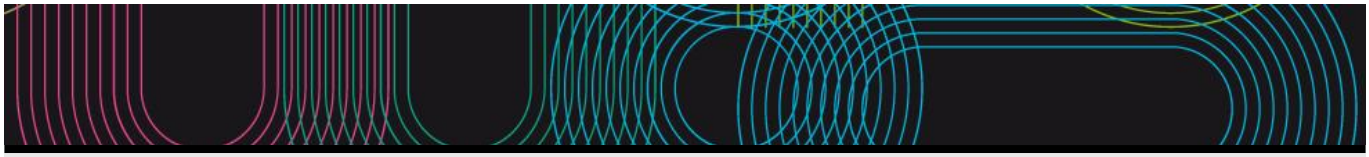

(*)Centro Universitario da Defensa na Escola Naval Militar de Marín (Pontevedra)

(*)Grao en Enxeñaría Mecánica

Subjects			
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

IDENTIFYING DATA				
Electronic technology				
Subject	Electronic technology			
Code	P52G381V01301			
Study programme	(*)Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Falcón Oubiña, Pablo			
Lecturers	Falcón Oubiña, Pablo Gómez Pérez, Paula			
E-mail	pfalcon@cud.uvigo.es			
Web	http://faitic.uvigo.es			
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.			

Competencies	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
C11	Knowledge of the fundamentals of electronics.
D2	Problems resolution.
D9	Apply knowledge.
D10	Self learning and work.
D17	Working as a team.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
To know of the operation of electronic devices.	B3	C11	D2 D9 D10 D17
Know conditioning and data acquisition electronic systems and devices.		C11	D10
To identify different types of industrial sensors.		C11	D10
To know the basics of a digital electronic system.		C11	D2 D9 D10 D17
To know basic electronic circuits for data communications.	B3	C11	D9 D10
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))		C11	
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))			D2 D9
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))			D10 D17
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))			D10

ENAEE LEARNING OUTCOME: CONTINUOUS EDUCATION D10
LO 8.2 Ability to stay up-to-date on science and technology.
(Basic (1))

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: 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 6: 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 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	35	63
Laboratory practical	14	4	18
Seminars	22	0	22
Problem and/or exercise solving	9	15	24
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
Essay	2	11	13

*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 professor 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 consult questions related to the subject contents, organization and/or planning. In personalized tutoring hours, each student, individually, can discuss with the teacher any problem regarding his/her understanding of the subject. Both tutorial actions aim to compensate the different learning rhythms through attention to diversity. The teachers of the subject will personally attend to the doubts and queries of the students, in person, according to the schedule that will be published on the website of the center, such as through telematic means (email, videoconference, FAITIC forums, etc.) under the modality of previous appointment.

Assessment

	Description	Qualification	Training and Learning Results		
Problem and/or exercise solving	Final exam to evaluate the global knowledge acquired of the subject, due at the end of the semester.	40	B3	C11	D2 D9 D10
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	B3	C11	D2 D9 D10
Problem and/or exercise solving	Second assessable test, corresponding to themes 4, 5 and 6 (approximate date: 9th week of the semester).	15	B3	C11	D2 D9 D10
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).	15	B3	C11	D2 D9 D10 D17
Essay	Group work corresponding to the first part of the practical evaluation (approximate date: 10th week of the semester).	15	B3	C11	D2 D9 D10 D17

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 group work and a practical laboratory test, as follows:

- Group work (L1):
    - Design and simulation of an electronic system for the solution of an engineering problem.
    - The work proposal will be approved by the teachers to check that it meets the minimum milestones of the task.
    - If the students do not propose a work within the deadline set by the teachers at the beginning of the course, a a generic work will be assigned to them with the necessary requirements.

    - Weight: 15% of the continuous evaluation score (NEC).
    - A minimum score of 4.0 points is required.

- 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: 15% 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 + 0.15*L1 + 0.15*L2
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

Physics: Physics 1/P52G381V01102
Physics: Physics II/P52G381V01106
Mathematics: Calculus 1/P52G381V01103
Fundamentals of electrical engineering/P52G381V01205
Mathematics: Calculus II and differential equations/P52G381V01201

Contingency plan

Description

In view of the possible appearance of extraordinary situations involving the suspension of face-to-face teaching activity and the change to a non-presential/online scenario, the following changes will be made:

CONTENTS

Theoretical credits
The teaching of the theoretical contents of the subject should not be affected by the transfer to non-presential/online mode. If the number of hours to be taught is considerably reduced, the contents of each of the subjects will be adapted in such a way as to guarantee the acquisition of the learning results and skills of the subject.

Practical credits
In view of the impossibility of working with the instrumentation equipment present in the laboratories, the corresponding practices will be replaced by equivalents that can be transferred to a virtual scenario. Specifically, the practices will be carried out as follow:

Practice 1: Introduction to electronic circuit simulation
The aim of this practice is to familiarize the student with the PSIM electronic circuit simulation software, as well as with the digital system simulator to carry out assemblies with analog devices and combinational systems respectively.

Practice 2: Applications with digital electronic devices
The aim of this practice is that the student is able to design, assemble and test a basic digital electronic circuit, based on combinational systems, from an engineering problem. In this practice, a digital circuit simulator will be used to assemble the circuit.

Practice 3: Design with operational amplifiers
This practice aims to further familiarize the student with the PSIM simulation software. In this practice it will be used to introduce the operational amplifiers and to let the student observe the usefulness of these devices to solve engineering problems. For this purpose, different assemblies will be made with these operational amplifiers where the student can check

the operation of the operational amplifiers under different conditions. These assemblies will also serve the student to reason how different assemblies should be joined together to obtain a given transfer function, which can be applied in many areas of engineering.

Practice 4: Assembly and measurement of basic electronic circuits with diodes
This practice aims at using the PSIM simulation software to mount and measure basic circuits with diodes, such as rectifier circuits (half-wave and full wave), as well as different configurations of signal trimming circuits.

Practice 5: Assembly and measurement of basic electronic circuits with transistors
The fundamental objective of this practice is that the student understands the concepts of the working point of a transistor, and in this way check the zones of operation it works (active, cut-off and saturation). For this purpose, different simple circuits in direct current with bipolar transistors will be carried out in PSIM.

Practice 6: Simulation of electronic circuits with diodes and transistors
The aim of this practice is to familiarize the student with the PSIM electronic circuit simulation software, for the realization of non-linear circuits with diodes and analysis of the working point of bipolar junction and field effect transistors. The small signal amplifiers will also be introduced in the simulator, so that the student understands how they work.

Practice 7: Design of complex analogue systems with amplifiers
The aim of this practice is that the student is able to design, assemble and test a multi-stage amplification circuit, in PSIM, combining different types of amplifiers (small signal and operational), observing the differences between them. For this purpose, the amplifier will be designed and the assembly will be done in an incremental way, incorporating progressively the elements (preampliication, amplification, impedance matching, etc.). In the same way, the student understands the usefulness of this type of amplifier assembly and its interconnection with other engineering concepts such as, for example, signal treatment of different devices and the adapting of the voltage or current levels to operate with them efficiently.

TEACHING METHODOLOGY

A new teaching methodology would be added:

Synchronous online meeting (theory or practical session):
These sessions will be given through a web videoconferencing platform within a virtual classroom. Each virtual classroom will contain various display panels and components, whose design can be customized by the teacher to suit the needs of the class. In the virtual classroom, teachers (and authorized participants) will be able to share their computer screen or files, use a whiteboard, chat, broadcast audio and video, or participate in interactive online activities (surveys, questions, etc.).

LEARNING ASSESSMENT

In a non-presential/online scenario, the evaluation of learning in the online modality will take place combining the FAITIC-Moodle platform with the Campus Remoto tool of the University of Vigo (and/or similar platforms). Below, we show the modifications in the weighting of the tests motivated by the change to the online teaching modality. These changes only affect the continuous assessment of the ordinary call.

Ordinary call

Continuous evaluation

The assessment of theoretical learning will remain unchanged from what was described earlier in this teaching guide in terms of content, weightings, minimum requirements and number of exams.

The assessment of practical learning will be modified by replacing the test that can be assessed in person with a paper. Therefore, the practical part will be evaluated by means of two works whose content and weighting is detailed in the following section.

Practical knowledge:

The laboratory practice part is evaluated by carrying out two group works, as follows:

Group work 1 (L1):
- Design and simulation of a digital circuit that solves a real problem that the students propose according to their particular needs.
- The work proposal will be approved by the teachers to check that it meets the minimum milestones of the task.

- In the event that the students do not propose a work within the deadline set by the teachers at the beginning of the course, a generic work will be assigned to them with the necessary requirements.
- The work will be done in groups of maximum 2 students.
- Weight: 15% of the continuous assessment score (NEC).
- It is qualified with 10 points.
- A minimum score of 4.0 points is required.

Group work 2 (L2):
- Design and simulation of an analogical electronic system for the solution of an engineering problem.
- The work proposal will be approved by the teachers to check that it meets the minimum milestones of the task.
- In the event that students do not propose a work within the deadline set by the teachers at the beginning of the course, a generic work will be assigned to them with the necessary requirements.
- Weight: 15% of the continuous assessment 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 + 0.15*L1 + 0.15*L2

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)

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

Competencies	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
B4	Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of Industrial Engineering in Mechanical specialty.
B5	Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
B6	Capacity for handling specifications, regulations and mandatory standards.
B11	Knowledge, understanding and ability to apply the necessary legislation in the exercise of the profession of Industrial Technical Engineer.
C25	Knowledge and skills for engineering materials.
D5	Information Management.
D7	Ability to organize and plan.
D9	Apply knowledge.
D10	Self learning and work.
D15	Objectification, identification and organization.
D17	Working as a team.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
To know the main forming processes and transformation of materials used in the industry.	B3 B4	C25	D5
(*)Work the critical spirit #since a point of linguistic view and *tradutolóxico.			
To show capacity to select the prepararon process more adapted for the obtention of basic pieces from a determinate material.	B3 B4 B5	C25	D7 D9
(*)Work the critical spirit #since a point of linguistic view and *tradutolóxico.			
To know the main union processes of the materials used in the industry.	B3	C25	D9

To comprise the complex interrelationships between the properties of the materials and forming and union processes to be able to optimise the properties and the productivity in a wide margin of industrial states.	B4 B5 B6	C25	D9
To know the characteristics of the materials more usually employed in Engineering.	B3 B6	C25	D5
To know the evolution of the distinct types of materials and of the processes for his possible forming.	B3 B6	C25	D5
To know and to apply the selection criteria for the most adapted material and a concrete application.		C25	D9
To analyse and to propose operative solutions to problems in the field of materials engineering.	B4 B11		D9 D15
To interpret, analyse, synthesize and extract conclusions and results of measures and essays.	B4	C25	D7 D15
To draft texts with the suitable structure to the aims of communication. To present text to a public with the strategies and the suitable means.	B11		D5 D7 D17
To show capacities of communication and work in team.		C25	D17
To identify the own needs of information and uses the means, spaces and available services to design and execute suitable researches to the thematic field.	B4	C25	D5
To carry out to term the works entrusted from the basic orientations given by the professor, deciding the length of the parts, including personal contributions and expanding sources of information.	B4 B6	C25	D7 D10
ENAEE learning outcome: KNOWLEDGE And UNDERSTANDING: LO1.2.- Knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront. [level of achievement (basic (1), intermediate (2) and advanced (3) for this learning outcome: intermediate (2)].	B3	C25	
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.1.- Ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses [intermediate (2)].	B4	C25	D9
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.2.- Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical □societal, health and safety, environmental, economic and industrial □ constraints [intermediate (2)].	B4		D9
ENAEE learning outcome: ENGINEERING DESIGN: LO3.1.- Ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical □ societal, health and safety, environmental, economic and industrial□ considerations; to select and apply relevant design methodologies [basic (1)].	B4 B5		D7 D9
ENAEE learning outcome: INVESTIGATIONS: LO4.1.- Ability to conduct searches of literature, to consult and to critically use scientific databases and other appropriate sources of information, to carry out simulation and analysis in order to pursue detailed investigations and research of technical issues in their field of study [intermediate (2)].	B6 B11		D5
ENAEE learning outcome: INVESTIGATIONS: LO4.3.- Laboratory/workshop skills and ability to design and conduct experimental investigations, interpret data and draw conclusions in their field of study [advanced (3)].		C25	D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.3.- Understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study [advanced (3)].		C25	D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.4.- Ability to apply norms of engineering practice in their field of study [intermediate (2)].	B6 B11		D9
ENAEE learning outcome: COMMUNICATION AND TEAM-WORKING: LO7.1.- Ability to communicate effectively information, ideas, problems and solutions with engineering community and society at large [basic (1)].	B4		D5
ENAEE learning outcome: COMMUNICATION AND TEAM-WORKING: LO7.2.- Ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers [intermediate (2)].			D5 D7 D10 D17

Contents

Topic	
UNIT 1: MECHANICAL PROPERTIES OF MATERIALS Location and length: Weeks 1-2 [5 hours] Objective and development: This unit sims to study the main selection criteria of materials, including technological and mechanical properties. It also studied the location, extraction and concentration of metals in nature.	1.1 CRITERIA OF MATERIAL SELECTION Introduction. Parameters that influence in the selection process. Materials in the design process. Technological properties: Cost, supply and transformation. Relation with user. Interaction with the environment. 1.2 MECHANICAL PROPERTIES Introduction. Relation stress-deformation. Elastic and plastic behaviour. Ductility. Hardness. Fracture. 1.3 OBTENTION OF METALLIC MATERIALS Introduction. Abundance of metals. Metals in nature. Metallurgy: obtention of metals from one of their minerals. Concentration of ores.
UNIT 2: MATERIALS FOR TOOLS Location and length: Weeks 2-3 [4 hours] Objective and development: It is estudiad the metallurgy operations, which involve the extraction and production of steel, as well as the obtention of other relevant structural materials.	2.1 STRUCTURAL MATERIALS: METALS AND ALLOYS Introduction. Iron extraction and steel production. Recycling of steel and its environmental impact (UNE-EN 13437). Steels classification. Non-ferrous alloys. 2.2 MATERIALS FOR DEFENCE: STEELS FOR ARMOURS; ALLOYS OF ALUMINIUM, TITANIUM AND MAGNESIUM
UNIT 3: STRUCTURAL AND BUILDING MATERIALS Location and length: Weeks 3-4 [4 hours] Objective and development: This unit deepens in building materials, mainly in the technology of concrete and wood, as well as the uses of the polymers and ceramic, regarding the raw materials and degradation, among others.	3.1 THE PORTLAND CEMENT. TECHNOLOGY OF CEMENTS Raw materials (water, arids, additives) and manufacture. Reactions of hydratation and hardening. Expansion and contraction. Mechanical resistance. Inventory of emmisions. Measures in fresh and hardened concrete. Degradation of cements. 3.2 WOODS Structures, properties and main woods. Technology of woods. Degradation and recycling of woods. 3.3 POLYMERS Structures, properties and main polymers. Uses as building materials. Degradation and recycling of polymers. 3.4 CERAMICS Structure, properties and main ceramic materials. Uses as building materials. Degradation and recycling of ceramic materials.
UNIT 4: DEGRADATION OF MATERIALS. THERMAL, THERMOCHEMICAL AND THERMOMECHANICAL TREATMENTS Location and length: Weeks 4-6 [6 hours] Objective and development: This unit analyses the principles of materials corrosion, the importance of the different microstructures in steels and the thermal treatments, as well as thermochemical treatments, with and without change of composition of the material.	4.1 DEGRADATION OF MATERIALS. PROCESSES OF CORROSION Principles of corrosion. Types of corrosion. Thermodynamics and kinetics of corrosion. Protection against corrosion. 4.2 THERMAL TREATMENTS Introduction. Thermal cycle. Normalisation and annealing. Martensitic transformations: Time-Temperature-Transformation diagrams (TTT). Quenching. Isothermal treatments: austempering, martempering, isothermal annealing. Problems generated during the thermal treatments. 4.3 THERMOCHEMICAL AND SUPERFICIAL TREATMENTS Introduction. Superficial modification, without change of composition: Quenching by flame, induction or laser, hardening by transformation, superficial fusion. Superficial modification, with change of composition: carburization, nitrurization, carbonitrurization. Types of coatings: coatings by immersion, coatings by electrodeposition, annealing, ceramic coatings, physical and chemical deposition, thermal projection. Preparation of the surfaces by mechanical treatments: cleaning with dissolvent, cleaning with mechanical tools.
UNIT 5: MATERIALS SUBJECTED TO SMELTING, PLASTIC AND VISCOELASTIC DEFORMATION AND POWDER COMPACTION Location and length: Weeks 7 -9 [6 hours] Objective and development: This unit analyses the answer of different materials subjected to distinct processes of conformed, like the smelting of metals, the plastic deformation of metals, the molding, injection and extrusion of polymers and the poder metallurgy.	5.1 SMELTING Foundations of the smelting of metals 5.2 ANSWER OF THE MATERIALS SUBJECTED TO THE MAIN PROCESSES OF PLASTIC DEFORMATION 5.3 ANSWER OF THE MATERIALS SUBJECTED TO THE MAIN VISCOELASTIC PROCESSE Molding of polymers 5.4 POWDER METALLURGY

UNIT 6: UNION AND WELDING TECHNOLOGIES Location and length: Weeks 9-11 [3 hours] Objective and development: This unit analyses the main union technologies: the union by means of adhesives and the union by means of welding.	6.1 ADHESIVE MATERIALS 6.2 MATERIALS FOR WELDING
LABORATORY (14 hours)	P1. Obtention of aluminium by aluminothermy and/or electrolysis (2 hours) It is studied the concentration processes of metals from the ores by means of extraction processes. It will be employed AENOR norms (accessible database through the University of Vigo). For example, it will be proposed to research some of the following norms and the consequent resolution of questions: . Mechanical characteristics of the aluminium and its alloys (UNE-EN 683-2:2008) . Annealing of aluminium and its alloys (UNE 38019:2017) . Scrap of the aluminium and its alloys (UNE-EN 12258-3:2004). . Welding of the aluminium and its alloys (UNE-EN ISO 9692-3:2016). P2. Evaluation of building materials (concretes) (4 hours) The student manufactures concrete with different compositions and study its properties in fresh and hardened material. It is also analized the Instruction of Structural Concrete (EHE-08). Students work in groups the resolution of a more complex problem, so that its realisation need of the cooperative work of two students (or three students, exceptionally). It is included in this time the presentation and evaluation of the project. P3. Influence of corrosion in the modification of mechanical properties (2 hours) Student performs essays of corrosion in metals and study the reactions involved. P4. Superficial treatments of materials: cataphoresis and electrolytic cleaning (2 hours) Student makes treatments of surfaces recovery with painting applied by means of cataphoresis and elimination of oxides adhered with electrolytic cleaning. P5. Thermal treatments of materials: normalised, annealing and quenching (2 hours) Students test three thermal treatments on metal probes and their effects on mechanical properties. P6. Union technologies: evaluation of adhesives (2 hours) Student determine the most effective unions between materials by means of simple or hybrid unions, in different environmental conditions. They will use the AENOR norms (accessible database through the University of Vigo). For example, it will be proposed researches of some of the following norms and the consequent resolution of questions: . Self-adhesive tapes (UNE-EN 12481:2002) . Adhesives for paper, cardboard and packagings (UNE-CR 14376:2002) . Adhesives. Terms and definitions (UNE-EN 923:2016) The laboratory program may vary to adjust to the master classes or seminar sessions.
SEMINARS (7 hours)	Seminars in small groups, which will reinforce the contents of the master classes.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	38	66
Problem solving	7	14	21

Seminars	15	15	30
Laboratory practical	12	0	12
Essay questions exam	4	4	8
Problem and/or exercise solving	9	0	9
Presentation	2	2	4

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

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

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

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

Other comments on the Evaluation

Ordinary and Extraordinary Examinations In order to evaluate all the competences in the ordinary and extraordinary exams, these will include, in addition to questions of theory and part of problems, questions of the laboratory sessions. The evaluation will be considered positive when a score of 5 points out of 10 is reached.**Intensive course**Those students who have not passed the course at the first opportunity will attend an intensive course of 15 hours, in which tasks will be carried out to reinforce the main theoretical and practical contents taught in the course. At the end of such course the extraordinary examination will be carried out.**ETHICAL COMMITMENT**It is expected that students have an adequate ethical behavior. If unethical behavior is detected (copying, plagiarism, use of unauthorized electronic devices or others), the student will be penalized with the impossibility of passing the subject by the continuous assessment modality (in which he will obtain a grade of 0.0). If this type of behavior is detected in ordinary or extraordinary exam, the student will obtain in the call a score in 0.0 points out of 10.

Sources of information

Basic Bibliography

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

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

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

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

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

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

Complementary Bibliography

Recommendations

Other comments

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

Contingency plan

Description

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

 Section 6 (CONTENTS):

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

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

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

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

 Section 10 (EVALUATION):

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

IDENTIFYING DATA				
Elasticity and additional topics in resistance of materials				
Subject	Elasticity and additional topics in resistance of materials			
Code	P52G381V01303			
Study programme	(*)Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Cacabelos Reyes, Antón			
Lecturers	Cacabelos Reyes, Antón Febrero Garrido, Lara			
E-mail	acacabelos@cud.uvigo.es			
Web	http://faitic.uvigo.es			
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. 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.			

Competencies	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
B4	Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of Industrial Engineering in Mechanical specialty.
C22	Knowledge and skills to apply the fundamentals of elasticity and strength of materials to the actual behavior of solids.
D2	Problems resolution.
D5	Information Management.
D9	Apply knowledge.
D10	Self learning and work.
D17	Working as a team.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Kowledge of the elasticity fundamentals	B3	C22	
Further deepening on mechanics of materials and stress analysis	B3 B4	C22	D2 D10
Knowledge of deformations in beams and shafts	B3 B4	C22	D2 D9
Ability to apply the knowledge of elasticity and mechanics of materials, and to analyze the mechanical performance of machines, structures, and general structural elements	B4	C22	D2 D5 D9

Ability to take decisions about suitable material, shape and dimensions for a structural element subjected to a specific load	B4	C22	D2 D5 D9 D17
Knowledge of different solving methods for structural problems and ability to choose the most suitable method for each specific problem	B4	C22	D2 D5 D9
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)].	B3	C22	
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)].	B4		D2 D9
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)].		C22	D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.1.- understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study [Level of achievement: Intermediate (2)].		C22	D9

Contents

Topic	
Review of Strength of Materials	Axial loading. Shear. Pure bending and nonuniform bending.
Fundamentals of elasticity	Introduction to Elasticity. Goals of Elasticity and Strength of Materials. Definition of stress in elastic solids. Stress tensor. Principal stresses and principal directions. Graphic representation of three-dimensional stress. Mohr´s Circles. Deformation analysis in continuum media. State of strain at a point. Strain tensor. Graphic representation of deformational state. Mohr´s Circles. Stress-Strain relations. Stress-Strain experimental relations. Generalized Hooke´s laws.
Torsion	Torsion of a prismatic bar of circular cross section. Coulomb□s theory. Design of transmission shafts. Strain energy stored by torsion. Statically indeterminate torsion members. Torsion of noncircular prismatic bars.
Combined loadings	Combined Loadings. Combined bending and torsion in bars of circular cross section Bending of beams of nonsymmetrical section. Shear center. Combined axial and bending load in non-slender bodies. Thin-wall pressure vessels.
Lateral bending. Buckling.	Buckling. Introduction. Centric compression load in slender column. Euler critical load. The effect of end conditions on critical load. Eccentric load in slender column. Validity range in Euler buckling theory. Design formulas for columns. Bucking coefficients method for column design.
Strain energy. Energy methods.	Strain energy concept. External loads and strain relations. Influence coefficients concept. Strain energy expressions. Clapeyron theorem. Principle of virtual works. Castigliano´s theorems.

Criteria for initiation of inelastic material behavior. Failure condition.	Plastic deformation of materials. Failure condition. Maximum normal stress theory or Rankine theory Maximum normal strain theory or Sain-Venant theory. Maximum shear stress theory or Coulomb theory. Maximum strain energy theory or Beltrami-Haigh theory Maximum distorsion energy theory or von Mises theory Comments about failure theories. Safety factor.
Experimental methods in elasticity	Electrical strain gages method. Fundamentals. Electrical strain gages. Data analysis. Photoelasticity. Fundamentals. Basic optical concepts in photoelasticity. Photoelasticity equipment. Interpretation of the stress contours.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	56	84
Problem solving	7	0	7
Seminars	15	0	15
Laboratory practical	14	14	28
Essay questions exam	11	2	13
Essay	1	2	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	The general contents of the subject will be presented in a structured way, emphasizing the fundamentals and main characteristics and those of more difficult understanding for the student. During the course, the content that will be taught during the following, week will be shown in the online platform, so that the student will be able to prepare the contents in advance.
Problem solving	Activity in which problems and/or exercises related to the subject will be solved. The student has to develop the suitable or correct solutions by means of the exercises, the application of formulas or algorithms, the aplication of procedures of transformation of the available information and the interpretation of the results. It complements the Master Session.
Seminars	Intensive course of 15 hours for those students who have failed the subject in first call, prior to the exam in second call. Group tutoring with the lecturer.
Laboratory practical	Practices of cooperative laboratory in which the theoretical concepts studied in the master sessions will be applied.

Personalized assistance

Methodologies	Description
Lecturing	In the field of the tutorial action, actions of academic tutorial as well as personalised tutorial can be considered. In the first case, the students will have office hours to ask about any question related with the contents. The tutorials can be one by one, but group tutorials for the resolution of problems will be encouraged. In the personalised tutorials, each student will be able to comment with the lecturers about any problem or idea to take a suitable follow-up of the subject. The lecturers of the subject will answer personally the questions and queries of the students, both in person, according to the schedule that will be published on the website of the center, and through telematic means (email, videoconference, FAITIC forums, etc. .) under the modality of previous appointment.

Assessment

	Description	Qualification	Training and Learning Results
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	B4 C22 D2 D5 D9 D10
Essay questions exam	Written tests: theoretical questions and problems. The written tests give as an objective to the evaluation of the learning of all the theoretical contents selected for the subject. - Final exam (PF): 40% - Intermediate exam (PI): 30%	70	B3 B4 D2 D9

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	B3 B4	C22	D2 D9 D10

Other comments on the Evaluation

The criteria of evaluation of each section will be published at the beginning of the quadmester. They will be provided to the students, through the virtual platform.

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 + 0,3*PI + 0,2*MP + 0,1*AE

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.

However, some minimum requirements will be demanded:

If some of the previous examinations is not delivered or a grade inferior to 4 points is obtained in the final examination, the qualification of the continuous evaluation will be the minimum of the grade of continuous evaluation calculated with the previous 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 suppose that the student or students involved will not pass the subject by continuous evaluation (where you will get a grade of 0,0). Likewise, the student or group of students who are found to have plagiarized or copied a work will obtain a grade of zero. 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 any case, the student who has passed the continuous evaluation, is offered the opportunity to sit for the ordinary exam to upload a grade.

Sources of information

Basic Bibliography

Hibbeler R.C., **Mecánica de Materiales**, 8ª Edición,
Gere J. M. y Timoshenko S. P., **Resistencia de Materiales**,
Craig R R., **Mechanics of Materials**, 3th Editio,

Complementary Bibliography

Hibbeler R.C., **Mechanics of Materials, SI Edition**, 9th Edition in SI units,
Gere J. M. y Goodno B. J., **Mechanics of Materials**, 8th Edition in SI units,
Luis Ortiz-Berrocal, **Elasticidad**, 3a Edición,
Luis Ortiz-Berrocal, **Resistencia de Materiales**, 3a Edición,
Philpot T. A., **Mechanics of materials: an integrated learning systems**, 2nd Edition,
Rodríguez Avial, M., **Problemas de elasticidad y resistencia de materiales**,
Lumbreras Azanza, José Javier, **Elasticidad y resistencia de materiales. Prácticas de laboratorio**,

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

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===

Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===

* Teaching methodologies modified

A new teaching methodology is added:

Synchronous online meeting (theory or practical session): It is taught through a web video conferencing platform. Each virtual classroom contains various display panels and components, the design of which can be customized to best suit the needs of the class. In the virtual classroom, lecturers (and those authorized participants) can share their computer screen or files, use a whiteboard, chat, stream audio and video, or participate in interactive online activities (surveys, questions, etc.).

* Non-attendance mechanisms for student attention (tutoring)

The tutorials will be held in a virtual office on the remote campus of University of Vigo.

* Modifications (if applicable) of the contents

Section 6 CONTENTS: The sessions of laboratories PL1, PL2, PL3 and PL6 are developed using equipment from the laboratories. These practices, as far as possible, would be replaced by demonstration tasks, solving exercises and / or practical cases that allow the student to achieve the objectives set for such practices. The PL4 and PL5 practices require computer programs. If the license of the programs and the capacities of the students' computer equipment allow it, these practices will be maintained or adapted to achieve the objectives set for those practices. The PL7 laboratory session, on the other hand, allows adaptation to the online modality in a simpler way since it is aimed at reinforcing topic 6 by solving problems by applying energy theorems.

=== ADAPTATION OF THE EVALUATION ===

Section 10: EVALUATION: The evaluation tests would be carried out by combining the FAITIC-Moodle online teaching platform and the Remote Campus of the University of Vigo.

IDENTIFYING DATA				
Enxeñaría gráfica				
Subject	Enxeñaría gráfica			
Code	P52G381V01304			
Study programme	Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	1c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín			
Coordinator	Arce Fariña, María Elena			
Lecturers	Arce Fariña, María Elena Puente Luna, Iván			
E-mail	elena.arce@cud.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Esta materia enmárcase dentro do módulo de Tecnoloxía Mecánica. Enlaza e complementa a materia Expresión Gráfica de primeiro curso e pretende englobar toda a linguaxe do debuxo técnico, reforzando a base teórica, os fundamentos xeométricos que permiten a concepción e visualización das formas e dimensións, e ampliando a práctica, a través dos xa ineludibles contornas informáticas. Todo iso sen esquecer o estudo da Normalización, que facilita o intercambio de información técnica a través da linguaxe gráfica das normas vixentes. O obxectivo é a creación e manexo de información gráfica desde a perspectiva do enxeñeiro mecánico, particularizando nas características concretas do grao impartido no Centro Universitario da Defensa de Marín. Abarcarase a xeometría descritiva de superficies, a informática gráfica, a definición de conxuntos e mecanismos de maneira inequívoca, a representación normalizada de buques, etc., buscando unha formación xeneralista e sobre todo adecuada e útil para o futuro desempeño dos estudantes.			

Competencias	
Code	
B1	Capacidade para a redacción, sinatura e desenvolvemento de proxectos no ámbito da enxeñaría industrial, na especialidade de Mecánica, que teñan por obxecto, dacordo cos coñecementos adquiridos segundo o establecido no apartado 5 de esta orde, a construción, reforma, reparación, conservación, demolición, fabricación, instalación, montaxe ou explotación de: estruturas, equipos mecánicos, instalacións enerxéticas, instalacións eléctricas e electrónicas, instalacións e plantas industriais, e procesos de fabricación e automatización.
C19	Coñecementos e capacidades para aplicar as técnicas de enxeñaría gráfica.
D2	Resolución de problemas.
D6	Aplicación da informática no ámbito de estudo.
D9	Aplicar coñecementos.
D10	Aprendizaxe e traballo autónomos.
D14	Creatividade.
D16	Razoamento crítico.
D17	Traballo en equipo.

Resultados de aprendizaxe			
Expected results from this subject	Training and Learning Results		
Coñecer e dispor de criterios fundamentados para a elección e aplicación de compoñentes normalizados.	B1	C19	D2 D9 D10 D16
Saber aplicar a xeometría na resolución de problemas de construcións e instalacións industriais.		C19	D2 D9 D14
Adquirir habilidades para crear e xestionar información gráfica relativa a problemas de enxeñaría mecánica.		C19	D10 D14 D16 D17
Capacidade para realizar análise do funcionamento dos mecanismos a partir das especificacións dos planos.	B1	C19	D2 D9 D14
Coñecer as tecnoloxías CAD para o modelado xeométrico e a xeración de planos a partir de leste.		C19	D6 D9 D10

RESULTADO 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)		C19	
RESULTADO 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)	B1		D2 D9
RESULTADO 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)			D2 D9 D14 D16
RESULTADO DE APRENDIZAXE ENAEE: 3. PROXECTOS EN 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: Avanzado (3)		C19	D2 D9
RESULTADO DE APRENDIZAXE ENAEE: 3. PROXECTOS EN ENXEÑARÍA Subresultado: 3.2 Capacidade de proxecto utilizando algún coñecemento de vangarda da súa especialidade de enxeñaría. Nivel de desenvolvemento: Adecuado (2)	B1	C19	D9
RESULTADO DE APRENDIZAXE ENAEE: 5. APLICACIÓN PRÁCTICA DA ENXEÑARÍA Subresultado: 5.1 Comprensión das técnicas aplicables e métodos de análises, proxecto e investigación e as súas limitacións no ámbito da súa especialidade. Nivel de desenvolvemento: Adecuado (2)		C19	D9
RESULTADO 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)			D2 D9 D16
RESULTADO 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)	B1		D10 D17

Contidos	
Topic	
CONTIDOS TEORICOS	.
Tema 1. Introdución aos gráficos de enxeñaría.	1.1. Tipos de gráficos en enxeñaría. Campos de aplicación. Gráficos para o deseño, a visualización e a comunicación. A linguaxe gráfica. 1.2. Sistemas gráficos. Tipos e estrutura dos ficheiros gráficos. Manexo da información. Xerarquías. Capas. 1.3. Modelos. Modelo xeométrico. Asociatividade da información. 1.4. Construcións gráficas empregadas en enxeñaría. 1.5. Diagramas e nomogramas.
Tema 2. Deseño mecánico e utilización de elementos de transmisión.	2.1. Condicións de utilización e montaxe de árbores e eixos, casquillos e rodamentos, poleas, rodas dentadas, cadeas de transmisión, cables, tensores, levas, cardans, flectores, amortiguadores, aisladores de vibracións. 2.2. Definición e representación de engrenaxes. Rodas dentadas. Representación convencional. 2.3. Definición e representación de rodamentos. Tipos de rodamentos. Representación convencional. Montaxe e freo. Tolerancias. Rótulas e cabezas de articulación con rótulas. 2.4. Estanqueidade. Estanqueidade estática e dinámica. Xuntas e Reténs. Compatibilidade cos líquidos.

Tema 3. Deseño estrutural.	3.1. Estudo de unións. Natureza das unións. Criterios para o deseño de unións: graos de liberdade. Métodos de realización de unións. 3.2. Utilización nos deseños de elementos de unión.Clasificación dos elementos de fixación. Estudo dos elementos de unión. Esforzos. Criterios de montaxe. Condicións específicas de utilización en deseño dos anteriores elementos de unión. 3.3. Deseño de unións permanentes. Soldadura, tipos e simboloxía empregada nos planos. Regras de deseño de pezas soldadas. Estudo de unións de chapas e perfís laminados. Consideracións de proxecto. Solucións máis frecuentes empregadas na realización de nós de estruturas metálicas. Remachado, tipos convencionais de remaches e sistemas especiais. Estudo de unións de chapas e perfís de uso aeronáutico.
Tema 4. Xestión da variabilidade; repercusión funcional das tolerancias. Análise e síntese de tolerancias.	4.1. A variabilidade asociada aos problemas de enxeñaría. 4.2. Variabilidade macro e micro xeométricas. 4.3. Tolerancias dimensionales e axustes. Especificación. 4.4. Tolerancias xeométricas. Especificación. 4.5. Referencias e sistemas de referencia. 4.6. Tolerancias de rugosidade superficial. Especificación. 4.7. Tolerancias estatísticas. Funcións de custo das tolerancias. 4.8. Análise de tolerancias e síntese de tolerancias. 4.9. Combinación de tolerancias; repercusión no funcionamento da acumulación de tolerancias.
Tema 5. Especificación xeométrica de produtos.	5.1. Especificación xeométrica segundo ISO. 5.2. Cadeas de Normas ISO. 5.4. Matrices de Normas GPS.
Tema 6. Fundamentos dos gráficos por computador.	6.1. Transformacións xeométricas básicas. 6.2. Graficación de liñas: algoritmos básicos. 6.3. Modelado de superficies: implícitas, paramétricas, redes poligonales. 6.4. Modelado de sólidos: métodos e esquemas de representación.
Tema 7. Sistemas CAD/CAE/CAM. Sistemas para adquisición de datos das xeometrías reais. Prototipado rápido.	7.1. Sistemas CAx (Computer Aided Technologies). 7.2. Ferramentas CAD/CAM. 7.3. Ferramentas CAE no contexto da enxeñaría de deseño. 7.4. Realidade virtual: características e dispositivos. Aplicacións no campo da enxeñaría. 7.5. Dixitalización de formas. Proxectos de enxeñaría inversa. 7.6. Sistemas de prototipado rápido.
Tema 8. Introdución ao deseño industrial.	8.1. Deseño. Tipos. O deseño industrial (produto, comunicación e imaxe corporativa). 8.2. Metodoloxías para o deseño. 8.3. Etapas do proceso de deseño. 8.4. A creatividade no proceso de deseño. 8.5. Valoración de alternativas de deseño. 8.6. DfX (Design for X).
Tema 9. Introdución ao debuxo naval.	9.1. Conceptos xerais en Construción Naval. 9.2. Clasificación de buques. 9.3. Introdución ás técnicas de representación de buques. 9.4. Dimensións e características principais dos buques. 9.5. Coeficientes adimensionais que caracterizan as formas do buque. 9.6. Elementos estruturais e construtivos.
Tema 10. Representación de buques.	10.1. Proxecto de construción do buque. Documentación e planos a desenvolver. 10.2. Plano de formas e liñas do buque. 10.3. Curva de áreas e sección mestra. 10.4. Marcas de calado. 10.5. Representación e anotación da estrutura e seccións do buque. 10.6. Planos xerais e de detalle da estrutura do buque. Coaderna mestra, desenvolvemento do forro exterior, seccións típicas, cubertas e bloques. 10.7. Disposición Xeral do buque. Contornos, espazos, tanques, etc... 10.8. Planos de instalacións e maquinaria.
CONTIDOS PRÁCTICOS	.
Prácticas 1, 2 e 3. Modelado de sólidos e ensambles.	Nas primeiras sesións de laboratorio o alumno aprenderá a xerar elementos tridimensionais utilizando as ferramentas habituais de modelado.
Práctica 4. Confección de documentación técnica (planos, proxectos, etc.).	O obxectivo fundamental desta práctica é que o alumno aprenda a utilizar as ferramentas de confección da documentación técnica obtida a partir dos modelos e ensamblaxes realizadas anteriormente.

Práctica 5. Enxeñaría inversa	O obxectivo fundamental desta práctica é que o alumno realice a reconstrución tridimensional dun obxecto a partir de fotografías. O software pode ser elixido polo alumno, suxeríndose a posibilidade de empregar: Meshroom, Eyescloud, ReCap Prol e Agisoft Photoscan (ou Metashape). A reconstrución realizarase a partir de varias fotografías, xa que se se utiliza unha única fotografía non se conseguirá unha reconstrución fiel, senón unha aproximación.
Prácticas 6 e 7. Deseño e modelado dun Equipo de Protección Individual (EPI) ou unha prótese ortopédica.	O obxectivo fundamental destas prácticas deseñar e desenvolver un destes elementos (a definir polo alumnado): EPI en postos de operarios (caretas protectoras, lentes de protección, cascos, orelleiras, etc.) para a prevención e protección fronte aos accidentes laborais e danos para a saúde. Prótese ortopédicas. O alumno deberá realizar o modelo 3D do conxunto ensamblado e planos do mesmo.

Planificación

	Class hours	Hours outside the classroom	Total hours
Lección maxistral	28	42	70
Prácticas con apoio das TIC	14	21	35
Seminario	7	7	14
Resolución de problemas e/ou exercicios	17	1	18
Exame de preguntas de desenvolvemento	9	1	10
Práctica de laboratorio	2	1	3

*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 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 transparencias 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 transparencias nunca deben ser consideradas como substitutos de apuntamentos tomados en clase ou dos textos suxeridos na bibliografía, senón como material complementario.
Prácticas con apoio das TIC	Actividades de aplicación dos coñecementos a situacións concretas e de adquisición de habilidades básicas e procedimentales relacionadas coa Enxeñería gráfica. Estas desenvolveranse en aulas de informática con equipamento especializado.
Seminario	Realización de actividades de reforzo á aprendizaxe mediante a resolución tutelada de maneira grupal de supostos prácticos vinculados aos contidos teóricos e prácticos da materia. 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 nestas clases de seminarios grupales.

Atención personalizada

Methodologies	Description
Seminario	No ámbito da acción titorial, distínguense accións de tutoría académica así como de tutoría personalizada. No primeiro dos casos, o alumnado terá á súa disposición horas de tutorías nas que pode consultar calquera dúbida relacionada cos contidos, organización e planificación da materia, co desenvolvemento dos temas, casos prácticos, comentarios de texto, etc. As tutorías poden ser individualizadas, pero fomentaranse tutorías grupales para a resolución de problemas relacionados coas actividades a realizar en grupo, ou simplemente para informar ao docente da evolución do traballo colaborativo. Nas tutorías personalizadas, 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. Conxugando ambos os tipos de acción titorial, preténdense compensar os diferentes ritmos de aprendizaxe mediante a atención á diversidade. Os profesores da materia atenderán persoalmente ás dúbidas e consultas dos estudantes, tanto de xeito presencial, segundo o horario que se publicará na páxina web do centro, como a través dos medios telemáticos (correo electrónico, videoconferencia, foros FAITIC, etc.) baixo a modalidade de cita previa.

Avaliación

	Description	Qualification	Training and Learning Results
Prácticas con apoio das TIC	PROBA PRÁCTICAS (peso na avaliación: 20%) Realizarase unha proba práctica de avaliación baseada nos problemas realizados en clase. ENTREGABLES PRÁCTICAS (peso na avaliación: 20%) Ao longo do cuadrimestre, en determinadas sesións de prácticas, exporanse problemas que deberán ser resoltos polos alumnos e entregaranse para a súa avaliación cando o determine o profesor. A avaliación de cada entregable estará de acordo cos criterios que con anterioridade comunicáronse aos alumnos	40	B1 C19 D2 D6 D9 D14 D16 D17
Resolución de problemas e/ou exercicios	PROBA INTERMEDIA. Realizarase unha proba de curta duración. A realización das proba será obrigatoria e esixible para superar a materia. A temática da proba abarcará os contidos avanzados ata a data.	20	B1 C19 D9 D10 D16
Exame de preguntas de desenvolvemento	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.	40	B1 C19 D9 D10 D16

Other comments on the Evaluation

OBSERVACIÓNS SOBRE A AVALIACIÓN: 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 (NAC): NAC= 0.20 * PROBA INTERMEDIA + 0.20 * ENTREGABLES PRÁCTICAS + 0.20 * PROBA PRÁCTICAS + 0.40 * PROBA FINAL. Para superar a materia, a nota final de avaliación continua (NAC) calculada pola fórmula anterior deberá ser polo menos 5 puntos sobre 10. Ademáis, esixiranse uns requisitos mínimos e condicións nalgúns dos apartados, que garantan o equilibrio entre todos os tipos de competencias. A pesar de obter unha NAC de polo menos 5 puntos sobre 10, o alumno deberá presentarse ao exame ordinario de todos os contidos da materia, que suporá o 100% da nota, nos seguintes supostos: a) Non realizar algunha das probas intermedias ou a non asistencia a máis dunha sesión de prácticas; b) Obter unha nota inferior a 4 puntos sobre 10 na proba final de avaliación continua (PF). 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 tódalas competencias da materia. Por iso, os exames ordinario e extraordinario incluirán unha proba práctica de programación no laboratorio.

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 no devandito exame unha cualificación de 0.0.

Bibliografía. Fontes de información

Basic Bibliography

Félez, J.; Martínez, M.L., **Fundamentos de Ingeniería Gráfica**, Síntesis, 1999

Félez, J.; Martínez, M.L., **Ingeniería Gráfica y Diseño**, Síntesis, 2008

Complementary Bibliography

Company, P. P.; Gomis, J. M.; Ferrer, I., Contero, M., **Dibujo normalizado**, Servicio de Publicaciones de la Universidad Polité, 1997

Company, P.; Vergara, M.; Mondragón, S., **Dibujo Industrial**, Publicacions de la Universitat Jaume I, 2007

Pérez, J. L.; Palacios, S., **Expresión Gráfica en la Ingeniería**, Prentice Hall, 1998

Recomendacións

Subjects that continue the syllabus

Deseño de máquinas/P52G381V01405

Enxeñaría de fabricación e calidade dimensional/P52G381V01407

Subjects that it is recommended to have taken before

Expresión gráfica: Expresión gráfica/P52G381V01101

Plan de Continxencias

Description

=== MEDIDAS EXCEPCIONAIS PLANIFICADAS ===
Ante a incerta e imprevisible evolución da alerta sanitaria provocada pola COVID- 19, a Universidade establece una planificación extraordinaria que se activará no momento en que as administracións e a propia institución o determinen atendendo a criterios de seguridade, saúde e responsabilidade, e garantindo a docencia nun escenario non presencial ou non totalmente presencial. Estas medidas xa planificadas garanten, no momento que sexa preceptivo, o desenvolvemento da docencia dun xeito mais áxil e eficaz ao ser coñecido de antemán (ou cunha ampla antelación) polo alumnado e o profesorado a través da ferramenta normalizada e institucionalizada das guías docentes DOCNET.

==========

A continuación, detállanse aqueles aspectos que se modificarán na guía no caso de que se determine algunha actuación derivada de criterios de seguridade.

Apartados da guía docente onde se reflectirán cambios:

 Metodoloxía docente

Engádese unha nova metodoloxía docente:

- Sesión maxistral e/ou sesión práctica virtual síncrona:
Impártese a través dunha plataforma de videoconferencia web. Cada aula virtual contén diversos paneis de visualización e compoñentes, cuxo deseño se pode personalizar para que se adapte mellor ás necesidades da clase. Na aula virtual, os profesores (e aqueles participantes autorizados) poden compartir a pantalla ou arquivos do seu equipo, empregar unha lousa, chatear, transmitir audio e vídeo ou participar en actividades en liña interactivas (enquisas, preguntas, etc.).

 Avaliación da aprendizaxe

- As probas de avaliación realizaranse combinando a plataforma de teledocencia FAITIC-Moodle e o Campus Remoto da Universidade de Vigo.

IDENTIFYING DATA				
Fluid machines				
Subject	Fluid machines			
Code	P52G381V01305			
Study programme	(*)Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Regueiro Pereira, Araceli			
Lecturers	Regueiro Pereira, Araceli			
E-mail	regueiro@cud.uvigo.es			
Web	http://faitic.uvigo.es			
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 degree in mechanical engineering taught at the CUD. 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 degree in mechanical engineering leads to the subject being taught and evaluated aboard the "Juan Sebastián de Elcano" Training Ship.			

Competencies	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
C24	Applied knowledge of the basics of fluidmechanics systems and machines.
D2	Problems resolution.
D9	Apply knowledge.
D10	Self learning and work.
D17	Working as a team.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Understand basic concepts of fluid machinery.	B3	C24	D2 D9 D10
Acquire skills in the sizing process of pumping facilities and fluid machines	B3	C24	D2 D9 D10 D17
ENAEE Learning outcome: KNOWLEDGE AND UNDERSTANDING: RA1.2.- 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).	B3	C24	
ENAEE Learning outcome: ENGINEERING ANALYSIS: RA2.2.- 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)].			D2 D9
ENAEE Learning outcome: ENGINEERING DESIGN: RA3.2.- Ability to design using some awareness of the forefront of their engineering specialisation [Basic (1)].		C24	D9
ENAEE Learning outcome: INVESTIGATIONS: RA4.3.- laboratory/workshop skills and ability to design and conduct experimental investigations, interpret data and draw conclusions in their field of study [Basic (1)].		C24	D9
ENAEE Learning outcome: ENGINEERING PRACTICE: RA5.1.- Understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study [Basic (1)].		C24	D9

ENAEE Learning outcome: ENGINEERING PRACTICE: RA5.2.- Practical skills for solving complex problems, realising complex engineering designs and conducting investigations in their field of study [Basic (1)].	D9
ENAEE Learning outcome: ENGINEERING PRACTICE: RA5.3.- Understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study [Basic (1)].	D9
ENAEE Learning outcome: LIFELONG LEARNING: RA8.2.- . Ability to follow developments in science and technology [Basic (1)].	D10

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 fluid machinery in CAD assemblies.	Aims and development: In this first practical session the student opens CAD files prepared by the lecturer to visualise the constitutive elements of fluid machinery and hydraulic installations. The main aim of this practical activity is to strengthen the nomenclature and facilitate the three-dimensional visualisation of the flow in the interior of fluid machines.
Practice 2: CFD simulation of positive displacement pumps.	Aims and development: In this first CFD practice activity, dynamic mesh models are explained in order to define the movement of pistons, valves and rotary parts in volumetric pumps.
Practice 3: Hydraulic circuit simulation with demo software.	Aims and development: To strengthen the theoretical knowledge related with lesson 4, in this practice a hydraulic circuit will be designed, with the aim to understand the activities of each one of the elements involved: elements of generation, actuation and of control.

Practice 4: Pneumatic circuit simulation with demo software.	Aims and development: To strengthen the theoretical knowledge of the subject 5 it is expected that the student designs a pneumatic circuit of intermediate complexity to satisfy some requirements imposed by the lecturer, analyse the operation of the different elements and look for the greater simplicity of the circuit.
Practice 5: Analysis of a real hydraulic or pneumatic circuit using Fluidsim software	Aims and development: In order to strengthen the theoretical knowledge acquired in topics 4 and 5, and to reinforce the concepts and skills of software management developed in practices 3 and 4, this practice is proposed, in which Fluidsim software is used, the updates of which incorporate knowledge of Vanguard. In it, the student has to analyze a simple case of a real hydraulic or pneumatic circuit (hydraulic jack, hydraulic component of an excavator, opening of a door ...). The student will choose the component that he wants to analyze so that different components are studied and each student has to face different problems.
Practice 6: Problem solving involving turbopumps and installations.	Aims and development: The student will solve a problem of turbopumps in which parameters of design of the impeller and the installation come into play. Taking as a starting point a table with the record of experimental measurements, the operating curves of a centrifugal turbopump are derived and the operating point is evaluated for different configurations.
Practice 7: Calculation of a real hydraulic installation using the Epanet software	Aims and development: In this practice, problems with real pumping facilities are modeled and solved with the Epanet software. This practice is intended to inculcate that the available software tools facilitate the calculation work, but do not free the user from having the necessary engineering knowledge for the correct introduction of the data and interpretation of the results.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	26	39	65
Laboratory practical	14	21	35
Problem solving	22	1	23
Objective questions exam	4	4	8
Problem and/or exercise solving	10	9	19

*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 deepens 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.
Problem solving	Resolution of problems and/or exercises. The teacher solves a representative problem linked to the theory.

Personalized assistance

Methodologies	Description
Problem solving	In personalized tutorials, each student, individually, will be able to discuss with the teacher any problem that is preventing them from adequately monitoring the subject, in order to find some kind of solution between them. This is intended to compensate for different learning rhythms through attention to diversity. The teacher of the subject will personally attend to the doubts and queries of the students, both in person (being available in the midshipmen library every school day from 18:15 - 19:00), and through telematic means (email, videoconference, FAITIC forums, etc.) by appointment.

Assessment

	Description	Qualification	Training and Learning Results
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) carried out in the daily class schedule and whose purpose is to evaluate the assimilation of the contents by the students, motivate the autonomous study and identify those students requiring attention individual tutorial attention. During the course two intermediate tests are carried out consisting of conceptual questions and short problems.	30	B3 C24 D2 D9 D10
Laboratory practical	The evaluation of the practices carries out realising the average of the punctuations obtained in each one of the sessions. In each script of practices collect the tasks to realise and the criteria of evaluation. The activity of evaluation is varied according to the practice. In some of the practices evaluates with report, in others with questionnaire of short answer and others with resolution of problems posed.	30	C24 D2 D9 D17
(*)	Final written exam is a long-term test (4 hours) that aims to evaluate the learning of all the contents of the subject.	40	B3 C24 D2 D9 D10

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 * IntExam1+ 0,15* IntExam2 + 0,3 * PracticeMark+ 0,4 * FinalExam 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. Students that do not achieve to pass the subject by continuos evaluation shoult attend to a eight-hours intensive course previous to the date of the regular exam. Both the regular and the extraordinary exam (July 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/she will obtain a grade of 0). If this type of behavior is detected in regular or extraordinary exams, a 0 mark qualification is transferred to his/her academic record.

Sources of information

Basic Bibliography

C. Paz Penín, E. Suárez Porto, A. Eirís Barca, **Máquinas hidráulicas de desplazamiento positivo**, 2012

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 hídráulicas. Problemas y soluciones**, 2016

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

Recommendations

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.

Contingency plan

Description

MODIFICATIONS IN CASE OF EXTRAORDINARY SITUATIONS THAT INVOLVE THE SUSPENSION OF THE PRESENTIAL ACADEMIC ACTIVITY.

Next, those aspects that will be modified in the guide are detailed in the event that any action derived from security criteria is determined.

Sections of the teaching guide where changes will be reflected:

5. Teaching methodology
Two new teaching methodologies are added:
5.1 Classes and practices in the online modality:
It is taught through a web video conferencing platform. Each room contains various display panels and components, the design of which can be customized to best suit the needs of the classroom. In the virtual classroom, teachers (and those authorized participants) can share their computer screen or files, use a whiteboard, chat, stream audio and video, or participate in interactive online activities (surveys, questions, etc.).
5.2. Discussion forums: activities developed in a virtual environment to resolve doubts and / or debate on issues that arise in the study of the subject.

7. Assessment of learning
7.1. The evaluation tests will be carried out by combining the FAITIC-Moodle remote teaching platform and the Remote Campus of the University of Vigo

IDENTIFYING DATA				
Basics of business management				
Subject	Basics of business management			
Code	P52G381V01306			
Study programme	(*)Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Rodríguez Rodríguez, Francisco Javier			
Lecturers	Rodríguez Rodríguez, Francisco Javier			
E-mail	fjavierrodriguez@cud.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The primary objective of the subject Basics of Operations Management is to provide students with a basic and sufficient level of knowledge related to the specific methods and techniques of Operations within organizations. In this field, the word Organization is applicable to private enterprises, whether industrial, commercial or services, public enterprises and administrations, public institutions and bodies, as well as quarters, headquarters, organs, fleets and sections of The Spanish Navy. All these organizations have in common that they must be managed by people with adequate training to perform an effective and efficient direction of operations, both from a strategic and operational perspective. The future graduates will practice their profession in the different organisms and units grouped within the Navy, which can be considered the parent organization of all the organizations that integrate it. Therefore, it is important that all students know the management tools needed to run an organization of any kind. The study of this subject will allow students to consolidate and expand some of the knowledge previously acquired in the first year subject Introduction to Business Management. The necessary skills will be developed to manage the organizations through the study and practice of applied knowledge of Operations management. Basics of Operations Management has an important relationship with the subject Logistics and Management of Resources in the Navy, which is taught within the specific military training of the two fundamental specialties of General Corps and Marine Infantry. The contents of the subject Basics of Operations Management of the Degree in Mechanical Engineering have been divided into six parts: General Introduction, Introduction to Project Management, Forecasting Demand, Basic Decisions in Production Management, Introduction to work study and Introduction to the Quality, Safety and Environmental managing. These six parts will be developed in eleven topics as specified in the subject planning.			

Competencies	
Code	
B8	Ability to apply the principles and methods of quality.
B9	Ability to organize and plan within the sphere of a company, and other institutions and organizations.
C15	Basic knowledge of production systems and manufacturing.
C17	Applied knowledge of business organization.
D1	Analysis and synthesis
D2	Problems resolution.
D7	Ability to organize and plan.
D8	Decision making.
D9	Apply knowledge.
D11	Ability to understand the meaning and application of the gender perspective in the various fields of knowledge and professional practice with the aim of achieving a more just and egalitarian society.
D18	Working in an international context.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
To know the basis on which the activities related to production and operations management are supported.	B8 B9	C15 C17	D1 D2 D7 D8 D9 D18

To know the scope of the different production-related activities.	B8 B9	C15 C17	D1 D2 D7 D8 D9 D18
To obtain an overall view for the execution of the activities related to production and operations management.	B8 B9	C15 C17	D1 D2 D7 D11
To conduct a workplace assessment from an approach that helps the development of people with a perspective of efficiency and equality.			D11
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:Basic (1)].	B9	C15 C17	
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 [Suitable (2)].		C15 C17	D2 D8 D9
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.2.- Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical -societal, health and safety, environmental, economic and industrial - constraints [Suitable (2)].			D1 D2 D8 D9 D11
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 [Suitable (2)].	B8		D2 D7 D9 D11
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.4- Ability to apply norms of engineering practice in their field of study [Suitable (2)].	B9		D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.5- Awareness of non-technical -societal, health and safety, environmental, economic and industrial - implications of engineering practice [Suitable (2)].			D11
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.6.- Awareness of economic, organisational and managerial issues (such as project management, risk and change management) in the industrial and business context [Suitable (2)].	B9	C17	
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 [Basic (1)].	B9		D11
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 [Suitable (2)].	B9	C17	

Contents

Topic	
Chapter 1. Production systems and components. Aims: To identify the concepts of operations, production and productivity in the organizational context.	Chapter index: 1.1. Notions of production. Production system. Current production systems. 1.2. Operations management. Organizing to produce goods and services. 1.3. New trends in production and operations. 1.4. Productivity, quality and social responsibility.
Chapter 2. Productivity and its measurement. Aims: To define and describe productivity measurement. To gain knowlegde on the factors affecting productivity and to apply management techniques that improve productivity.	Chapter index: 2.1. Concept of productivity. Productivity measurement. 2.2. Productivity variables. Management role. Strategies for productivity growth. 2.3. Productivity in companies and organizations. Productivity and the service sector.
Chapter 3. Concept and functions of operations management. Aims: To define production management and to identify its basic functions.	Chapter index: 3.1. Production management. Production planning, scheduling and controlling. 3.2. Relationships between production, logistics and operations. 3.3. Supply chain. Managing inventory. Independent vs. Dependent demands. 3.4. The role of an Operations manager.

Chapter 4. Project Planning, Scheduling and Controlling. Aims: To understand each product or service as a new project. To explain the main project management techniques.	Chapter index: 4.1. Strategic importance of project management. 4.2. Project planning. 4.3. Project scheduling. 4.4. Project controlling. 4.5. Introduction to PERT and CPM. 4.6. PERT/CPM networks. 4.7. Calculating Slack time and identifying the critical path(s). 4.8. Variability in activity times.
Chapter 5. Forecasting demand. Aims: To define the forecasting process and its approaches. To describe the quantitative forecasting methods.	Chapter index: 5.1. Forecasting. Types of forecasts. The importance of forecasting. Forecasting approaches. 5.2. Quantitative methods. Time-series models. Associative models.
Chapter 6. Strategic decisions. Aims: To identify the process and layout strategies within the organizations. To present the concept of capacity planning.	Chapter index: 6.1. Process and layout strategies. Process analysis and design. 6.2. Capacity. Capacity planning. Tools for analysis and decision-making. 6.3. Location strategy. Factors that affect location decisions. Methods of evaluating location alternatives.
Chapter 7. Tactical decisions. Inventory management. Aims: To describe the functions of inventory and basic inventory models.	Chapter index: 7.1. Functions of inventory. Inventory management. 7.2. Inventory models. Models for independent demand. Other models.
Chapter 8. Tactical decisions. Production Planning, Scheduling and Controlling. Aims: To identify the planning, scheduling and controlling processes. To explain Material Requirements Planning.	Chapter index: 8.1. The planning process. Aggregate planning. Production scheduling and control. 8.2. Material Requirements Planning (MRP). Inventory management for dependent demand. 8.3. MRP structure and management. 8.4. Enterprise Resource Planning (ERP).
Chapter 9. Tactical decisions. JIT Philosophy. Definition and principles. Aims: To describe Just In Time (JIT) phylosophy and Lean Manufacturing. Objectives and principles.	Chapter index: 9.1. Introduction to JIT. 9.2. The 4Ps of JIT. 9.3. Lean Manufacturing. 9.4. Total productive maintenance, TPM.
Chapter 10. Introduction to work study. Aims: To define job design. To understand the importance of an effective and efficient Human Resources management. To explain the fundamentals of the Method study. To describe Time studies. To explain Predetermined Time Standards. To describe work sampling.	Chapter index: 10.1. Job design. 10.2. Ergonomics and work physiology. 10.3. Method analysis and work measurement. 10.4. Time studies. 10.5. Predetermined Time Standards. Methods-Time Measurement (MTM). 10.6. Work sampling.
Chapter 11. Introduction to quality, environment and safety. Aims: To define quality and the international quality standards.To identify the environmental management systems and standards. To define safety and industrial hygiene and to understand their importance in the prevention of occupational risks.	Chapter index: 11.1. Quality. International quality standards. ISO 9000 standards. Standards PECAL/AQAP with requirements of the Spanish Ministry of Defense (NATO requirements). 11.2. Environmental management systems. ISO 14000 standards. EMAS regulation. 11.3. Safety and industrial hygiene. Prevention of occupational risks.
Practical session 1. Productivity calculations.	Situations of industrial or services companies are raised in which students should determine or measure the productivity from the data supplied. These exercises are presented and resolved.
Practical session 2. Project planning.	It comprises the determination of project schedules with PERT/ CPM charts.
Practical session 3. Forecasting demand.	It consists in forecasting the demand for products or services of a company, using time-series models and associative models that have been studied. Several exercises for forecasting are presented and resolved.

Practical session 4. Process analysis. Layout design. Capacity decisions.	Examples are given of flow charts and operation process charts (process charts, flow diagrams, etc.) for process analysis. Problems on break-even analysis are presented and resolved.
Practical session 5. Inventory models for independent demand.	Inventory problems are presented and resolved using the ABC method, as well as exercises based on the Economic Order Quantity (EOQ) model and its variations (independent demand).
Practical session 6. Aggregate planning.	Aggregate planning problems, with the two pure strategies: chase and level, are presented and resolved.
Practical session 7. Inventory models for dependent demand.	Diverse problems are presented and resolved using the MRP technique, preparing materials lists and calculating gross and net requirements (dependent demand).

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	26	39	65
Problem solving	14	21	35
Seminars	22	15	37
Essay questions exam	13	0	13

*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 professor, 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 dashboard will be used to convey information such as definitions, graphics, pictures, etc. As far as possible, copies of the presentations will be provided to the students prior to the lecture, focusing the effort of the teacher and students in 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	Problems and /or exercises are formulated that the student must solve by interpreting the available information, applying formulas or algorithms and interpreting the results. These exercises can be collected at the end of the class or sent over the intranet in a short time.
Seminars	They consist in the realization of activities of reinforcement to the learning by means of: Troubleshooting. Complementing to the realised in the practical classes. Case studies. Analysis of real events, fundamentally in companies and Defense organizations with the purpose of knowing them, interpreting them, reflecting, diagnosing and elaborating possible solutions. 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 doubt, they can be resolved in these 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.

Personalized assistance

Methodologies	Description
Seminars	PERSONALIZED ATTENTION In addition to tutorials or group seminars, individual tutorials can be carried out, in which each student, individually, can consult the professor doubts or difficulties that prevent him from following the theoretical or practical contents of the subject. Additional exercises will be proposed to reinforce the learning of the contents of the subject, aimed at students who show difficulties to follow in an appropriate way the development of classes.

Assessment

Description	Qualification	Training and Learning Results

Lecturing	Intermediate test of continuous assessment: It has as objective the evaluation of the acquired competences, being able to include multiple-choice test questions with different alternatives of answer, direct short answer questions and troubleshooting. It will be realized during the quadmester and will be of short duration. The execution of the test will be compulsory and required to pass the subject. (Percentage on the final grade: 25%) Final exam of continuous assessment: a final test will be carried out covering all the contents of the subject, both theoretical and practical, and it may include test questions, reasoning questions, troubleshooting and case study's development. It is required to achieve a minimum grade of 4 points out of 10 possible to be able to pass the subject, as well as exceed a minimum grade of 3 points out of 10 in each part (theory and problems) of the aforementioned exam.(Percentage over final grade: 50%)	70	B8 C15 D1 B9 C17 D2 D7 D8 D9 D11
Problem solving	Assessment of the practical sessions: 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 professor. The evaluation of each deliverable will be in accordance with the criteria that have previously been communicated to the students.	25	B8 C15 D1 B9 C17 D2 D7 D8 D9 D11 D18
Seminars	Participation: Participation and attitude will be evaluated during theoretical classes, practical sessions and group tutorials, as well as contributions in the virtual platform.	5	B8 C15 D1 B9 C17 D2 D7 D8 D9 D11

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= 0,25*INTERMEDIATE TEST + 0,20*PRACTICAL SESSIONS + 0,50* FINAL EXAM + 0,05* PARTICIPATION*

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. Otherwise, students must take the ordinary exam.

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 test 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, as well as not achieve a minimum grade of 3 points out of 10 in any of the parts (theory and problems) of the aforementioned exam.

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. To pass the subject in either of these two calls, it will be necessary to exceed a minimum grade of 3 points out of 10 in each part (theory and problems) of these exams.

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.

Sources of information

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**,

Recommendations

Other comments

The subject 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 basic calculation and synthesis of information.
- Teamwork and communication skills.
- At least basic knowledge acquired in the subject Introduction to Business Management taught in first year.

The most frequent learning difficulties are related to the lack of such knowledge, but can be saved with a little effort and the means available in this center.

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained

* Teaching methodologies modified

* Non-attendance mechanisms for student attention (tutoring)

* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Pending tests that are maintained
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Tests that are modified
[Previous test] => [New test]

* New tests

* Additional Information