G381V01303			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Val García, Jesús del			
Lecturers	Val García, Jesús del			
E-mail	jesusdv@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The subject Elasticity and Advanced Strength of Materials is a subject of the specific mechanic block that is taught in the first quadmester of the third academic year in the CUD-ENM. The subject is continuation and extension of the subject Strength of Materials of second-year. To establish the general equations that govern the mechanical behaviour of the deformable solids, it is necessary to complement the equations of the statics, kinematics and dynamics, with equations that relate the stress and deformations in the surroundings of the point. In the case of small deformations, it is checked that in most of materials the process of deformation is reversible, in terms of elastic behaviour. Then, it is established as the goal of the "Theory of the Elasticity" the study of the deformable solids with elastic behaviour. The mathematical formulation of all these theories drives to equations of big complexity and the finding of exact solutions remain limited to some particular cases. For the case of one-dimensional or two-dimensional solids, it is possible to establish simplifying hypothesis regarding to the stress distribution. This is the approach of the "Strength of Materials" that allows to attach the study of those deformable solids that admit simplifying hypothesis in relation to its stress and deformational states. The teaching of this subject pursues that the students aquire the basic knowledge related with the capacity to know and understand the behaviour of the elastic solid under any type of load. Besides they reinforce the basic concepts of the stress analysis so that it can be applied to the design and calculation of structural elements and elements of machines. The elasticity and strength of materials establishes the criteria that allow to determine the most convenient material, the shape and the most adapted dimensions that the elements of a structure or a machine need to resist the action of the external loads without an excessive economic cost. Likewise, the students are initiated in the handling of computational programs to calculate efforts, of trips and tensions of basic structural systems.			

Skills	
Code	
CG3	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.
CG4	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.
CE22	Knowledge and skills to apply the fundamentals of elasticity and strength of materials to the actual behavior of solids.
CT2	Problems resolution.
CT5	Information Management.
CT9	Apply knowledge.
CT10	Self learning and work.
CT17	Working as a team.

Learning outcomes	Competences		
Kowledge of the elasticity fundamentals	CG3	CE22	
Further deepening on mechanics of materials and stress analysis	CG3 CG4	CE22	CT2 CT10
Knowledge of deformations in beams and shafts	CG3 CG4	CE22	CT2 CT9
Ability to apply the knowledge of elasticity and mechanics of materials, and to analyze the mechanical performance of machines, structures, and general structural elements	CG4	CE22	CT2 CT5 CT9

Ability to take decisions about suitable material, shape and dimensions for a structural element subjected to a specific load	CG4	CE22	CT2 CT5 CT9 CT17
Knowledge of different solving methods for structural problems and ability to choose the most suitable method for each specific problem	CG4	CE22	CT2 CT5 CT9
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	CG3	CE22	
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 [Level of achievement: Intermediate (2)].	CG4		CT2 CT9
ENAEE learning outcome: RESEARCH AND INNOVATION: LO4.3 Ability to perform experimental investigation, understand the results and draw conclusions in the study field [Level of achievement: Intermediate (2)].		CE22	CT9
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 [Level of achievement: Intermediate (2)].		CE22	CT9

Contents

Topic	
1. Introduction. Review of Strength of Materials	1.1. Axial loading. 1.2. Shear. 1.3. Pure bending and nonuniform bending. Bending and axial load 1.4. Diagrams. Derformations. Mohr□s Theorems 1.5. Statically indeterminate beams. Simplifications in symmetric and antisymmetric beams
2. Fundamentals of elasticity	2.1. Introduction to Elasticity 2.1.1. Goals of Elasticity and Strength of Materials 2.2. Definition of stress in elastic solids 2.2.1. Stress tensor 2.2.2. Principal stresses and principal directions 2.2.3. Graphic representation of three-dimensional stress. Mohr´s Circles 2.3. Deformation analysis in continuum media 2.3.1. State of strain at a point 2.3.2. Strain tensor 2.3.3. Graphic representation of deformational state. Mohr´s Circles 2.4. Stress-Strain relations 2.4.1 Generalized Hooke´s laws
3. Criteria for initiation of inelastic material behavior. Failure condition	3.1. Plastic deformation of materials. Failure condition 3.2.Maximum normal stress theory or Rankine theory 3.3. Maximum normal strain theory or Sain-Venant theory 3.4. Maximum shear stress theory or Coulomb theory 3.5. Maximum strain energy theory or Beltrami-Haigh theory 3.6. Maximum distorsion energy theory or von Mises theory 3.7. Comments about failure theories. Safety factor
4. Torsion	4.1 Torsion of a prismatic bar of circular cross section. Coulomb□s theory 4.2. Design of transmission shafts 4.3. Strain energy stored by torsion 4.4. Statically indeterminate torsion members
5. Combined loadings	5.1. Combined Loadings 5.2. Combined bending and torsion in bars of circular cross section 5.3. Bending of beams of nonsymmetrical section. Shear center 5.4. Combined axial and bending load in non-slender bodies 5.5. Thin-wall pressure vessels
6. Lateral bending. Buckling	6.1. Buckling. Introduction 6.2. Centric compression load in slender column. Euler critical load 6.3. The effect of end conditions on critical load 6.4. Eccentric load in slender column 6.5. Validity range in Euler buckling theory. Design formulas for columns 6.6. Bucking coefficients method for column design

7. Strain energy. Energy methods	7.1. Strain energy concept 7.2. External loads and strain relations. Influence coefficients concept 7.3. Strain energy expressions. Clapeyron theorem 7.4. Principle of virtual works. 7.5. Castigliano´s theorems
8. Experimental methods in elasticity	8.1. Electrical strain gages method. Fundamentals 8.2. Electrical strain gages. Data analysis 8.3. Photoelasticity. Fundamentals 8.4. Basic optical concepts in photoelasticity 8.5. Photoelasticity equipment. Interpretation of the stress contours

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Problem solving	7	0	7
Seminars	15	7	22
Laboratory practical	14	14	28
Essay questions exam	14	4	18
Essay	2	3	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 of the contents of the subject matter, theoretical bases and/or guidelines of a work, exercise or project to be developed by the student. Presentations and blackboard will be used in combination. At the beginning of the course, students are given a notebook with all the slides used by the teachers. Therefore, the students have the work material at their disposal prior to the presentation, thus focusing the effort of the lecturer and the students on the presentation and understanding of the knowledge and not simply on the transmission of knowledge. In any case, paper reproductions of transparencies should never be considered as substitutes for texts or notes, but as complementary material. The aim is to give the student the possibility to contrast his class notes with them and, in this way, to help him to better understand the ideas conveyed by the lecturer.
Problem solving	Activity in which problems and/or exercises related to the subject are formulated. The student must develop the appropriate or correct solutions through the exercise of routines, the application of formulas or algorithms, the application of transformation procedures of the available information and the interpretation of the results. It is usually used as a complement to the lectures.
Seminars	Intensive course of 15 hours for those students who have failed the course in the first call, prior to the exam in in the second call. Group tutorials with the lecturer.
Laboratory practical	Activities for the application of knowledge to concrete situations and the acquisition of basic and procedural skills related to the subject matter. They are developed in special spaces with specialized equipment (laboratories, computer classrooms, etc.).

Personalized assistance

Methodologies	Description
Lecturing	In the field of tutorial action, there are two types of actions: academic tutoring and personalized tutoring. In the first case, the students will have at their disposal hours of tutorials in which they can ask any question related to the contents, organization and planning of the subject, etc. The tutorials can be individualized, but group tutorials will be encouraged for the resolution of problems related to the activities to be carried out in group. In the personalized tutorials, each student, individually, will be able to discuss with the lecturer any problem that is preventing him/her from following the subject properly, in order to find some kind of solution between both of them. By combining both types of tutorial action, the aim is to compensate for the different learning rhythms through attention to diversity. The lecturers of the subject will personally answer the students' questions and queries, both in person, according to the schedule that will be published on the center's web page, and through telematic means (e-mail, videoconference, Moovi online teaching platform, etc.) under the modality of previous appointment.

Assessment

	Description	Qualification	Evaluated Competencess		
Laboratory practical	The evaluation of the practices will be valued by checking the memories of practices (MP) that the student will have to deliver	20	CG4	CE22	CT2 CT5 CT9 CT10

Essay questions exam	Written tests: theoretical questions and problems. The purpose of the written tests is to evaluate the learning of all the theoretical contents selected for the course. - Final exam (PF): 40% - Intermediate exams (PI): 30% (PI1 15%, PI2 15%)	70	CG3 CG4		CT2 CT9
Essay	During the course of the subject, evaluable activities will be proposed (evaluable problems or work) with the aim of having students solve them autonomously and / or expose them in their own class. - Evaluable activities (AE): 10%	10	CG3 CG4	CE22	CT2 CT9 CT10

Other comments on the Evaluation

The evaluation criteria for each section will be published at the beginning of the quadmester. The relevant information will be provided to the students through the virtual platform Moovi.

The final evaluation of student will be the sum of the grades obtained in each one of the parts previously mentioned, being his/her grade of continuous evaluation (NEC):

NEC = 0.4*PF + 0.15*PI1 + 0.15PI2 + 0.2*MP + 0.1*AE

However, some minimum requirements will be demanded, in some of the sections, to guarantee a balance between all types of competencies

If the NEC is inferior to 5, the student will have to attend to the ordinary exam of all the contents of the subject, that will suppose 100% of the grade. Therefore, the student must sit for the regular exam in the following cases:

1. Failure to complete or submit any of the previous items.
2. Obtaining a grade lower than 4 points out of 10 in the final exam of continuous evaluation.

In either of these two cases, the continuous evaluation grade will be the minimum of the continuous evaluation grade calculated with the above formula and 4 points.

Detection of cheating in any kind of evaluation activity (midterm or final exams, laboratory work, etc.) will be penalized with a zero in the evaluated item and, in those evaluations with a mandatory minimum grade to pass the course, the student will not be evaluated by continuous evaluation. This sanction will affect both students copying during the evaluation tests, and those that facilitate copying.

The attempt of academic fraud during the realization of any of these tests (PI or PF) will mean that the student or students involved will not pass the subject by continuous evaluation (in which they will obtain a grade of 0.0). Likewise, the student or group of students who are detected to have plagiarized or copied a work will obtain a grade of zero. If this type of behavior is detected in the ordinary exam or in the extraordinary exam, the student will obtain a grade of 0.0.

In any case, the student who has passed the continuous evaluation will be offered the opportunity to take the regular exam in order to obtain a higher grade.

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Philpot T. A., **Mechanics of materials: an integrated learning systems**, 2nd Edition,

Recommendations

Subjects that continue the syllabus

Machine design/P52G381V01405
Theory of structures and industrial constructions/P52G381V01404

Subjects that it is recommended to have taken before

Resistance of materials/P52G381V01204

IDENTIFYING DATA				
Graphic engineering				
Subject	Graphic engineering			
Code	P52G381V01304			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Puente Luna, Iván			
Lecturers	Pérez Vallejo, Javier Puente Luna, Iván			
E-mail	ipuente@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This subject is part of the module of Specific Mechanical Technology. It links and complements the first-year subject Graphic Expression and aims to encompass all the language of the technical drawing, reinforcing the theoretical basis, the geometric foundations that allow the conception and visualization of shapes and dimensions, while expanding the practice, through the already inescapable computing environments. All of this without forgetting the study of the Standardization, that facilitates the exchange of technical information through the graphic language of current regulations. The aim is the creation and management of graphical information from the mechanical engineer's perspective, focusing on the specific characteristics of the Bachelor Degree taught at the CUD-ENM. It will cover contents on descriptive geometry, computer graphics, the definition of sets and mechanisms unequivocally, the normalized representation of ships, etc., seeking a general training but especially adequate and useful for the future performance of the students.			

Skills	
Code	
CG1	Skills for writing, signing and developing projects in the field of industrial engineering, whose purpose is, specializing in Mechanics, according to the knowledge acquired pursuant to paragraph 5 of this order, construction, alteration, repair, maintenance, demolition, manufacturing, installation, assembly or operation of: structures, mechanical equipments, energy facilities, electrical systems and electronic installations and industrial plants, and manufacturing processes and automation.
CE19	Knowledge and skills to apply the techniques of engineering graphics.
CT2	Problems resolution.
CT6	Application of computer science in the field of study.
CT9	Apply knowledge.
CT10	Self learning and work.
CT14	Creativity.
CT16	Critical thinking.
CT17	Working as a team.

Learning outcomes	Competences		
To know and to posess well-grounded criteria for the selection and application of standard components.	CG1	CE19	CT2 CT9 CT10 CT16
To know CAD technologies for the geometrical modelling and the generation of technical drawings from it.		CE19	CT6 CT9 CT10
Ability to perform analysis on the operation of mechanisms from the specifications contained in technical drawings.	CG1	CE19	CT2 CT9 CT14
To know how to apply Geometry to the resolution of problems about constructions and industrial installations.		CE19	CT2 CT9 CT14
To acquire skills for creating and managing graphic information related to Mechanical Engineering problems.		CE19	CT10 CT14 CT16 CT17

ENAEE learning outcome: 1. KNOWLEDGE and UNDERSTANDING LO1.2. Knowledge and understanding of engineering disciplines underlying their specialization, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront. Level of achievement: Intermediate (2).		CE19	
ENAEE learning outcome: 2. ENGINEERING ANALYSIS LO2.1. Ability to analyze 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. Level of achievement: Intermediate (2).	CG1		CT2 CT9
ENAEE learning outcome: 2. 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. Level of achievement: Intermediate (2).			CT2 CT9 CT14 CT16
ENAEE learning outcome: 3. 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. Level of achievement: Advanced (3).		CE19	CT2 CT9
ENAEE learning outcome: 3. ENGINEERING DESIGN LO3.2. Ability to design using some awareness of the forefront of their engineering specialization Level of achievement: Intermediate (2).	CG1	CE19	CT9
ENAEE learning outcome: 5. ENGINEERING PRACTICE LO5.1 Understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study. Level of achievement: Intermediate (2).		CE19	CT9
ENAEE learning outcome: 5. ENGINEERING PRACTICE LO5.2 Practical skills for solving complex problems, realizing complex engineering designs and conducting investigations in their field of study. Level of achievement: Intermediate (2).			CT2 CT9 CT16
ENAEE learning outcome: 7. 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. Level of achievement: Intermediate (2).	CG1		CT10 CT17

Contents	
Topic	
THEORETICAL CONTENTS	
Chapter 1. Introduction to graphics in engineering.	1.1. Types of graphics in engineering. Fields of application. Graphics for the design, the visualization and the communication. The graphic language. 1.2. Graphic systems. Types and structure of the graphic files. Information management. Hierarchies. Layers. 1.3. Models. Geometrical model. Information associativity. 1.4. Graphic constructions used in engineering. 1.5. Diagrams and nomograms.
Chapter 2. Mechanical design and use of transmission elements.	2.1 Definition and representation of axles and shafts. 2.2 Definition and representation of gears and cogwheels. Standard representation. 2.3 Definition and representation of bearings and plugs. Standard representation. 2.4 Definition and representation of sealing elements.
Chapter 3. Structural design.	3.1 Study of joints. Typology. Elementary functions. Joining methods. 3.2 Threaded joints. Threads. Joint elements. Design criteria. Representation of threaded joints. 3.3 Permanent joints. Welding. Rivets. Representation of permanent joints.
Chapter 4. Management of the variability; functional impact of tolerances. Analysis and synthesis of tolerances.	4.1 Variability associated to engineering problems. 4.2 Macro- and micro-geometrical variability. 4.3 Size tolerances and fits. Specification. 4.4 References and reference systems. 4.5 Statistical tolerances. Cost functions for tolerances. 4.6 Analysis and synthesis of tolerances. 4.7 Combination of tolerances; consequences of the tolerance cummulation on the operation of mechanisms.

Chapter 5. Geometrical product specifications.	5.1 The geometrical specification concept according to ISO. 5.2 Chains of standards. 5.3 GPS standards matrices.
Chapter 6. Fundamentals of computer graphics.	6.1 Basic geometrical transformations. 6.2 Grafication of lines: basic algorithms. 6.3 Surface modeling: implicit, parametric, poligonal. 6.4 Solid modeling: representation schemes & methods.
Chapter 7. CAD/CAE/CAM systems. Systems for data acquisition from actual geometries. Rapid prototyping.	7.1. Systems CAx (Computer Aided Technologies). 7.2. CAD/CAM tools. 7.3. CAE tools in the context of Design Engineering. 7.4. Virtual reality: characteristics and devices. Applications in the Engineering field. 7.5. Digitalization of forms. Reverse engineering projects. 7.6. Rapid prototyping systems.
Chapter 8. Introduction to industrial design.	8.1 Design. Types. Industrial Design (product, communication and corporate image). 8.2 Design methodologies. 8.3 Stages in the design process. 8.4 Creativity in the design process. 8.5 Assessment of design alternatives. 8.6 DfX (Design for X).
Chapter 9. Introduction to ship design.	9.1 Ship classification. 9.2 Introduction to ship representation techniques. 9.3 Main ship dimensions and characteristics. 9.4 Ship form dimensionless coefficients. 9.5 Structural and constructive elements.
Chapter 10. Ship hull representation.	10.1 Ship construction project. Documentation and plans to develop. 10.2 Hull form and lines drawing. 10.3 Sectional area curve and midship section. 10.4 Draft marks. 10.5 Representation and dimensioning of the ship structure and sections. 10.6 General and detailed plans of the ship structure. Midship frame, shell expansion, typical sections, decks and blocks. 10.7 General layout of the ship. Contours, spaces, tanks, etc... 10.8 Machinery and facility plans.
PRACTICAL CONTENTS	
Practical sessions 1,2 & 3. Solid modeling and assemblies.	In the first laboratory sessions, the student will learn to generate three-dimensional elements using regular modeling tools.
Practical session 4. Preparation of technical documentation (plans, projects,...).	The main objective of this practical session is for the student to learn to use the tools for the production of technical documentation obtained from the models and assemblies made previously.
Practical session 5. Reverse engineering.	The key objective of this practical session is for the student to carry out a three-dimensional reconstruction of an object from photographs. The software can be chosen by the student, suggesting the possibility of using: Meshroom, Eyescloud, ReCap Pro and Agisoft Photoscan (or Metashape). The reconstruction will be made from several photographs, since if a single photograph is used, a faithful reconstruction will not be achieved, but an approximation.
Practical sessions 6 & 7. Design and modeling of a Personal Protective Equipment (PPE).	The main objective of these practical sessions is to design and develop PPE in operator positions (protective masks, goggles, helmets, ear muffs, etc.) for the prevention and protection against occupational accidents and damage to health. The student must generate the 3D model of the assembled set and its drawings.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	20	25	45
Problem solving	8	10	18
Practices through ICT	8	12	20
Collaborative Learning	2	3	5
Project based learning	4	6	10
Seminars	7	7	14
Problem and/or exercise solving	17	10	27
Essay questions exam	9	0	9
Laboratory practice	2	0	2

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

Methodologies	
	Description
Lecturing	Each lecture session will be presented by the lecturer, setting examples for a better understanding of the contents. By raising issues in theoretical contents and examples, the active student participation will be boosted and assessed. Office presentations and the blackboard will be used to convey information such as definitions, graphics, pictures, etc. To the extent possible, copies of the presentations will be provided to the students prior to the lecture, focusing the effort of the lecturer and students on the exhibition and understanding of the knowledge. Printed reproductions of the presentations should never be considered as substitutes for notes taken in class or the texts suggested in the bibliography, but as complementary material.
Problem solving	Activities where problems related to Graphic Engineering are formulated. The student must develop adequate or correct solutions through the practice of routines, the application of formulas or algorithms, the application of transformation procedures of the available information and the interpretation of the results. This methodology constitutes a complement to lecturing.
Practices through ICT	Activities for the application of knowledge to specific situations and for the acquisition of basic and procedural skills related to Graphic Engineering. These practical sessions will take place in computer rooms with specialized equipment.
Collaborative Learning	Implementation of activities that require active participation and collaboration among students.
Project based learning	Throughout the quadmester, different 2D and 3D modeling projects will be carried out on a scheduled basis and during practical classes.
Seminars	Activities to reinforce learning through a supervised group resolution of practical exercises linked to the theoretical and practical contents of the subject. Those exercises in laboratory classes that students were unable to finish, need to be addressed in their study hours and if there is any difficulty or question, they can be resolved in these seminars.

Personalized assistance	
Methodologies	**Description**
Seminars	In addition to group tutorials, individualized seminars can be carried out, in which each student, individually, will be able to consult the lecturer with doubts or difficulties that prevent them from monitoring the theoretical or practical contents of the subject. Complementary exercises will be proposed to reinforce the learning of the contents of the subject, aimed at students who show difficulties to adequately follow the development of the classes. The lecturers will solve the questions of the students both in person, according to the tutoring schedule published on the web page of the CUD-ENM, as well as through telematic means (email,videoconference, MooVi forums, etc.) with previous appointment.

Assessment					
	Description	Qualification	Evaluated Competencess		
Practices through ICT	LABORATORY PRACTICE EXAM (percentage on the final grade: 15%) There will be a practical assessment test based on the problems made in class. ASSESSMENT OF THE PRACTICAL SESSIONS (percentage on the final grade: 15%): During the quadmester, in certain practical sessions, problems or exercises will be raised to be solved by the students and submitted for evaluation when determined by the lecturer. The evaluation of each deliverable will be in accordance with the criteria that have previously been communicated to the students.	30	CG1	CE19	CT2 CT6 CT9 CT14 CT16 CT17
Problem and/or exercise solving	INTERMEDIATE TESTS OF CONTINUOUS ASSESSMENT: They will be realized during the quadmester and will be of short duration. The execution of both tests will be compulsory and required to pass the subject. The tests will cover the contents taught to date.	30	CG1	CE19	CT9 CT10 CT16
Essay questions exam	A final exam will be carried out covering all the contents of the subject, both theoretical and practical, and it may include test questions, reasoning questions, problem solving and case study's development. It is required to achieve a minimum score of 4.0 points over 10 possible to pass the subject.	40	CG1	CE19	CT9 CT10 CT16

Other comments on the Evaluation

Final assessment of students will attend to the sum of the score given to each of the above mentioned parts, being their overall continuous assessment grade (CAG):

*CAG= 0,10 *INTERMEDIATE TEST 1 + 0,20 * INTERMEDIATE TEST 2 + 0,15 *PRACTICAL SESSIONS + 0,15* LABORATORY PRACTICE EXAM + 0,40* FINAL EXAM*

In order to pass the subject, the overall continuous assessment grade (CAG) calculated by the previous formula must be at least 5 points out of 10. However, minimum requirements and conditions will be required in some of the sections, which ensure a balance between all types of competences.

The student must take the ordinary exam of all the contents of the subject, which will represent 100% of the grade, in the following cases:

- If a student fails to take the intermediate tests or does not attend more than one practical session.
- If a student earns a grade below 4 points out of 10 in the final exam of continuous assessment.

In either of these two assumptions, the continuous assessment grade will be the minimum of the continuous assessment grade calculated with the previous formula and 4 points. In any case, students who have passed the continuous assessment, will have the possibility to take the ordinary exam to increase grades.

Both the ordinary and the extraordinary exams (July call) will evaluate all the competences of the subject. Therefore, the exams will include a practical assessment test in the computer room.

ETHICAL COMMITMENT: Students are expected to have appropiate 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 continuos assessment modality (in which he/she will obtain a grade of 0,0). If this type of behavior is detected in ordinary or extraordinary exams, the student will obtain in that call a grade of 0,0.

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Guirado Fernández, J. J., **Iniciación a la Expresión Gráfica en la Ingeniería: Los fundamentos proyectivos de la representación**, Gamesal, 2003

Izquierdo Asensi, F., **Geometría Descriptiva I (Sistemas y perspectivas)**, 26ª, Grefol, 2008

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Pérez Díaz, J. L.; Palacios Cuenca, S., **Expresión Gráfica en la Ingeniería: Introducción al dibujo industrial**, Prentice Hall, 1998

Sanz Adán, F.; Lafargue Izquierdo, J., **Diseño Industrial: Desarrollo del producto**, Paraninfo, 2002

Recommendations

Subjects that continue the syllabus

Machine design/P52G381V01405
Manufacturing engineering and dimensional quality/P52G381V01407
Technical Office/P52G381V01501

Subjects that it is recommended to have taken before

Mechanism and machine theory/P52G381V01206

Other comments

The subject of Graphic Engineering has no associated prerequisite. However, in order to successfully complete this course, the student must have:
- Sufficiently developed written and oral comprehension skills.
- Capacity of spatial vision, basic calculation and synthesis of information.
- Teamwork and communication skills.

- At least basic knowledge acquired in the subjects Graphic Expression, Mechanism and machine theory and Physics, taught in previous years.
The most frequent learning difficulties are related to the lack of such knowledge, but it can be saved with a little effort and the resources available of this center.

IDENTIFYING DATA				
Fluid machines				
Subject	Fluid machines			
Code	P52G381V01305			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Lareo Calviño, Guillermo			
Lecturers	Lareo Calviño, Guillermo			
E-mail	glareo@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The subject "Fluid Machines" is a subject of the specific mechanical block that is taught in the second semester of the third course of the bachelor degree in mechanical engineering taught at the CUD-ENM. The subject uses the fundamental tools used in the study of fluid movement (differential, integral and dimensional analysis) acquired in the subject "Fluid Mechanics" and applies them to energy transformer devices in which energy is transferred between the fluid that runs through the machine and its moving parts. The subject is focused on the study of machines with incompressible fluid. The need to reconcile the specific military training of the future Navy Officer with that of the bachelor degree in mechanical engineering leads to the subject being taught and evaluated aboard the "Juan Sebastián de Elcano" Training Ship.			

Skills	
Code	
CG3	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.
CE24	Applied knowledge of the basics of fluidmechanics systems and machines.
CT2	Problems resolution.
CT9	Apply knowledge.
CT10	Self learning and work.
CT17	Working as a team.

Learning outcomes			
Learning outcomes	Competences		
Comprise the basic appearances of the machines of fluid	CG3	CE24	CT2 CT9 CT10
Acquire skills in the sizing process of pumping facilities and fluid machines	CG3	CE24	CT2 CT9 CT10 CT17
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 development of each sub result (Basic (1), Appropriate (2) and Advanced (3)] In this sub-result appropriate (2).	CG3	CE24	
ENAEE Learning outcome: ENGINEERING ANALYSIS: LO2.2.- 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 [Appropriate (2)].			CT2 CT9
ENAEE Learning outcome: ENGINEERING DESIGN: LO3.2.- Ability to design using some awareness of the forefront of their engineering specialisation [Basic (1)].		CE24	CT9
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 [Basic (1)].		CE24	CT9
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)].		CE24	CT9
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)].			CT9

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)].	CT9
ENAEE Learning outcome: LIFELONG LEARNING: LO8.2.- Ability to follow developments in science and technology [Basic (1)].	CT10

Contents	
Topic	
Unit 1: Fluid machinery classification.	1.1.-Fluid machinery classification. 1.2.-Constitutive parts. 1.3.-Fluid machinery applications.
Unit 2: Energy balance in fluid machinery.	2.1.-Characterisation of fluid machinery. Inlet and outlet sections definition. 2.2.-Total energy conservation law. 2.3.-Internal energy conservation law. 2.4.-Mechanical energy conservation law. Hydraulic head. 2.5.-Mechanical energy balance and performance in driven machinery. 2.6.-Mechanical energy balance and performance in driving machinery.
Unit 3: Positive displacement machinery.	3.1.-Positive displacement machinery. Principles and classification. Characteristics. Applications. 3.2.-Alternative volumetric pumps. 3.3.-Rotary and peristaltic volumetric pumps. 3.4.-Hydraulic motors and linear actuators. Performance curves.
Unit 4: Principles of hydraulic circuits.	4.1.-General diagram of hydraulic circuits. Functional decomposition and simbology. 4.2.-Control elements and accessories in hydraulic circuits. 4.3.-Design and control of elementary hydraulic circuits.
Unit 5: Principles of pneumatic circuits.	5.1.-General diagram of pneumatic circuits. Functional decomposition and simbology. 5.2.-Control elements and accessories in pneumatic circuits. 5.3.-Design and control of elementary pneumatic circuits.
Unit 6: Hydraulic turbomachinery fundamentals.	6.1.-Introduction. Reference systems. Normalized views. 6.2.-Angula momentum conservation law. Euler theorem. 6.3.-One-dimensional theory. 6.4.-Bernouilli equation in rotor reference frame. 6.5.-Simplified theory of radial turbomachines. Centrifugal pumps. Francis turbines. 6.6.-Simplified theory of axial turbomachines. Kaplan turbines. 6.7.-Dimensional analysis and physical similarity in hydraulic turbomachinery.
Unit 7: Fluid machinery and instalations practice.	7.1.-Pumps and pump stations calculations. Pump performance and installation curves. 7.2.-Pelton turbine operation. Regulation. 7.3.-Francis turbine operations. Regulation. 7.4.-Marine propellers. 7.5.-Wind turbines. 7.6.-Revesible hydraulic plants.
Practice 1: Identification of the elements of machines of fluid in assemblings CAD.	Aims and development: In this first practical session the student goes to open archives CAD prepared by the professor to visualise the constitutive elements of hydraulic installations and machines of fluids. The main aim of this practical is to strengthen the nomenclature and facilitate the three-dimensional visualisation of the flow in the interior of the machines of fluid.
Practice 2: Mentored work (TT). Bank of positive displacement pumps	Aims and development: The aim of this second practical session is the visualisation of the different positive displacement pumps by means of the available multimedia content to the effect. It treats to characterise and comprise the operation of these pumps, looking for the understanding of his characteristics and possible applications. Indeed, it supposes the start of the mentored work.

Practice 3: Simulation of oleohydraulic circuits with demostrative software FluidSim	Aims and development: To strengthen the theoretical knowledges of the subject 4, in this practice will design a simple hydraulic circuit, with the aim to comprise the activities of each one of the elements involved: elements of generation, of performance and of control. It uses the software Fluidsim (hydraulic version, previusly instaled in portable teams), with the last updates. It delivers to the student presentation of introduction, example guided and problem proposed.
Practice 4: Simulation of pneumatic circuits with demostrative software FluidSim.	Aims and development: To strengthen the theoretical knowledges of the subject 5 pretends that the student design a pneumatic circuit of intermediate complexity to satisfy some requirements imposed by the professor, analyse the operation of the different elements and research of the greater simplicity of the circuit. It uses the software Fluidsim (pneumatic version, previusly instaled in portable teams), with the last updates. It delivers to the student presentation of introduction, example guided and problem proposed.
Practice 5: Mentored work (TT)	Aims and development: Realisation of the mentored work.
Practice 6: Mentored work (TT). Calculation of a real hydraulic installation by means of the software Epanet	Aims and development: In this practice model is created and problems of installations of real pumping with the software Epanet (previusly installed in portable computers) are resolved. This practice aims to convey the importance of using the sofware, although the user needs the knowledges of necessary engineering for the correct introduction of the data and interpretation of the results. It delivers to the student presentation of introduction, example guided and real case proposed. This content will be implemented in the mentored work.
Practice 7: Mentored work (TT)	Aims and development: Realisation of the mentored work.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Laboratory practical	8	15	23
Mentored work	6	6	12
Problem solving	7	7	14
Objective questions exam	21	10	31

*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 these sessions the basic theoretical contents of the program will be explained in detail, exposing clarifying examples that deepen in the understanding of the subject. A digital board will be used in exposition and edition mode. At the beginning of the course, copy of the slides will be provided to the students that request it in the office of the sailing ship. Anyway, paper copies of the slides never should be considered like substitutes of textbooks or notes, but like complementary material.
Laboratory practical	Practices of laboratory with computer. Computer sessions are of paramount importance. Circuit simulations facilitate enormously the understanding of hydraulic and pneumatic systems. In a similar way, CFD simulations allow to visualise the three-dimensional flow in turbomachines and volume chamber evolution in volumetric machines. Resolution of problems and/or exercises in autonomous form. Some practical sessions conclude by posing a problem like closing activity of the practice.
Mentored work	The student, alone or in a group, elaborates a document on the thematic of the matter or prepares seminars, investigations, memories, essays, summaries of readings, conferences, etc.
Problem solving	Resolution of problems and/or exercises. The lecturer solves a representative problem linked to the theory.

Personalized assistance

Methodologies	Description

Problem solving	In the field of the tutorial action, distinguish actions of academic tutorials, as well as of personalised tutorials. In the first case, the students will have to his disposal hours of tutorships in which it can consult any doubt related with the contents, organisation and planning of the subject, etc. The tutorships can be with one or several students, with resolution of problems related with the contents. The aim is to comment with the lecturer any problem that is preventing him make a suitable follow-up of the subject, with the aim to find between both some type of solution. The lecturer of the subject will ask personally the questions and queries of the students, so much of face-to-face form under demand, in the library of "guardiamarinas", as through telematic means (email, videoconference, forums of Moovi, etc.).

Assessment

	Description	Qualification	Evaluated Competencess
Lecturing	The theoretical contents will be evaluated through 2 intermediate controls compulsory (PI1 and PI2) during the course, marked on 10 points. Percentage on the final qualification: (15%PI1, 15%PI2)	30	CG3 CE24 CT2 CT9 CT10
Laboratory practical	The evaluation of the practices will be carried out by means of lab reports (MP) or questionnaires of the activity made in the practices not included in the mentored work, this is, the practical Pr1, Pr3 and Pr4 that they will be able to be individual or in group. The student will have to deliver these activities when finalising the practice. The format of each memory will be specified in each practice. The note of each memory of practices will be on 10 points. The note of the Memories of Practices (MP) will be the average of the notes of the practical Pr1, Pr3 and Pr4. It allows the absence to a session of practices remaining this practice excluded of the calculation of the average note. The absence to more than a session of practices prevents that the student can pass the matter by continuous evaluation.	10	CE24 CT2 CT9 CT17
Mentored work	The students will have to make a work in group on a subject of the matter, that will suppose 20% of the qualification. For his realisation, will have 4 sessions of laboratory and 4 seminars. The work will have to be evaluated so that it guarantee the individual exigibility and the possitive interdependency, this is, all the members of the group have to contribute to the final product and have to know all the parts 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.	20	
(*)	It will make a final examination that will cover the whole of the contents of the subject, so many theorists like practical, and that it will be able to include ask type test, questions of reasoning, resolution of problems and development of practical cases. It demands reach a minimum qualification of 4 points on 10 possible to be able to surpass the subject.	40	CG3 CE24 CT2 CT9 CT10

Other comments on the Evaluation

The final evaluation of the student will be the following, being his note of continuous evaluation (NEC):

NEC = 0,15 * PI1 + 0,15 * PI2 + 0,1 * MP + 0,2 * TT + 0,40 * PF

To pass the subject by evaluation continuous demands a note NEC equal or upper to 5 points. However, there are some requests in any of the sections to guarantee the balance between all the types of competitions. These requests are:

1. The realization and delivery of all the scored previously explained.

2. Obtain an equal or upper note to 4 points on 10 in the final proof of evaluation continuous (PF).

The students with NEC inferior to 5 or that do not fulfil any of the two previous requests have to go to the ordinary examination to be able to surpass the subject. For those students that do not fulfil the two requests the final note of evaluation continuous obtains eat: FINAL NEC = min (4, NEC). Indeed, offers the option to attend to the ordinary examination to all those students who want to improve their results.

Ordinary and extraordinary exams will include at least one question concerning the tasks made during the practical sessions.

ETHICAL COMMITMENT : it expects that the students have a suitable ethical behaviour. If not (cheating, plagiarism, use of forbiden devices,...) during the continuous evaluation the student will not pass the subject by the modality of continuous evaluation (qualification of 0). If this type of behaviour is detected in ordinary or extraordinary exams, the student will receive a qualification of 0.

Sources of information

Basic Bibliography

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J. Agüera Soriano, **Mecánica de fluidos incompresibles y turbomáquinas hidráulicas**, 5ª, 2002

J. Roldán Viloria, **Tecnología y circuitos de aplicación neumática, hidráulica y electricidad**, 2012

Complementary Bibliography

A. Esposito, **Fluid power with applications**, 7ª, 2009

J. Hernández Rodríguez, P. Gómez del Pino, C. Zanzi, **Máquinas hidráulicas. Problemas y soluciones**, 2016

A. Serrano Nicolás, **Oleohidráulica**, 2002

Recommendations

Subjects that it is recommended to have taken before

Fluid mechanics/P52G381V01208

Other comments

Fluid Mechanics fundamentals are invoked very often during the course. In case of difficulties it is recommended that students refresh acquired knowledge and they can also go to tutorials.

IDENTIFYING DATA				
Fundamentos de organización de empresas				
Subject	Fundamentos de organización de empresas			
Code	P52G381V01306			
Study programme	Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	3	2c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín			
Coordinator	Rodríguez Rodríguez, Francisco Javier			
Lecturers	Rodríguez Rodríguez, Francisco Javier			
E-mail	fjavierrodriguez@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	O obxectivo primordial da materia Fundamentos de Organización de Empresas é o de dotar aos alumnos dun nivel básico e suficiente de coñecementos relacionados cos métodos e técnicas específicos da área de operacións das organizacións. Neste ámbito, a palabra Organización é aplicable ás empresas privadas, xa sexan industriais, comerciais ou de servizos, ás empresas e administracións públicas, ás institucións e organismos públicos, así como a cuarteis, xefaturas, órganos, frotas e seccións da Armada Española. Todas estas organizacións teñen en común que deben ser xestionadas por persoas cunha formación adecuada para desempeñar unha dirección de operacións eficaz e eficiente, tanto desde unha perspectiva estratéxica como operativa. Os futuros egresados exercerán a súa profesión nos diferentes organismos e unidades agrupados no seo da Armada, a cal pode considerarse a organización matriz de todas as organizacións que a integran. Por todo iso, é importante que todos os alumnos coñezan as ferramentas de xestión necesarias para dirixir unha organización de calquera tipo. O estudo desta materia permitirá aos alumnos consolidar e ampliar algúns dos coñecementos previamente adquiridos na materia de primeiro curso Introdución á Xestión Empresarial. Desenvolveranse as habilidades necesarias para xestionar as organizacións mediante o estudo e a práctica de coñecementos aplicados de organización de empresas. A materia Fundamentos de Organización de Empresas garda unha importante relación coa materia Loxística e Xestión de Recursos na Armada, que se imparte dentro da formación militar específica das dúas especialidades fundamentais de Corpo Xeral e Infantaría de Mariña. Os contidos da materia Fundamentos de Organización de Empresas do Grao en Enxeñaría Mecánica dividíronse en seis partes: Introdución Xeral, Introdución á Dirección e Xestión de Proxectos, Previsión da Demanda, Decisións Básicas na Xestión da Produción, Introdución ao Estudo do Traballo e Introdución á Xestión da Calidade, a Seguridade e o Medio Ambiente. Este seis partes serán desenvolvidas en once temas segundo especifícase na programación da materia.			

Competencias	
Code	
CG8	Capacidade para aplicar os principios e métodos da calidade.
CG9	Capacidade de organización e planificación no ámbito da empresa, e outras institucións e organizacións.
CE15	Coñecementos básicos dos sistemas de produción e fabricación.
CE17	Coñecementos aplicados de organización de empresas.
CT1	Análise e síntese.
CT2	Resolución de problemas.
CT7	Capacidade para organizar e planificar.
CT8	Toma de decisións.
CT9	Aplicar coñecementos.
CT11	Capacidad para comprender o significado e aplicación da perspectiva de xénero nos distintos ámbitos de coñecemento e na práctica profesional co obxectivo de acadar unha sociedade máis xusta e igualitaria.
CT18	Traballo nun contexto internacional.

Resultados de aprendizaxe			
Learning outcomes	Competences		
Coñecer a base sobre a que apoian as actividades relacionadas coa organización e xestión da produción.	CG8 CG9	CE15 CE17	CT1 CT2 CT7 CT8 CT9 CT18

Coñecer o alcance das distintas actividades relacionadas coa produción.	CG8 CG9	CE15 CE17	CT1 CT2 CT7 CT8 CT9 CT18
Adquirir unha visión de conxunto para a execución das actividades relacionadas coa organización e xestión da produción.	CG8 CG9	CE15 CE17	CT1 CT2 CT7 CT11
Realizar unha valoración dos postos de traballo desde un enfoque que axude ao desenvolvemento das persoas cunha perspectiva de eficiencia e igualdade.			CT11
Resultado de aprendizaxe ENAEE: COÑECEMENTO E COMPRENSIÓN: RA1.3.- Ser conscientes do contexto multidisciplinar da enxeñaría [nivel de desenvolvemento (básico (1), adecuado (2) ou avanzado (3)) deste sub-resultado: Básico (1)].	CG9	CE15 CE17	
Resultado de aprendizaxe ENAEE: ANÁLISE EN ENXEÑARÍA: RA2.1.- A capacidade de analizar produtos, procesos e sistemas complexos no seu campo de estudo; elixir e aplicar de forma pertinente métodos analíticos, de cálculo e experimentais xa establecidos e interpretar correctamente resultados de devanditas análises [Adecuado (2)].		CE15 CE17	CT2 CT8 CT9
Resultado de aprendizaxe ENAEE: ANÁLISE EN ENXEÑARÍA: RA2.2.- A capacidade de identificar, formular e resolver problemas de enxeñaría na súa especialidade; elixir e aplicar de forma adecuada métodos analíticos, de cálculo e experimentais xa establecidos; recoñecer a importancia das restricións sociais, de saúde e seguridade, ambientais, económicas e industriais [Adecuado (2)].			CT1 CT2 CT8 CT9 CT11
Resultado de aprendizaxe ENAEE: PROXECTOS DE ENXEÑARÍA: RA3.1.- Capacidade para proxectar, deseñar e desenvolver produtos complexos (pezas, compoñentes, produtos acabados, etc.), procesos e sistemas da súa especialidade, que cumpran cos requisitos establecidos, incluíndo ter conciencia dos aspectos sociais, de saúde e seguridade, ambientais, económicos e industriais; así como seleccionar e aplicar métodos de proxecto apropiados [Adecuado (2)].	CG8		CT2 CT7 CT9 CT11
Resultado de aprendizaxe ENAEE: APLICACIÓN PRÁCTICA DA ENXEÑARÍA: RA5.4- Capacidade para aplicar normas da práctica da enxeñaría da súa especialidade [Adecuado (2)].	CG9		CT9
Resultado de aprendizaxe ENAEE: APLICACIÓN PRÁCTICA DA ENXEÑARÍA: RA5.5- Coñecemento das implicacións sociais, de saúde e seguridade, ambientais, económicas e industriais da práctica da enxeñaría [Básico (1)].			CT11
Resultado de aprendizaxe ENAEE: APLICACIÓN PRÁCTICA DA ENXEÑARÍA: RA5.6.- Ideas xerais sobre cuestións económicas, de organización e de xestión (como xestión de proxectos, xestión do risco e do cambio) no contexto industrial e de empresa [Adecuado (2)].	CG9	CE17	
Resultado de aprendizaxe ENAEE: ELABORACIÓN DE XUÍZOS: RA6.1.- Capacidade de recoller e interpretar datos e manexar conceptos complexos dentro da súa especialidade, para emitir xuízos que impliquen reflexión sobre temas éticos e sociais [Básico (1)].	CG9		CT11
Resultado de aprendizaxe ENAEE: ELABORACIÓN DE XUÍZOS: RA6.2.- Capacidade de xestionar complexas actividades técnicas ou profesionais ou proxectos da súa especialidade, responsabilizándose da toma de decisións [Adecuado (2)].	CG9	CE17	

Contidos

Topic	
Tema 1. Concepto de sistema produtivo e os seus elementos. Obxectivos e desenvolvemento: Identificar os conceptos de operacións, produción e produtividade no contexto das empresas e das organizacións en xeral. Analizar estudos de casos e lecturas nos que se aplique coñecemento de matemáticas, estatísticas, economía e outros campos científicos para a análise de situacións empresariais.	Índice do tema 1.1. Nocións de produción. Sistema produtivo. Contorna actual dos sistemas produtivos. 1.2. Dirección de operacións. Organización para producir bens e servizos. 1.3. Novas tendencias en produción e operacións. 1.4. Produtividade, calidade e responsabilidade social.
Tema 2. A produtividade e a súa medida. Obxectivos e desenvolvemento: Definir e describir a medida da produtividade. Coñecer os factores que afectan á produtividade e aplicar técnicas organizativas para aumentar a produtividade.	Índice do tema 2.1. Concepto de produtividade. Medida da produtividade. 2.2. Factores da produtividade. Labor da dirección. Técnicas para aumentar a produtividade. 2.3. A produtividade nas empresas e nas organizacións. Produtividade e sector servizos.

Tema 3. Concepto e funcións da xestión da produción. Obxectivos e desenvolvemento: Definir a xestión da produción e identificar as funcións básicas da mesma.	Índice do tema 3.1. Xestión da produción. Planificación, programación e control da produción. 3.2. Relacións entre produción, loxística empresarial e operacións. 3.3. Cadea de subministracións. Xestión de existencias. Demanda independente fronte a demanda dependente. 3.4. Funcións do director de produción e operacións.
Tema 4. Planificación, programación e control de proxectos. Obxectivos e desenvolvemento: Entender cada novo produto ou servizo como un proxecto. Explicar as principais técnicas para planificar, programar e controlar proxectos.	Índice do tema 4.1. Importancia estratéxica da dirección de proxectos. 4.2. Planificación do proxecto. 4.3. Programación do proxecto. 4.4. Control do proxecto. 4.5. Introdución a PERT/CPM. 4.6. Representación gráfica de redes PERT/CPM. 4.7. Folguras e camiño crítico. 4.8. Variabilidade nas duracións das actividades.
Tema 5. Métodos de previsión da demanda. Obxectivos e desenvolvemento: Definir a previsión e os seus enfoques. Describir os métodos de previsión cuantitativos.	Índice do tema 5.1. Previsión. Tipos de previsións. Importancia da previsión da demanda. Enfoques da previsión. 5.2. Métodos de previsión cuantitativos. Modelos de series temporais. Modelos causales.
Tema 6. Decisións estratéxicas. Obxectivos e desenvolvemento: Identificar os enfoques ou estratexias de proceso e layout nas organizacións. Introducir o concepto de planificación da capacidade.	Índice do tema 6.1. Estratexias de procesos e layout. Análise e deseño de procesos. 6.2. Capacidade. Planificación das necesidades de capacidade. Ferramentas para a análise e toma de decisións. 6.3. Estratexia de localización. Factores que afectan á decisión de localización. Avaliación de alternativas.
Tema 7. Decisións tácticas. Xestión de existencias. Obxectivos e desenvolvemento: Describir a xestión de existencias e os seus modelos básicos.	Índice do tema 7.1. Funcións das existencias ou inventarios. Xestión de existencias. 7.2. Modelos de inventarios. Modelos con demanda independente. Outros modelos.
Tema 8. Decisións tácticas. Planificación, programación e control da produción. Obxectivos e desenvolvemento: Identificar os procesos de planificación, programación e control. Explicar a planificación das necesidades de materiais.	Índice do tema 8.1. O proceso de planificación. Planificación agregada. Programación e control da produción. 8.2. Planificación das necesidades de materiais (MRP). Xestión de existencias con demanda dependente. 8.3. Estrutura e xestión do MRP. 8.4. Planificación dos recursos da empresa (ERP).
Tema 9. Decisións tácticas. A filosofía JIT. Definición e principios. Obxectivos e desenvolvemento: Describir a filosofía Just In Time (JIT) e Lean Manufacturing, obxectivos e principios.	Índice do tema 9.1. Introdución ao JIT. 9.2. As 4P do JIT. 9.3. Lean Manufacturing. 9.4. Mantemento produtivo total TPM.
Tema 10. Introdución ao estudo do traballo. Obxetivos e desenvolvemento: Definir o deseño do traballo. Comprender a importancia dunha xestión eficaz e eficiente dos recursos humanos. Explicar os fundamentos do estudo de métodos. Describir o estudo de tempos. Explicar os sistemas de tempos predeterminados. Describir a mostraxe do traballo.	Índice do tema 10.1. Deseño do traballo. 10.2. Ergonomía e fisioloxía do traballo. 10.3. Estudo e mellora de métodos. 10.4. Estudo de tempos por cronometraxe. 10.5. Sistemas de tempo predeterminados. O Sistema Methods-Time Measurement (MTM). 10.6. Mostraxe do traballo.

Tema 11. Introdución á calidade, medioambiente e seguridade. Obxectivos e desenvolvemento: Definir a calidade e as normas internacionais de calidade. Identificar os sistemas e normas de xestión ambiental. Definir a seguridade e a hixiene industrial e comprender a súa importancia na prevención de accidentes no traballo. Analizar varios estudos de caso nos que as empresas tratan aspectos sociais, sanitarios e de seguridade industrial. Co obxectivo de incrementar o número de actividades en que se traten tales aspectos analizaranse varios casos de estudo e vídeos, os cales están reflictidos nas referencias web da bibliografía.	Índice do tema 11.1. Definición da calidade. Normas internacionais de calidade. Normas ISO 9000. Normas PECAL/AQAP de requisitos do Ministerio de Defensa (requisitos OTAN). 11.2. Sistemas de xestión ambiental. Normas ISO 14000. Regulamento EMAS. 11.3. Seguridade e hixiene industrial. Prevención de riscos laborais.
Práctica 1. Medida e cálculo da produtividade.	Desenvolvemento: Exponse situacións de empresas ou organizacións industriais e de servizos nas cales se debe determinar ou medir a produtividade a partir dos datos que se fornecen. Resólvense os problemas e exercicios expostos. Nesta práctica, de cara ó manexo de datos encamiñados a emitir xuízos que impliquen reflexión sobre temas ético-sociais por parte dos alumnos, abordaranse cuestións relativas á planificación de horarios, para intentar dar unha resposta efectiva ás necesidades de persoal, e así analizar como a planificación de horarios supón unha restrición na optimización de procesos dentro dunha empresa.
Práctica 2. Programación de proxectos.	Desenvolvemento: Consiste na determinación do programa ou calendario dun proxecto mediante as técnicas de PERT e CPM. Nesta práctica, de cara ao manexo de datos encamiñados a emitir xuízos que impliquen reflexión sobre temas ético-sociais por parte dos alumnos, abordaranse cuestións relativas á medida do rendemento dos traballadores e os niveis de motivación laboral, factores que afectan directamente á eficiencia e á duración dun proxecto.
Práctica 3. Estimacións da previsión da demanda.	Desenvolvemento: Consiste en estimar a previsión da demanda dos produtos ou servizos dunha empresa, utilizando os modelos de series temporais e os modelos causales que se estudaron. Exponse e resólvense diversos problemas de previsión.
Práctica 4. Análise de procesos. Deseño de layout. Decisións de capacidade.	Desenvolvemento: Preséntanse exemplos de diagramas de fluxo e gráficos de procesos e operacións (cursogramas sinópticos e analíticos, diagramas de percorrido, etc.) para a análise de procesos. Exponse e resolven problemas de análises de limiar de rendibilidade, análise de investimentos. Nesta práctica, de cara ó manexo de datos que permitan emitir xuízos que impliquen reflexión sobre temas ético-sociais por parte dos alumnos, abordaranse cuestións encamiñadas a identifica-la incidencia dunha empresa en conservación da natureza, así como no grao de avance cara á equidade social e a eficiencia económica na área de actuación da dita empresa.
Práctica 5. Modelos de inventarios con demanda independente.	Desenvolvemento: Exponse e resolven problemas de xestión de existencias mediante a análise ABC, así como exercicios baseados no modelo da cantidade económica de pedido (EOQ) e as súas variacións (a demanda é independente).
Práctica 6. Planificación agregada.	Desenvolvemento: Exponse e resolven problemas de planificación agregada coas dúas alternativas puras: caza e nivelación.
Práctica 7. Modelos de inventarios con demanda dependente.	Desenvolvemento: Exponse e resolven problemas mediante a técnica do MRP, elaborando listas de materiais e calculando os plans de necesidades brutas e netas (a demanda é dependente).

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	28	42	70
Resolución de problemas	14	21	35
Seminario	12	19	31
Exame de preguntas de desenvolvemento	14	0	14
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente
Description

Lección maxistral	Cada unidade temática teórica será presentada polo profesor, expondo exemplos para unha mellor comprensión dos contidos. Mediante a formulación de cuestións sobre os contidos teóricos e exemplos fomentarase e valorará a participación activa do alumnado. Utilizaranse presentacións ofimáticas e a lousa para transmitir información como definicións, gráficos, fotografías, etc. Na medida do posible, proporcionarase copia das presentacións aos alumnos con anterioridade á exposición, centrando o esforzo do profesor e do alumnado na exposición e comprensión dos coñecementos. As reproducións en papel das presentacións nunca deben ser consideradas como substitutos de apuntamentos tomados en clase ou dos textos suxeridos na bibliografía, senón como material complementario.
Resolución de problemas	Formúlanse problemas e/ou exercicios que o alumno debe resolver interpretando a información dispoñible, aplicando fórmulas ou algoritmos e interpretando os resultados. Estes exercicios pódense recoller ao final da clase ou ser enviados mediante a través de intranet nun curto prazo de tempo.
Seminario	Consisten na realización de actividades de reforzo á aprendizaxe mediante: Resolución de problemas. Complementando aos realizados nas clases prácticas. Estudo de casos. Análise de sucesos reais, fundamentalmente en empresas e en organizacións de Defensa coa finalidade de coñecelos, interpretalos, reflexionar, diagnosticar e elaborar posibles solucións. Aqueles exercicios de clases de laboratorio que o alumno non puidese finalizar, tratará de facelo nas súas horas de estudo e se ten algunha dificultade ou dúbida poderase resolver nestes seminarios. Curso intensivo de 15 horas para os alumnos que suspenderon a materia na primeira convocatoria, antes do exame en segunda convocatoria. Titorías en grupo co profesor.

Atención personalizada

Methodologies	Description
Seminario	ATENCIÓN PERSONALIZADA Ademais das titorías ou seminarios grupales pódense levar a cabo titorías individualizadas, nas que cada alumno, de maneira individual, poderá consultar ao profesor dubidas ou dificultades que lle impiden realizar un seguimento dos contidos teóricos ou prácticos da materia. Proporanse exercicios complementarios para o reforzo á aprendizaxe dos contidos da materia, dirixidos aos alumnos que mostren dificultades para seguir de forma adecuada o desenvolvemento das clases. O profesor da materia atenderá persoalmente ás dúbidas e consultas dos alumnos, tanto de xeito presencial (estando dispoñible na biblioteca de guardamarinas todos os días escolares de 18:15 a 19:15), como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de previa cita.

Avaliación

	Description	Qualification	Evaluated Competencess
Lección maxistral	Probas intermedias de avaliación continua: teñen como obxecto a avaliación das competencias adquiridas, podendo incluír preguntas tipo test pechadas con diferentes alternativas de resposta, preguntas de resposta curta directas e resolución de problemas. Realizaranse ao longo do cuadrimestre e serán de curta duración. A realización das probas será obrigatoria e esixible para superar a materia. (Porcentaxe sobre a cualificación final: 40%) Exame final de avaliación continua: realizarase unha proba final que abarcará a totalidade dos contidos da materia, tanto teóricos como prácticos, e que poderá incluír probas tipo test, preguntas de razoamento, resolución de problemas e desenvolvemento de casos prácticos. Esíxese alcanzar unha cualificación mínima de 4 puntos sobre 10 posibles para poder superar a materia, así como superar unha nota mínima de 3 puntos sobre 10 en cada unha das partes (teoría e problemas) do devandito exame. (Porcentaxe sobre a cualificación final: 40%)	80	CG8 CG9 CE15 CE17 CT1 CT2 CT7 CT8 CT9 CT11
Resolución de problemas	Avaliación das prácticas: ao longo do cuadrimestre, en determinadas clases prácticas, exporanse problemas ou exercicios que deberán ser resoltos polos alumnos e entregados para a súa avaliación cando o determine o profesor. A avaliación de cada entregable estará de acordo cos criterios que con anterioridade se comunicaron aos alumnos.	15	CG8 CG9 CE15 CE17 CT1 CT2 CT7 CT8 CT9 CT11 CT18

Seminario	Participación: Avaliarase a participación e actitude en clases teóricas, prácticas e titorías de grupo, así como contribucións na plataforma virtual.	5	CG8 CG9	CE15 CE17	CT1 CT2 CT7 CT8 CT9 CT11

Other comments on the Evaluation

A avaliación final de alumno atenderá á suma da puntuación outorgada a cada unha das partes antes comentadas, sendo a súa nota de avaliación continua final (NEC):

NEC= 0,20 PROBA INTERMEDIA 1 + 0,20 PROBA INTERMEDIA 2 + 0,15 PRÁCTICAS + 0,40 PROBA FINAL + 0,05 PARTICIPACIÓN.
Para superar a materia, a nota final de avaliación continua (NEC) calculada pola fórmula anterior deberá ser polo menos 5 puntos sobre 10. En caso contrario, deberá presentarse ao exame ordinario.Con todo, esixiranse uns requisitos mínimos e condicións nalgúns dos apartados, que garantan o equilibrio entre todos os tipos de competencias.O alumno deberá presentarse ao exame ordinario de todos os contidos da materia, que suporá o 100% da nota, nos seguintes supostos:

- Non realizar algunha das probas intermedias ou a non asistencia a máis dunha sesión de prácticas.
- Obter unha nota inferior a 4 puntos sobre 10 na proba final de avaliación continua, así como non superar unha nota mínima de 3 puntos sobre 10 nalgunha das partes (teoría e problemas) do devandito exame.

En calquera destes dous supostos a cualificación da avaliación continua será o mínimo da nota de avaliación continua calculada coa fórmula anterior e 4 puntos.En calquera caso, o alumno que superase a avaliación continua, terá a posibilidade de presentarse ao exame ordinario para subir nota.
Tanto no exame ordinario como no extraordinario (convocatoria de xullo) avaliaranse todas as competencias da materia. Para aprobar a materia en calquera destas dúas convocatorias, será necesario superar unha nota mínima de 3 puntos sobre 10 en cada unha das partes (teoría e problemas) en que se divide este exame.

COMPROMISO ÉTICO: Espérase que os alumnos teñan un comportamento ético adecuado. Se se detecta un comportamento pouco ético (copia, plaxio, uso de dispositivos electrónicos non autorizados ou outros) penalizarase ao alumno coa imposibilidade de superar a materia pola modalidade de avaliación continua (na que obterá unha cualificación de 0,0). Se este tipo de comportamento detéctase en exame ordinario ou extraordinario, o alumno obterá na devandita convocatoria unha cualificación en acta de 0,0.

Bibliografía. Fontes de información

Basic Bibliography

Heizer, J., Render, B., **Dirección de la producción y de operaciones. Decisiones estratégicas**, 8ª ed., Pearson Educación S.A., 2007

Heizer, J., Render, B., **Dirección de la producción y de operaciones. Decisiones tácticas**, 8ª ed., Pearson Educación S.A., 2008

Chase, R.B., Jacobs, F.R., Aquilano, N.J., **Administración de operaciones. Producción y cadena de suministros**, 13ª ed., McGraw-Hill, 2014

Complementary Bibliography

Velasco, J., Campins, J.A., **Gestión de la producción en la empresa. Planificación, programación y control**, Ediciones Pirámide, 2013

Velasco, J., **Organización de la producción. Distribuciones en planta y mejora de los métodos y los tiempos**, Ediciones Pirámide, 2010

López Varela, P., Iglesias Baniela, S., **Planificación, programación y control de proyectos mediante técnicas de camino crítico**, Tórculo Edicions, 2007

Vallhonrat, J.M., Corominas, A., **Localización, distribución en planta y manutención**, Marcombo, 1991

Roux, M., **Manual de logística para la gestión de almacenes**, Ediciones Gestión 2000, 1997

Oficina Internacional del Trabajo (OIT) Ginebra, **Introducción al estudio del trabajo**, 1986

Hodson, W.K., **Manual del Ingeniero Industrial Maynard**, McGraw-Hill, 1996

Goldratt, E.M., Cox,J., **La Meta: un proceso de mejora continua**, Ediciones Díaz de Santos, 2005

American Production Inventory Control Society, **Información sobre producción y control de inventarios**,

Heizer, J., Render, B., **Blog del libro: Dirección de la producción y de operaciones**,

Toyota, **Toyota Production System**,

PennState University, **Supply Chain Professional Certificate - Military options**,

Asociación Española de Normalización y Certificación, **Normas de Calidad y Medioambiente**,

Ministerio de Defensa, **Normativa PECAL/AQAP**,

Instituto Nacional de Seguridad e Higiene en el Trabajo, **Normativa PRL**,

Automática e instrumentación, **Información sobre la modificación de una línea de montaje de subchásis para fabricar respiradores asistidos**,
USDepartmentofLabor, **Consejos de seguridad para líneas de montaje durante la pandemia por COVID-19**,
Grupo PSA, **Información sobre un exoesqueleto para facilitar el trabajo y prevenir lesiones**,

Recomendacións

Other comments

A materia non ten asociado ningún prerrequisito. Con todo para cursar esta materia con éxito o alumno debe ter:
- Capacidade de comprensión escrita e oral suficientemente desenvolvida.
- Capacidade de cálculo básico e síntese da información.
- Destrezas para o traballo en grupo e para a comunicación grupal.
- Polo menos nocións básicas adquiridas na materia Introdución á Xestión Empresarial impartida en primeiro curso.

As dificultades de aprendizaxe máis frecuentes están ligadas a carencias dos devanditos coñecementos, pero pódense salvar cun pouco de esforzo e os medios de que dispón este centro.

IDENTIFYING DATA				
Fundamentos de automática				
Subject	Fundamentos de automática			
Code	P52G381V01401			
Study programme	Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4	1c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín			
Coordinator	González Prieto, José Antonio			
Lecturers	Falcón Oubiña, Pablo González Prieto, José Antonio			
E-mail	jose.gonzalez@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Esta materia enmárcase dentro do módulo Común á Rama Industrial, e nela perséguese dotar ao alumnado dunha formación básica, tanto teórica como práctica, sobre os conceptos fundamentais relativos á automatización de procesos industriais, así como á análise e deseño de sistemas de control. Desta forma nesta materia desenvólvense, nun primeiro bloque de contidos, os conceptos fundamentais asociados ao modelado de sistemas lóxicos de eventos discretos mediante Redes de Petri así como a súa implantación en autómatas programables (PLC). No segundo bloque de contidos introdúcense os conceptos fundamentais asociados á teoría de sistemas dinámicos, abordando o seu modelado, representación e estudo analítico, así como temas relativos á análise e deseño de controladores integrados no lazo realimentado de control. Farase especial fincapé no carácter multidisciplinar da materia, tanto nas sesións teóricas como nas sesións prácticas de laboratorio. Desta forma, en ambos os bloques de contidos exponse problemas de aplicación en ámbitos moi diversos (electricidade, mecánica, termodinámica, química, neumática, loxística, bioloxía, robótica e comunicacións), aínda que con especial atención ás aplicacións relativas á enxeñaría electro-mecánica.			

Competencias	
Code	
CG3	Coñecemento en materias básicas e tecnolóxicas que os capacite para a aprendizaxe de novos métodos e teorías, e os dote de versatilidade para adaptarse a novas situacións.
CE12	Coñecementos sobre os fundamentos de automatismos e métodos de control.
CT2	Resolución de problemas.
CT3	Comunicación oral e escrita de coñecementos.
CT6	Aplicación da informática no ámbito de estudo.
CT9	Aplicar coñecementos.
CT16	Razoamento crítico.
CT17	Traballo en equipo.
CT20	Capacidade para comunicarse con persoas non expertas na materia.

Resultados de aprendizaxe			
Learning outcomes	Competences		
Adquirir unha visión global e realista do alcance actual dos sistemas de automatización industrial	CG3	CE12	CT3 CT16
Coñecer cales son os elementos constitutivos dun sistema de automatización industrial, como funcionan, e como se dimensionan	CG3	CE12	CT2 CT3 CT9 CT16
Coñecemento aplicado sobre os autómatas programables, a súa programación e a súa aplicación á automatización de sistemas industriais	CG3	CE12	CT2 CT3 CT6 CT9 CT16 CT17 CT20

Coñecementos xerais sobre o control continuo de sistemas dinámicos, das principais ferramentas de simulación de sistemas continuos e dos principais dispositivos de control de procesos con maior interese a nivel industrial	CG3	CE12	CT2 CT3 CT6 CT9 CT16 CT17 CT20
Conceptos xerais das técnicas de axuste de reguladores industriais	CG3	CE12	CT2 CT3 CT9 CT16
Resultado de aprendizaxe ENAEE: COÑECEMENTO E COMPRENSIÓN: RA1.3.- Ser conscientes do contexto multidisciplinar da enxeñaría. [nivel de desenvolvemento (básico (1), adecuado (2) e avanzado (3)) deste sub-resultado: Adecuado (2)].	CG3	CE12	
Resultado de aprendizaxe ENAEE: ANÁLISE EN ENXEÑARÍA: RA2.1.- A capacidade de analizar produtos, procesos e sistemas complexos no seu campo de estudo; elixir e aplicar de forma pertinente métodos analíticos, de cálculo e experimentais xa establecidos e interpretar correctamente resultados de devanditas análises. [nivel de desenvolvemento (básico (1), adecuado (2) e avanzado (3)) deste sub-resultado: Adecuado (2)].			CT2 CT9

Contidos

Topic	
Tema 1. Introdución á automatización industrial e elementos de automatización.	1.1. Introdución á automatización de tarefas e procesos industriais. 1.1.1. A automatización de procesos industriais. 1.1.2 O autómata programable industrial ou PLC. 1.1.3 Elementos do autómata programable. Entradas, saídas, e memoria. 1.1.4 Ciclo de funcionamento do autómata. Tempo de ciclo. 1.2 Características xerais dos autómatas programables. 1.2.1. Operadores lóxicos e aritméticos. 1.2.2 Operadores de asignación (con memoria e sen memoria). 1.2.3 Combinacións de variables binarias. 1.2.3 Temporizadores e contadores. 1.3 Linguaxes e técnicas de programación de autómatas programables. 1.3.1. Formas de representación dun programa (FBD, AWL, ST, Grafcet, LADDER). 1.3.2 Programación lineal e estruturada. 1.3.3 Introdución á lóxica de contactos (LADDER). 1.3.4 Introdución á programación modular estruturada en LADDER.

Tema 2. Ferramentas de modelado de sistemas secuenciais.	2.1 Introdución ao modelado de sistemas dinámicos de eventos discretos. 2.1.1. Modelado mediante grafos de estados e táboas. O problema dimensional. 2.1.2 Modelado mediante Redes de Petri. Descrición con procesos distribuídos 2.1.3 Principais elementos e propiedades das Redes de Petri. Regras de evolución. 2.1.4 Representación e lóxica asociada ás Redes de Petri. Distribución e selección. 2.2 Modelado de procesos distribuídos mediante Redes de Petri. 2.2.1. Representación de procesos e ciclos. Repeticións dun proceso simple. 2.2.2 Aplicación de temporizadores. Activacións controladas por tempo. 2.2.3 Aplicación de contadores. Contaxe de eventos e ciclos de procesos. 2.2.3 Arcos inhibidores e as súas aplicacións. 2.2.5. Secuencias simultáneas. Sincronización de procesos concorrentes. 2.2.6. Exclusión mutua entre procesos. Xestión de recursos compartidos. 2.2.7. Sistemas colaborativos. Coordinación de múltiples tarefas independentes. 2.3 Programación modular estruturada de Redes de Petri en LADDER. 2.3.1. Estrutura modular de programación. 2.3.2. Desenvolvemento do módulo de definición e inicialización de variables. 2.3.3. Desenvolvemento do módulo de avaliación de transicións. 2.3.4. Integración de temporizadores e contadores no módulo de transicións. 2.3.5. Desenvolvemento do módulo de activación de lugares. 2.3.6. Desenvolvemento do módulo de activación de saídas.
Tema 3. Representación, modelado e simulación de sistemas dinámicos continuos.	3.1 Introdución aos modelos de sistemas dinámicos. 3.1.1. Modelos lineais e modelos non lineais. 3.1.2 Modelos continuos e modelos discretos. 3.1.3 Modelado en variables de estado. 3.1.4 O concepto de estabilidade. 3.2 Sistemas dinámicos lineais. 3.2.1. Caracterización e propiedades fundamentais. 3.2.2 Variables de estado. 3.2.3 Funcións de transferencia. A transformada de Laplace e as súas propiedades. 3.2.4 Diagramas de bloques de funcións de transferencia. Operacións básicas. 3.2.5 A función de transferencia con realimentación. 3.3 Modelado de sistemas físicos. 3.3.1. Sistemas mecánicos. 3.3.2. Sistemas eléctricos. 3.3.3. Sistemas químicos, hidráulicos e pneumáticos. 3.3.4. Sistemas biolóxicos e sociolóxicos.

Tema 4. Análise de sistemas dinámicos continuos.	4.1 Introdución á análise de sistemas dinámicos continuos. 4.1.1. Réxime transitorio e estacionario. 4.1.2. Tipos de sinais (impulso, chanzo, rampla) e as súas transformadas de Laplace. 4.1.3. Polos e ceros da función de transferencia. Propiedades do plano de Laplace. 4.1.4. Propiedades frecuenciales de sistemas dinámicos lineais continuos. 4.2 Caracterización da resposta no dominio temporal. 4.2.1. Especificacions no dominio temporal. 4.2.2. Sistemas de primeira orde. Función de transferencia, resposta temporal e estabilidade. 4.2.3. Sistemas de segunda orde. Función de transferencia, resposta temporal e estabilidade. 4.2.4. Descrición e análise do erro en réxime permanente. 4.3 Caracterización da resposta no dominio frecuencial. 4.3.1. Especificacions no dominio da frecuencia. Diagramas de Bode. 4.3.2. Propiedades frecuenciais dos sistemas de primeira orde. 4.3.3. Propiedades frecuenciais dos sistemas de segunda orde.
Tema 5. Introdución aos sistemas de control. Deseño de controladores PID	5.1 Introdución aos sistemas de control. 5.1.1. O lazo de control 5.1.2. Actuadores e sensores. 5.1.3. Controladores dixitais. 5.1.4. Accións básicas de control: Proporcional (P), integral (I) e derivativo (D). 5.2 Regulador PID para sistemas de primeira orde. 5.2.1. Especificaciones temporais e frecuenciais. 5.2.2. Deseño mediante asignación de polos. 5.2.3. Análise de estabilidade. 5.2.4. Análise dos efectos da presenza dun cero. 5.3 Regulador PID para sistemas de segunda orde. 5.3.1. Especificaciones temporais e frecuenciais . 5.3.2. Deseño mediante asignación de polos. 5.3.3. Análise de estabilidade. 5.3.4. Análise dos efectos da presenza dun cero.

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	28	42	70
Prácticas de laboratorio	14	14	28
Seminario	7	0	7
Foros de discusión	0	7	7
Traballo tutelado	15	7	22
Exame de preguntas de desenvolvemento	2	0	2
Exame de preguntas de desenvolvemento	2	0	2
Exame de preguntas de desenvolvemento	3	0	3
Exame de preguntas de desenvolvemento	1	0	1
Exame de preguntas de desenvolvemento	3	0	3
Exame de preguntas de desenvolvemento	3	0	3
Exame de preguntas de desenvolvemento	1	0	1
Exame de preguntas de desenvolvemento	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente	
	Description
Lección maxistral	Exposición por parte do profesor dos contidos sobre a materia obxecto de estudo, bases teóricas e directrices dun traballo, exercicio ou proxecto a desenvolver polo estudante. Para iso utilizaranse medios como lousas virtuais e software de programación visual con soporte para realizar animacións dos resultados prácticos expostos en clase.

Prácticas de laboratorio	Actividade na que se formulan problemas relacionados coa materia. O alumno debe desenvolver as solucións adecuadas ou correctas mediante a exercitación de rutinas, a aplicación de fórmulas ou algoritmos, a aplicación de procedementos de transformación da información dispoñible e a interpretación dos resultados. Durante os seminarios os alumnos realizarán a preparación das solucións que posteriormente serán simuladas nas clases prácticas de laboratorio.
Seminario	Actividade na que se formulan problemas relacionados coa materia. O alumno debe desenvolver as solucións adecuadas ou correctas mediante a exercitación de rutinas, a aplicación de fórmulas ou algoritmos, a aplicación de procedementos de transformación da información dispoñible e a interpretación dos resultados.
Foros de discusión	Neste apartado valórase a participación e a actitude do alumno durante as sesións de teoría, prácticas e tutorías de seminario. Eventualmente, valoraranse as distintas actividades expostas na plataforma de docencia virtual e a dedicación do alumno a resolver en horas non lectivas os problemas expostos na materia.
Traballo tutelado	Análise e estudo por parte do profesor e dos alumnos dos contidos sobre a materia obxecto de estudo como método formativo cuxo obxectivo é reforzar e asentar os coñecementos adquiridos prestando especial atención a aqueles contidos que se consideren mais problemáticos.

Atención personalizada

Methodologies	Description
Lección maxistral	Os profesores da materia atenderán persoalmente as dúbidas e consultas dos alumnos,tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.
Prácticas de laboratorio	Os profesores da materia atenderán persoalmente as dúbidas e consultas dos alumnos,tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.
Seminario	Os profesores da materia atenderán persoalmente as dúbidas e consultas dos alumnos,tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.
Traballo tutelado	Os profesores da materia atenderán persoalmente as dúbidas e consultas dos alumnos,tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.
Foros de discusión	Os profesores da materia atenderán persoalmente as dúbidas e consultas dos alumnos,tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.

Avaliación

	Description	Qualification	Evaluated Competencess		
Foros de discusión	Participación (P) Neste apartado valórase a participación e a actitude do alumno durante as sesións de teoría, prácticas e tutorías de seminario. Eventualmente, valoraranse as distintas actividades expostas na plataforma de docencia virtual.	5	CG3	CE12	CT3 CT9 CT16 CT17 CT20
Exame de preguntas de desenvolvemento	Proba puntuable de teoría (PT1) - Proba escrita para avaliar os coñecementos adquiridos nos temas 1 e 2 - Semana 7 do cuadrimestre. - A proba terá 2 horas de duración. - A proba realízase de maneira individual. - Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores.	15	CG3	CE12	CT2 CT3 CT9 CT16

Exame de preguntas de desenvolvemento	Proba puntuable de teoría (PT2) - Proba escrita para avaliar os coñecementos adquiridos nos temas 3, 4 e 5. - Semana 11 do cuadrimestre. - A proba terá 2 horas de duración. - A proba realízase de maneira individual. - Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores	15	CG3	CE12	CT2 CT3 CT9 CT16
Exame de preguntas de desenvolvemento	Exame final de teoría (ET) - Proba escrita para avaliar os coñecementos adquiridos en todos os temas. - Semana 14 do cuadrimestre. - A proba terá 3 horas de duración. - A proba realízase de maneira individual. - Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores	40	CG3	CE12	CT2 CT3 CT9 CT16
Exame de preguntas de desenvolvemento	Exame final de laboratorio (L) - Proba escrita para avaliar os coñecementos adquiridos en todos os temas. - Semana 14 do cuadrimestre. - A proba terá 1 hora de duración. - A proba realízase de maneira individual. - Realizarase coincidindo coa proba puntuable do exame final de teoría (ET). - Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores	25	CG3	CE12	CT2 CT3 CT9 CT16

Other comments on the Evaluation

Nota final e requisitos mínimos para superar a materia mediante avaliación continua:

Para asegurar que o alumno adquiriu as destrezas mínimas en cada un dos aspectos da materia esixirase aos alumnos que alcancen unha nota mínima de 4 sobre 10 no exame final de teoría, de modo que a nota final en avaliación continua (NEC) calcúlase coas seguintes fórmulas:

$$MED\_CON = 0{,}15\ PT1 + 0{,}15\ PT2 + 0{,}40\ ET + 0{,}25\ L + 0{,}05\ P$$

$$NEC = MED\_CON \text{ si } ET \geq 4$$

$$NEC = \min(4, MED\_CON) \text{ si } ET < 4$$

É necesario que esta nota (NEC) sexa igual ou superior a 5 puntos (sobre unha escala de 10) para superar a materia. O alumno que non supere a materia nesta convocatoria debe presentarse ao exame ordinario.

Nota final e requisitos mínimos para superar a materia no exame ordinario:

A nota final (NEO) calcúlase coa seguinte fórmula:

$$NEO = 0{,}75\ T + 0{,}25\ L$$

Onde:

- **T:** representa a parte teórica do exame ordinario da materia. Proba escrita individual para avaliar os coñecementos adquiridos nas sesións de teoría. Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores.
- **L:** representa a parte práctica do exame ordinario da materia. Proba escrita individual para avaliar os coñecementos adquiridos nas sesións prácticas. Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas relacionados coas prácticas ou algunha combinación das anteriores.

É necesario que esta nota (NEO) sexa igual ou superior a 5 puntos (sobre unha escala de 10) para superar a materia. O alumno que non supere a materia nesta convocatoria ou en avaliación continua debe presentarse á convocatoria extraordinaria.

Nota final e requisitos mínimos para superar a asignatura no exame extraordinario:

A nota final (NEE) calcúlase coa seguinte fórmula:

NEE = 0,75 T + 0,25 L

Onde:

- **T:** representa a parte teórica do exame ordinario da materia. Proba escrita individual para avaliar os coñecementos adquiridos nas sesións de teoría. Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores.
- **L:** representa a parte práctica do exame ordinario da materia. Proba escrita individual para avaliar os coñecementos adquiridos nas sesións prácticas. Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas relacionados coas prácticas ou algunha combinación das anteriores.

É necesario que esta nota (NEE) sexa igual ou superior a 5 puntos (sobre unha escala de 10) para superar a materia.

Criterios de avaliación en caso de fraude académica:

A fraude académica (a copia, o plaxio ou o seu facilitación a terceiros, así como o uso de dispositivos electrónicos non autorizados en calquera das probas das que consta a avaliación da materia) será penalizado da seguinte maneira:

- **Avaliación continua:** o alumno non poderá aprobar a materia mediante avaliación continua, e será cualificado con NEC=0.
- **Exame ordinario**: o alumno será cualificado con NEO=0 y NPC=0.
- **Exame extraordinario**: o alumno será cualificado con NEE=0.

Bibliografía. Fontes de información

Basic Bibliography

Jose A. Gonzalez Prieto, Jose P. Gonzalez Coma, **Fundamentos de Automática**, 1,

Mandado; Acevedo; Fernández; Armesto, **Autómatas programables y sistemas de automatizaciónn**, 1, Marcombo, 2009

Ogata, **Ingeniería de control moderna**, 5, Prentice - Hall, 2010

Complementary Bibliography

Valdivia, **Sistemas de control continuos y discretos**, 1, Ediciones Paraninfo, 2012

Dorf, **Sistemas de control modernos**, 10, Prentice - Hall, 2005

Cucharero, **Guiado y control de misiles**, 1, Ministerio de Defensa, 1995

Silva, **Las redes de Petri en la Automática y la Informática**, 1, Editorial AC, 1985

Recomendacións

Subjects that it is recommended to have taken before

Fundamentos de electrotecnia/P52G381V01205
Matemáticas: cálculo II e ecuacións diferenciais/P52G381V01201
Tecnoloxía electrónica/P52G381V01301

Other comments

Ademais, para cursar esta materia con éxito, o alumno debe ter:
- Capacidade de comprensión escrita e oral.
- Capacidade de abstracción, cálculo básico e síntese da información.
- Destrezas para o traballo en grupo e para a comunicación grupal.

IDENTIFYING DATA				
Fundamentals of manufacturing systems and technologies				
Subject	Fundamentals of manufacturing systems and technologies			
Code	P52G381V01402			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Álvarez Feijoo, Miguel Ángel			
Lecturers	Álvarez Feijoo, Miguel Ángel Lareo Calviño, Guillermo			
E-mail	alvarezfeijoo@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The course Fundamentals of Manufacturing Systems and Technologies focuses on the study and application of scientific and technical knowledge related to the manufacturing processes of components and assemblies whose functional purpose is mechanical, as well as the evaluation of their dimensional accuracy and that of the products to be obtained, with a given quality. All this includes from the preparation phases to the use of instruments, tools, tooling, equipment, machine tools and systems necessary for its realization, according to the established standards and specifications, and applying optimization criteria.			

Skills	
Code	
CG3	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.
CE15	Basic knowledge of production systems and manufacturing.
CT2	Problems resolution.
CT8	Decision making.
CT9	Apply knowledge.
CT10	Self learning and work.
CT17	Working as a team.
CT20	Ability to communicate with people not expert in the field.

Learning outcomes			
Learning outcomes	Competences		
To know the technological basis and basic aspects of manufacturing processes.	CG3	CE15	CT2 CT9 CT10 CT20
To understand the basics of manufacturing systems.	CG3	CE15	CT2 CT10
To acquire skills for the selection of manufacturing processes and elaboration of manufacturing planning.		CE15	CT2 CT8 CT17
To develop skills for the fabrication of assemblies and elements in CAD/CAM environments.	CG3	CE15	CT2 CT8 CT9 CT17 CT20
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING LO1.2.- Knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes. Adequate (2).	CG3		
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. Advanced (3).		CE15	
ENAEE learning outcome: ANALYSIS IN ENGINEERING: LO2.2.- The ability to identify, formulate and solve engineering problems in their specialty; to choose and properly apply established analytical, computational and experimental methods; to recognize the importance of social, health and safety, environmental, economic and industrial constraints. Adequate (2).			CT2 CT9

ENAEE learning outcome: PRACTICAL APPLICATION OF ENGINEERING: LO5.1.- Understanding of the applicable techniques and methods of analysis, design and research and their limitations in the field of their specialty. Basic (1).	CT2 CT9
ENAEE learning outcome: PRACTICAL APPLICATION OF ENGINEERING: LO5.2.- Practical competence to solve complex problems, to carry out complex engineering projects and to carry out research in his/her specialty [level of development. Adequate (2).	CT9 CT10
ENAEE learning outcome: COMMUNICATION AND TEAMWORK: LO7.1.- Ability to communicate effectively information, ideas, problems and solutions in the field of engineering and with society in general [level of development. Basic (1).	CT8 CT10 CT17
ENAEE learning outcome: COMMUNICATION AND TEAMWORK: LO7.2.- Ability to function effectively in national and international contexts, individually and in teams and to cooperate both with engineers and with people from other disciplines. Adequate (2).	CT20

Contents

Topic	
UNIT 1. INTRODUCTION	Lesson 1. Introduction to the manufacturing technologies.
UNIT 2. METROLOGY AND MEASUREMENT TECHNOLOGY.	Lesson 2. Principles of Dimensional Metrology. Lesson 3. Instruments and methods of measure. Lesson 4. Coordinate measurement. Lesson 5. Image measurement.
UNIT 3. MATERIAL REMOVAL FORMING PROCESSES	Lesson 6. Introduction to the material removal forming. Lesson 7. Fundamentals and theories of cutting. Lesson 8. Lathe turning: operations, machines and tooling. Lesson 9. Milling: operations, machines and tooling. Lesson 10. Hole machining with rectilinear main movement: operations, machines and tooling. Lesson 11. Abrasive forming: operations, machines and tooling. Lesson 12. Non-conventional machining processes.
UNIT 4. AUTOMATION AND MANAGEMENT OF MANUFACTURING PROCESSES	Lesson 13. Numerical control of machines-tool.
UNIT 5. LIQUID AND GRANULAR MATERIAL FORMING PROCESSES	Lesson 14. General aspects of metal casting forming. Lesson 15. Models, molds and core boxes. Lesson 16. Melting, casting and finishing technology. Lesson 17. Equipment and furnaces used in casting. Lesson 18. Conformation of granular materials: powder metallurgy.
UNIT 6. PLASTIC DEFORMING PROCESSES BY PLASTIC DEFORMING OF METALS.	Lesson 19. General aspects of plastic deformation forming. Lesson 20. Rolling and forging processes. Lesson 21. Extrusion and stretching processes. Lesson 22. Sheet metal forming processes.
UNIT 7. JOINING FORMING PROCESSES	Lesson 23. Welding process technology. Lesson 24. Joining and assembly processes without welding.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Problem solving	3	0	3
Seminars	15	0	15
Laboratory practical	14	7	21
Mentored work	4	14	18
Objective questions exam	4	4	8
Essay questions exam	9	6	15

*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 lecturer of the contents of the subject, theoretical bases and/or guidelines of a work, exercise or project to be developed.
Problem solving	Activity in which problems and/or exercises related to the subject are formulated. The student must develop the appropriate or correct solutions through the exercise of routines, the application of formulas or algorithms, the application of transformation procedures of the available information and the interpretation of the results. It is usually used as a complement to the master class.
Seminars	Intensive course of 15 hours for those students who have failed the course in the first call, prior to the exam in the second call. Group tutorials with the professor.

Laboratory practical	Activities of application of knowledge to concrete situations and acquisition of basic and procedural skills related to the subject matter. They are carried out in special spaces with specialized equipment (laboratories, computer rooms, etc.).
Mentored work	The student, individually or in groups, prepares a document on one of the topics of the course or prepares seminars, research, reports, essays, summaries of readings, lectures, etc.

Personalized assistance

Methodologies	Description
Lecturing	In the field of tutorial action, there are academic tutoring actions, as well as personalized tutoring. In the first case, students will have at their disposal hours of tutorials in which they can ask any question related to the contents, organization and planning of the course. In the personalized tutorials, each student, individually, will be able to discuss with the lecturer any problem that is preventing him/her from following the course properly, in order to find some kind of solution between both of them. By combining both types of tutorial action, the aim is to compensate the different learning rhythms through attention to diversity. The lecturers of the course will answer the questions and consultations of the students in a synchronous way in physical or virtual offices under the modality of previous arrangement or asynchronous by telematic means (e-mail, Moovi forums, etc.).
Mentored work	The lecturers will answer the questions and consultations of the students in the hours dedicated to the work, as well as synchronously in physical or virtual offices under the modality of previous arrangement or asynchronously by telematic means (e-mail, Moovi forums, etc.).

Assessment

	Description	Qualification	Evaluated Competencess		
Lecturing	Intermediate tests: theoretical questions and problems. The objective of these tests is to evaluate the learning of all the theoretical contents selected for the course. - Intermediate tests (PI): 15% + 15%.	30	CG3	CE15	CT2 CT8 CT9 CT17 CT20
Laboratory practical	The evaluation of the practises will be based on the evaluation of the practises reports (MP) that the student must submit.	10	CG3	CE15	CT2 CT8 CT9 CT10 CT17
Mentored work	Evaluation of the mentored work (TT). Percentage of the final grade: - Submission 1. Initial version of the report: 6%. - Submission 2. Intermediate version of the report: 6%. - Submission 3. Final version of the final report: 8%.	20	CG3	CE15	CT2 CT8 CT9 CT10 CT17 CT20
Essay questions exam	Writing final test (PF) final to evaluate the global knowledge of the subject (official date of evaluation)	40	CG3	CE15	CT2 CT8 CT9 CT10 CT17

Other comments on the Evaluation

The final evaluation of the student will be the sum of the score awarded to each of the parts mentioned above and taking into account the requirement of a minimum of 4 in the final exam.

Being, therefore, the continuous evaluation grade:

NEC = 0.40·PF + 0.15·PI1 + 0.15·PI2 + 0.20·TT + 0.10·MP

The student must attend to the ordinary examination of all the contents of the subject, which will be 100% of the grade, in the following cases:

- The non-completion or delivery of any of the previous points.

- Get a grade below 4 points out of 10 in the final exam.

- Not having passed the continuous assessment with a 5.

In any case, the student who has passed the continuous assessment, will have the possibility of attending the ordinary exam to raise the grade.

ETHICAL COMMITMENT: Students are expected to have adequate ethical behavior. If unethical behavior is detected (cheating, 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/she 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.

Sources of information
Basic Bibliography
Kalpakjian, Serope, **Manufactura, ingeniería y tecnología**, Pearson, 2002
Todd, R.H.; Allen, D.K.; Alting, L., **Fundamental principles of manufacturing processes**, Industrial Press Inc., 2011
Alting, L., **Procesos para ingenieria de manufactura**, Alfaomega, 1990
Faura, F., **Prácticas de tecnología mecánica**, Ed. Universidad de Murcia, 1994
Groover, M. P., **Fundamentos de manufactura moderna: materiales, procesos y sistemas**, Prentice Hall,
Dieguez, J.L.; Pereira, A.; Ares, J.E:, ´**Fundamentos de fabricación mecánica**,
De Garmo; Black; Kohser, **Materiales y procesos de fabricación**, Reverté, 1988
Lasheras, J.M., **Tecnología mecánica y metrotecnia**, Donostiarra, 2000
Complementary Bibliography

Recommendations
Subjects that continue the syllabus
Manufacturing engineering and dimensional quality/P52G381V01407

IDENTIFYING DATA				
Thermal engineering I				
Subject	Thermal engineering I			
Code	P52G381V01403			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Cacabelos Reyes, Antón			
Lecturers	Cacabelos Reyes, Antón González Gil, Arturo			
E-mail	acacabelos@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This document shows the competences that the students must acquire with the subject Advanced Thermodynamics. It contains the program contents, an estimation of the students working load and the evaluation criteria. This subject, taken by fourth-year students of the mechanical engineering bachelor degree, explains the fundamentals of combustion, the mixture of air and water vapor and the main processes occurred in thermal systems.			

Skills	
Code	
CG1	Skills for writing, signing and developing projects in the field of industrial engineering, whose purpose is, specializing in Mechanics, according to the knowledge acquired pursuant to paragraph 5 of this order, construction, alteration, repair, maintenance, demolition, manufacturing, installation, assembly or operation of: structures, mechanical equipments, energy facilities, electrical systems and electronic installations and industrial plants, and manufacturing processes and automation.
CE21	Knowledge applied to thermal engineering.
CT1	Analysis and synthesis
CT2	Problems resolution.
CT6	Application of computer science in the field of study.
CT8	Decision making.
CT10	Self learning and work.
CT14	Creativity.
CT16	Critical thinking.
CT17	Working as a team.

Learning outcomes			
Learning outcomes	Competences		
Understanding the processes in which humid air is involved and managing of the psychrometric chart.	CG1	CE21	CT1 CT2 CT10
Understanding the fundamentals of combustion.	CG1	CE21	CT1 CT2 CT6 CT10 CT16 CT17
Understanding the power production cycles.		CE21	CT1 CT2 CT6 CT10 CT14 CT16

Ability to assess any basic thermal process.	CG1	CE21	CT1 CT2 CT6 CT8 CT10 CT14 CT16 CT17
To acquire basic knowledge about thermal machines.	CG1	CE21	CT1 CT2 CT8 CT10 CT17
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- Knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [Level of achievement (Basic (1), Intermediate (2) and Advanced (3)) for this learning outcome: Intermediate (2)].		CE21	
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.1.- Awareness of the multidisciplinary context of the engineering [Intermediate (2)].	CG1		CT2 CT8
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)].			CT1 CT2 CT8 CT14 CT16
ENAEE learning outcome: ENGINEERING PROJECTS: LO3.1.- The ability to apply their knowledge to plan and carry out projects that meet previously specified requirements [Basic (1)].			CT2
ENAEE learning outcome: RESEARCHING AND INNOVATION: LO4.3.- Ability to design and conduct experiments, interpret data and draw conclusions [Basic (1)].		CE21	
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 [Intermediate (2)].		CE21	
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 [Intermediate (2)].			CT6 CT8
ENAEE learning outcome: COMMUNICATION AND TEAM-WORKIN: 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 [Basic (1)].	CG1		CT8 CT10 CT17

Contents	
Topic	
BLOCK 1 (B1): Gas-vapor mixtures.	B1-1. Dry air and atmospheric air. Specific and relative humidity of the air. B1-2 Dew point temperature. Psychrometric charts. B1-3 Air conditioning.
BLOCK 2 (B2): Combustion and fuels properties.	B2-1. Fuels. Description and characteristics. Boilers and burners. B2-2 The combustion process. Theoretical and actual combustion. B2-3 Enthalpy of formation, enthalpy of combustion and heating values. B2-4 First-law analysis of reacting systems. B2-5 Second-law analysis of reacting systems.
BLOCK 3 (B3) Power production cycles.	B3-1 Gas power cycles I: Otto, Diesel, Stirling and Ericsson ideal cycles. Air standard cycles. B3-2 Gas power cycles II: Brayton cycle. Actual cycles. Intercooling reheating and regeneration. Ideal jet-propulsion cycles. B3-3 Vapor and combined power cycles: Rankine cycle. Actual vapor cycles. Reheating and regeneration. Open and closed feedwater heaters. B3-4 Combined gas-vapor power cycles.

BLOCK 4 (B4) Refrigeration cycles.	B4-1 Vapor-compression refrigeration systems: Actual cycles. Refrigerant properties. B4-2 Heat pumps. B4-3 Innovative vapor-compression refrigeration systems: Cascade refrigeration systems. Multistage compression refrigeration systems. Multipurpose refrigeration systems with a single compressor. B4-4 Gas refrigeration cycles. B4-5 Absorption refrigeration systems.
Practices of laboratory	PL 1. Introduction to thermal comfort and indoor air quality. The aim of this practice is to determine the air humidity in different indoor stays of buildings and in the outside. Besides, the concept of thermal comfort and indoor air quality are introduced, features that are related with the health and the welfare of the users of buildings. Equipment of measurement employed: hygrometers, sensors of temperature, measurers of quality of indoor air, etc. PL 2. Visit to the boiler room of the students residence. The students will make a technical visit to the boiler room in Francisco Moreno residence, that consists of two boilers of natural gas and provides domestic hot water (DHW) and heating to the students residence. The aim of the visit is to identify the equipments involved in a heeating system and to make a simplified diagram of the installation. Besides, this practice includes the study of conditions of security and health in a boiler room: identification of risks, measures of emergency, risks prevention, control of the Legionella, etc. PL 3. Development and presentation of works on social, health and security features related to Thermal Engineering. In this practice the students have to present the work developed during the first weeks of course. The works are proposed by the lecturers at the beginning of the course and they will be made by groups of 4 or 5 students. The subjects will treat on social, health and industrial security of related to Thermal Engineering. For example: energy efficiency in buildings, energy efficiency in ships, storage and transport of liquid fuels, maritime transport of fuels, thermal solar energy in buildings, renewable energies, cogeneration and trigeneration, etc. PL 4. Analysis of thermodynamic cycles with computer software. This practice consists of learning to use a computer tools for the simulation of power and refrigeration cycles (CYCLEPAD). The practice is oriented to the resolution of problems of cycles (ideal and real) used in the more usual thermal machines. PL 5. Quantitative analysis of Stirling cycle. By means of an experimental Stirling engine, the studdents will analyse different variables that affect the operation of the engine, the developed cycle, and its performance. Also, they will study the operation of the engine in reverse cycle like thermal cooling machine. PL 6. Experimental study of a heat pump In this practice the students will study the operation of an experimental installation of a heat pump. They will make energy balances in each one of its components to determine the coefficient of operation (COP), working as heating machine and cooling machine. Likewise, they will study its behaviour working as water - water heatpump and air - water heatpump. PL 7. Introduction to the design of solar refrigeration installations. It is a theoretical and demo practice on installations of production of cold by means of thermal solar energy. It pretends that the students know an efficient alternative to the use of conventional equipmente, whose refrigerants are highly hurtful for the environment.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Laboratory practical	14	0	14
Seminars	7	7	14
Problem solving	26	26	52

*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 these sessions, the lecturer will explain in detail the basic theoretical contents of the course, exposing clarifying examples that help to better understand the concepts. Computer presentations and the blackboard will be used, especially to transmit information like definitions, charts, algorithms, schematics etc.
Laboratory practical	Supervised laboratory and computer practices. The didactic method to be followed in the teaching of the practical classes consists in that the lecturer supervises the work and progress done by the different groups. The practices of laboratory are headed to strengthen the theoretical concepts tackled in the sessions in the classroom.
Seminars	In the seminars, the lecturer analyses and proposes a series of problems that have to make individually or in group. The student will have to solve exercises and problems under the supervision and correction of the lecturer.
Problem solving	Intensive course of 15 hours for those students that have failed the subject in first announcement, previous to the examination in second announcement. Tutorships in groups with the lecturer. Realisation of examinations. Tasks of evaluation and hours of reinforcement.

Personalized assistance	
Methodologies	**Description**
Lecturing	Attention to student will be personalized both in the office hours and through email. Tutorial actions can be classified into academic or personalized tutoring. In the first case, students will have available office hours in which they can ask any questions regarding the contents, organization and planning of the course. Tutoring can also be individualized, but solving problems related to the activities carried out in groups will be encouraged. In personalized tutoring, each student, individually, can discuss with the lecturer any problem that is blocking an adequate progress in the course, in order to find some kind of solution. Combining both types of action tutorial students are intended to compensate for the different rates of learning through attention to diversity. The lecturers will answer the questions and queries of the student in person or by telematic means (email, videoconference, forums of Moovi, etc.) in the schedule published in the web or under the modality of previous appointment.
Problem solving	Attention to student will be personalized both in the office hours and through email. Tutorial actions can be classified into academic or personalized tutoring. In the first case, students will have available office hours in which they can ask any questions regarding the contents, organization and planning of the course. Tutoring can also be individualized, but solving problems related to the activities carried out in groups will be encouraged. In personalized tutoring, each student, individually, can discuss with the lecturer any problem that is blocking an adequate progress in the course, in order to find some kind of solution. Combining both types of action tutorial students are intended to compensate for the different rates of learning through attention to diversity. The lecturers will answer the questions and queries of the student in person or by telematic means (email, videoconference, forums of Moovi, etc.) in the schedule published in the web or under the modality of previous appointment.
Laboratory practical	Attention to student will be personalized both in the office hours and through email. Tutorial actions can be classified into academic or personalized tutoring. In the first case, students will have available office hours in which they can ask any questions regarding the contents, organization and planning of the course. Tutoring can also be individualized, but solving problems related to the activities carried out in groups will be encouraged. In personalized tutoring, each student, individually, can discuss with the lecturer any problem that is blocking an adequate progress in the course, in order to find some kind of solution. Combining both types of action tutorial students are intended to compensate for the different rates of learning through attention to diversity. The lecturers will answer the questions and queries of the student in person or by telematic means (email, videoconference, forums of Moovi, etc.) in the schedule published in the web or under the modality of previous appointment.

Seminars	Attention to student will be personalized both in the office hours and through email. Tutorial actions can be classified into academic or personalized tutoring. In the first case, students will have available office hours in which they can ask any questions regarding the contents, organization and planning of the course. Tutoring can also be individualized, but solving problems related to the activities carried out in groups will be encouraged. In personalized tutoring, each student, individually, can discuss with the lecturer any problem that is blocking an adequate progress in the course, in order to find some kind of solution. Combining both types of action tutorial students are intended to compensate for the different rates of learning through attention to diversity. The lecturers will answer the questions and queries of the student in person or by telematic means (email, videoconference, forums of Moovi, etc.) in the schedule published in the web or under the modality of previous appointment.

Assessment

	Description	Qualification	Evaluated Competencess		
Lecturing	A final test of continuous evaluation will be done during the evaluation week and will be graded over 10 points. A minimum grade of 4 points in this exam will be necessary to pass the subject in the continuous evaluation. This proof will have a weight of 40% of the grade of continuous evaluation. Two partial exams of continuous evaluation will be done, which will suppose 30% of the grade of continuous evaluation (15% each one of them).	70	CG1	CE21	CT1 CT2 CT8 CT10 CT14 CT16
Laboratory practical	Lab practices will be performed in small groups. Each group will have to deliver a memory of practices at the end of each practice, or group of practices. The memories of practices will have a weight of 10% of the grade of continuous evaluation.	10	CG1	CE21	CT1 CT2 CT6 CT8 CT10 CT14 CT16 CT17
Seminars	A group work will be done about social, health and industrial security features related to Thermal Engineering, that will be presented by the students in the practice 3 of the subject. The group work will have a weight of 10% of the grade of continuous evaluation.	10	CG1	CE21	CT1 CT2 CT8 CT10 CT14 CT16 CT17
Problem solving	Seminars will be graded through individual or group tests or resolution of exercises performed in some of the seminar sessions when the lecturer request. These will mean 10% of the final grade.	10	CG1	CE21	CT1 CT2 CT8 CT14 CT16 CT17

Other comments on the Evaluation

The evaluation will be considered positive when a score of 5 is reached for the continuous evaluation. The students must attend the ordinary exam, which addresses the whole subject contents, if the total grade of continuous evaluation is lower than 5. They also will have to attend the ordinary exam if any of the following cases happens:

- Any of the tests or exams is missed.

- A grade lower than 4 points in the final theory exam is obtained.

For these cases, the continuous evaluation grade will be the minimum of 4 points and total continuous evaluation grade. In any case, the student who has passed the continuous evaluation, will be allowed to attend to the ordinary exam to increase the grade.

Detection of cheating in any kind of evaluation activity (midterms, final terms, laboratory work, test in seminars, etc.) will be penalized with a zero in the evaluated item and, in those evaluations with a mandatory minimum grade to pass the course, the student will not be evaluated by continuous evaluation. This sanction will affect both students cheating during the evaluation tests, and those that facilitate cheating. Cheating in ordinary or extraordinary evaluation will be penalized with a zero so the students must attend the next evaluation. Detection of copies will imply the immediate expulsion of the classroom in the day in which it has been detected. Also, there will be equally penalized those students using unauthorized material during the evaluation exams (unauthorized calculators or other electronic devices, documents, notes, etc.).

Sources of information

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Alarcón Aguín, J.M., **SISCECT, Simulación y Cálculo de Sistemas Termodinámicos**, Bellisco, 1999

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Recommendations

Subjects that continue the syllabus

Naval engines and machines/P52G381V01409

Subjects that it is recommended to have taken before

Thermodynamics and heat transfer/P52G381V01203

Other comments

It is strongly recommended to review the "Thermodynamics and heat transfer" course, especially those topics related to energy balances, thermal properties of materials and ideal gases behavior. It is also recommended to review the chemical reactions fundamentals.

IDENTIFYING DATA				
Theory of structures and industrial constructions				
Subject	Theory of structures and industrial constructions			
Code	P52G381V01404			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4th	1st
Teaching language	Spanish			
Department				
Coordinator	González Gil, Arturo			
Lecturers	González Gil, Arturo Regueiro Pereira, Araceli			
E-mail	arturogg@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The main objective of the subject of Theory of Structures and Industrial Constructions is to provide the student with the basic knowledge for the analysis and design of structural elements and systems more frequent in industrial constructions. To do this, the structural typologies and the most common elements in the industrial buildings will be identified. In addition, different tools will be studied for their analysis and design. The students will be also introduced in the management of the current regulations, and in particular the standars for structures made of steel and reinforced concrete, respectively. It is, therefore, a subject that will provide fundamental knowledge for the professional exercise of the graduate in mechanical engineering. In fact, knowledge and ability to calculate and design structures and industrial constructions is one of the competencies that, according to Ministerial Order CIN / 351/2009, of February 9, must be acquired in the official degrees which, as in this case, qualify for the exercise of the Industrial Technical Engineer profession.			

Skills	
Code	
CG3	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.
CG4	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.
CG5	Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
CG6	Capacity for handling specifications, regulations and mandatory standards.
CG11	Knowledge, understanding and ability to apply the necessary legislation in the exercise of the profession of Industrial Technical Engineer.
CE23	Knowledge and ability to calculate and design of structures and industrial buildings.
CT2	Problems resolution.
CT5	Information Management.
CT8	Decision making.
CT9	Apply knowledge.
CT10	Self learning and work.
CT17	Working as a team.

Learning outcomes	Competences		
Knowing the requirements that the structures must meet to fulfill their functions, taking into account the external loads, the security criteria and the bases of calculation	CG3 CG4 CG5 CG6 CG11	CE23	CT2 CT5 CT8 CT9 CT10 CT17
Acquire capacity to convert a real structure into a model for analysis, and vice versa	CG3 CG4 CG5 CG6 CG11	CE23	CT2 CT5 CT8 CT9 CT10 CT17

Identifying the most important typologies and elements used in industrial structures and constructions	CG3 CG4 CG5 CG6 CG11	CE23	CT2 CT5 CT8 CT9 CT10 CT17
Ability to determine stress laws, stresses and deformations in the elements of structures	CG3 CG4 CG5 CG6 CG11	CE23	CT2 CT5 CT8 CT9 CT10 CT17
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	CG3	CE23	
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)].	CG4	CE23	CT2 CT8 CT9
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 [Intermediate (2)].	CG4 CG5	CE23	CT2 CT9
ENAEE learning outcome: ENGINEERING DESIGN: LO3.2.- ability to design using some awareness of the forefront of their engineering specialisation [Basic (1)].	CG4 CG5	CE23	CT9
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 [Basic (1)].	CG6 CG11		CT5
ENAEE learning outcome: INVESTIGATIONS: LO4.2.- ability to consult and apply codes of practice and safety regulations in their field of study [Advanced (3)].	CG6 CG11		
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 [Intermediate (2)].		CE23	CT9
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)].	CG4 CG5		CT2 CT9
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)].			CT8 CT9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.4.- ability to apply norms of engineering practice in their field of study [Intermediate (2)].	CG6 CG11		CT9

Contents

Topic	
Unit 1. Introduction to the analysis and design of structures	Objectives and development: This theme will serve like an introduction to the structural analysis. It will present the fundamental considerations for the idealisation and the analysis of a structure, will identify the main types of structures and their elements and, finally, will describe the different types of loads in a structure. Index: 1.1 Analysis and structural design 1.2 Classification of structures 1.3 Types of loads on structures 1.4 Idealisation of structures 1.5 Structural behaviour: load distribution 1.6 Basic principles of the structural analysis

Unit 2. Industrial Constructions: Typology and Constructive Elements	Objectives and development: This theme will introduce the concept of industrial urbanism and identify the different types of structures used in industrial buildings, as well as their basic constructive elements. Also, the student will be introduced to the systems and construction processes used in industrial buildings. Index: 2.1 General information on architecture and industrial urbanism 2.2 Types of structures in industrial buildings 2.3 Building elements: Foundations 2.4 Building elements: Beams, pillars and slabs 2.5 Building elements: Enclosures and covers
Unit 3. Normative frame in the calculation and design of structures and industrial constructions	Objectives and development: The codes currentluy in force for the design of industrial constructions and the calculation of their structures will be presented. The criteria of structural security that govern the calculation of structures in Spain and in the European Union will be studied. This includes the determination of the loads on a structure. Besides, an apporach to different criteria that must be taken into account in the design and the construction of industrial buildings: evaluation and prevention of risks in the construction phase, security of utilisation and accessibility, energy saving and use of renewable energies, healthy indoor environment, noise protection, etc. Index: 3.1 Regulatory framework for industrial constructions 3.2 The Technical Building Code (CTE) 3.3 Loads according to the CTE 3.4 Structural security according to the CTE: verification of Limit States 3.5 Load combination 3.6 Social, environmental, security and health aspects in industrial buildings
Unit 4. Introduction to the design of metal structures	Objectives and development: The fundamentals of the design and calculation of metal structures will be explained. The main characteristics of steel structures used in industrial buildings will be presented. An introduction will be made to the sizing and verification of the main elements of steel structures. Index: 4.1 Introduction to metal structures 4.2 Steel: classes and main characteristics 4.3 Standard steel sections 4.4 Introduction to the calculation of steel elements subjected to tensile, compression and bending forces
Unit 5. Introduction to the design of concrete structures	Objectives and development: The main characteristics and behavior of the concrete structures used in industrial buildings will be described. The properties and applications of concrete as a construction material (bulk, reinforced and prestressed concrete) will be studied. Concrete selection and identification criteria will be introduced. Index: 5.1 Introduction to concrete structures 5.2 Types of concrete used in buildings 5.3 Reinforced concrete: components and structural behavior 5.4 Selection and identification of concrete as a building material
Unit 6. Analysis of reticular structures with articulated knots	Objectives and development: The main features of bar structures with articulated knots will be defined and their main types will be identified. Different analytical methods will be studied to determine stresses and deformations in both isostatic and hyperstatic structures. The results obtained with this type of analysis will be related to the fundamentals of metal structures design, seen in unit 4. Index: 6.1 Characteristics of structures with articulated knots 6.2 Analysis of isostatic structures: method of knots 6.3 Analysis of isostatic structures: method of sections 6.4 Analysis of isostatic structures: determining deformations 6.5 Analysis of hyperstatic structures 6.6 Anlaysis of articulated frames and articulated beams

Unit 7. Analysis of reticular structures with rigid knots	Objectives and development: The behavior of bar structures with rigid knots will be analysed. The fundamentals of the method of Cross of distribution of moments will be presented as tool of analysis of this type of structures. This method will be applied to determine the internal forces in hyperstatic beams and frames. The results obtained with this type of analysis will be related to the fundamentals of design of metal and concrete structures, seen in unit 4 and 5, respectively. Index: 7.1 Characteristics of structures with rigid knots 7.2 Fundamentals of the Cross method 7.3 Analysis of hyperestatic beams using the Cross method 7.4 Analysis of frames using the Cross method
Unit 8. Cables and Arches	Objectives and development: The fundamentals of the structural analysis of cables and arches will be studied. Both the cables supporting to puntual and distributed vertical loads will be analysed. Three-Hinged arches will be studied as a basic case of the analysis of arches. Index: 81 General characteristics of cables 8.2 Analysis of cables supporting vertical concentrated loads 8.3 Analysis of cables supporting vertical distributed loads 8.4 General characteristics of arches 8.5 Analysis of three-hinged arches
Unit 9. Buildings in the Spanish Navy	Objectives and development: Some of the most relevant aspects of constructions in the Armed Forces, and in particular the Spanish Navy, will be estudied. Different cases of buildings present in military units and bases will be analyzed from the constructive and structural point of view. It is intended that this unit serves to review and apply some of the most relevant content of the course through its contextualization in a more familiar environment, and if possible more motivating, for the students. Index: 9.1 Examples of buildings in military environments 9.2 Management of building projects in the Navy
Practice 1. Identification and idealization of structures	Objectives and development: With this practice, it is intended to complement the contents of the first two units of the subject, as well as to review basic knowledge of structural stability, acquired in previous courses. Different examples of real structures will be proposed for the student to idealize, determine their external loads and analyze their stability. In addition, this practice will be complemented with a visit to several buildings of the ENM in which students will be able to identify different types and structural elements studied during the course.
Practice 2. Determining design loads on industrial buildings	Objectives and development: This practice aims to introduce the student to the management of the current regulations applicable to the design of structures, in particular to determining loads according to CTE. For this, an exercise is proposed in which the students must determine the loads actuating on different structural elements of an industrial warehouse. This practice is related to the first three units of the subject.
Practice 3. Sizing structural steel elements	Objectives and development: With this practice, the students are expected to complement and expand their knowledge on calculation and combination of loads, applying them to the dimensioning of different elements of steel structures. For this, the student will solve one practical case raised by the lecturer. This practice is related to units 2, 3 and 4.
Practice 4. Introduction to reticular structures with articulated and rigid knots	Objectives and development: This practice intends to introduce the student to the study of structures based on bars with articulated knots or with rigid knots, which will be approached, respectively, in units 6 and 7 of the subject. Different demonstrative assemblies of models of articulated knot and rigid knot bar structures will be carried out, in such a way that students can visualize and understand the behavior of these structural typologies under different external loads.

Practice 5. Analysis of deformations in trusses	Objectives and development: In this practice, deformation measurements will be made in a truss model under different load conditions. Likewise, a theoretical approach to the experimentally measured results will be carried out. The main objective is to reinforce the knowledge acquired in unit 6 of the subject.
Practice 6. Introduction to the use of professional structural calculation software	Objectives and development: In this practical session, the student will be introduced to the management of professional structural calculation programs with a dual objective: i) to promote the consolidation of basic knowledge on design and calculation of structures acquired throughout the course; ii) show the possibilities offered by a professional structure calculation software. There will be a brief presentation of the software available at the center (Autodesk Robot Structural Analysis) and the sizing of different structural elements and simple structures will be carried out
Practice 7. Social, environmental, safety and health aspects in the design and construction of industrial buildings	Objectives and development: Students, working in groups of three to five people, must present and defend a work on different social, environmental, safety and health aspects that according to the Technical Building Code and other reference regulations must be taken into account in the design and the construction of industrial buildings. These works will be raised by the lecturers of the subject during the teaching of unic 3. The result of this practice will be evaluated within the Group Work item (TG), according to what is established in the Assesment item of this teaching guide.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Laboratory practical	14	7	21
Seminars	7	0	7
Problem solving	28	16	44
Mentored work	0	8	8

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

Methodologies

	Description
Lecturing	The methodology of these classes will approximate to a masterful participatory session. The fundamentals of each topic will be explained and explanatory examples will be presented. Also, the student will be guided to study the contents of the subject in an autonomous way. As an expository method, the digital screen available in the classroom will preferably be used. As far as possible, copies of the presentation slides will be provided to the students prior to the class, focusing the efforts of the lecturer and students on the exposition and understanding of the knowledge. Additionally, collaborative learning will be encouraged in the classroom through group activities. The aim is to motivate the student in the research activity, and encourage personal skills while sharing problems and solutions. With a dedication that will vary throughout the course and depending on the specific needs of the subject, part of the classroom classes will be dedicated to solving problems by teams (problem-based learning).
Laboratory practical	The practical teaching will aim to apply, expand and consolidate the concepts studied in the theoretical classes. With the idea of promoting both the creativity and technical skills of the student, a series of sessions are presented, which include, on the one hand, the performance of laboratory practices, and on the other, the study of cases and the resolution of problems and/or exercises. These sessions will deal with the experimental analysis of deformations in structures, the resolution of exercises of structural analysis by classical methods and with computer software, the handling of specifications, regulations and obligatory standards in the design of industrial buildings. These classes will begin with a presentation of the practice by the lecturer, and if necessary, with an explanation of new theoretical concepts that are necessary for its realisation. Subsequently, the students will carry out the practice in question working in small groups, and under the supervision of the lecturer. At the end of each practice, each group of students must submit a summary report with the results obtained.
Seminars	Classes designed to solve problems and/or exercises and to study cases, which students must carry out individually or in group. The fact that the number of students in these classes is reduced (around 10), allows a greater proximity between lecturer and student, which facilitates the understanding and the comprehension of the fundamental concepts of the subject
Problem solving	Intensive course (15 hours) for those students who have failed the subject at first call, prior to the exam in second call. Group tutoring with the lecturer. Doing examans. Assessment tasks and reinforcement hours.

Mentored work	Students, working in groups of three to five people, must present and defend a work on different social, environmental, safety and health aspects that according to the Technical Building Code and other reference regulations must be taken into account in the design and the construction of industrial buildings. These works will be proposed by the teaching staff of the subject during the teaching of unit 3 and will be presented in the hours allocated to the 7th laboratory practice.

Personalized assistance

Methodologies	Description
Problem solving	In the scope of the tutorial action, we distinguish actions of academic tutoring and personalised tutoring. The students will have at their disposal hours of academic tutoring in which they will be able to ask any question related to the contents of the subject, its organisation, evaluation, etc. These tutorials can be individualised or in a group. Notwithstanding, group tutorials will be encouraged for solving problems or clarifying different contents of the subject. In addition, the lecturer will be available for the student to comment or ask for advice on any circumstance that prevents him/her from adequately following the subject (personalised tutorials). With the combination of these two types of tutorial action, we aim to achieve an academic-personal balance that allows the student to achieve their goals in the most effective way. The faculty of this subject will be available for tutorials in the schedule published on the website of the centre, as long as the students confirm in advance by email their interest in attending them. However, the students may arrange a tutorial with the lecturer at any time (not necessarily in this schedule). Finally, the teaching staff will be able to answer the students' questions by telematic means (email, videoconference, forums on online teaching platforms, etc.).

Assessment

	Description	Qualification	Evaluated Competencess		
Lecturing	Written tests: theoretical questions and problems The written tests aim to evaluate the learning of all the theoretical contents of the subject. There will be two partial tests and one final exam. Each partial test will contribute 15% of the final grade of the student. The final exam, which will cover all the subject matter, will have a weight of 40% in the final grade. The written tests will consist of a series of questions and exercises that give priority to the conceptual and logical reasoning, in order to verify the intellectual maturity of the students to obtain conclusions from the notions or theories exposed in class. All tests will be evaluated for a total of 10 points.	70	CG3 CG4 CG5 CG6 CG11	CE23	CT2 CT5 CT8 CT9 CT10
Laboratory practical	The students must present a report of practices for each laboratory practice performed (in case the practice is done in group, only one practice will be delivered per group). Each report will be evaluated on 10 points. The final grade of practices will be the average value of the grades obtained in each practice delivered.	10	CG3 CG4 CG5 CG6 CG11	CE23	CT2 CT5 CT8 CT9 CT10 CT17
Seminars	Throughout the course (in particular during the seminar hours), different exercises will be proposed to students, who may do them in groups or individually. Each of these exercises will be evaluated over 10 points. The grade of this item will be the average value of the grades obtained in each deliverable.	10	CG3 CG4 CG5 CG6 CG11	CE23	CT2 CT5 CT8 CT9 CT10 CT17
Mentored work	Group work that must be accompanied with a memory and an oral presentation. The work will be valued on a maximum of 10 points.	10	CG3 CG4 CG5 CG6 CG11	CE23	CT2 CT5 CT8 CT9 CT10 CT17

Other comments on the Evaluation

A numerical rating system with values between 0 and 10 will be used, according to the current legislation (R.D. 1125/2003 de 5 de septiembre, B.O.E. nº224 de 18 de septiembre).

Ordinary call: continuous evaluation

The continuous evaluation method (EC) will assess the results achieved by the students in the different activities carried out throughout the course, which will be grouped as follows: Final Test (PF), Theoretical-Practical Controls (CT), Lab Reports (MP), Evaluables Exercises (EE), and Group Work (TG). The grade of each part will be calculated as the arithmetic mean of the items made up to the moment of the evaluation in that part.

There will be two tests of evaluation of theoretical-practical knowledge (CT) throughout the course. The student must

present a report for each laboratory practice provided that it is indicated in the realization of the same, which will be evaluated in item MP. In the seminar and / or theory class hours, the student may be offered the completion and delivery of different exercises, which will be evaluated in item EE. In the event that a student is unable to attend a session (due to a justified reason) in which exercises that can be evaluated are carried out, the student must notify the lecturers by email so that they have a record and this circumstance is taken into account at the time of the evaluation. In addition, the students must carry out and present a group work on the social, environmental, safety and health aspects in the design and construction of industrial buildings (see practice 7), which will be evaluated in item TG. The final continuous assessment test (PF) will include all the contents of the subject and will have a weight of 40% in the final grade of continuous assessment.

The grade of the continuous evaluation (NEC), will be the result of applying the weighted average to all the evaluated parts; that is, it will be calculated as follows:

NEC= 0.4 PF + 0.15 CT1 + 0.15 CT2 + 0.1 MP + 0.1 EE + 0.1 TG

The student will pass the subject by continuous evaluation when each and every one of the following requirements is met:

1. Have completed all evaluable tasks (except duly justified cases)
2. Have a score of at least 4 points out of 10 in the continuous assessment final exam (PF)
3. Have a NEC value greater than or equal to 5 points (out of 10)

In case of not fulfilling any of the first two requirements, the final grade of continuous evaluation will be equal to the minimum value between NEC and 4 points.

Ordinary call: ordinary exam

Those students who fail to pass the subject by the continuous assessment method, must do the ordinary exam, where all the competences of the subject will be assessed. The results of this exam will suppose 100% of the student's final grade, being an essential requirement to pass the course to obtain a grade of at least 5 points out of 10.

Students who have passed the subject by continuous evaluation will have the possibility of taking the ordinary exam to improve their grade.

Extraordinary call

Students who have not passed the subject in the ordinary call will take an extraordinary exam that will have the same format and the same requirements as the ordinary exam.

Ethical commitment

In their double condition of military and student of the University of Vigo, students are subject to the obligations derived from both institutions. As regards a university student, the University Student Statute, approved by Royal Decree 1791/2010 of December 30, establishes in its article 12, point 2d, that the university student has the duty to abstain from using or cooperation in fraudulent procedures in assessment tests, in the work carried out or in official university documents. Likewise, the LCM, in its article 4 concerning the rules of behavior of the military, establishes in its fifteenth rule that the latter will carry out his duties and obligations exactly, driven by the feeling of honor, ...

Therefore, the student is expected to have adequate ethical behavior. If during the course unethical behavior is detected in the performance of any evaluable test or exercise (cheating, plagiarism, use of unauthorized electronic devices or others), the student in question will not pass the subject by continuous evaluation (in which he will obtain a rating of 0.0). Likewise, if this type of behavior were detected in the ordinary exam or in the extraordinary exam, the student would obtain a grade of 0.0 in such call.

Sources of information

Basic Bibliography

Hibbeler, R.C, **Análisis estructural**, 8ª ed., Pearson Educación, 2012

McCormac, J.C, **Análisis de estructuras. Métodos clásico y matricial**, 4ª ed., Ed. Marcombo, 2011

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Beer, F.P, Johnston, E.R, Mazurek, D.F., **Mecánica vectorial para ingenieros: Estática**, 10ª ed., McGraw Hill, 2013
Leet, K.M, Uang, C.M, Gilbert, A.M, **Fundamentals of structural analysis**, 4ª ed., McGraw Hill, 2011
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Fiol Femenía, F, Fiol Oliván, F, **Manual de Cimentaciones**, 1ª ed., Editorial Monte Carmelo, 2009
Jiménez Montoya, P, García Meseguer, A, Morán Cabré, F, Arroyo Portero, J.C, **Hormigón Armado**, 15ª ed., Gustavo Gili, 2010
Montalvá Subirats, J.M, Hospitaler Pérez, A, Saura Arnau, H, **Proyecto Estructural de Edificio Industrial: diseño y cálculo de estructura metálica**, 2ª ed., Universidad Politécnica de Valencia, Servicio de P, 2014
Montalvá Subirats, J.M, Saura Arnau, H., **Construcción y arquitectura industrial: Colección de problemas resueltos**, 2ª ed., Universidad Politécnica de Valencia, Servicio de P, 2014
Urbán Brotóns, P., **Construcción de estructuras metálicas**, 5ª ed., Ed. Club Universitario, 2015

Recommendations

Subjects that it is recommended to have taken before

Materials science and technology/P52G381V01202
Resistance of materials/P52G381V01204
Elasticity and additional topics in resistance of materials/P52G381V01303

Other comments

For a correct follow-up of this subject, the students must have solid knowledge of vector calculus and master the concept of static equilibrium. In addition, they must have the ability to analyse tensions and deformations in elementary structures. They should also be familiar with the mechanical properties of structural materials such as steel. It is therefore highly recommended that the students have completed and passed the following subjects of the curriculum: Physics I, Materials Science and Technology, Resistance of materials and Elasticity and Advanced strength of materials.
The knowledge acquired in the structural analysis part of this subject can be useful to the student in the follow-up of subjects such as Machine design (second term of the fourth year) or Theory of the ship and shipbuilding (first term of the fifth year). Also, the knowledge acquired in the construction part will be complemented by the subject of Basics of topography, which is only taught to students of Marine Corps.

IDENTIFYING DATA				
Deseño de máquinas				
Subject	Deseño de máquinas			
Code	P52G381V01405			
Study programme	Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4	2c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín			
Coordinator	Casqueiro Placer, Carlos			
Lecturers	Casqueiro Placer, Carlos Núñez Nieto, Xavier			
E-mail	ccasqueiro@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Esta materia permitirá ao alumno aplicar os fundamentos básicos da Teoría de Máquinas e Mecanismos ao Deseño de Máquinas e coñecer, comprender, aplicar os conceptos relacionados co Deseño de Máquinas e a súa aplicación na Enxeñaría Mecánica. Achegaralle coñecementos, sobre os conceptos máis importantes relacionados co Deseño de Máquinas. Coñecerá e aplicará as técnicas de análises para Deseño de Máquinas, tanto analíticas como mediante a utilización eficaz de software de simulación.			

Competencias	
Code	
CG4	Capacidade de resolver problemas con iniciativa, toma de decisións, creatividade, razoamento crítico e de comunicar e transmitir coñecementos, habilidades e destrezas no campo da Enxeñaría Industrial na especialidade de Mecánica.
CG5	Coñecementos para a realización de medicións, cálculos, valoracións, taxacións, peritaxes, estudos, informes, planes de labores e outros traballos análogos.
CG6	Capacidade para o manexo de especificacións, regulamentos e normas de obrigado cumprimento.
CG9	Capacidade de organización e planificación no ámbito da empresa, e outras institucións e organizacións.
CG10	Capacidade para traballar nun medio multilingüe e multidisciplinar.
CG11	Coñecemento, comprensión e capacidade para aplicar a lexislación necesaria no exercicio da profesión de Enxeñeiro Técnico Industrial.
CE13	Coñecemento dos principios de teoría de máquinas e mecanismos.
CE20	Coñecementos e capacidades para o cálculo, deseño e ensaio de máquinas.
CT2	Resolución de problemas.
CT9	Aplicar coñecementos.
CT10	Aprendizaxe e traballo autónomos.
CT17	Traballo en equipo.

Resultados de aprendizaxe			
Learning outcomes	Competences		
Aplicar os fundamentos básicos da Teoría de Máquinas e Mecanismos ó Deseño de Máquinas.	CG4 CG5 CG6 CG9 CG10 CG11	CE13 CE20	CT2 CT9 CT10 CT17
Coñecer, comprender, aplicar os conceptos relacionados co Deseño de Máquinas.	CG4 CG5 CG6 CG9 CG10 CG11	CE13 CE20	CT2 CT9 CT10 CT17
Resultado de aprendizaxe ENAEE: 1.2 Coñecemento e comprensión das disciplinas de enxeñaría propias da su especialidad, no nivel necesario para adquirir o resto de competencias do título, incluíndo nocións dos últimos adelantos. Nivel: adecuado.		CE13 CE20	
Resultado de aprendizaxe ENAEE: 2.2 Capacidade para identificar, formular e resolver problemas de enxeñaría na súa especialidade; escoller e aplicar métodos analíticos, de cálculo e experimentos adecuadamente establecidos, e coñecer a importancia das restricións sociais, de saúde e seguridade, ambientais, económicas e industriais. Nivel: adecuado.	CG4	CE20	CT2 CT9

Resultado de aprendizaxe ENAEE: 3.1 Capacidade para deseñar, deseñar e desenvolver produtos complexos (pezas, compoñentes, produtos acabados, etc.), procesos e sistemas da súa especialidade, que cumpran os requisitos establecidos, incluíndo o coñecemento dos aspectos sociais, de saúde e seguridade, e ambientais económico e industrial; así como seleccionar e aplicar métodos de proxecto apropiados. Nivel: adecuado.	CG4 CG5	CE20	CT2 CT9
Resultado de aprendizaxe ENAEE: 3.2 Capacidade do proxecto utilizando algúns coñecementos avanzados da súa especialidade de enxeñaría. Nivel: adecuado.	CG4 CG5	CE20	CT9
Resultado de aprendizaxe ENAEE: 4.1 Capacidade para realizar buscas bibliográficas, consultar e utilizar bases de datos de criterios e outras fontes de información, para realizar simulacións e análises co obxectivo de realizar investigacións sobre temas técnicos da súa especialidade. Nivel: básico.	CG6 CG11		
Resultado de aprendizaxe ENAEE: 4.2 Capacidade para consultar e aplicar códigos de boa práctica e de seguridad na súa especialidade. Nivel: básico.	CG6 CG11		
Resultado de aprendizaxe ENAEE: 4.3 Capacidade e destreza para proxectar e levar a cabo investigacións experimentais, interpretar resultados e obter conclusións no seu campo de estudo. Nivel: adecuado.		CE13 CE20	CT9
Resultado de aprendizaxe ENAEE: 5.2 Competencia práctica para resolver problemas complexos, realizar proxectos complexos de enxeñaría e realizar investigacións específicas para a súa especialidade. Nivel: adecuado.	CG4 CG5		CT2 CT9
Resultado de aprendizaxe ENAEE: 5.3 Coñecemento da aplicación de materiais, equipos e ferramentas, procesos de tecnoloxía e enxeñería e as súas limitacións no ámbito da súa especialidade. Nivel: adecuado.			CT9
Resultado de aprendizaxe ENAEE: 5.4 Capacidade para aplicar normas da práctica da enxeñaría da súa especialidade. Nivel: adecuado.	CG6 CG9 CG11		CT9
Resultado de aprendizaxe ENAEE: 6.2 Capacidade para xestionar actividades ou proxectos técnicos ou profesionais complexos da súa especialidade, asumindo a responsabilidade da toma de decisións. Nivel: básico.	CG9		

Contidos	
Topic	
Tema 1. Predición de falla por carga estática. (T1)	Resistencia estática. Concentración do esforzo. Teorías de falla. Selección de criterios de falla. Introducción á Fatiga. Esfuerzos cíclicos. Resistencia á fatiga e límite de fatiga. Factores de modificación do límite de fatiga. Esforzos variables e fluctuantes: dano por fatiga acumulada.
Tema 2. Vibracións en deseño de máquinas. (T2)	Frecuencia natural e vibracións forzadas en sistemas de 1GL. Frecuencias naturais e modos de vibración en sistema de máis de 1GL. Frecuencias naturais e modos de vibración en sistemas continuos.
Tema 3. O uso do MEF no deseño mecánico. (T3)	Mallado. Aplicación de condicións de contorno.
Tema 4. Enxeñaría inversa e prototipado. (T4)	Adquisición e tratamento de xeometría. Prototipado e impresión 3d.
Tema 5. Eixos e árbores. (T5)	Deseño de árbores segundo tensións. Velocidades críticas de árbores.
Tema 6. Rodamientos e coxinetes. (T6)	Comparación entre coxinetes e rodamientos. Tipos de rodamientos. Deseño de rodamientos. Selección de rodamientos por catálogo. Tipos de coxinetes. Teoría da lubricación hidrodinámica. Deseño de coxinete hidrodinámico.
Tema 7. Engrenaxes. (T7)	Condición de engrane. Tipos de engrenaxes. Parámetros xeométricos. Interferencia. Análise de forzas. Deseño e dimensionamiento de engrenaxes. Trens de engrenaxes.
Tema 8. Embragues e freos. (T8)	Freos de cinta, de tambor e de disco. Embragues cónicos e de disco. Par transmisible. Enerxía disipada.
Tema 9. Unións roscadas e parafusos de potencia. (T9)	Morfoloxía das unións roscadas. Normas. Dimensionamiento. Parafuso de potencia.
Tema 10. Sistemas flexibles de transmisión de potencia. (T10)	Correas e cadeas de transmisión. Cálculo e dimensionamiento.
Tema 11. Resortes (T11)	Cálculo e dimensionamento de resortes.
T12. Acoplamentos (T12).	Deseño de acoplamentos. Cálculo e dimensionamento.
Prácticas 1, 2 e 3. Análise estática mediante FEM con software CAE. (PL1, PL2 e PL3)	Mallado da/s xeometría/s, aplicación de materiais, restricións e cargas. Análise de resultados.
Práctica 4. Análise de vibracións mediante FEM con software CAE. (PL4)	Mallado da/s xeometría/s, aplicación de materiais, restricións e cargas. Análise de resultados.
Práctica 5, e 6. Adquisición de xeometrías e o seu tratamento. (PL5 e PL6)	Emprego de escáner tridimensional para a adquisición de xeometrías. Tratamento das nubes de puntos. Deseño a partir de mallas. Análise e redeseño de elementos mecánicos.

Práctica 7. Presentación e discusión do traballo realizado.	Presentación de cada traballo polos autores ó resto do alumnado.

Planificación

	Class hours	Hours outside the classroom	Total hours
Resolución de problemas	7	7	14
Prácticas con apoio das TIC	14	7	21
Resolución de problemas de forma autónoma	11	14	25
Seminario	15	10	25
Lección maxistral	28	37	65

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

Metodoloxía docente

	Description
Resolución de problemas	Resolución de problemas utilizando os conceptos teóricos presentados en aula.
Prácticas con apoio das TIC	Realización de tarefas prácticas en aula informática.
Resolución de problemas de forma autónoma	Empregados nas probas de avaliación con obxecto de verificar as capacidades adquiridas polo alumno.
Seminario	Curso intensivo de 15 horas para aqueles alumnos que suspenderon a materia en primeira convocatoria, previo ao exame en segunda convocatoria. Titorías grupais co profesor.
Lección maxistral	Clase maxistral na que se expoñen os contidos teóricos.

Atención personalizada

Methodologies	Description
Prácticas con apoio das TIC	O alumno recibe atención personalizada durante a realización das prácticas. O profesor da materia atenderá persoalmente as dúbidas e consultas dos alumnos, tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.
Seminario	Titorias grupais co profesor da materia. O profesor da materia atenderá persoalmente as dúbidas e consultas dos alumnos, tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.

Avaliación

	Description	Qualification	Evaluated Competencess		
Prácticas con apoio das TIC	Valorarase as memorias das prácticas de laboratorio (10%) e os traballos realizados empregando os mesmos medios e metodoloxías (20%).	30	CG4 CG5 CG9	CE13 CE20	CT2 CT9
Resolución de problemas de forma autónoma	Realizaranse dous Controis teórico-prácticos de avaliación continua (15% cada un). A súa valoración realizarase sobre 10 puntos cada un. A Proba Final (PF) de avaliación continua (cun peso do 40%) realizarase na semana de avaliación e valorarase sobre 10 puntos. Será necesario obter unha nota maior ou igual a 4 puntos sobre 10 no exame final de avaliación continua para poder optar ao aprobado por avaliación continua.	70	CG4 CG5 CG6 CG9 CG11	CE13 CE20	CT2 CT9 CT10

Other comments on the Evaluation

O alumno deberá presentarse ao exame ordinario de todos os contidos da materia, que suporá o 100% da nota, nos seguintes supostos:

- A nota final de avaliación continua (NEC) é menor de 5.
- A non realización ou entrega da memoria de prácticas, salvo que sexa eximido por causa xustificada, ou a non superación do mínimo de 4 puntos nas mesmas.
- Obter unha nota inferior a 4 puntos sobre 10 no exame final de avaliación continua.

A nota de avaliación continua en caso de non cumprir algún do tres últimos requisitos será obtida mediante a expresión: NECS = min (4, NEC).

En calquera caso, o alumno que superase a avaliación continua, terá a posibilidade de presentarse ao exame ordinario para subir nota.

Nota importante: Un dos deberes de cada estudante universitario é "Absterse de empregar ou cooperar en procedementos fraudulentos nas probas de avaliación, nos traballos que se realicen ou nos documentos oficiais da universidade". (Real decreto 1791/2010, do 30 de decembro, polo que se aproba o Estatuto do Estudante Universitario). A participación en calquera procedemento fraudulento, así como a posesión de material non autorizado durante a realización de calquera das probas (como dispositivos electrónicos, notas ou calquera outra documentación relacionada co asunto) conducirá á suspensión na convocatoria actual (valorada 0) e informar á Dirección do Centro.

Bibliografía. Fontes de información

Basic Bibliography

Budinas, Richard, **Diseño en Ingeniería Mecánica de Shigley**, 9ª, McGraw Hill,

Norton, Robert L, **Diseño de Máquinas**, 4ª, Editorial Pearson,

Complementary Bibliography

Budinas, Richard, **Shigley□s Mechanical Engineering Design**, 9ª, McGraw Hill,

Norton, Robert L, **Machine Design**, 5ª, Editorial Pearson,

Juvinall, Robert C, **Diseño de Elementos de Máquinas,**, 2ª, Wiley,

Juvinall, Robert C, **Fundamentals of Machine Component Design**, 5ª, Wiley,

Mott, Robert, **Diseño de elementos de máquinas**, 4ª, Editorial Pearson,

Mott, Robert, **Machine Elements in Mechanical Design**, 5ª, Editorial Pearson,

Recomendacións

IDENTIFYING DATA				
English II				
Subject	English II			
Code	P52G381V01406			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	English			
Department				
Coordinator	Douglas , Heidi Jennifer Diane			
Lecturers	Douglas , Heidi Jennifer Diane Gómez Garrido, Sandra Hawthorne , Kaye Louise Muradás Sanromán, Macarena			
E-mail	externo.hdouglas@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	In this subject, students are expected to improve their mastery of the four basic skills of English (listening, speaking, reading, writing) at B2 Level CEFR (Common European Framework of Reference for Languages) in order to foster the use of the language in the professional military environment.			

Skills	
Code	
CG10	Ability to work in a multidisciplinary and multilingual environment.
CE34	CITN4 To promote, through speaking and writing in Spanish and English, communication skills to ease the transmission and understanding of orders, ideas and concepts.
CT4	Oral and written proficiency in a foreign language.
CT5	Information Management.
CT7	Ability to organize and plan.
CT8	Decision making.
CT9	Apply knowledge.
CT15	Objectification, identification and organization.
CT17	Working as a team.
CT18	Working in an international context.

Learning outcomes	Competences		
OVERALL ORAL PRODUCTION To give clear, systematically developed descriptions and presentations, with appropriate highlighting of significant points, and relevant supporting details. SUSTAINED MONOLOGUE: DESCRIBING EXPERIENCE To give clear, detailed descriptions on a wide range of subjects related to his/her field of interest. SUSTAINED MONOLOGUE: PUTTING A CASE To develop an argument systematically with appropriate highlighting of significant points, and relevant supporting detail. ADDRESSING AUDIENCES To give a clear, prepared presentation, giving reasons in support of or against a particular point of view and giving the advantages and disadvantages of various options. To take a series of follow up questions with a degree of fluency and spontaneity which poses no strain either him/herself or the audience. OVERALL SPOKEN INTERACTION To use the language fluently, accurately and effectively on a wide range of general, academic, vocational or leisure topics, marking clearly the relationships between ideas. To communicate spontaneously with good grammatical control without much sign of having to restrict what s/he wants to say, adopting a level of formality appropriate to the circumstances.	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18

OVERALL WRITTEN PRODUCTION To write clear, detailed texts on a variety of subjects related to his/her field of interest, synthesising and evaluating information and arguments from a number of sources. REPORTS AND ESSAYS To write an essay or report which develops an argument systematically with appropriate highlighting of significant points and relevant supporting detail.	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18
OVERALL LISTENING COMPREHENSION To understand standard spoken language, live or broadcast, on both familiar and unfamiliar topics normally encountered in personal, social, academic or vocational life. Only extreme background noise, inadequate discourse structure and/or idiomatic usage influences the ability to understand. UNDERSTANDING CONVERSATION BETWEEN NATIVE SPEAKERS To keep up with animated conversation between native speakers. LISTENING AS A MEMBER OF A LIVE AUDIENCE To follow the essentials of lectures, talks and reports and other forms of academic/professional presentation which are propositionally and linguistically complex. LISTENING TO ANNOUNCEMENTS AND INSTRUCTIONS To understand announcements and messages on concrete and abstract topics spoken in standard dialect at normal speed. LISTENING TO AUDIO MEDIA AND RECORDINGS To understand recordings in standard dialect likely to be encountered in social, professional or academic life and identify the speaker viewpoints and attitudes as well as the information content.	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18
OVERALL READING COMPREHENSION To read with a large degree of independence, adapting style and speed of reading to different texts and purposes, and using appropriate reference sources selectively. READING FOR ORIENTATION To scan quickly through long and complex texts, locating relevant details. READING INSTRUCTIONS To understand lengthy, complex instructions in his/her field, including details on conditions and warnings, provided s/he can reread difficult sections.	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18
ENAEE Learning Outcome: KNOWLEDGE AND UNDERSTANDING: LO1.3.- Awareness of the wider multidisciplinary context of engineering [Intermediate (2)].	CG10		
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)].			CT5
ENAEE Learning Outcome: COMMUNICATION AND TEAM-WORKING: LO7.1.- Ability to communicate effectively information, ideas, problems and solutions within the engineering community and society at large [Intermediate (2)].		CE34	CT4 CT18
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)].		CE34	CT4 CT7 CT8 CT17 CT18
ENAEE Learning Outcome: LIFELONG LEARNING: LO8.1.- Ability to recognise the need for and to engage in independent life-long learning [Basic (1)].			CT8
ENAEE Learning Outcome: LIFELONG LEARNING: LO8.2.- Ability to follow developments in science and technology [Basic (1)].			CT8

Contents	
Topic	
Unit 6	6.1. Night night 6.2. Music to my ears
Unit 7	7.1. Let's not argue 7.2. It's all an act
Unit 8	8.1. Cutting crime 8.2. Fake news
Unit 9	9.1. Good business 9.2. Supercities
Unit 10	10.1. Science fact, science-fiction 10.2. Free speech

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	22	20	42
Mentored work	22	20	42
Essay questions exam	30	20	50
Essay	4	4	8
Oral exam	4	4	8

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

Methodologies	
	Description
Lecturing	The communicative approach is based on the idea that language learning successfully comes through interspersing different didactic methods. Theory lessons will consist of checking the theoretical knowledge students have and, consequently, teaching the contents designed for completing the knowledge students have previously acquired.
Mentored work	Theory lessons will be completed with practical sessions in which different activities will be done in order to develop students' competence in the four linguistic skills and, therefore, reach the abovementioned goals.

Personalized assistance	
Tests	**Description**
Essay questions exam	The teachers will answer their students' questions themselves, both in the office, at the time published on the website of the college, and through the use of web-based technology (e-mail, videoconferences, MooVi forums, etc.) on appointment.
Oral exam	The teachers will answer their students' questions themselves, both in the office, at the time published on the website of the college, and through the use of web-based technology (e-mail, videoconferences, MooVi forums, etc.) on appointment.
Essay	The teachers will answer their students' questions themselves, both in the office, at the time published on the website of the college, and through the use of web-based technology (e-mail, videoconferences, MooVi forums, etc.) on appointment.

Assessment					
	Description	Qualification	Evaluated Competencess		
Essay questions exam	Taking into account both the methodologies and the different activities done throughout the whole term (whose main objective is the acquisition of the learning outcomes), the following is the percentage of the global mark corresponding to each part of the exam: Reading - 20% Listening -20% Writing - 30% Speaking - 30% Global - 100% Exams (2 per term) 70% Mid-term exam - 30% Final exam - 40%	70	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18
Essay	Activity 1 (15%)	15	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18
Oral exam	Activity 2 (15%)	15	CG10	CE34	CT4 CT5 CT7 CT8 CT9 CT15 CT17 CT18

Other comments on the Evaluation
The main goal of the subject is to assess the learning of all of the contents. Exams must be complete, i. e., they will cover all of the contents, since the main goal is to assess what students know about the subject in general, not about a part of it. The mid-term exam will be worth 30% of the overall mark of the continuous assessment, and the final exam will be worth 40% since the latter covers all of the contents taught throughout the term. Moreover, in the final exam, it will be necessary to fulfil the following condition: 1. Obtain at least 40% on each of the 4 parts of the exam, corresponding to the four linguistic skills. If the student does not fulfil the abovementioned requirement, the mark of the part of the exam where the student has got the highest mark will become the mark of the final exam and, therefore, of the continuous assessment. This mark will never be higher than 3/10 (3 out of 10) since this is the highest possible mark in each of the two parts of the exam whose marks are the highest (writing and speaking). To pass the subject via continuous assessment, the student should get at least 5 points as a whole. Ordinary and/or extraordinary exam In order to pass this exam, it will be necessary to fulfil the following condition: 1. Pass (get at least half of the points on) each of the four parts of the exam, corresponding to the four linguistic skills. If the student does not fulfil the abovementioned requirement, the mark of the part of the exam where the student has got the highest mark will become the mark of the exam (Exam 2) and, therefore, of the continuous assessment. This mark will never be higher than 3/10 (3 out of 10) since this is the highest possible mark in each of the two parts of the exam whose marks are the highest (writing and speaking). To pass the subject via continuous assessment, the student should get at least 5 points as a whole. Both in the exams which make up the continuous assessment (mid-term exam and final exam) and in the ordinary and extraordinary exams, all of the students, independently of the class group (1, 2, 3 or 4) they belong to, are being assessed on the same compulsory subject of the Degree in Mechanical Engineering of the Defense College, English II. Consequently, for the speaking part of the exam, students will be grouped by following objective and consistent criteria. Although, if possible, the grouping of students to do the abovementioned part of the exam will aim to be similar to class groups, this will not be compulsory. IMPORTANT NOTES:1. During the time students are sitting exams, they will be banned from using electronic devices (except the student on duty, who will put her/his mobile on the desk, in sight of the teachers invigilating the exam at issue). If the teachers invigilating the exam realise that a student (except the student on duty, who will be allowed to have the regulatory mobile) has, handles or uses an electronic device, her/his mark will be 0 in the exam as a whole and, if they do so during the ordinary/extraordinary exam, their mark will be 0 in the assessment as a whole. Under no circumstances will there be any special permission to allow the students to have electronic devices during the time they will be sitting exams. 2. The organisation of exam procedures, which is published both on the "orden diaria" and the virtual platform of the subject, will be only and exclusively designed by the coordinator of the subject, who will have reached an agreement with the governing body of the Defense College. Under no circumstances will there be any changes derived from decisions made by people different from the coordinator or the members of the governing body of the Defense College. The mark of those students who do not fulfil the abovementioned requirements will be 0 on the exam and, if they do not fulfil the above mentioned requirements during the ordinary/extraordinary exam, their mark will be 0 on the assessment as a whole.

Sources of information
Basic Bibliography
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Complementary Bibliography
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Random House Webster Unabridged Dictionary, Random House Reference Publishing, 2005
The BBC,
The British Army,
The British Council,
The British Forces Broadcasting Service,
The CNN,
The Guardian,
The Naked Scientists,
The National Army Museum,
The New York Times,
The Royal Air Force,
English Listening,
Lingo Rank,
NATO,
US Department of Defence Dictionary of Military and Associated Terms,
US-based military English website,
Military definitions,
Airforce magazine,
Dudley Knox library, a directory of military information,

Recommendations

Subjects that it is recommended to have taken before

English I/P52G381V01209

Other comments

To take this subject, students are highly encouraged to have taken the subject English Language of the Naval College. Both the knowledge and skills acquired once students haven taken the subject will allow them to be able to succeed in subjects taken later, because at the end of the academic year students are expected to be able to acquire CEFR Level B2. Therefore, to be able to succeed, it is advisable to have the following skills:
-Reading and listening skills
-Writing and speaking skills
-Skill to think abstractly and summarise information
-Skill for group work and communication

IDENTIFYING DATA				
Manufacturing engineering and dimensional quality				
Subject	Manufacturing engineering and dimensional quality			
Code	P52G381V01407			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Suárez García, Andrés			
Lecturers	Carrasco Pena, Pedro Jesús Suárez García, Andrés Troncoso Pastoriza, Francisco Manuel			
E-mail	asuarez@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The main objective of Manufacturing Engineering and Dimensional Quality is to complement the knowledge acquired in the subject "Fundamentals of Systems and Manufacturing Technologies" on manufacturing processes. The student will acquire skills to identify and plan the different stages of the production process from the product design specifications, selecting the different phases, machines, equipment, tools, and verification techniques more convenient. In addition, the knowledge of the student in the development of simple computer numerical control computer-aided design and manufacturing techniques programs will be strengthened.			

Skills	
Code	
CG3	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.
CG8	Ability to apply the principles and methods of quality.
CE26	Applied knowledge of systems and manufacturing processes, metrology and quality control.
CT2	Problems resolution.
CT8	Decision making.
CT9	Apply knowledge.
CT10	Self learning and work.
CT17	Working as a team.
CT20	Ability to communicate with people not expert in the field.

Learning outcomes	Competences		
To know the technological base and basic aspects of manufacturing processes.	CG3 CG8		CT2 CT8 CT9 CT10 CT17 CT20
To understand basic aspects of manufacturing systems.	CG3 CG8		CT2 CT8 CT9 CT10 CT20
To acquire skills to select manufacturing processes and to plan manufacturing.	CG3 CG8	CE26	CT2 CT8 CT9 CT10 CT20
To develop skills to manufacture groups and elements in CAD-CAM environments.	CG3	CE26	CT8 CT9 CT10

Application of CAQ technologies	CG3	CE26	CT2 CT8 CT9 CT10 CT17 CT20
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING LO1.2.- Knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes. Advanced (3).	CG3	CE26	
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).		CE26	CT2 CT8 CT9
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. Intermediate (2).	CG8	CE26	CT2 CT9
ENAEE learning outcome: ENGINEERING DESIGN LO3.2.- Ability to design using some awareness of the forefront of their engineering specialisation. Advanced (3).		CE26	CT9
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. Intermediate (2).			CT8 CT9
ENAEE learning outcome: ENGINEERING PRACTICE LO5.4.- Ability to apply norms of engineering practice in their field of study. Basic (1).			CT9
ENAEE learning outcome: LIFELONG LEARNING LO8.1.- Ability to recognise the need for and to engage in independent life-long learning. Basic (1).			CT8

Contents	
Topic	
THEORY	
1. Introduction to industrial production	- Productive system - Industrial revolutions - Concurrent Engineering - Lean manufacturing - Lean Six Sigma
2. Process analysis, simulation and optimization	- Shaping of materials by removal, deformation and molding - CAD, CAE, CAM systems - Additive manufacturing - Software slicer
3. Implementation of manufacturing processes	- Transfer systems - Production lines and systems - Flexible manufacturing systems and cells - Integrated Manufacturing
4. Planning of manufacturing systems	- Design plan analysis - Selection of processes and determination of the manufacturing sequence - Definition of process sheet - Manufacturing technology management
5. Design quality	- Kano model - Fault tree analysis - Failure mode and effects analysis - Design of experiments
6. Manufacturing quality	- Ishikawa diagram - Pareto chart - Statistical process control - Variable control charts - Attribute control charts - Machine and process capacity
7. Inspection and metrology	- Measurement uncertainty - Errors and measurement chains - Traceability and dissemination - Calibration - Calibration plan - The field of dimensional metrology - The metrological organization - Metrological techniques and systems

8. Quality of measurements in industry	- Precision in the industry - Legal and industrial metrology - Evaluation of the quality of the measurements - Tools and techniques to evaluate dimensional quality and its costs. - Modeling and measurement of surface quality. - Systems, machines, inspection and verification equipment in mechanical manufacturing.
PRACTICE	
Practical Sessions 1 and 2: Statistical Process Control	Practical cases of analysis of productive systems through control charts by variables, control charts by attributes and the study of machine and process capacities will be carried out.
Practical sessions 3, 4 and 5: Quality in industry	Tools and techniques will be studied to evaluate the dimensional quality and its costs. In addition, the importance and principles of continuous improvement will be presented through the analysis of real cases. All this will allow to train students for the maintenance and improvement of the basic stability in the organizations.
Practical sessions 6 and 7: Computer Aided Manufacturing	These practical sessions are aimed at the computer-aided design of Personal Protective Equipment (PPE) in accordance with Royal Decree 773/1997 (Directive 89/656/EEC) on the use of PPE and Regulation (EU) 2016/425 on its marketing. The PPE designed will be printed in 3D, and the students must select the material, the manufacturing characteristics, as well as carry out the rapid prototyping of these parts. With these practices, the aim is to apply theoretical knowledge to the machining of parts using Autodesk Inventor software.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	34	62
Practices through ICT	14	0	14
Mentored work	0	14	14
Seminars	7	5	12
Seminars	15	8	23
Essay questions exam	2	0	2
Report of practices, practicum and external practices	0	13	13
Essay questions exam	9	0	9
Problem and/or exercise solving	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	In these sessions, the basic theoretical contents of the subject will be explained in detail, exposing explanatory examples to deepen the understanding of the subject. The slides and the blackboard will be used in combination. As far as possible, a copy of the slides will be provided to the students prior to the lesson, focusing the effort of the lecturer and students on the exposure and understanding of the knowledge. In any case, paper reproductions of slides should never be considered as substitutes for texts or notes, but as complementary material.
Practices through ICT	In order to contribute to the acquisition of generic competences, the evaluation of practice sessions is proposed either with the preparation of individual reports or with reports by group. When the elaboration of the report is collective and in order to ensure that the interdependence is positive, all the members of the group must have worked and contributed to the final product and must dominate, minimally, all aspects of the practical session.
Mentored work	The didactic method to follow in the delivery of practical classes is that the lecturer mentored the work carried out by the groups in which the students are divided. The practices are aimed at strengthening the theoretical concepts addressed in the lecturing sessions and facilitate the assimilation of the concepts with regard to their application in the design of structures and elements of machines.
Seminars	Given that the tutorial action is addressed as a group support action to the student's learning process by solving problems and exercises, the sessions will be carried out preferably in seminars and in the format of small meeting groups.
Seminars	Intensive course of 15 hours for those students who did not pass the subject in the first call, prior to the examination of the second call. Tutorial groups with the lecturer.

Personalized assistance

Methodologies	Description

Seminars	In the seminars lecturers propose the resolution of problems and study cases related with the lecturing sessions. The faculty will personally answer the questions and queries of the students, both in person (the timetable will be published on the centre's website) and through telematic means (e-mail, videoconference, MooVi forums, etc.) by appointment.
Mentored work	During the practical sessions of the subject different mentored works will be implemented in groups of students. The lecturer will answer personally questions and queries of the students.

Assessment

	Description	Qualification	Evaluated Competencess		
Essay questions exam	PI. Two mandatory intermediate tests will be held during the course (PI1 and PI2). PI1 for subjects T1-T4 and PI2 for subjects T5-T7. Each test has a weight of 15% on the final grade.	30	CG3 CG8	CE26	CT2 CT9 CT10 CT20
Report of practices, practicum and external practices	MP Delivery of reports to evaluate the knowledge acquired in the practical sessions and mentored works (P1-P7)	20	CG3	CE26	CT2 CT8 CT9 CT10 CT17 CT20
Essay questions exam	PF Writing final test final to evaluate the global knowledge of the subject (official date of evaluation)	40	CG3 CG8	CE26	CT2 CT8 CT9 CT10 CT20
Problem and/or exercise solving	CT. Questionnaires and tests will be carried out through online teaching platforms corresponding to the subject matter taught. These will be done during class hours.	10	CG3 CG8	CE26	CT2 CT9 CT10 CT20

Other comments on the Evaluation

The final evaluation of the student will be the sum of the score awarded to each of the parts mentioned above and taking into account the requirement of a minimum of 4 in the final exam.

Being, therefore, the continuous evaluation grade:

- In case of meeting the requirements, NEC = 0.40·PF + 0.15·PI1 + 0.15·PI2 + 0.20·MP + 0.1·CT
- In case of not meeting the requirements, the maximum grade obtained will be a 4.

The student must attend to the ordinary examination of all the contents of the subject, which will be 100% of the grade, in the following cases:

- The non-completion or delivery of any of the previous points.
- Get a grade below 4 points out of 10 in the final exam.
- Not having passed the continuous assessment with a 5.

In any case, the student who has passed the continuous assessment, will have the possibility of attending the ordinary exam to raise the grade.

ETHICAL COMMITMENT: Students are expected to have adequate ethical behavior. If unethical behavior is detected (cheating, 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/she 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.

Sources of information

Basic Bibliography

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Lasheras Esteban, José, **Tecnología Mecánica y Metrotecnia**,

Todd, R., **Fundamental Principles of Manufacturing Processes**,

Complementary Bibliography

Groover, M., **Fundamentos de Manufactura Moderna: Materiales, Procesos y Sistemas**,

Recommendations

Subjects that it is recommended to have taken before

Resistance of materials/P52G381V01204
Fundamentals of manufacturing systems and technologies/P52G381V01402

Other comments

The student who accesses the fourth year of the mechanics engineering bachelor degree, and in particular to this subject, should have a minimum capacity to:
- Written and oral comprehension.
- Abstraction, basic calculation and synthesis of information.
- Use dimensional measurement and verification instruments in the laboratory/workshop.
- Use statistics in the Quality control.
- Dimension and define tolerances adequately and precisely to mechanical elements.
- Represent using 3D CAD parts and basic sets.
- Use and know the manual machine tools and their basic operations.
- Develop basic programs of numerical control in lathe and milling machine, and select the tools.
- Plan processes of machining, deformation and welding to produce parts and/or basic sets.
- Apply the theory of Elasticity and know how to represent tension states through Mohr circles.

If the student accesses without these competences, he/she will not be able to have an optimal learning process and will need a longer time to acquire and update their skills so that the final training is as expected.

IDENTIFYING DATA				
Radio-communication systems				
Subject	Radio-communication systems			
Code	P52G381V01408			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Nocelo López, Rubén			
Lecturers	Nocelo López, Rubén Núñez Ortuño, José María			
E-mail	rubennocelo@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This course, which is part of the specialization module in Naval Technology, introduces the basic principles of radio communication, so much theoretical as practical. During the course we will review the physical phenomena and technological developments that made possible the transmission of information using electromagnetic waves. We discuss the propagation of radio-waves, the organization of the radio-electric spectrum, the operation and design of antennas, and the design criteria for a radio link. Finally, we review the radio-communication systems in use nowadays, with focus on those used in the Navy.			

Skills	
Code	
CG3	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.
CE27	CITN1 To acquire the ability to understand the mechanisms of propagation of electromagnetic waves and the corresponding organization of the radioelectric space.
CE28	CITN2 To know the mechanism of operation of antennas and their different types.
CE29	CITN3 To acquire the ability to select equipment, media and transmission systems.
CT1	Analysis and synthesis
CT2	Problems resolution.
CT3	Oral and written proficiency
CT8	Decision making.
CT9	Apply knowledge.
CT10	Self learning and work.
CT16	Critical thinking.
CT17	Working as a team.

Learning outcomes			
Learning outcomes		Competences	
To know the technological base of telecommunication systems	CG3	CE27 CE29	CT1 CT2 CT3 CT8 CT9 CT10 CT16 CT17
To understand the fundamentals of electromagnetic wave propagation and the organisation of the radio-electric spectrum.	CG3	CE27	CT1 CT2 CT3 CT9 CT10 CT16 CT17

To understand the basic mechanisms of operation of antennas	CG3	CE28 CE29	CT1 CT2 CT3 CT9 CT10 CT16 CT17
To understand the basic operation of naval communication systems	CG3	CE29	CT1 CT3 CT8 CT10 CT16
ENAEE learning outcome: KNOWLEDGE AND UNDERSTANDING: LO1.3.- Be aware of the multidisciplinary context of engineering [level of achievement (basic (1), intermediate (2) and advanced (3)) of this learning outcome: Basic (1)].		CE27 CE28 CE29	
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 recognize the importance of non-technical societal, health and safety, environmental, economic and industrial constraints [Intermediate (2)].			CT1 CT2 CT8 CT9 CT16
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)].		CE27 CE28 CE29	CT8 CT9
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 [Basic (1)].			CT3 CT8 CT10 CT17
ENAEE learning outcome: CONTINUOUS TRAINING: LO8.1.- Ability to recognize the need of continuous training, to be carried out along a their own career in an independent way [Advanced (3)].			CT8 CT10
ENAEE learning outcome: CONTINUOUS TRAINING: LO8.2.- Ability to be keep updated on the last developments in science and technology [Intermediate (2)].			CT8 CT10

Contents	
Topic	
Chapter 1. Introduction	Aims and development: The aim of this chapter is to introduce basic concepts needed to understand the propagation of electromagnetic waves, and the tools needed to analyse the operation and characteristics of radio systems, tools such as spectral analysis and decibels units. Index of the subject 1.1 Historical Perspective: from Oersted to Marconi 1.2 Review of fundamental concepts 1.3 Equation of the travelling wave 1.4 Electromagnetic spectrum 1.5 Decibels
Chapter 2. Antennas	Aims and development: The aim of this chapter is to present the operation of antennas and how to characterize their performance, numerically and graphically. We will see different types of antennas and their application. Index of the subject 2.1 Radiation in free space 2.2 Parameters of the antennas 2.3 Radiation pattern 2.4 Types of antennas
Chapter 3. Link	Aims and development: The aim of this chapter is to present the radio communication system as a whole, and to quantify its feasibility and performance in real circumstances using the link budget. Index of the subject 3.1 Friis Equation 3.2 Noise 3.3 Interference 3.4 Availability

Chapter 4. Radio-propagation	Aims and development: The aim of this chapter is to introduce the mechanisms of propagation of electromagnetic waves in more complex and realistic scenarios. Different strategies are discussed for communication over long distances Index of the subject 4.1 Influence of the terrain. 4.2 Surface wave 4.3 Ionospheric wave 4.4 Space wave
Chapter 5. Modulations	Aims and development: The aim of this chapter is to explain how can electromagnetic propagation be harness to transport information. We introduce the concept of modulation, we discuss its types, characteristics and limitations. Index of the subject 5.1 Basic concepts 5.2 Analog modulation 5.3 A/D conversion 5.4 Digital modulation 5.5 Multiplexing
Chapter 6. Current systems	Aims and development: The aim of this chapter is to present and discuss some of the radio communication systems that are currently in use. Index of the subject 6.1 Management of radio-electric spectrum 6.2 Mobile communication systems 6.3 Satellite communication systems 6.4 Radio-navigation systems 6.5 Radio-communication systems in the Navy
R&D project	Aims and development: The aim of the R&D project is give the student the opportunity to tackle the study of a subject of his election, as long as it is compatible with the contents of the course. We encourage the student to find solutions to open problems using the methods and tools at hand. The R&D project encourages the student to synthesize the acquired results into a multimedia format. During this session the class will review and discuss a selection of the results of the R&D project. The selection criteria will be: quality and compatibility with the course curriculum.
Lab session 1. Introduction	Aims: This first session poses a number of challenges and open exercises that will reinforce some fundamental concepts and units. Virtual laboratories will be used to visualize the propagation of electromagnetic waves, and other fundamental parameters. Students will practice operation with natural and logarithmic units, often making conversions between them, using either manual calculator and Matlab for verification.
Lab session 2. Antennas	Aims: The Lucas-Nülle training station will be used to study the characteristic parameters of a number of antennas (monopole, dipole, Yagi-Uda, slot antenna, etc.). Array antenna will be experiences using simulation software.
Lab session 3. Link	Aims: The students will practice evaluating the radio link budget, identifying and manipulating all the terms involved in Friis equation, as well as other parameters that are used to characterize the performance and overall quality of a radio link, such as SNR, CIR, availability. A practical case will be considered using simulation software.
Lab session 4. Satellite	Aims: The students will establish communication with one or several geostationary satellites. They will have to locate the position of the satellite, aim the antenna, and describe the characteristics of the received signal.

Lab session 5. Radio-propagation	Aims: Students will experience the various modes of propagation of electromagnetic waves, and how that can impact the communication. Several modes of propagation will be studied. The students will identify the propagation mode with the help of a calibrated antenna and a field measuring unit. In case the instrumentation is not available, simulation software will be used to study radio propagation via ionospheric and surface wave.
Lab session 6. Analog modulation	Aims: Basic concepts such as base-band or transmission bandwidth will be reviewed from a practical perspective. Software-defined-radio (SDR) software will be used to compare various analog modulations in terms of quality and bandwidth efficiency. We will review also the demodulation AM and FM signals.
Lab session 7. Digital modulation	Aims: Using SDR software a number of concepts will be reviewed, such as the impact that the digital modulation has on the bit error rate (BER). The students will compare different modulation schemes (ASK, QPSK and QAM) and the differences between their respective characteristic parameters.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	26	26	52
Laboratory practical	14	14	28
Seminars	7	5	12
Project based learning	2	13	15
Seminars	14	8	22
Essay questions exam	13	8	21

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

Methodologies

	Description
Lecturing	Participatory master class. In these sessions, the contents of the program are presented. Examples are used to help students understand the matter. Computer presentations and the blackboard will be used as the main media for content transmission. As much as possible, results will be supported by experiments, either done inside the classroom or shown via videos or other interactive content. A copy of the slides will be available for students prior to the lecture, so that both the lecturer and the students can focus, respectively, on the transmission and reception of the concepts. The slides are provided not as a substitute for textbooks or lecture notes, but as supplementary material. Project-based learning. Two masterclass sessions are programmed to visualize and discuss the results of the R&D projects. A number of projects will be selected according to quality and fitness to the course curriculum, and discussed with the class. Resolution of problems and/or exercises. With these sessions we engage the student in problem solving activities, while boosting skills in collaborative work and interpersonal relations. Active methodologies will be used, as stated in section 4 of this Guide. The student will be presented with a number of problems and challenges that involve other engineering disciplines. This way, students will gain a transversal vision of the contents of the course and will see how it can help addressing the problems in other disciplines. If possible, some time each week will be reserved to group work, although the actual amount of time may vary along the course depending on the current load. During those activities a problem-solving learning method will be followed.

Laboratory practical	Small participatory lectures. Sometimes, it will be convenient to tackle some concepts before the laboratory sessions in this form, to review and expand on the concepts that will be used during the session. Guided laboratory sessions. The procedure in these sessions is as follows: smaller groups of students are formed to solve a number of challenges and problems, with minimal intervention by the lecturer. The aim is to let students arrive to solutions using the knowledge and the tools at their disposal. The lecturer will merely guide the work of the students, by adjusting the difficulty of the tasks to the capacity of each group.
Seminars	Problems sessions. These sessions seek to support the learning process by means of problem solving, either as a group activity or individually. Problems and challenges will be posed to the group. Students will have to reach a solution through discussion and collaboration. Sessions will be preferably held in groups of around 10 students, although individual sessions can also be arranged.
Project based learning	We propose a R&D project with an open topic to be carried out by a group of 2 students. The procedure is as follows: we provide the students with a list of videos, as reference. Said videos show demonstrations or tutorials related to the course curriculum; for example: the design and implementation of a AM receptor or an experimental demonstration of ionospheric refraction using a scale model. We ask the students to make a similar video, with free topic but within the course contents. The aim of this project is to encourage students to acquire knowledge by themselves, employing any tool or method at their disposal. On top of that, we boost skills for autonomous investigation, problem solving, and capabilities in synthesis and presentation.
Seminars	This corresponds to an intensive course that reviews the main concepts and problems in preparation for the extraordinary exam.

Personalized assistance

Methodologies	Description
Seminars	We offer students both group and individualized tutoring. In the former, students have access to tutoring hours where lecturers are available to discuss any topic related to the course content, organisation, and planning. During these hours the lecturer can propose problems related to the course curriculum, either to reinforce the contents already presented or to challenge and deepen the student mastery of the subject. In the latter, the lecturer is available to each student to address any issue that may be hindering the student performance, or preventing him/her to follow the course. The aim of these sessions is to find, between both, some solution to these problems. Using both types of tutoring we adapt for the different learning speeds, and we address diversity outreach. The course lecturers will respond personally to all the doubts and questions that the students may rise. This will be done either in face-to-face meetings, according to the schedule published in the website of the center, or through telematic means (such as email, videoconference, Moovi forums, etc.) if the course is held online

Assessment

	Description	Qualification	Evaluated Competencess		
Lecturing	It consists of 3 written exams: containing theoretical questions and problems covering the curriculum of the course. The distribution of the three exams is as follows: First mid-term: it covers chapters 1 and 2, and has a weight of 15% of the final grade. Second mid-term: covers chapters 3 and 4, and has a weight of 15% of the final grade. Final examination: covers all chapters (from 1 to 6) and has a weight of 40% of the evaluation. The R&D project grade is awarded by the lecturer in terms of quality and relevance to course curriculum. It has a weight of 10% of the final grade.	80	CG3	CE27 CE28 CE29	CT1 CT2 CT3 CT8 CT9 CT10 CT16

Laboratory practical	Groups of 2/3 students follow the laboratory procedures and deliver a log of the work done in each lab session. The lecturers will grade each deliverable, in terms of correctness and mastery of the session contents. The lab grade, calculated as the arithmetic mean of the grades of all deliverable, has a weight of 20% of the final grade.	20	CG3	CE27 CE28 CE29	CT1 CT3 CT9 CT10 CT17

Other comments on the Evaluation

On the lab sessions

If a lab session is missed, or if the log is not delivered before deadline, the grade for that deliverable would be 0.0. The student will be responsible for notifying the reason of absence before the publication of the session grades. It is up to the lecturer to decide whether the provided reason constitutes proper justification.

In case one session is missed, and it is properly justified, the final lab grade will be computed using the remaining grades. If more than one session is missed, and all are properly justified, the student will be given de opportunity to carry out the lab work on another date, or, alternatively, deliver an essay that covers the contents of the relevant lab work.

A minimum grade of 4,0 points over 10 is required in the lab sessions to pass the course.

Final grade and requirements to pass the course in continuous evaluation

To ensure that the student acquires the skills specified in the course plan a minimum grade is required in the following sections:

- 4,0 points over 10 in the final exam grade, and
- 4,0 points over 10 in the lab sessions grade.

The student will pass the course if, having complied with the requirements above, the calculation of the continuous evaluation grade (CEG) is equal or higher than 5,0 points over 10. Failing to comply with the requirements, the CEG cannot be greater than 4,0. If a student does no pass the course in the continuous evaluation modality, he/she will have to attend the regular exam. Students may decide to attend the regular exam to improve their grade.

Regular exam

The regular examination grade (REG) uses the same weights as in continuous evaluation: 80% for the theory and 20% for lab sessions.

It will consist of a single written exam, that will cover all the course curriculum, both theory and practical. The exam will have a duration of 3 hours, and can take the form of a multiple-choice test, a short answers test, a problem exam, or a combination of the former.

The student will pass the course if the REG is equal or greater than 5,0 points over 10. The student that fails the regular exam has to attend the make-up exam.

First call grade

The grade of the first call is calculated as the maximum of the continuous evaluation grade (CEG) and the regular examination grade (REG)

Second call grade (Make-up exam)

A make-up exam is offered for those that have not reached the course requirements in the first call. The format and requirements are the same than those of the regular exam.

Ethical commitment: The Center is both a military academy and a university center, and the student must therefore comply with the obligations imposed by both institutions.

As a university student, he/she must "abstain of the use of fraudulent means, or cooperation with, in any examination, deliverable, or official document from/to the university" as stated in the Statute of the University Student ("Estatuto del Estudiante Universitario"), approved by the Royal decree 1791/2010 of 30 December, in article 12, point 2nd.

As a military student, he/she "will fulfill with accuracy his duties and obligations promoted by a feeling of honor, [...]" as stated in the Military Career Law ("Ley de la Carrera Militar"), in its fifteenth rule.

If an unethical behavior is detected (either copy, plagiarism, use of unauthorized electronic devices, or any other mean) in any examination or deliverable, during continuous evaluation, all the students involved in the deed will be awarded a 0.0 grade in that test (either theoretical or practical). If unethical behavior is detected in a regular or make-up exam, the students involved in the deed will be awarded a 0.0 grade in said call.

Sources of information

Basic Bibliography

Hernando Rábanos, José María, **Transmisión por radio**, 6ª, Centro de Estudios Ramón Areces, 2008

Arias Acuña, Alberto Marcos; Rubiños López, José Oscar, **Radiocomunicación**, Andavira, 2011

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Complementary Bibliography

Balanis, Constantine A., **Antenna Theory. Analysis and Design**, 4ª, John Wiley & Sons, 2016

Griffiths, John, **Radio wave propagation and antennas: an introduction**, Prentice Hall, 1987

Couch, Leon W., **Digital & analog communication systems**, 8ª, Pearson Education, 2013
Burillo Martínez, Vicente [et. al., **Comunicaciones analógicas y digitales Vol. I**, 1ª, UPM, Dpto. Ing. Sistemas Telem., 1991
Kim, John C.; Muehldorf, Eugene I., **Naval shipboard communications systems**, 1ª, Prentice Hall, 1995

Recommendations

Subjects that it is recommended to have taken before

Fundamentals of electrical engineering/P52G381V01205
Mathematics: Calculus II and differential equations/P52G381V01201
Electronic technology/P52G381V01301

IDENTIFYING DATA				
Naval engines and machines				
Subject	Naval engines and machines			
Code	P52G381V01409			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Pérez Collazo, Carlos			
Lecturers	Álvarez Feijoo, Miguel Ángel Pérez Collazo, Carlos			
E-mail	carlos.perez.collazo@cud.uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	This learning guide presents the information relative to the subject of Naval Engines and Machines of the 4th course of the Bachelor Degree in Mechanical Engineering. The guide collects the skills that the students have to acquire in this course, the calendar of planned educational activities, the contents and their temporal programme, an estimation of the student's volume of work and the specific criteria of evaluation. Naval Engines and Machines will cover the propulsion and auxiliary systems that can be find in the Navy ships. Besides, combustion engines thermal cycles will be studied, mainly Otto and Diesel; then Marine Diesel engines will be covered in a deeper way, studying the parts of the engines in existent engines in the laboratory, observing material and manufacturing processes of the different parts, realising the multidisciplinary aim of the subject. This subject of the Bachelor Degree in Mechanical Engineering showcases to the student the main types of naval engines, the configurations of the control and propulsion systems, and the auxiliary systems of heat pumps, water and waste treatment, etc.			

Skills	
Code	
CG3	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.
CG4	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.
CG5	Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
CG6	Capacity for handling specifications, regulations and mandatory standards.
CG7	Ability to analyze and assess the social and environmental impact of the technical solutions.
CE35	CITN9/OPT5 Applied knowledge of energy systems and naval propulsion.
CE36	CITN10/OPT6 Knowledge of naval equipment and naval auxiliary systems.
CE37	CITN11/OPT7 Applied knowledge of naval electrical systems.
CT1	Analysis and synthesis
CT2	Problems resolution.
CT3	Oral and written proficiency
CT5	Information Management.
CT7	Ability to organize and plan.
CT8	Decision making.
CT9	Apply knowledge.
CT10	Self learning and work.
CT15	Objectification, identification and organization.
CT16	Critical thinking.
CT17	Working as a team.
CT20	Ability to communicate with people not expert in the field.

Learning outcomes	
Learning outcomes	Competences

Get to know the technological base that supports internal combustion engines.	CG3 CG4 CG5	CE35 CE36	CT3 CT5 CT7 CT8 CT9 CT10 CT15 CT17 CT20
Get to know and understand the operation of a propulsion plant of the Navy Vessels.	CG3 CG4	CE35 CE36 CE37	CT1 CT2 CT3 CT5 CT7 CT9 CT10 CT15 CT17 CT20
Get to know the main auxiliary systems that support the propeller plants on Navy vessels.	CG3 CG4 CG6 CG7	CE35 CE36 CE37	CT1 CT2 CT3 CT5 CT7 CT9 CT10 CT15 CT16 CT17 CT20
ENAEE learning outcomes: KNOWLEDGE AND UNDERSTANDING: LO1.3 - Be aware of the multidisciplinary context of the engineering. [Level of development (basic (1), intermediate (2) and advanced (3)) of this sub-result: intermediate (2)].		CE35 CE36 CE37	
ENAEE learning outcomes: ANALYSIS IN ENGINEERING: LO2.2.- The capacity to identify, formulate and resolve problems of engineering in his speciality; choose and apply of suitable form analytical methods, of calculation and experimental already established; recognise the importance of the social restrictions, of health and security, environmental, economic and industrial. [Level of development (basic (1), intermediate (2) and advanced (3)) of this sub-result: Intermediate (2)].	CG4		CT1 CT2 CT8 CT9 CT16
ENAEE learning outcomes: PRACTICAL APPLICATION OF THE ENGINEERING: LO5.3.- Knowledge of application of materials, equipment and tools, technology and processes of engineering and its limitations in the field of its speciality. Level of development (basic (1), intermediate (2) and advanced (3)) of this sub-result: Intermediate (2)].		CE35 CE36 CE37	CT8 CT9
ENAEE learning outcomes: PRACTICAL APPLICATION OF THE ENGINEERING: LO5.5.- Knowledge of the social implications, of health and safety, environmental, economic and industrial practice of the engineering. [Level of development (basic (1), intermediate (2) and advanced (3)) of this sub-result: Intermediate (2)].	CG7		

Contents	
Topic	
Block 1: Engines of internal combustion.	T1.1. Review of thermal engines. T1.2. Diesel engines. - Classification of the diesel engines. - 2 and 4 strokes diesel engines. - Diagrams. - Otto-Diesel comparative. T1.3. Main components of marine diesel engines. T1.4. Refrigeration and lubrication systems. T1.5. Fuel injection system. T1.6. Marine gas turbines.

Block 2: Current marine propulsion systems.	T2.1. Introduction to marine propulsion systems. - Classification of the marine propulsion systems. - Types of propellers. - Cavitation. - The MARPOL agreement and the emissions reduction commitments. - Future trends in marine propulsion systems. T2.2. Combined propulsion systems. - CODAD. - CODOG/CODAG. - COGAG. - CODEOG. T2.3. Electrical propulsion systems. T2.4. Azipodal propulsion. T2.5. Nuclear propulsion and propulsion in submarines. T2.6. Vessel electrical systems. - Electrical power plant of an F-100. - Integrated control platform system(SICP). - General diagram of the electrical power plant of an F-100 and working modes. T2.7. Propulsion plant support systems. - Centrifugal treatment systems. - Fresh and salt water cooling systems. - Refrigeration systems for vessels.
Block 3: Auxiliary systems.	T3.1. Data acquisition systems. - Temperature, pressure and flow. - Level and angular velocity. T3.2. Marine air compressors. T3.3. Heat exchangers. T3.4. Marine pumping systems. - Continuous flow and positive displacement pumps. T3.5: Water discharge systems. - Vacuum faecal plants. - Faecal water treatment. - Decantation and electrolytic cell treatment plants. - Separation of bilges by decantation. - Coalescent bilge separator. T3.8. Vessel steering and stabilisation systems. - Electrohydraulic power transmission systems. - Electrohydraulic rudder servomotor. - Electromechanical power transmission. - Electromechanical rudder servomotor. - Basics of stabiliser fins. - Anti-balance tanks. - Gyro-stabilisers. - Stabiliser rudders.
PL1: Combustion engines.	Study of the operation of combustion engines.
PL2: Diesel engines.	Study of the operation of marine diesel engines.
PL3: 2-stroke engines.	Study and analysis of the operation of 2-stroke engines. For this, students will work in groups disassembling 2-stroke engines with the available tools.
PL4: 4-stroke engines.	Study and analysis of the operation of 4-stroke engines. For this, students will work in groups disassembling 4-stroke engines with the available tools.
PL5: Gas turbines.	Parametric study and operation of gas turbines.
PL6: Vessel electrical systems.	Study and analysis of the configuration and operation of the electrical installation in military vessels, as well as the process to connect and disconnect them to an onshore power supply.
PL7: Vessel auxiliary systems.	Parametric study and operation of various auxiliary systems in vessels.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	28	56
Laboratory practical	14	14	28
Project based learning	5	19	24
Problem solving	2	0	2
Seminars	15	9	24

Essay questions exam	16	0	16

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

Methodologies

	Description
Lecturing	The lecturer presents the fundamental contents of the matter object of study, on a theoretical basis and/or the guidelines for a personal work, exercise or project to develop by the student.
Laboratory practical	Activities of application of the knowledge to concrete situations and of acquisition of basic skills and procedures related with the matter object of study. To be developed in special spaces with specialised equipment (laboratories, computer classrooms, etc.).
Project based learning	Method in which the students develop a project over a fix period to resolve a problem or tackle a task by means of the planning, design and completion of a series of activities.
Problem solving	Activity in which problems and/or exercises related with the subject are proposed. The student has to develop the suitable or correct solutions by means of the application of routines, equations or algorithms, the application of procedures of transformation of the available information and the interpretation of the results. To be used as suport of lectures.
Seminars	Intensive course of 15 hours for those students who did not pass the subject in the ordinary announcement, previous to the examination in second announcement. These will involve group tutorials with the lecturer.

Personalized assistance

Methodologies	Description
Lecturing	The tutorial action distinguishes actions of academic attention as well as personalised attention. In the first one, students will have available attention hours in which they can ask any question related with the contents, organisation and planning of the subject. In the personalised attention, each student, in an individual way, would be able to comment with the lecturer any problem that may prevents him to make a suitable follow-up of the subject, aiming to find between both some type of solution. Bringing together both types of attention, aims to compensate the different learning rhythms by means of the attention to the diversity. The lecturers of the subject will answer the questions and queries of the students in a synchronous form in physical or virtual offices under the modality of a previous appointment or asynchronous by online means (email, forums of MOOVI, etc.).

Assessment

	Description	Qualification	Evaluated Competencess		
Lecturing	Written assessments: theoretical questions and problems. The written assessments have the aim of evaluating the learning of all the theoretical contents of the subject. These must consist in questions where conceptual and logical reasoning should prevail, to verify the intellectual maturity of the students by obtaining conclusions from the notions or the exposed theories in class.	25	CG3 CG4 CG5 CG6 CG7	CE35 CE36 CE37	CT1 CT2 CT7 CT9 CT15 CT16
Laboratory practical	The evaluation of the labs will involve laboratory reports (MP) which the student will have to submit.	10	CG3 CG4 CG5 CG6 CG7	CE35 CE36 CE37	CT1 CT2 CT3 CT7 CT9 CT10 CT15 CT16 CT17 CT20
Project based learning	The project will consist in a work in groups of students. This will be evaluated in a way that individual work is assessed, together with the positive independence (i.e., each member of the group should have to had participated and collaborated to the final version of the project).	25	CG3 CG4 CG5 CG6	CE35 CE36 CE37	CT3 CT5 CT7 CT8 CT9 CT10 CT15 CT16 CT17 CT20

Essay questions exam	Final assessment of the continuous evaluation (assess all the contents of the matter).	40	CG3 CG4 CG7	CE35 CE36 CE37	CT1 CT2 CT7 CT9 CT15 CT16

Other comments on the Evaluation

The final assessment will have to the following characteristic. In the first place, it has to be complete, that is to say, will cover all given matter, since it judges what the student knows of a subject, no of a single part of it. Second, it has to contain problems and questions, to verify the intellectual maturity of the students to obtain conclusions from the notions and exposed theories in class. In third place, has to provide a greater weight to that part of the matter that has not been already evaluated in the previous continuous evaluation. In fourth place, the assessment will consist on two different parts, one covering the contents of Parts (1, 2 and 3) and the second one for Parts (4, 5 and 6). It will be carried out during the assessment week and will be marked over 10 points.

The interim assessments (2) aims to better follow the matter by the student, and in these part of the contents will be assessed. Each one of the interim assessments will have a proportional weight (12,5%).
The project based learning will be carried out in groups of students, and will represent the 25% of the final mark. The project will have to be evaluated so that it guarantees the individual requirements and a positive independence, this means that all the members of the group have to have worked and contributed to the final product and have to dominate, up to a minimum, all the aspects of the project. All have to show, therefore, a deep knowledge of the product delivered, independently of the part in which they had centred their efforts.

The evaluation of the labs will be carried out by means of reports, where the knowledge acquired by the students during the laboratory classes will be assessed. This will represent the 10% of the total mark.

The overall final mark of the student will represent the sum of the marks awarded to each one of the before commented parts, being the continuous evaluation mark (NEC). To pass the matter by Continuous Evaluation, the final mark (NEC) will have to be greater or the same to 5, and will be calculated in the following way:
NEC = 0,40*PF + 0,25*PI + 0,25*EBP + 0,10*MP
If the NEC is lower than 5, the student will have to go to the ordinary examination of all the contents of the subject, that will represent 100% of the mark. Besides, the student will have to go to the ordinary examination in the following assumptions:

- The no realisation or delivery of any of the previous interim assessments.
- To obtain a lower mark to 4 over 10 in any one of the two parts of the final written assessment of the continuous evaluation.

In any one of these assumptions, the mark of continuous evaluation will be calculated as:

NEC FINAL = min (4, NEC)

Furthermore, all those students that wish to improve their mark obtained at the continuous evaluation will be able to attend the ordinary examination.

In both, the ordinary call as well as in the extraordinary (July call) all the competencies of the subject will be assessed.

ETHICAL COMMITMENT:

It is expected that students will follow a suitable ethical behaviour. If it is detected the minimum little ethical misbehaviour (cheating, plagiarism, use of unauthorised electronic devices or others) the student will be penalised with the impossibility to pass the subject by the modality of continuous evaluation (in which it will obtain a mark of 0.0). If this type of behaviour is detected during an ordinary or extraordinary assessment, the student will obtain in such call a mark of 0,0.

Sources of information

Basic Bibliography

Muñoz M. y Payri F., **Motores de combustión interna alternativos**, Reverté, 2011

Monografías ENM, **Introducción a las turbinas de gas marinas**,

Monografías ENM, **Principios básicos de las turbinas de gas navales**,

Casanova Rivas, E., **Máquinas para la propulsión de buques**, Servicio de publicaciones de la Universidade da Co, 2001

Manzarredo Beutel, L., **Evolución de la propulsión naval mecánica**, Fondo editorial de ingeniería naval, 1992

Delgado Lallemand, L., **De proa a popa. Tomo 2: Equipos del barco**, Thomson, 2007

Monografías ENM, **Aparatos y servicios auxiliares**,

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Heywood J.B., **Internal Combustion Engine Fundamentals**, McGraw Hill, 1988
Cengel B., **Termodinámica**, McGraw Hill, 2012
Morán, M.J. y Shapiro, H.M., **Fundamentos de Termodinámica Técnica**, Reverté, 1999
Muñoz, M. y Payri, F., **Motores de combustión interna alternativos.**, Servicio de Publicaciones de la UP Valencia, 1984
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Haywood, R.W., **Ciclos termodinámicos de potencia y refrigeración**, Limusa, 2000
Segura J., **Termodinámica Técnica**, Reverté, 1998
Basshuysen, R., **Internal Combustion Engine Handbook**, SAE Internacional, 2004
Mollenhauer, K. y Tschöke, H., **Handbook of Diesel Engines**, Springer, 2010
OMI, **Convenio internacional para prevenir la contaminación por los buques (MARPOL)**, 1978

Recommendations

Subjects that it is recommended to have taken before

Thermodynamics and heat transfer/P52G381V01203
Thermal engineering I/P52G381V01403

Other comments

The subject Machines and Naval Engines constitutes the culmination of the studies of thermal and energetic systems already initiated in Thermodynamics and Heat Transfer, and continued in Thermal Engineering I. This discipline requires of a necessary conceptual base for its correct understanding.
Besides, the student has to possess:
- Capacity of written and oral understanding very developed.
- Capacity of abstraction, basic calculation and synthesis of the information.
- Skills for group work and for public speaking.

IDENTIFYING DATA				
Basics of topography				
Subject	Basics of topography			
Code	P52G381V01410			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Puente Luna, Iván			
Lecturers	Puente Luna, Iván			
E-mail	ipuente@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The course of Basics of Topography is composed of a total of seven units (theoretical teaching) that are complemented with practical classes. Depending on the objectives of the units, this course is divided into two different sections: - Section I: Topography. Composed of four units including basics aspects of topography, preparation of plans and their application to land works. - Section II. Other geomatic techniques. Composed of three units, including complementary techniques most commonly used for the recognition and representation of the terrain.			

Skills	
Code	
CG3	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.
CG4	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.
CG5	Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
CE42	CITN16/OPT12 The level of topographic skills to trace and follow trails over unknown terrain
CE43	CITN17/OPT13 Acquire knowledge of topography and its application to the representation of the land and works.
CT2	Problems resolution.
CT3	Oral and written proficiency
CT7	Ability to organize and plan.
CT8	Decision making.
CT9	Apply knowledge.
CT10	Self learning and work.
CT17	Working as a team.
CT20	Ability to communicate with people not expert in the field.

Learning outcomes	Competences		
To know the technological base on which the topography and elaboration of plans are based.	CG3 CG4 CG5	CE42 CE43	CT2 CT3 CT7 CT8 CT9 CT10 CT17 CT20
To understand the basic aspects of the application of Topography to land works.	CG3 CG4	CE42 CE43	CT2 CT9
To know other complementary geomatic techniques for the recognition and representation of the land.	CG3 CG4 CG5	CE42 CE43	CT2 CT3 CT7 CT8 CT9 CT10

ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	CG3		
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)].	CG4		CT2 CT8 CT9
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 [Intermediate (2)].			CT9
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 [Intermediate (2)].	CG4 CG5		CT2 CT9
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 [Intermediate (2)].		CE42 CE43	CT8 CT9
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 [Intermediate (2)].	CG4		CT3 CT20
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)].			CT7 CT8 CT10 CT17

Contents

Topic	
Unit 1. Introduction to Topography. Objectives: to update and review the concepts acquired by the students in the previous subjects of Topography within the specific military training. To consolidate a scientific knowledge of the basics of Topography.	1.1 Definitions. Relation of Topography with other sciences. Geodesy and Topography. Shape of the Earth: geoid and ellipsoid. Geodesic methods. Geodesic reference systems. Datum or fundamental astronomical point. Base and geodesic triangulation. Geodesy by satellite. Limit of a topographic survey. Influence of the Earth curvature in planimetry and altimetry. 1.2 Graphic representation systems. Projections. Orthogonal projection and system. Graphic representation of the terrain. Maps, charts and planes. Graphic and numerical scales. Triangulation, geodesic and topographic networks. 1.3 Cartography. Cartographic projections. Deformations and local scale. Classification of the projections. Mercator's Projection. UTM Projection. UTM grid. 1.4 Coordinates: Cartesian and polar coordinates. Geographic coordinates. Transformation of coordinates. Lines and distances. Concept of geodesic line. Angles and alignments. The terrestrial magnetic field. Magnetic declination. Magnetic and grid azimuths.
Unit 2. Instruments and systems used in Topography. Objectives: To identify and know the different instruments and systems commonly used in Topography. To acquire the necessary ability and skills for a basic management of real Topographic equipment to be used by the students during the practical sessions of the subject.	2.1 Topographic observations. Uncertainty and errors in Topography. General concepts of geometrical optics. Optical instruments. Prisms and lens. Telescopes. Topographic telescope. 2.2 Auxiliary Topographic elements: tripods, levels, platforms for levelling, plummets. Theodolites and tachymeters. Horizontal and vertical circles, vernier and micrometers. Goniometers. 2.3 Total Station. Operation of the Total Station. 2.4 Global Positioning System (GPS). Application of the GPS in geodesy and topography. 2.5 Units of measure: length, surface, angular units. Centesimal and sexagesimal systems. Transformation of units between systems. 2.6 Horizontal and vertical angles. Errors.
Unit 3. Topographic methods: planimetry and altimetry. Objectives: To know and apply the planimetric methods to properly represent a terrain into a flat surface. To know and apply the altimetric methods to properly represent the altitude and morphology of a terrain.	3.1 Planimetric methods. Method of abscissas and ordinates to an unique axis. Method of decomposition in triangles. Method of alignments. Method of radiation. Itinerary or poligonation. Method of intersections: direct and inverse intersection, mixed intersection, graphic and numerical solutions. 3.2 Altimetric methods. Levels and telescopic sights: description. Comparison plane: heights, differences of level and altitude. Trigonometric levelling. Geometrical levelling. 3.3 Digital Model of the Terrain (MDT). Contour lines. 3.4 Interpretation of planes. Visibility between two points in the terrain.

Unit 4. Applications of the Topography. Objectives: To be able to apply the theoretical and practical contents of the topography for the realisation of the different topographic works and its applications on construction as well as in other fields.	4.1 Topographic, cadastral and urban surveys. Topography in mining and tunnelling. Surveying for engineering projects. Design of a topographic project. 4.2 Profiles: longitudinal and transversal. Land movement: slope and land clearing. Civil work. Construction stakeout surveys. 4.3 Defensive organisation of the terrain. Construction of tracks and forest paths.
Unit 5. Introduction to Geomatic. Objectives: To know the different geomatic techniques for cartographic production.	5.1 Definition and fundamentals of the geomatic as source of data for cartographic production. 5.2 Introduction to long-range systems: spatial remote sensing. Landsat and Spot sensors. 5.3 Introduction to close-range systems: photogrammetry and LiDAR technology (aerial and terrestrial systems). 5.4 Introduction to the geophysical prospection: georadar and acoustic (sonar). Bathymetries.
Unit 6. Geographic Information Systems (GIS). Objectives: To know and apply the fundamentals of Geographic Information Systems, as well as the management of large amounts of cartographic and geographic data in different formats.	6.1 Concept of Geographic Information System (GIS). Differences between GIS, database and CAD. 6.2 Concepts about geographic and spatial information: data and metadata. Raster and vectorial models. Geoprocessing. Digitization and georeferencing of data. 6.3 Main applications of GIS for the management and planning of the territory. Military GIS. 6.4 Phases of a GIS project. Basic concepts of Thematic Cartography. 6.5 Cartographic data sources. Web GIS and Spatial Data Infrastructure (SDI).
Unit 7. Photogrammetry and its applications. Objectives: To know the techniques of the photogrammetry and its applications, both in civil and military fields. To understand the importance of the photogrammetry as a tool to produce maps and plans, as well as its utility for georeferencing a territory.	7.1 Aerial photogrammetry and its applications. The photography as a conical perspective. Types of aerial photographs. Aerial photography and plane: comparison. Photogrammetry. Generalities and definitions. Applications. The problem of the photogrammetry. Perspective beams. The aerial and the metric cameras. Internal data of the projective beams. Identification of homologous rays. External data of the projective beams. Control points. Intersection of homologous rays. Photogrammetric restitution. Accuracy of photogrammetric surveys. 7.2 The orthophoto. Close-range photogrammetry. Instruments and data acquisition: cameras. Measuring instruments. Methods. Applications: industrial photogrammetry, photogrammetry applied to civil engineering and architecture.
Practical Activity 1. First contact with topographic instrumentation.	Total Station and the measurement of areas.
Practical Activity 2. Planning a topographic survey in the field and design of a closed itinerary.	Method of itinerary in the field.
Practical Activity 3. Method of radiation in the field.	Acquisition of strategic and filling points.
Practical Activity 4. Elaboration of the point cloud and calculation of coordinates.	Generation of planimetry.
Practical Activity 5. MDT. Contour lines. Longitudinal and transversal profiles.	Generation of altimetry.
Practical Activity 6. Development of a GIS case study.	Geoprocessing and Thematic Cartography.
Practical Activity 7. Session dedicated to the presentation of the final projects.	Evaluation of the field project regarding the elaboration of a topographic survey.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	35	63
Field practice	6	6	12
Problem solving	7	7	14
Practices through ICT	4	4	8
Seminars	15	16	31
Project based learning	4	4	8
Essay questions exam	14	0	14
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Lecturing	The lecturer will expose in the theoretical classes the contents of the subject. The presentations will be screened and the blackboard will be simultaneously used, as well as to the sporadically use of computerized systems. The student will have copies of the material projected, to facilitate them for taking notes and follow-up the sessions. The students will be able to consult basic bibliography for the follow-up of the subject. The participation will be encouraged through questions, motivational techniques such as intentional errors, incomplete solutions, etc.
Field practice	During the field sessions, the student will use topographic instrumentation in groups of 3-4, in order to learn the process of data acquisition. The students have to deliver, individually or as a group according to previous indication by the lecturer, the resolution of some practical case studies proposed at the end of each session. The lecturer will evaluate both the deliver of the proposed exercise as well as the results presented. If the report is delivered blank with the name of the student, it will be failed (0,0). If the report is a plagiarism of another one, the evaluation for all the practical section (outdoor study and Project) will be failed (0,0). These deliveries will serve to evaluate the phase of development of a topographic survey and data processing in the final Project. The lecturer will establish the deadline for each deliver at the end of the sessions, although it should not be extended more than two weeks from their realization.
Problem solving	The lecturer will propose activities to solve exercises related to the contents explained in the theoretical sessions, following a learning methodology based on problems.
Practices through ICT	The practical sessions in the computer room will be carried out using the means available in the center. For some sessions, Topocal software will be necessary to manage different tools for the generation of plans and other concepts explained in the theoretical sessions, and AutoCAD software will be needed for the edition of plans. The software gvSIG will be also used for the geospatial analysis of geographic data, as well as for the elaboration of thematic cartography.
Seminars	Intensive course (15 hours) for those students who have failed the subject at first call, prior to the exam in second call. Group tutoring with the lecturer.
Project based learning	The students have to submit, at the end of the semester, a final Project. This Project must include all the practical procedures carried out during the outdoor study in order to perform a topographic survey, the data processing in laboratory and the elaboration of the planimetric and altimetric planes. The Project will be carried out in group (3-4 students) and the results will be presented in both forms: (1) a Project report and (2) a public presentation to the lecturer and the rest of the students in the subject. The lecturer will evaluate both the content on the report and the quality in the presentation. All the students have to participate in the public presentation. Otherwise, the project assessment will be failed (0,0).

Personalized assistance

Methodologies	Description
Problem solving	The lecturer will solve the questions of the students both in person, according to the tutoring schedule published on the web page of the CUD, as well as through telematic means (email, videoconference, MooVi forums, etc.) with previous appointment.
Project based learning	The lecturer will solve the questions of the students both in person, according to the tutoring schedule published on the web page of the CUD, as well as through telematic means (email, videoconference, MooVi forums, etc.) with previous appointment.
Seminars	Group tutoring with the lecturer, either personally or through telematic means.

Assessment

	Description	Qualification	Evaluated Competencess		
Lecturing	A mid-term exam, in a continuous assessment, to evaluate the knowledge acquired by the students in the theoretical sessions of initiation to the topography and topographic surveys.	15	CG3 CG4	CE42 CE43	CT2 CT8 CT9
Problem solving	Practical tests of laboratory/seminar to evaluate the resolution of exercises or case studies and the implementation of the theoretical knowledge acquired.	15	CG3 CG4 CG5	CE42 CE43	CT2 CT7 CT9 CT10
Project based learning	Project evaluation. The development of the project is evaluated, as well as the final report delivered, results and quality of the public presentation.	30	CG3 CG4 CG5	CE43	CT2 CT3 CT7 CT8 CT9 CT17 CT20

Essay questions exam	A final exam, in a continuous assessment, covering all the contents of the subject.	40	CG3 CG4	CE42 CE43	CT2 CT8 CT9

Other comments on the Evaluation

A numerical rating system with values from 0.0 to 10.0 points will be used according to current legislation (R.D. 1125/2003 of September 5, B.O.E. No. 224 of September 18). The subject will be considered passed when the student achieves a minimum qualification of 5.0 points.

The evaluation techniques of the subject will be:

- Final exam in continuous assessment (up to 40% of the total qualification): a final exam will be carried out covering all the contents of the subject, both theoretical and practical. It is required to achieve a minimum score of 4.0 points over 10 possible to pass the subject. The action of cheating in an exam will be penalized, and the student will be qualified in this component with 0.0 (failed).
- Mid-term test in continuous assessment (up to 15% of the total qualification): An evaluation test will be carried out throughout the semester. The test will be carried out, proposed by the lecturer, at the most appropriate times within the theory classes of the subject. This test will be mandatory and required to pass the subject. The action of cheating in an exam will be penalized, and the student will be qualified in this component with 0.0 (failed).
- Individual work based on a GIS case study (up to 15% of the total qualification): The students, individually, have to present a work based on a practical case study to be solved with GIS tools, including: purpose of the analysis, input data, analysis tools and / or geoprocessing, the results obtained and the thematic cartography elaborated.
- Development of a project (up to 30% of the total qualification): During the semester, the students have to develop a topographic survey in groups of 3-4 students. At the end of the semester, the students have to present the project in a public presentation. The presentation will be planned on the day and time previously communicated to the students and with the evaluation criteria previously indicated by the lecturer (evaluation rubric). All the students have to participate in the public presentation. Otherwise, the Project qualification will be 0.0 (failed).

Regarding the evaluation criteria and qualification of the project-based learning, the total score of the activity (30%) will be the sum of the following partial evaluations: project development (10%), content of the project report (10%) and contents and quality of the presentation (10%). In the project development, the delivery of the partial results of the project, which are obtained after each field session, will be taken into account. Both the delivery of documents and the calculation procedures and the correct resolution will be assessed. The deliveries have to be presented on time (except for properly justified reasons). Otherwise, the student will be qualified in this component with 0.0. The final qualification of this component will be reduced depending on the number of deliveries not presented on time.Those students who have not reached the minimum score in any of the qualifying tests in continuous assessment will obtain a maximum score of 4.5 in continuous evaluation.
All the students who have not passed the subject during the continuous evaluation will have the right to recover the subject in an ordinary call. Those students who wish to raise their score in continuous assessment may present this ordinary call, in which case the final exam will constitute 100% of the final score, being necessary to reach a minimum of 5.0 points to pass the subject. It is understood that the score obtained in the ordinary exam substitutes, if higher, the one obtained in the continuous evaluation.
Similarly, all the students who have not passed the subject during the first call will have the right to recover the subject in an extraordinary exam (second call). This exam will constitute 100% of the final score, being necessary to reach a minimum of 5.0 points to pass the subject.
The action of cheating in an exam will be penalized, and the student will be qualified in this component with 0.0 (failed).

Sources of information

Basic Bibliography

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Recommendations

Subjects that continue the syllabus

Technical Office/P52G381V01501

Subjects that it is recommended to have taken before

Graphic engineering/P52G381V01304

Other comments

In order to successfully pass the subject, the student must consider the following recommendations:
1. A regular and active attendance to classes, both theoretical and practical.
2. To maintain a minimum daily study.

It is recommended that the student of the subject Basics of Topography have completed and passed previous subjects of design and spatial vision such as Graphic Expression and Graphic Engineering.
For the correct development of the theoretical classes, as well as laboratory and seminars sessions, it is recommended to have the basic calculation tools.

IDENTIFYING DATA				
Technical Office				
Subject	Technical Office			
Code	P52G381V01501			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	5th	1st
Teaching language	Spanish			
Department				
Coordinator	Núñez Nieto, Xavier			
Lecturers	Núñez Nieto, Xavier Rodríguez Rodríguez, Francisco Javier			
E-mail	xnnieto@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This course, common to the industrial branch, pursues to orient the student in the acquisition of the knowledge and the skills that enable them for the handle and application of methodologies and technical tools, regarding with the organisation and management of engineering projects and another technical documentation of usual use in a Technical Office. To achieve this mentioned aims there are applied a wide approach of the units composing the course, looking for the integration of the knowledge adquired along the degree and its application by means of a methodology, organisation and management of distinct modalities of technical works, as true essence of the profession of engineer, in the frame of his attributions and fields of activity. It promotes the development of the competences of the matter by means of active and technical methodologies of collaboration. In this way, the exposed contents in theoretical classes implement in the development of the practical activities, oriented to the industrial reality of the profession, assimilating the agile and precise employment of the distinct rule of application and of the professional best practices established, supporting in the new technologies to document, elaborate, manage and present the technical documentation that correspond.			

Skills	
Code	
CG1	Skills for writing, signing and developing projects in the field of industrial engineering, whose purpose is, specializing in Mechanics, according to the knowledge acquired pursuant to paragraph 5 of this order, construction, alteration, repair, maintenance, demolition, manufacturing, installation, assembly or operation of: structures, mechanical equipments, energy facilities, electrical systems and electronic installations and industrial plants, and manufacturing processes and automation.
CG2	Ability to manage the activities object of the engineering projects described in CG1.
CE18	Knowledge and skills to organize and manage projects. To know the organizational structure and functions of a project office.
CT2	Problems resolution.
CT3	Oral and written proficiency
CT5	Information Management.
CT7	Ability to organize and plan.
CT8	Decision making.
CT9	Apply knowledge.
CT10	Self learning and work.
CT12	Research skills.
CT14	Creativity.
CT15	Objectification, identification and organization.
CT17	Working as a team.
CT20	Ability to communicate with people not expert in the field.

Learning outcomes	Competences		
Manage of methods, technics and tools of design, organisation and management of projects	CG1 CG2	CE18	CT3 CT5 CT7 CT8 CT9 CT14 CT15 CT17 CT20

Ability in the handle of information an communication systems in the industrial field.	CG1 CG2	CE18	CT3 CT5 CT7 CT8 CT9 CT10 CT14 CT15 CT17 CT20
Ability to generate the documents of the project and other similar technical documents.	CG1		CT3 CT5 CT20
Ability in the facultative direction of projects in the field of the industrial engineering.	CG2	CE18	CT5 CT7 CT8 CT17 CT20
Skills to communicate properly the knowledge, procedures, results of the field of the Industrial Engineering.	CG1		CT3 CT20
ENAEE LEARNING OUTCOME: KNOWLEDGE And UNDERSTANDING: LO1.3.- Awareness of the wider multidisciplinary context of engineering (Level of achievement: Intermediate (2)).		CE18	
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 (Level of achievement: Intermediate (2)).	CG1 CG2		CT2 CT8 CT9
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 (level of achievement: Intermediate (2)).			CT2 CT8 CT9 CT14
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 (level of achievement: Intermediate (2)).		CE18	CT2 CT7 CT9
ENAEE LEARNING OUTCOME: ENGINEERING DESIGN: LO3.2.- Ability to design using some awareness of the forefront of their engineering specialisation (level of achievement: Intermediate (2)).	CG1	CE18	CT7 CT9
ENAEE LEARNING OUTCOME: INVESTIGATIONS: LO.4.1.- 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 (level of achievement: Intermediate (2)).		CE18	CT5 CT12
ENAEE LEARNING OUTCOME: INVESTIGATIONS: LO4.2.- Ability to consult and apply codes of practice and safety regulations in their field of study (level of achievement: Intermediate (2)).		CE18	
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 (level of achievement: Intermediate (2)).		CE18	CT2 CT9 CT12 CT15
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 (level of achievement: Intermediate (2)).			CT8 CT9
ENAEE LEARNING OUTCOME: ENGINEERING PRACTICE: LO5.4.- Ability to apply norms of engineering practice in their field of study (level of achievement: Intermediate (2)).		CE18	CT9
ENAEE LEARNING OUTCOME: ENGINEERING PRACTICE: LO5.5.- Awareness of non-technical - societal, health and safety, environmental, economic and industrial - implications of engineering practice (level of achievement Intermediate (2)).		CE18	
ENAEE LEARNING OUTCOME: MAKING JUDGEMENTS: LO6.2.- Ability to manage complex technical or professional activities or projects in their field of study, taking responsibility for decision making (level of achievement: Intermediate (2)).	CG1 CG2	CE18	
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 (level of achievement: Intermediate (2)).	CG1		CT3 CT5 CT20

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 (level of achievement: Intermediate (2)).	CG1	CT3 CT5 CT7 CT8 CT10 CT17 CT20

Contents	
Topic	
Unit 1. The technical office	1.1 Concept of technical office 1.2 Functions and scope of work 1.3 Departmental infrastructure 1.4 Exercise of the engineer profession 1.5 Attributions and professional competences 1.6 Professional engineering associations
Unit 2. Stages of the project	2.1 Previous study 2.2 Preliminary engineering 2.3 Detail engineering 2.4 Material execution
Unit 3. Project management	3.1 Methodology 3.2 Organisation of the project 3.3 Planning procces 3.4 Management software
Unit 4. Documents of the project	4.1 Memory 4.2 Planes 4.3 Folder of Conditions 4.4 Budget 4.5 Own entity studies 4.6 Attachments
Unit 5. Transaction and contracting	5.1 Criteria and procedure rules 5.2 Licenses, authorizations and permits 5.3 Bidding and contracting
Unit 6. Facultative direction	6.1 Protagonists in the execution of a project 6.2 Functions of the facultative direction 6.3 Obligations and responsibilities
Unit 7. Legal framework	7.1 Legislative basis and scope of the project 7.2 Specifications and technical standards 7.3 Standardization, certification and homologation 7.4 Standardization and certification entities
Laboratory: Engineering Project	Description: During the laboratory sessions, the group development of a traditional Mechanical Engineering project will be carried out, applying the knowledge acquired during the theoretical sessions, which will cover the overall content of the whole subject. This project will include all the technical documentation associated with the elaboration of its content, namely: Memory, Plans, Folder of Conditions and Budget. Objectives: Analysis of the problem, situation, conditioning characteristics and feasibility study. Preparation of the technical documentation associated with the project, including descriptive memory, measurements and calculations. Handling, scaling, plotting and folding of planes. Study and elaboration of the technical, optional, economic and legal specifications. Estimate of the material execution budget. Inclusion, when appropriate, of the pertinent own entity studies regarding the project: Health and Safety, Occupational Hygiene and Environmental Impact Assessment. Exhibition and public oral defence of the projected work. Duration: The students will have the practical laboratory sessions, under the supervision of the teachers, to carry out the development of the project, which will culminate with its defense and oral presentation.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	28	56
Laboratory practical	12	24	36
Seminars	20	17	37
Practices through ICT	6	6	12
Objective questions exam	6	0	6
Project	2	0	2
Problem and/or exercise solving	1	0	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	Master class. Each thematic unit will be presented by the lecturer, complemented with the comments of the students with base in the bibliography assigned or another pertinent. In these sessions, there will be explained in detail the basic theoretical contents of the program, exposing explanatory examples from which deepen in the understanding of the subject. They will be used computer presentations and the blackboard, especially to transmit information like definitions, charts and so on. Whenever is possible, there will be provided a copy of the slides to the students before the exhibition, focusing the effort of the lecturer and the student on the exposure and understanding of the knowledge. Anyway, the reproductions in paper of the slides never have to be considered like substitutes of the texts or notes, but like complementary material.
Laboratory practical	It will be proposed a project of realisation in group that will cover the knowledge and the total length of the course. For the realisation of that task there will be employed the methodology of project-based learning. It will be provided the needed material for the realisation of the work. Finally there will be carried out a public exhibition of the project.
Seminars	An intensive review course will be held, aimed at students who fail to pass the subject in the first call.
Practices through ICT	There will be proposed exercises that will be solved in group or individually. By means of this methodology and the suitable software of project management, there will be carried out diverse activities, whose final result will suppose the whole planning process corresponding to a constructive project considering all its stages. There will be proposed several activities, using the appropriate software for project management, related to the planning process of an engineering project throughout its different stages.

Personalized assistance

Methodologies	Description
Seminars	The teaching staff of the subject will answer the doubts and queries of the students in a face to face and telematic way (email, videoconference, virtual forums, etc.), during the tutoring schedule available on the website of the center.

Assessment

	Description	Qualification	Evaluated Competencess		
Objective questions exam	There will be carried out two written exams with questions test type and/or of development on the theoretical sessions: One Intermediate Exam (PI) with an average weight of 20% on the grade of the course and a Final Exam (PF) with an average weight on the grade of the matter of 40%.	60	CG1	CE18	CT5 CT8 CT14 CT15
Project	Project report and defence by means of oral presentation.	30	CG1 CG2	CE18	CT2 CT3 CT5 CT7 CT8 CT9 CT10 CT12 CT14 CT15 CT17 CT20

Problem and/or exercise solving	Questionnaire that will cover all the sessions in this regard.	10	CG2	CE18	CT2 CT5 CT7 CT8 CT9 CT15 CT17

Other comments on the Evaluation

The final evaluation will be the sum of the punctuation awarded to each one of the before commented parts, being the Note of Final Continuous Evaluation (FCE):

FCE = 0,6 * THEORY + 0,3 * PROJECT + 0,1 * QUESTIONNAIRE

In addition to reaching a final qualification of at least 5 points on 10 (FCE ≥ 5), to surpass the matter by continuous evaluation there will be demanded some minimum requirements, that guarantee the balance between all the types of skills. These requirements are the following:

- To obtain a note of at least 4 points on 10 in the continuous evaluation final exam (PF).

In case of not surpassing the matter by continuous evaluation, the students will have to attend the ordinary examination of first call. Likewise, in the particular supposition of not to fulfil the minimum requirements established, the qualification of the continuous evaluation will be calculated as follows: FCE FINAL = min (4, FCE). On the other hand, the students that surpass the matter by continuous evaluation will be able to attend to the ordinary examination of first call to improve their qualification.

Both, in the ordinary examination of first call and the extraordinary (second call), will be evaluated all the skills of the course, including those referred to the theoretical sessions, practical, seminars and to the realisation of the group project.

The detection of academic fraud during the development of the continuous evaluation will suppose automatically the impossibility to surpass the matter by means of the mentioned modality and will imply a qualification of 0 points in that. The detection of academic fraud, either in ordinary announcement or extraordinary, will imply automatically a qualification of 0 points in both cases.

Sources of information

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Serer Figueroa, Marcos, **GESTIÓN INTEGRADA DE PROYECTOS**, Ediciones UPC, 3ª Edición, 2010

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Hervo, Corinne, **MICROSOFT OFFICE 2013: WORD, EXCEL POWERPOINT Y OUTLOOK 2013: FUNCIONES BÁSICAS**, Ediciones ENI, 1ª Edición, 2014

Leach, James A., **AUTOCAD 2016 INSTRUCTOR**, SDC Publications, 1ª Edición, 2016

Reyes Rodríguez, Antonio Manuel, **AUTOCAD 2016**, Anaya, 1ª Edición, 2015

Recommendations

Subjects that continue the syllabus

Final Year Dissertation/P52G381V01991

Subjects that it is recommended to have taken before

Graphic engineering/P52G381V01304

Other comments

For the successfull development of this subject it is recommended to possess a personal profile in which they are present the following qualities and skills:

- Capacity of written and oral understanding.
- Autonomous capacity for research and information compilation.
- Skills for the work in group.
- Basic notions related with the field of the design in the engineering, the calculation of installations and the industrial construction.

IDENTIFYING DATA				
Naval sensors				
Subject	Naval sensors			
Code	P52G381V01502			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	5th	1st
Teaching language	Spanish			
Department				
Coordinator	Núñez Ortuño, José María			
Lecturers	Nocelo López, Rubén Núñez Ortuño, José María			
E-mail	jnunez@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This subject gets framed into the Intensification in Naval Technology, and its goal is to provide the student with a theoretical and practical training over the basic operation of radar, sonar and optoelectronic sensors in naval and terrestrial environments. Along this subject, students learn the concept of naval sensor and will acknowledge the most usual sensors in their operative environment. The main concepts for all remote sensing system will be provided, so the student understand the multidisciplinary character of this subject, applying different knowledge from previous subjects, such as radiocommunication systems, electronic circuits and filters, automatic control, electrotechnics of physics (electromagnetic fields). It will be mainly focused on radar sensors, both continuous and pulsed wave systems, analysing the parameters that limit the radar range, the probability of detection and of false alarm, the concept of radar cross section, clutter, etc. We will also analyse the basic and most common techniques for radar signal processing, most of them used in other remote sensing systems (such as sonar), emphasizing the multidisciplinary nature of the subject. The student will be able to understand the proper acoustic characterisation of the underwater environment, and the propagation issues associated, such as noise and reverberation. The architecture and characterisation of the active and passive sonar systems will also be studied, along with their acoustics tranducers. Lastly, the optical spectrum and the classification of the existing emitting sources will be analysed, understanding the operation of the distinct types of optoelectronic sensors and their main characteristics.			

Skills	
Code	
CG3	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.
CE30	CITN5/OPT1 To understand the principles that govern the operation of communications systems and naval sensors.
CT1	Analysis and synthesis
CT2	Problems resolution.
CT5	Information Management.
CT8	Decision making.
CT9	Apply knowledge.
CT10	Self learning and work.
CT16	Critical thinking.

Learning outcomes			
Learning outcomes	Competences		
To know the technological basis supporting naval sensors.	CG3	CE30	CT1 CT5 CT10
To understand the basic operation of naval sensors.	CG3	CE30	CT1 CT2 CT8 CT9 CT10 CT16

ENAEE LEARNING OUTCOME: KNOWLEDGE AND UNDERSTANDING LO 1.2 Knowledge and understanding of the engineering disciplines of their specialty, at the proper level to acquire the rest of the competences of the degree, including notions of the latest advances. (level of development of this sub-learning outcome: Medium (2))	CG3	
ENAEE LEARNING OUTCOME: KNOWLEDGE AND UNDERSTANDING LO 1.3 Be aware of the multidisciplinary context of engineering. (Medium (2))	CE30	
ENAEE LEARNING OUTCOME: ENGINEERING ANALYSIS LO 2.2 Ability to identify, formulate and solve engineering problems within an specialty; choose and apply properly analytical methodologies; recognize the importance of social, health and safety, environmental, economic and industrial restrictions. (Medium (2))		CT1 CT2 CT8 CT9 CT16
ENAEE LEARNING OUTCOME: ENGINEERING PRACTICAL APPLICATION LO 5.15.1 Understanding the applicable techniques and methods for analysis, planning and research and their limitations in the field of their specialty. (Medium (2))		CT9
ENAEE LEARNING OUTCOME: ENGINEERING PRACTICAL APPLICATION LO 5.3 Application knowledge on materials, equipment and tools, technology and engineering processes and their limitations within the field of their specialty. (Medium (2))	CE30	CT8 CT9
ENAEE LEARNING OUTCOME: CONTINUOUS EDUCATION LO 8.1 Ability to realize the need for continuous training and undertake this activity throughout their professional life on their own. (Basic (1))		CT8 CT10

Contents

Topic	
Chapter 1. Introduction to Naval Sensors	1.1 Basic concepts of naval sensors. 1.2 Frequency bands. 1.3 Introduction to radar systems. 1.4 Fundamental parameters of radar systems: PRF/PRI, range resolution, angular resolution, maximum non-ambiguous range, time of observation, ... 1.5 Monostatic, bistatic and multistatic radar systems 1.6 Pulsed wave and continuous wave radar systems. 1.7 Radar cross section (RCS) and simplified radar range equation. 1.8 Simplified block diagram of a radar system.
Chapter 2. Pulsed wave radar systems	2.1 Introduction 2.2 Signal-to-noise ratio and probability of detection. 2.3 Pulse integration techniques. 2.4 Attenuation losses in radar range equation: 2.4.1 Fluctuating targets. 2.4.2 Propagation losses. 2.4.3 Atmospherical losses. 2.4.4 Interferences: clutter, jamming, ... 2.5 Radar Cross Section (RCS) and stealth technologies.
Chapter 3. Continuous wave radar systems	3.1 Introduction: 3.1.1 Doppler effect. 3.1.2 Pulsed wave (PW) radar vs. continuous wave (CW) radar systems. 3.2 CW radars modulated in frequency (CWFM). 3.2.1 With sawtooth modulation (CHIRP). 3.2.2 With triangular modulation. 3.3 Radar range equation for CW radar systems. 3.4 Advantages and disadvantages of CW radar systems.
Chapter 4. Digital signal processing	4.1 Pulse compression techniques. 4.1.1 Frequency pulse compression. 4.1.2 Phase pulse compression. 4.2 MTI systems and pulse-Doppler systems. 4.3 PRF Staggering
Chapter 5. Optoelectronical sensors	5.1 Optical spectrum. 5.2 Infrared sensors (thermal, medium-IR) 5.3 Night-vision sensors (near-IR). 5.4 Optoelectronic emitters: Laser vs. LED. 5.5 Optoelectronic sensors: photodetectors. 5.6 Other sensors and applications: laser telemeter, luxometer, etc.

Chapter 6. Acoustic sensors and sonar systems	6.1 Introduction. 6.2 Acoustic oceanography. 6.3 Underwater signal propagation. 6.4 Active and passive sonar systems. 6.5 Noise and reverberation.
Chapter 7. Specific purpose radar systems	7.1 Multifunction radars. 7.2 Secondary radar (IFF). 7.3 LPI radars. 7.4 Sinthetic aperture radars (SAR).
Lab session 1: Introduction to remote sensing and radar systems	The goal of this practice is introducing the basic concepts of remote sensing and radar systems analysed in the theoretical classes. By means of short Matlab scripts, the influence of each one of the parameters in the simplified radar range equation will be illustrated. The relationship between resolution and pulse spreading for a target conformed by several primary scatterers will be analysed. Students will be able to check whether some common techniques (such as pulse integration) effectively improve the probability of detection.
Lab session 2: Pulsed wave radars (PW radars)	This practice enhances the comprehension of the operative differences between PW and CW radars, as well as their different applications and limitations. Radar simulators will be used instead real radar systems, because, on the one hand, it is neither operative nor safe to activate several of such systems within a short range, and in the second hand, simulators allow to create different tactical scenarios which could not be possible in a real environment. An overview of radar cross section concepts explained in theory will also be analysed. The dependence on the geometry of the radar cross section and radar response will be studied.
Lab session 3: Movement detector radar	This practice describes a simple CW radar system works, by means of a movement sensor. The student will set up a basic CW radar system within the laboratory, where the ability of the student to handle instrumentation equipment will also be evaluated.
Lab session 4: Digital signal processing	The goal of this practice is to help the comprehension of the digital signal processing techniques used in radar systems nowadays. It will include: MTI systems, filter banks and pulse compression techniques.
Lab session 5: Optoelectronic devices	The goal of this practice is to get the student to know about optoelectronic sensors operating either in visible or in non-visible spectrum. They will learn to operate different optoelectronic equipment, such as thermal cameras, night-vision cameras, telemeters, □ They will also learn about the primary light-emitting devices, such as LEDs or LASER.
Lab session 6: Acoustic propagation	The goal of this session is to help the student visualise the mechanisms that play a role in underwater acoustic propagation. With the aid of a computer program, the student will simulate and observe how acoustic waves propagate in multilayered media. This will enable him to analyze the performance of SONAR systems under different conditions (e.g. warm waters vs. cold waters) and identify the opportunities where submarines can go undetected. Several types of SONAR systems will be analyzed, with their strengths and weaknesses.
Lab session 7: Echo sounder	The goal of this session is to help the student understand the operation of an ultrasonic echo sounder, and the underlying physical phenomena. The student will use a scale model comprising: a computer, a pulse-echo ultrasound system, a water tank, sand and rocks to simulate the seabed, and different objects as targets. With this low-scale sonar system, the student will learn the operation of this type of equipment, as well as the interpretation of the results. The student will analyze the limitations of the system, as well as various artifacts due to the mechanisms of acoustic propagation. The student will generalize the observed results to a real system, analyzing the potential problems (or advantages) that could arise.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Laboratory practical	14	7	21
Seminars	21	5	26
Problem and/or exercise solving	9	12	21
Problem and/or exercise solving	2	4	6
Objective questions exam	1	1	2
Essay	1	3	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	These sessions will be used to explain in detail the theoretical contents of the syllabus. Whiteboard and slides will be used as the basic methodology. Whenever slides are used, a copy in paper will be provided beforehand. However, slides should not be considered as a replacement for lectures, since they are only complementary material.
Laboratory practical	Lectures If necessary, a prior explanation of some particular concepts will be performed beforehand, in order to optimize the practical sessions. Laboratory practices: Students will be working in groups and the lecturer will take care of their work. The goal of these sessions is to strengthen the theoretical concepts studied in theoretical lectures. Practical sessions have a series of rules that the student must abide: - Practical sessions are compulsory and in-person classes. - Lost sessions cannot be recovered, unless justified absences.
Seminars	Some weekly hours will be dedicated to solve problems, where small groups will be encouraged. This section includes the intensive course designed for preparing the extraordinary exam.

Personalized assistance

Methodologies	Description
Seminars	Two types of tutorial actions might be distinguished: the academic tutoring and the personalized tutoring. In the academic tutoring, office hours will be at the student disposition where they can consult any doubt related with the contents, organisation and/or schedule of the subject. Tutorials can be individualized, encouraging group sessions for problem-solving hours. In the personalized tutoring, each student, individually, will be able to comment with the lecturer any problem with the subject, with the goal of finding a proper solution. Combining both types of tutorial actions, the different paces of learning will be attended through attention to diversity. Lecturers will properly assist the students through the learning process, both in-person and/or online formats (email, VTC, Moovi forums,...), and always under prior appointment.

Assessment

	Description	Qualification	Evaluated Competencess		
Problem and/or exercise solving	Midterm exam: It will evaluate 30% of the theoretical knowledge of the subject. Individual, of about approximately 1 hour. Over 10 points. Can have the form of test, short questions, problems or a combination of all of them. No minimum required.	30	CG3	CE30	CT1 CT2 CT5 CT8 CT9 CT10 CT16

Problem and/or exercise solving	Final term exam: It will evaluate the 40% of the theoretical knowledge of the subject. Individual, about 2-3 hours. Over 10 points. Can have the form of test, short questions, problems or a combination of all of them. A minimum of 4.0 points over 10 is required in each of the parts to be able to pass the subject.	40	CG3	CE30	CT1 CT2 CT5 CT8 CT9 CT10 CT16
Objective questions exam	Laboratory exams: It will evaluate 20% of the practical knowledge of the subject, divided in 2 test of a 10%. Individual, of about 10-20 min. Over 10 points. Can have the form of test, short questions, problems or a combination of all of them. A minimum of 4.0 over 10 is required in the 20% assigned to laboratory training.	20		CE30	CT1 CT2 CT5 CT8 CT9 CT16
Essay	Multimedia video: It will evaluate 10% of the full knowledge of the subject (theoretical and practical). Video recorded by the students, performing an easy subject-related experiment. Maximum length: 3 min. Individual, or in groups of two students. Over 10 points.	10	CG3	CE30	CT1 CT2 CT9 CT10

Other comments on the Evaluation

Ordinary exam:

The weight of the distinct parts in the final note of the ordinary exam (*NEO*) gets distributed as follows:

- Theory (*T*): 80%
- Practices (*L*): 20%

Theory:

Consists of:

- A single exam, of approximately 2-3 hours, to be performed within the course calendar.
- Ranked over 10 points (*T*).
- Individual.
- It can include tests, short questions and/or problems or a combination of them.

Laboratory:

Consists of:

- A single exam, of approximately 20-30 min., regarding the contents of the practical sessions.
- Ranked over 10 points (*L*).

- Individual.
- It can include tests, short questions and/or problems or a combination of them.

Final mark and minimum requirements to pass the subject:

The final mark (*NEO*) will be computed following the next equation:

NEO = 0.8 * T + 0.2 * L

A minimum of 4.0 points over 10 is required for both the L exam and the T exam. Once obtained these minimums, a minimum of 5.0 points over 10 in the total computation of *NEO* is mandatory to pass the subject.

Extraordinary exam:

The students that did not pass the subject on first convocatory must attend the second convocatory (or extraordinary exam), that will have the same structure, exam duration, percentages and minimum points required thant in the ordinary exam.

Code of Honor:

During exams, the use of non-allowed electronic devices, notes or books is forbidden.

Exams lacking some of the sheets will not be graded.

Results obtained must be properly justified in all cases, in any of the exams or activities. None of the numerical results will be considered if no explanation is given about the methodoly used to obtain them.

It is expected that all the students abide to these considerations. If a non-ethical behaviour is detected, the student will automatically be graded with a 0.0 at the current examination.

Sources of information

Basic Bibliography

Curry, G. Richard, **Radar Essentials. A concise handbook for radar design and performance analysis**, 1ª ed., Scitech Publishing Inc., 2012

Complementary Bibliography

Denny M., **Blip, Ping & Buzz. Making sense of radar and sonar**, 1ª ed., The Johns Hopkins University Press, 2007
Skolnik, Merril I., **Introduction to Radar Systems**, 3ª ed., McGraw□Hill, 2003
Eaves J., Reedy E., **Principles of Modern Radar**, 2ª ed., Springer, 2011
Marage J., Mori Y.,, **Sonars and Underwater acoustics**, 1ª ed., Wiley, 2010
Mahafza B. R., **Radar systems analysis and design using Matlab**, 3ª ed., CRC Press, 2010

Recommendations

Subjects that it is recommended to have taken before

Fundamentals of electrical engineering/P52G381V01205
Electronic technology/P52G381V01301
Radio-communication systems/P52G381V01408

IDENTIFYING DATA				
Basics of computer networks				
Subject	Basics of computer networks			
Code	P52G381V01503			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	5th	1st
Teaching language	Spanish			
Department				
Coordinator	Fernández Gavilanes, Milagros			
Lecturers	Fernández García, Norberto Fernández Gavilanes, Milagros			
E-mail	mfgavilanes@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This subject is part of the Intensification in Naval Technologies, and it is sought to provide the students with training, both theoretical and practical, on the fundamental concepts of communication networks and telematic services: basis on data transmission technologies, architecture of networks and communication services, the main components of ICT infrastructures and information systems, network management and planning methods, and basic aspects of computer network security. In the final part of the subject, basic questions related to cyber defense and cybersecurity are also introduced. The classroom sessions will be used to introduce theoretical concepts, which will be complemented with different laboratory practices and problem solving during the tutoring sessions and the seminars.			

Skills	
Code	
CG3	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.
CE31	CITN6/OPT2 To acquire the ability to understand the concepts of network architecture, protocols and communication interfaces.
CE32	CITN7/OPT3 To acquire the ability to differentiate the concepts of access and transport networks, circuit switching and packet switching networks, as well as knowledge of methods of interconnecting networks and routing.
CE33	CITN8/OPT4 To know and use correctly the information systems.
CT1	Analysis and synthesis
CT2	Problems resolution.
CT3	Oral and written proficiency
CT6	Application of computer science in the field of study.
CT8	Decision making.
CT9	Apply knowledge.
CT10	Self learning and work.

Learning outcomes	Competences		
Know the technological basis of telematics and data transmission.	CG3	CE31 CE32 CE33	CT1 CT3 CT6 CT9 CT10
Understand the basic principles and architectures of communication networks and services.	CG3	CE31 CE32 CE33	CT3 CT6 CT9 CT10
Know the main components of ICT infrastructures.	CG3	CE31 CE32 CE33	CT1 CT2 CT3 CT6 CT8 CT9 CT10

Know the basic security aspects of computer networks.	CG3	CE31 CE32 CE33	CT1 CT3 CT6 CT9 CT10
ENAEE learning outcome: 1.- Knowledge and understanding. LO 1.3.- Be aware of the multidisciplinary context of engineering. Level of development: Adequate (2)		CE31 CE32 CE33	
ENAEE learning outcome: 5.- Practical application of engineering. LO 5.1.- Understanding of the applicable techniques and analysis, project and research methods and their limitations in the field of their specialty. Level of development: Adequate (2)			CT9
ENAEE learning outcome: 5.- Practical application of engineering. LO 5.3.- Knowledge of the application of materials, equipment and tools, technology and engineering processes and their limitations in the field of their specialty. Level of development: Adequate (2)		CE31 CE32 CE33	CT6 CT9
ENAEE learning outcome: 6.- Elaboration of judgements LO 6.1- Ability to collect and interpret data and handle complex concepts within their speciality, in order to make judgements involving reflection on ethical and social issues.		CE31 CE32 CE33	

Contents	
Topic	
Introduction, protocols and layers.	Introduction and motivation. Basic network concepts. Reference models. Standardisation bodies. History of the Internet.
Physical and link layers.	Introduction to the physical layer. Transmission media. Signals and modulations. Limit capacity of communication channels. Introduction to the link layer. Frame delimitation. Introduction to transmission errors. Detection and correction of errors.
Retransmission, multiple access and switching.	Retransmission. Random multiple access. Multiple access without contention. Switched Local Area Networks (LAN). Virtual LAN.
Packet forwarding and network connection.	Introduction to the network layer. IP protocol (v4 and v6). ARP protocol Packet fragmentation ICMP protocol Network Address Translation (NAT). Virtual circuits (MPLS).
Routing.	Introduction to routing. Dijkstra's algorithm. Routing algorithms in networks. Hierarchical routing. Border Gateway Protocol (BGP).
Transport layer. Reliable transport.	Introduction to the transport layer. Connectionless protocols: User Datagram Protocol (UDP). Connection-oriented protocols: Transmission Control Protocol (TCP) Connection establishment and release. Reliability mechanisms. Flow control. Congestion control.
Quality of service.	Introduction to quality of service. Multimedia data transmission over best effort networks. Content distribution networks. Differentiated services.
Application layer.	Introduction to the application layer. Domain Name System (DNS). Hypertext Transfer Protocol (HTTP). Dynamic Host Configuration Protocol (DHCP).

Cyberdefense and cybersecurity.	Introduction to security in computer networks. Ethical-social aspects of network security. Cybersecurity risk management. Confidentiality of messages. Authenticity and integrity of messages. Security protocols: WPA, IPsec, TLS. Security software tools.
Networked information systems.	Architecture and components of an information system. Big data and cloud computing. Intelligent Systems.
Information and command and control systems in the Navy.	Intranet overview. Command and control systems. NATO Secret WAN. Naval command system. SIJE. Future of information systems. SIM.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	47	75
Laboratory practical	12	12	24
Problem solving	7	0	7
Mentored work	15	14	29
Presentation	2	2	4
Laboratory practice	3	0	3
Essay questions exam	2	0	2
Essay questions exam	6	0	6

*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 lecturer of the contents on the subject under study, theoretical basis and guidelines of a work, exercise or project to be developed by the student.
Laboratory practical	Activities with the goal of applying knowledge to specific situations and for the acquisition of basic and procedural skills related to the subject matter of the study. They take place in special spaces with specialized equipment (laboratories, computer rooms, etc.).
Problem solving	Activity in which problems and exercises related to the course are formulated. The student must develop the appropriate or correct solutions through the exercise of routines, the application of formulas or algorithms, the application of transformation procedures of the available information and the interpretation of the results.
Mentored work	An intensive course will be developed in which the students who have not passed the course in ordinary call will work, under the supervision of the lecturer, reviewing the theoretical and practical concepts and carrying out activities, problems and exercises in preparation for the examination of the extraordinary call.

Personalized assistance

Methodologies	Description
Lecturing	The lecturers of the course will personally answer the doubts and queries of the students, both in person, according to the schedule that will be published on the center's website, and through telematic means (email, videoconference, Moovi forums, etc.) by previous appointment.
Laboratory practical	The lecturers of the course will personally answer the doubts and queries of the students, both in person, according to the schedule that will be published on the center's website, and through telematic means (email, videoconference, Moovi forums, etc.) by previous appointment.
Mentored work	The lecturers of the course will personally answer the doubts and queries of the students, both in person, according to the schedule that will be published on the center's website, and through telematic means (email, videoconference, Moovi forums, etc.) by previous appointment.
Problem solving	The lecturers of the course will personally answer the doubts and queries of the students, both in person, according to the schedule that will be published on the center's website, and through telematic means (email, videoconference, Moovi forums, etc.) by previous appointment.

Assessment

	Description	Qualification	Evaluated Competencess		
Presentation	Submission and presentation of a work related to the subject matter (TL): Evaluation of the work related to the subject and their presentations (approximate date: week 13 of the semester)	15	CG3	CE31 CE32 CE33	CT1 CT3 CT6 CT8 CT10
Laboratory practice	Practical examination (PL): Individual test to evaluate the knowledge acquired in the practical sessions (approximate date: week 14 of the semester). It consists of solving problems similar to those analyzed in the practical sessions.	15	CG3	CE31 CE32 CE33	CT1 CT2 CT3 CT6 CT9 CT10
Essay questions exam	Partial examination (PT, 30% of the grade): Written exam to evaluate the knowledge acquired in the theory sessions T1 to T6 (approximate date: week 8 of the semester). Final Exam (ET, 40% of the grade): Final written exam to evaluate the knowledge acquired in the theory sessions T1 to T11 (approximate date: week 14 of the semester). These examinations can be in the form of a multiple choice questionnaire, short answer questionnaire, problem solving, or some combination of the above.	70	CG3	CE31 CE32 CE33	CT1 CT2 CT3 CT6 CT8 CT9

Other comments on the Evaluation

Final mark and minimum requirements to pass the course through continuous assessment:
To ensure that the student has acquired the minimum skills in each of the aspects of the course, students will be required to achieve a minimum score of 4.0 out of 10 in the final theory exam. If we name MED_CON to the average grade for continuous assessment, which is calculated as:

MED_CON = 0.3 * PT + 0.4 * ET + 0.15 * PL + 0.15 * TL

The final continuous assessment mark (NEC) will coincide with MED_CON in the event that ET is greater than or equal to 4.0 and, otherwise, it will be calculated as:

NEC = min (4, MED_CON)

This grade (NEC) should be equal to or greater than 5 (on a scale of 10) to pass the course. The student who does not pass the course in this call must take the ordinary exam.

Final mark and minimum requirements to pass the course in the ordinary exam:
The final grade in the ordinary exam (NEO) is calculated with the following formula:

NEO = 0.7 * T + 0.3 * L

Where:

- T represents the theoretical part of the ordinary exam of the course. Individual written exam to evaluate the knowledge acquired in the theory sessions T1 to T11. It can be in the form of a multiple choice questionnaire, short answer questionnaire, problem solving, or some combination of the above.
- L represents the practical part of the ordinary exam of the course. Individual written exam to evaluate the knowledge acquired in the practical sessions of the subject. It consists of solving problems similar to those analyzed in the practical sessions and / or questions about the work presented and / or presentations.

This grade (NEO) should be equal to or greater than 5 (on a scale of 10) to pass the course. The student who does not pass the course in this call or in continuous assessment must attend the extraordinary call.

Final mark and minimum requirements to pass the course in the extraordinary exam:
The final grade in the extraordinary exam (NEE) is calculated with the following formula:

NEE = 0.7 * T + 0.3 * L

Where:

- T represents the theoretical part of the extraordinary exam of the course. Individual written exam to evaluate the knowledge acquired in the theory sessions T1 to T11. It can be in the form of a multiple choice questionnaire, short answer questionnaire, problem solving, or some combination of the above.
- L represents the practical part of the extraordinary exam of the course. Individual written exam to evaluate the knowledge acquired in the practical sessions of the subject. It consists of solving problems similar to those analyzed in the practical sessions and / or questions about the work presented and / or presentations.

This grade (NEE) should be equal to or greater than 5 (on a scale of 10) to pass the course.

STUDENT ETHICAL CODE
Any attempt at evaluation fraud will be prosecuted and punished. Fraud carried out by a student or its facilitation to third parties will be penalized as follows:

- **Continuous assessment**: The student will receive a 0 as grade in the part of the course (theory or practical) where fraud occurs.
- **Ordinary exam**: The student will receive a 0 as grade for all parts of the exam.
- **Extraordinary exam**: The student will receive a 0 as grade in all parts of the exam.

Sources of information

Basic Bibliography

A. S. Tanenbaum, N. Feamster, D. Wetherall, **Computer Networks: Global Editionnal Version**, 6a edición, Prentice-Hall, 2021

J. F. Kurose , K. W. Ross, **Redes de computadoras: Un enfoque descendente**, 7a edición, Pearson Education, 2017

Complementary Bibliography

R. K. Jain, **The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling**, 1a edición, Wiley, 1991

K. R. Fall, W. R. Stevens, **TCP/IP Illustrated, Volume 1: The Protocols**, 2a edición, Addison-Wesley, 2011

K. R. Fall, W. R. Stevens, **TCP/IP Illustrated, Volume 2: The Implementation**, 2a edición, Addison-Wesley, 2011

Recommendations

Other comments

In order for the student to successfully pass this subject, it is advisable to have:

- Well-developed written and oral comprehension skills.
- Ability to abstract and synthesize information.
- Skills for group work and group communication.

IDENTIFYING DATA				
Theory of the ship and shipbuilding				
Subject	Theory of the ship and shipbuilding			
Code	P52G381V01504			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	5th	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Carrasco Pena, Pedro Jesús			
Lecturers	Carrasco Pena, Pedro Jesús González-Cela Echevarría, Gerardo			
E-mail	pedrocarrasco@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This subject is framed among the specific ones of the intensification in naval technology (General Corps). Its objective is to provide specific skills or abilities to carry out the position of Damage Control Officer (S.I.). The S.I. is the set of processes, standards, techniques and material and human means used to prevent, reduce, and correct the effects that, on a ship or its crew, derive from accidents or enemy actions. The first objective of the course is to ensure that students know and understand everything related to ship stability (hydrostatic and intact and damage stability). As well as the basic concepts related to naval hydrodynamics and seakeeping due to the interaction with external factors such as waves, wind, or currents. Secondly, the course will enable students to acquire sufficient knowledge of shipbuilding. Thus, they will know the structural elements of the ship, its purpose, behavior, forms of failure and their implications when they occur. This knowledge will enable future officers to take on roles related to the survivability of surface ships and submarines. In this way, graduates will be able to have naval units ready for combat, to sustain them in combat and to carry out the temporary post-combat repairs necessary to maintain the ship at the highest operational level.			

Skills	
Code	
CG3	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.
CG4	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.
CG6	Capacity for handling specifications, regulations and mandatory standards.
CE38	CITN12/OPT8 To know the nomenclature, the basic principles of the procedures of construction and operation of ships, the basics of buoyancy and stability, the materials for its construction and structure.
CE39	CITN13/OPT9 To acquire the ability to perform calculations of buoyancy and stability.
CE40	CITN14/OPT10 To apply the principles of control breakdowns in order to reduce the risk of personal and material, and for decision-making in case of onboard emergencies.
CT2	Problems resolution.
CT8	Decision making.
CT9	Apply knowledge.
CT16	Critical thinking.

Learning outcomes	Competences		
Know the ship building technology and operation and the basics of buoyancy and stability	CG3 CG6	CE38	
Know ship buoyancy and stabiliby calculations	CG4	CE39	CT2 CT8 CT9 CT16
Know the basics of damage control on board	CG3 CG6	CE40	
ENAEE LEARNING OUTCOME: KNOWLEDGE AND UNDERSTANDING: LO1.3.- Awareness of the wider multidisciplinary context of engineering (Level of achievement: Intermediate (2)).		CE38 CE39	

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 (level of achievement: Intermediate (2)).	CG4	CE39	CT2 CT8 CT9 CT16
ENAEE LEARNING OUTCOME: INVESTIGATIONS: LO4.2.- Ability to consult and apply codes of practice and safety regulations in their field of study (level of achievement: Intermediate (2)).	CG6		
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 (level of achievement: Intermediate (2)).		CE38 CE39 CE40	CT8 CT9
ENAEE LEARNING OUTCOME: ENGINEERING PRACTICE: LO5.4.- Ability to apply norms of engineering practice in their field of study (level of achievement: Intermediate (2)).	CG6	CE40	CT9

Contents	
Topic	
1. General considerations on ship theory:	1.1. Buoyancy. 1.2. Stability.
2. Geometry of the hull:	2.1. Lines plan 2.2. Offset tables. 2.3. Main coefficients. 2.4. Hydrostatic curves.
3. Transverse Stabiliy:	3.1. Initial stability 3.2. Stability experiment. 3.3. Grounding.
4. Longitudinal stability:	4.1. Effect of grounding. 4.2. Docking. 4.3. Launching.
5. Damage stability:	5.1. Floodings. 5.2. Effects.
6. Watertight subdivision:	6.1. Compartmentalization. 6.2. Tightness control.
7. Regulations:	7.1. Classification. 7.2. IMO rules. 7.3. Freeboard. 7.4 GT rules.
8. CAD apps:	8.1. Naval Design. 8.2. Shipbuilding.
9. Shipbuilding:	9.1. Definition. 9.2. The ship and its types. 9.3. Shipbuilding materials.
10. General description of the hull:	10.1. Structural topology. 10.2. Hull elements. 10.3. Joint processes.
11. Structural Stresses:	11.1. Calm Waters.
12.Structural Stresses:	12.1. Rough seas.
13. Basics of naval structures calculations.	13.1. Flowchart for calculations.
14. Warship□s structure particulars.	14.1. Special loads.
Practices:	P1: Buoyancy. P2: Transversal Stability. P3: Longitudinal Stability. P4: Damage conditions. P5: Transversal Stability Spredsheet. P6: Longitudinal Stability Spredsheet P7: Technical Documentation use.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Laboratory practical	14	28	42
Seminars	14	17	31
Problem solving	7	0	7
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Lecturing	The basic theoretical contents of the program will be explained in detail in these lectures. Explanatory examples will be presented for deeper understanding of the subject. Slide presentations and blackboard will be used in combination. As far as possible, presentations will be provided to the students prior to the sessions. In any case, the hardcopy reproductions of the slide presentations should never be considered as substitutes of texts or notes. Thus, this material must be considered a complementary material.
Laboratory practical	Practical Tips in Master Classes. Sometimes, it will be necessary to explain certain practical concepts by providing useful tips for making the best use of the practical classes. Problem Solving. Activity in which problems and / or exercises related to the subject are formulated by the lecturers. The student must develop the appropriate or correct solutions through the repetition of routines, the application of formulas or of procedures. It is usually used as a complement to evaluate the students. Laboratory Practical. Activities for applying the knowledge to situations and for the acquisition of basic and procedural skills related to the subject. They are developed in dedicated rooms like laboratories, computer rooms, etc.
Seminars	The tutorial action is faced as a group support of the student's learning process. Tutorials are preferably done in small group seminars. In the seminars, the student's attitude towards the lecturer and the rest of their classmates is evaluated through annotations made by the lecturer.
Problem solving	Activity in which problems and / or exercises related to the subject are formulated by lecturers. The student must develop the appropriate or correct solutions through the repetition of routines, the application of formulas or of procedures. It is usually used as a complement to the lecture sessions.

Personalized assistance

Methodologies	Description
Problem solving	The teaching action will distinguish academic tutoring actions and personalized tutoring actions. For academic tutoring, students will have scheduled hours of tutoring. In these hours of tutoring, students will be able to consult any questions related to the contents, organization of the subject, development of the project, etc. For these tutorials, group tutorials will be encouraged to solve problems related to group activities, or simply to inform the lecturer about the evolution of group work. In the personalized tutorials, each student, individually, will be able to comment with the lecturer about any problem that prevents him from adequately monitoring the subject or any of its parts. these tutorials seek to find a solution to these problems between student and lecturer. It seeks, combining the two types of tutoring, it is intended to compensate the different learning rhythms through attention to diversity. The lecturers of the subject will answer the questions and queries of the students in person, following the schedule that will be published on the Centre□s website. They will also answer these questions through telematic means (email, videoconference, Moovi forums, etc.) under the modality of prior appointment.

Assessment

	Description	Qualification	Evaluated Competencess		
Lecturing	The theory contents taught in the master sessions are evaluated by 2 intermediate exams along the semester. These intermediate exams are short written tests (1 hour), whose purpose is to evaluate the assimilation of the contents by the students, are to motivate the autonomous study and identify those students requiring individual tutorial attention. During the course two intermediate tests are carried out consisting of conceptual questions and short problems with a weigth of 15% each one in the final note. Regarding the final exam is a long-term test (4 hours) that aims to evaluate the learning of all the contents of the subject by means of theory questions and problems. The weigth assigned to this part is 40%.	70	CG3 CG4 CG6	CE38 CE39 CE40	CT2 CT8 CT9 CT16
Laboratory practical	The evaluation of the practices (NP) carries out making the average of the punctuations obtained in each one of the practices, all of them has the same weight.	20		CE39	CT2 CT9 CT16
Problem solving	Participation (date: it evaluates in the seminars and in the debates in class of theory)	10			CT16

Other comments on the Evaluation

Student final mark is obtained by a weighted sum over the scores achieved in each of the above mentioned parts. A continuous evaluation mark (NEC) is defined according to:

NEC = 0,15 * PI1 + 0,15 * PI2 + 0,2 * NP + 0,4 * PF + 0,1 * CP

Passing the course by continuous evaluation requires a NEC mark equal to or greater than 5 points. However, minimum requirements will be required in some sections in order to ensure a satisfactory balance between all types of skills. These

requirements are:
1. Carry out of both intermediate exams and conduct at least 6 of the 7 practical sessions.2. Obtain a grade of 4 or more points out of 10 in the Final Exam.
Students with NEC less than 5 or who do not fulfill one of the two previous requirements must attend to the regular exam in order to pass the subject. For those students who do not meet the two requirements the final mark of continuous evaluation is obtained as: NEC FINAL = min (4, NEC). In addition, the option to attend the regular exam is offered to all those students who wish to improve their continuous evaluation mark.
Both the regular and the extraordinary exam will evaluate all the subject skills. Therefore, these exams will include a question regarding the tasks performed during the practices.
ETHICAL COMMITMENT: Students are expected to have appropriate ethical behavior. If unethical behavior (cheating, plagiarism, use of unauthorized electronic devices or others) is detected, the student will be penalized with the impossibility of passing the subject by the continuous evaluation modality (in which he will obtain a grade of 0). If this type of behavior is detected in regular or extraordinary exams, a 0 mark qualification is passed to his academic record.

Sources of information

Basic Bibliography

Armada Española, **I-CP-03 Estabilidad**, Armada,

Armada Española, **I-CP-02 Control de averías**, Armada,

Complementary Bibliography

A. Biran, **Ship hydrostatics and stability**, New Riders Publishing,

J. Olivella Puig, **Teoría del buque. Flotabilidad y estabilidad**, UPC,

J. Olivella Puig, **Teoría del buque. Flotabilidad y estabilidad (Problemas).**, UPC,

Lewis, E. V., **Principles of naval architecture second revision: stability and strength. Volume I.**, SNAME,

Lewis, E. V., **Principles of naval architecture second revision: stability and strength. Volume II.**, SNAME,

Bonilla de la Corte, A., **Teoría del buque.**, Librería San José,

Bonilla de la Corte, A., **Construcción naval y servicios.**, Librería San José,

de Juan García Aguado, J. M., **Estática del buque.**, UDC,

de Juan García Aguado, J. M., **Principios de teoría del buque: Dinámica.**, UDC,

Bureau of Naval Personel USN, **Principles of naval engineering**, NAVPERS,

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Calculus II and differential equations/P52G381V01201
Fluid mechanics/P52G381V01208

Other comments

It is recommended a review of basic elements studied in other subjects such as:
- Gravitation, Center of gravity, composition of centers of masses, Pappus-Guldin and Steiner theorems.
- Density, Archimedes' theorem, fundamental principle of hydrostatics, viscosity, Bernoulli's equations, continuity and Venturi effect.
- Descriptive geometry, systems of orthografic views and cutting planes.
- Methods of approximate integration of areas and volumes, linear regressions, trapezoidal and Simpson's rules.

IDENTIFYING DATA				
Automobiles				
Subject	Automobiles			
Code	P52G381V01505			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	5th	1st
Teaching language	Spanish			
Department				
Coordinator	Casqueiro Placer, Carlos			
Lecturers	Casqueiro Placer, Carlos			
E-mail	ccasqueiro@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This guide presents relative information to the subject of Automobiles of fifth course of the Bachelor Degree in Mechanical Engineering taught in the Defense University Center at the Spanish Naval Academy, which lists the competencies that the students have to achieve, the schedule of educational activities, the contents and its temporary programming, an estimate of the work load of the student, the specific criteria for his evaluation and the bibliography recommended for a correct follow-up of the matter. The main objetive of the subject will be to develop the knowledge of the vehicular dynamics. This is an exclusive competency of this subject.			

Skills	
Code	
CG3	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.
CG4	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.
CE41	CITN15/OPT11 Develop knowledge of vehicle dynamics
CT1	Analysis and synthesis
CT2	Problems resolution.
CT3	Oral and written proficiency
CT5	Information Management.
CT8	Decision making.
CT9	Apply knowledge.
CT10	Self learning and work.
CT12	Research skills.
CT16	Critical thinking.
CT17	Working as a team.
CT20	Ability to communicate with people not expert in the field.

Learning outcomes	Competences		
To know the technological basis of the automobile vehicles	CG3 CG4	CE41	CT1 CT2 CT3 CT5 CT8 CT9 CT10 CT12 CT16 CT17
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [Intermediate (2)].	CG3		
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)].	CG4		CT1 CT2 CT8 CT9 CT16

ENAEE learning outcome: ENGINEERING PRACTICE: 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)].			CT5
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 [Intermediate (2)].	CG4		CT2 CT9 CT12 CT16
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 [Intermediate (2)].		CE41	CT8 CT9
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 [Intermediate (2)].			CT1 CT3 CT20
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)].			CT17

Contents	
Topic	
Topic 1: Introduction to the theory of the automotive vehicles. (T1)	The automotive vehicle: concept. Main requests of the automotive vehicle. The system man-machine-enviroment. Objectives and scope of the theory of the automotive vehicles.
Topic 2: Introduction to tactical vehicles. (T2)	Basic characteristics of tactical vehicles. Spanish marines' vehicles. Most common faults: diagnosis. Specific legislation of circulation.
Topic 3: Interaction between vehicle and road surface. (T3)	General characteristics of tyres. Mechanical characteristics of tyres. Longitudinal stress (traction, braking). Lateral stress (slip angle). Mathematical models. Rolling characteristics of chain vehicles.
Topic 4: Longitudinal dynamics: perfomances. (T4)	Resistance to movement. Basic equation of longitudinal motion. Maximum tractive effort limited by adhesion. Motor and transmission characteristics. Prediction of the performance of a vehicle.
Topic 5: The powertrain. (T5)	The internal combustion engine. Types of transmissions. Transmission components. The manual gearbox. Automatic gearboxes. Homokinetic joints. The differential, function and types. Differential lock. Reducer gearbox.
Topic 6: Braking of automotive vehicles. (T6)	Moment and forces of the braking process. Adhesion condition: optimal braking. Braking process. Braking system.
Topic 7: Vehicle lateral dynamics. (T7)	Steering geometry. Low speed manoeuvrability.Tipping and skid speed limit. Directional steady-state vehicle behavior. Load influence.
Topic 8: Suspension system. (T8)	Vibrations, vehicle and human effects. Suspension system: mathematical model. Kinematics of suspension. Suspension systems: elastic elements (spring, torsion bars, leaf springs) and dampers. Pneumatic suspension. Influence of suspension on the vehicle dynamic behaviour. Kinematics of suspension and tyre behaviour. Suspension set up.
Topic 9: Driving techniques. (T9)	Driver position. Use of hands. The vision. Specific off road driving techniques. Sand, mud and snow driving.
Topic 10: Vehicle recovery. (T10)	Theory of levers and pulleys: levers of first, second and third genus. Practical examples. Pulleys, forces and tensions. Pulley friction and resistance. Vehicle recovery: definition. Recovery steps. Traction recovery. Forces to consider. Recovery machines: mechanical advantage. Resistance according to the terrain and according to the slope. Recovery of overturned vehicles: forces to consider. Anchors. Exceptional traction and anchoring methods. Expedited methods of hoisting. Traction recovery practices: with return and without return. Practices of anchors: from bar to sand. IM recovery means. Capabilities of the vehicle winches in service of the IM: Hummer, Pegaso 7323 and Iveco 257M trucks. Anchors for towing, recovery and hoisting of the main IM vehicles: Hummer, Pegaso 7323 and Iveco 257M trucks, AAV, CCM M-60, Piranha III. Car M-88 and AAVR: crane and winch capabilities. General description of the M-88 car crane: limitations. Overview of the AAVR Truck Crane: Limitations.

Topic 11: Safety systems. (T11)	Active and passive safety. Driving assistance systems: traction and stability control, ABS. Influence of driving technique. Passive safety: deformable structures, safety cell, seat belts, airbag.
Topic 12: Alternative powertrains. (T12)	The fuel cell. Hybrid vehicles. Electric vehicles. Hydrogen propulsion systems.
Practical sessions 1 and 2 (2 sessions, 4 hours). Vehicle monitoring. (PL1 y PL2)	Use of Data Acquisition Systems (DAS) in the automobile: installation of hardware, configuration, reading and interpretation of data. The student will give a report about the work done and / or will answer a questionnaire.
Practical sessions 3 and 4 (2 sessions, 4 hours). Calculation of perfomances and braking characteristics (PL4)	Analysis and prediction of vehicle performance using software. Analysis and prediction of the braking performance of the vehicle using software. The student will give a report with the results and / or will answer a questionnaire.
Practical sessions 5, 6 and 7 (3 sessions, 6 hours). Lateral dynamics. (PL5, PL6 and PL7)	Analysis and prediction of lateral dynamic behavior of the vehicle using software. The student will give a report with the results and / or will answer a questionnaire.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	25	22	47
Problem solving	7	14	21
Mentored work	3	6	9
Practices through ICT	12	10.6	22.6
Laboratory practical	2	1.4	3.4
Seminars	15	10	25
Autonomous problem solving	11	11	22

*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 these sessions, the basic theoretical contents of the program will be explained in detail, explaining examples with which to deepen the understanding of the subject. Computer presentations and blackboard will be used, especially to convey information such as definitions, graphs, etc. The content of these classes will be complemented with notes and the slides will also be available for the student.
Problem solving	Since the tutorial action is treated as a group support action to the student's learning process, the tutorials will preferably be conducted in seminars and in the form of small group meetings, with problem solving, exercises or case studies.
Mentored work	It is intended to motivate the student in the research activity, and to foster personal relationships by sharing problems and solutions. In order to acquire certain competences it is necessary to propose activities based on the use of active methodologies. Part of the theoretical content should be developed and / or applied to practical cases treated in group and presented in class, for which part of the time devoted to theoretical classes will be allocated.
Practices through ICT	Analysis and prediction of lateral and longitudinal dynamic behavior of the vehicle using software. The student will deliver reports with the results and / or answer questionnaires. The didactic method to follow in the delivery of practical classes is that the lecturer supervises the work done by the students. The laboratory practices are aimed at strengthening the theoretical concepts addressed in the sessions in the classroom.
Laboratory practical	The didactic method to follow in the delivery of practical classes is that the lecturer supervises the work done by the students. The laboratory practices are aimed at strengthening the theoretical concepts addressed in the sessions in the classroom.
Seminars	Intensive course of 15 hours stop those students that suspended the subject in first call, previous to the examination in second call. Group tutoring with lecturer.
Autonomous problem solving	Employed in the assessment tests in order to verify the abilities acquired by the student.

Personalized assistance

Methodologies	Description
Problem solving	Student solves exercises or practical cases with lecturer help. In the personalized tutoring, each student, individually, can discuss with the lecturer any problem related to their learning achievements in the subject. The lecturer will personally solve the questions of the students both in person, according to the tutoring schedule published on the web page of the CUD-ENM, as well as through telematic means (email, videoconference, Moovi forums, etc.) with previous appointment.

Seminars	Group tutorials with the subject lecturer. In the personalized tutoring, each student, individually, can discuss with the lecturer any problem related to their learning achievements in the subject. The lecturer will personally solve the questions of the students both in person, according to the tutoring schedule published on the web page of the CUD-ENM, as well as through telematic means (email, videoconference, Moovi forums, etc.) with previous appointment.

Assessment

	Description	Qualification	Evaluated Competencess	
Mentored work	The student will carry out a research work (TI) about a case proposed by the lecturer and will deal with issues related to topics 11 and 12. The work will be scored from 0 to 10 according to their content and defense, following the rubric provided at the time of assigning the topics to the students	15	CG3 CG4	CT1 CT2 CT3 CT5 CT8 CT9 CT10 CT16 CT17
Practices through ICT	The evaluation of the practical part (NP) will be made from the reports or questionnaires corresponding to each one (a total of 4-5), with a total value of 10 points.	15	CG3 CG4	CT1 CT2 CT3 CT5 CT8 CT9 CT10 CT16 CT17 CT20
Autonomous problem solving	Two theoretical and practical tests of continuous evaluation (15% each) will be carried out at the end of blocks or parts 2 and 3. Their evaluation will be carried out on 10 points each. The Continuous Assessment Final Test (with a 40% weight) will be carried out in the evaluation week and will be valued at 10 points. It will be necessary to obtain a grade higher or equal to 4 points out of 10 in the final exam of continuous evaluation in order to qualify for the one approved by continuous assessment.	70	CG3 CG4	CT1 CT2 CT3 CT5 CT8 CT9 CT16

Other comments on the Evaluation

The final mark of continuous assessment (NEC) shall be calculated as follows:

$NEC = 0.15 \cdot P1 + 0.15 \cdot P2 + 0.15 \cdot TI + 0.15 \cdot NP + 0.4 \cdot PF$

The student must submit to the regular examination of all the contents of the subject, which will represent 100% of the grade, in the following cases:

- The final grade of continuous assessment (NEC) is less than 5.
- The non-delivery of research work.
- The non-execution or delivery of the memory of practices, unless it is exempted for good cause.
- Obtain a grade below 4 points out of 10 on the final continuous assessment exam.

The continuous evaluation note in case of not fulfilling some of the last four previous requirements will be obtained by the expression: NECS = min (4, NEC)

In any case, the student who has passed the continuous assessment, will have the possibility to submit to the regular exam to improve his/her grade.

In case the student is discovered performing any action that makes possible the copy in some of his/her exams, or in possession of material not allowed during the performance of any of the tests, or whose research work has incurred plagiarism, will be qualified with a zero in the current call.

Sources of information

Basic Bibliography

Luque, P, **Ingeniería del Automóvil. Sistemas y comportamiento dinámico**, Ed. Paraninfo, 2004

Complementary Bibliography

Arias-Paz, M., **Motocicletas**, Ed. Dossat,

Bosch, **Manual de la Técnica del Automóvil**, Ed. Reverté,

Cascajosa, Manuel, **Ingeniería de vehículos : sistemas y cálculos**, Ed. Tebar,

Técnica de recuperación de vehículos de ruedas, Escuela de Aplicación de Infantería de Marina,

Conducción Todo-Terreno y Recuperación de vehículos, Escuela de Infantería de Marina.,

Manual de Características de los Vehículos de Infantería de Marina, Junta Táctica de Infantería de Marina.,

Guía del conductor militar (OR6-002), Estado Mayor del Ejército de Tierra.,

Recommendations

Other comments

Proper development of the subject requires that the student has competencies in the field of differential calculus, vector and kinematic computation and dynamics of the point and the solid.

IDENTIFYING DATA				
Complementary training				
Subject	Complementary training			
Code	P52G381V01506			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	5th	2nd
Teaching language				
Department				
Coordinator	Barragáns Martínez, Ana Belén			
Lecturers	Barragáns Martínez, Ana Belén			
E-mail	belen@cud.uvigo.es			

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Final Year Dissertation				
Subject	Final Year Dissertation			
Code	P52G381V01991			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Type	Year	Quadmester
	12	Mandatory	5th	2nd
Teaching language	Spanish English			
Department				
Coordinator	Maceiras Castro, María del Rocío			
Lecturers	Maceiras Castro, María del Rocío			
E-mail	rmaceiras@cud.uvigo.es			
Web	http://cud.uvigo.es/trabajos-fin-de-grado/			
General description	The Final Year Project (TFG) forms part, like module, of the curriculum of the Mechanical Engineering Bachelor Degree. It is an original and personal work that each student will make under lecturer supervision, allowing him/her to show in an integrated way the acquisition of the formative contents and the competences associated to the degree. With this work the student applies the knowledges adquired during his/her training, so much of the module of specific mechanical technology as of other fields of knowledge related with the mechanical engineering necessary to carry out the TFG, which reflects its multidisciplinary character. Moreover, it is pretended that the student adquire or reinforce some capacities that allow him/her to project, design and develop complex products, processes and systems of the speciality; have consciousness of the social appearances, of health and security, environmental, economic and industrial; select and apply methods of appropriate project; and look for solutions from a technical point of view as well as its implementation and adequation to the environment. Its definition and contents are explained more extensively in the regulations for the completion of the Final Year Project approved by Centre Board, in its first version, in session celebrated on 2/9/2014, and whose updated content is shown in the website of CUD-ENM, in the section dedicated to the TFG (Studies Section -> Mechanical Engineering Degree ->Student -> Final Year Project).			

Skills	
Code	
CG1	Skills for writing, signing and developing projects in the field of industrial engineering, whose purpose is, specializing in Mechanics, according to the knowledge acquired pursuant to paragraph 5 of this order, construction, alteration, repair, maintenance, demolition, manufacturing, installation, assembly or operation of: structures, mechanical equipments, energy facilities, electrical systems and electronic installations and industrial plants, and manufacturing processes and automation.
CG2	Ability to manage the activities object of the engineering projects described in CG1.
CG3	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.
CG4	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.
CG10	Ability to work in a multidisciplinary and multilingual environment.
CG12	Original exercise to realise individually and present and defend in front of a university committee, consistent in a project in the field of the specific technologies of the Industrial Engineering in the Mechanical speciality of professional nature in which the skills and competences acquired in the educations are summarised and integrated.
CT4	Oral and written proficiency in a foreign language.
CT12	Research skills.

Learning outcomes		
Learning outcomes	Competences	
Research and structuring of information on any subject	CG1 CG2 CG3 CG4 CG10 CG12	CT12

Preparation of a project reportwhich collects : introdcution, problematic or state of the art, aims, phases of the project, development of the project, conclusions and future lines.	CG1 CG2 CG3 CG4 CG10 CG12	CT4 CT12
Design of equipments, prototypes, programs of simulation, etc, according to specifications.	CG1 CG2 CG3 CG4 CG10 CG12	CT12
ENAEE LEARNING OUTCOME. KNOWLEDGE AND UNDERSTANDING LO1.3.- awareness of the wider multidisciplinary context of engineering (level of development of this learning outcome - Intermediate (2)).	CG10 CG12	
ENAEE LEARNING OUTCOME. ENGINEERING ANALYSIS LO2.1.- The capacity to analyse products, processes and complex systems in his field of study; choose and apply of pertinent form analytical methods, of calculation and experimental already established and interpret properly resulted of said analysis (Intermediate (2))	CG1 CG2 CG4	
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))	CG4	
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 (Intermediate (2))	CG4 CG12	
ENAEE LEARNING OUTCOME. ENGINEERING DESIGN LO3.2.- ability to design using some awareness of the forefront of their engineering specialisation (Intermediate (2))	CG1 CG4 CG12	
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))		CT12
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))	CG12	CT12
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 (Intermediate (2))	CG4	CT12
ENAEE LEARNING OUTCOME. MAKING JUDGEMENTS LO6.2.- ability to manage complex technical or professional activities or projects in their field of study, taking responsibility for decision making (Advanced (3))	CG1 CG2	
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 (Advanced (3))	CG1 CG4 CG12	CT4
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))	CG1	CT4

Contents

Topic	
Final Year Project	It tries to tackle the resolution of an original and individual exercise in which the student confronts to a real problem of the field of the engineering, uses the methodology acquired during his/her training and proposes a technically valid and viable solution. The contents of each TFG will be defined in the individual proposals offered by the lecturers and approved in the Centre Board, according to the regulations for the realisation of the Final Year Project. Each TFG will have a different content.

Planning

	Class hours	Hours outside the classroom	Total hours
Mentored work	20	0	20

Seminars	10	40	50
Autonomous problem solving	0	210	210
Presentation	5	15	20

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

Methodologies

	Description
Mentored work	The student, in an individual way, guided and supervised by his/her advisor, elaborates, as a result of the developed work, a project according to the indications of the Regulations for the realisation of the Final Year Project of the CUD-ENM. In said memory, the student presents the results of his/her work in which he/she has had to project, design or develop products, processes or systems of the field, as well as propose solutions to the problem posed in the field of the engineering, taking into account in the measure of the possible social factors, of health and security, environmental, economic and industrial.
Seminars	The students that fails the Final Year Project will have to improve, in an individual way, guided and supervised by his/her advisor, the project according to the indications of committee.
Autonomous problem solving	Studies/previous activities Before carrying out the work (also during the same), the student will have to make bibliographic researches and consult specific databases, what will allow him/her a better processing and preparation so much of documentation, as of proposals of resolution to the problem proposed in the TFG. These activities will be carried out in the classroom and/or laboratory, independently by the students. Personalised and individualized attention by the advisor The advisor will supervise the progress of the TFG through periodic meetings where he/she will provide feedback to the student. Integrated methodologies The student presents the result obtained in the preparation of a document on the thematic of the matter. It will be carried out individually, both in writing (memory) and orally (presentation). Presentation and public defense The students must prepare and defend the work done in front of a committee. The defense may be carried out in a face-to-face or online session (by using a web conference platform).

Personalized assistance

Methodologies	Description
Mentored work	The advisor will supervise the progress of the TFG through periodic meetings where he/she will provide feedback to the student. The advisor will take time to help personally to each of the TFG students, to guide their work and guide their learning process, as well as to review and correct the report.
Seminars	The advisor will supervise the improvement of the TFG through periodic meetings where he/she will provide feedback to the student. The advisor will take time to help personally to the TFG students, to guide their work and guide their learning process, as well as to review and correct the report.
Tests	**Description**
Presentation	The students must prepare and defend the work done in front of a committee. It will be able to be presentially or telematically, through the platform of videoconference web.

Assessment

	Description	Qualification	Evaluated Competencess	
Mentored work	Report of the TFG advisor	25	CG1 CG2 CG4 CG12	CT12
Presentation	Report of the committee of the TFG Evaluation of the presentation and defense	75	CG1 CG2 CG3 CG4 CG10 CG12	CT4 CT12

Other comments on the Evaluation

At least one committee will be appointed, consisting of three lecturers for each of the following areas: **MAT** (Mathematics), **MEC** (Mechanics), **ELE** (Electricity, Electrotechnics and Automatic), **QUI** (Chemical and Environmental Technology), **TEL**

(Telecommunications), **OI** (Industrial Organization).

The evaluation will be carried out according to the regulations for the completion of the Final Year Project as well as the evaluation rubric, both approved by the Center Board, whose updated contents are shown on the CUD-ENM website, in the section dedicated to the TFG (Studies Section -> Mechanical Engineering Degree ->Student -> Final Year Project).

ETHICAL COMMITMENT: Students are expected to have adequate ethical behavior. If a type of unethical behavior is detected (cheating, plagiarism or others), the student will be penalized so that in that call he / she will obtain a qualification of 0.0.

If the student fails, the evaluation committee will make a report with the appropriate recommendations to the student or advisors for improving the work in afuture evaluation.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

Important information: In the moment of the defense of the TFG, the student must have all the remaining subjects of the degree passed, as established in the article 7.7 of the Regulation for the realisation of the Final Year Project of the University of Vigo.