



(*)Escola de Enxeñaría Industrial

Information

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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	González-Viso Pulido, José Jaime			
Lecturers	González-Viso Pulido, José Jaime			
E-mail	jose.jaime.gonzalez-viso.pulido@uvigo.es			
Web	http://moovi.uvigo.gal/			
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>			

Training and Learning Results

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.

Expected results from this subject

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	<input type="checkbox"/> Simulación by means of computer programs of 3-phase circuits and transformers.
Problem solving	<input type="checkbox"/> 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		Qualification	Training and Learning Results
Description			
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 Edicións,

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 had surpassed or well be enrolled of all the subjects of the inferior courses to the course in the that is summoned this subject

IDENTIFYING DATA**Enxeñaría de materiais**

Subject	Enxeñaría de materiais			
Code	V12G360V01502			
Study programme	Grao en Enxeñaría en Tecnoloxías Industriais			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	1c
Teaching language	#EnglishFriendly Castelán			
Department				
Coordinator	Pérez Vázquez, María Consuelo			
Lecturers	Cortes Redin, María Begoña Pérez Vázquez, María Consuelo Riobó Coya, Cristina			
E-mail	mcperez@uvigo.es			
Web	http://moovi.uvigo.gal/			
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.			

Resultados de Formación e Aprendizaxe

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.
B4	CG4 Capacidade para resolver problemas con iniciativa, toma de decisións, creatividade, razoamento crítico e de comunicar e transmitir coñecementos, habilidades e destrezas no campo da enxeñaría industrial.
B5	CG5 Coñecementos para a realización de medicións, cálculos, valoracións, taxacións, peritaxes, estudos, informes, planes de labores e outros traballos análogos.
B6	CG6 Capacidade para o manexo de especificacións, regulamentos e normas de obrigado cumprimento.
B11	CG11 Coñecemento, comprensión e capacidade para aplicar a lexislación relativa a instalacións industriais.
C19	CE19 Coñecementos e capacidades para a aplicación da enxeñaría de materiais.
D1	CT1 Análise e síntese.
D5	CT5 Xestión da información.
D7	CT7 Capacidade de organizar e planificar.
D9	CT9 Aplicar coñecementos.
D10	CT10 Aprendizaxe e traballo autónomos.
D15	CT15 Obxectivación, identificación e organización.
D17	CT17 Traballo en equipo.

Resultados previstos na materia

Expected results from this subject	Training and Learning Results
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<input type="checkbox"/> Coñece os principais procesos de conformación e transformación de materiais usados na industria.	B3	C19	D1
<input type="checkbox"/> Demostra capacidade para seleccionar o proceso de elaboración máis adecuado para a obtención de pezas básicas a partir dun material determinado.	B4		D5
<input type="checkbox"/> Coñece os principais procesos de unión dos materiais usados na industria.	B5		D7
<input type="checkbox"/> Comprende as complexas interrelacións entre as propiedades dos materiais e os procesos de conformación e unión para poder optimizar as propiedades e a produtividade nunha ampla marxe de sectores industriais.	B6		D9
<input type="checkbox"/> Coñece as características dos materiais máis habitualmente empregados en Enxeñaría.	B11		D10
<input type="checkbox"/> Coñece a evolución dos distintos tipos de materiais e dos procesos para a súa posible conformación.			D15
<input type="checkbox"/> Coñece e aplica os criterios para a selección do material máis adecuado para unha aplicación concreta			D17
<input type="checkbox"/> Analiza e propón solucións operativas a problemas no ámbito da enxeñaría de materiais.			
<input type="checkbox"/> Interpreta, analiza, sintetiza e extrae conclusións e resultados de medidas e ensaios.			
<input type="checkbox"/> Redacta textos coa estrutura adecuada aos obxectivos de comunicación. Presenta o texto a un público coas estratexias e os medios adecuados			
<input type="checkbox"/> Demostra capacidades de comunicación e traballo en equipo.			
<input type="checkbox"/> Identifica as propias necesidades de información e utiliza os medios, espazos e servizos dispoñibles para deseñar e executar procuras adecuadas ao ámbito temático.			
<input type="checkbox"/> Leva a termo os traballos encomendados a partir das orientacións básicas dadas polo profesor, decidindo a duración das partes, incluíndo achegas persoais e ampliando fontes de información			

Contidos

Topic

Introdución á Enxeñaría de Materiais.

Presentación da materia.

Tema 1. Fatiga	Concepto e importancia. Características das superficies de fractura. Curva S-N. Criterio de acumulación do dano de Palmgren-Miner. Efecto da tensión media: criterios de Gerber e Goodman. Factores que afectan á vida a fatiga.
Tema 2. Mecánica de fractura.	Integridade estrutural e a súa relación coa presenza de defectos. Teorías de Griffith e Irwin. Criterios de fractura en medios elásticos lineais. Análise de tensións arredor de gretas: condicións de tensión plana e de deformación plana. Tenacidade de fractura en deformación plana. Aplicación da mecánica de fractura ó crecemento da grieta baixo cargas cíclicas. Predicción da vida en servizo.
Tema 3. Termofluencia.	Efecto da temperatura na resistencia mecánica. Curva de fluencia. Parámetros de deseño. Ensaio de termofluencia para metais e polímeros. Dependencia da termofluencia coa tensión e a temperatura. Extrapolación de datos. Desenvolvemento de aliaxes resistentes a termofluencia. Selección de materiais. Mecanismos de deformación.
Tema 4. Fundamentos e tecnoloxía da corrosión.	Importancia económico-social. Clasificación dos diferentes procesos de corrosión. Corrosión electroquímica. Aspectos termodinámicos. Potencial de electrodo e diagramas de Pourbaix. Aspectos cinéticos. Velocidade de corrosión. Fenómenos de polarización. Pasivación. Métodos de control da corrosión: estratexias de deseño, modificación do material e/ou medio, protección mediante recubrimentos, protección electroquímica (catódica e anódica).
Unidade temática II: Técnicas de conformado, tratamento e unión de metais.	Características tecnolóxicas da fundición: compacidade, colabilidade e agretabilidade. Aleacións para moldeo. Moldeo direccional, moldeo de monocristais e metais amorfos. Forxa de metal líquido (Squeeze Casting).
Tema 5: Conformado por fundición: procesos avanzados de moldeo.	Colado e procesamento de aliaxes semisólidas (Thixofundición e thixoforxado).
Tema 6: Resposta dos materiais ao conformado por deformación plástica en frío e en quente.	Endurecemento por deformación plástica. Factores de influencia sobre a deformación plástica. Eliminación da acritude: recocido de recristalización. Traballo en quente: restauración e recristalización dinámicas. Estructuras obtidas por moldeo: efecto da velocidade de enfriamento e elementos de aliaxe. Conformado en frío e en quente.
Tema 7. Tratamentos térmicos e termomecánicos	Temple e templabilidade. Revenido. Temple escalonado (martempering). Transformación isotérmica bainítica (austempering). Tratamentos termomecánicos: concepto e clasificación. Tratamentos termomecánicos de alta e baixa temperatura (laminación controlada e ausformado), con deformación plástica durante a transformación (isoformado) e posteriores á transformación da austenita (marformado e perlitoformado).

Tema 8. Metalurxia da soldadura.	Clasificación de procesos s/AWS. Ciclo térmico: actores de influencia. Zonas da unión soldada. Solidificación do baño de fusión: epitaxis e crecemento competitivo. Estructura bruta de solidificación. Soldadura en varias pasadas. Zona rexenerada. Zona afectada térmicamente (ZAT). Materiais endurecidos por solución sólida. Zona de sobrequecemento. Materiais endurecidos por acritude recristalización e crecemento de gran. Materiais endurecidos por transformación. Materiais endurecidos por precipitación. Tratamentos térmicos post-soldadura.
Unidade Temática III: Materiais estruturais.	Aceiros de uso xeral laminados en quente. Aceiros microaleados. Aceiros con resistencia mellorada á corrosión atmosférica. Aceiros para temple e revido. Aceiros para baixas temperaturas. Aceiros inoxidables.
Tema 9. Aceros estructurales e inoxidables	Características da película pasiva. Clasificación
Tema 10. Aleacións de aluminio	Fortalecemento do aluminio. Clasificación xeral das aliaxes de aluminio. Aliaxes de aluminio para forxa. Aliaxes de aluminio para moldeo.
Tema 11. Materiais compostos	Definición. Vantaxes e limitacións. Tipos de materiais compostos. Materiais Poliméricos reforzados con fibras: propiedades e fabricación. Materiais Poliméricos laminados. MMC e CMC.
Temario de prácticas	Características macrográficas e micrográficas das superficies de fractura.
Práctica 1. Fractografía e comportamento a fatiga	Microscopía electrónica de varrido. Casos prácticos. Fatiga: fundamentos do ensaio. Obtención da curva de Wöhler. Análise dos factores de influencia na resistencia á fatiga. Resolución de exercicios.
Práctica 2. Tecnoloxía da corrosión. Protección anticorrosiva	Técnicas electroquímicas para o estudo dos fenómenos de corrosión. Estudo metalográfico. Técnicas de avaliación de recubrimentos. Avaliación de diferentes mecanismos de fallo.
Práctica 3: Estudo metalográfico: efecto do conformado na estrutura do material.	Estruturas obtidas por moldeo: efecto da velocidade de enfriamento e elementos de aliaxe. Conformado en frío e conformado en quente.
Práctica 4: Metalografía de aliaxes tratadas termicamente	Tratamento térmico dos aceiros. Tratamento térmico das aliaxes lixeiras.
Práctica 5: Avaliación da templabilidade. Ensaio Jominy.	Obtención da curva Jominy. Principio, obxectivo e campo de aplicación. Metodoloxía de ensaio e expresión de resultados.
Práctica 6. Inspección mediante líquidos penetrantes e partículas magnéticas.	Principio, obxectivo e campo de aplicación. Metodoloxía de ensaio e informe de inspección.
Práctica 7. Radiografía industrial e ultrasonidos (parte I)	Radiografía industrial. Principio, obxectivo e campo de aplicación. Metodoloxía de ensaio. Xeración de ultrasonidos. Métodos de emisión-recepción e impulso eco. Inspección por ultrasonidos: calibración, determinación de espesores pola técnica de ecos múltiples.
Práctica 8. Inspección por ultrasonidos (parte II).	Exame e verificación de pezas metálicas con palpador normal. Avaliación de estruturas de formigón in situ. Esclerómetro: determinación da dureza superficial e relación coa resistencia a compresión do formigón. Inspección mediante transmisión directa. Determinación da velocidade de propagación en transmisión indirecta. Correlación entre a velocidade do pulso ultrasónico e a resistencia.

Planificación

	Class hours	Hours outside the classroom	Total hours
Prácticas de laboratorio	13	19	32
Traballo tutelado	0	11	11
Seminario	3	3	6
Resolución de problemas	4	8	12
Lección maxistral	33	56	89

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

Metodoloxía docente

	Description
Prácticas de laboratorio	Actividades de aplicación dos coñecementos e situacións concretas e da adquisición de habilidades básicas e procedimentais relacionadas coa materia obxecto de estudo. Desenvólvense en laboratorios con equipamento especializado.

Traballo tutelado	<p>O estudante, de maneira individual ou en grupo, elabora un documento sobre a temática da materia ou prepara seminarios, investigacións, memorias, ensaios, resumos de lecturas, conferencias, etc.</p> <p>Cada grupo de traballo, elaborará un documento sobre a temática da materia proposta seguindo a guía de elaboración dispoñible a través da plataforma de teledocencia. Deberán respetarse as indicacións da guía tanto no referente a súa estrutura xeral como na súa extensión.</p> <p>Os integrantes do grupo deben levar a cabo unha ampla búsqueda bibliográfica consultando diversas fontes de información.</p> <p>Finalizada a memoria cada estudante participará na exposición do traballo do seu grupo e respostará ás preguntas plantexadas tanto por o docente como por o resto dos alumnos de outros grupos, abréndose un debate en relación á temática proposta.</p>
Seminario	Preténdese facer un seguimento do traballo do alumno, así como resolver as dificultades que atope na comprensión dos contidos da asignatura.
Resolución de problemas	<p>Actividade na que o profesor propón aos alumnos unha serie de problemas e/ou exercicios relacionados coa materia, para que traballe sobre eles en casa.</p> <p>O alumno debe desenvolver as solucións adecuadas ou correctas mediante a realización de rutinas, a aplicación de fórmulas ou algoritmos, a aplicación de procedementos de transformación da información dispoñible e a interpretación dos resultados. A resolución dos problemas farase en clase, por parte do profesor ou dalgún alumno.</p>
Lección maxistral	Exposición oral e directa, por parte do profesor, dos coñecementos fundamentais correspondentes aos temas da materia en cuestión.

Atención personalizada

Methodologies	Description
Lección maxistral	O/A alumno/a terá unha atención personalizada a través das horas de titorías do docente. A atención personalizada do estudante poderá ter lugar ben de xeito presencial, ben a través da plataforma de Campus Remoto, no despacho virtual do docente.
Prácticas de laboratorio	O/A alumno/a terá unha atención personalizada a través das horas de titorías do docente. A atención personalizada do estudante poderá ter lugar ben de xeito presencial, ben a través da plataforma de Campus Remoto, no despacho virtual do docente.
Traballo tutelado	O/A alumno/a terá unha atención personalizada a través das horas de titorías do docente. A atención personalizada do estudante poderá ter lugar ben de xeito presencial, ben a través da plataforma de Campus Remoto, no despacho virtual do docente.
Seminario	non hai grupos C

Avaliación

Description		Qualification	Training and Learning Results
Prácticas de laboratorio	As actividades formativas de carácter práctico avaliaránse segundo os criterios de asistencia e grao de participación, informes de desenrrolo de prácticas e unha proba de avaliación ó fin do período de impartición das clases prácticas.	20	D5 D9 D10 D15 D17
Traballo tutelado	Avaliaranse polos informes presentados, e a exposición en clase dos traballos. Dado que cada estudante participará en la exposición del trabajo de su grupo y responderá a la preguntas planteadas tanto por el docente como por el resto de los alumnos de otros grupos, se evaluará tanto la calidad de la memoria presentada como las competencias relativas al trabajo en grupo y a la exposición/comunicación de ideas en el ámbito de la ingeniería.	10	B3 D9 B4 D10 B11 D15 D17
Lección maxistral	Farase mediante duas probas escritas (preguntas cortas, problemas e tipo test) que recolla os coñecementos adquiridos por o alumno ao longo de todo o curso. Unha proba farase durante o período de impartición da materia (30%) e a outra na data fixada polo centro (40%)	70	B3 D5 B4 D7 B5 D9 B6 D10 B11 D15

Other comments on the Evaluation

PRIMEIRA EDICIÓN:

a) Modalidade de Avaliación continua

A avaliación continua realizarase durante o período de impartición da materia. Para superar a materia o alumno deberá acadar un 5 ou superior. A contribución de cada proba a nota é como segue:

- 1) Avaliación dos contidos de prácticas mediante proba escrita, elaboración e entrega da memoria de prácticas (20% da cualificación). Poderáse facer na semá destinada para a primeira proba da Avaliación continua marcada polo Centro.
- 2) Elaboración e presentación dun traballo (10% da cualificación).
- 3) Primeira proba escrita dos contidos impartidos nas clases non prácticas (30% da cualificación). Esta proba está programada para mediados do cuatrimestre de impartición da materia e segundo fixa o Art. 20 do Regulamento sobre a avaliación, a calificación e a calidade da docencia e do proceso de aprendizaxe do estudantado, faráse no horario lectivo da materia.
- 4) Segunda proba escrita dos contidos impartidos nas clases non prácticas (40% da cualificación). Esta proba levaráse a cabo na data oficial marcada polo centro para realizar a avaliación global da materia.

Para superar a materia na primeira edición da acta por avaliación continua, deberáse acadar **un 40% como mínimo** en cada unha das probas escritas referidas aos contidos teóricos da materia.

- a) No suposto de que o alumno, **na primeira proba non acade este mínimo**, poderá ser avaliado a través da metodoloxía de avaliación global, expresando por escrito a súa renuncia a avaliación continua.
- b) No caso de que **non acade o mínimo na segunda proba de avaliación continua**, non se considerarán as cualificacións 1) e 2).

b) Modalidade de Avaliación global.

Aqueles alumnos que renunciem á metodoloxía de avaliación continua e polo tanto empreguen a metodoloxía de avaliación global, farán un exame sobre a totalidade dos contidos da materia (impartidos tanto nas clases teóricas como nas prácticas) na data marcada polo centro, sobre unha puntuación de 10 puntos, sendo preciso acadar 5 puntos.

SEGUNDA EDICIÓN (exame de Xullo):

Na segunda edición da acta:

- a) Aqueles alumnos que na edición anterior se avaliaron pola **modalidade da Avaliación continua**, se o desexan, poderán manter as cualificacións dos apartados 1) e 2). Neste caso, serán avaliados mediante unha proba escrita, sobre os contidos impartidos nas clases teóricas. A proba representará un 70% da cualificación final, sendo preciso acadar un mínimo do 40%, para que a nota desta proba pódase sumar ás obtidas nos apartados 1) e 2). Esta proba realizaráse na data oficial fixada polo centro.
- b) **Modalidade de Avaliación global:** Nesta modalidade o alumno fará unha proba escrita que avaliará a totalidade dos contidos da materia, impartidos nas clases de teoría e de prácticas. Para superar a materia o alumno deberá obter 5 puntos sobre 10. Esta proba realizaráse na data oficial fixada polo centro para a segunda oportunidade.

Compromiso Ético: Espérase que o alumno/a presente un comportamento ético adecuado, tal como se recolle nos Artigos 39, 40, 41 e 42 do Regulamento sobre a avaliación, a calificación e a calidade da docencia e do proceso de aprendizaxe do estudantado, aprobado no Claustro do 18 de Abril do 2023. No caso de detectar un comportamento non ético (copia, plaxio, emprego de aparellos eléctricos non autorizados, e outros) considerarase que o alumno non reúne os requisitos necesarios para superar a materia. Neste caso, a cualificación global non presente curso académico será de suspenso (0.0).

AVISO: No suposto de haber discrepancias entre as diferentes versións lingüísticas da guía, prevalecerá o recollido na versión de galego.

Bibliografía. Fontes de información

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.,

Recomendacións

Subjects that are recommended to be taken simultaneously

Enxeñaría de fabricación/V12G360V01604

Subjects that it is recommended to have taken before

Fundamentos de sistemas e tecnoloxías de fabricación/V12G360V01402

Ciencia e tecnoloxía dos materiais/V12G380V01301

Other comments

Requisitos:

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

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

IDENTIFYING DATA				
Physics 3				
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	http://moovi.uvigo.gal/			
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>			

Training and Learning Results	
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.

Expected results from this subject			
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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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. Electrodynamic potentials 1.12. The energy law of the electromagnetic field
II.2. TIME-INDEPENDENT FIELDS: ELECTROSTATICS, STEADY ELECTRIC CURRENT AND MAGNETOSTATICS	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 1.1 Structured activity sessions: <ul style="list-style-type: none"> - 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	Tests 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. Ordinary call (December-January)

1.1 Continuous assessment

- The final mark G0 results from the classroom mark A0 (80% of the final mark), on topics of Parts I and II, and the lab mark L0 (20% of the final mark), on topics of Part III.

- Mark A0 combines the classroom mark C0 (40% of the final mark), that is obtained from theoretical-practical tests (essay-questions and problem/exercise solving) to be developed during the term, and the classroom mark F0 (40% of the final mark), that is obtained from an end-of-term theoretical-practical test to be held on the same date that the exam of the ordinary call.

- Mark L0 combines the mark L01 (10% of the final mark), that is obtained from theoretical-practical tests to be developed during the term (essay-questions and problem/exercise solving) on topics of Part III.1, and the mark L02 (10% of the final mark) that is obtained from a lab report corresponding to topics of Part III.2. Only students that have regularly attended the lab sessions can obtain a mark L0 different from "0,0".

- The final mark of the continuous assessment in the ordinary call is obtained as

$$G0 = A0 (80\%) + L0(20\%) = C0 (40\%) + F0 (40\%) + L01 (10\%) + L02 (10\%)$$

- To pass the course, a student must obtain a final mark G0 equal to or higher than 5.

1.2 Global assessment

- Those students who have been granted the waiver of the continuous assessment in the ordinary call will obtain 100% of their final mark G1 from a exam corresponding to the ordinary call.

- The final mark G1 results from the classroom mark A1 (80% of the final mark), on topics of Parts I and II, and the lab mark L1 (20% of the final mark), on topics of Part III.1.

- Mark A1 combines marks C1 (40%of the final mark) and F1 (40% of the final mark), that are obtained from theoretical-practical tests (essay-questions and problem/exercise solving).

- Mark L1 (20% of the final mark) is obtained from a theoretical-practical test (essay-questions and problem/exercise solving).

- The final mark of the global assessment in the ordinary call is obtained as

$$G1 = A1 (80\%) + L1(20\%) = C1 (40\%) + F1 (40\%) + L1 (20\%)$$

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

2. Extraordinary call (June-July)

- All students, whether they have waived continuous assessment or not, will obtain 100% of their final mark G2 from an exam corresponding to the extraordinary call.

- The final mark G2 results from the classroom mark A2 (80% of the final mark), on topics of Parts I and II, and the lab mark L2 (20% of the final mark), on topics of Part III.1.

- Mark A2 combines marks C2 (40% of the final mark) and F2 (40% of the final mark), that are obtained from theoretical-practical tests (essay-questions and problem/exercise solving).

- Mark L2 (20% of the finalmark) is obtained from a theoretical-practical test (essay-questions and problem/exercise solving).

- The final mark of the continuous or global assessment in the extraordinary call is obtained as

$$G2 = A2 (80\%) + L2(20\%) = C2 (40\%) + F2 (40\%) + L2 (20\%)$$

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

3. Common features and interconnection among the assessment alternatives

- In the continuous and global assessment modalities for the ordinary and extraordinary calls that have been defined in the previous sections, we can classify marks that are equivalent to each other in three sets with three elements each: classroom marks C0, C1 and C2, classroom marks F0, F1 and F2 and lab marks L0, L1 and L2. If C is the most recent valid mark from C0, C1 and C2, F is the most recent valid mark from F0, F1 and F2 and L is the most recent valid mark from L0, L1 and L2, the final mark G in the ordinary or the extraordinary call, either for continuous or global assessment, is obtained as

$$G = C(40\%) + F(40\%) + L(20\%)$$

- To pass the course, a student must obtain a final mark G equal to or higher than 5 in any of the assessment alternatives.

- To obtain the final mark G2 in the extraordinary call the students, whether they have waived continuous assessment or not, can choose between:

a) answering the part of the exam of the extraordinary call corresponding to marks C2, F2, and/or L2, that will be used in the formula of the final mark of the extraordinary call G2.

b) use the most recent valid mark of each type (C0 or C1, F0 or F1 and/or L0 or L1) to be used instead of marks C2, F2 and/or L2, respectively, in the formula of the final mark of the extraordinary call G2, not taking the corresponding part of the exam of this call.

4. End-of-degree call

- The end-of-degree call follows the same assessment scheme as the extraordinary call.

- The end-of-degree assessment is completely independent of the assessments in the ordinary and extraordinary calls (in particular, the features and interconnections described in the previous section do not apply).

5. Supplementary assessment rules

- Students should not have access to or use any electronic device during the tests and exams, unless specifically authorized. The mere act of taking an unauthorized electronic device into the examination room will result in the student failing the subject and the final mark in the corresponding call will be "suspense (0,0)".

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

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

6. Ethical commitment

Every student is expected to behave in an appropriate ethical manner. Should unethical conduct be detected (copying, plagiarism, utilization of unauthorized electronic devices, or others), the student will be considered not to have fulfilled the necessary requirements to pass the subject. In this case, the final mark in the corresponding call will be "suspense (0,0)".

Sources of information

Basic Bibliography

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

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. Semendyayeb, **Handbook of Mathematics**, Springer, 2007

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

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

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

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 Leite Herbelo, Pablo			
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.			

Training and Learning Results

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.

Expected results from this subject

Expected results from this subject	Training and Learning Results		
<input type="checkbox"/> 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	10	16
Problem solving	12	27	39
Essay questions exam	1	0	1
Essay questions exam	0.75	0	0.75
Essay questions exam	0.75	0	0.75
Essay questions exam	0.5	0	0.5

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

Methodologies

	Description
Lecturing	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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Laboratory practical	Evaluation that will be able to include: - Resolution of problems - Reports of practical - practical Questions of oral form/written	10	B3	C8 C25	D9 D10
Essay questions exam	Proof written that it will be able to consist of: - theoretical Questions - practical Questions - Resolution of exercises/problems - Subject to develop	40	B3	C8 C25	D2 D9 D10
Essay questions exam	Partial proof written that it will be able to consist of: - practical theoretical/Questions - Resolution of exercises/problems - Subject to develop	20	B3	C8 C25	D2 D9 D10
Essay questions exam	Partial proof written that it will be able to consist of: - practical theoretical/Questions - Resolution of exercises/problems - Subject to develop	20	B3	C8 C25	D2 D9 D10
Essay questions exam	Partial proof written that it will be able to consist of: - practical theoretical/Questions - Resolution of exercises/problems - Subject to develop	10	B3	C8 C25	D2 D9 D10

Other comments on the Evaluation

Global assessment: in the two official editions the renunciation to the continuous and *elección of the system of *evaluación global make following the procedure and the term established by the centre. State of a *nicio examination written in the official date fixed by the School that *tendrá a weight of 100% of the note, and evaluate *n all the contents you *rich and *prácticos of the subject.

Ordinary call: Continuous assessment. consist of distinct proofs made during the subject and a final proof in the official date previously fixed by the centre. In this final proof demand a note *mínima of 4 on 10 to be able to approve the subject. To approve, the final note have to be, at least, of 5 on 10. In case of not reaching the note *mínima in the final examination, him award to the student a note of 4.5.

Extraordinary call: Continuous assessment. The student *podrá decide in the terms established if it keeps the note of the part *práctica and partial proofs of the *evaluación continuous (60%), or if it renounces to her and opts by the *evaluación global. The proof make in the official date previously fixed by the centre. In this final proof demand a note *mínima of 4 on 10 to be able to approve the subject. To approve, the final note have to be, at least, of 5 on 10. In case of not reaching the note *mínima in the final examination, him award to the student a note of 4.5.

Behaviour *tico: it expects that the present student a behaviour *tico suitable, attending especially to the indicated in the *Artículos 39, 40, 41 and 42 of the Regulation on the *evaluación, the *calificación and the quality of the teaching and of the process of learning of the *estudiantado of the *Universidad de Vigo (approved in the *claustró of 18 April 2023).

WARNING: In case of discrepancies between the distinct versions *lingüísticas of the *guía to prevail the indicated in the *versión in Spanish

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.

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				
Coordinator	Vidal Vázquez, Ricardo			
Lecturers	Vidal Vázquez, Ricardo			
E-mail	rvidal@uvigo.es			
Web				
General description				

Resultados de Formación e Aprendizaxe

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 previstos na materia

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.	40	B3	D1 D2
Resolución de problemas e/ou exercicios	Avaliación continua: Asistencia as clases teóricas e practicas (10%). Presentación dunha worksheet en Sage cos traballos propostos ó alumno: Traballo 1º (metade de curso): (20%) Traballo 2º (final de curso): (30%)	60	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**, 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**, 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.

IDENTIFYING DATA**Machine design and testing**

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	http://moovi.uvigo.gal/			
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>			

Training and Learning Results

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.

Expected results from this subject

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

Contents

Topic

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	30	C13 C26	D2 D9 D16 D20
Problem and/or exercise solving	It will evaluate in questionnaires focused to the corresponding problems to the knowledges given during the classes of classroom and laboratory. They evaluate all the results of learning.	30	B3 B4 B5 B6	C13 C26 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	40	B11 C26	C13 D9 D16

Other comments on the Evaluation

General outline 1 Edition

1 . Practical asynchronous quizzes; Term 1 week; Max grade: 3; Minimum grade: 1; Type of min.: Sum; Results are saved for 2 ED.

2 . Asynchronous Questionnaires; Term 1 week; Limited time: 1 hour; Max grade: 3; Minimum note: 1; Type of min.: Sum; No results are saved for 2 ED.

3 . Academic final exam; official date; Limited time: 1 hour; Max grade: 4 ; Note min.: 1.5; Type of min.: Veto; If the minimum is not reached, the maximum grade of the subject is 3 out of 10.

General scheme 2 Edition

1 . Practical asynchronous quizzes; Term 1 week; Max grade: 3; Minimum note: 1; Type of min.: Sum; Results of the 1 ED are saved.

2 . Academic final exam; official date; ; Max grade: 7 ; Note min.: 2.8; Type of min.: Veto; If the minimum is not reached, the

maximum score of the subject is 3.9 out of 10.

General outline Disclaimer EC 1 Edition

1 . Practical exam; Max grade: 3; Minimum grade: 1; Type of min.: Sum; Results are saved for 2 ED.

2 . Academic final exam; official date; ; Max grade: 7 ; Note min.: 2.8; Type of min.: Veto; If the minimum is not reached, the maximum score of the subject is 3.9 out of 10.

General outline Disclaimer EC 2 Edition

1 . Practical exam; Max grade: 3; Minimum grade: 1; Type of min.: Sum; Results of the 1 ED are saved.

2 . Academic final exam; official date; ; Max grade: 7 ; Note min.: 2.8; Type of min.: Veto; If the minimum is not reached, the maximum score of the subject is 3.9 out of 10.

"Ethical commitment: The student is expected to present adequate ethical behavior. In case of detecting unethical behavior (copying, plagiarism, use of unauthorized electronic devices, and others) it will be considered that the student does not meet the necessary requirements to pass subject. In this case, the overall grade for this academic year will be fail (0.0)."

The use of any electronic device during the evaluation tests will not be allowed unless expressly authorized. The fact of introducing an unauthorized electronic device into the exam room will be considered a reason for not passing the subject in this academic year and the overall grade will be failed (0.0)."

*A numerical rating system from 0 to 10 points will be used according to current legislation (RD 1125/2003 of September 5, BOE of September 18).

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

Recommendations

Subjects that it is recommended to have taken before

Materials science and technology/V12G360V01301

Mechanics of materials/V12G360V01404

Mechanism and machine theory/V12G360V01303

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.

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

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	García González, Marcos Lorenzo Mateo, Jaime Alberto Riveiro Rodríguez, Antonio			
E-mail	ariveiro@uvigo.es			
Web				
General description	This course will study the fundamentals of elasticity and deepen the study of mechanics of materials in order to be able to apply their knowledge to the actual behavior of solids (structures , machinery and resistant elements in general). This course, along with mechanics of materials course, is a holder of more specialized subjects whose object is the mechanical design.			

Training and Learning Results

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.

Expected results from this subject

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

Contents

Topic

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

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	0.5	0	0.5
Previous studies	0	6	6
Lecturing	13	26	39
Problem solving	18	22	40
Laboratory practical	18	7	25
Autonomous problem solving	0	15	15
Problem and/or exercise solving	2	17.5	19.5
Self-assessment	0	5	5

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

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

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

Personalized assistance

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

Assessment

Description	Qualification	Training and Learning Results
<p>Laboratory practical</p> <p>Active participation in all classes will be valued, and when applicable, the submission of the lab reports and their content will be assessed according to the guidelines provided by the lecturers. The grading will be on a scale of 0 to 10.</p> <p>The grade obtained will be the same in both the first and second opportunities of the course's examination session.</p>	5	B4 C14 D2 D5 D9 D10 D17
<p>Problem and/or exercise solving</p> <p>Several tests will be proposed to assess the acquired learning results in the subject. They will consist of problem-solving and/or theoretical questions by the students. None of these tests will exceed 40% of the overall grade for the subject. The tests will be conducted throughout the course during class hours and/or on dates/times approved by the institution. The final test will be performed during the official examination schedule approved by the "Comisión Permanente" of the School of Industrial Engineering. It will be graded on a scale of 0 to 10. The minimum average grade for all tests will be 4.5/10, with a minimum grade of 4/10 required for each individual test.</p> <p>In the second opportunity of the course's examination session, there will be a single test that encompasses all the content of the subject, carrying a weight of 95% of the final grade. In this case, the minimum mark to pass the subject will be 4.5/10.</p> <p>The duration of the test, as well as the weight of each question, will be provided at the time of the test.</p>	95	B3 C14 D2 B4 D9

Other comments on the Evaluation

It will be necessary to obtain a minimum score of 5 out of 10 to pass the subject. Students who have been granted with the waive of continuous assessment may take the final exam, which will be the 100% of the final mark. This exam will assess the competencies covered in the entire subject.

Comments regarding continuous assessment activities:

The failure to submit lab reports, whether justified or not, will not result in the repetition of the lab practice on a different

date.

The dates and locations for all exam sessions will be set by the School of Industrial Engineering before the start of the course and will be made public.

Ethical commitment: it is expected an adequate ethical behavior of the student. If any unethical behavior is detected (cheating, plagiarism, unauthorized use of electronic devices, etc.), it will be considered that the student does not meet the necessary requirements to pass the course. In such cases, 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).

Sources of information

Basic Bibliography

José Antonio González Taboada, **Tensiones y deformaciones en materiales elásticos**, 1st ed., Tórculo, 1997

José Antonio González Taboada, **Fundamentos y problemas de tensiones y deformaciones en materiales elásticos**, 1st ed., Tórculo, 2008

Manuel Vázquez, **Resistencia de Materiales**, 4th ed., Ed. Noela, 2008

Complementary Bibliography

Luis Ortiz Berrocal, **Elasticidad**, 3rd ed., McGraw-Hill, 1998

Robert Mott, Joseph A. Untener, **Applied Strength of Materials**, 6th ed., CRC Press, 2016

Ansel C. Ugural, Saul K. Fenster, **Advanced Mechanics of Materials and Applied Elasticity**, 6th ed., Pearson, 2021

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics 1/V12G360V01102

Physics: Physics 2/V12G360V01202

Mechanics of materials/V12G360V01404

Other comments

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.

IDENTIFYING DATA**Manufacturing engineering**

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			
E-mail	apereira@uvigo.es			
Web				
General description				

Training and Learning Results

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.

Expected results from this subject

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	1	0	1
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
Presentation	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

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

	Description	Qualification	Training and Learning Results
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.	40	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.	40	C20 D2 D9 D10 D17 D20
Essay questions exam	Development of problems and or cases	10	C20 D2 D8 D9 D10
Presentation	(*)Exposición de Desarrollo de trabajo realizado	10	

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).

Sources of information

Basic Bibliography

Complementary Bibliography

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

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

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

Recommendations

Subjects that it is recommended to have taken before

Fundamentals of manufacturing systems and technologies/V12G360V01402

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.

IDENTIFYING DATA				
Máquinas eléctricas				
Subject	Máquinas eléctricas			
Code	V12G360V01605			
Study programme	Grao en Enxeñaría en Tecnoloxías Industriais			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	2c
Teaching language	Castelán Galego			
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.			

Resultados de Formación e Aprendizaxe	
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.
C10	CE10 Coñecemento e utilización dos principios de teoría de circuitos e máquinas eléctricas.
D1	CT1 Análise e síntese.
D2	CT2 Resolución de problemas.
D6	CT6 Aplicación da informática no ámbito de estudo.
D14	CT14 Creatividade.
D16	CT16 Razoamento crítico.
D17	CT17 Traballo en equipo.
D19	CT19 Sustentabilidade e compromiso ambiental. Uso equitativo, responsable e eficiente dos recursos.

Resultados previstos na materia			
Expected results from this subject	Training and Learning Results		
Comprender os aspectos básicos da constitución e funcionamento das máquinas eléctricas clásicas	B3	C10	D1 D16
Coñecer o proceso experimental utilizado para a caracterización dos distintos tipos de máquinas.	B3	C10	D1 D2 D6 D16 D17
Coñecer as aplicacións industriais dos distintos tipos de máquinas eléctricas.	B3		D1 D14 D16 D19
Coñecer as máquinas "clásicas" e as "modernas".	B3	C10	

Contidos	
Topic	
TEMA I - INTRODUCCIÓN ÁS MÁQUINAS ELÉCTRICAS ROTATIVAS	<p>I.1 -Fundamentos electromagnéticos e electromecánicos.</p> <p>I.2 -.- Consideracións previas sobre as máquinas eléctricas rotativas: Constitución física xeral. Tipos de máquinas. Perdas. Balance de potencias. Rendemento. Quecemento. Potencia nominal. Tipos de illantes. Graos de protección mecánica e formas construtivas. Normas. Placa de características.</p> <p>I.3.- Aspectos construtivos. Polos magnéticos. Liña neutra. Paso polar.</p> <p>I.4.- FMM no entreferro e FEM inducida na MER: Campo magnético producido por devanados concentrados e distribuídos. Campo magnético xiratorio. Factores que afectan á FMM inducida nun devanado. FEM inducida nun devanado dunha MER</p>

TEMA II: MÁQUINAS ASÍNCRONAS

- II.1.- A máquina asíncrona trifásica:
- Constitución.
 - Principio de funcionamento como motor.
 - Circuito equivalente.
 - Ensaíos.
 - Balance de potencias e rendemento.
 - Par e característica par-deslizamento.
 - Modos de funcionamento.
 - Arranque e regulación de velocidade.

II.2.- Motor de indución monofásico:

- Constitución e principio de funcionamento.
- Circuito equivalente e métodos de arranque.

TEMA III: MÁQUINAS SÍNCRONAS

- Constitución
- Funcionamento como xerador. Reacción de inducido.
- Circuíto equivalente
- Funcionamento dun xerador axustado a unha rede de potencia infinita.
- Motor síncrono: Características e aplicacións

TEMA IV: MOTORES DE CORRENTE CONTINUA E MOTORES ESPECIAIS

IV.1. Máquinas de corrente continua

- Constitución das máquinas de CC.
- Principio de funcionamento como motor.
- Sistemas de excitación.
- Reacción de inducido
- Conmutación
- Regulación de velocidade dos motores de CC.

IV.2. Motores eléctricos especiais

TEMA V: MANDO E PROTECCIÓN DAS MÁQUINAS ELÉCTRICAS

- Dispositivos de mando das máquinas eléctricas: esquemas de mando orientados á seguridade na operación das máquinas
- Sistemas de protección das máquinas eléctricas: elementos e sistemas de protección orientados á seguridade de máquinas e persoas

Planificación

	Class hours	Hours outside the classroom	Total hours
Lección maxistral	32.5	65	97.5
Prácticas de laboratorio	10	16	26
Prácticas con apoio das TIC	8	16	24
Exame de preguntas obxectivas	1	0	1
Resolución de problemas e/ou exercicios	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.

Metodoloxía docente

	Description
Lección maxistral	Exposición por parte do profesor dos contidos sobre a materia de máquinas eléctricas.
Prácticas de laboratorio	Actividades de aplicación dos coñecementos teóricos a situacións concretas e de adquisición de habilidades básicas e procedimentales relacionadas coas máquinas eléctricas rotativas. Os alumnos aprenderán os métodos activos e pasivos de protección para conseguir unha suficiente seguridade das persoas e das maquinas. Desenvolverase no laboratorio de máquinas eléctricas correspondente.
Prácticas con apoio das TIC	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.

Atención personalizada

Methodologies	Description
Lección maxistral	O profesor atenderá as dúbidas que podan presentar os alumnos correspondentes á materia que se está expondo en cada momento da sesión. Ademais, nas horas asignadas a tutorías, o profesor atenderá calquera dúbida relacionada ca metería.
Prácticas de laboratorio	Durante a realización das prácticas, o profesor atenderá persoalmente as dúbidas que poidan expor os alumnos.
Prácticas con apoio das TIC	Durante a realización das prácticas na aula de informática, o profesor atenderá persoalmente as dúbidas que poidan expor os alumnos.

Avaliación

	Description	Qualification	Training and Learning Results
Prácticas de laboratorio	A avaliación da parte práctica de laboratorio realizarase de forma continua (sesión a sesión). Os criterios de avaliación son: - Asistencia mínima do 80%. -Puntualidade. - Preparación previa das prácticas. - Utilización correcta do material. -Os resultados entregados por cada alumno ou grupo ao finalizar cada práctica, nos casos que así se esixa e os cuestionarios relativos a práctica si os houberse. A non asistencia a unha sesión de prácticas supón que será puntuada con 0 puntos. Unha asistencia a clases de practicas inferior ao 80% supón que a nota total de prácticas é de cero puntos. Para poder aprobar a materia é necesario obter unha nota mínima do 40%, sobre a nota máxima nesta parte.	10	B3 C10 D1 D2 D14 D16 D17 D19
Prácticas con apoio das TIC	A avaliación continua das prácticas con apoio das TIC realizarase conforme aos seguintes criterios: - Asistencia mínima do 80%. -Puntualidade. - Preparación previa -Resultados entregados por cada alumno ao finalizar cada clase e/ou cuestionarios relativos á práctica, nos casos nos que así se esixa. A non asistencia a unha sesión de prácticas supón que será puntuada con 0 puntos. Unha asistencia a clases de practicas inferior ao 80% supón que a nota total de prácticas é de cero puntos.	10	B3 C10 D1 D2 D6 D16
Exame de preguntas obxectivas	A avaliación dos coñecementos adquiridos polo alumno farase de forma individual e sen a utilización de ningún tipo de fonte de información, mediante exames de tipo test que englobarán toda a materia impartida no cuatrimestre, tanto en teoría como en prácticas de laboratorio. Para poder aprobar a materia é necesario obter unha nota mínima do 40%, sobre a nota máxima nesta parte.	50	B3 C10 D1 D6
Resolución de problemas e/ou exercicios	Proba escrita na que se avaliará a aplicación práctica dos coñecementos teóricos á resolución de problemas tipo de máquinas eléctricas. Para poder aprobar a materia é necesario obter unha nota mínima do 40%, sobre a nota máxima nesta parte.	30	C10 D1 D2 D14 D16

Other comments on the Evaluation

Avaliación continua en primeira oportunidade

Ó largo do cuatrimestre realizaranse as seguintes actividades puntuables: prácticas de laboratorio, prácticas con axuda das TIC e un exame de preguntas obxectivas na parte media do cuatrimestre. Suman entre todas unha puntuación do 60% do total. o 40% restante da materia será avaliado na data oficial fixada polo centro nun exame de preguntas obxectivas (10%) e resolución de problemas(30%). Para superar a materia será necesario obter un mínimo do 40% da nota máxima correspondente a cada unha das partes (Preguntas obxectivas (2/5 puntos), resolución de problemas (1.2/3 puntos), prácticas (0.8/2 puntos)). Se nalgunha das probas non se alcanza a nota mínima e a suma de totalas cualificacions é superior a 5 puntos, a nota que aparecerá na acta será a de suspenso (4 puntos).

Avaliación continua en segunda oportunidade

Mantense a nota obtida en prácticas e realizarase un exame de preguntas obxectivas correspondente co 50% (5 puntos) da nota e un exame de problemas correspondente co 30% (3 puntos) de la nota. Para superar a materia será necesario obter un mínimo de 40% da nota correspondente a cada una de las partes (Preguntas obxectivas (2/5 puntos), resolución de problemas (1.2/3 puntos), prácticas (0.8/2 puntos)). Se nalgunha das probas non se alcanza a nota mínima e a suma de totalas cualificacions é superior a 5 puntos, a nota que aparecerá na acta será a de suspenso (4 puntos).

Avaliación global

Os alumnos que renuncien a avaliación continua serán avaliados sobre todo o contido, teórico e práctico, que corresponderá co 100% da nota global. Para superar a materia será necesario obter un mínimo do 40% da nota correspondente a cada unha das partes (Teoría (2/5 puntos), Práctica(2/5 puntos)). Se nalgunha das probas non se alcanza a nota mínima e a suma de totalas cualificacions é superior a 5 puntos, a nota que aparecerá na acta será a de suspenso (4 puntos).

Compromiso ético: Espérase que o alumno presente un comportamento ético axeitado. No caso de detectar un comportamento non ético (copia, plaxio, utilización de aparatos electrónicos non autorizados, e outros) considerarase que o alumno non reúne os requisitos necesarios para superar a materia. Neste caso a cualificación global no presente curso académico será de suspenso (0.0).

Bibliografía. Fontes de información

Basic Bibliography

Jesús Fraile Mora, **Máquinas Eléctricas**, McGraw-Hill/Interameericana de España S.A.U,

Jesús Fraile Mora y Jesús Fraile Ardanuy, **Problemas de Máquinas Eléctricas**, McGraw-Hill/Interameericana 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

Recomendacións

Subjects that it is recommended to have taken before

Física: Física I/V12G360V01102

Física: Física II/V12G360V01202

Fundamentos de teoría de circuitos e máquinas eléctricas/V12G360V01302

Electrotecnia aplicada/V12G360V01501

Física III/V12G360V01503

Other comments

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

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

IDENTIFYING DATA				
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	Fernández Sanromán, Antía 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.			

Training and Learning Results	
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.

Expected results from this subject				
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	15	40	55
Problem solving	17	31	48
Laboratory practical	8	8	16
Studies excursion	4	1	5
Simulation	4	2	6
Objective questions exam	1.5	4.5	6
Problem and/or exercise solving	3	9	12
Report of practices, practicum and external practices	0	2	2

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

Methodologies

	Description
Lecturing	Oral and direct exhibition, by part of the professor, of the most important knowledges corresponding to the subjects of the subject in question.
Problem solving	The professor proposes to the students a series of problems so that they work on them home, before that resolve them in class or seminars. Besides along the course made diverse controls in which the students will have to resolve problems of the level of similar difficulty to the made in class
Laboratory practical	The students will make some experiences in the laboratory related with the subjects treated along the course.
Studies excursion	Visits of the students to companies of the surroundings to make an approach to the business reality and visualise the application of the theoretical contents given in the subject
Simulation	Learning and utilisation of programs of simulation applied to the contents of the subject

Personalized assistance

Methodologies	Description
Lecturing	The students will be able to consult to the professor in any one doubts related with this methodology, as well as in the review of the different proofs of evaluation made, those that doubts have on theoretical and practical appearances linked with the subject.
Problem solving	The students will be able to consult to the professor in any one doubts related with this methodology, as well as in the review of the different proofs of evaluation made, those that doubts have on theoretical and practical appearances linked with the subject.
Laboratory practical	The students will be able to consult to the professor in any one doubts related with this methodology, as well as in the review of the different proofs of evaluation made, those that doubts have on theoretical and practical appearances linked with the subject.
Studies excursion	The students will be able to consult to the professor in any one doubts related with this methodology, as well as in the review of the different proofs of evaluation made, those that doubts have on theoretical and practical appearances linked with the subject.
Simulation	The students will be able to consult to the professor in any one doubts related with this methodology, as well as in the review of the different proofs of evaluation made, those that doubts have on theoretical and practical appearances linked with the subject.

Assessment

	Description	Qualification	Training and Learning Results
Studies excursion	Questions and activities related to the visit to be made will be carried out. These may take place before or after the visit.	5	B4 C4 D2 D9 D10 D17
Simulation	Realisation of diverse simulations of chemical processes that will have to deliver after the sessions of simulation that will make along the course	15	B3 C4 D2 B4 D9 D10 D17

Objective questions exam	This evaluation test includes two types of exams with objective questions: + multiple-choice questions in the lecture sessions, which will represent 10% of the total. + Short questions that will be asked in different controls throughout the course, which will represent 20% of the total value of the exam.	30	B3 B4	C4	D2 D9 D10 D17
Problem and/or exercise solving	They will make diverse controls, stating each one of them of problems.	40	B3 B4	C4	D2 D9
Report of practices, practicum and external practices	It will evaluate in this item both the realisation of the practices of laboratory like the reasoning and treatment of the results obtained in the development of the practical classes of laboratory.	10		C4	D9 D10 D17

Other comments on the Evaluation

ASSESSMENT:

The participation of the student in any of the evaluation systems of the subject (laboratory practicals, problem solving and exercises, simulation, field trip, exam of objective questions) will imply the condition of presented and its qualification in the minutes. A minimum attendance of 75% of the practicals, field trips and simulations of the course is required to have the right to the evaluation of the same. Otherwise, the mark for these evaluation systems will be 0.0.

A student who "does not officially waive the continuous assessment" will be failed if he/she does not achieve a MINIMUM mark of 4.0 points (out of 10) in each of the tests described above. The student will pass the subject if the FINAL GRADE is ≥ 5.0 , that is, if the sum of the grades obtained in the different evaluation systems of the subject is ≥ 5.0 .

Second call:

In the second round, students will take a final exam in which they will be assessed on all the teaching methodologies applied throughout the course. This mark will be 100% of the grade.

STUDENTS RELEASED FROM CONTINUOUS ASSESSMENT:

When the School releases a student from the continuous assessment process, a "FINAL EXAMINATION" will be held on the dates established in the school calendar. The grade will be the sum of 90% of the mark obtained in the "FINAL EXAMINATION" and 10% of the laboratory practicals mark.

ETHICAL COMMITMENT:

The student is expected to show appropriate ethical behaviour. If ethically reprehensible behaviour is detected (for example: copying, plagiarism, use of unauthorised electronic devices, etc.) the student will not be considered to meet the necessary requirements to pass the subject. In this case the overall grade for the current academic year will be a fail (0.0). The use of any electronic device will not be permitted during the assessment tests unless expressly authorised. Bringing an unauthorised electronic device into the examination room will be considered as a reason for failing the subject in the current academic year and the overall grade will be a fail (0.0).

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

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

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.
