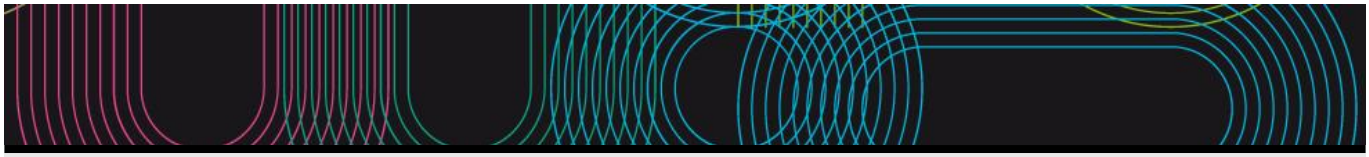

(*)Centro Universitario da Defensa da Escola Naval Militar de Marín

Grado en Ingeniería Mecánica

Subjects			
Year 2nd			
Code	Name	Quadmester	Total Cr.
P52G382V01201	Mathematics: Calculus II and differential equations	1st	6
P52G382V01202	Physics: Physics II	1st	6
P52G382V01203	Thermodynamics and heat transfer	1st	6
P52G382V01204	Resistance of materials	1st	6
P52G382V01205	Fundamentals of electrical engineering	2nd	6
P52G382V01206	Mechanism and machine theory	2nd	6
P52G382V01207	Environmental technology	2nd	6
P52G382V01208	Fluid mechanics	2nd	6
P52G382V01209	English I	2nd	6

IDENTIFYING DATA

Mathematics: Calculus II and differential equations

Subject	Mathematics: Calculus II and differential equations			
Code	P52G382V01201			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Álvarez Hernández, María			
Lecturers	Álvarez Hernández, María González Coma, José Pablo			
E-mail	maria.alvarez@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The aim of this course is for students to learn the basic techniques of integral calculus in several variables, vector calculus, ordinary differential equations and their applications.			

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.
C1	Ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and partial differential equations, numerical methods, numerical algorithms, statistics and optimization.
D1	Analysis and synthesis
D2	Problems resolution.
D3	Oral and written proficiency
D6	Application of computer science in the field of study.
D9	Apply knowledge.
D15	Objectification, identification and organization.
D16	Critical thinking.

Expected results from this subject

Expected results from this subject	Training and Learning Results		
Understanding of the basic concepts of integral calculus in several variables.	B3	C1	D1
Knowledge of the main techniques of integration of functions of several variables.	B3 B4	C1	D1 D2 D9
Knowledge of the main results of vector calculus and its applications.	B3 B4	C1	D1 D2 D9
Understand the importance of integral calculus, vector calculus and differential equations for the study of the physical world.		C1	D9 D16
Apply knowledge of integral calculus, vector calculus and differential equations.		C1	D2 D6 D9 D16
Acquisition of the ability to use this knowledge to solve questions, exercises and problems manually and by computer.		C1	D1 D2 D3 D6 D9 D15 D16
Acquire the basic knowledge for solving linear differential equations and systems.	B3	C1	

ENAEE LEARNING OUTCOME: KNOWLEDGE AND UNDERSTANDING: LO1.1 - Knowledge and understanding of mathematics and other basic sciences inherent to his/her engineering specialisation, at a level that allows the acquisition of the rest of the competences of the degree [development level (basic (1), adequate (2) and advanced (3)) of this sub-outcome: Adequate (2)].	B3	C1	
ENAEE LEARNING OUTCOME: ENGINEERING ANALYSIS: LO2.2 - The ability to identify, formulate and solve engineering problems in their speciality; to choose and apply established analytical, computational and experimental methods appropriately; to recognise the importance of social, health and safety, environmental, economic and industrial constraints [Adequate (2)].	B4	C1	D1 D2 D9 D16
ENAEE LEARNING OUTCOME: RESEARCH AND INNOVATION: LO4.3 - Ability and skill to design and carry out experimental investigations, interpret results and draw conclusions in their field of study [Adequate (2)].			D9

Contents

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

Planning

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

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

Methodologies

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

Personalized assistance

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

Assessment

	Description	Qualification	Training and Learning Results

Problem solving	A complementary activity will be carried out consisting of resolution of exercises.	15	B3 B4	C1	D1 D2 D3 D6 D9 D15 D16
Problem and/or exercise solving	There will be two mid-term exams on Topics 1 and 2.	30	B3 B4	C1	D1 D2 D3 D9 D15 D16
Laboratory practice	A practical problem-solving exercise will be carried out with Matlab.	15	B3 B4	C1	D2 D6 D9
Essay questions exam	There will be a final continuous assessment exam on the contents of the whole subject.	40	B3 B4	C1	D1 D2 D3 D9 D15 D16

Other comments on the Evaluation

GENERAL OBSERVATIONS ON THE CALCULATION OF THE MARK:

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

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

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

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

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

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

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

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

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

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

Complementary Bibliography

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

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Algebra and statistics/P52G382V01104
Mathematics: Calculus 1/P52G382V01103

Other comments

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

IDENTIFYING DATA				
Physics: Physics II				
Subject	Physics: Physics II			
Code	P52G382V01202			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Eiras Barca, Jorge			
Lecturers	Eiras Barca, Jorge Vázquez Carpentier, Alicia			
E-mail	jeiras@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The fundamental objectives shared by both this subject and its predecessor Physical I are, on the one hand, the consolidation, with the appropriate conceptual and formal rigor, of previously acquired knowledge. On the other hand, the establishment of the necessary bases for the study of other disciplines, either basic or fundamental. All this in such a way shows that the final objective is not the mere theoretical speculation but the application of the acquired knowledge to the technology, through the appropriate models and physical-mathematical schemes. The necessary skills and abilities will be developed for the resolution of technical problems related to Physics, practicing the analytical-deductive methodology of this science. The program of the Physics II subject of the Bachelor Degree in Mechanical Engineering is divided into two large blocks: Thermodynamics and Electricity and Magnetism, which will be developed in nine chapters as detailed in the contents section. This subject is key to understand subjects that will be studied later such as Thermodynamics and Heat Transfer, Thermal Engineering I, Foundations of Electrical Engineering or Electronic Technology. The second block is articulated in seven chapters that will follow a quasi-chronological development of classical electromagnetism. As in this second block, the first block will develop the classical formulation of thermodynamics summarized in two sections.			

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.
C2	Understanding and mastering the basics of the general laws of mechanics, thermodynamics, waves and electromagnetic fields, and their application for solving engineering problems.
D2	Problems resolution.
D9	Apply knowledge.
D10	Self learning and work.

Expected results from this subject	Training and Learning Results		
To understand the basic concepts of the general laws of electromagnetism and thermodynamics.	B3	C2	D2 D9 D10
To know the basic instrumentation to measure physical magnitudes.	B3	C2	D2 D9 D10
To know the basic techniques of evaluation of experimental data.	B3	C2	D2 D9 D10
To develop practical solutions to elementary technical problems of engineering in the fields of electromagnetism and thermodynamics.	B3	C2	D2 D9 D10
ENAEE learning outcome: KNOWLEDGE AND UNDERSTANDING: LO1.- Knowledge and understanding of the scientific and mathematical principles that underlie its engineering branch. Adequate.	B3	C2	
ENAEE learning outcome: KNOWLEDGE AND UNDERSTANDING: LO2.- A systematic understanding of the concepts and key aspects of its engineering branch. Adequate.		C2	D2 D9

ENAEE learning outcome: RESEARCH AND INNOVATION: LO11.- The capacity to design and realize experiments, interpret the data and take out conclusions. Basic.	C2	D9

Contents	
Topic	
1. FIRST PRINCIPLE OF THERMODYNAMICS	1.1. Introduction. Temperature and thermal equilibrium. Calorimetry. Changes of state and ideal gas. Equations of state. 1.2. Thermodynamic systems. 1.3. Work done in compression and expasion processes. 1.4. First law of thermodynamics. 1.5. Thermodynamic transformations. 1.6. Thermodynamics of ideal gases.
2. SECOND PRINCIPLE OF THERMODYNAMICS	2.1. Thermal machines. 2.2. The second law of thermodynamics. 2.3. Thermal cycles. 2.4. The Carnot cycle. 2.5. Entropy and physical interpretation. 2.6. Nerst's theorem. The third law of thermodynamics. 2.7. Perpetual motion of first and second species.
3. ELECTRIC FIELD I	3.1. Electric charge. Nature and units. Conductive and insulating materials. 3.2. Electrostatic forces. Coulomb's law. Electric field: Definition and units. Electric field originated by point charges. Electric field caused by charge distributions. 3.3. Electrostatic flow. Application of Gauss's theorem to the determination of electrostatic fields in typical configurations. 3.4. Electrostatic force work. Electrostatic potential energy. Electric potential: Definition and units. Equipotential surfaces. 3.5. Electric potential originated by point charges or charge distributions. Electric field and potential in conductors and insulators. Case studies of typical configurations.
4. ELECTRIC FIELD II	4.1. Electric field vectors, polarization and electric displacement. Relative permittivity. 4.2 Electrostatic capacitance. Definition and units. Capacitors. 4.3 Capacitance of capacitors. Particular analysis of the plane, cylindrical and spherical cases. 4.4 Electrostatic energy.
5. ELECTRIC CURRENT	5.1. Charge transport under potential differences. Current intensity and current density. Definition and units. 5.2. Conductance and resistivity. Conductance and resistance. Definition and units. Ohm's law. 5.3. Electromotive force and circuits. Kirchoff's laws in resistive circuits. 5.4. Energy and power in electrical circuits.
6. MAGNETIC FIELD I	6.1 Introduction to magnetism. Oersted's experience. Sources of the magnetic field. Magnetic induction field originated by a moving charge and a current element. Biot-Savart law. 6.2. Calculation of the magnetic induction field caused by simple configurations of current: Rectilinear conductor of great length at a given distance and circular current loop at the points of its axis. 6.3. Mutual force between parallel rectilinear conductors. Definition of the Ampere in the International System. 6.4. Ampere's law. Applications: Very long solenoid and toroidal solenoid. 6.5. Magnetic fields in material media. Magnetic susceptibility and magnetization vectors and magnetic field strength. 6.6. Different types of materials according to the value of their magnetic susceptibility.
7. MAGNETIC FIELD II	7.1. Lorentz force. 7.2. Analysis of particular cases of motion of charges in magnetic fields. Applications. 7.3. Magnetic force on current-carrying conductors. Moment of forces on current loops. Dipole magnetic torque of a loop. 7.4. Applications: DC engine, electromagnetic pump and Hall effect.

8. ELECTROMAGNETIC INDUCTION	8.1. Electromotive force induced by magnetic field flux variations. Experimental introduction. Faraday-Henry's law of induction and Lenz's law. 8.2. Electromotive force induced by the movement of currents within magnetic fields. Applications: Dynamos and alternators. 8.3. Mutual induction between magnetic elements. Self-induction. Coefficients of self-induction and mutual induction. Units. 8.4. Energy stored by the magnetic field. Formulation in terms of magnetic fluxes and intensities. Applications.
9. ELECTROMAGNETIC WAVES	9.1. Review of Ampère's law. 9.2. Maxwell's equations. 9.3. Poynting vector. 9.4. Electromagnetic plane wave. Properties.
LABORATORY SESSIONS	P1.- P-V relationship in a closed gas. P2.- Instruments and methods of electrical measurements. P3.- Capacitors. P4.- Magnetic field I. P5.- Electromagnetic induction. Problem Solving Session I. Problem Solving Session II.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Seminars	14	0	14
Laboratory practical	14	14	28
Problem solving	15	5	20
Essay questions exam	2	0	2
Essay questions exam	2	0	2
Objective questions exam	3	0	3
Essay	0	5	5
Objective questions exam	3	0	3
Objective questions exam	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	The lecturer will present the contents of each unit throughout theoretical classes. Presentations will be projected and the blackboard will be used simultaneously. Occasionally, computer media will be used. The copies of the projected material will be available to the student, to facilitate the taking of notes and the follow-up of the sessions. Students will also be able to consult basic texts for the follow-up of the course. Participation will be encouraged with questions, motivational techniques such as intentional errors, incomplete solutions, etc., Each session will have a duration of 1h and involves a personalized attention in groups.
Seminars	Directed activities will be planned in the classroom, some of them will be carried out individually by each student and others in groups, in order to encourage collaborative groups, to promote collaborative learning and personalized attention during the activities. Basically, the aim will be to solve problems related to the contents presented in the lecture sessions, so that a teaching methodology of problem-based learning is followed. The student will have to solve exercises and problems which will be corrected and evaluated by the lecturer. As in the master sessions, the use of blackboard and occasionally computer media is considered.

Laboratory practical	In these practical classes, the material available in the center's laboratory will be used. For some of the sessions it may be necessary to use MATLAB (or, alternatively and at the student's choice, Python) to handle a series of tools for testing concepts introduced in the theoretical sessions. With regard to the practical laboratory practical classes, the student must take into account the following directives, which will be mandatory: -The practical sessions are compulsory and of face-to-face character. -The student must hand in the corresponding report for each of the programmed laboratory practical sessions. It is considered the case that the report is handed in blank with the name or names of the students (it is considered as delivered and with a grade of 0). -The students who do not meet either of the above two requirements will not be able to pass the laboratory. -The time of delivery of the practices will be established by the lecturer in each session. session.
Problem solving	Problems related to the proposed laboratory practical sessions. These are proposed so that the student can better understand and relate the theoretical concepts of the subject with their practical application. The student will have to solve these exercises that will be corrected and graded by the lecturer.

Personalized assistance

Methodologies	Description
Seminars	In the field of tutorial action, academic tutoring actions are distinguished, as well as personalized tutoring where students will have at their disposal hours of tutorials in which they can consult any doubt related to the contents, organization or planning of the subject. The tutorials can be individualized, but group tutorials will be encouraged for the resolution of problems related to the contents of the course. In the personalized tutorials, each student, individually, will be able to discuss with the lecturer any problem that is preventing him/her from following the course properly, in order to find some kind of solution between both of them. The lecturers of the subject will personally attend to the doubts and queries of the students, both in person, according to the schedule that will be published on the web page of the center, and through e-mail or other telematic means (use of the virtual office by appointment, videoconference, use of Moovi forums, etc.).

Assessment

	Description	Qualification	Training and Learning Results		
Laboratory practical	Evaluation of the laboratory reports (EP).	15	B3	C2	D9 D10
Essay questions exam	First exam of the continuous evaluation program (P1).	15	B3	C2	D2 D9 D10
Essay questions exam	Second exam of the continuous evaluation pogram (P2).	15	B3	C2	D2 D9
Objective questions exam	Final exam of the continuous evaluation program (FE).	40	B3	C2	D2 D9 D10
Essay	Complementary activity (CA).	15			D10
Objective questions exam	Recovery - Ordinary Exam.	100	B3	C2	D2 D9 D10
Objective questions exam	Recovery - Extraordinary Exam.	100	B3	C2	D2 D9 D10

Other comments on the Evaluation

The ongoing evaluation techniques for this course will be the following:

Continuous evaluation tests (P1 and P2): Two evaluation tests will be carried out throughout the four-month period. The tests will be carried out in the theoretical classes as proposed by the lecturers. The completion of the two tests will be mandatory and required to pass the course.

Evaluation of laboratory practices (EP): Throughout the term, in certain sessions of practices problems or exercises will be posed for resolution by the students (individually or in groups) and subsequent delivery to the lecturer, who will evaluate them according to the criteria that will have been previously communicated to the students. The undelivered reports will count with a zero at the time of averaging. The grade of this component will be the average of the grades of all the reports handed in. Some practices will be evaluated through the completion of small evaluable questionnaires related to the work done during the practice and its subsequent analysis.

Complementary activities (CA): During the course of the course, activities (problems, complementary works, etc.) will be proposed so that the students can solve them autonomously and/or present them in class. Both the resolution and the explanation of the resolution process will be valued, as well as the skills of oral expression, comprehension and public exposition.

Final exam of continuous evaluation (FE): There will be a final exam that will cover all the contents of the course, both theoretical and practical. It is required to achieve a minimum grade of 4 points out of 10 in each of the possible blocks of the subject in order to be eligible for a passing grade by continuous evaluation.

The student's final evaluation will be based on the sum of the score given to each of the above mentioned parts, being the continuous evaluation grade (CEG):

$CEG = 0.15 \cdot P1 + 0.15 \cdot P2 + 0.15 \cdot EP + 0.15 \cdot CA + 0.40 \cdot FE.$

Being:

P1 - First continuous evaluation test.

P2 - Second continuous evaluation test.

EP - Evaluation of practices.

CA - Complementary activities.

FE - Final continuous evaluation exam.

In addition, due to the fact that the subject matter of the course is divided into two well differentiated thematic blocks (Thermodynamics and Electromagnetism), a minimum grade of 4 will be required in each of the blocks in order to obtain an average. The percentage corresponding to each block in the ordinary and extraordinary exams will be determined by the proportion of hours of theory taught in each block. For this reason, the electromagnetism block will represent 85% of the final grade and the thermodynamics block will represent the remaining 15%.

Therefore, some minimum requirements and conditions will be demanded in some of the sections that guarantee the balance between all types of competences.

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

A. Not having reached the minimum grade established in each of the blocks or in the final continuous evaluation test.

B. Obtaining a grade lower than 5 points out of 10 in the continuous evaluation grade. (CEG lower than 5).

The continuous evaluation grade of the student who fails to comply with assumption A, will be the minimum between CEG and 4 points.

Recovery plan of the final grade in first call:

Each and every student who has not passed the course during the continuous evaluation has the right to access a plan to recover the course.

The recovery plan consists of the right, already acquired, to take a new exam, called ordinary or first call, on the dates set, whose grade, if higher, will replace the one obtained previously and will count for all purposes in the calculation of the final grade.

It is understood that the grade obtained in the exam replaces, in case of being higher, the grade obtained through the continuous evaluation of the subject throughout the four-month period, replacing the aggregation of the grades of the practical tests, the continuous evaluation tests, the complementary activity and the continuous evaluation exam.

The requirement to pass each of the blocks of the subject (Electromagnetism and Thermodynamics), with a minimum grade of 4 in each of them, is maintained for the ordinary exam or first call.

Recovery plan of the final grade in the second call:

Each and every one of the students who have not passed the subject during the first call are again entitled to access a plan to recover the subject.

The recovery plan consists of the right, already acquired, to take a new exam, called extraordinary or second call, on the dates set, whose grade will replace the one obtained previously and will count for all purposes in the calculation of the final grade.

It is understood that the grade obtained in the exam replaces, in case of being higher, the grade obtained in the ordinary or first call exam.

The requirement to pass each of the blocks of the subject (Electromagnetism and Thermodynamics), with a minimum grade of 4 in each of them, is maintained for the extraordinary exam or second call.

Improvement plan for the final grade:

Each and every student can access a plan to improve their final grade.

The improvement plan consists of the right, already acquired, to take a new exam, coinciding with the ordinary exam or first call, on the dates set by the center. The new grade will replace the one obtained previously just if it is higher than the one already obtained, and will count for all purposes as the only reference in calculating the final grade.

Protocol for the detection of academic fraud:

Students are subject to the ethical commitment required for all students of the University of Vigo and military training centers. The actions of the faculty in case of detection of academic fraud will also be based on the following:

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
Young H.D., Freedman R.A., **Física Universitaria, V1 y V2**, 13, Pearson Educación, 2013
De Juana J., **Física General (VOL. II)**, 2, Pearson Educación, 2007
Fernández J.L., Pérez-Amor M. J., **Guía para la resolución de problemas de electromagnetismo. Problemas resueltos.**, 1, Reverté, 2012
Fidalgo J. A. y Fernández M. R., **1000 Problemas de física general**, 8, Everest S. A., 2004
González F.A., **La Física en problemas**, 1, Tébar Flores, 2002
Pellicer J., Manzanares J.A., **100 problemas de Termodinámica**, 1, Alianza Editorial, 1996
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Serway R. A., Jewett J. W., **Física para ciencias e ingeniería V1 y V2s**, 7, Cengage Learning, 2008
Tipler P., Mosca, B., **Física para la ciencia y la tecnología, V1 y V2**, 6, Reverté, 2010
Wangsness R. K., **Campos electromagnéticos**, 1, Limusa, 2001

Recommendations
Subjects that continue the syllabus
Electronic technology/P52G381V01301
Final Year Dissertation/P52G381V01991

Other comments

The Physics II course is a linking element between the knowledge acquired in previous stages of the degree and the knowledge to be assimilated in more advanced stages.

This discipline, of a fundamental nature, provides the conceptual basis necessary to continue, if necessary, the study of other subjects of other subjects of a similar nature and, in general, of those related subjects specific to the syllabus of the

corresponding degree. It is for this reason that in order to successfully take this subject the student must have:

1. Basic knowledge acquired in the subjects of Physics and Mathematics in previous courses of high school or equivalent (review is recommended).

2. Written and oral comprehension skills

3. Capacity for abstraction, basic calculation and synthesis of information.

4. Group work and group communication skills.

In addition, the student is reminded that the learning of Physics requires a progressive work methodology. So, in order to guarantee the success in this subject, the study of this subject should be kept up to date.

IDENTIFYING DATA				
Thermodynamics and heat transfer				
Subject	Thermodynamics and heat transfer			
Code	P52G382V01203			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Alfonsín Pérez, Víctor Ángel			
Lecturers	Alfonsín Pérez, Víctor Ángel Cacabelos Reyes, Antón González Gil, Lorena			
E-mail	valfonsin@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The aim of this subject is to train future graduates in Bachelor Degree in Mechanical Engineering with the ability to apply the principles of Thermodynamics and Heat Transfer required in almost all industrial processes and domestic installations. The knowledge of these principles is basic in Thermal Engineering, for instance, to carry out an energy analysis (determining the energy and exergy efficiency) of power systems for electricity generation (combined cycle with steam and gas turbine), a mechanical power cycle, a heat pump cycle, etc. The knowledge of whether a thermodynamic process can occur in reality is essential for the design of new processes, as well as the knowledge of the maximum benefits that can be obtained by the different devices present in an energy installation, and the causes hindering those maximum benefits. Furthermore, the study of the thermodynamic properties of the working fluids that circulate through the devices, water, air, refrigerants, gases and gas mixtures, is essential to analyse the behaviour of thermal systems. Likewise, studying the procedure needed for the energy analysis of refrigeration, air conditioning and in combustion processes is of great interest. On the other hand, it is essential for students to know the heat transfer mechanisms, focusing on determining the way and rate of the energy exchanged. Thus, at the end of the course, students are expected to be able to properly state and solve heat transfer engineering problems and to perform a basic design of heat exchangers.			

Training and Learning Results	
Code	
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.
B7	Ability to analyze and assess the social and environmental impact of the technical solutions.
B11	Knowledge, understanding and ability to apply the necessary legislation in the exercise of the profession of Industrial Technical Engineer.
C7	Knowledge of applied thermodynamics and heat transfer. Basic principles and their application to solving engineering problems.
D2	Problems resolution.
D7	Ability to organize and plan.
D9	Apply knowledge.
D10	Self learning and work.
D17	Team working.

Expected results from this subject	Training and Learning Results		
Capacity to know, understand and use the principles and fundamentals of applied thermodynamics	B4 B5 B6 B7	C7	D2 D7 D9 D10 D17
Ability to know and understand the principles and fundamentals of heat transmission	B5 B6 B7 B11	C7	D2 D7 D9 D10 D17

Analyze the operation of thermal systems, such as heat pump systems, refrigeration cycles or power cycles, identifying components, as well as the cycles used to obtain high performance.	B4 B5 B6 B7 B11	C7	D2 D7 D9 D17
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- Knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [Level of achievement (Basic (1), Intermediate (2) and Advanced (3)) for this learning outcome: [Advanced (3)].		C7	
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.2.- Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical - societal, health and safety, environmental, economic and industrial - constraints [Advanced (3)].	B4 B7		D2 D9
ENAEE learning outcome: RESEARCH AND INNOVATION: LO4.1.- Ability to conduct searches of literature, to consult and to critically use scientific databases and other appropriate sources of information, to carry out simulation and analysis in order to pursue detailed investigations and research of technical issues in their field of study. [Basic (1)].	B6 B11		
ENAEE learning outcome: RESEARCH AND INNOVATION: LO4.2.- Ability to consult and apply codes of practice and safety regulations in their field of study [Basic (1)].	B6 B7 B11		
ENAEE learning outcome: RESEARCHING AND INNOVATION: LO4.3.- Ability to design and conduct experiments, interpret data and draw conclusions [Intermediate (2)].		C7	D9
ENAEE learning outcome: ENGINEERING PRACTICE LO5.4.- Ability to apply norms of engineering practice in their field of study [Basic (1)].	B6 B7 B11		D9
ENAEE learning outcome: ENGINEERING PRACTICE LO5.5- Awareness of non-technical -societal, health and safety, environmental, economic and industrial implications of engineering practice [Basic (1)].	B7		
ENAEE learning outcome: MAKING JUDGEMENTS LO6.1.- Ability to gather and interpret relevant data and handle complex concepts within their field of study, to make judgements that involve reflection on ethical and social issues [Basic (1)].	B6 B7 B11		

Contents
Topic

BLOCK 1 (B1): Fundamental concepts and principles in heat transfer	B1-1. Introduction to heat transfer - Fundamental concepts in heat transfer - Mechanisms of heat transfer: conduction, convection and radiation - Fourier's law. Thermal conductivity and diffusivity - Newton's law of cooling. Convection coefficient - Stefan-Boltzmann law. Emissivity and absorptivity B1-2. Heat transfer by conduction - General heat conduction equation - One-dimensional conduction in steady state. Plane walls - Thermal resistance. Thermal resistance network - Global heat transfer coefficient - Stationary conduction with thermal energy generation - Conduction in radial systems: cylinders and spheres B1-3. Heat exchangers - General considerations - Classification of heat exchangers. Characteristics and selection criteria - Parallel, countercurrent and cross flow temperature distribution - Considerations for the design of heat exchangers - Heat flow exchanged - Logarithmic mean temperature difference (DTML) method - Efficiency method-number of transfer units (E-NUT) B1-4. Heat transfer by convection - Movement of a fluid. Laminar and turbulent flows - Boundary layers of convection: hydraulic and thermal - Dimensionless numbers - Free and forced convection - Empirical correlations for external and internal flows B1-5. Heat transfer by radiation: general principles - Fundamental concepts. Electromagnetic spectrum. Thermal radiation - Blackbody radiation. Planck's Law. Wien's Law - Definitions: radiation intensity, irradiance, emissivity - Surface absorptivity, reflectivity and transmissivity - Kirchhoff's Law
BLOCK 2 (B2): Properties of pure, simple and compressible substances	B2-1. Review of basic concepts and definitions - Systems definition - Description of the systems and their behaviour - Temperature measurement. Zero Law of Thermodynamics - Heat and specific heat - Phase change and latent heat - Ideal gas. State equations - The First Law of Thermodynamics - Thermodynamic transformations of an ideal gas - The Second Law of Thermodynamics B2-2. Properties of a pure, simple and compressible substance - Definition of the thermodynamic state - The p-v-T relationship - Calculation of thermodynamic properties - The ideal gas model - Internal energy, enthalpy and specific heats of ideal gases - Calculation of internal energy and enthalpy changes in ideal gases - Polytropic processes of an ideal gas

BLOCK 3 (B3): Energy analysis of systems according to the First and Second Law	B3-1. Energy analysis of control volumes - Conservation of mass - Conservation of energy - Steady state analysis - Transient analysis B3-2. The Second Law of Thermodynamics - Using the 2nd law - Formulations of the 2nd law - Identification of irreversibilities - Application of the 2nd low to thermodynamic cycles - The Kelvin temperature scale - Maximum efficiency measurements for cycles operating between two heat sources - The Carnot cycle B3-3. Entropy and its use - Clausius inequality - Definition of entropy change - Obtaining entropy values - Entropy change in internally reversible processes - Entropy balance for closed systems - Entropy balance for control volumes - Isentropic processes - Isentropic efficiencies of turbines, nozzles, compressors and pumps B3-4. Exergy analysis - Definition of exergy - Exergy balances - Exergy efficiency (second law)
BLOCK 4 (B4): Introduction to thermodynamic analysis of thermal motors and machines	B4-1. Power production facilities - Introduction to power production facilities - Vapor power production: the Rankine Cycle - Gas turbine power production facilities: the Brayton cycle - Combined cycle B4-2. Gas cycles in reciprocating internal combustion engines - Otto cycle - Diesel cycle B4-3. Refrigeration cycles - Refrigerators - Heat pumps

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

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	37	65
Laboratory practical	14	7	21
Problem solving	7	7	14
Seminars	15	12	27
Problem and/or exercise solving	0	4	4
Objective questions exam	4	4	8
Essay questions exam	3	2	5
Essay questions exam	6	0	6
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Lecturing	Teaching in the classroom of the key concepts and procedures for learning the syllabus contents. In addition to the information published on the online teaching platform Moovi, which contains the file with the lesson slides, the students have in the recommended bibliography the contents of each leasson with a more detailed development.
Laboratory practical	Application of the knowledge acquired in the lectures to the resolution of practical problems. A series of practices have been designed in accordance with the content of the subject in order to fix the explained concepts, so that the the student develops his creativity and his ability to propose technical solutions
Problem solving	The student must solve exercises and problems related to the subject individually.
Seminars	Intensive 15-hour course for those students who have failed the subject on the first call, prior to the exam on the second call. The lecturer briefly reviews theoretical concepts of the subject and proposes problems to be solved, while individually supervising the work of each student. An active learning methodology is promoted.

Personalized assistance

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

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	The assessment will be carried out through deliverables and a questionnaire (ECP). The questionnaire will be loaded in Moovi and it will assess the knowledge acquired in the lectures and in the laboratory related to the practices. On the other hand, the deliverables of each practice evaluate the quality of the experimental data collection, the understanding of the practice, synthesis capacity, logical reasoning, teamwork and the search for appropriate sources of information that help to understand the problem under study and to contrast the results obtained. The mark of each deliverable and the questionnaire will be out of 10 points. The global grade of practices will be the average of the mark of all the deliverables and the questionnaire.	20	B4 C7 D2 B5 D7 B6 D9 B7 D10 B11 D17
Problem and/or exercise solving	During the semester different tasks (TE) will be proposed, some will be individual and others may be in group. The objective of these tasks will be to promote the understanding of the theoretical/practical contents and to delve into other key aspects of the subject, such as the management and application of regulations such as the Technical Building Code in matters of energy saving. These activities will be compulsory and scored, each one of them, out of 10 points.	10	B4 C7 D2 B5 D7 B6 D9 B7 D10 B11 D17
Objective questions exam	Mid-term exams (PP) Their objective is to evaluate the theoretical contents and the ability to solve problems acquired during part of subject, since two mid-term exams will be conducted (weighting 15% each). These tests will consist of a series of questions and exercises that prioritize conceptual and logical reasoning, in order to verify the intellectual maturity of the students to obtain conclusions from contents presented in lectures. Both test will be compulsory and scored on 10 points each.	30	B4 C7 D2 B5 D7 B7 D9 B11 D10

Essay questions exam	Final Exam (EF) Its objective is to evaluate the theoretical contents and the ability to solve problems acquired during the whole subject in the lectures and seminars. This test will consist of a series of questions and exercises that prioritize conceptual and logical reasoning, in order to verify the intellectual maturity of the students to obtain conclusions from contents presented in lectures. This test will be compulsory and scored on 10 points.	40	B4 B5 B7 B11	C7 D2 D7 D9 D10
Essay questions exam	Ordinary and Extraordinary Exam If the students do not pass the continuous evaluation, they will have an ordinary exam after the final exam. In this exam the students will be evaluated of all the contents taught in the lectures, seminars and practical sessions. This exam will represent 100% of the final grade of the student. It will be necessary to obtain a grade higher than 5 points out of 10 to pass the exam. If the students do not pass the ordinary exam, they would go directly to the second call in July. In the extraordinary exam the student will be examined of all the theoretical/practical contents taught in the subject during the ordinary course.	100	B4 B5 B6 B7 B11	C7 D2 D7 D9 D10

Other comments on the Evaluation

The student must be examined of all the subject contents in the ordinary exam, if the final grade of continuous assessment is less than 5 and also in the following cases:

- The no realisation or delivery of any of the activities.
- Obtain a grade to inferior 4.0 points over 10 in the final exam

In the case that they do not fulfill those conditions, the maximum qualification of the student by continuous evaluation will be 4.0. In any case, the student that has passed the continuous evaluation, will have the possibility to attend to the ordinary exam to improve his/her grade.

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

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

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

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

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

Complementary Bibliography

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

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

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

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

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

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

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

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

Recommendations

Subjects that continue the syllabus

Thermal engineering I/P52G381V01403

Other comments

To successfully complete this subject, the student must have the following skills:
- Written and oral comprehension.
- Abstraction, basic calculation and synthesis of information.

IDENTIFYING DATA				
Resistance of materials				
Subject	Resistance of materials			
Code	P52G382V01204			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Suárez García, Andrés			
Lecturers	Suárez García, Andrés Val García, Jesús del			
E-mail	asuarez@cud.uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	Introduction to linear elastic materials, and analysis of internal loadings, stress and strain relationships. Study of the fundamentals of mechanics of materials and particularization for shafts and beam structures.			

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.
C14	Knowledge and use of the principles of strength of materials.
D1	Analysis and synthesis
D2	Problems resolution.
D9	Apply knowledge.
D10	Self learning and work.
D16	Critical thinking.
D17	Team working.

Expected results from this subject	Training and Learning Results		
Know the differences between rigid and elastic solids.	B3 B4	C14	D1 D2 D9 D10 D16 D17
Apply the acquired knowledge to maximum stress calculation at a point in a deformable solid.	B3 B4	C14	D1 D2 D9 D10 D16 D17
To know the basic principles governing Strength of Materials.	B3 B4	C14	D1 D2 D9 D10 D16 D17
To know the relationships between the different stresses and the stresses they cause.	B3 B4	C14	D1 D2 D9 D10 D16 D17

Apply the acquired knowledge to the determination of stresses.	B3 B4	C14	D1 D2 D9 D10 D16 D17
Apply the acquired knowledge of stresses to their estimation in bar elements.	B3 B4	C14	D1 D2 D9 D10 D16 D17
To know the fundamentals of the deformations of bar elements.	B3 B4	C14	D1 D2 D9 D10 D16 D17
Apply the knowledge acquired to the dimensioning of busbar elements.	B3 B4	C14	D1 D2 D9 D10 D16 D17
ENAEE LEARNING OUTCOME: KNOWLEDGE AND UNDERSTANDING. LO 1.2: Knowledge and understanding of the engineering disciplines specific to their speciality, at the level necessary to acquire the rest of the competences of the degree, including notions of the latest developments. Level of development: Adequate (2). NOTE: The possible values for the level of development are: Basic (1), Adequate (2) and Advanced (3).	B3	C14	
ENAEE LEARNING OUTCOME: ENGINEERING ANALYSIS. LO 2.2: The ability to identify, formulate and solve engineering problems in their speciality; to choose and apply established analytical, computational and experimental methods appropriately; to recognise the importance of social, health and safety, environmental, economic and industrial constraints. Level of development: Adequate (2).	B4		D1 D2 D9 D16
ENAEE LEARNING OUTCOME: RESEARCH AND INNOVATION. LO 4.3: Ability and skill to plan and carry out experimental research, interpret results and reach conclusions in their field of study. Level of development: Basic (1).		C14	D9

Contents	
Topic	
Topic 1. Statics	- Concept of an elastic solid - Moment of a force - Static equilibrium. Equations - Moments and products of inertia - Static equilibrium and elastic equilibrium - Stresses on a section in elastic regime
Topic 2. Basic Concepts of Strength of Materials	- Object and purpose of strength of materials - Stresses and strains - Principle of relative stiffness and superposition - Elastic equilibrium - Reactions at supports. Types of supports - Isostatic and hyperstatic systems
Topic 3. Stress State and Failure	- Stress state. Stress matrix. Mohr's circle. Principal planes - Failure criteria. Limit state. Ductile material. Brittle material - Safety factor
Topic 4. Tension-Compression	- Stress and normal stress - Deformations. Poisson's ratio. Generalized Hooke's law - Statically determinate problems - Hyperstatic problems - Uniaxial tension or compression due to thermal variations
Topic 5. Fundamentals of Buckling	- Definition - Critical load. Euler's formulation - Section modulus - Limits of application of Euler's formulation

Topic 6. Shear	- Shear stress and normal stress - Shear deformations - Shear modulus - Relationships between elastic modulus, shear modulus, and Poisson's ratio
Topic 7. Bending and Shear	- Beams. Deformation and classes. Applied forces on beams - Types of bending. Assumptions and limitations - Shear stress and bending moment. Diagrams and relationships - Normal stresses. Navier's law - Concept of section modulus. Optimal sections - Analysis of deformations: rotations and deflections. Moment-curvature relationship. Elastic curve equation. Theorems for deformation calculations - Hyperstatic vending
Laboratory 1. Tensile Test	This practical exercise aims to familiarize the student with tensile testing and the regulations that describe it.
Laboratory 2. Bending Test	This practical exercise aims to familiarize the student with bending tests and the regulations that describe them. Analyze different configurations: simply supported beam, hinged beam, and cantilever beam. Calculate the bending moment and deflection associated with each of them.
Laboratory 3. Compression Test	This practical exercise aims to familiarize the student with compression tests and the regulations that describe them. Perform tests on prototypes with different slenderness ratios and calculate the critical force. The gripping method should be the same for all specimens, resulting in a sudden change in cross-section. The normal stress diagram will also be calculated.
Laboratory 4. Shear Test	This practical exercise aims to familiarize the student with shear tests and the regulations that describe them.
Laboratory 5. Modulus of Elasticity and Other Elastoplastic Constants	This practical exercise focuses on the calculation of the experimental modulus of elasticity. The student will use data collected in previous laboratory sessions. The relationship between the elastic modulus and stresses in each test performed will be reviewed.
Laboratories 6 and 7. Software Practice	This practical exercise aims to familiarize the student with calculating normal stresses, tensions, and deformations in different scenarios using structural analysis software.

Planning

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

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

Methodologies

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

Personalized assistance

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

Assessment					
	Description	Qualification	Training and Learning Results		
Essay questions exam	Final Exam (FE) which represents 40% of the continuous assessment (EC). 2 Theoretical-Practical Assessment (TPA) representing: 2x15%=30% of EC.	70	B3 B4	C14	D1 D2 D9 D10 D16
Laboratory practice	Laboratory Practices (LP) which represent 20% of the EC. Quizzes and Tests (QT) representing 10% of EC.	30	B3 B4	C14	D1 D2 D9 D16 D17

Other comments on the Evaluation

ORDINARY CALL: CONTINUOUS ASSESSMENT

The method of continuous assessment (CA) will assess the results achieved by students in different activities carried out throughout the course, grouped into four parts: Final Exam (FE), Theoretical-Practical Controls (TPA), Laboratory Practices (LP), and Quizzes and Tests (QT). The weights for each part will be: FE 40%, TPA 30%, LP 20%, and QT 10%.

Two assessments of theoretical-practical knowledge (TP1 and TP2) will be conducted during the course. Each of them will account for 15% of the final continuous assessment grade. These assessments will be interspersed with theory sessions. The TPA grade will be the arithmetic mean of TP1 and TP2.

The student will be evaluated for each laboratory practice completed (LP1 to LP7). This evaluation will be done through practice reports or questionnaires related to them. It could happen that, to evaluate a single practice, both a report and a questionnaire are required simultaneously. The submission of reports and completion of questionnaires will be done electronically through the MOOVI platform. Additionally, during seminar and/or theory class hours, the student will be asked to complete different Quizzes and Tests (QT).

The final continuous assessment exam (FE) will include all the content of the subject and will carry a weight of 40% in the final continuous assessment grade.

The continuous assessment grade (CAG) will be the result of applying the weighted arithmetic mean of the grade for each part (FE, TPA, LP, and QT), as reflected in the following equation:

$CAG = 0.4 * FE + 0.3 * TPA + 0.2 * LP + 0.1 * QT$

To pass the continuous assessment, two conditions must be met: having a $CAG \geq 5$ and an $FE \geq 4$. If the latter condition is not met, the LP grade will be ignored, resulting in a failing grade for the continuous assessment of the subject, with a score equal to the minimum of 4.0 and the weighted average of FE and TPA.

ORDINARY CALL: ORDINARY EXAM

Those students who fail to pass the subject through continuous assessment must take the ordinary exam, which will evaluate all the competencies of the subject. The results of this exam will constitute 100% of the student's final grade, and obtaining a grade greater than or equal to 5 is a requirement to pass the subject. Finally, it is worth noting that every student has the option to improve their CAG. In other words, students who have passed the subject through continuous assessment will have the opportunity to take the ordinary exam to improve their grade.

EXTRAORDINARY CALL

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

ACADEMIC INTREGITY

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

Hibbeler, Rusell, **Mecánina de Materiales**,

Complementary Bibliography

Ortiz Berrocal, Luis, **Resistencia de Materiales**,

Da Beer, Ferdinand et al., **Mecanica vectorial para ingenieros. Estática.**,

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics 1/P52G382V01106

Other comments

The subject of Strength of Materials constitutes the study of the behavior of real materials in relation to their characteristics of strength, rigidity, and stability. This discipline requires the necessary conceptual foundation for its proper understanding. That is why, in order to successfully take this course, students must have:

- Knowledge of kinematics, dynamics, and statics acquired in the subject of Physics I in the first year of the Mechanical Engineering degree (review is recommended).

- Capacity for written and oral comprehension.

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

IDENTIFYING DATA				
Fundamentals of electrical engineering				
Subject	Fundamentals of electrical engineering			
Code	P52G382V01205			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Falcón Oubiña, Pablo			
Lecturers	Falcón Oubiña, Pablo González Prieto, José Antonio Val García, Jesús del			
E-mail	pfalcon@cud.uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	The knowledge of electricity, its use and its protections is basic for the development of any kind of engineer, regardless of his branch. That is why Fundamentals of Electrical Engineering represents one of the most important pillars of the knowledge of the future technician, and given its broad spectrum, it will contain a theoretical part and a further part eminently practical. The main objective of this course is to transmit the fundamental concepts of the Theory of Circuits and Electrical Machines for application in the design of electrical distribution systems and electronic circuits. These concepts represent the basis of electrical engineering which brings together different aspects and technical sciences such as, among others, Electronics, Power Electronics, Control and Regulation, Automation Systems and Electrical Machines. All this forms the basis of the current field of action of industrial electricity.			

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.
C10	Knowledge and use of the principles of circuit theory and electrical machines.
D1	Analysis and synthesis
D2	Problems resolution.
D6	Application of computer science in the field of study.
D10	Self learning and work.
D14	Creativity.
D16	Critical thinking.
D17	Team working.

Expected results from this subject	Training and Learning Results		
To understand the basics of the operation of circuits and electrical machines	B3	C10	
To know the experimental process used when working with electrical circuits and electrical machines			D1 D2 D17
To know the current techniques available for the analysis of electrical circuits		C10	D6
To know the techniques of measure of electrical circuits			D6 D10
To acquire skills on the process of analysis of electrical circuits			D1 D2 D6 D10 D14 D16 D17
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		

ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.3.- awareness of the wider multidisciplinary context of engineering [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	C10
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.2.- practical skills for solving complex problems, realising complex engineering designs and conducting investigations in their field of study [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	D2 D16
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.3.- understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	D6
ENAEE learning outcome :COMMUNICATION and TEAM-WORKING: LO7.2.- ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	D10 D17

Contents

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

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

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

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

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

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

Personalized assistance

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

Assessment

Description	Qualification	Training and Learning Results

Lecturing	The final grade will be determined from the grades obtained in: 1. Continuous evaluation, through the assessment of practical work and activities proposed throughout the course. 2. Final evaluation, by means of examinations carried out in the calls and dates set by the University and the Centre. In the framework of the continuous evaluation, it will be a first theoretical partial examination of the contents seen so far (circuits of direct and alternating current). This test will account for 15% of the total grade final of continuous assessment, there being no minimum score on this test. Before the final exam of the course, a second exam will be taken with contents related to three-phase systems and electrical machines seen up to that point. This test will account for 15% of the total the final mark for continuous assessment, there being no minimum mark in this proof. Throughout the four-month period, they will take place at different times, short questionnaires to check follow-up and commitment to subject by the students. The tests will be carried out with the support of the platform for the subject's tele-education. These tests will involve in total 10% of the final mark for continuous assessment, with no minimum mark. At the end of the four-month period, a final exam will be taken that will cover the all the contents of the course, both theoretical and practical, and which may include multiple choice tests, reasoning questions, resolution of problems and development of case studies. The examination, which will account for 40 per cent of the final continuous assessment score, will be based on the assessment of problem-based learning by the parties to the Block I: Circuit Theory (Direct Current, Alternating Current and three phase) and Block II: Electrical Machines. It will be distributed in trouble and/or theoretical questions, which can be about the theory and seminars seen in the classroom or about the practices seen in the laboratory. In order to pass the course, a mark of 5.0 points out of 10 will be required in the computation of the final Continuous Evaluation Note (NEC). Additionally is required: - A minimum of 40% of the score assigned to Block I (Theory of Circuits) - A minimum of 40% of the score assigned to Block II (Machines Electrical) Those students who do not reach the minimums established in any of the two parts, must be submitted to the Ordinary Examination. In this case, your the final continuous evaluation note (NEC) will be calculated as: NEC = min {4.0, NEC}	80	B3 C10	D1 D2 D14 D16
Laboratory practical	Laboratory practical will be evaluated on the basis of the work done by the student during the practice sessions and by evaluating the technical reports produced at the end of each one. The grade for this block of practices will represent 20% of the total grade end of continuous evaluation. The student must reach 40% of the score assigned to the practices of each of the blocks of the subject.	20	B3 C10	D1 D6 D10 D16 D17

Other comments on the Evaluation

Qualification Assurance Plan

Recovery plan of the final qualification in the First Call

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

- Have not passed the subject during the Continuous Assessment (NEC < 5.0)
- Wish to improve the grade obtained by the Continuous Assessment method.

The ordinary examination will be based on the evaluation of problem-based learning in the parts of Block I: Circuit Theory (direct current, alternating current and three-phase current) and Block II: Electrical Machines. The practice part will also be evaluated with a test based on the circuit and machine simulation tool that will be used during the course.

The ordinary examination will contain a theoretical part and a practical part. The student will pass the course when the Note

of the Ordinary Examination (NEO) is greater or equal to 5.0 points out of 10, being also necessary to overcome the minimums established in the following table:

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

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

NEO = 0.8-T + 0.2-P

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

NEO = min {4.0, NEO}

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

NPC = max {NEC, NEO}

Recovery plan of the final qualification in the Second Call

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

NEE = 0.8-T + 0.2-P

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

NEE = min {4.0, NEE}

Plan to improve the final rating

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

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

James W. Nilsson, **Electric Circuits**, 10ª, Pearson, 2014

Fraile Mora, J., **Máquinas Eléctricas**, 8ª, Garceta Grupo, 2016

Complementary Bibliography

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

Conejo, A, **Circuitos eléctricos para la ingeniería**, 1ª, McGraw-Hill, 2004
Gabladon, A, **Problemas de circuitos eléctricos**, 1ª, Editorial Diego Marín, 2000
Garrido, C. y Cidrás, J., **Problemas de Circuitos Eléctricos**, 1ª, Editorial Reverte, 1992
Espinosa, J. y Belenguer, **Problemas resueltos de máquinas eléctricas rotativas**, 1ª, Universidad Jaume I, 2012
Chapman, S.J, **Máquinas Eléctricas**, 5ª, McGraw Hill, 2012
Corrales Martín, J., **Cálculo Industrial de Máquinas Eléctricas, Tomo II**, 1ª, Marcombo Boixerau Editores, 1982
Duncan Glover, J. y Sarma, M., **Sistemas de Potencia. Análisis y Diseño**, 3ª, Cengage Learning Editores S.A., 2003
Kosow, I.L., **Máquinas Eléctricas y Transformadores**, 1ª, Pearson Educación, 1993
Casals Torrens, Pau, **Máquinas eléctricas. Aplicaciones de ingeniería eléctrica a instalaciones navales y marinas**, 1ª, Ediciones UPC, 2010

Recommendations

Subjects that continue the syllabus

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

Other comments

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

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

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

IDENTIFYING DATA				
Mechanism and machine theory				
Subject	Mechanism and machine theory			
Code	P52G382V01206			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Pérez Vallejo, Javier			
Lecturers	Cacabelos Reyes, Antón Pérez Vallejo, Javier			
E-mail	jvallejo@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The main objective of the subject is to provide the student with knowledge of the principles of the Theory of Machines and Mechanisms, a competence contained in the Ministerial Order CIN/351/2009 which establishes the requirements for the verification of the degrees that enable for the exercise of the profession of Industrial Technical Engineer. This subject addresses the aforementioned competence and allows the development of related competences in subsequent subjects.			

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.
C13	Knowledge of the principles of the theory of machines and mechanisms.
D2	Problems resolution.
D6	Application of computer science in the field of study.
D9	Apply knowledge.
D10	Self learning and work.
D16	Critical thinking.

Expected results from this subject	Training and Learning Results		
Know the basic foundations of the Theory of Machines and Mechanisms and their application in Mechanical Engineering to solve the problems related with said matter in the field of Industrial Engineering.	B3 B4	C13	D2 D9 D10 D16
Know, understand, apply and practice the concepts related to the Theory of Machines and Mechanisms.		C13	D2 D9 D10 D16
Know and apply the techniques of kinematic and dynamic analysis of mechanical systems.		C13	D2 D9 D10 D16
Know and use mechanism analysis software effectively.		C13	D2 D6 D9 D10 D16
ENAEE learning outcome: 1. KNOWLEDGE AND UNDERSTANDING. 1.2.- Knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront. Level of achievement: Basic (1).	B3	C13	

ENAEE learning outcome: 2. ENGINEERING ANALYSIS. 2.2. Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical societal, health and safety, environmental, economic and industrial constraints. Level of achievement: Advanced (3).	B4	D2 D9 D16
ENAEE learning outcome: 3. ENGINEERING DESIGN. 3.1. Ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical, societal, health and safety, environmental, economic and industrial considerations; to select and apply relevant design methodologies. Level of achievement: Basic (1).	B4	D2 D9
ENAEE learning outcome: 5. ENGINEERING PRACTICE. 5.3. Understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study. Level of achievement: Basic (1).		D6 D9

Contents

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

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

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	35	63
Laboratory practical	12	0	12
Seminars	7	7	14
Problem solving	15	24	39
Mentored work	2	7	9
Essay questions exam	13	0	13

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

Methodologies

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

Personalized assistance

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

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	Practice Reports (MP): Reports to be delivered for each laboratory practice (if the practice is carried out in a group, only one group memory will be delivered). Each report will be scored out of 10 points. The MP grade will be the average value of the grades obtained in each report delivered and will represent 10% of the continuous evaluation grade.	10	B3 C13 D2 B4 D6 D9 D10 D16
Seminars	Assessable Exercises (EE): Resolutions of problems to be delivered that will be proposed along the course (in particular in the seminar hours). Each exercise will be scored out of 10 points. The EE grade will be the average value of the grades obtained in each exercise delivered and will represent 10% of the continuous evaluation grade.	10	B3 C13 D2 B4 D9 D10 D16

Mentored work	Group Project (TG): Common project consisting of the delivery of a report and an oral presentation. The project will be scored out of 10 points. The TG grade will represent 10% of the continuous assessment grade.	10	B3 B4	C13	D2 D6 D9 D10 D16
Essay questions exam	Partial Tests (PP): Two written tests (theoretical questions and problems) that evaluate the contents taught to date. These tests will be interspersed with theory sessions during the quadmester. Each test will be scored out of 10 points. The PP1 (15%) and PP2 (15%) grades will represent 30% of the continuous assessment grade. Final Test (PF): Written test (theoretical questions and problems) that evaluate the entire subject. This test will take place at the end of the quadmester. The final test will be scored out of 10 points. The note PF will represent 40% of the continuous assessment grade.	70	B3 B4	C13	D2 D9 D10 D16

Other comments on the Evaluation

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

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

Ordinary call: continuous assessment

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

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

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

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

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

Ordinary call: ordinary exam

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

Extraordinary call

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

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

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R. Calero Pérez, J.A Carta González, **Fundamentos de mecanismos y máquinas para ingenieros**, McGraw-Hill, 1999

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P. Lafont, A. Díaz Lantada, J. Echevarría Otero, **Diseño y cálculo de transmisiones por engranajes**, ETSII Universidad Politécnica de Madrid, 2009

Recommendations

Other comments

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

IDENTIFYING DATA				
Environmental technology				
Subject	Environmental technology			
Code	P52G382V01207			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Maceiras Castro, María del Rocío			
Lecturers	Alfonsín Pérez, Víctor Ángel González Gil, Lorena Maceiras Castro, María del Rocío			
E-mail	rmaceiras@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This syllabus collects the competencies that the students must acquire in this course, the calendar of planned educational activities, the contents and its distribution, an estimate of the volume of work of the student and the specific criteria of assessment. The aim of this subject is to form future graduates in Bachelor Mechanical Engineering with the ability to identify the environmental impacts of industrial and human activities, with the aim to minimize, prevent and solve them. In fact, the increase in legal requirements related to environmental protection, together with the interest of society in the application of more environmentally friendly technological solutions enhance the need for professionals capable of solving environmental problems within multidisciplinary contexts. To achieve this, in this subject it is carried out an approach to Environmental Engineering in combination with other knowledge fields, such as Mechanical Engineering (equipment design), Chemistry (study of pollutants and their behavior), Biology (biotechnological processes) and Process Engineering (design of physical, chemical and biological processes to mitigate contamination). More specifically, in this subject some technical and practical knowledge about environmental pollution in different ecosystems and their flows of matter and energy will be needed, to later study all the vectors of pollution and evaluate the most appropriate technologies to minimize them, complying whit the current legislation. Lastly, basic knowledge is given on the main policies, tools and indicators developed within the framework of environmental management for the prevention of industrial pollution.			

Training and Learning Results	
Code	
B7	Ability to analyze and assess the social and environmental impact of the technical solutions.
C16	Basic knowledge and application of environmental technologies and sustainability.
D1	Analysis and synthesis
D2	Problems resolution.
D3	Oral and written proficiency
D9	Apply knowledge.
D10	Self learning and work.
D12	Research skills.
D17	Team working.
D19	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources.

Expected results from this subject	Training and Learning Results	
To know the available environmental technologies for control of gaseous pollutants	C16	D2 D3 D10
To know the performance of wastewater treatment plants	C16	D2 D3 D10
To know the integrated process of industrial waste treatment	C16	D2 D3 D10 D19

To know and be able to apply the different tools for preventing industrial pollution		C16	D1 D2 D3 D9 D10 D12 D17 D19
Ability to analyze and determine the social and environmental impact of the technical solutions to environmental problems	B7		D1 D3 D9 D10 D17 D19
ENAEE LEARNING OUTCOME. KNOWLEDGE AND UNDERSTANDING LO1.3.- awareness of the wider multidisciplinary context of engineering (level of development this sub-resulted of learning: Intermediate (2))		C16	
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))	B7		D1 D2 D9 D19
ENAEE LEARNING OUTCOME. ENGINEERING DESIGN LO3.1.- ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical societal, health and safety, environmental, economic and industrial considerations; to select and apply relevant design methodologies (Intermediate (2))	B7		D2 D9 D19
ENAEE LEARNING OUTCOME. INVESTIGATIONS LO4.2.- ability to consult and apply codes of practice and safety regulations in their field of study (Intermediate (2))	B7		
ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE LO5.1.- understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study (Intermediate (2))			D9 D12
ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE LO5.4.- ability to apply norms of engineering practice in their field of study (Basic (1))	B7		D9
ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE LO5.5- awareness of non-technical societal, health and safety, environmental, economic and industrial implications of engineering practice (Intermediate (2))	B7	C16	D19
ENAEE LEARNING OUTCOME. MAKING JUDGEMENTS LO6.1.- ability to gather and interpret relevant data and handle complexity within their field of study, to inform judgements that include reflection on relevant social and ethical issues (Intermediate (2))	B7		D19

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

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

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	31	59
Laboratory practical	14	7	21
Problem solving	7	7	14
Seminars	15	15	30
Objective questions exam	4	0	4
Essay	0	5	5
Problem and/or exercise solving	0	2	2
Essay questions exam	3	2	5
Essay questions exam	3	2	5
Essay questions exam	3	2	5

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

Methodologies

	Description
Lecturing	Teaching in the classroom of the key concepts and procedures for learning the syllabus contents. In addition to the information published on the online teaching platform, which contains the file with the lesson slides, the students have in the recommended bibliography the contents of each leasson with a more detailed development.
Laboratory practical	Application of the knowledge acquired to the resolution of problems of environmental technology. A series of practices have been designed in accordance with the content of the subject in order to fix concepts explained in this class.
Problem solving	In the seminars, the student will have to solve exercises and problems that will be corrected by the lecturer. Likewise, they will have to do exercises in individual way.
Seminars	Intensive 15-hour course for those students who have failed the subject on the first call, prior to the exam on the second call. Group tutoring with the lecturer.

Personalized assistance

Methodologies	Description
Laboratory practical	Academic tutoring and personalized tutoring.

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

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	Evaluation of the work in the laboratory and of the summary report with the data obtained in the practices, its analysis and discussion. At the end of each practice, the student must prepare a detailed report including aspects such as: objectives and theoretical fundaments of the practice, experimental procedure, materials used, the results obtained and their discussion. In addition, the comprehension of the practice, the student's synthesis capacity, the writing style and the presentation of the report, as well as the student's personal contribution, are evaluated. These reports will be compulsory and rated, each of them, on 10 points, and represent 10% of the continuous assessment. In addition, an exam corresponding to laboratory practices (5%) will be carried out.	15	B7 C16 D1 D3 D9 D12 D17 D19
Objective questions exam	The theoretical and practical knowledge acquired by the student during the masterclasses and seminars will be monitored. There will be two continuous assessment tests of theory and problems (P1 and P2), with a weight of 15% each. Such tests will be compulsory and scored on 10 points.	30	B7 C16 D1 D2 D3 D9 D10 D12 D17
Essay	The students, in pairs or groups of 3, will carry out a written essay on contents related to Topic 8 "Environmental impact assessment and management" or on key aspects of other lessons that it is appropriate to further study. Part of the work will focus on seeking the real application of the addressed topic in different industrial or social fields, evidencing the multidisciplinary application of environmental engineering. Moreover, the students will have to reflect on the ethical and social implications of the studied content. Finally, each group will present their work orally and the peer-assessment among students will be encouraged.	5	C16 D1 D3 D9 D10 D12 D17 D19
Problem and/or exercise solving	During class hours, individual tasks (TI, 5%) and activities to promote the student learning (TO, 5%), that may be individuals or in groups and they will be proposed in order to monitor the contents taught. These activities will be compulsory and scored, each of them, on 10 points.	10	C16 D1 D3 D9 D10 D12 D17 D19
Essay questions exam	Final Exam (FE) At the end of the course, the knowledge acquired by the student will be evaluated by means of a written test with theoretical contents (4 points) and problems (6 points). Such exam will be compulsory and scored on 10 points.	40	B7 C16 D1 D2 D3 D9 D10 D12 D17
Essay questions exam	Ordinary Exam If the students do not pass the continuous evaluation, they will have an ordinary exam after the final exam. In this exam the students will be evaluated of all the contents taught, both theoretical and practical. It will be necessary to obtain a grade higher than 4 points out of 10 in each of the parts (theory and problems) in such exam. Besides, there will be a test related to the laboratory practices (with a weight of 5%).	100	B7 C16 D1 D2 D3 D9 D10 D12 D17
Essay questions exam	Extraordinary Exam The student will be examined of all the theoretical / practical contents taught in the subject during the ordinary course. In addition, it will be necessary to obtain a grade higher than 4 points out of 10 in each of the parts (theory and problems) evaluated in such exam. Besides, there will be a test related to the laboratory practices (with a weight of 5%).	100	B7 C16 D1 D2 D3 D9 D10 D12 D17

Other comments on the Evaluation

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

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

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

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 inthe assessment process, as well as the cooperation in it will result in theassignment 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.

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

Sources of information

Basic Bibliography

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Recommendations

Other comments

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

IDENTIFYING DATA				
Fluid mechanics				
Subject	Fluid mechanics			
Code	P52G382V01208			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Febrero Garrido, Lara			
Lecturers	Eirís Barca, Antonio Febrero Garrido, Lara			
E-mail	lfebrero@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Fluid Mechanics is a basic subject, in which the fundamental principles of physics and mechanics are applied to fluid matter. The aim is for students of the degree in mechanical engineering to acquire the knowledge and tools necessary to know how to analyse and understand fluid problems of different categories, to serve as support for other subjects in the syllabus related to the properties and movement of fluids, both basic and more oriented to real problems in the field of engineering. The development of generic skills and competences such as teamwork and autonomous learning is also encouraged. Fluid Mechanics describes the relevant physical phenomena of fluid motion, describing the general equations of these movements. This knowledge provides the basic principles necessary to analyse any system in which fluid is the working medium. The field of applications of Fluid Mechanics in engineering is very broad: transport of fluids in pipelines, aeronautics, engines, ships, biological flows, etc. The principles of Fluid Mechanics are necessary for such diverse fields as: - Design of hydraulic machinery. - Lubrication. - Heating and ventilation, heating and cooling systems. - Design of piping systems. - Means of transport: transmission, air conditioning, exhaust systems, aerodynamics and hydrodynamics, refrigeration, etc. - Aerodynamics of structures and buildings - Thermal and fluid power plants for conventional and renewable energy production.			

Training and Learning Results	
Code	
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.
C8	Knowledge of the basic principles of fluid mechanics and their application to solving problems in the field of engineering. Calculation of pipes, channels and fluid systems.
D2	Problems resolution.
D9	Apply knowledge.
D10	Self learning and work.

Expected results from this subject	Training and Learning Results		
(*)Coñecer e comprender os procesos de cambio e as continuidades que se produciron en Galicia na época moderna			
Understand the basic principles of fluid movement	B4 B5	C8	D2 D9 D10
Ability to calculate pipes and channels	B4 B5	C8	D2 D9 D10
Ability to handle fluid magnitude meters	B4 B5	C8	D2 D9 D10

Ability to know and master the tools with which fluid flow problems are approached	B4 B5	C8	D2 D9 D10
ENAEE LEARNING OUTCOMES: 1. KNOWLEDGE AND UNDERSTANDING: Sub-learning outcome: 1.2 Knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront. Level of development: Suitable (2)		C8	
ENAEE LEARNING OUTCOME: 2. ENGINEERING ANALYSIS: Sub-learning outcome: 2.1 Ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses. Level of development: Suitable (2)	B4		D2 D9
ENAEE LEARNING OUTCOME: 2. ENGINEERING ANALYSIS: Sub-learning outcome: 2.2 Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical (societal, health and safety, environmental, economic and industrial) constraints. Level of development: Suitable (2)	B4		D2 D9
ENAEE LEARNING OUTCOME: 3. ENGINEERING DESIGN: Sub-learning outcome: 3.1 Ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical (societal, health and safety, environmental, economic and industrial) considerations; to select and apply relevant design methodologies. Level of development: Basic (1)	B4 B5	C8	D2 D9
ENAEE LEARNING OUTCOME: 3. ENGINEERING DESIGN: Sub-learning outcome: 3.2 Ability to design using some awareness of the forefront of their engineering specialisation. Level of development: Suitable (2)	B4 B5		
ENAEE LEARNING OUTCOME: 4. INVESTIGATIONS: Sub-learning outcome: 4.3 Laboratory/workshop skills and ability to design and conduct experimental investigations, interpret data and draw conclusions in their field of study. Level of development: Suitable (2)		C8	D9
ENAEE LEARNING OUTCOME: 5. ENGINEERING PRACTICE: Sub-learning outcome: 5.2 Practical skills for solving complex problems, realising complex engineering designs and conducting investigations in their field of study. Level of development: Suitable (2)	B4 B5		D2 D9
ENAEE LEARNING OUTCOME: 5. ENGINEERING PRACTICE: Sub-learning outcome: 5.3 Understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study. Level of development: Basic (1)			D9
ENAEE LEARNING OUTCOME: 7. COMMUNICATION AND TEAM-WORKING: Sub-learning outcome: 7.2 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 development: Suitable (2)			D10
ENAEE LEARNING OUTCOME: 8. LIFELONG LEARNING: Sub-learning outcome: 8.1 Ability to recognise the need for and to engage in independent life-long learning. Level of development: Basic (1)			D10
ENAEE LEARNING OUTCOME: 8. LIFELONG LEARNING: Sub-learning outcome: 8.2 Ability to follow developments in science and technology. Level of development: Basic (1)			D10

Contents

Topic	
UD I. INTRODUCTION	I.1. Fundamental Concepts. Concept of a Fluid I.2. The Fluid as a Continuum I.3. Characteristics of fluids I.4. Thermodynamic Properties of a Fluid. Newtonian vs non-Newtonian Fluids I.5. Viscosity and Other Secondary Properties

UD II. FLUID STATICS	II.1. Pressure and Pressure Gradient II.2. Equilibrium of a Fluid Particle II.3. Hydrostatic Pressure Distributions II.4. Hydrostatic forces on Plane Surfaces II.5. Hydrostatic forces on Curved Surfaces II.6. Buoyancy and Stability II.7. Pressure Distribution in Rigid-Body Motion II.8. Pressure Measurement
UD III. FLUID FLOW FUNDAMENTALS	III.1. Properties of the velocity field. Eulerian and Lagrangian method III.2. Flow Patterns: Streamlines, Pathlines and Streaklines III.3. Types of Flows 3.1. According to Kinematic Conditions 3.2. According to Geometric Conditions 3.3. According to Mechanical Boundary Conditions 3.4. According to Internal Movement Conditions 3.5. According to Reaction to Obstacles III.4. Systems and Control Volume III.5. Extended Integral Fluid Volumes 5.1. Reynolds transport theorem
UD IV. INTEGRAL RELATIONS FOR A CONTROL VOLUME	IV.1. Conservation of Mass IV.2. Conservation of Momentum IV.3. The Angular Momentum Theorem IV.4. The Energy Equation IV.5. Frictionless Flow: The Bernoulli Equation
UD V. DIFFERENTIAL RELATIONS FOR A FLUID PARTICLE	V.1. The Acceleration Field of a Fluid V.2. Differential Equation of Conservation of Mass V.3. Differential Equation of Momentum V.4. Differential Equation of Angular Momentum V.5. Differential Energy Equation V.6. Boundary conditions for the basic equations V.7. The Stream Function V.8. Vorticity and Irrotationality V.9. Non-viscous Irrotational Flows
UD VI. DIMENSIONAL ANALYSIS AND SIMILARITY	VI.1 Dimensionless Parameters VI.2. Nature of Dimensional Analysis VI.3. The Buckingham Pi Theorem. Applications VI.4. Important Dimensionless Groups in Fluid Mechanics 4.1. Physical Meaning of Dimensional Numbers VI.5. Similarity 5.1. Partial Similarity 5.2. Scale Effect VI.6. Fluid Meters
UD VII. LAMINAR FLOW	VII.1. Introduction VII.2. Permanent Laminar Movement 2.1. Hagen-Poiseuille Flows 2.2. Flows in Circular Ducts 2.3. Flows in Other Sections VII.3. Effect of Finite Length of the Tube VII.4. Pressure Drop 4.1. Coefficient of Friction VII.5. Stability of Laminar Flow
UD VIII. TURBULENT FLOW	VIII.1 Regimes Depending on Reynolds VIII.2 Modelling of Turbulence VIII.3 Internal Flows and External Flows VIII.4 Pressure Drop in Turbulent Flows 4.1. Nikuradse Chart 4.2. Moody Chart VIII.5 Concept of Boundary Layer VIII.6 Empirical Formulas for Flow in Pipes
UD IX. INTRODUCTION TO BOUNDARY LAYER	IX.1 Concept of Boundary Layer IX.2 Incompressible Two-Dimensional Boundary Layer Equations IX.3 Boundary Layer Thickness

UD X. FLOW IN PIPES OF VARIABLE SECTION	X.I. Introduction X.2. Local Losses 2.1. Loss at the Entrance of a Tube 2.2. Loss at the Outlet of a Tube 2.3. Contraction Loss 2.4. Widening Loss 2.5. Loss on Elbows X.4. Branch Pipes X.5. Serial Pipes X.6. Parallel Pipes X.7. Pipes Networks
LABORATORY PRACTICES	Practice PL1. Archimedes' principle [2h]. Objectives: To determine the buoyancy of bodies immersed in liquids. Practical equipment: 1250.1683 Principio de Arquímedes (Didaciencia). Practice PL2. Measurement of hydrostatic pressure [2h]. Objectives: Measurement of hydrostatic pressure with a U-shaped manometer. Practical equipment: 1250.1676 Manómetro en U con escala (Didaciencia). Practice PL3. Bernoulli's equation [2h]. Objectives: Study the pressure in pipes with variable and constant diameters through which liquid flows. The vertical tubes indicate the static pressure. Practical equipment: 1250.1689 Principio de Bernoulli (Didaciencia). Practical PL4 Dimensional analysis and similarity [2h]. Objectives: Apply the learning received in the theoretical sessions on dimensional analysis to a practical problem typical of Fluid Mechanics, specifically to the drag force of a sphere. Practical equipment: GUNT HM 135. Practical PL5 Flow meters [2h]. Objectives: Measure the flow rate in pipes using differential pressure flowmeters (Venturi, nozzle and calibrated orifice) and rotameter. Measure the velocity inside a pipe with a Pitot-Prandtl tube. Practical equipment: GUNT HM 150.13. Practice PL6. Demonstration of losses in pipes and connectors [2h]. Objectives: Study of pressure losses in pipes and accessories. Experimental determination of friction factors and loss constants in singular elements. Practical equipment GUNT HM 150.11. Practice PL7. Supervised work [2h]. Objectives: On the basis of problems posed by the students themselves, following the guidelines established by the lecturer, the students, divided into groups, will have to carry out a project based on a pre-established template based on the Final Degree Project. The aim is to familiarise them with the standard structure of a scientific article, working with formats, references, indexes, etc., as well as the distribution of tasks, teamwork, etc. The scheduled laboratory or computer classroom practicals may vary in content and order depending on the material available to carry them out, as well as the organisational needs of the academic year.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	28	56
Laboratory practical	12	14	26
Seminars	7	7	14
Essay questions exam	5	7	12
Essay	2	8	10
Essay questions exam	6	7	13
Problem and/or exercise solving	15	4	19

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

Methodologies	
	Description
Lecturing	In these sessions, the basic theoretical contents of the programme will be explained in detail, giving explanatory examples with which to deepen the understanding of the subject. Computer presentations and the blackboard will be used. As far as possible, the slides will be provided to the students before the presentation, focusing the effort of the lecturer and the students on the presentation and understanding of the knowledge.
Laboratory practical	In the practical classes, the concepts developed in each subject will be applied to laboratory practices. A series of practicals (PL1 to PL6) have been designed in accordance with the development of the theory subject in order to fix concepts explained in that class. Integrated methodologies - Project-based learning. The last practical session (PL7: Supervised work) will be devoted to monitoring the work proposed to the various groups into which the students are divided. Material and bibliography will be provided, although the aim is to encourage the ability to search for information, synthesis skills, etc.
Seminars	Resolution of problems and/or exercises. Problems and/or exercises related to the subject will be formulated. The student will have to develop adequate or correct solutions by applying formulas or algorithms, applying transformation procedures to the available information and interpreting the results. It will be used as a complement to the lecture. Integrated methodologies - Collaborative learning. The aim is to motivate the student in the research activity, and to encourage personal relationships by sharing problems and solutions. A fraction of the classroom classes will be reserved for the resolution of the problems posed by teams. This dedication may vary throughout the term and depending on the specific needs of the subject. - Project-based learning. A teaching-learning method whose starting point is a problem that, designed by the lecturer, the student has to solve in order to develop certain competences. This teaching methodology will be used to solve simple problems.

Personalized assistance	
Methodologies	**Description**
Lecturing	In the field of tutorial action, a distinction is made between academic tutoring and personalised tutoring. In the first case, students will have at their disposal hours of tutorials in which they can expose any questions related to the contents, organisation and planning of the course, etc. In the personalised tutorials, each student, individually, will be able to discuss with the lecturer any problem that is preventing them from following the course properly, in order to find some kind of solution between the two 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 course will answer to students' questions and queries synchronously in physical or virtual offices by prior arrangement or asynchronously by telematic means (e-mail, Moovi forums, etc.).
Laboratory practical	In the field of tutorial action, a distinction is made between academic tutoring and personalised tutoring. In the first case, students will have at their disposal hours of tutorials in which they can expose any questions related to the contents, organisation and planning of the course, etc. In the personalised tutorials, each student, individually, will be able to discuss with the lecturer any problem that is preventing them from following the course properly, in order to find some kind of solution between the two 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 course will answer to students' questions and queries synchronously in physical or virtual offices by prior arrangement or asynchronously by telematic means (e-mail, Moovi forums, etc.).
Seminars	In the field of tutorial action, a distinction is made between academic tutoring and personalised tutoring. In the first case, students will have at their disposal hours of tutorials in which they can expose any questions related to the contents, organisation and planning of the course, etc. In the personalised tutorials, each student, individually, will be able to discuss with the lecturer any problem that is preventing them from following the course properly, in order to find some kind of solution between the two 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 course will answer to students' questions and queries synchronously in physical or virtual offices by prior arrangement or asynchronously by telematic means (e-mail, Moovi forums, etc.).

Assessment			
	Description	Qualification	Training and Learning Results

Laboratory practical	The evaluation of the laboratory practicals (PL1-PL6) will be carried out by means of questionnaires through Moovi, where the student will be evaluated on the knowledge acquired in the laboratory or through the evaluation of the practical reports. The practical mark (MP) will be the average of the marks of all the practical questionnaires carried out and the marks of the practical reports.	15	B4 C8 D2 B5 D9 D10
Essay questions exam	Final test (PF): The final test (PF) aims to evaluate the learning of all the theoretical contents selected for the subject. It will be designed to judge what the student knows about the whole subject (PF). It should consist of a series of questions that prioritise conceptual and logical reasoning, in order to verify the intellectual maturity of the students to draw conclusions from the notions or theories presented in class. The final continuous assessment test will take place during the week of assessment and will be assessed out of 10 points. It will be necessary to obtain a mark of 4 or more points out of 10 in the final continuous assessment exam in order to qualify for a pass in continuous assessment.	40	B4 C8 D2 B5 D9 D10
Essay	Since the tutored work must be assessed in a way that ensures individual accountability and positive interdependence (i.e. all group members must have worked on and contributed to the final product and must have mastered, at a minimum, all aspects of the work), in the oral presentation and defence session, all group members will be involved and any group member must be able to answer questions on the work, regardless of the part on which he/she specialised. Everyone must therefore demonstrate a thorough knowledge of the delivered product, regardless of the part on which they have focused their efforts.	15	B4 C8 D2 B5 D9 D10
Essay questions exam	Partial tests (P1 and P2): Tests P1 and P2 are aimed at assessing the learning of all the theoretical contents selected for the subject. They will be designed to judge what the student knows about a part of the subject (P1, P2). Secondly, they must consist of a series of questions that prioritise conceptual and logical reasoning, in order to verify the intellectual maturity of the students to draw conclusions from the notions or theories presented in class. There will be two (2) partial continuous assessment tests. Each control will account for 15% of the continuous assessment mark.	30	B4 C8 D2 B5 D9 D10

Other comments on the Evaluation

To pass the subject by Continuous Assessment, the final mark (NEC) must be greater than or equal to 5 and will be calculated as follows:

NEC = 0,40PF + 0,15P1 + 0,15P2 + 0,15TT + 0,15MP

The student will have to take the ordinary exam of all the contents of the course, which will represent 100% of the mark, if the final mark of the continuous assessment is less than 5 points out of 10:

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

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

In any of these cases, the grade for the continuous assessment will be the minimum of the continuous assessment mark and 4 points (in this case, the student will obtain a maximum of 4 points). In any case, the student who has passed the continuous assessment will have the possibility to sit the ordinary exam in order to obtain a higher mark.

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

WHITE, F. M., **MECÁNICA DE FLUIDOS**, MCGRAW HILL, 2008

CRESPO, A., **MECÁNICA DE FLUIDOS**, PARANINFO, 2006
CENGEL, Y. A.; CIMBALA, J. M., **MECÁNICA DE FLUIDOS: FUNDAMENTOS Y APLICACIONES**, MCGRAW HILL, 2018
CENGEL, Y. A.; CIMBALA, J. M., **FLUID MECHANICS: FUNDAMENTALS AND APPLICATIONS**, MCGRAW HILL, 2018
GILES, R.V., **MECÁNICA DE LOS FLUIDOS E HIDRÁULICA**, MCGRAW HILL, 1994

Complementary Bibliography

LÓPEZ-HERRERA SÁNCHEZ, J.M., **MECÁNICA DE FLUIDOS: PROBLEMAS RESUELTOS**, MCGRAW HILL, 2005
BARRERO RIPOLL, A.; PÉREZ-SABORIDO SÁNCHEZ-PASTOR, M., **FUNDAMENTOS Y APLICACIONES DE LA MECÁNICA DE FLUIDOS**, MCGRAW HILL, 2005
GORDILLO ARIAS DE SAAVEDRA, J. M.; RIBOUX ACHER, G.; FERNÁNDEZ GARCÍA, J.M., **INTRODUCCIÓN A LA MECÁNICA DE FLUIDOS**, PARANINFO, 2017
VERA COELLO, M.; IGLESIAS ESTRADÉ, I.; SÁNCHEZ PÉREZ, A. L.; MARTÍNEZ BAZÁN, C., **INGENIERÍA FLUIDOMECÁNICA**, PARANINFO, 2012

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics 1/P52G382V01106
Mathematics: Calculus 1/P52G382V01103
Physics: Physics II/P52G382V01202
Mathematics: Calculus II and differential equations/P52G382V01201
Thermodynamics and heat transfer/P52G382V01203

Other comments

In order to successfully complete this course, students should follow the following recommendations:

- Regular and active attendance to classes, both theoretical and practical.
- Maintain a minimum of daily study.

It is recommended to have passed Calculus I, Calculus II and Differential Equations, Physics I, Physics II, Thermodynamics and Heat Transmission

IDENTIFYING DATA				
English I				
Subject	English I			
Code	P52G382V01209			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	English			
Department				
Coordinator	Douglas , Heidi Jennifer Diane			
Lecturers	Douglas , Heidi Jennifer Diane Gómez Garrido, Sandra Muradás Sanromán, Macarena Piñeiro Ronquete, María Jesús			
E-mail	externo.hdouglas@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	In this subject, students are expected to improve their mastery of the four basic skills of English (listening, speaking, reading, writing) at B1+ Level CEFR (Common European Framework of Reference for Languages) in order to foster the use of the language in the professional military environment.			

Training and Learning Results	
Code	
B10	Ability to work in a multidisciplinary and multilingual environment.
C34	CITN4 To promote, through speaking and writing in Spanish and English, communication skills to ease the transmission and understanding of orders, ideas and concepts.
D4	Oral and written proficiency in a foreign language.
D5	Information Management.
D7	Ability to organize and plan.
D8	Decision making.
D9	Apply knowledge.
D15	Objectification, identification and organization.
D17	Team working.
D18	Working in an international context.

Expected results from this subject	Training and Learning Results		
ORAL EXPRESSION IN GENERAL Carry out, with reasonable fluency, a simple description on a variety of topics that are of interest to them, presenting them in a linear sequence of elements. SUSTAINED MONOLOGUE: DESCRIPTION OF EXPERIENCES Create simple descriptions on a variety of common topics within their speciality. SUSTAINED MONOLOGUE: ARGUMENTATION Develop arguments well enough that they can be easily understood most of the time. PUBLIC SPEAKING Being able to give a short, prepared presentation on a topic within your specialty that is clear enough to be easy to follow most of the time, and where the main ideas are explained with reasonable precision. Be able to answer follow-up questions, but may have to ask for a repetition if spoken quickly. ORAL INTERACTION IN GENERAL Communicate with some confidence, both in matters that are common and in the unusual, related to their personal interests and their specialty. Exchange, check and confirm information, deal with less common situations and explain the reason for a problem. Being able to express oneself on more abstract and cultural topics.	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18

WRITTEN EXPRESSION IN GENERAL Write simple and cohesive texts on a series of everyday topics within their field of interest, linking a series of different short elements in a linear sequence. REPORTS AND EDITORIALS Write short and simple essays on topics of interest. Summarize, communicate and offer their opinion with some certainty on specific facts related to daily matters, habitual or not, typical of their specialty.	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18
GENERAL LISTENING COMPREHENSION Understand specific information related to everyday topics or work and identify both the general message and specific details as long as the speech is clearly articulated and with a normal accent. UNDERSTAND CONVERSATIONS BETWEEN NATIVE SPEAKERS Generally follow the main ideas of a long debate going on around you, as long as the speech is clearly articulated at a standard language level. LISTEN TO LECTURES AND PRESENTATIONS Understand a lecture or talk about your specialty, provided the topic is familiar to you and the presentation is simple and clearly structured. LISTEN TO NOTICES AND INSTRUCTIONS Understand simple technical information, such as operating instructions for frequently used appliances. LISTEN TO BROADCASTS AND RECORDED MATERIAL Understand the informational content of most recorded or broadcast material relating to topics of personal interest with clear and standard pronunciation.	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18
GENERAL READING COMPREHENSION Read simple texts about specific facts that deal with topics related to their specialty with a satisfactory level of comprehension. READ TO ORIENT Being able to consult long texts in order to find the desired information, and knowing how to collect information from different parts of a text or from different texts in order to carry out a specific task. READ INSTRUCTIONS Understand simple, clearly written instructions for an appliance.	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18

Contents	
Topic	
1.1. Questions and answers	-Grammatical knowledge: interrogative sentences -Lexical knowledge: contextual meaning -Phonological knowledge: intonation
1.2. It's a mystery	-Grammatical knowledge: auxiliary verbs -Lexical knowledge: compound adjectives -Phonological knowledge: sentence intonation
2.1. Doctor, doctor	-Grammatical knowledge: present perfect simple and continuous -Lexical knowledge: diseases and injuries -Phonological knowledge: consonant sounds
2.2. Act your age	-Grammatical knowledge: adjectives -Lexical knowledge: clothing and fashion -Phonological knowledge: vowel sounds
3.1. Fasten your seat belts	-Grammatical knowledge: narrative verb tenses -Lexical knowledge: air transportation -Phonological knowledge: affixes, sentence intonation
3.2. A really good ending?	-Grammatical knowledge: adverb position -Lexical knowledge: adverbs and adverbial phrases -Phonological knowledge: syllabic and sentence accentuation
4.1. Stormy weather	-Grammatical knowledge: future perfect and future continuous -Lexical knowledge: environment, weather conditions -Phonological knowledge: vowel sounds
4.2. A risky business	-Grammatical knowledge: conditional sentences -Lexical knowledge: expressions with "take" -Phonological knowledge: sentence accentuation
5.1. I'm a survivor	-Grammatical knowledge: conditional sentences -Lexical knowledge: feelings -Phonological knowledge: accentuation

5.2. Wish you were here	-Grammatical knowledge: structures with "wish" -Lexical knowledge: adjectives ending in -ed/-ing -Phonological knowledge: rhythm and intonation.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	22	20	42
Laboratory practical	22	20	42
Seminars	15	15	30
Problem and/or exercise solving	3	2	5
Essay questions exam	4	2	6
Presentation	5	4	9
Objective questions exam	5	3	8
Objective questions exam	5	3	8

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

Methodologies	
	Description
Lecturing	The communicative approach is based on the idea that language learning successfully comes through interspersing different didactic methods. Theory lessons will consist of checking the theoretical knowledge students have and, consequently, teaching the contents designed for completing the knowledge students have previously acquired.
Laboratory practical	Theory lessons will be completed with practical sessions in which different activities will be done in order to develop students' competence in the four linguistic skills and, therefore, reach the abovementioned goals.
Seminars	An intensive course (15 hours long) is organized for those students who have failed the subject at first call, prior to the exam in second call. Group tutoring with the lecturer.

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

Assessment					
	Description	Qualification	Training and Learning Results		
Problem and/or exercise solving	Grammar and Vocabulary tests/problem solving based on the material studied up to that moment	7.5	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18

Essay questions exam	Timed essay written in class	7.5	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18
Presentation	Oral presentation prepared by the student and given in class.	15	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18
Objective questions exam	Midterm exam Reading - 20% Listening - 20% Writing - 30% Speaking - 30% Global - 100%	30	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18
Objective questions exam	Final exam Reading - 20% Listening - 20% Writing - 30% Speaking - 30% Global - 100%	40	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18

Other comments on the Evaluation

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

1. Obtain at least 40% on each of the 4 parts of the exam, corresponding to the four linguistic skills.
If the student does not fulfil the abovementioned requirement, the mark of the part of the exam where the student has got the highest mark will become the mark of the final exam and, therefore, of the continuous assessment. This mark will never be higher than 3/10 (3 out of 10) since this is the highest possible mark in each of the two parts of the exam whose marks are the highest (writing and speaking). To pass the subject via continuous assessment, the student should get at least 5 points as a whole.

Ordinary and/or extraordinary exam
In order to pass this exam, it will be necessary to fulfil the following condition:
1. Pass (get at least half of the points on) each of the four parts of the exam, corresponding to the four linguistic skills.
If the student does not fulfil the abovementioned requirement, the mark of the part of the exam where the student has got the highest mark will become the mark of the exam (Exam 2) and, therefore, of the continuous assessment. This mark will never be higher than 3/10 (3 out of 10) since this is the highest possible mark in each of the two parts of the exam whose marks are the highest (writing and speaking). To pass the subject via continuous assessment, the student should get at least 5 points as a whole.

Both in the exams which make up the continuous assessment (mid-term exam and final exam) and in the ordinary and extraordinary exams, all of the students, independently of the class group (1, 2, 3 or 4) they belong to, are being assessed on the same compulsory course of the Bachelor Degree in Mechanical Engineering. Consequently, for the speaking part of the exam, students will be grouped by following objective and consistent criteria. Although, if possible, the grouping of students to do the abovementioned part of the exam will aim to be similar to class groups, this will not be compulsory.

IMPORTANT NOTES:

1. During the time students are sitting exams, they will be banned from using electronic devices (except the student on duty, who will put her/his mobile on the desk, in sight of the teachers invigilating the exam at issue). If the lecturers invigilating the exam realise that a student (except the student on duty, who will be allowed to have the regulatory mobile) has, handles or uses an electronic device, it will be applied what is established below regarding the ethical commitment of the students. Under no circumstances will there be any special permission to allow the students to have electronic devices during the time they will be sitting exams.

2. The organisation of exam procedures, which is published both on the "orden diaria" and the virtual platform of the subject, will be only and exclusively designed by the coordinator of the subject, who will have reached an agreement with the governing body of the CUD-ENM. Under no circumstances will there be any changes derived from decisions made by people different from the coordinator or the members of the governing body of the CUD-ENM. With respect to those students who do not fulfil the abovementioned requirements, it will be applied what is established below regarding the ethical commitment of the students.

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

Latham-Koenig, C et al, **English File, Upper-Intermediate, B2.2. 4th edition**, 4th, Oxford University press, 2020

Complementary Bibliography

Recommendations

Other comments

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