



## (\*)Escola de Enxeñaría Industrial

### Information

For additional information about the centre and its degrees visit the centre's website <https://eei.uvigo.es/>

## Grado en Ingeniería en Tecnologías Industriales

### Subjects

#### Year 3rd

Code	Name	Quadmester	Total Cr.
V12G363V01501	Applied electrotechnics	1st	6
V12G363V01502	Materials engineering	1st	6
V12G363V01503	Physics 3	1st	6
V12G363V01504	Hydraulic turbomachines	1st	6
V12G363V01505	Specialized mathematics	1st	6
V12G363V01602	Machine design and testing	2nd	6
V12G363V01603	Elasticity and additional topics in mechanics of materials	2nd	6
V12G363V01604	Manufacturing engineering	2nd	6
V12G363V01605	Electrical machines	2nd	6
V12G363V01606	Chemical technology	2nd	6

<b>IDENTIFYING DATA</b>				
<b>Applied electrotechnics</b>				
Subject	Applied electrotechnics			
Code	V12G363V01501			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language				
Department				
Coordinator	Novo Ramos, Bernardino			
Lecturers	Novo Ramos, Bernardino			
E-mail	bnovo@uvigo.es			
Web				
General description	<p>The objective of Applied Electrotechnic is to complete the training of the students of the Industrial Technologies Degree in what is related with Three-phase Systems and Power Transformers. This subject will provide specific tools to analyse and evaluate the behaviour of the most usual electrical installations under balanced and unbalanced situations.</p> <p>The subject is conceived also, to provide the necessary knowledge and competencies to be able to follow some subjects in the 3rd and 4rd years of the Degree.</p> <p>The students have to be familiar with subjects like "Basics of Theory of Circuits and Electric Machines" and "Calculus I and II" because some of the information provided in these subjects will be necessary to follow Applied Electrotechnic, without and extra effort</p>			

<b>Skills</b>
Code

<b>Learning outcomes</b>
Expected results from this subject
Training and Learning Results

<b>Contents</b>	
Topic	
UNIT I: 3-PHASE CIRCUITS, POWER MEASUREMENTS AND REACTIVE POWER COMPENSATION.	<ul style="list-style-type: none"> <li>□ Introduction: Generators, loads and 3-phase circuits</li> <li>□ Balanced 3-phase circuits. Voltages and currents.</li> <li>□ Conversion of 3-phase sources and loads.</li> </ul>
This Unit will allow the student to understand how to analyse 3-phase circuits under either balanced or unbalanced conditions	<ul style="list-style-type: none"> <li>□ Analysis of balanced 3-phase circuits.</li> <li>□ Powers in balanced 3-phase circuits. Compensation.</li> <li>□ Analysis of unbalanced 3-phase circuits.</li> </ul>
Initially the unit covers the basic concepts for the analysis of balanced circuits. It continues analysing unbalanced circuits, the different methods to measure the electrical powers and the compensation of the reactive power.	
UNIT II: TRANSFORMERS	<ul style="list-style-type: none"> <li>□ Analogies between electric and magnetic circuits.</li> </ul>
This Unit will allow the student to learn about the constructive characteristics of the transformers, to determine its characteristic parameters and to understand the machine main properties and its utilization in the electrical systems.	<ul style="list-style-type: none"> <li>□ Introduction to the transformers: constructive aspects.</li> <li>□ The ideal transformer.</li> <li>□ Operation of the real transformer.</li> <li>□ Equivalent circuit of the single-phase transformer real: e.m.f's and voltages.</li> <li>□ No-load and in short-circuit tests of the transformer.</li> <li>□ Voltage drops , losses and performance of a transformer.</li> <li>□ Autotransformers.</li> <li>□ 3-phase transformers: Constitution, connection diagrams and tests.</li> <li>□ Instrument transformers.</li> </ul>

<b>Planning</b>			
	Class hours	Hours outside the classroom	Total hours
Lecturing	20	60	80
Problem solving	9	18	27

Collaborative Learning	9	9	18
Laboratory practical	9	9	18
Essay questions exam	7	0	7

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

<b>Methodologies</b>	
	Description
Lecturing	The usual lecture
Problem solving	The professor will guide the first steps of the alumni in order to show them how to analyse different problems/situations and how to solve them
Collaborative Learning	Once taught how to solve a "generalistic problem" the alumni will have to create groups to find out the solutions to some proposed problems related with the subject.
	They will be requested to collaborate in order to hand the professor the proper solution at the end
Laboratory practical	Experimental solving of proposed lab tests, realization of measurements and presentation of results.

<b>Personalized assistance</b>	
<b>Methodologies</b>	<b>Description</b>
Laboratory practical	The doubts and questions that can arise during the classes or personal assignments of the students will be solved either in situ or during the tuition hours. The tuition personal attention should be required by e-mail. The professor will use his "Virtual Office" to solve any of these questions, if in-person tuition is not needed
Lecturing	he doubts and questions that can arise during the classes or personal assignments of the students will be solved either in situ or during the tuition hours. The tuition personal attention should be required by e-mail. The professor will use his "Virtual Office" to solve any of these questions, if in-person tuition is not needed
Problem solving	he doubts and questions that can arise during the classes or personal assignments of the students will be solved either in situ or during the tuition hours. The tuition personal attention should be required by e-mail. The professor will use his "Virtual Office" to solve any of these questions, if in-person tuition is not needed

<b>Assessment</b>			
	Description	Qualification	Training and Learning Results
Lecturing	It will cover 40% of the mark of the second part assessment	20	
Problem solving	It will cover 100% of the mark of the first part assessment	70	
	It will cover 40% of the mark of the second part assessment		
Laboratory practical	Included in the second part theory test. They will be valued as a 10% of the final mark	10	

### **Other comments on the Evaluation**

Continuous assessment (100%):

At the end of each Part ( I & II) the student will perform a test that will be scored from 0 to 10 points. The passing mark is 5. The test will cover theoretical issues and practical exercises. In each Part the student can reach 50% of the final mark. The passed partial tests are released from the corresponding part in the final exam.

For the students who pass all tests, the final mark will be the average of the marks of the partial tests.

Students who fail any or all partial tests, will have to take a final exam where she/he will be graded from 0 to 10 points.

To pass the subject it is necessary to achieve a minimum grade of 3 points in each part and an average mark bigger than 5.

Students approved by partial tests can modify (maybe improve) their mark by presenting to the final exam.

The professors will indicate the dates and places of publication of marks and revisions

### **Sources of information**

#### **Basic Bibliography**

#### **Complementary Bibliography**

### **Recommendations**

#### **Subjects that continue the syllabus**

Electrical machines/V12G363V01605

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**Subjects that are recommended to be taken simultaneously**

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Physics: Physics 2/V12G363V01202

Mathematics: Calculus 2 and differential equations/V12G363V01204

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**Subjects that it is recommended to have taken before**

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Basics of circuit analysis and electrical machines/V12G363V01302

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**Other comments**

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Requirements: To enrol in this subject is necessary either to had surpassed or to be enrolled in all the subjects of the previous courses of the one where this subject is summoned

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**IDENTIFYING DATA****Materials engineering**

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

**Skills**

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

**Learning outcomes**

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

**Contents**

Topic
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Unit I: In-service materials performance.

Lesson 1. Fatigue

Definition and importance. Fracture surface characteristics. S-N curve. Fatigue crack propagation and service life prediction. Cumulative fatigue damage: Palmgren-Miner's rule. Influence of the mean stress: Goodman and Gerber criteria. Factors that influence on fatigue.

Lesson 2. Fracture mechanics.

Griffith and Irwin theories. Linear elastic fracture mechanics. Stress distribution at the crack tip: plain stress and plain strain. Plain strain fracture toughness.

Lesson 3. Creep.

Influence of temperature on strength. The creep curve: creep rate, creep strain, temperature and stress. Creep tests for metals and plastics. Influence of stress and temperature. Prediction of long-time properties. Development of creep resistant alloys. Materials selection. Deformation mechanisms.

Lesson 4. Fundamentals of corrosion.

Economic and social importance. Electrochemical corrosion. Thermodynamic analysis. Electrode potential and Pourbaix diagrams. Kinetic analysis. Corrosion rate. Polarization phenomena. Passivation. Corrosion control strategies: design, change of material and/or exposure environment, protective layers, cathodic and anodic protection.

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Unit II: Metal-casting and forming processes, heat treatments and joining processes.

Lesson 5: Fundamentals of metal casting: especial casting methods.

Castability: fluidity, no cavities and resistance to hot cracking. Casting alloys. Directional solidification, casting for single-crystal components and metallic glasses. Squeeze casting. Semi-solid forming (rheocasting and thixocasting).

Lesson 6: Plastic forming of metals: cold working and hot forming.

Strain hardening. Characteristics of cold working. Annealing of a cold-worked piece. Hot forming: dynamic recovery and dynamic recrystallization. Characteristics of hot forming. Benefits of hot forming for cast structures.

Lesson 7. Heat treatments and thermomechanical treatments.

Quench and hardenability. Tempering. Martempering and austempering. Thermomechanical treatments: definition and types. Controlled rolling, ausforming, isoforming and marforming.

Lesson 8. Welding metallurgy.

Classification of welding processes according to AWS. Thermal cycle: influencing factors. Weld zone: epitaxial and competitive growth. Heat affected zone. Solid solution strengthened alloys. Work-hardened alloys. Precipitation hardened alloys. Transformation hardening alloys. Post-welding treatments.

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Unit III: Structural materials.

Lesson 9. Structural steels and stainless steels.

Hot-rolled steels for general purposes. Microalloyed steels. Atmospheric corrosion resistant steels. Steels for quench and tempering. Low-temperature applications steels. Stainless steels. Passive layer characteristics. Classification.

Lesson 10. Aluminum alloys.

Strengthening of aluminum alloys. Classification of the aluminum alloys. Cast and wrought aluminum alloys.

Lesson 11. Composite materials.

Definition: advantages and drawbacks. Types of composite materials. Fiber-reinforced plastics: properties and fabrication. Laminated structures. Metallic and ceramic matrix composite materials.

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## Laboratory contents

Laboratory 1. Fractography and fatigue testing.  
Macroscopic and microscopic features of the fracture surfaces. Scanning Electron Microscope. Practical examples. Fatigue: general concepts. Fatigue testing: Wöhler curve. Factors that influence on fatigue. Examples.

Laboratory 2. Corrosion technology. Corrosion protection. Electrochemical techniques for the corrosion assessment. Metallographic analysis. Assessment of protective layers. Thickness and adherence. Assessment of failure mechanisms.

Laboratory 3. Metallography I: forming techniques. Cast structures: influence of cooling rate and alloying elements. Cold worked and hot formed structures.

Laboratory 4. Metallography II: heat-treated alloys. Steels and Al alloys.

Laboratory 5. Hardenability. Jominy test. Jominy curve. Objective and applications. Jominy test and results designation.

Laboratory 6. Liquid penetrating and magnetic particles testing. Definition, objectives and applications. Testing methodology and report.

Laboratory 7. Radiography and ultrasounds (I)  
Radiography: definitions, objectives and applications. Testing. Ultrasounds: through-transmission (transmitter-receiver) and pulse-echo modes. Ultrasonic inspection: calibration and thickness assessment.

Laboratory 8. Ultrasonic inspection (II)  
Inspections of metallic pieces with a contact transducer. In-situ assessment of concrete structures. Sclerometer test: surface hardening and strength relationship. Ultrasonic inspections with the direct transmission mode. Ultrasonic pulse velocity in concrete: indirect mode. Ultrasonic pulse velocity and strength relationship.

Laboratory 9. Exposition of projects. Each student will participate in the exposition of his/her group and will answer the questions posed either by the lecturer and/or by students from other groups.

## Planning

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

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

## Methodologies

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

## Personalized assistance

### Methodologies Description

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

### Assessment

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

### Other comments on the Evaluation

#### FIRST ATTEMPT:

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

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

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

#### SECOND ATTEMPT (exam in July):

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

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

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

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

### Sources of information

#### Basic Bibliography

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

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

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

#### Complementary Bibliography

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



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

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

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

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

Beeley, P., **Foundry Technology**, Butterworth-Heinemann, Ltd.,

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### **Recommendations**

#### **Subjects that continue the syllabus**

Fundamentals of manufacturing systems and technologies/V12G363V01402

Mechanics of materials/V12G363V01404

Manufacturing engineering/V12G363V01604

#### **Subjects that it is recommended to have taken before**

Materials science and technology/V12G363V01301

<b>IDENTIFYING DATA</b>				
<b>Physics 3</b>				
Subject	Physics 3			
Code	V12G363V01503			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	López Vázquez, José Carlos			
Lecturers	López Vázquez, José Carlos			
E-mail	jclopez@uvigo.es			
Web	<a href="http://moovi.uvigo.gal/">http://moovi.uvigo.gal/</a>			
General description	<p>The main goals of Physics III are:</p> <p>a) To get a deeper understanding of the physical foundations of engineering, specifically those related to electromagnetic and wave phenomena.</p> <p>b) To introduce the use of mathematical tools, in particular vector analysis and differential equations and their associated boundary value problems, within the framework of problems and models in Physics.</p> <p>c) To combine theoretical education and a practical engineering approach, stressing the relevance of fundamentals to deal with problem analysis and synthesis of solutions in real-life situations.</p> <p>d) To relate the topics in the fundamentals of electromagnetism and wave phenomena to the contents of other more technological subjects included in the curriculum for the Degree.</p> <p>The topics of Physics III are, essentially, an introduction to wave phenomena in general (three units) and the study of classical electromagnetism using an axiomatic approach employing a mathematical treatment based on differential vector operators (four units).</p>			

<b>Skills</b>	
Code	
B10	CG10 Ability to work in a multidisciplinary and multilingual environment.
C2	CE2 Understanding and mastering the basics of the general laws of mechanics, thermodynamics, waves and electromagnetic fields, as well as their application for solving engineering problems.
D10	CT10 Self learning and work.

<b>Learning outcomes</b>			
Expected results from this subject	Training and Learning Results		
To know and to understand the physical foundations of electricity and magnetism as well as of vibrations and waves.	B10	C2	
To know and to be able to apply, in simple cases, vector analysis and differential equations of mathematical physics, as problem solving tools within the framework of fundamentals of physics.	B10	C2	
To be able to establish efficient strategies and procedures for solving problems in fundamentals of physics related to industrial technologies.	B10	C2	
To be able to implement specific solutions in the laboratory to experimental problems in fundamentals of physics.	B10	C2	D10

<b>Contents</b>	
Topic	
I.1. WAVE MOTION	1.1. Wave phenomena 1.2. Fundamental characteristics of waves 1.3. The wave equation 1.4. Plane waves 1.5. Wavefront and wavevector 1.6. Cylindrical and spherical waves 1.7. Longitudinal and transverse waves 1.8. Huygens' principle 1.9. Reflection and refraction of waves

I.2. MECHANICAL WAVES	<ul style="list-style-type: none"> <li>2.1. The nature of mechanical waves</li> <li>2.2. Longitudinal waves in thin rods</li> <li>2.3. Longitudinal waves in springs</li> <li>2.4. Transverse waves in strings</li> <li>2.5. Power flow and intensity of a wave</li> <li>2.6. Longitudinal waves in fluids</li> </ul>
I.3. DESCRIPTION OF PHYSICAL QUANTITIES BY MEANS OF VECTOR ANALYSIS	<ul style="list-style-type: none"> <li>3.1. Differential of arc of a curve</li> <li>3.2. Scalar fields</li> <li>3.3. Directional derivative</li> <li>3.4. Gradient</li> <li>3.5. Vector fields</li> <li>3.6. Flux of a vector field</li> <li>3.7. Solenoidal fields</li> <li>3.8. Divergence of a vector field</li> <li>3.9. Ostrogradski-Gauss' theorem or divergence theorem</li> <li>3.10. Divergence of a solenoidal field</li> <li>3.11. Circulation of a vector field</li> <li>3.12. Rotation or curl of a vector field</li> <li>3.13. Stokes' theorem</li> <li>3.14. Conservative fields</li> </ul>
II.1. GENERAL EQUATIONS OF ELECTROMAGNETISM	<ul style="list-style-type: none"> <li>1.1. Definition of electric and magnetic fields</li> <li>1.2. Field sources: macroscopic electric charges and currents</li> <li>1.3. Relations among fields E and B and their sources: Maxwell's equations</li> <li>1.4. Free charge</li> <li>1.5. Polarization charge</li> <li>1.6. Electric current</li> <li>1.7. Polarization current</li> <li>1.8. Magnetization current</li> <li>1.9. Maxwell's equations as a function of fields E, D, B, and H</li> <li>1.10. Boundary conditions for electromagnetic fields</li> <li>1.11. Electrodynamic potentials</li> <li>1.12. The energy law of the electromagnetic field</li> </ul>
II.2. TIME-INDEPENDENT FIELDS: ELECTROSTATICS, STEADY ELECTRIC CURRENT AND MAGNETOSTATICS	<ul style="list-style-type: none"> <li>2.1. Fundamental equations of electrostatics</li> <li>2.2. Electric dipole</li> <li>2.3. Fundamental equations for steady electric current</li> <li>2.4. Equations including media properties</li> <li>2.5. Electrical resistance</li> <li>2.6. Joule's law</li> <li>2.7. Electromotive forces and generators</li> <li>2.8. Potential distribution in a resistor</li> <li>2.9. Fundamental equations of magnetostatics</li> <li>2.10. Equations including media properties</li> <li>2.11. Magnetic forces</li> <li>2.12. Magnetic circuit</li> <li>2.13. Magnetic dipole</li> </ul>
II.3. ELECTROMAGNETIC INDUCTION AND QUASISTATIC FIELDS	<ul style="list-style-type: none"> <li>3.1. Electromagnetism in moving media</li> <li>3.2. Galilean transformation of electric and magnetic fields</li> <li>3.3. Electromotive force around a circuit</li> <li>3.4. Faraday's law of electromagnetic induction</li> <li>3.5. Definition of quasistatic fields</li> <li>3.6. Self-inductance and mutual inductance</li> <li>3.7. Magnetic energy</li> </ul>
II.4. ELECTROMAGNETIC WAVES	<ul style="list-style-type: none"> <li>4.1. Wave equations for fields E and H</li> <li>4.2. E.M. monochromatic plane waves in lossless media</li> <li>4.3. E.M. monochromatic plane waves in lossy media</li> <li>4.4. Incidence of a plane wave on an interface between two perfect dielectrics</li> <li>4.5. Incidence of a plane wave on an interface between a perfect dielectric and a conductor</li> </ul>
III.1 LABS: STRUCTURED ACTIVITY SESSIONS	<ul style="list-style-type: none"> <li>1.1 Structured activity sessions: <ul style="list-style-type: none"> <li>- Experimental data processing (approximate quantities, measurement of physical magnitudes, error estimation)</li> <li>- Adequate operation with basic measurement instruments (flex-meter, micrometer, multimeter (analog and digital), oscilloscope)</li> <li>- Laboratory experiments with mechanical or electromagnetic waves (emission and reception of ultrasonic waves, microwaves or light waves, standing waves along one direction, Michelson interferometer)</li> </ul> </li> </ul>

III.2 LABS: UNSTRUCTURED ACTIVITY (OPEN LAB) SESSIONS

2.1. Unstructured activity (open lab) sessions:

- A practical problem, formulated with basic initial data, will be assigned to each working team. Then, under the teacher's supervision, each team must analyze the problem, select a possible solution and carry it out in the lab
- For the open lab problems, a diversity of topics and experimental techniques are considered within the field of wave and electromagnetic phenomena, in particular, electric current conduction and electromagnetic induction in quasi-static regime
- As a reference, some open lab problems that can be proposed are: measuring the electric field on a weakly conducting sheet, numerical solution of the Laplace equation, measuring the self-inductance of a coil or a solenoid, measuring the mutual inductance of two coils or two solenoids
- As an option, the open lab session may be replaced by a well-documented piece of work reporting some topic/technique/process/device related to science or technology where wave or electromagnetic phenomena play an essential role. The report must include a model of the problem, clearly identifying the relevant quantities and physical laws

<b>Planning</b>			
	Class hours	Hours outside the classroom	Total hours
Lecturing	20	30	50
Problem solving	11.5	30.5	42
Laboratory practical	18	18	36
Essay questions exam	2	0	2
Problem and/or exercise solving	2	0	2
Report of practices, practicum and external practices	0	18	18

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

<b>Methodologies</b>	
	Description
Lecturing	The main topics of the subject are introduced by the teacher using projected presentations and the chalkboard, emphasizing the theoretical basis and fundamentals and stressing the critical or key points. Occasionally, demonstrative experiments or audiovisual material may be employed
Problem solving	Academic problems related to the topics of the subject are formulated and worked out at the chalkboard by the teacher or the students. By practicing standard schemes, formulas or algorithms and by analyzing the results, the student must develop adequate skills to be able to obtain the correct solution to the problem on his/her own at the end of the course
Laboratory practical	Activities for applying the knowledge to particular situations and for developing basic and procedural skills related to the subject. These activities will be held in specific rooms with specialized equipment (laboratory and computer rooms)

<b>Personalized assistance</b>	
Methodologies	Description
Lecturing	In tutoring hours
Laboratory practical	In tutoring hours
Problem solving	In tutoring hours

<b>Assessment</b>				
	Description	Qualification	Training and Learning Results	
Essay questions exam	Test that includes open questions on a topic. Students should develop, relate, organize and present knowledge on the subject in an argued response	50	B10	C2
Problem and/or exercise solving	Test in which the student must solve a series of problems and/or exercises in a time/conditions set by the teacher	40	B10	C2 D10
Report of practices, practicum and external practices	Each team should write a report on the activities carried out. The report must include the tasks and procedures developed, the results obtained or the observations taken, as well as a detailed description of the data processing and analysis	10	B10	C2 D10

**Other comments on the Evaluation**

## **1. CONTINUOUS ASSESSMENT**

### **CONTINUOUS ASSESSMENT TESTS (40%)**

- Mark A0 (20%) will be obtained from essay-questions exams on topics of Parts I and II
- Mark L0 (20%) will be obtained from a problem-solving exam on topics of Part III.1 (10%) and from the open lab report (or the topic report) corresponding to Part III.2 (10%). Only students that have regularly attended the lab sessions can obtain mark L0

### **FINAL EXAM (60%)**

- To be held in the December-January call
- Mark T1 (30%) will be obtained from an essay-questions exam on topics of Parts I and II
- Mark P1 (30%) will be obtained from a problem-solving exam on topics of Parts I and II

### **GLOBAL MARK**

- The global mark G1 is obtained as

$$G1 = T1 + P1 + L0 + A0$$

- To pass the course, a student must obtain a global mark G1 equal to or higher than 5

## **2. END-OF-TERM ASSESSMENT**

### **EXAM THAT REPLACES CONTINUOUS ASSESSMENT TESTS (40%)**

- To be held on the same date as the final exam in the December-January call
- Mark A1 (20%) will be obtained from essay-questions exams on topics of Parts I and II
- Mark L1 (20%) will be obtained from a problem-solving exam on topics of Part III.1

### **GLOBAL MARK**

- In this case the global mark G1 is obtained as

$$G1 = T1 + P1 + L1 + A1$$

- To pass the course, a student must obtain a global mark G1 equal to or higher than 5
- A student that has previously obtained marks L0 or A0 (or both) can choose between:
  - a) answering the exam(s) corresponding to mark L1 and/or mark A1, in such a way that the new mark L1 replaces L0 and/or the new mark A1 replaces A0
  - b) maintaining mark L0 and/or mark A0 instead of taking the exam(s) corresponding to mark L1 and/or mark A1, respectively

## **3. ASSESSMENT IN THE SECOND CALL (JUNE-JULY)**

### **FINAL EXAM (60%)**

- To be held in the June-July call
- Mark T2 (30%) will be obtained from an essay-questions exam on topics of Parts I and II
- Mark P2 (30%) will be obtained from a problem-solving exam on topics of Parts I and II

### **EXAM THAT REPLACES CONTINUOUS ASSESSMENT TESTS (40%)**

- To be held on the same date as the final exam in the June-July call
- Mark A2 (20%) will be obtained from essay-questions exams on topics of Parts I and II
- Mark L2 (20%) will be obtained from a problem-solving exam on topics of Part III.1

## **GLOBAL MARK**

- In this case the global mark G2 is obtained as

$$G2 = T2 + P2 + L2 + A2$$

- To pass the course, a student must obtain a global mark G2 equal to or higher than 5

- A student that has previously obtained marks L0, L1, A0 or A1 can choose between:

a) answering the exam(s) corresponding to mark L2 and/or mark A2, in such a way that the new mark L2 and/or the new mark A2 will replace the marks of the same type (L0 or L1 and/or A0 or A1, respectively)

b) maintaining the most recent marks of each type (L0 or L1 and/or A0 or A1) instead of taking the exam(s) corresponding to mark L2 and/or mark A2, respectively

## **4. NOTATION FOR MARKS**

- L = the latest mark from L0, L1 and L2

- A = the latest mark from A0, A1 and A2

- T = T1 in December-January call (1st edition) or T2 in June-July call (2nd edition)

- P = P1 in December-January call (1st edition) or P2 in June-July call (2nd edition)

- G = G1 in December-January call (1st edition) or G2 in June-July call (2nd edition)

- In either of the calls the global mark G is obtained as

$$G = T + P + L + A$$

- To pass the course, a student must obtain a global mark G equal to or higher than 5

## **5. SUPPLEMENTARY ASSESSMENT RULES**

- Presentation of DNI or any other identification document is compulsory during tests and exams

- Students should not have access to or use any electronic device during the tests and exams, unless specifically authorised. The mere fact of taking an unauthorised electronic device into the examination room will result in the student failing the subject in the present academic year and the global mark will be "suspenso (0.0)"

- The tests and exams will be jointly set and assessed by the teaching team of the subject

- The global mark for students not attending the final exam will be "non presentado"

- The dates for the final exams at each call will be assigned by the board of directors of the School of Industrial Engineering (E.E.I.)

- The exams corresponding to the end-of-degree call, as well as any exam held on dates and times other than those stated by the E.E.I. for official exams, could have a different format from the one described above. Nevertheless, each mark (L, A, T and P) will hold its value to calculate the global mark G

- The date and times for the revision (of marks and the results of tests and exams) will be announced in advance. Revision at any other time will be possible only if a justifiable reason for non-attendance is documented

## **6. ETHICAL COMMITMENT**

Every student is expected to behave in an appropriate ethical manner. Should unethical conduct be detected (copying, plagiarism, utilisation of unauthorised electronic devices, or others), the student will be considered not to have fulfilled the necessary requirements to pass the subject. In this case, the global mark in the present academic year will be "suspenso (0.0)"

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### **Sources of information**

### **Basic Bibliography**

---

J. L. Fernández, M. J. Pérez-Amor, **Guía para la resolución de problemas de electromagnetismo. Compendio de teoría**, Reverté, 2012

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J. L. Fernández, M. J. Pérez-Amor, **Guía para la resolución de problemas de electromagnetismo. Problemas resueltos**, Reverté, 2012

---

M. Alonso y E. J. Finn, **Física**, Addison-Wesley Iberoamericana, 2000

---

M. Alonso and E. J. Finn, **Physics**, Pearson, 1992

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#### **Complementary Bibliography**

---

M. R. Spiegel, **Análisis vectorial**, McGraw-Hill, serie Schaum, 2011

---

M. R. Spiegel, **Schaum's Outline of Vector Analysis**, McGraw-Hill, Schaum's Outline Series, 2009

---

D. K. Cheng, **Fundamentos de electromagnetismo para ingeniería**, Addison-Wesley, 1997

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D. K. Cheng, **Fundamentals of Engineering Electromagnetics**, Prentice Hall 1993, Pearson 2014,

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J. A. Edminister, **Electromagnetismo**, McGraw-Hill, serie Schaum, 1992

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J. A. Edminister, M. Nahvi, **Schaum's Outline of Electromagnetics**, McGraw-Hill, Schaum's Outline Series, 2013

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I. Bronshtein, **Manual de matemáticas para ingenieros y estudiantes**, MIR 1982, MIR-Rubiños 1993,

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I. N. Bronshtein, K. A. Semendyayeb, **Handbook of Mathematics**, Springer, 2007

---

M. R. Spiegel, **Fórmulas y tablas de matemática aplicada**, McGraw-Hill, serie Schaum, 2014

---

M. R. Spiegel, S. Lipschutz, J. Liu, **Schaum's Outline of Mathematical Handbook of Formulas and Tables**, McGraw-Hill, Schaum's Outline Series, 2011

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#### **Recommendations**

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##### **Subjects that it is recommended to have taken before**

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Physics: Physics 1/V12G360V01102

Physics: Physics 2/V12G360V01202

Mathematics: Algebra and statistics/V12G360V01103

Mathematics: Calculus 1/V12G360V01104

Mathematics: Calculus 2 and differential equations/V12G360V01204

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##### **Other comments**

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Requirements: To register in this subject, it is mandatory to have been registered or to be registered in all the subjects corresponding to the first and second years of the curriculum of the Degree in Industrial Technologies Engineering

In particular, it is highly recommended to have reviewed the topics in Physics and Mathematics included within the subjects that should have been passed previously

In the event of discrepancy, the Spanish version of this syllabus prevails

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<b>IDENTIFYING DATA</b>				
<b>Hydraulic turbomachines</b>				
Subject	Hydraulic turbomachines			
Code	V12G363V01504			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language				
Department				
Coordinator	Meis Fernández, Marcos			
Lecturers	Meis Fernández, Marcos			
E-mail	mmeis@uvigo.es			
Web				
General description	<p>This syllabus presents information the Hydraulic Turbomachines course that belongs to the 3rd year of the degree in Industrial Technologies Engineering, 2020-2021, in accordance to the marked guidelines by the European Space of Upper Education.</p> <p>This is a first course in Hydraulic Turbomachines, focusing on the topics that are relevant to Industrial Technologies Engineering applications.</p> <p>The course is intended to acquire essential knowledge about the fundamental principles and performance of Hydraulic Turbomachines, studying the main parts of a turbomachines and their classification, the application of fundamental Euler's theorem, and the performance of both turbines and pumps with different arrangements in hydroelectric power plants and pumps stations, respectively. Finally, some brief comments are explained to acquire fundamental knowledge of fans, airfoils and positive displacement machines</p>			

<b>Skills</b>	
Code	
B3	CG3 Knowledge of basic and technological subjects that enable students to learn new methods and theories, and to adapt to new situations.
C8	CE8 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.
C25	CE25 Applied knowledge of the basics of fluidmechanics systems and machines.
D2	CT2 Problem solving.
D9	CT9 Application of knowledge.
D10	CT10 Self learning and work.

<b>Learning outcomes</b>				
Expected results from this subject	Training and Learning Results			
Understand fundamentals of hydraulic machines	B3	C8 C25	D2 D9 D10	
Acquire skills for sizing pumps facilities and fluid machines	B3	C8 C25	D2 D9 D10	

<b>Contents</b>	
Topic	
1.- Introduction	1.- Turbomachinery. Classification 2.- Hydraulic turbomachines 3.- Applications to the Industry 4.- General specifications
2.- Transfer of Energy	1.- Equation of conservation of the energy 2.- Hydraulic turbomachines applications 3.- Dimensionless parameters 4.- Power and efficiencies
3.- Similarity and Characteristic Curves	1.- Similarity in hydraulic turbomachines 2.- Practical application of similarity laws 3.- Comparison of hydraulic turbomachines 4.- Characteristic curves in hydraulic pumps 5.- Characteristic curves in hydraulic turbines 6.- Dimensionless coefficients. Specific speed and specific power



4.- Transfer of Work	<ul style="list-style-type: none"> <li>1.- Fundamental equation of hydraulic turbomachinery: Euler's equations. Expressions</li> <li>2.- One-dimensional (ideal) theory of hydraulic turbomachinery</li> <li>3.- Two-dimensional (ideal) theory of hydraulic turbomachinery</li> <li>4.- Real flow. Losses</li> <li>5.- Cavitation in HTM</li> </ul>
5.- Fluids machines of low pressure rise	<ul style="list-style-type: none"> <li>1.-Classification</li> <li>2.- Fans. Characteristic curves</li> <li>3.- Wind turbines. Classification</li> <li>- Disk actuator theory.Betz's limit</li> <li>- Fundamentals Theory of Airfoils. NACA Airfoils</li> <li>- Blade element theory</li> <li>- Characteristic curves</li> </ul>
6.- Positive displacement machines and hydraulic transmissions	<ul style="list-style-type: none"> <li>1.- Types and classification</li> <li>2.- Alternative and rotatory pumps.</li> <li>3.- Hydraulic engines of positive displacement</li> <li>4.- Transmissions and hydraulic couplings</li> </ul>
Laboratory sessions	<ul style="list-style-type: none"> <li>1. Introduction to the pneumatic systems: <ul style="list-style-type: none"> <li>- detailed description of the pneumatic systems and his components.</li> <li>-Basic circuits.</li> <li>-Problems resolutions</li> </ul> </li> <li>2. Resolution of problems of of hydraulic turbomachines</li>   <li>3. Hydraulic turbines <ul style="list-style-type: none"> <li>- Hill chart Francis Turbine</li> </ul> </li>   <li>4. Resolution of problems of Positive displacemetn machines</li> </ul>

### Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	32	60	92
Laboratory practical	6	7	13
Problem solving	12	18	30
Essay questions exam	3	0	3
Problem and/or exercise solving	0	12	12

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

### Methodologies

	Description
Lecturing	Readings solution of problems
Laboratory practical	Practices of pneumatic (see description in contents)
	Practices of HTM (see description in contents)
Problem solving	Calculation methods and techniques Interpretation of results Practical cases

### Personalized assistance

Methodologies	Description
Problem solving	Personalized attention will be given to the students during class (throughout the possible questions that could arise) and during the specific timetable of the teacher for tutorships. Updated information of the tutorships timetables will be given to the students
Lecturing	Personalized attention will be given to the students during class (throughout the possible questions that could arise) and during the specific timetable of the teacher for tutorships. Updated information of the tutorships timetables will be given to the students
Laboratory practical	Personalized attention will be given to the students during class (throughout the possible questions that could arise) and during the specific timetable of the teacher for tutorships. Updated information of the tutorships timetables will be given to the students

### Assessment

Description	Qualification Training and Learning Results
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Essay questions exam	Proof written that it will be able to consist of: - theoretical questions - practical questions - Resolution of exercises/problems - Short covering of a topic	80	B3	C8	D2 D9 D10
Problem and/or exercise solving	Resolution of exercises proposed, including: -Short reports/exercises proposed	20	B3	C8	D2 D9 D10
(*)	-	-			

### Other comments on the Evaluation

Continuous evaluation: represents 20% of the grade, which consists of solving some proposed exercises. Except official renounce of the student, the course is followed under continuous assessment mode.

Continuous assessment grading is not saved year after year

Final exam (first call): 80% of the total mark, which consists of theoretical question, practical questions, resolution of exercises/problems or short covering of a topic

July final exam (second call): represents 100% of the grade (continuous evaluation is not considered)

Ethical Commitment: In case of noticing a non ethical behaviour (copy, plagiarism, utilisation of unauthorised electronic devices, and others) it will be considered that the student does not gather the necessary requirements to pass the course. In this case, the global qualification of the present academic course will be failed (0.0)

### Sources of information

#### Basic Bibliography

Viedma A., Zamora B., **Teoría y Problemas de máquinas hidráulicas**, 3ª Ed., Horacio Escarabajal Editores., 2008

Mataix, C., **Turbomáquinas Hidráulicas**, Editorial ICAI, 1975

Mataix, C., **Mecánica de Fluidos y Máquinas Hidráulicas**, Editorial del Castillo S.A., 1986

Srinivasan, K.M., **rotodynamic Pumps**, New Age International Publishers, 2008

#### Complementary Bibliography

Hernández Krahe, J. M., **Mecánica de Fluidos y Máquinas Hidráulicas.**, UNED, 1998

Krivchenko, G, **Hydraulic Machines: Turbines and Pumps**, 2ª ed., Lewis, 1994

Creus, A., **Neumática e Hidráulica.**, Marcombo Ed., 2011

Karassik, I. J., **Pump Handbook**, 2ª ed., Nueva York, McGraw-Hill., 1986

### Recommendations

#### Subjects that it is recommended to have taken before

Physics: Physics 1/V12G360V01102

Physics: Physics 2/V12G360V01202

Mathematics: Calculus 2 and differential equations/V12G360V01204

Fluid mechanics/V12G360V01403

#### Other comments

Recommends to the student:

Attend to class

Spend the hours outside the classroom studying the subject

**IDENTIFYING DATA****Matemáticas da especialidade**

Subject	Matemáticas da especialidade			
Code	V12G363V01505			
Study programme	Grao en Enxeñaría en Tecnoloxías Industriais			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	1c
Teaching language				
Department	Matemática aplicada I			
Coordinator	Vidal Vázquez, Ricardo			
Lecturers	Vidal Vázquez, Ricardo			
E-mail	rvidal@uvigo.es			
Web				
General description				

**Competencias**

Code	
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**Resultados de aprendizaxe**

Expected results from this subject	Training and Learning Results
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**Contidos**

Topic	
Tema 1. Resolución de ecuacións non lineais	1. Métodos directos, de *bisección e de punto fixo. 2. Métodos de *linealización.
Tema 2. Ampliación de ecuacións diferenciais	1. Métodos numéricos de *Euler e *Runge-*Kutta.
Tema 3. Variable complexa	1. O corpo dos números complexos 2. Funcións *holomorfas 3. Integración complexa 4. Series de potencias 5. Series de Laurent 6.*Teorema dos residuos 7. Transformada *z
Tema 4. Análise de *Fourier e Transformadas integrais	1. Espazos con produto escalar 2. Sistemas *ortonormales completos 3. Series de *Fourier *trigonométricas 4. Problemas de *Sturm-*Liouville 5. Transformada de *Fourier 6. Transformada de Laplace 7. Aplicacións

**Planificación**

	Class hours	Hours outside the classroom	Total hours
Lección maxistral	31	62	93
Prácticas con apoio das TIC	18	27	45
Exame de preguntas de desenvolvemento	3	3	6
Resolución de problemas e/ou exercicios	0	6	6

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

**Metodoloxía docente**

	Description
Lección maxistral	Exposición da teoría. Translación de problemas técnicos a modelos matemáticos.
Prácticas con apoio das TIC	Técnicas de cálculo e programación, presentación e interpretación de solucións.

**Atención personalizada**

Methodologies	Description

Lección maxistral	O profesor atenderá as dúbidas e preguntas do alumnado.
Prácticas con apoio das TIC	O profesor atenderá as dúbidas e preguntas do alumnado.

<b>Avaliación</b>		
	Description	Qualification Training and Learning Results
Exame de preguntas de desenvolvemento	Realizarase un exame final de resolución de problemas na aula informática onde se poderán utilizar os programas preparados polo alumno, sobre os contidos de toda a materia.	60
Resolución de problemas e/ou exercicios	Avaliación continua: Asistencia as clases teóricas e practicas. Presentación dunha worksheet en Sage cos traballos propostos ó alumno.	40

### **Other comments on the Evaluation**

Para os alumnos que renunciem á avaliación continua o examen final suporá o 100% da nota.

A avaliación dos alumnos en segunda convocatoria consistirá nun exame sobre os contidos da totalidade da materia, que suporá o 100% da nota.

#### COMPROMISO ÉTICO:

"Esperase que o alumno presente un comportamento ético adecuado. En caso de detectar un comportamento non ético (copia, plaxio, utilización de aparellos electrónicos non autorizados, e outros) se considerará que o alumno non reúne os requisitos necesarios para superar a materia. Neste caso a calificación global no presente curso académico será de suspenso (0.0)."

### **Bibliografía. Fontes de información**

#### **Basic Bibliography**

E. Corbacho, **Matemáticas de la Especialidad**, Curso 2014-2015,

F. De Arriba, E. Corbacho, MC. Somoza, R. Vidal, **Implementación e desenvolvemento de aulas de matemáticas avanzadas en Sage**, 2018

F. De Arriba, A. Castejón, E. Corbacho, MC. Somoza, R. Vidal, **Implementación e desenvolvemento de aulas de xeometría euclídea e diferencial en Sage**, 2020

M.R. Spiegel, **Análisis de Fourier. Teoría y problemas**,

M. Crouzeix , A.L. Mignot, **Analyse numérique des équations différentielles**,

#### **Complementary Bibliography**

P.G. Ciarlet, **Introduction à l'analyse numérique matricielle et à l'optimisation**,

H. Rinhard, **Éléments de mathématiques du signal**,

D.G Zill, **Ecuaciones diferenciales con aplicaciones de modelado**,

### **Recomendacións**

#### **Subjects that it is recommended to have taken before**

Matemáticas: Álgebra e estatística/V12G360V01103

Matemáticas: Cálculo I/V12G360V01104

Matemáticas: Cálculo II e ecuacións diferenciais/V12G360V01204

#### **Other comments**

Requisitos:

Para matricularse nesta materia é necesario superar ou ben estar matriculado de todas as materias dos cursos inferiores ao curso no que está situada esta materia.

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

**IDENTIFYING DATA****Machine design and testing**

Subject	Machine design and testing			
Code	V12G363V01602			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Casarejos Ruiz, Enrique			
Lecturers	Casarejos Ruiz, Enrique González Baldonado, Jacobo Segade Robleda, Abraham			
E-mail	e.casarejos@uvigo.es			
Web	<a href="http://moovi.uvigo.gal/">http://moovi.uvigo.gal/</a>			
General description	<p>This subject is intended to allow the students to apply the fundamentals of Mechanism and Machines Theory to the design of machines as well as the necessary knowledge, comprehension, and application of these concepts concerning to the field of Mechanical engineering.</p> <p>It also provides the students with the most important concepts related to the design of machines. The students will know and apply analysis methods for the design of machines by applying analytical methods or/and through the effective use of simulation software.</p>			

**Skills**

Code	
B3	CG3 Knowledge of basic and technological subjects that enable students to learn new methods and theories, and to adapt to new situations.
B4	CG4 Ability to solve problems through initiative, decision-making, creativity, critical reasoning, and to communicate and transmit knowledge, skills and abilities in the field of industrial engineering.
B5	CG5 Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
B6	CG6 Capacity for handling specifications, regulations and mandatory standards.
B11	CG11 Knowledge, understanding and ability to apply the legislation relating to industrial installations.
C13	CE13 Knowledge of the principles of the theory of machines and mechanisms.
C26	CE26 Knowledge and abilities to calculate, design and test machines.
D2	CT2 Problem solving.
D9	CT9 Application of knowledge.
D16	CT16 Critical thinking.
D20	CT20 Ability to communicate with people not expert in the field.

**Learning outcomes**

Expected results from this subject	Training and Learning Results		
Knowledge of calculation methods applied in Mechanical design.	B3	C13	D2
	B4	C26	D9
	B5		D16
Knowledge and design capabilities applied in mechanical power transmissions.	B6	C13	D2
		C26	D9
			D16
			D20
Knowledge of the fundamental laws applied in the study of machine elements.	B11	C13	D2
		C26	D9
			D16
			D20
Calculation capabilities and analysis applied for different machine components.	B3	C13	D2
	B11	C26	D9
			D16
			D16

**Contents**

Topic
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Mechanical design	1. Design vs. static loads 2. Design vs. dynamic loads
Power Transmissions	3. Introduction to power transmission systems 4. Gears (spur, bevel, and worm gears) 5. Axles and shafts
Machine elements	6. Clutches and brakes 7. Bolted joints and power screws 8. Plain and ball bearings

### Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	23	19.5	42.5
Problem solving	9	30	39
Laboratory practical	18	47	65
Objective questions exam	3.5	0	3.5

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

### Methodologies

	Description
Lecturing	Lectures about the topics of the subject
Problem solving	Discussion of exercises
Laboratory practical	Practical sessions including specific material and software tools.

### Personalized assistance

Methodologies	Description
Lecturing	Group or individual tutorial sessions will be held during office hours to strengthen the acquired knowledge and to guide and assess the proposed works/papers
Problem solving	Group or individual tutorials will be held during office hours to strengthen the acquired knowledge and to guide and assess the proposed works/papers.
Laboratory practical	Group or individual tutorials will be held during office hours to strengthen the acquired knowledge and to guide and assess the proposed works/papers.

### Assessment

	Description	Qualification	Training and Learning Results		
Laboratory practical	Attendance and participation as well as practices reports, papers, and tests will be rated. However, to be evaluated, students must attend a minimum of 7 practice sessions; otherwise, students won't be evaluated and will get 0 points. Learning outcomes: all will be graded	20	C13 C26	D2 D9 D16 D20	
Objective questions exam	Final and mid-term tests will be focused on the contents taught at classes and laboratory sessions. Learning outcomes: all will be graded	80	B3 B4 B5 B6 B11	C13 C26 D2 D9 D16	

### Other comments on the Evaluation

Students must achieve 5 points (\*) or higher grade to pass the subject, following these rules:

- Laboratory Practical.
  - Students are required to attend and utilized the laboratory/Computer room. Practices reports, papers, and tests for each practice session as well as proposed works/papers from tutorials will be evaluated and graded with a maximum of 2 points. This grade will be kept for the second term in the student's evaluation records (July). To be evaluated, students must attend a minimum of 7 practice sessions; otherwise, students won't be evaluated and will get 0 points.
  - For those students who have been officially granted the right to waive their continued evaluation, there will be a mandatory final test where they will be able to get a maximum grade of 2 points. However, an advanced request must be made to the professor to prepare the necessary materials for this test.
- Objective question exam. It will be graded in a test that have a minimum grade of 8 points.

(\*) Grades are calculated using a system of numerical qualification from 0 to 10 points conforming to the Spanish current legislation (RD 1125/2003, 5 September; BOE 18 September). Ethical commitment: An adequate ethical behaviour of the student is expected at all times. In case an unethical behaviour is detected (copying, plagiarism, unauthorized use of electronic devices, and others); the student will be considered unfit to meet the necessary requirements to pass the subject. In this case, the overall qualification in the current academic year will be a Fail grade (0.0).

The use of any electronic devices during tests is completely forbidden unless is specified and authorized. The fact of introducing unauthorized electronic devices in the examination room will be considered reason enough to fail the subject in the current academic year and the overall qualification will be a Fail grade (0.0).

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### Sources of information

#### Basic Bibliography

Norton, R., **Machine Design. An Integrated Approach**, Pearson, 2012

Shigley, J.E., **Mechanical Engineering Design**, 9ª edición, Mc Graw Hill, 2012

Norton, R., **Diseño de Máquinas. Un Enfoque Integrado**, Pearson, 2012

Shigley, J.E., **Diseño de en Ingeniería Mecánica**, 9ª edición, Mc Graw Hill, 2012

#### Complementary Bibliography

Mott, Robert L., **Machine Elements in Mechanical Design**, Pearson, 2006

Lombard, M., **Solidworks 2013 Bible**, Wiley, 2013

Hamrock, Bernard J, et al., **Fundamental Machine Elements**, Mc Graw Hill, 2000

Mott, Robert L., **Diseño de elementos de máquinas**, Pearson, 2006

Hamrock, Bernard J, et al., **Elementos de Máquinas**, Mc Graw Hill, 2000

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### Recommendations

#### Subjects that it is recommended to have taken before

Materials science and technology/V12G360V01301

Mechanics of materials/V12G360V01404

Mechanism and machine theory/V12G360V01303

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**IDENTIFYING DATA****Elasticity and additional topics in mechanics of materials**

Subject	Elasticity and additional topics in mechanics of materials			
Code	V12G363V01603			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Riveiro Rodríguez, Antonio			
Lecturers	Comesaña Piñeiro, Rafael Riveiro Rodríguez, Antonio			
E-mail	ariveiro@uvigo.es			
Web				
General description	This course will study the fundamentals of elasticity and deepen the study of mechanics of materials in order to be able to apply their knowledge to the actual behavior of solids (structures , machinery and resistant elements in general). This course, along with mechanics of materials course, is a holder of more specialized subjects whose object is the mechanical design.			

**Skills**

Code	
B3	CG3 Knowledge of basic and technological subjects that enable students to learn new methods and theories, and to adapt to new situations.
B4	CG4 Ability to solve problems through initiative, decision-making, creativity, critical reasoning, and to communicate and transmit knowledge, skills and abilities in the field of industrial engineering.
C14	CE14 Knowledge and use of the principles of strength of materials.
D2	CT2 Problem solving.
D5	CT5 Information Management.
D9	CT9 Application of knowledge.
D10	CT10 Self learning and work.
D17	CT17 Working as a team.

**Learning outcomes**

Expected results from this subject	Training and Learning Results		
Knowledge of the foundations of the elasticity theory	B3	C14	
Further deepening on mechanics of materials and stress analysis	B3 B4	C14	D2 D10
Knowledge of deformations in beams and shafts	B3 B4	C14	D2 D9
Ability to apply the knowledge of elasticity and mechanics of materials, and to analyze the mechanical performance of machines, structures, and general structural elements	B4	C14	D2 D5 D9
Ability to take decisions about suitable material, shape and dimensions for a structural element subjected to a specific load	B4	C14	D2 D5 D9 D17
Knowledge of different solving methods for structural problems and ability to choose the most suitable method for each specific problem	B4	C14	D2 D5 D9

**Contents**

Topic	
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Fundamentals of elasticity	Introduction to the theory of elasticity Stress analysis of elastic solids Strain Stress-strain relationships Two-dimensional elasticity
Criteria of failure	Saint-Venant's failure criterion Tresca's failure criterion Von-Mises' failure criterion Safety coefficient
Bending	Non uniform bending: Shear stresses. Zhuravski expression Principal stresses. Stress trajectories Bending and axial load: Normal stresses. Neutral axis Eccentric axial loads Kern of the cross-section Beams of different materials
Bending. Statically indeterminate beams	General method Settlements in fixed supports Continuous beams Simplifications in symmetric and antisymmetric beams
Torsion	Definition Coulomb's fundamental theory Static torque diagrams Stress and angle of twist Statically indeterminate problems
Combined loads	Definition Bending and torsion loaded circular shafts Shear center Stress and strain calculation in plane-spatial structures
Strain energy and energy methods	Strain energy: Axial load/shearing loads/bending/torsion/general expression. Clapeyron's theorem Indirect and direct work Maxwell's Betti Reciprocal Theorem. Applications. Castigliano's theorem. Mohr's integrals. Applications. Principle of virtual works.
Trusses	Definition and general comments Degree of indeterminacy Analytical method of force calculation Pinned joint displacement determination External indeterminacy and internal indeterminacy
Structures with rigid joint connections	Definition Joint stiffness factor and distribution factor Degree of indeterminacy. Analysis by the stiffness method.
Moving loads	Influence lines. Definition and general properties.

## Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	0.5	0	0.5
Previous studies	0	6	6
Lecturing	13	26	39
Problem solving	18	22	40
Laboratory practical	18	4	22
Autonomous problem solving	0	15	15
Problem and/or exercise solving	2	17.5	19.5
Self-assessment	0	5	5
Laboratory practice	1	2	3

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

## Methodologies

	Description
Introductory activities	Introduction to the subject: Course aims, expected learning outcomes, course syllabus, teaching methods, assessments and grading policy.

Previous studies	<p>Student previous activities to lectures.</p> <p>The students will receive detailed instructions to complete and send certain exercises before lectures/laboratory sessions. The purpose of this assessment is to optimize the session outcome.</p> <p>The delivery of these exercises will modify the obtained qualification of the continuous assessment (laboratory practices and conceptual tests) as explained in the section of "Other comments and second call" in this guide.</p>
Lecturing	<p>The contents of the subject will be presented in a organized way. Special emphasis will be put on the fundamentals of the subject and on the most troublesome points. To improve the comprehension, the contents of the next lectures will be announced on Tema platform on a weekly basis.</p>
Problem solving	<p>Each week will devote a time to the resolution by part of the student of exercises or problems proposed, related with the content studied in each moment.</p>
Laboratory practical	<p>Application of theory concepts to laboratory collaborative works.</p>
Autonomous problem solving	<p>The students will be supplied with exercises and problems to solve, the solutions will be provided for level self-evaluation.</p>

### Personalized assistance

Methodologies	Description
Autonomous problem solving	<p>The lecturers are at disposal of the students during office hours to solve any question related to the subject contents. The students will be able to verify if the completed assignments are correct and to identify the mistakes of miscalculations. The detailed schedule will be provided to the students at the beginning of the course through the TEMA platform. Any modification will be previously announced.</p>

### Assessment

	Description	Qualification	Training and Learning Results
Previous studies	<p>The delivery of these exercises will modify the obtained qualification of the continuous assessment (laboratory practices and conceptual tests) as explained in the section of "Other comments and second call" in this guide. It shall be deemed completed when a previous activity fully answer all questions.</p>	0	D5 D9 D10 D17
Laboratory practical	<p>Attendance and active participation in the complete laboratory lessons and practice reports will be assessed. They will be graded from 0 to 10, provided that the student gets a minimum mark in the written examination (minimum mark: 4.5/10).</p> <p>The qualification will be modified by the coefficient introduced in the "Other comments and second call" section in this guide.</p>	5	B4 C14 D2 D5 D9 D10 D17
Problem and/or exercise solving	<p>Exam for the assessment of the module learning outcomes. The exam comprises of brief problems and/or theoretical questions.</p> <p>The duration and precise grading will be communicated at the beginning of the exam.</p>	80	B3 C14 D2 B4 D9
Laboratory practice	<p>Short exercises and conceptual tests will be taken during the course (within lecture or laboratory hours; grading from 0 to 10). The mark will be added to the exam mark, provided that the student gets a minimum mark in the written examination (minimum mark: 4.0/10).</p> <p>The qualification will be modified by the coefficient introduced in the "Other comments and second call" section in this guide.</p>	15	B3 D9

### Other comments on the Evaluation

In this module the minimum required mark to pass is 5 out of 10.

The written examination of students not able to attend laboratory sessions will be graded 100% of the module mark, provided the student resigns from continuous assessment (and gets the required school approval) within the period established for that purpose. This examination will assess the subject overall competencies.

The qualification obtained in the laboratory practices in any of the two previous years (5% of the qualification) will be

preserved in the current year, provided the student requests that within an established period in the beginning of the course.

The qualification obtained in the conceptual tests in any of the two previous years (15% of the qualification) will be preserved in the current year, provided the student requests that within an established period in the beginning of the course. The rating obtained only remain within the language chosen at the time in which he studied the subject.

Comments about continuous assessment:

The handing of previous exercises (within the established period for each exercise) will modify the qualification of laboratory practices and follow-up conceptual tests as following explained:

Qualification of laboratory practices =  $K \times (\text{overall practice grade}) / (\text{nr of laboratory sessions})$

Qualification of conceptual tests =  $K \times (\text{addition of tests grades}) / (\text{nr of tests})$

$K = (\text{nr of previous exercises delivered}) / (\text{total nr of previous exercises})$

Additional comments:

The absence from a laboratory session, even justified, does not lead to the repetition of the session.

The absence from a test, even justified, does not lead to the repetition of the test.

The date and place of examinations of all calls shall be determined by the center before the start of course and will make them public .

Ethical commitment: it is expected an adequate ethical behaviour of the student. In case of detecting unethical behaviour (copying, plagiarism, unauthorized use of electronic devices, etc.) shall be deemed that the student does not meet the requirements for passing the subject. In this case, the overall rating in the current academic year will be Fail (0.0).

The use of any electronic device for the assessment tests is not allowed unless explicitly authorized. The fact of introducing unauthorized electronic device in the examination room will be considered reason for not passing the subject in the current academic year and will hold overall rating (0.0).

Group responsible lecturer: Groups with teaching in Spanish: Marcos García González and Adrián Pérez Riveiro.

Group with teaching in English: Rafael Comesaña and Antonio Riveiro

Reading list for the group in English:

Recommended:

- Hibbeler R.C., Mechanics of Materials, SI Edition, Prentice Hall. 9th. edition
- José Antonio González Taboada , Tensiones y deformaciones en materiales elásticos, 2a Edición, Tórculo.
- José Antonio González Taboada , Fundamentos y problemas de tensiones y deformaciones en materiales elásticos, 1ª Edición, Tórculo.

Complementary:

- Timoshenko, Goodier, Theory of elasticity, 3rd ed., (International student ed.), McGraw-Hill
- Manuel Vázquez , Resistencia de Materiales.

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### Sources of information

#### Basic Bibliography

José Antonio González Taboada, **Tensiones y deformaciones en materiales elásticos**,  
José Antonio González Taboada, **Fundamentos y problemas de tensiones y deformaciones en materiales elásticos**,  
Manuel Vázquez, **Resistencia de Materiales**,

#### Complementary Bibliography

Luis Ortiz Berrocal, **Elasticidad**,  
Robert Mott, Joseph A. Untener, **Applied Strength of Materials**, 6ª, CRC Press, 2016

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### Recommendations

**Subjects that it is recommended to have taken before**

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Physics: Physics 1/V12G360V01102

Physics: Physics 2/V12G360V01202

Mechanics of materials/V12G360V01404

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**Other comments**

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To register for this module the student must have passed or be registered for all the modules of the previous years.

The original teaching guide is written in Spanish. In case of discrepancies, shall prevail Spanish version of this guide.

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<b>IDENTIFYING DATA</b>				
<b>Manufacturing engineering</b>				
Subject	Manufacturing engineering			
Code	V12G363V01604			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Prado Cerqueira, María Teresa			
Lecturers	Prado Cerqueira, María Teresa			
E-mail	tprado@uvigo.es			
Web				
General description				

<b>Skills</b>	
Code	
B3	CG3 Knowledge of basic and technological subjects that enable students to learn new methods and theories, and to adapt to new situations.
C20	CE20 Applied knowledge of systems and manufacturing processes, metrology and quality control.
D2	CT2 Problem solving.
D8	CT8 Decision making.
D9	CT9 Application of knowledge.
D10	CT10 Self learning and work.
D17	CT17 Working as a team.
D20	CT20 Ability to communicate with people not expert in the field.

<b>Learning outcomes</b>			
Expected results from this subject	Training and Learning Results		
- Know the technological basis and the basics of manufacturing processes	B3	C20	D2
- Understand the basics of manufacturing systems			D8
- Acquire skills for the selection of manufacturing processes and developing manufacturing planning			D9
- Develop skills for making assemblies and parts in CAD/CAM environments			D10
- Application of CAQ technologies			D17
			D20

<b>Contents</b>	
Topic	
Thematic block I: Integration of product design and manufacturing.	Chapter 0. Product and process design. Chapter 1. Manufacturing systems. Chapter 2. Additive manufacturing technologies. Chapter 3. Design for manufacturing and assembly (DFMA).
Thematic block II: Design and planning of manufacturing processes.	Chapter 4. Design and planning methodologies for manufacturing processes. Chapter 5. Selection of operations, tools, equipment and process conditions. Chapter 6. Datum references, jigs, fixtures and equipments. Chapter 7. Design and process improvement techniques.
Thematic block III: Resources of manufacturing systems.	Chapter 8. Description and structure of CNC machine tools. Chapter 9. handlers and industrial robots. Positioning systems. Maintenance. Chapter 10. Measurement and verification systems in manufacturing lines. Definition of control ranges.

<b>Planning</b>			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	0	2

Problem solving	18	16	34
Laboratory practical	18	0	18
Mentored work	0	60	60
Lecturing	14	14	28
Objective questions exam	2	0	2
Essay	2	0	2
Essay questions exam	2	2	4

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

## Methodologies

Methodologies	Description
Introductory activities	<ul style="list-style-type: none"> <li>- Introduction</li> <li>- Objectives</li> <li>- Theoretical classes</li> <li>- Practical classes</li> <li>- Assessment</li> <li>- Project development. Topic selection and work progress.</li> <li>- References</li> </ul>
Problem solving	Development of real practical cases and exercises on the following contents <ol style="list-style-type: none"> <li>1. Plant distribution</li> <li>2. Product and tools design</li> <li>3. DFMA application</li> <li>4. Application of dimensional, geometrical and surface finishing tolerances.</li> <li>5. Sequence of manufacturing operations.</li> <li>6. Setting of the conditions in manufacturing processes.</li> <li>7. Calculation of cutting speeds, feeds, strengths and cutting powers in manufacturing.</li> <li>8. Measurement procedures.</li> </ol>
Laboratory practical	P1-2. PLM introduction. Product and process design. CAD software. Available software: Catia, NX, Fusion. 2 hour +2 hour P3. Part manufacturing process planning. Tooling design for product. 2 hour P4 -5 -6. Computer-aided tooling manufacturing, CAM prismatic, (Catia, NX, Fusion). 6 hour P7 -8 -9 Supervision of project development. 6 hour
Mentored work	Project (Work to make by student. It would correspond to Groups C of 5 students) Total 18*h
Lecturing	Development of the contents of the subject Proposition real cases and problems

## Personalized assistance

Methodologies	Description
Mentored work	Attending Works and supervising projects (groups from among 3 and 5 people).

## Assessment

	Description	Qualification	Training and Learning Results		
			B3	C20	D2
Objective questions exam	<ul style="list-style-type: none"> <li>- Test-type questions, marks will be deducted for incorret answer.</li> <li>- The test can involve problem and essay type questions.</li> </ul>	50	B3	C20	D2 D8 D9
Essay	Project development. Teamwork, creativity, self-sufficiency will be evaluated and in case of public presentation the ability for synthesis and communication	50		C20	D2 D9 D10 D17 D20
Essay questions exam	- Development of problems and/or cases.	50		C20	D2 D8 D9 D10

## Other comments on the Evaluation

The evaluation consists of:

A.-) Multiple choice exam: It's mandatory. The students must have a mark > 4 (0 to 10) to be able to make average with part B. Value 50%

Practical Part, The student have to choose between \*B1 or \*B2

B1.-)Project. Value 50%

B2.-)Essaytype questions: problems and cases. Value 50%.

The finalmark is the average mark A +B, being B= B1 or B2

Ethical commitment:The student is expected to exhibit appropriate ethical behavior. In the case of detecting non-ethical behaviour (copy, plagiarism, utilisation of unauthorised electronic devices, and others), it will be considered that the student does not gather the necessary requirements to pass the subject. In this case the global qualification in the present academic course will be fail (0.0).

Other comments Requirements: To enrol in this subject is necessary to have passed or be enrolled in all the matters of the previous courses.

ethical Commitment: it expects that the present student a suitable ethical behaviour. In the case to detect a no ethical behaviour (copy, plagiarism, utilisation of unauthorised electronic devices, and others) will consider that the student does not gather the necessary requirements to surpass the matter. In this case the global qualification in the present academic course will be of suspense (0.0).

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### **Sources of information**

#### **Basic Bibliography**

#### **Complementary Bibliography**

Pereira A., Prado T., **Notes of the subject IF**, 2015,

Pereira A., **Exercises and cases of manufacturing Engineering**, 2016,

Kalpakjian, S., **Manufacturing Engineering and Technology**, 7th ed.,

Notes of the ME subject,

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### **Recommendations**

#### **Subjects that it is recommended to have taken before**

Fundamentals of manufacturing systems and technologies/V12G360V01402

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#### **Other comments**

Requirements:

To enrol in this matter is necessary to have surpassed or be enrolled of all the matters of the inferior courses to the course in which it is situated this matter.

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<b>IDENTIFYING DATA</b>				
<b>Electrical machines</b>				
Subject	Electrical machines			
Code	V12G363V01605			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language				
Department				
Coordinator	Novo Ramos, Bernardino			
Lecturers	Novo Ramos, Bernardino			
E-mail	bnovo@uvigo.es			
Web				
General description				

<b>Skills</b>
Code

<b>Learning outcomes</b>
Expected results from this subject
Training and Learning Results

<b>Contents</b>	
Topic	
UNIT I: INTRODUCTION TO THE ELECTRICAL MACHINES	<p>I-1 Electromagnetic and electro-mechanic fundamental laws. General behaviour notes: Physical arrangement of the electrical machines. Types of machines. Losses. Energy balance. Efficiency. Heating. Cooling. Rated power. Insulation types. Degrees of mechanical protection and construction types. Nameplate.</p> <p>I-2 Usual construction: Magnetic poles. Windings.</p> <p>I-3 M.M.F's and E.M.F's inside the machine: Fields generated with concentrated and distributed windings. Rotating magnetic field. Winding factor</p>
UNIT II: INDUCTION MOTORS (ASYNCHRONOUS)	<p>II-1 Three-phase induction machine Construction characteristics. Operating principles. Electrical equivalent circuit. Powers and torques. Electrical tests. Energy balance and efficiency. T-s curve. Operation modes. Starting methods and speed control.</p> <p>AC motor protection and control switchgear. Security oriented control circuits Security oriented protection schemes</p> <p>II-2 Single-phase induction motor Construction characteristics. Operating principles. Electrical equivalent circuit. Starting methods.</p>
UNIT III: SYNCHRONOUS MACHINES (GENERATORS)	<p>UNIT III: SYNCHRONOUS MACHINES (GENERATORS) Construction characteristics. Operating principles. Armature reaction. Salient poles and cylindrical rotor machines. Electrical equivalent circuit. Stand-alone and grid-connected behaviours. Synchronous motor: Characteristics and uses.</p>
UNIT IV: D.C. MOTORS. SPECIAL MACHINES	<p>IV-1 Classic D.C. motor: Construction characteristics. Operating principles. Excitation systems. Armature reaction. Commutation. Speed control. Nameplate information.</p> <p>IV-2 Special machines: BLDC, Stepper Motors.</p>

<b>Planning</b>			
	Class hours	Hours outside the classroom	Total hours



Problem solving	8	16	24
Laboratory practical	10	16	26
Lecturing	32.5	65	97.5
Objective questions exam	1	0	1
Problem and/or exercise solving	1.5	0	1.5

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

### Methodologies

	Description
Problem solving	<p>Student will be required to work in groups to solve and present some proposed ac machines problems.</p> <p>This activity could be done using the "virtual office" if presentality is not possible due to the COVID19 University self-quarantine policies</p>
Laboratory practical	<p>Typical lab session in the Electrical Machines laoratory. They can be done online ( iusing some machine simulation software ) if presentality is not possible due to the COVID19 University self-quarantine policies</p> <p>During these lessons students will apply the theoretical knowledge provided during the theory lessons, and at the same time they will learn how to protect themselves, other people and the machines against ANY possible electrical hazzard. Active and Passive Security will be taught and followed in these hours</p>
Lecturing	<p>Typical lecture. Either presential or using the "virtual office" facility. The place will depend on the COVID19 University self-quarantine policies</p>

### Personalized assistance

Methodologies	Description
Lecturing	<p>Course-related discussions, asking for extra help, seeking clarification of material presented in class and following up on aspects of the class you find compelling can be done during the "Office Hours". They can be presential or "virtual". The student should ask the lecturer ( e-mail ) in order to decide the day and the time</p>
Problem solving	<p>Course-related discussions, asking for extra help, seeking clarification of material presented in class and following up on aspects of the class you find compelling can be done during the "Office Hours". They can be presential or "virtual". The student should ask the lecturer ( e-mail ) in order to decide the day and the time</p>

### Assessment

	Description	Qualification Training and Learning Results
Problem solving	<p>The assessment method will be a numerical resolution of some exercises of electrical machines A minimum mark of 40% will be required in this part</p> <p>Part of this qualification percentage could be obtained with some continuous evaluation, depending on the lecturer. (5/40). Student will be properly informed if this option is activated.</p>	40
Lecturing	<p>The assessment method will be a test, to be done individually without the use of any information source. There will be one unique test for the whole subject, and it will cover not only the theoretical lessons but the practical lab tests. A minimum mark of 40% will be required in this part</p> <p>Part of this qualification percentage could be obtained with some continuous evaluation in the lab lessons, depending on the lecturer. (10/60). Student will be properly informed if this option is activated.</p>	60

### Other comments on the Evaluation

To pass the subject a minimum of 5/10 will be required (result of the sum of the 2 parts)

If the student final mark is bigger than 5, but the minimum in each part is not reached, the overall given mark will be 4.0 (FAILED)

Commitment: An student ethical behaviour is expected. If a non-ethical behaviour is detected (copying, cheating in any way, using unlicensed electronic devices, and others), it will be considered that the student does not gather the necessary requirements to pass the subject. In case of some unethical behaviour the mark will be 0.0 (FAILED) The COVID19 University policies can modify the final exam type, if we have to move to a "virtual exam". Any change will be announced properly so the students can adapt their learning processes to the new situation

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### **Sources of information**

#### **Basic Bibliography**

#### **Complementary Bibliography**

B. Novo, **Class notes**,

Any ac machines book,

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### **Recommendations**

#### **Subjects that are recommended to be taken simultaneously**

Automation and control fundamentals/V12G363V01304

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#### **Subjects that it is recommended to have taken before**

Physics: Physics 1/V12G363V01102

Physics: Physics 2/V12G363V01202

Basics of circuit analysis and electrical machines/V12G363V01302

Applied electrotechnics/V12G363V01501

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<b>IDENTIFYING DATA</b>				
<b>Chemical technology</b>				
Subject	Chemical technology			
Code	V12G363V01606			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	English			
Department				
Coordinator	Rosales Villanueva, Emilio			
Lecturers	Rosales Villanueva, Emilio Sanroman Braga, María Ángeles			
E-mail	emiliorv@uvigo.es			
Web				
General description	In this subject, students learn the basic aspects of Chemical Engineering and the fundamentals of the basic operations most employed in industry.			

<b>Skills</b>	
Code	
B3	CG3 Knowledge of basic and technological subjects that enable students to learn new methods and theories, and to adapt to new situations.
B4	CG4 Ability to solve problems through initiative, decision-making, creativity, critical reasoning, and to communicate and transmit knowledge, skills and abilities in the field of industrial engineering.
C4	CE4 Ability to understand and apply the basic knowledge of general chemistry, organic chemistry and inorganic chemistry, and their applications in engineering.
D2	CT2 Problem solving.
D9	CT9 Application of knowledge.
D10	CT10 Self learning and work.
D17	CT17 Working as a team.

<b>Learning outcomes</b>				
Expected results from this subject	Training and Learning Results			
To know the bases of chemical technology.	B3	C4	D9	
To apply mass and energy balances to real systems.	B4	C4	D2 D9 D10 D17	
To know and understand the basic aspects of mass transfer.	B3	C4	D9	
To know the fundamentals of separation processes and their application to real cases.	B4	C4	D2 D9 D10 D17	

<b>Contents</b>	
Topic	
Introduction	Chemical Engineering. Basic principles. Chemical processes. Unit conversion and calculation tools
Mass and energy balances	Mass balances for systems without chemical reaction. Mass balances for systems with chemical reaction. Energy balances
Implementation of balances into chemical reactor design	Stoichiometry. Reaction rate. Ideal reactors
Mass transfer	Introduction. Mass transfer equations: individual and global coefficients
Distillation and rectification of liquid mixtures	Vapour-liquid equilibrium. Simple distillation. Rectification. Azeotropic and extractive distillation.
Liquid-liquid extraction	Fundamentals. Binary and ternary mixtures. Factors that affect the separation. Operation by simple contact, multiple contact in direct current, multiple contact in multiple countercurrent
Other operations in chemical processes	Gas absorption. Liquid-solid extraction. Adsorption and ion exchange.

<b>Planning</b>			
	Class hours	Hours outside the classroom	Total hours
Lecturing	20	40	60
Problem solving	17	31	48
Laboratory practical	8	8	16
Problem and/or exercise solving	2	8	10
Report of practices, practicum and external practices	0	2	2
Essay questions exam	3.5	10.5	14

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

<b>Methodologies</b>	
	Description
Lecturing	Direct oral exposition of the most important contents of the subject by the lecturer.
Problem solving	The lecturer suggests various problems to the students so they can work on them at home. Then, the lecturer solves them in the seminar classes.
Laboratory practical	The students will perform some experiments in the laboratory, solving problems in seminar classes and field practices in companies related to the topics covered throughout the course. In addition, the students will evaluate different processes using simulation software. The aim of the laboratory practices is to deepen basic concepts.

<b>Personalized assistance</b>	
Methodologies	Description
Lecturing	The students can ask the lecturer any question about the theoretical and practical aspects of this subject, about this methodology and the correction of the assessment tests.
Problem solving	The students can ask the lecturer any question about the theoretical and practical aspects of this subject, about this methodology and the correction of the assessment tests.
Laboratory practical	The students can ask the lecturer any question about the theoretical and practical aspects of this subject, about this methodology and the correction of the assessment tests.

<b>Assessment</b>				
	Description	Qualification	Training and Learning Results	
Problem and/or exercise solving	The students will carry out various tests with problems and short-answer questions. The average mark will represent 30% of the final mark.	30	B3 B4	C4 D2 D9
Report of practices, practicum and external practices	Apart from the mark of the practice report, the lecturer will take into account the attendance as well as the attitude that the students have on the practices.	10		C4 D9 D10 D17
Essay questions exam	Theoretical-practical exam of the basic concepts and procedures related to the subject matter, in the date fixed by the Centre.	60	B3 B4	C4 D2 D9

#### **Other comments on the Evaluation**

**ASSESSMENT:**The participation of the student in any of the evaluation systems of the subject (laboratory practicals, problem solving and exercises) will imply that the student effectively take the subject and its qualification. A minimum attendance of 75% of the practices is required to have the right to the evaluation of the same. Otherwise, the mark for this section will be 0.0 and they will have to take an exam in the final exam. A student who "officially renounces continuous assessment", will fail if he/she does not achieve a MINIMUM mark of 4.0 points (out of 10) in each of the parts of the "FINAL EXAMINATION". If the minimum mark in the "FINAL EXAMINATION" is passed, the student will pass the course if the FINAL GRADE is  $\geq 5.0$ , that is, if the sum of the marks obtained in the different systems of evaluation of the course is  $\geq 5.0$ .

**Second call:**The same criteria will be applied in the second sitting. With regard to the July exam, the grade of the different assessment systems (laboratory practicals, problem solving and exercises) will be maintained, so students will only take the "FINAL EXAM"

**STUDENTS RELEASED FROM CONTINUOUS ASSESSMENT:**When the School releases a student from the continuous assessment process, his/her grade will be the sum of 90% of the mark obtained in the "FINAL EXAM" and 10% of the laboratory practicals mark.

**ETHICAL COMMITMENT:**The student is expected to present adequate ethical behaviour. In the event that unethical behaviour is detected (copying, plagiarism, unauthorized use of electronic devices, etc.), it will be considered that the student does not meet the necessary requirements to pass the subject. In that case, the overall rating in the current academic year will be [fail (0.0)]. The use of any electronic device for the assessment exams is not allowed unless explicitly authorised. The fact of introducing unauthorised electronic devices in the examination room will be considered as a reason for not to pass the subject in the current academic year and will hold overall rating (0.0).

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**Sources of information****Basic Bibliography**

Himmelblau, D.M., **Basic principles and calculations in chemical engineering**, 7th, Prentice Hall International, 2004

Felder, R.M. and Rousseau, R.W., **Elementary principles of chemical processes**, 3rd, John Wiley & Sons, Inc., 2005

Chohey, N.P., **Handbook of Chemical Engineering Calculations**, 3rd, McGraw-Hill Companies, 2003

Fogler, H.S., **Elements of Chemical Reaction Engineering**, 5th, Prentice Hall International,

Levenspiel, O., **Chemical Reaction Engineering**, 3rd,

Coulson, J.M. and others, **Chemical Engineering vol. 1 and vol 2**, 5th, Butterworth-Heinemann, 2002

McCabe, W.L., Smith, J.C. and Harriott, P., **Unit operations of chemical engineering**, 5th, McGraw-Hill International Editions, 1993

Seader, J.D., Henley, E.J., Roper, D.K., **Separation process principles. Chemical and Biochemical Operations**, 3rd, John Wiley & Sons, Inc., 2011

**Complementary Bibliography**

Treybal, R.E., **Mass-transfer operations**, 3rd,

Ocón, J. y Tojo, G., **Problemas de Ingeniería Química**, 3rd,

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**Recommendations****Subjects that it is recommended to have taken before**

Physics: Physics 1/V12G360V01102

Physics: Physics 2/V12G360V01202

Mathematics: Calculus 1/V12G360V01104

Mathematics: Calculus 2 and differential equations/V12G360V01204

Chemistry: Chemistry/V12G360V01205

**Other comments**

Requirements: To enrol in this subject, it is necessary to have passed or be enrolled in every subject of inferior courses. In case of discrepancies, it will prevail the Spanish version of this document.