



## (\*)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.
V12G360V01501	Applied electrotechnics	1st	6
V12G360V01502	Materials engineering	1st	6
V12G360V01503	Physics 3	1st	6
V12G360V01504	Hydraulic turbomachines	1st	6
V12G360V01505	Specialized mathematics	1st	6
V12G360V01602	Machine design and testing	2nd	6
V12G360V01603	Elasticity and additional topics in mechanics of materials	2nd	6
V12G360V01604	Manufacturing engineering	2nd	6
V12G360V01605	Electrical machines	2nd	6
V12G360V01606	Chemical technology	2nd	6

IDENTIFYING DATA				
Applied electrotechnics				
Subject	Applied electrotechnics			
Code	V12G360V01501			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Garrido Suárez, Carlos			
Lecturers	Garrido Suárez, Carlos			
E-mail	garridos@uvigo.es			
Web	<a href="http://moovi.uvigo.gal/">http://moovi.uvigo.gal/</a>			
General description	<p>The objective of Applied Electrotechnic is to complete the training of the students of the Degree of Engineering in Industrial Technologies in what is related with Theory of Circuits and Electric Machines. This subject will provide them specific tools to analyse and evaluate the behaviour of the electric circuits in stable and transitory regime.</p> <p>The subject is conceived to provide the necessary knowledge and competencies to be able to be taught some subjects in the 3rd and 4rd years of the Degree.</p> <p>The students would have studied previously the subjects "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, without and extra effort, Applied Electrotechnic</p>			

Skills	
Code	
B3	CG3 Knowledge in basic and technological subjects that will enable them to learn new methods and theories, and equip them with versatility to adapt to new situations.
C22	CE22 Applied knowledge of electrical engineering
D1	CT1 Analysis and synthesis.
D2	CT2 Problems resolution.
D6	CT6 Application of computer science in the field of study.
D10	CT10 Self learning and work.
D14	CT14 Creativity.
D17	CT17 Working as a team.

Learning outcomes				
Expected results from this subject			Training and Learning Results	
To understand the behaviour of the electric circuits in case of a change of the working conditions	B3	C22	D1	
			D2	
			D6	
			D10	
			D14	
			D17	
To master the actual techniques for the analysis of 3-phase balanced and unbalanced electric circuits	B3	C22	D1	
			D2	
			D6	
			D10	
			D14	
			D17	
To know the measurement and data register techniques in the real electric circuits	B3	C22	D1	
			D2	
			D6	
			D10	
			D14	
			D17	

To acquire analysis skill to evaluate the circuits working under fault conditions. These skills will be applied to the study of the electrical transformers.

B3 C22 D1  
D2  
D6  
D10  
D14  
D17

## Contents

### Topic

#### UNIT I: 3-PHASE CIRCUITS, POWER MEASUREMENTS AND REACTIVE POWER COMPENSATION.

This Unit will allow the student to understand how to analyse 3-phase circuits under much balanced or unbalanced conditions

Initially the unit covers the basic concepts for the analysis of balanced circuits. It continues covering unbalanced circuits, the different methods to measure the electrical powers and the compensation of reactive power.

- Introduction: Generators, loads and 3-phase circuits
- Balanced 3-phase circuits. Voltages and currents.
- Conversion of 3-phase sources and loads.
- Analysis of balanced 3-phase circuits.
- Powers in balanced 3-phase circuits. Compensation.
- Analysis of unbalanced 3-phase circuits.

#### UNIT II: TRANSFORMERS

This Unit will allow the student to learn about the constructive characteristics of the transformers, to determine his characteristic parameters and to understand the machine main properties and his utilization in the electric systems.

- Analogies between electric and magnetic circuits.
- Introduction to the transformers: constructive aspects.
- The ideal transformer.
- Operation of the real transformer.
- Equivalent circuit of the single-phase transformer real: e.m.f's and voltages.
- No-load and in short-circuit tests of the transformer.
- Voltage drops, losses and performance of a transformer.
- Autotransformers.
- 3-phase transformers: Constitution, connection diagrams and tests.
- Instrument transformers.

## Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	9	9	18
Practices through ICT	9	9	18
Problem solving	9	18	27
Lecturing	20	60	80
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.

## Methodologies

	Description
Laboratory practical	Experimental solving of of proposed lab tests, realization of measurements and presentation of results.
Practices through ICT	□ Simulación by means of computer programs of 3-phase circuits and transformers.
Problem solving	□ Students solving of proposed exercises. Personal guidance if required
Lecturing	The usual master lessons

## Personalized assistance

Methodologies	Description
Lecturing	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.
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.
Practices through ICT	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.
Problem solving	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.

Assessment				
Description		Qualification Training and Learning Results		
Essay questions exam	Continuous assessment (100%): At the end of each subject the student will perform a test that will be scored from 0 to 10 points. The passing grade is 5. The test will assess theoretical issues and practical exercises. In each test the student can reach 50% of the final grade. The passed partial tests are released from the corresponding part in the final exam. For students who pass all tests, the final grade will be the weighted average of the marks of the partial tests. Students who fail or fail to submit any or all partial tests, will take a final exam in the official exam that 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 unit. The students approved by partial tests can modify the note and also present the final test. The examination will indicate the dates and places of publication of grades and revisions.	100	B3 C22 D1 D2 D6 D10 D14 D17	

### Other comments on the Evaluation

The student only has to take the failed partial in the July exam. The July final mark will be calculated equally as for the first final mark.

### Sources of information

#### Basic Bibliography

Parra V.M., Ortega J., Pastor A. y Pérez-Coyto A, **Teoría de Circuitos**, UNED,  
 González E., Garrido C. y Cidrás J, **Ejercicios resueltos de circuitos eléctricos**, Tórculo Edicions,  
 Fraile Mora, Jesús, **Máquinas Eléctricas**, McGraw-Hill,  
 Jesús Fraile Mora y Jesús Fraile Ardanuy, **Problemas de Máquinas Eléctricas**, McGraw-Hill/InterAmericana de España,

#### Complementary Bibliography

### Recommendations

#### Subjects that continue the syllabus

Electrical machines/V12G360V01605

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

Physics: Physics 2/V12G360V01202  
 Mathematics: Calculus 2 and differential equations/V12G360V01204  
 Basics of circuit analysis and electrical machines/V12G360V01302

### Other comments

Requirements: To enrol in this subject is necessary to have surpassed or well be enrolled of all the subjects of the inferior courses to the course in the that is summoned this subject

### Contingency plan

#### Description

=== EXCEPTIONAL PLANNING ===

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

=== ADAPTATION OF THE METHODOLOGIES ===

\* Teaching methodologies maintained

In case of virtual or mixed teaching, keep the same educational methodologies that in face-to-face teaching using the telematic means that the University puts to disposal of the teachers and students (Faitic, Campus Remoto, Campus Integra, computer programs)

\* Teaching methodologies modified

The practices of laboratory substitute by tasks using computer programs of electrical simulation.

\* Non-attendance mechanisms for student attention (tutoring)

The student attention (tutoring), in case of virtual or mixed teaching, will manage of telematic form by means of the use of the available telematic tools (Faitic, Campus Remoto and/or Campus Integra, e-mail, phone)

\* Modifications (if applicable) of the contents

Any

\* Additional bibliography to facilitate self-learning

Any

\* Other modifications

Any

=== ADAPTATION OF THE TESTS ===

\* Tests already carried out

The face-to-face proofs made keep his value and weight in the global evaluation

\* Pending tests that are maintained

The pending proofs to make are supported by his value and weight in the global evaluation, making through the distinct tools put to disposal of the teachers and students (faitic, email, Campus Remoto , Campus Integra, telephone, etc.)

\* Tests that are modified

Any

\* New tests

Any

\* Additional Information

The criteria of evaluation are kept adapted to the realisation of the proofs, in the case to be necessary and by indication in Resolution Rectoral, using the telematic means places to disposal of the theachers

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IDENTIFYING DATA				
Materials engineering				
Subject	Materials engineering			
Code	V12G360V01502			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Pérez Vázquez, María Consuelo			
Lecturers	Collazo Fernández, Antonio Gomez Barreiro, Silvia Pérez Vázquez, María Consuelo			
E-mail	mcperez@uvigo.es			
Web	<a href="http://moovi.uvigo.gal/">http://moovi.uvigo.gal/</a>			
General description	(*)Nesta materia preténdese axuntar os fundamentos científicos que xustifican a relación entre estrutura, propiedades e comportamento, cos aspectos máis tecnolóxicos da forma en que esas interaccións mutuas ven afectadas polos procesos de elaboración e polas condicións de servizo.			

Skills	
Code	
B3	CG3 Knowledge in basic and technological subjects that will enable them to learn new methods and theories, and equip them with versatility to adapt to new situations.
B4	CG4 Ability to solve problems with initiative, decision making, creativity, critical thinking 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 Apply 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		
New	B3	C19	D1
	B4		D5
	B5		D7
	B6		D9
	B11		D10
			D15
			D17

Contents
Topic

&#149; Mechanical behaviour of the materials.  
 &#149; Answer of the materials subjected to processes of conformed by foundry, \*moldeo and injection.  
 &#149; Answer of the materials subjected to processes of conformed by plastic deformation, \*viscoelástica and \*compactación of dusts.  
 &#149; Modification of materials by means of thermal treatments, \*termoquímicos and \*termomecánicos.  
 &#149; Technologies of the union and \*soldabilidad.  
 &#149; Materials of construction.  
 &#149; Materials for tools.

.Materials under tensions  
 plastic Deformation  
 Conformed of sheet  
 .\*Moldeo And defects of \*moldeo  
 .\*Fractografía

Parts of laboratory	Mechanical essays Essays no destructive electrochemical Essays
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## Planning

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

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

## Methodologies

	Description
Laboratory practical	Activities of application of the *conocimientos and concrete situations and of the acquisition of basic skills and *procedimentales related with the matter *objecto of study. They develop in *laboratorios with skilled equipment.
Mentored work	The student, of individual way or in group, elaborates a document on the thematic of the matter or prepares seminars, investigations, memories, essays, summaries of readings, conferences, etc.
Seminars	It pretends do *unseguimiento of the work of the student, as well as resolve the *dificultatades that find in the understanding of the contents of the *asignatura.
Problem solving	Activity in which the professor proposes to the students a series of problems and/or exercises related with the *asignatura, so that it work on them home. The student has to develop the suitable or correct solutions by means of the realisation of routines, the application of formulas or algorithms, the application of procedures of transformation of the available information and the interpretation of the results. The resolution of the problems will do in class, by part of the professor or of some student.
Lecturing	Oral and direct exhibition, by part of the professor, of the corresponding fundamental knowledges to the subjects of the *asignatura in question.

## Personalized assistance

Methodologies	Description
Mentored work	
Seminars	

## Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	The formative activities of practical character will evaluate according to the criteria of assistance and degree of participation, reports of development of practices or of visits to companies (individual or by groups)	15	D5 D9 D10 D15 D17
Mentored work	They will evaluate by the reports presented, and the exhibition in class of the works.	15	B3 B4 B11 D9 D10 D15 D17

Lecturing	It will realise by means of a proof written (short questions and type test) that collect the knowledges purchased by the student along the course.	70	B3 B4 B5 B6 B11	D5 D7 D9 D10 D15
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## Other comments on the Evaluation

### Sources of information

#### Basic Bibliography

Kalpakjian, S. y Schmid, S. R., **Manufactura, Ingeniería y Tecnología**, Pearson Educación,  
Mikell P. Groover, **Fundamentos de Manufactura Moderna: Materiales, Procesos y Sistemas**, Prentice Hall, Hispanoamericana, S.A,  
G. E. DIETER, **MECHANICAL METALURGY**, McGraw-Hill Book Company,

#### Complementary Bibliography

Manuel Reina Gómez, **Soldadura de los aceros, aplicaciones.**, Gráficas Lormo,  
Sindo Kou, **Welding Metallurgy**, John Wiley & Sons,  
GEORGE KRAUSS, **STEELS: Heat Treatment and Processing Principles**, ASM International,  
BROOKS, CH., **Principles of the Surface Treatment of Steels.**, Inc. Lancaster,  
M. G. RANDALL, **Sintering: Theory and Practice**, John Wiley & Sons,  
P. Beeley, **Foundry Technology**, Butterworth-Heinemann, Ltd.,

### Recommendations

#### Subjects that continue the syllabus

Materials and technologies in mechanical manufacturing/V12G380V01912  
Materials selection, tools and manufacturing resources/V12G380V01932  
Fluidmechanic systems and advanced materials for transportation/V12G380V01942

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

Materials science and technology/V12G380V01301

### Contingency plan

#### Description

=== EXCEPTIONAL PLANNING ===

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

=== ADAPTATION OF THE METHODOLOGIES ===

- \* Teaching methodologies maintained
- \* Teaching methodologies modified
- \* Non-attendance mechanisms for student attention (tutoring)
- \* Modifications (if applicable) of the contents
- \* Additional bibliography to facilitate self-learning
- \* Other modifications

=== ADAPTATION OF THE TESTS ===

- \* Tests already carried out
- Test XX: [Previous Weight 00%] [Proposed Weight 00%]
- ...
- \* Pending tests that are maintained



Test XX: [Previous Weight 00%] [Proposed Weight 00%]

...

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

\* New tests

\* Additional Information

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IDENTIFYING DATA				
<b>Physics 3</b>				
Subject	Physics 3			
Code	V12G360V01503			
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	Fernández Fernández, José Luís 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>			

Skills	
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.

Learning outcomes			
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

Contents	
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	2.1. The nature of mechanical waves 2.2. Longitudinal waves in thin rods 2.3. Longitudinal waves in springs 2.4. Transverse waves in strings 2.5. Power flow and intensity of a wave 2.6. Longitudinal waves in fluids
I.3. DESCRIPTION OF PHYSICAL QUANTITIES BY MEANS OF VECTOR ANALYSIS	3.1. Differential of arc of a curve 3.2. Scalar fields 3.3. Directional derivative 3.4. Gradient 3.5. Vector fields 3.6. Flux of a vector field 3.7. Solenoidal fields 3.8. Divergence of a vector field 3.9. Ostrogradski-Gauss' theorem or divergence theorem 3.10. Divergence of a solenoidal field 3.11. Circulation of a vector field 3.12. Rotation or curl of a vector field 3.13. Stokes' theorem 3.14. Conservative fields
II.1. GENERAL EQUATIONS OF ELECTROMAGNETISM	1.1. Definition of electric and magnetic fields 1.2. Field sources: macroscopic electric charges and currents 1.3. Relations among fields E and B and their sources: Maxwell's equations 1.4. Free charge 1.5. Polarization charge 1.6. Electric current 1.7. Polarization current 1.8. Magnetization current 1.9. Maxwell's equations as a function of fields E, D, B, and H 1.10. Boundary conditions for electromagnetic fields 1.11. Electrodynamical potentials 1.12. The energy law of the electromagnetic field
II.2. TIME-INDEPENDENT FIELDS: ELECTROSTATICS, STEADY ELECTRIC CURRENT AND MAGNETOSTATICS	2.1. Fundamental equations of electrostatics 2.2. Electric dipole 2.3. Fundamental equations for steady electric current 2.4. Equations including media properties 2.5. Electrical resistance 2.6. Joule's law 2.7. Electromotive forces and generators 2.8. Potential distribution in a resistor 2.9. Fundamental equations of magnetostatics 2.10. Equations including media properties 2.11. Magnetic forces 2.12. Magnetic circuit 2.13. Magnetic dipole
II.3. ELECTROMAGNETIC INDUCTION AND QUASISTATIC FIELDS	3.1. Electromagnetism in moving media 3.2. Galilean transformation of electric and magnetic fields 3.3. Electromotive force around a circuit 3.4. Faraday's law of electromagnetic induction 3.5. Definition of quasistatic fields 3.6. Self-inductance and mutual inductance 3.7. Magnetic energy
II.4. ELECTROMAGNETIC WAVES	4.1. Wave equations for fields E and H 4.2. E.M. monochromatic plane waves in lossless media 4.3. E.M. monochromatic plane waves in lossy media 4.4. Incidence of a plane wave on an interface between two perfect dielectrics 4.5. Incidence of a plane wave on an interface between a perfect dielectric and a conductor
III.1 LABS: STRUCTURED ACTIVITY SESSIONS	1.1 Structured activity sessions: - Experimental data processing (approximate quantities, measurement of physical magnitudes, error estimation) - Adequate operation with basic measurement instruments (flex-meter, micrometer, multimeter (analog and digital), oscilloscope) - Laboratory experiments with mechanical or electromagnetic waves (emission and reception of ultrasonic waves, microwaves or light waves, standing waves along one direction, Michelson interferometer)

### 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

Planning			
	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.

Methodologies	
	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)

#### Personalized assistance

Methodologies	Description
Lecturing	In tutoring hours
Laboratory practical	In tutoring hours
Problem solving	In tutoring hours

Assessment				
	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**

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

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

#### **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

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

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

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

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

I. N. Bronshtein, K. A. Semendyayev, **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

#### **Recommendations**

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

Physics: Physics 1/V12G360V01102

Physics: Physics 2/V12G360V01202

Mathematics: Algebra and statistics/V12G360V01103

Mathematics: Calculus 1/V12G360V01104

Mathematics: Calculus 2 and differential equations/V12G360V01204

##### **Other comments**

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

#### **Contingency plan**

##### **Description**

=== EXCEPTIONAL PLANNING ===

Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo has established an extraordinary plan that will be activated when the administrations and the institution itself so determine, considering safety, health and responsibility criteria to ensure continued distance and blended learning. These already planned measures will guarantee, when required, the development of teaching in a more agile and effective way, as students and teachers will be made aware in advance (or well in advance) through the official channel of the syllabus document.

=== ADAPTATION OF THE METHODOLOGIES ===

\* Teaching methodologies maintained

\* Teaching methodologies modified

All the methodologies (lecturing, problem solving and laboratory practical): in the blended learning regime face-to-face classroom activities will be combined with on-line lecturing through the virtual campus ([Campus Remoto]), using the learning platform as an additional support. In the distance learning regime only online lecturing will take place through the virtual campus ([Campus Remoto]), using the learning platform as an additional support. To guarantee student access to the materials and resources of the course, other methodologies and media may be implemented if needed.

In particular, for the laboratory practical in the blended learning regime the operation of experimental devices by the students and the associated data acquisition activities could suffer major restrictions (due to the reduced capacity of the laboratory classroom, the mandatory use of personal protective equipment, the implementation of special hygiene measures and other factors). For these reasons, these activities will be mostly replaced by demonstrations developed by the lecturer in

a face-to-face session with some of the students from the laboratory group. These demonstrations will be followed online by the rest of the students from the same group. Data processing and analysis are highly independent from the operation of experimental devices and can be undertaken outside of the laboratory classroom (in another classroom, at home, etc.). In the distance learning regime, the laboratory practical will be undertaken entirely online and the operation of experimental devices and data acquisition activities will be completely replaced by demonstrations by the lecturer that will be followed online by the students. These demonstration could be complemented by other specific audiovisual materials.

\* Non-attendance mechanisms for student attention (tutoring)

Tutoring hours could be held both face-to-face (provided that health and safety measures can be guaranteed using personal protective equipment) or online, by using asynchronous media (email, forum, etc.) or by making an appointment (videoconference).

\* Modifications (if applicable) of the contents

\* Additional bibliography to facilitate self-learning

\* Other modifications

=== ADAPTATION OF THE TESTS ===

\* Tests already carried out

Test XX: [Previous Weight 00%] [Proposed Weight 00%]

...

\* Pending tests that are maintained

Test XX: [Previous Weight 00%] [Proposed Weight 00%]

...

\* Tests that are modified

[Previous test] => [New test]

The weights of the tests for continuous assessment in the classroom (A-20%) and in the laboratory (L-20%) and the final theory (T-30%) and problems (P-30%) exams are kept unchanged. However, more flexibility could be introduced in the type of questions that can be employed in each part as detailed below.

Continuous assessment test, part A, weight 20%. Type of assessment: essay questions.

=>

Continuous assessment test, part A, weight 20%. Type of assessment: objective questions, problems and/or exercises solving, and essay questions.

Continuous assessment test, part L, weight 20%. Type of assessment: problems and/or exercises solving (10%) and report (10%).

=>

Continuous assessment test, part L, weight 20%. Type of assessment: problems and/or exercises solving and objective questions (10%), and report (10%).

Final exam, part P, weight 30%. Type of assessment: problems and/or exercises solving.

=>

Final exam, part P, weight 30%. Type of assessment: problems and/or exercises solving, and objective questions.

Final exam, part T, weight 30%. Type of assessment: essay questions.

=>

Final exam, part T, weight 30%. Type of assessment: objective questions and essay questions.

\* New tests

\* Additional Information

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IDENTIFYING DATA				
Hydraulic turbomachines				
Subject	Hydraulic turbomachines			
Code	V12G360V01504			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language				
Department				
Coordinator	Gil Pereira, Christian			
Lecturers	Gil Pereira, Christian			
E-mail	chgil@uvigo.es			
Web				
General description	The *asignatura *Turbomáquinas Hydraulic describes the operation of the group of machines that govern by the principle of Euler (machines *rotodinámicas). The knowledge of these machines provides the necessary basic principles to analyse the behaviour of the same in any installation in which they find , as well as the basic principles for his design and *dimensionado.			

Skills	
Code	
B3	CG3 Knowledge in basic and technological subjects that will enable them to learn new methods and theories, and equip them with versatility 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 Problems resolution.
D9	CT9 Apply knowledge.
D10	CT10 Self learning and work.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
□ Purchase skills on the process of *dimensionado of installations of pumping and machines of fluids	B3	C8 C25	D2 D9 D10
To understand basic aspects of hydraulic machines	B3	C8 C25	D2 D9 D10

Contents	
Topic	
1.- Introduction	1.- Machines of Fluids. Classification 2.- *Turbomáquinas Hydraulic 3.- Applications to the Industry 4.-Characteristic general
2.- Transfer of Energy	1.- Equation of conservation of the energy 2.- Application to *Turbomáquinas 3.- Adimensional parameters and coefficients of speed 4.-Performances
3.- Similarity and characteristic Curves	1.- Similarity in *turbomáquinas 2.- Practical utilisation of the laws of similarity 3.- Comparison between *turbomáquinas 4.- Characteristic curves in hydraulic bombs 5. Characteristic curves in hydraulic turbines 6. Adimensional coefficients. Specific speed and specific power

4.- Transfer of Work	1.- Fundamental equation of the *Turbomáquinas. Equation of Euler. Distinct expressions of the equation of Euler 2.- One-dimensional ideal theory of *TMH 3.- Two-dimensional ideal theory of *TMH 4.- Real flow. Losses 5.- *Cavitación In *TMH
5.- Machines of fluids of despicable compressibility	1.-Classification 2.- Fans. Characteristic curves 3.- *Aerogeneradores. Classification - Theory of the disk actuator. Limit of *Betz - basic Concepts of aerodynamic profiles - Theory of the element of shovel - Curves of power
6.- Machines of positive trip and hydraulic transmissions	1.- Types and classification 2.- Alternative and rotatory bombs. 3.- Hydraulic engines of positive trip 4.- Transmissions and hydraulic attachments
Practices	1. Introduction to the pneumatic systems: - Description detailed of the pneumatic systems and his components. -Basic circuits. -Resolution of problems proposed  2. Resolution problems of *TMH  3. *Turbomáquinas -Test characterisation turbine Francis  4. Resolution of problems of *MDP

### 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	Exhibition of the theory *Traslación of technical problems to mathematical models.
Laboratory practical	Practices of pneumatic (see description in contents)
	Practices of *TH (see description in contents)
Problem solving	Technicians of design and calculation Presentation and interpretation of solutions.Practical cases

### Personalized assistance

Methodologies	Description
Problem solving	The professors will attend personally the doubts and queries of the students, so much in the classes as in the *tutorías.
Lecturing	The professors will attend personally the doubts and queries of the students, so much in the classes as in the *tutorías.
Laboratory practical	The professors will attend personally the doubts and queries of the students, so much in the classes as in the *tutorías.

### 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 - Subject to develop	80	B3	C8 C25	D2 D9 D10
Problem and/or exercise solving	Resolution of exercises proposed, including: -*Memoria/exercises proposed of practices	20	B3	C8 C25	D2 D9 D10

### Other comments on the Evaluation

Continuous evaluation: it will have a final weight of 30% of the final note of the \*asignatura. 20% will consist in the resolution of exercises proposed. 10% to the active assistance to class. The note of continuous evaluation will not save of a course for another neither for the announcement of Julio. To final Examination of the \*asignatura (first announcement): it will have a final weight of 70% of the final note of the \*asignatura. It will consist, as it indicates in the previous section of: Proof written that it will be able to consist of: - theoretical Questions - practical Questions - Resolution of exercises/problems - Subject to develop so much of the classes of theory as of the classes of practices. Second announcement of Julio: it will consist in a final examination that represents 100% of the note of the \*asignatura. Expects that the present student a suitable ethical behaviour. In case to detect a no ethical behaviour (copy, plagiarism, utilisation of unauthorised electronic devices, for example) 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).

It will not allow the utilisation of any electronic device during the \*probas of evaluation except permission expresses. The fact to enter an unauthorised electronic device in the classroom of examination will be considered reason of no \*superación of the matter in the present academic course and the global qualification will be of suspense (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

#### 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

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 finds this matter.

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

### Contingency plan

#### Description

=== EXCEPTIONAL MEASURES SCHEDULED ===

In front of the uncertain and unpredictable evolution of the sanitary alert caused by the \*COVID-19, the University of Vigo establishes an extraordinary planning that will activate in the moment in that the administrations and the own institution determine it attending to criteria of security, health and responsibility, and guaranteeing the teaching in a no face-to-face

stage or partially face-to-face. These already scheduled measures guarantee, in the moment that was prescriptive, the development of the teaching of a more agile and effective way when being known in advance (or with a wide \*antelación) by the students and the \*profesorado through the tool normalised and institutionalised of the educational guides.

#### === ADAPTATION OF THE METHODOLOGIES ===

\* educational Methodologies that keep

- Lesson \*magistral and Resolution of problems: they will make of telematic form

\* educational Methodologies that modify

- Practical of laboratory: they will substitute by videos and explanatory documents that will allow to complete the tasks proposed

\* Mechanism no face-to-face of attention to the students (\*tutorías)

- The \*tutorías will make through Remote Campus in the dispatch assigned

\* Other modifications

#### === ADAPTATION OF THE EVALUATION ===

\* Test that they keep

- The proofs will make of telematic form keeping the contents, weights and criteria of evaluation

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IDENTIFYING DATA				
Matemáticas da especialidade				
Subject	Matemáticas da especialidade			
Code	V12G360V01505			
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	
B3	CG3 Coñecemento en materias básicas e tecnolóxicas, que os capacite para a aprendizaxe de novos métodos e teorías, e os dote de versatilidade para adaptarse a novas situacións.
D1	CT1 Análise e síntese.
D2	CT2 Resolución de problemas.

Resultados de aprendizaxe		
Expected results from this subject	Training and Learning Results	
Proporcionar os coñecementos básicos sobre variable complexa, análise de *Fourier e Transformadas integrais, ampliación e tratamento numérico de ecuacións diferenciais e técnicas de resolución de ecuacións non lineais	B3	D1 D2
Aplicar os coñecementos básicos sobre variable complexa, análise de *Fourier e Transformadas integrais, ampliación e tratamento numérico de ecuacións diferenciais e técnicas de resolución de ecuacións non lineais para resolver problemas técnicos	B3	D1 D2

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 de los 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 persoalmente as dúbidas e preguntas do alumnado.
Prácticas con apoio das TIC	O profesor atenderá persoalmente as dúbidas e preguntas do alumnado.

Avaliación				
	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	B3	D1 D2
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	B3	D1 D2

#### Other comments on the Evaluation

Para os alumnos que renuncien á avaliación continua o exame 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**, 978-84-8158-796-8, Servizo de Publicacións da Universidade de Vigo, 2018

F. De Arriba, A. Castejón, E. Corbacho, MC. Somoza, R. Vidal, **Implementación e desenvolvemento de aulas de xeometría euclídea e diferencial en Sage**, 978-84-8158-845-3, Servizo de Publicacións da Universidade de Vigo, 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.

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## **Plan de Continxencias**

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### **Description**

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=== MEDIDAS EXCEPCIONAIS PLANIFICADAS ===

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

=== ADAPTACIÓN DAS METODOLOXÍAS ===

Se a situación sanitaria o require,

- A actividade docente realizarase a través de Campus Remoto, utilizando tamén a plataforma de teledocencia FAITIC como reforzo, todo elo sen perxuício de poder utilizar medidas complementarias que garanticen a accesibilidade dos

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<b>IDENTIFYING DATA</b>				
<b>Machine design and testing</b>				
Subject	Machine design and testing			
Code	V12G360V01602			
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	Yáñez Alfonso, Pablo			
Lecturers	Fernández Álvarez, José Manuel Yáñez Alfonso, Pablo			
E-mail	pyanez@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 in basic and technological subjects that will enable them to learn new methods and theories, and equip them with versatility to adapt to new situations.
B4	CG4 Ability to solve problems with initiative, decision making, creativity, critical thinking 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 Problems resolution.
D9	CT9 Apply 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 B4 B5	C13 C26	D2 D9 D16
Knowledge and design capabilities applied in mechanical power transmissions.	B6	C13 C26	D2 D9 D16 D20
Knowledge of the fundamental laws applied in the study of machine elements.	B11	C13 C26	D2 D9 D16 D20
Calculation capabilities and analysis applied for different machine components.	B3 B11	C13 C26	D2 D9 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
Problem solving	9	30	39
Laboratory practical	18	47	65
Lecturing	23	19.5	42.5
Problem and/or exercise solving	5.5	0	5.5
Problem and/or exercise solving	1	0	1

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

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

#### Personalized assistance

Methodologies	Description
Laboratory practical	There is only one practice group available for the classes held in English, so students must attend to their assigned group

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	
Problem and/or exercise solving	Final and mid-term tests will be focused on the contents taught at classes and laboratory sessions. Learning outcomes: all will be graded	60	B3 B4 B5 B6	C13 C26	D2 D9 D16
Problem and/or exercise solving	Final and mid-term tests will be focused on the contents taught at classes and laboratory sessions. Learning outcomes: all will be graded	20	B11	C13 C26	D9 D16

#### Other comments on the Evaluation

Students must achieve at least 5 points (out of 10 points) to pass the subject, according to the following rules:

1. 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 of the final grade. 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.
2. 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.
3. The final test will consist in short answer questions and problems, where the distribution of 20% and 60% of the final grade is simply an indicative percentage, depending on each examination sitting. The final test will have a maximum 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

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### 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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### Other comments

Requirements: to enrol in this subject, it is mandatory to have passed or at least, to have been enrolled in all the subjects in previous years.

In case of discrepancies, the Spanish version of this guide prevails.

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## Contingency plan

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### Description

=== EXCEPTIONAL PLANNING ===

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

In the event that attendance to classes become legally entirely or partially limited, the measures set on place will be:

1. To guarantee the necessary means, namely personal computer or internet access, to every enrolled student so they can follow the distance learning classes, appropriately. Therefore, to apply the appropriate solutions, any student who does not have any of these means should inform the course coordinator.

2. To inform students of the different measures adopted, the department will use the platform, Fatic. 3. On top of that, in the case of cancelation of face-to-face classes, the teaching guide will show the next modifications:

A. Competences. They will not be modified.

B. Learning outcomes. They will not be modified.

C. Contents. They will not be modified.

D. Planning. It will not be modified.

E. Methodology. It will be modified: Lecturing and Problem solving. They will require the employment of electronic means (virtual classroom of the Remote Campus or others). Laboratory Practices. The department will provide every student access to CAD and FEM software, so that they can carry out the practices remotely instead of from the Mechanical Engineering laboratory. The professor will supervise these practices using electronic means (virtual classroom of the Remote Campus or others).

F. Tutoring Lessons. They will be carried out by previously arranged electronic means (e-mail, faitic forums or virtual classroom at campus remote, []).

G. Assessment. Assessment methodologies/test will not be modified: Laboratory practical and Essay questions exam. Description, qualification, and competences, they will not be modified. All exams will use electronic means (virtual classroom of the Remote Campus or others); the department will publish in advance the specific rules for each test in the platform, Faitic. According to attendance at the virtual practice sessions, the professor will compute and validate each practice attendance on virtual classroom of the Remote Campus. Partial tests for the evaluation of specific contests of the subject can be proposed. Once again, the professor will publish in advance the rules concerning each test in the platform, Faitic.

H. Bibliography. Besides the bibliographical references found in this guide, the documentation provided at Faitic, and the problem bulletins and previous exams, the professor might facilitate additional notes, videos, web-references, and others, so that students can appropriately follow the course during the non-face-to-face classes.

This guide can be modified following Rectoral rules.

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<b>IDENTIFYING DATA</b>				
<b>Elasticity and additional topics in mechanics of materials</b>				
Subject	Elasticity and additional topics in mechanics of materials			
Code	V12G360V01603			
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	Badaoui Fernández, Aida García González, Marcos Pérez Riveiro, Adrián Riveiro Rodríguez, Antonio			
E-mail	ariveiro@uvigo.es			
Web				
General description	<p>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).</p> <p>This course, along with mechanics of materials course, is a holder of more specialized subjects whose object is the mechanical design.</p>			

<b>Skills</b>	
Code	
B3	CG3 Knowledge in basic and technological subjects that will enable them to learn new methods and theories, and equip them with versatility to adapt to new situations.
B4	CG4 Ability to solve problems with initiative, decision making, creativity, critical thinking 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 Problems resolution.
D5	CT5 Information Management.
D9	CT9 Apply 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		
Knowledge of the foundations of the elasticity theory		B3	C14	
Further deepening on mechanics of materials and stress analysis		B3	C14	D2
		B4		D10
Knowledge of deformations in beams and shafts		B3	C14	D2
		B4		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

<b>Contents</b>	
Topic	

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-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.</p> <p>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.</p> <p>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

Assessment	Description	Qualification	Training and Learning Results			
Previous studies	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.	0				D5 D9 D10 D17
Laboratory practical	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).  The qualification will be modified by the coefficient introduced in the "Other comments and second call" section in this guide.	5	B4	C14		D2 D5 D9 D10 D17
Problem and/or exercise solving	Exam for the assessment of the module learning outcomes. The exam comprises of brief problems and/or theoretical questions.  The duration and precise grading will be communicated at the beginning of the exam.	80	B3 B4	C14		D2 D9
Laboratory practice	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).  The qualification will be modified by the coefficient introduced in the "Other comments and second call" section in this guide.	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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**Contingency plan**

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**Description**

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=== EXCEPTIONAL MEASURES PLANNED ===

Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes extraordinary planning that will be activated at the time that the administrations and the institution itself determine it based on criteria of safety, health and responsibility, and guaranteeing teaching in a non-classroom or partially classroom setting. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way by being known in advance (or well in advance) by students and teachers through the standardized tool and institutionalized teaching guides.

=== ADAPTATION OF THE METHODOLOGIES ===

An attempt will be made to ensure that the degree of presentiality in teaching guarantees the safety and health of all parties involved. In any case, the guidelines will be followed in instructions indicated by the management of the center. In the event that there is a situation in which the teaching activities cannot be attended, neither the content nor the learning results contemplated in the subject will be affected. To this end, the following adaptations will be made.

Theory sessions:

In the event that they cannot be attended, remote classrooms, video recordings of classes, or any other means enabled by the university will be used for delivery. The contents taught will be the same.

Laboratory sessions:

The carrying out of experimental practices will be replaced by non-contact activities to solve similar problems that may require the use of specific calculation / simulation software.

Tutorials:

For the situation of non-attendance, email and, if necessary, videoconference will be used.

Evaluation:

In the event that the tests cannot be carried out in person, they will be carried out by telematic means. The number of assessment tests will not change, nor will the relative weight of each one of them in the course grade.

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<b>IDENTIFYING DATA</b>				
<b>Manufacturing engineering</b>				
Subject	Manufacturing engineering			
Code	V12G360V01604			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Pereira Domínguez, Alejandro			
Lecturers	Pereira Domínguez, Alejandro Pérez García, José Antonio			
E-mail	apereira@uvigo.es			
Web				
General description				

### Skills

Code	
B3	CG3 Knowledge in basic and technological subjects that will enable them to learn new methods and theories, and equip them with versatility to adapt to new situations.
C20	CE20 Applied knowledge of systems and manufacturing processes, metrology and quality control.
D2	CT2 Problems resolution.
D8	CT8 Decision making.
D9	CT9 Apply 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.

### Learning outcomes

Expected results from this subject	Training and Learning Results		
(*)	B3	C20	D2 D8 D9 D10 D17 D20

### Contents

Topic	
Thematic block I: Integration of Design of product and manufacture.	Chapter 0. Design of product and of process chapter 1. Systems of manufacture. Chapter 2. Technologies of additive manufacturing Chapter 3. Design of product for manufacturing (DFMA)
Thematic block II: Design and planning of processes of manufacture.	Chapter 4. Methodology of Design and Planning of processes of manufacture. Chapter 5. Choosing of operations, tools, toolings and conditions of process. chapter 6. Datums, fixturing and toolings. Chapter 7. Technicians of improvement of design and processes.
Thematic block III: Resources of the Systems of Manufacture.	Chapter 8. Machines tools with Numerical Control and components Chapter 9. Industrial robots and logistics devices. Systems of positioning, maintenance Chapter 10. Systems of measurement and verification in lines of manufacture. Definition of control charts

### Planning

	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	
	Description
Introductory activities	Introduction Objective theoretical topics practical topics Assessment Develop of projects. Design and Develop Bibliographic Resources
Problem solving	Development of real practical cases and exercises on the following contents 1. Distribution in plant 2. Design of product / tooling 3. Application *DFMA 4. Application dimensional tolerances, geometrical and of superficial finishing 5. Design of operations of manufacture. 6. Conditions of process manufacturing. 7. Calculus of speeds, feeds, strengths and powers in manufacture 8. Procedures of measurement.
Laboratory practical	*P1-2 PLM. Design of product and of process. Platform CAD/CAM available (Catia, NX, Fusion ) 2h +2h  P3 Planning process of manufacturing. Design of Tooling for product 2h  P4 -5 -6 Programming assisted of machined tooling, CAM, (Catia, NX, Fusion, ) 6h P7 -8 -9 Supervising works 6*h
Mentored work	Project (Work to make by student. It would correspond to Groups C of 5 students) Total 18*h
Lecturing	Synthetic teaching of the topics  Proposition real cases and problems

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

Assessment		Qualification Training and Learning Results			
	Description				
Objective questions exam	Examination with questions type test, in which the no hit answers discount. The test can comport questions of type problems and development.	50	B3	C20	D2 D8 D9
Essay	Development of project of course. It will evaluate , the capacity of work in team, creativity, autonomous work and in case of public presentation the capacity of communication and *sintesis.	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.-) Examination of theoretical questions : It's mandatory that students have a mark > 4 (0 to 10) to be able to make average with part B ( Project or Examination of questions of development) Value 50%	

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

B1.-)Project. Value 50%

B2.-)Examination of development questions : Consistent in problems and cases. Value 50%

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

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,

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

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#### Recommendations

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#### 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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#### Contingency plan

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##### Description

=== EXCEPTIONAL MEASURES PLANNED ===

Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes extraordinary planning that will be activated at the time that the administrations and the institution itself determine it based on safety, health and responsibility criteria. , and guaranteeing teaching in a non-classroom or partially classroom setting. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way by being known in advance (or well in advance) by students and teachers through the standardized tool and institutionalized teaching guides.

=== ADAPTATION OF THE METHODOLOGIES ===

\* Teaching methodologies that are maintained

All. With the exception of the realization that will be carried out remotely

\* Non-face-to-face service mechanism for students (tutorials)

Through virtual dispatch on remote campus

\* Additional bibliography to facilitate self-learning

Documents or links to necessary educational resources will be published in fatic

=== ADAPTATION OF THE EVALUATION ===

\* Tests already carried out

They are all kept with the same weight and value

\* Pending tests that are maintained

They will be carried out electronically through fatic keeping the same weight and value

IDENTIFYING DATA				
Electrical machines				
Subject	Electrical machines			
Code	V12G360V01605			
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	Prieto Alonso, Manuel Angel			
Lecturers	Prieto Alonso, Manuel Angel			
E-mail	maprieto@uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	O obxectivo desta materia é dotar ao alumno dunha formación básica, tanto teórica como práctica, sobre as máquinas eléctricas rotativas, en canto á constitución, modos de funcionamento e aplicacións.			

### Skills

Code	
B3	CG3 Knowledge in basic and technological subjects that will enable them to learn new methods and theories, and equip them with versatility to adapt to new situations.
C10	CE10 Knowledge and use of the principles of circuit theory and electrical machines.
D1	CT1 Analysis and synthesis.
D2	CT2 Problems resolution.
D6	CT6 Application of computer science in the field of study.
D14	CT14 Creativity.
D16	CT16 Critical thinking.
D17	CT17 Working as a team.
D19	CT19

### Learning outcomes

Expected results from this subject	Training and Learning Results		
To understand the basic aspects of the construction and operation of the classical electric machines.	B3	C10	D1 D16
To master the experimental process used to characterise the different types of E.M.	B3	C10	D1 D2 D6 D16 D17
To know the industrial use of the different types of E.M.	B3		D1 D14 D16 D19
To understand the difference between 'classical' and 'modern' E.M.	B3	C10	

### Contents

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 Principles of Construction. Magnetic poles. Neutral line. Pole-pitch.</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>II-2 Single-phase induction motor Construction characteristics. Operating principles. Electrical equivalent circuit. Starting methods.</p> <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 III: SYNCHRONOUS MACHINES (GENERATORS)	<p>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 Construction characteristics. Operating principles. Excitation systems. Armature reaction. Commutation. Armature reaction. Speed control.</p> <p>IV-2 Special machines: Step Motors, PMDC, Reluctance Motors</p>
UNIT V: PROTECTION AND CONTROL OF ELECTRICAL MOTORS	Low voltage switch gear. Electrical machines protection systems.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	32.5	65	97.5
Laboratory practical	10	16	26
Problem solving	8	16	24
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
Lecturing	(*)Exposición por parte do profesor dos contidos sobre a materia de máquinas eléctricas.
Laboratory practical	(*)Actividades de aplicación dos coñecementos teóricos a situacións concretas e de adquisición de habilidades básicas e procedimentales relacionadas coas máquinas eléctricas rotativas. Desenvolverase no laboratorio de máquinas eléctricas correspondente.
Problem solving	(*)Actividade na que se formulan problemas e exercicios relacionados coa materia de máquinas eléctricas rotativas. O profesor resolverá problemas tipo de máquinas rotativas e o alumno debe resolver problemas similares.

Personalized assistance	
Methodologies	Description
Lecturing	Any question can be arised during the lessons. Office hours are also available for the students.
Laboratory practical	During the realization of the practical tests any possible question will be solved.
Problem solving	All numerical exercises will be solved in this classes. Q and A will be highly recommended.

Assessment						
	Description	Qualification	Training and Learning Results			
Laboratory practical	<p>The evaluation of the practical laboratory tests will be done in a continuous way (session to session).</p> <p>The evaluation criteria is :</p> <ul style="list-style-type: none"> <li>- Minimum attendance of 80%.</li> <li>- Punctuality</li> <li>- Previous preparation of the practical test.</li> <li>- Correct utilization of the material</li> <li>- Practical tests results, if required .</li> </ul> <p>Not attending the lab lessons will imply 0 point in this part.</p> <p>Attendance below 80% will imply 0 point in this part.</p> <p>To pass the whole subject, a mark higher than 40% in this part in mandatory.</p>	10	B3	C10	D1 D2 D14 D16 D17 D19	

Problem solving	The evaluation of the exercises will be done in a continuous way (session to session). The evaluation criteria is : - Minimum attendance of 80%. - Punctuality - Previous preparation of the exercise, if required. - Correct exercise result, if required.	5	B3	C10	D1 D2 D6 D16
Objective questions exam	The assessment method will be a multiple choice 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.	55	B3	C10	D1 D6
Problem and/or exercise solving	The assessment method will be a numerical resolution of an exercise of electrical machines A minimum mark of 40% will be required in this part.	30		C10	D1 D2 D14 D16

### Other comments on the Evaluation

Second attempt (July)

If a student does not reach an 80% for the lab lessons or his/her marks are not higher the minimum required, a practical exam will be necessary to pass this part.

To pass the subject a minimum of 5/10 will be required (result of the sum of the 4 subject parts)

Commitment: An student ethical behaviour is expected. If not ethical behaviour is detected (copying, cheating in any way, using unlicensed electronic devices, and others), it will 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 (0.0). (FAILED)

### Sources of information

#### Basic Bibliography

Jesús Fraile Mora, **Máquinas Eléctricas**, McGraw-Hill/Interamericana de España S.A.U,  
Jesús Fraile Mora y Jesús Fraile Ardanuy, **Problemas de Máquinas Eléctricas**, McGraw-Hill/Interamericana de España,  
Stephen J. Chapman, **Máquinas Eléctricas**, McGraw-Hill,  
Manuel Cortés Cherta, **Curso Moderno de Máquinas Eléctricas Rotativas (I,II,III)**, Editores Técnicos Asociados,

#### Complementary Bibliography

Javier Sanz Feito, **Máquinas Eléctricas**, Prentice Hall, 2002  
Sanjurjo Navarro, **Máquinas Eléctricas**, García-Maroto, 2011  
Suárez Creo, Juan M, **Máquinas eléctricas : funcionamiento en régimen permanente**, Tórculo, 2006  
Fitzgerald, Arthur Eugene, **Máquinas Eléctricas**, McGraw-Hill, 2004

### Recommendations

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

Physics: Physics 1/V12G360V01102  
Physics: Physics 2/V12G360V01202  
Basics of circuit analysis and electrical machines/V12G360V01302  
Applied electrotechnics/V12G360V01501  
Physics 3/V12G360V01503

#### Other comments

Requirements: To enrol in this subject is necessary to surpass or well be enrolled of all the subjects of the inferior courses to the course in the that is situated this subject.

In case of discrepancies, will prevail the version in Castilian of this guide.

### Contingency plan

#### Description

### === EXCEPTIONAL MEASURES SCHEDULED ===

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

### ADAPTATION OF THE METHODOLOGIES

1- educational Methodologies that keep

- Lesson \*magistral

- Resolution of problems

2- educational Methodologies that modify

- Practical of laboratory: they would substitute by explanatory videos and the utilisation of programs of simulation

3- Mechanism no face-to-face of attention to the students (\*tutorías)

- The sessions of \*tutorías can make by telematic means: email, forums of \*FAITIC, ...Etc or videoconference under the modality of \*concertación previous.

### ADAPTATION OF The EVALUATION

The proofs of evaluation would be supported by the even format and with the same weights, making these with the telematic means provided by the University of Vigo

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IDENTIFYING DATA				
Chemical technology				
Subject	Chemical technology			
Code	V12G360V01606			
Study programme	Grado en Ingeniería en Tecnologías Industriales			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Sanroman Braga, María Ángeles			
Lecturers	Longo González, María Asunción Rosales Villanueva, Emilio Sanroman Braga, María Ángeles			
E-mail	sanroman@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.			
	English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

## Skills

Code	
B3	CG3 Knowledge in basic and technological subjects that will enable them to learn new methods and theories, and equip them with versatility to adapt to new situations.
B4	CG4 Ability to solve problems with initiative, decision making, creativity, critical thinking 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 Problems resolution.
D9	CT9 Apply knowledge.
D10	CT10 Self learning and work.
D17	CT17 Working as a team.

## Learning outcomes

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

## Contents

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.

## Planning

	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.

## Methodologies

	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.

## Personalized assistance

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.

## Assessment

	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	C4	D2
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
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	C4	D2
			B4		D9

## Other comments on the Evaluation

The participation of the student in any of the evaluation systems of the subject will imply that the student effectively take the subject and its qualification.

To pass the subject, it is necessary that the student obtains a minimum of 5 points out of 10 in each of the proposed evaluation systems. In the case of students who do not attain the minimum in all evaluation systems, they will fail to achieve the pass mark, with a numerical value obtained by following the percentages of the evaluation systems described above, or equal to that obtained in the non passed part.

In July, the previous marks of the evaluation systems will be kept if a minimum of 5 points out of 10 is achieved; therefore, the students will just have to take an essay or questions exam (theoretical-practical exam).

For students who are allowed by the School to skip the continuous assessment procedure: The qualification of these students will be formed by the mark of the essay & questions exam (90%) and the mark of the practices (10%).

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 . 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**, 6th,  
Felder, R.M. y Rousseau, R.W., **Elementary principles of chemical processes**, 3rd,  
Ocón, J. y Tojo, G., **Problemas de Ingeniería Química**, 3rd,  
Coulson, J.M. and others, **Chemical Engineering vol. 1 and vol 2**, 5th,  
Treybal, R.E., **Mass-transfer operations**, 3rd,  
Calleja, G., **Introducción a la ingeniería química**, 1ª,  
Levenspiel, O., **Chemical Reaction Engineering**, 3rd,  
Wankat, P.C., **Ingeniería de procesos de separación**, 2ª,  
McCabe, W.L., Smith, J.C. y Harriott, P., **Unit operations of chemical engineering**, 7th,

#### Complementary Bibliography

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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.

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### Contingency plan

#### Description

=== EXCEPTIONAL MEASURES SCHEDULED ===

In front of the uncertain and unpredictable evolution of the sanitary alert caused by the \*COVID-19, the University of Vigo establishes an extraordinary planning that will be activated in the moment that the administrations and the own institution determine it attending to criteria of security, health and responsibility, and guaranteeing the teaching in blended or distance learning mode. These already scheduled measures guarantee, in the moment that was prescriptive, the development of the teaching of a more agile and effective way when being known in advance by the students and the teaching staff through the tool normalised and institutionalised of the educational guides.

=== ADAPTATION OF THE METHODOLOGIES ===

\* educational Methodologies that keep

Lesson magistral: they will develop by means of synchronous virtual sessions that they will be able to be complemented with videos or other didactic materials.

Resolution of problems: it will be proposed to the students series of problems so that they work on them and that will be reviewed in synchronous virtual sessions.

Practices of Laboratory: it will make only by means of the evaluation of industrial chemical processes by means of the handle of a Chemical processes simulation software.

Educational Methodologies that modify

None adapt all the methodologies to the non face-to-face modality

\* Mechanism non face-to-face of attention to the students tutoring.

differentiate two types of mechanisms non face-to-face of attention to the students: generals and individual.

Generals: The lecturers in the schedule established by the centre will connect in a virtual classroom to which will assist all the students and in which the lecturers will orient on the material supplied to the students or will expand concepts according to the established in the educational guide.

Individual: The lecturers will attend in their schedule of tutoring to the students in the virtual room.

- \* Modifications (if they proceed) of the contents to give there are not modifications
- \* additional Bibliography to facilitate the self-learning is not necessary
- \* Other modifications

#### === ADAPTATION OF THE EVALUATION ===

- \* Test already made

Proof XX: [previous Weight 00%] [Weight Proposed 00%]

...

- \* Pending proofs that keep

Proof XX: [previous Weight 00%] [Weight Proposed 00%]

...

- \* Proofs that modify

[previous Proof] => [new Proof]

- \* New test

- \* additional Information

Vulnerable students: It will be made a methodological adaptation, facilitating them additional specific information when it is proved that they cannot have access to the contents provided by the conventional ways.

Evaluation: The systems of evaluation will be developed face to face except Resolution of the university board that indicate that they have to do in non face to face mode, making of this way through the different tools put to disposal of the teaching staff.

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