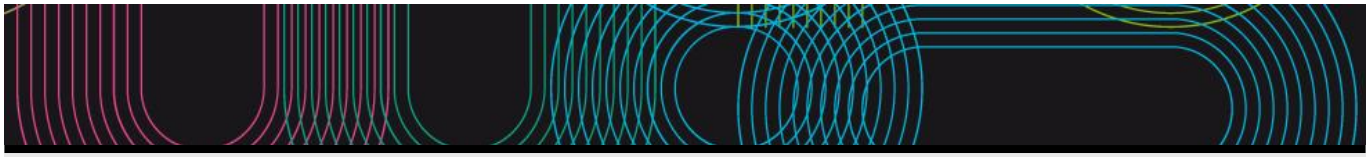

(*)Centro Universitario da Defensa da Escola Naval Militar de Marín

Grado en Ingeniería 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	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Troncoso Pastoriza, Francisco Manuel			
Lecturers	Falcón Oubiña, Pablo Troncoso Pastoriza, Francisco Manuel			
E-mail	ftroncoso@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
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.			

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

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

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: Circuit simulation	The goal of this practice is to introduce the Autodesk Tinkercad electronic circuit simulation software to carry out assemblies with digital electronic elements focused on solving basic engineering problems. This software will be used to complement the laboratory assemblies during practice sessions 3 to 6, allowing a first contact in a more accessible and simple way before transferring the simulated scheme to the real prototype.
Practice 2: Digital Electronics	This practice introduces the student to digital combinational circuits by assembling basic circuits within a protoboard.
Practice 3: Basic electronic circuits with 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 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: 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).

Practice 7: Laboratory evaluation test	This is a test where the ability acquired by the student for the simulation and assembly of electronic circuits and the verification of its operation with the instruments used in the practices will be evaluated. The test will consist of two parts: the first one will be dedicated to the simulation in the Tinkercad program, and the second will consist of the assembly and validation of a proposed electronic circuit, which will include various components treated during the rest of the laboratory sessions.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Laboratory practical	12	12	24
Seminars	22	0	22
Problem and/or exercise solving	7	13	20
Problem and/or exercise solving	1.5	2	3.5
Problem and/or exercise solving	1.5	2	3.5
Laboratory practice	2	2	4
Laboratory practice	3	0	3

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

Methodologies

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

Personalized assistance

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

Assessment

	Description	Qualification	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 (approximate 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 3, 4 and 5 (approximate date: 9th week of the semester).	15	B3	C11	D2 D9 D10

Laboratory practice	Resolution of practical problems, attitude, cleaning and care of the material (approximate date: practical sessions 1 to 6)	15	B3	C11	D2 D9 D10 D17
Laboratory practice	Laboratory exam where the ability to understand, ensemble and simulate basic electronic circuits are tested (approximate date: last practice session).	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 a practical laboratory test, as follows:

- Practical laboratory exam (*PL*):
    - During each practical session, the student will be asked various questions or simulation and assembly exercises that they must carry out during the corresponding session. The attitude of the student during the class will also be evaluated, as well as the cleanliness of the workplace at the end of the practice and the care of the material provided in the laboratory.
    - The realization of the test is individual.
    - Weight: 15% of the continuous evaluation score (NEC).
    - It is qualified with 10 points for each laboratory session.
    - **There is no minimum qualification exclusive to this item.**

- Practical laboratory exam (*EL*):
    - This is a test to evaluate the ability acquired by the student to simulate and 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.
    - **There is no minimum qualification exclusive to this item.**

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 (L).

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*PL + 0.15*EL
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.

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

Sources of information

Basic Bibliography

Malvino, Albert; Bates, David J., **Principios de Electrónica**, 7ª,

E. Mandado, **Sistemas Electrónicos Digitales**, 10ª,

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

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

Training and Learning Results	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
B4	Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of Industrial Engineering in Mechanical specialty.
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 materials engineering.
D5	Information Management.
D7	Ability to organize and plan.
D9	Apply knowledge.
D10	Self learning and work.
D15	Objectification, identification and organization.
D17	Team working.

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
To show capacity to select the most appropriate manufacturing process for the obtention of basic pieces from a given material.	B3 B4 B5	C25	D7 D9
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 aims to study the main selection criteria of materials, including technological and mechanical properties. It also studied the location, extraction and concentration of metals in nature.	1.1 CRITERIA OF MATERIAL SELECTION Introduction. Parameters that influence in the selection process. Materials in the design process. Technological properties: Cost, supply and transformation. Relation with user. Interaction with the environment. 1.2 MECHANICAL PROPERTIES Introduction. Relation stress-deformation. Elastic and plastic behaviour. Ductility. Hardness. Fracture. 1.3 OBTENTION OF METALLIC MATERIALS Introduction. Abundance of metals. Metals in nature. Metallurgy: obtention of metals from one of their minerals. Concentration of ores.
UNIT 2: MATERIALS FOR TOOLS Location and length: Weeks 3-4 [4 hours] Objective and development: Once metallurgy operations have been studied, the extraction and production of steel is studied as well as the obtention of other relevant structural materials.	2.1 STRUCTURAL MATERIALS: METALS AND ALLOYS Introduction. Iron extraction and steel production. Steels classification. Non-ferrous alloys. 2.2 MATERIALS FOR DEFENCE: STEELS FOR ARMOURS; ALLOYS OF ALUMINIUM, TITANIUM AND MAGNESIUM 2.3 RECYCLING OF STEEL AND ITS ENVIRONMENTAL IMPACT (UNE-EN 13437).
UNIT 3: STRUCTURAL AND BUILDING MATERIALS Location and length: Weeks 5-6 [4 hours] Objective and development: This unit deepens in building materials, mainly in the technology of concrete and wood, as well as the uses of the polymers and ceramic, regarding the raw materials and degradation, among others.	3.1 THE PORTLAND CEMENT. TECHNOLOGY OF CEMENTS Raw materials (water, arids, additives) and manufacture. Reactions of hydratation and hardening. Expansion and contraction. Mechanical resistance. Inventory of emmisions. Measures in fresh and hardened concrete. Degradation and recycling of cements. 3.2 WOODS Structures, properties and main woods. Technology of woods. Degradation and recycling of woods. 3.3 POLYMERS Structures, properties and main polymers. Uses as building materials. Degradation and recycling of polymers. 3.4 CERAMICS Structure, properties and main ceramic materials. Uses as building materials. Degradation and recycling of ceramic materials.
UNIT 4: DEGRADATION OF MATERIALS. THERMAL, THERMOCHEMICAL AND THERMOMECHANICAL TREATMENTS Location and length: Weeks 6-8 [5 hours] Objective and development: This unit analyses the principles of materials corrosion, the importance of the different microstructures in steels and the thermal treatments, as well as thermochemical treatments, with and without change of composition of the material.	4.1 DEGRADATION OF MATERIALS. PROCESSES OF CORROSION Principles of corrosion. Types of corrosion. Thermodynamics and kinetics of corrosion. Protection against corrosion. 4.2 THERMAL TREATMENTS Introduction. Thermal cycle. Normalisation and annealing. Martensitic transformations: Time-Temperature-Transformation diagrams (TTT). Quenching. Isothermal treatments: austempering, martempering, isothermal annealing. Problems generated during the thermal treatments. 4.3 THERMOCHEMICAL AND SUPERFICIAL TREATMENTS Introduction. Superficial modification, without change of composition: Quenching by flame, induction or laser, hardening by transformation, superficial fusion. Superficial modification, with change of composition: carburization, nitrurization, carbonitrurization. Types of coatings: coatings by immersion, coatings by electrodeposition, annealing, ceramic coatings, physical and chemical deposition, thermal projection. Preparation of the surfaces by mechanical treatments: cleaning with dissolvent, cleaning with mechanical tools.
UNIT 5: MATERIALS SUBJECTED TO SMELTING, PLASTIC AND VISCOELASTIC DEFORMATION AND POWDER COMPACTION Location and length: Weeks 8-10 [6 hours] Objective and development: This unit analyses the answer of different materials subjected to distinct processes of conformed, like the smelting of metals, the plastic deformation of metals, the molding, injection and extrusion of polymers and the poder metallurgy.	5.1 SMELTING Foundations of the smelting of metals 5.2 ANSWER OF THE MATERIALS SUBJECTED TO THE MAIN PROCESSES OF PLASTIC DEFORMATION 5.3 ANSWER OF THE MATERIALS SUBJECTED TO THE MAIN VISCOELASTIC PROCESSES Molding of polymers 5.4 POWDER METALLURGY

UNIT 6: UNION AND WELDING TECHNOLOGIES Location and length: Weeks 11-12 [4 hours] Objective and development: This unit analyses the main union technologies: the union by means of adhesives and the union by means of welding.	6.1 ADHESIVE MATERIALS 6.2 MATERIALS FOR WELDING
LABORATORY (14 hours)	Practice 1. Superficial treatments of materials: cataphoresis and electrolytic cleaning (2 hours) Student makes treatments of surfaces recovery with painting applied by means of cataphoresis and elimination of oxides adhered with electrolytic cleaning. Practice 2. Obtention of aluminium by aluminothermy and/or electrolysis (2 hours) It is studied the concentration processes of metals from the ores by means of extraction processes. It will be employed AENOR norms (accessible database through the University of Vigo) for searches related to aluminum technology. For example, it will be proposed to research some of the following norms and the consequent resolution of questions: . Mechanical characteristics of the aluminium and its alloys (UNE-EN 683-2:2008) . Annealing of aluminium and its alloys (UNE 38019:2017) . Scrap of the aluminium and its alloys (UNE-EN 12258-3:2004). . Welding of the aluminium and its alloys (UNE-EN ISO 9692-3:2016). Practice 3. Union technologies: evaluation of adhesives (2 hours) Student determines the most effective unions between materials by means of simple or hybrid unions, in different environmental conditions. They will use the AENOR norms (accessible database through the University of Vigo). For example, it will be proposed researches of some of the following norms and the consequent resolution of questions: . Self-adhesive tapes (UNE-EN 12481:2002) . Adhesives for paper, cardboard and packagings (UNE-CR 14376:2002 or updates) . Adhesives. Terms and definitions (UNE-EN 923:2016) . Adhesives for wood (UNE-EN 14292:2005) . Structural adhesives for metals and plastics (UNE-EN 13887:2004) Practice 4, 5 and 6. Evaluation of building materials (concretes) (6 hours) The student manufactures concrete with different compositions and study its properties in fresh and hardened material. It is also analized the Structural Code (RD 470/2021). Students work in groups the resolution of a more complex problem (project), so that its realisation need of the cooperative work of two students (or three students, exceptionally). It is included in this time the presentation and evaluation of the project. Practice 7. Public presentation of the project (2 hours) The last practice session will be reserved for the students' oral presentation of the project carried out on the evaluation of construction materials (concrete). The laboratory program may vary to adjust to the master classes or seminar sessions.
SEMINARS (7 hours)	Seminars in small groups, which will reinforce the contents of the master classes.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	28	56
Problem solving	7	14	21
Seminars	15	15	30

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

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

Methodologies

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

Personalized assistance

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

Assessment

	Description	Qualification	Training and Learning Results		
Problem solving	It will be evaluated: the autonomous resolution of exercises or questions, proposed by the lecturers, assessing, among other concepts: the proper resolution of exercises, the approach, order and delivery on time.	10	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.	10	B4 B6 B11	C25	D5 D7 D9 D10 D15
Essay questions exam	INTERMEDIATE EXAMS: Two intermediate exams will be carried out (30%), in which all the topics explained so far will be evaluated. GLOBAL EXAM (40%): It will consist of a theory part and a problem part. It is a necessary condition to pass the subject by continuous evaluation to obtain a minimum of 4 in each part.	70	B3 B4 B5 B6 B11	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 lecturers. In the oral presentation, any member of the group has to answer to questions of the project. All have to show, therefore, deep knowledge of the product delivered, independently of the part in which they had centred their efforts.	10	B4 B6 B11	C25	D5 D7 D9 D10 D15 D17

Other comments on the Evaluation

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

Ordinary and Extraordinary Examinations

In order to evaluate all the competences in the ordinary and extraordinary exams, these will include, in addition to questions of theory and part of problems, questions of the laboratory sessions. The evaluation will be considered positive when a score of 5 points out of 10 is reached.

Intensive course

Those students who have not passed the course at the first opportunity will attend an intensive course of 15 hours, in which

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

Sources of information

Basic Bibliography

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

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Complementary Bibliography

Recommendations

Other comments

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

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

Training and Learning Results	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
B4	Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of Industrial Engineering in Mechanical specialty.
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	Team working.

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	
1. Fundamentals of elasticity	1.1. Introduction to Elasticity 1.1.1. Goals of Elasticity and Strength of Materials 1.2. Definition of stress in elastic solids 1.2.1. Stress tensor 1.2.2. Principal stresses and principal directions 1.2.3. Graphic representation of three-dimensional stress. Mohr´s Circles 1.3. Deformation analysis in continuum media 1.3.1. State of strain at a point 1.3.2. Strain tensor 1.3.3. Graphic representation of deformational state. Mohr´s Circles 1.4. Stress-Strain relations 1.4.1 Generalized Hooke´s laws 1.5. Thin-wall pressure vessels
2. Criteria for initiation of inelastic material behavior. Failure condition	2.1. Plastic deformation of materials. Failure condition 2.2.Maximum normal stress theory or Rankine theory 2.3. Maximum normal strain theory or Sain-Venant theory 2.4. Maximum shear stress theory or Coulomb theory 2.5. Maximum strain energy theory or Beltrami-Haigh theory 2.6. Maximum distorsion energy theory or von Mises theory 2.7. Comments about failure theories. Safety factor
3. Torsion	3.1 Torsion of a prismatic bar of circular cross section. Coulomb□s theory 3.2. Design of transmission shafts 3.3. Strain energy stored by torsion 3.4. Statically indeterminate torsion members
4. Bending	4.1. Pure bending. Flexure Navier formula 4.2. Simple bending. Shear stresses. Zhuravski expression 4.3. Combined bending. Normal stresses. Neutral axis. Kern of the cross-section 4.4. Strain analysis. Beam deflection and slope. Curvature-moment ratio. Beam differential equation 4.5. Statically indeterminate beams. General method
5. Combined loadings	5.1. Combined Loadings 5.2. Combined bending and torsion in bars of circular cross section 5.3. Bending of beams of nonsymmetrical section. Shear center 5.4. Combined axial and bending load in non-slender bodies 5.5. Thin-wall pressure vessels
6. Lateral bending. Buckling	6.1. Buckling. Introduction 6.2. Centric compression load in slender column. Euler critical load 6.3. The effect of end conditions on critical load 6.4. Eccentric load in slender column 6.5. Validity range in Euler buckling theory. Design formulas for columns 6.6. Bucking coefficients method for column design

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

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Problem solving	7	0	7
Seminars	15	7	22
Laboratory practical	14	14	28
Essay questions exam	14	4	18
Essay	2	3	5

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

Methodologies

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

Personalized assistance

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

Assessment

	Description	Qualification	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 purpose of the written tests is to evaluate the learning of all the theoretical contents selected for the course. - Final exam (PF): 40% - Intermediate exams (PI): 30% (PI1 15%, PI2 15%)	70	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 evaluation criteria for each section will be published at the beginning of the quadmester. The relevant information will be provided to the students through the virtual platform Moovi.

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

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

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

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

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

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

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

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

Sources of information

Basic Bibliography

Hibbeler R.C., **Mecánica de Materiales**, 8ª Edición,

Gere J. M. y Timoshenko S. P., **Resistencia de Materiales**,

Craig R R., **Mechanics of Materials**, 3ª Edición,

Luis Ortiz-Berrocal, **Resistencia de Materiales**, 3ª Edición,

Solaguren-Beascoa F., **Elasticidad y resistencia de materiales**, 1º Edición,

Complementary Bibliography

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Rodríguez Avial M., **Problemas de elasticidad y resistencia de materiales**,

de la Fuente Tremps, E., Hernando Díaz, J.L., Torres Sánchez, R., **Resistencia de Materiales. Teoría y problemas resueltos**, 1º Edición,

de la Fuente Tremps, E., Hernando Díaz, J.L., Torres Sánchez, R., **El sólido deformable. Una introducción a la teoría de la elasticidad**, 1º Edición,

Recommendations

Subjects that continue the syllabus

Machine design/P52G381V01405

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

Training and Learning Results	
Code	
B1	Skills for writing, signing and developing projects in the field of industrial engineering, whose purpose is, specializing in Mechanics, construction, alteration, repair, maintenance, demolition, manufacturing, installation, assembly or operation of: structures, mechanical equipments, energy facilities, electrical systems and electronic installations and industrial plants, and manufacturing processes and automation.
C19	Knowledge and skills to apply the techniques of graphics engineering.
D2	Problems resolution.
D6	Application of computer science in the field of study.
D9	Apply knowledge.
D10	Self learning and work.
D14	Creativity.
D16	Critical thinking.
D17	Team working.

Expected results from this subject	Training and Learning Results		
To know and to posess well-grounded criteria for the selection and application of standard components.	B1	C19	D2 D9 D10 D16
To know CAD technologies for the geometrical modelling and the generation of technical drawings from it.		C19	D6 D9 D10
Ability to perform analysis on the operation of mechanisms from the specifications contained in technical drawings.	B1	C19	D2 D9 D14
To know how to apply Geometry to the resolution of problems about constructions and industrial installations.		C19	D2 D9 D14
To acquire skills for creating and managing graphic information related to Mechanical Engineering problems.		C19	D10 D14 D16 D17

ENAEE learning outcome: 1. KNOWLEDGE and UNDERSTANDING LO1.2. Knowledge and understanding of engineering disciplines underlying their specialization, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront. Level of achievement: Intermediate (2).		C19	
ENAEE learning outcome: 2. ENGINEERING ANALYSIS LO2.1. Ability to analyze complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses. Level of achievement: Intermediate (2).	B1		D2 D9
ENAEE learning outcome: 2. ENGINEERING ANALYSIS LO2.2. Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical - societal, health and safety, environmental, economic and industrial- constraints. Level of achievement: Intermediate (2).			D2 D9 D14 D16
ENAEE learning outcome: 3. ENGINEERING DESIGN LO3.1 Ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical - societal, health and safety, environmental, economic and industrial- considerations; to select and apply relevant design methodologies. Level of achievement: Advanced (3).		C19	D2 D9
ENAEE learning outcome: 3. ENGINEERING DESIGN LO3.2. Ability to design using some awareness of the forefront of their engineering specialization Level of achievement: Intermediate (2).	B1	C19	D9
ENAEE learning outcome: 5. ENGINEERING PRACTICE LO5.1 Understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study. Level of achievement: Intermediate (2).		C19	D9
ENAEE learning outcome: 5. ENGINEERING PRACTICE LO5.2 Practical skills for solving complex problems, realizing complex engineering designs and conducting investigations in their field of study. Level of achievement: Intermediate (2).			D2 D9 D16
ENAEE learning outcome: 7. COMMUNICATION AND TEAM-WORKING LO7.2 Ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers. Level of achievement: Intermediate (2).	B1		D10 D17

Contents

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

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

Planning

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

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

Methodologies

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

Personalized assistance

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

Assessment

	Description	Qualification	Training and Learning Results
Practices through ICT	LABORATORY PRACTICE EXAM (percentage on the final grade: 15%) There will be a practical assessment test based on the problems made in class. ASSESSMENT OF THE PRACTICAL SESSIONS (percentage on the final grade: 15%): During the quadmester, in certain practical sessions, problems or exercises will be raised to be solved by the students and submitted for evaluation when determined by the lecturer. The evaluation of each deliverable will be in accordance with the criteria that have previously been communicated to the students.	30	B1 C19 D2 D6 D9 D14 D16 D17
Problem and/or exercise solving	INTERMEDIATE TESTS OF CONTINUOUS ASSESSMENT: They will be realized during the quadmester and will be of short duration. The execution of both tests will be compulsory and required to pass the subject. The tests will cover the contents taught to date.	30	B1 C19 D9 D10 D16
Essay questions exam	A final exam will be carried out covering all the contents of the subject, both theoretical and practical, and it may include test questions, reasoning questions, problem solving and case study's development. It is required to achieve a minimum score of 4.0 points over 10 possible to pass the subject.	40	B1 C19 D9 D10 D16

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

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

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

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

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

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

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

Sources of information

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

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

Izquierdo Asensi, F., **Geometría Descriptiva II (Líneas y superficies)**, 26ª, Grefol, 2008

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

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

Recommendations

Subjects that continue the syllabus

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

Other comments

The subject of Graphic Engineering has no associated prerequisite. However, in order to successfully complete this course, the student must have:

- Sufficiently developed written and oral comprehension skills.
- Capacity of spatial vision, basic calculation and synthesis of information.
- Teamwork and communication skills.
- At least basic knowledge acquired in the subjects Graphic Expression, Mechanism and machine theory and Physics, taught in previous years.

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

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

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

Expected results from this subject	Training and Learning Results		
Comprise the basic appearances of the machines of fluid	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: LO1.2.- Knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront [Level of development of each sub result (Basic (1), Appropriate (2) and Advanced (3)] In this sub-result appropriate (2).	B3	C24	
ENAEE Learning outcome: ENGINEERING ANALYSIS: LO2.2.- Ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses [Appropriate (2)].			D2 D9
ENAEE Learning outcome: ENGINEERING DESIGN: LO3.2.- Ability to design using some awareness of the forefront of their engineering specialisation [Basic (1)].		C24	D9
ENAEE Learning outcome: INVESTIGATIONS: LO4.3.- laboratory/workshop skills and ability to design and conduct experimental investigations, interpret data and draw conclusions in their field of study [Basic (1)].		C24	D9
ENAEE Learning outcome: ENGINEERING PRACTICE: LO5.1.- Understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study [Basic (1)].		C24	D9

ENAEE Learning outcome: ENGINEERING PRACTICE: LO5.2.- Practical skills for solving complex problems, realising complex engineering designs and conducting investigations in their field of study [Basic (1)].	D9
ENAEE Learning outcome: ENGINEERING PRACTICE: LO5.3.- Understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study [Basic (1)].	D9
ENAEE Learning outcome: LIFELONG LEARNING: LO8.2.- 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 machines of fluid in assemblings CAD.	Aims and development: In this first practical session the student goes to open media files (images, videos, CAD files) prepared by the professor to visualise the constitutive elements of hydraulic installations and machines of fluids. The main aim of this practical is to strengthen the nomenclature and facilitate the three-dimensional visualisation of the flow in the interior of the machines of fluid.
Practice 2: Mentored work (TT). Bank of positive displacement pumps	Aims and development: The aim of this second practical session is the visualisation of the different positive displacement pumps by means of the available multimedia content to the effect. It treats to characterise and comprise the operation of these pumps, looking for the understanding of his characteristics and possible applications. Indeed, it supposes the start of the mentored work.

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

Planning

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

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

Methodologies

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

Personalized assistance

Methodologies	Description

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

Assessment

	Description	Qualification	Training and Learning Results
Lecturing	The theoretical contents will be evaluated through 2 intermediate controls compulsory (PI1 and PI2) during the course, marked on 10 points. Percentage on the final qualification: (15%PI1, 15%PI2)	30	B3 C24 D2 D9 D10
Laboratory practical	The evaluation of the practices will be carried out by means of lab reports (MP) or questionnaires of the activity made in the practices not included in the mentored work, this is, the practical Pr1, Pr3 and Pr4 that they will be able to be individual or in group. The student will have to deliver these activities when finalising the practice. The format of each memory will be specified in each practice. The note of each memory of practices will be on 10 points. The note of the Memories of Practices (MP) will be the average of the notes of the practical Pr1, Pr3 and Pr4. It allows the absence to a session of practices remaining this practice excluded of the calculation of the average note. The absence to more than a session of practices prevents that the student can pass the matter by continuous evaluation.	10	C24 D2 D9 D17
Mentored work	The students will have to make a work in group on a subject of the matter, that will suppose 20% of the qualification. For his realisation, will have 4 sessions of laboratory and 4 seminars. The work will have to be evaluated so that it guarantee the individual exigibility and the possitive interdependency, this is, all the members of the group have to contribute to the final product and have to know all the parts of the project. All have to show, therefore, deep knowledge of the product delivered, independently of the part in which they had centred their efforts.	20	
(*)	It will make a final examination that will cover the whole of the contents of the subject, so many theorists like practical, and that it will be able to include ask type test, questions of reasoning, resolution of problems and development of practical cases. It demands reach a minimum qualification of 4 points on 10 possible to be able to surpass the subject.	40	B3 C24 D2 D9 D10

Other comments on the Evaluation

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

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

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

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

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

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

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

ACADEMIC INTEGRITY: Students are expected to show adequate ethical behaviour, committing to act honestly. Based on article 42.1 of the *Regulation on the evaluation, qualification and quality of teaching and the student learning process of the University of Vigo*, as well as point 6 of the fifth rule of *Order DEF/711/2022, of July 18th, which establishes the requirements for evaluation, progress, and ongoing enrolment in military educational training centres for incorporation into the ranks of the Armed Forces,* **any violation of academic integrity in the assessment process, as well as the cooperation in it will result in the assignment of a failing grade to the student (zero) for the entire course in**

the corresponding assessment opportunity, regardless of the percentage of importance that the test in question had in the overall continuous assessment and independently of other disciplinary actions that may be applied.

Sources of information
Basic Bibliography
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 hidráulicas. Problemas y soluciones**, 2016
A. Serrano Nicolás, **Oleohidráulica**, 2002

Recommendations

Other comments

During the teaching of the subject lecturers will do continuously quotation to foundations of the Fluid mechanics that assume that the student dominates. In case of difficulties it is recommended that the students freshen knowledges purchased and attend to office hours. In order to follow successfully the course, the students must possess:

* Capacity of written and oral understanding very developed.
* Capacity of abstraction and synthesis of the information.
* Skills for the work in group and for the communication in groups.

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

Resultados de Formación e Aprendizaxe	
Code	
B8	Capacidade para aplicar os principios e métodos da calidade.
B9	Capacidade de organización e planificación no ámbito da empresa, e outras institucións e organizacións.
C15	Coñecementos básicos dos sistemas de produción e fabricación.
C17	Coñecementos aplicados de organización de empresas.
D1	Análise e síntese.
D2	Resolución de problemas.
D7	Capacidade para organizar e planificar.
D8	Toma de decisións.
D9	Aplicar coñecementos.
D11	Capacidad para comprender o significado e aplicación da perspectiva de xénero nos distintos ámbitos de coñecemento e na práctica profesional co obxectivo de acadar unha sociedade máis xusta e igualitaria.
D18	Traballo nun contexto internacional.

Resultados previstos na materia			
Expected results from this subject	Training and Learning Results		
Coñecer a base sobre a que apoian as actividades relacionadas coa organización e xestión da produción.	B8 B9	C15 C17	D1 D2 D7 D8 D9 D18

Coñecer o alcance das distintas actividades relacionadas coa produción.	B8 B9	C15 C17	D1 D2 D7 D8 D9 D18
Adquirir unha visión de conxunto para a execución das actividades relacionadas coa organización e xestión da produción.	B8 B9	C15 C17	D1 D2 D7 D11
Realizar unha valoración dos postos de traballo desde un enfoque que axude ao desenvolvemento das persoas cunha perspectiva de eficiencia e igualdade.			D11
Resultado de aprendizaxe ENAEE: COÑECEMENTO E COMPRENSIÓN: RA1.3.- Ser conscientes do contexto multidisciplinar da enxeñaría [nivel de desenvolvemento (básico (1), adecuado (2) ou avanzado (3)) deste sub-resultado: Básico (1)].	B9	C15 C17	
Resultado de aprendizaxe ENAEE: ANÁLISE EN ENXEÑARÍA: RA2.1.- A capacidade de analizar produtos, procesos e sistemas complexos no seu campo de estudo; elixir e aplicar de forma pertinente métodos analíticos, de cálculo e experimentais xa establecidos e interpretar correctamente resultados de devanditas análises [Adecuado (2)].		C15 C17	D2 D8 D9
Resultado de aprendizaxe ENAEE: ANÁLISE EN ENXEÑARÍA: RA2.2.- A capacidade de identificar, formular e resolver problemas de enxeñaría na súa especialidade; elixir e aplicar de forma adecuada métodos analíticos, de cálculo e experimentais xa establecidos; recoñecer a importancia das restricións sociais, de saúde e seguridade, ambientais, económicas e industriais [Adecuado (2)].			D1 D2 D8 D9 D11
Resultado de aprendizaxe ENAEE: PROXECTOS DE ENXEÑARÍA: RA3.1.- Capacidade para proxectar, deseñar e desenvolver produtos complexos (pezas, compoñentes, produtos acabados, etc.), procesos e sistemas da súa especialidade, que cumpran cos requisitos establecidos, incluíndo ter conciencia dos aspectos sociais, de saúde e seguridade, ambientais, económicos e industriais; así como seleccionar e aplicar métodos de proxecto apropiados [Adecuado (2)].	B8		D2 D7 D9 D11
Resultado de aprendizaxe ENAEE: APLICACIÓN PRÁCTICA DA ENXEÑARÍA: RA5.4- Capacidade para aplicar normas da práctica da enxeñaría da súa especialidade [Adecuado (2)].	B9		D9
Resultado de aprendizaxe ENAEE: APLICACIÓN PRÁCTICA DA ENXEÑARÍA: RA5.5- Coñecemento das implicacións sociais, de saúde e seguridade, ambientais, económicas e industriais da práctica da enxeñaría [Básico (1)].			D11
Resultado de aprendizaxe ENAEE: APLICACIÓN PRÁCTICA DA ENXEÑARÍA: RA5.6.- Ideas xerais sobre cuestións económicas, de organización e de xestión (como xestión de proxectos, xestión do risco e do cambio) no contexto industrial e de empresa [Adecuado (2)].	B9	C17	
Resultado de aprendizaxe ENAEE: ELABORACIÓN DE XUÍZOS: RA6.1.- Capacidade de recoller e interpretar datos e manexar conceptos complexos dentro da súa especialidade, para emitir xuízos que impliquen reflexión sobre temas éticos e sociais [Básico (1)].	B9		D11
Resultado de aprendizaxe ENAEE: ELABORACIÓN DE XUÍZOS: RA6.2.- Capacidade de xestionar complexas actividades técnicas ou profesionais ou proxectos da súa especialidade, responsabilizándose da toma de decisións [Adecuado (2)].	B9	C17	

Contidos

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

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

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

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

Metodoloxía docente
Description

Lección maxistral	Cada unidade temática teórica será presentada polo profesor, expondo exemplos para unha mellor comprensión dos contidos. Mediante a formulación de cuestións sobre os contidos teóricos e exemplos fomentarase e valorará a participación activa do alumnado. Utilizaranse presentacións ofimáticas e a lousa para transmitir información como definicións, gráficos, fotografías, etc. Na medida do posible, proporcionarase copia das presentacións aos alumnos con anterioridade á exposición, centrando o esforzo do profesor e do alumnado na exposición e comprensión dos coñecementos. As reproducións en papel das presentacións nunca deben ser consideradas como substitutos de apuntamentos tomados en clase ou dos textos suxeridos na bibliografía, senón como material complementario.
Resolución de problemas	Formúlanse problemas e/ou exercicios que o alumno debe resolver interpretando a información dispoñible, aplicando fórmulas ou algoritmos e interpretando os resultados. Estes exercicios pódense recoller ao final da clase ou ser enviados mediante a través de intranet nun curto prazo de tempo.
Seminario	Consisten na realización de actividades de reforzo á aprendizaxe mediante: Resolución de problemas. Complementando aos realizados nas clases prácticas. Estudo de casos. Análise de sucesos reais, fundamentalmente en empresas e en organizacións de Defensa coa finalidade de coñecelos, interpretalos, reflexionar, diagnosticar e elaborar posibles solucións. Aqueles exercicios de clases de laboratorio que o alumno non puidese finalizar, tratará de facelo nas súas horas de estudo e se ten algunha dificultade ou dúbida poderase resolver nestes seminarios. Contabilízanse neste apartado 5 horas de tutorías de apoio para aquelles alumnos que suspenderon a materia por evaluación continua, previas á realización do exame ordinario. Tutorías grupais co profesor.

Atención personalizada

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

Avaliación

	Description	Qualification	Training and Learning Results
Lección maxistral	Probas intermedias de avaliación continua: teñen como obxecto a avaliación das competencias adquiridas, podendo incluír preguntas tipo test pechadas con diferentes alternativas de resposta, preguntas de resposta curta directas e resolución de problemas. Realizaranse ao longo do cuadrimestre e serán de curta duración. A realización das probas será obrigatoria e esixible para superar a materia. (Porcentaxe sobre a cualificación final: 50%) Exame final de avaliación continua: realizarase unha proba final que abarcará a totalidade dos contidos da materia, tanto teóricos como prácticos, e que poderá incluír probas tipo test, preguntas de razoamento, resolución de problemas e desenvolvemento de casos prácticos. Esíxese alcanzar unha cualificación mínima de 4 puntos sobre 10 posibles para poder superar a materia, así como superar unha nota mínima de 3 puntos sobre 10 en cada unha das partes (teoría e problemas) do devandito exame. (Porcentaxe sobre a cualificación final: 40%)	90	B8 C15 D1 B9 C17 D2 D7 D8 D9 D11

Resolución de problemas	Avaliación das prácticas: ao longo do cuadrimestre, en determinadas clases prácticas, exporanse problemas ou exercicios que deberán ser resoltos polos alumnos e entregados para a súa avaliación cando o determine o profesor. A avaliación de cada entregable estará de acordo cos criterios que con anterioridade se comunicaron aos alumnos.	10	B8 C15 D1 B9 C17 D2 D7 D8 D9 D11 D18

Other comments on the Evaluation

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

NEC= 0,25 PROBA INTERMEDIA 1 + 0,25 PROBA INTERMEDIA 2 + 0,10 PRÁCTICAS + 0,40 PROBA FINAL.
Para superar a materia, a nota final de avaliación continua (NEC) calculada pola fórmula anterior deberá ser polo menos 5 puntos sobre 10. En caso contrario, deberá presentarse ao exame ordinario.Con todo, esixiranse uns requisitos mínimos e condicións nalgúns dos apartados, que garantan o equilibrio entre todos os tipos de competencias.O alumno deberá presentarse ao exame ordinario de todos os contidos da materia, que suporá o 100% da nota, nos seguintes supostos:

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

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

COMPROMISO ÉTICO: Agárdase que o estudantado teña un comportamento ético axeitado, comprometéndose a actuar con honestidade. En base ao artigo 42.1 do *Regulamento sobre a avaliación, a cualificación e a calidade da docencia e do proceso de aprendizaxe do estudantado da Universidade de Vigo*, así como ao punto 6 da norma quinta da *Orde DEF/711/2022, do 18 de xullo, pola que se establecen as normas de avaliación, progreso e permanencia nos centros docentes militares de formación para a incorporación ás escalas das Forzas Armadas*, **a utilización de procedementos fraudulentos en probas de avaliación, así como a cooperación neles implicará a cualificación de cero (suspenso) na acta da convocatoria correspondente**, con independencia do valor que sobre a cualificación global tivese a proba en cuestión e sen prexuízo das posibles consecuencias de índole disciplinaria que poidan producirse.

Bibliografía. Fontes de información

Basic Bibliography

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

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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

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

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

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

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

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

Toyota, **Toyota Production System**,

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

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

Ministerio de Defensa, **Normativa PECAL/AQAP**,
Instituto Nacional de Seguridad e Higiene en el Trabajo, **Normativa PRL**,
Automática e instrumentación, **Información sobre la modificación de una línea de montaje de subchásis para fabricar respiradores asistidos**,
USDepartmentofLabor, **Consejos de seguridad para líneas de montaje durante la pandemia por COVID-19**,
Grupo PSA, **Información sobre un exoesqueleto para facilitar el trabajo y prevenir lesiones**,

Recomendacións

Other comments

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

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