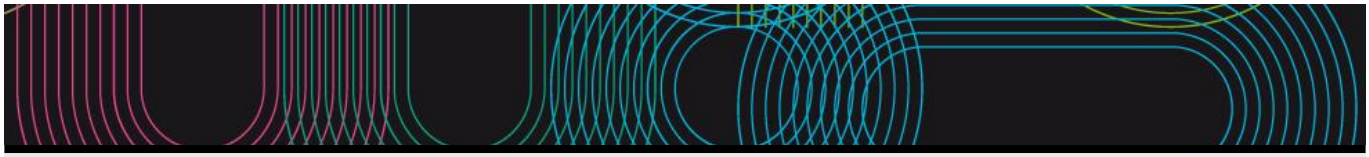

(*)Centro Universitario da Defensa da Escola Naval Militar de Marín

Grado en Ingeniería Mecánica

Subjects			
Year 4th			
Code	Name	Quadmester	Total Cr.
P52G381V01401	Fundamentals of automation	1st	6
P52G381V01402	Fundamentals of manufacturing systems and technologies	1st	6
P52G381V01403	Thermal engineering I	1st	6
P52G381V01404	Theory of structures and industrial constructions	1st	6
P52G381V01405	Machine design	2nd	6
P52G381V01406	English II	2nd	6
P52G381V01407	Manufacturing engineering and dimensional quality	2nd	6
P52G381V01408	Radio-communication systems	2nd	6
P52G381V01409	Naval engines and machines	2nd	6
P52G381V01410	Basics of topography	2nd	6

IDENTIFYING DATA				
Fundamentos de automática				
Subject	Fundamentos de automática			
Code	P52G381V01401			
Study programme	Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4	1c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín			
Coordinator	González Prieto, José Antonio			
Lecturers	Falcón Oubiña, Pablo González Prieto, José Antonio			
E-mail	jose.gonzalez@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Esta materia enmárcase dentro do módulo Común á Rama Industrial, e nela perséguese dotar ao alumnado dunha formación básica, tanto teórica como práctica, sobre os conceptos fundamentais relativos á automatización de procesos industriais, así como á análise e deseño de sistemas de control. Desta forma nesta materia desenvólvense, nun primeiro bloque de contidos, os conceptos fundamentais asociados ao modelado de sistemas lóxicos de eventos discretos mediante Redes de Petri así como a súa implantación en autómatas programables (PLC). No segundo bloque de contidos introdúcense os conceptos fundamentais asociados á teoría de sistemas dinámicos, abordando o seu modelado, representación e estudo analítico, así como temas relativos á análise e deseño de controladores integrados no lazo realimentado de control. Farase especial fincapé no carácter multidisciplinar da materia, tanto nas sesións teóricas como nas sesións prácticas de laboratorio. Desta forma, en ambos os bloques de contidos exponse problemas de aplicación en ámbitos moi diversos (electricidade, mecánica, termodinámica, química, neumática, loxística, bioloxía, robótica e comunicacións), aínda que con especial atención ás aplicacións relativas á enxeñaría electro-mecánica.			

Competencias	
Code	
B3	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.
C12	Coñecementos sobre os fundamentos de automatismos e métodos de control.
D2	Resolución de problemas.
D3	Comunicación oral e escrita de coñecementos.
D6	Aplicación da informática no ámbito de estudo.
D9	Aplicar coñecementos.
D16	Razoamento crítico.
D17	Traballo en equipo.
D20	Capacidade para comunicarse con persoas non expertas na materia.

Resultados de aprendizaxe			
Expected results from this subject	Training and Learning Results		
Adquirir unha visión global e realista do alcance actual dos sistemas de automatización industrial	B3	C12	D3 D16
Coñecer cales son os elementos constitutivos dun sistema de automatización industrial, como funcionan, e como se dimensionan	B3	C12	D2 D3 D9 D16
Coñecemento aplicado sobre os autómatas programables, a súa programación e a súa aplicación á automatización de sistemas industriais	B3	C12	D2 D3 D6 D9 D16 D17 D20

Coñecementos xerais sobre o control continuo de sistemas dinámicos, das principais ferramentas de simulación de sistemas continuos e dos principais dispositivos de control de procesos con maior interese a nivel industrial	B3	C12	D2 D3 D6 D9 D16 D17 D20
Recoñecer o significado, os contidos e diversas teorizacións sobre a política e o poder.			
Conceptos xerais das técnicas de axuste de reguladores industriais	B3	C12	D2 D3 D9 D16
Resultado de aprendizaxe ENAEE: COÑECEMENTO E COMPRENSIÓN: RA1.3.- Ser conscientes do contexto multidisciplinar da enxeñaría. [nivel de desenvolvemento (básico (1), adecuado (2) e avanzado (3)) deste sub-resultado: Adecuado (2)].	B3	C12	
Resultado de aprendizaxe ENAEE: ANÁLISE EN ENXEÑARÍA: RA2.1.- A capacidade de analizar produtos, procesos e sistemas complexos no seu campo de estudo; elixir e aplicar de forma pertinente métodos analíticos, de cálculo e experimentais xa establecidos e interpretar correctamente resultados de devanditas análises. [nivel de desenvolvemento (básico (1), adecuado (2) e avanzado (3)) deste sub-resultado: Adecuado (2)].			D2 D9

Contidos

Topic	
Tema 1. Introdución á automatización industrial e elementos de automatización.	1.1. Introdución á automatización de tarefas e procesos industriais. 1.1.1. A automatización de procesos industriais. 1.1.2 O autómata programable industrial ou PLC. 1.1.3 Elementos do autómata programable. Entradas, saídas, e memoria. 1.1.4 Ciclo de funcionamento do autómata. Tempo de ciclo. 1.2 Características xerais dos autómatas programables. 1.2.1. Operadores lóxicos e aritméticos. 1.2.2 Operadores de asignación (con memoria e sen memoria). 1.2.3 Combinacións de variables binarias. 1.2.3 Temporizadores e contadores. 1.3 Linguaxes e técnicas de programación de autómatas programables. 1.3.1. Formas de representación dun programa (FBD, AWL, ST, Grafcet, LADDER). 1.3.2 Programación lineal e estruturada. 1.3.3 Introdución á lóxica de contactos (LADDER). 1.3.4 Introdución á programación modular estruturada en LADDER.

Tema 2. Ferramentas de modelado de sistemas secuenciais.	2.1 Introdución ao modelado de sistemas dinámicos de eventos discretos. 2.1.1. Modelado mediante grafos de estados e táboas. O problema dimensional. 2.1.2 Modelado mediante Redes de Petri. Descrición con procesos distribuídos 2.1.3 Principais elementos e propiedades das Redes de Petri. Regras de evolución. 2.1.4 Representación e lóxica asociada ás Redes de Petri. Distribución e selección. 2.2 Modelado de procesos distribuídos mediante Redes de Petri. 2.2.1. Representación de procesos e ciclos. Repeticións dun proceso simple. 2.2.2 Aplicación de temporizadores. Activacións controladas por tempo. 2.2.3 Aplicación de contadores. Contaxe de eventos e ciclos de procesos. 2.2.3 Arcos inhibidores e as súas aplicacións. 2.2.5. Secuencias simultáneas. Sincronización de procesos concorrentes. 2.2.6. Exclusión mutua entre procesos. Xestión de recursos compartidos. 2.2.7. Sistemas colaborativos. Coordinación de múltiples tarefas independentes. 2.3 Programación modular estruturada de Redes de Petri en LADDER. 2.3.1. Estrutura modular de programación. 2.3.2. Desenvolvemento do módulo de definición e inicialización de variables. 2.3.3. Desenvolvemento do módulo de avaliación de transicións. 2.3.4. Integración de temporizadores e contadores no módulo de transicións. 2.3.5. Desenvolvemento do módulo de activación de lugares. 2.3.6. Desenvolvemento do módulo de activación de saídas.
Tema 3. Representación, modelado e simulación de sistemas dinámicos continuos.	3.1 Introdución aos modelos de sistemas dinámicos. 3.1.1. Modelos lineais e modelos non lineais. 3.1.2 Modelos continuos e modelos discretos. 3.1.3 Modelado en variables de estado. 3.1.4 O concepto de estabilidade. 3.2 Sistemas dinámicos lineais. 3.2.1. Caracterización e propiedades fundamentais. 3.2.2 Variables de estado. 3.2.3 Funcións de transferencia. A transformada de Laplace e as súas propiedades. 3.2.4 Diagramas de bloques de funcións de transferencia. Operacións básicas. 3.2.5 A función de transferencia con realimentación. 3.3 Modelado de sistemas físicos. 3.3.1. Sistemas mecánicos. 3.3.2. Sistemas eléctricos. 3.3.3. Sistemas químicos, hidráulicos e pneumáticos. 3.3.4. Sistemas biolóxicos e sociolóxicos.

Tema 4. Análise de sistemas dinámicos continuos.	4.1 Introdución á análise de sistemas dinámicos continuos. 4.1.1. Réxime transitorio e estacionario. 4.1.2. Tipos de sinais (impulso, chanzo, rampla) e as súas transformadas de Laplace. 4.1.3. Polos e ceros da función de transferencia. Propiedades do plano de Laplace. 4.1.4. Propiedades frecuenciales de sistemas dinámicos lineais continuos. 4.2 Caracterización da resposta no dominio temporal. 4.2.1. Especificacions no dominio temporal. 4.2.2. Sistemas de primeira orde. Función de transferencia, resposta temporal e estabilidade. 4.2.3. Sistemas de segunda orde. Función de transferencia, resposta temporal e estabilidade. 4.2.4. Descrición e análise do erro en réxime permanente. 4.3 Caracterización da resposta no dominio frecuencial. 4.3.1. Especificacions no dominio da frecuencia. Diagramas de Bode. 4.3.2. Propiedades frecuenciais dos sistemas de primeira orde. 4.3.3. Propiedades frecuenciais dos sistemas de segunda orde.
Tema 5. Introdución aos sistemas de control. Deseño de controladores PID	5.1 Introdución aos sistemas de control. 5.1.1. O lazo de control 5.1.2. Actuadores e sensores. 5.1.3. Controladores dixitais. 5.1.4. Accións básicas de control: Proporcional (P), integral (I) e derivativo (D). 5.2 Regulador PID para sistemas de primeira orde. 5.2.1. Especificaciones temporais e frecuenciais. 5.2.2. Deseño mediante asignación de polos. 5.2.3. Análise de estabilidade. 5.2.4. Análise dos efectos da presenza dun cero. 5.3 Regulador PID para sistemas de segunda orde. 5.3.1. Especificaciones temporais e frecuenciais . 5.3.2. Deseño mediante asignación de polos. 5.3.3. Análise de estabilidade. 5.3.4. Análise dos efectos da presenza dun cero.

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	28	42	70
Prácticas de laboratorio	14	14	28
Seminario	7	0	7
Foros de discusión	0	7	7
Traballo tutelado	15	7	22
Exame de preguntas de desenvolvemento	2	0	2
Exame de preguntas de desenvolvemento	2	0	2
Exame de preguntas de desenvolvemento	3	0	3
Exame de preguntas de desenvolvemento	1	0	1
Exame de preguntas de desenvolvemento	3	0	3
Exame de preguntas de desenvolvemento	3	0	3
Exame de preguntas de desenvolvemento	1	0	1
Exame de preguntas de desenvolvemento	1	0	1
*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 obxecto de estudo, bases teóricas e directrices dun traballo, exercicio ou proxecto a desenvolver polo estudante. Para iso utilizaranse medios como lousas virtuais e software de programación visual con soporte para realizar animacións dos resultados prácticos expostos en clase.

Prácticas de laboratorio	Actividade na que se formulan problemas relacionados coa materia. O alumno debe desenvolver as solucións adecuadas ou correctas mediante a exercitación de rutinas, a aplicación de fórmulas ou algoritmos, a aplicación de procedementos de transformación da información dispoñible e a interpretación dos resultados. Durante os seminarios os alumnos realizarán a preparación das solucións que posteriormente serán simuladas nas clases prácticas de laboratorio.
Seminario	Actividade na que se formulan problemas relacionados coa materia. O alumno debe desenvolver as solucións adecuadas ou correctas mediante a exercitación de rutinas, a aplicación de fórmulas ou algoritmos, a aplicación de procedementos de transformación da información dispoñible e a interpretación dos resultados.
Foros de discusión	Neste apartado valórase a participación e a actitude do alumno durante as sesións de teoría, prácticas e tutorías de seminario. Eventualmente, valoraranse as distintas actividades expostas na plataforma de docencia virtual e a dedicación do alumno a resolver en horas non lectivas os problemas expostos na materia.
Traballo tutelado	Análise e estudo por parte do profesor e dos alumnos dos contidos sobre a materia obxecto de estudo como método formativo cuxo obxectivo é reforzar e asentar os coñecementos adquiridos prestando especial atención a aqueles contidos que se consideren mais problemáticos.

Atención personalizada

Methodologies	Description
Lección maxistral	Os profesores da materia atenderán persoalmente as dúbidas e consultas dos alumnos,tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.
Prácticas de laboratorio	Os profesores da materia atenderán persoalmente as dúbidas e consultas dos alumnos,tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.
Seminario	Os profesores da materia atenderán persoalmente as dúbidas e consultas dos alumnos,tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.
Traballo tutelado	Os profesores da materia atenderán persoalmente as dúbidas e consultas dos alumnos,tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.
Foros de discusión	Os profesores da materia atenderán persoalmente as dúbidas e consultas dos alumnos,tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.

Avaliación

	Description	Qualification	Training and Learning Results
Foros de discusión	Participación (P) Neste apartado valórase a participación e a actitude do alumno durante as sesións de teoría, prácticas e tutorías de seminario. Eventualmente, valoraranse as distintas actividades expostas na plataforma de docencia virtual.	5	B3 C12 D3 D9 D16 D17 D20
Exame de preguntas de desenvolvemento	Proba puntuable de teoría (PT1) - Proba escrita para avaliar os coñecementos adquiridos nos temas 1 e 2 - Semana 7 do cuadrimestre. - A proba terá 2 horas de duración. - A proba realízase de maneira individual. - Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores.	15	B3 C12 D2 D3 D9 D16

Exame de preguntas de desenvolvemento	Proba puntuable de teoría (PT2) - Proba escrita para avaliar os coñecementos adquiridos nos temas 3, 4 e 5. - Semana 11 do cuadrimestre. - A proba terá 2 horas de duración. - A proba realízase de maneira individual. - Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores	15	B3	C12	D2 D3 D9 D16
Exame de preguntas de desenvolvemento	Exame final de teoría (ET) - Proba escrita para avaliar os coñecementos adquiridos en todos os temas. - Semana 14 do cuadrimestre. - A proba terá 3 horas de duración. - A proba realízase de maneira individual. - Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores	40	B3	C12	D2 D3 D9 D16
Exame de preguntas de desenvolvemento	Exame final de laboratorio (L) - Proba escrita para avaliar os coñecementos adquiridos en todos os temas. - Semana 14 do cuadrimestre. - A proba terá 1 hora de duración. - A proba realízase de maneira individual. - Realizarase coincidindo coa proba puntuable do exame final de teoría (ET). - Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores	25	B3	C12	D2 D3 D9 D16

Other comments on the Evaluation

Nota final e requisitos mínimos para superar a materia mediante avaliación continua:

Para asegurar que o alumno adquiriu as destrezas mínimas en cada un dos aspectos da materia esixirase aos alumnos que alcancen unha nota mínima de 4 sobre 10 no exame final de teoría, de modo que a nota final en avaliación continua (NEC) calcúlase coas seguintes fórmulas:

$$MED\_CON = 0{,}15\ PT1 + 0{,}15\ PT2 + 0{,}40\ ET + 0{,}25\ L + 0{,}05\ P$$

$$NEC = MED\_CON \text{ si } ET \geq 4$$

$$NEC = \min(4, MED\_CON) \text{ si } ET < 4$$

É necesario que esta nota (NEC) sexa igual ou superior a 5 puntos (sobre unha escala de 10) para superar a materia. O alumno que non supere a materia nesta convocatoria debe presentarse ao exame ordinario.

Nota final e requisitos mínimos para superar a materia no exame ordinario:

A nota final (NEO) calcúlase coa seguinte fórmula:

$$NEO = 0{,}75\ T + 0{,}25\ L$$

Onde:

- **T:** representa a parte teórica do exame ordinario da materia. Proba escrita individual para avaliar os coñecementos adquiridos nas sesións de teoría. Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores.
- **L:** representa a parte práctica do exame ordinario da materia. Proba escrita individual para avaliar os coñecementos adquiridos nas sesións prácticas. Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas relacionados coas prácticas ou algunha combinación das anteriores.

É necesario que esta nota (NEO) sexa igual ou superior a 5 puntos (sobre unha escala de 10) para superar a materia. O alumno que non supere a materia nesta convocatoria ou en avaliación continua debe presentarse á convocatoria extraordinaria.

Nota final e requisitos mínimos para superar a asignatura no exame extraordinario:

A nota final (NEE) calcúlase coa seguinte fórmula:

NEE = 0,75 T + 0,25 L

Onde:

- **T:** representa a parte teórica do exame ordinario da materia. Proba escrita individual para avaliar os coñecementos adquiridos nas sesións de teoría. Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas ou algunha combinación das anteriores.
- **L:** representa a parte práctica do exame ordinario da materia. Proba escrita individual para avaliar os coñecementos adquiridos nas sesións prácticas. Pode ter a forma de cuestionario tipo test, cuestionario de respostas curtas, resolución de problemas relacionados coas prácticas ou algunha combinación das anteriores.

É necesario que esta nota (NEE) sexa igual ou superior a 5 puntos (sobre unha escala de 10) para superar a materia.

Criterios de avaliación en caso de fraude académica:

A fraude académica (a copia, o plaxio ou o seu facilitación a terceiros, así como o uso de dispositivos electrónicos non autorizados en calquera das probas das que consta a avaliación da materia) será penalizado da seguinte maneira:

- **Avaliación continua:** o alumno non poderá aprobar a materia mediante avaliación continua, e será cualificado con NEC=0.
- **Exame ordinario**: o alumno será cualificado con NEO=0 y NPC=0.
- **Exame extraordinario**: o alumno será cualificado con NEE=0.

Bibliografía. Fontes de información

Basic Bibliography

Jose A. Gonzalez Prieto, Jose P. Gonzalez Coma, **Fundamentos de Automática**, 1,

Mandado; Acevedo; Fernández; Armesto, **Autómatas programables y sistemas de automatizaciónn**, 1, Marcombo, 2009

Ogata, **Ingeniería de control moderna**, 5, Prentice - Hall, 2010

Complementary Bibliography

Valdivia, **Sistemas de control continuos y discretos**, 1, Ediciones Paraninfo, 2012

Dorf, **Sistemas de control modernos**, 10, Prentice - Hall, 2005

Cucharero, **Guiado y control de misiles**, 1, Ministerio de Defensa, 1995

Silva, **Las redes de Petri en la Automática y la Informática**, 1, Editorial AC, 1985

Recomendacións

Subjects that it is recommended to have taken before

Fundamentos de electrotecnia/P52G381V01205
Matemáticas: cálculo II e ecuacións diferenciais/P52G381V01201
Tecnoloxía electrónica/P52G381V01301

Other comments

Ademais, para cursar esta materia con éxito, o alumno debe ter:
- Capacidade de comprensión escrita e oral.
- Capacidade de abstracción, cálculo básico e síntese da información.
- Destrezas para o traballo en grupo e para a comunicación grupal.

IDENTIFYING DATA				
Fundamentals of manufacturing systems and technologies				
Subject	Fundamentals of manufacturing systems and technologies			
Code	P52G381V01402			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Álvarez Feijoo, Miguel Ángel			
Lecturers	Álvarez Feijoo, Miguel Ángel Lareo Calviño, Guillermo			
E-mail	alvarezfeijoo@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The course Fundamentals of Manufacturing Systems and Technologies focuses on the study and application of scientific and technical knowledge related to the manufacturing processes of components and assemblies whose functional purpose is mechanical, as well as the evaluation of their dimensional accuracy and that of the products to be obtained, with a given quality. All this includes from the preparation phases to the use of instruments, tools, tooling, equipment, machine tools and systems necessary for its realization, according to the established standards and specifications, and applying optimization criteria.			

Skills	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
C15	Basic knowledge of production systems and manufacturing.
D2	Problems resolution.
D8	Decision making.
D9	Apply knowledge.
D10	Self learning and work.
D17	Working as a team.
D20	Ability to communicate with people not expert in the field.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
1. Recognise the meaning, the contents and diverse theories on the (about) gobernanza, globalisation and human rights. 2. Enumerate different types of consequences that the taking of decisions and the acts of the public servers have on the people and the society. 3. Identify the solution of ethical problems and morals to international level, analysing the relation of the gobernanza with the improvement of the democratic quality, and the problem of the corruption and little spirit of the citizenship by the politics 4. Identify the foundations of the international politics compared in a context of globalisation and the instruments for the agreements between States. 5. Integrate the external politics of the main world-wide actors to international level with the right and the politics of the European Union and the Spanish State. 6. Describe the human rights and his main guarantees in a multinivel context and of 2030 Agenda, enumerating real cases. 7. Apply the knowledges purchased to concrete cases in a political global context. 8. Describe the main political of global dimension, especially the related with the equality and no discrimination, the environment, the cultural heritage and the security.			
To know the technological basis and basic aspects of manufacturing processes.	B3	C15	D2 D9 D10 D20
To understand the basics of manufacturing systems.	B3	C15	D2 D10

To acquire skills for the selection of manufacturing processes and elaboration of manufacturing planning.		C15	D2 D8 D17
To develop skills for the fabrication of assemblies and elements in CAD/CAM environments.	B3	C15	D2 D8 D9 D17 D20
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING LO1.2.- Knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes. Adequate (2).	B3		
ENAEE learning outcome: ENGINEERING ANALYSIS LO2.1.- Ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses. Advanced (3).		C15	
ENAEE learning outcome: ANALYSIS IN ENGINEERING: LO2.2.- The ability to identify, formulate and solve engineering problems in their specialty; to choose and properly apply established analytical, computational and experimental methods; to recognize the importance of social, health and safety, environmental, economic and industrial constraints. Adequate (2).			D2 D9
ENAEE learning outcome: PRACTICAL APPLICATION OF ENGINEERING: LO5.1.- Understanding of the applicable techniques and methods of analysis, design and research and their limitations in the field of their specialty. Basic (1).			D2 D9
ENAEE learning outcome: PRACTICAL APPLICATION OF ENGINEERING: LO5.2.- Practical competence to solve complex problems, to carry out complex engineering projects and to carry out research in his/her specialty [level of development. Adequate (2).			D9 D10
ENAEE learning outcome: COMMUNICATION AND TEAMWORK: LO7.1.- Ability to communicate effectively information, ideas, problems and solutions in the field of engineering and with society in general [level of development. Basic (1).			D8 D10 D17
ENAEE learning outcome: COMMUNICATION AND TEAMWORK: LO7.2.- Ability to function effectively in national and international contexts, individually and in teams and to cooperate both with engineers and with people from other disciplines. Adequate (2).			D20

Contents

Topic	
UNIT 1. INTRODUCTION	Lesson 1. Introduction to the manufacturing technologies.
UNIT 2. METROLOGY AND MEASUREMENT TECHNOLOGY.	Lesson 2. Principles of Dimensional Metrology. Lesson 3. Instruments and methods of measure. Lesson 4. Coordinate measurement. Lesson 5. Image measurement.
UNIT 3. MATERIAL REMOVAL FORMING PROCESSES	Lesson 6. Introduction to the material removal forming. Lesson 7. Fundamentals and theories of cutting. Lesson 8. Lathe turning: operations, machines and tooling. Lesson 9. Milling: operations, machines and tooling. Lesson 10. Hole machining with rectilinear main movement: operations, machines and tooling. Lesson 11. Abrasive forming: operations, machines and tooling. Lesson 12. Non-conventional machining processes.
UNIT 4. AUTOMATION AND MANAGEMENT OF MANUFACTURING PROCESSES	Lesson 13. Numerical control of machines-tool.
UNIT 5. LIQUID AND GRANULAR MATERIAL FORMING PROCESSES	Lesson 14. General aspects of metal casting forming. Lesson 15. Models, molds and core boxes. Lesson 16. Melting, casting and finishing technology. Lesson 17. Equipment and furnaces used in casting. Lesson 18. Conformation of granular materials: powder metallurgy.
UNIT 6. PLASTIC DEFORMING PROCESSES BY PLASTIC DEFORMING OF METALS.	Lesson 19. General aspects of plastic deformation forming. Lesson 20. Rolling and forging processes. Lesson 21. Extrusion and stretching processes. Lesson 22. Sheet metal forming processes.
UNIT 7. JOINING FORMING PROCESSES	Lesson 23. Welding process technology. Lesson 24. Joining and assembly processes without welding.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Problem solving	3	0	3
Seminars	15	0	15

Laboratory practical	14	7	21
Mentored work	4	14	18
Objective questions exam	4	4	8
Essay questions exam	9	6	15

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

Methodologies

	Description
Lecturing	Presentation by the lecturer of the contents of the subject, theoretical bases and/or guidelines of a work, exercise or project to be developed.
Problem solving	Activity in which problems and/or exercises related to the subject are formulated. The student must develop the appropriate or correct solutions through the exercise of routines, the application of formulas or algorithms, the application of transformation procedures of the available information and the interpretation of the results. It is usually used as a complement to the master class.
Seminars	Intensive course of 15 hours for those students who have failed the course in the first call, prior to the exam in the second call. Group tutorials with the professor.
Laboratory practical	Activities of application of knowledge to concrete situations and acquisition of basic and procedural skills related to the subject matter. They are carried out in special spaces with specialized equipment (laboratories, computer rooms, etc.).
Mentored work	The student, individually or in groups, prepares a document on one of the topics of the course or prepares seminars, research, reports, essays, summaries of readings, lectures, etc.

Personalized assistance

Methodologies	Description
Lecturing	In the field of tutorial action, there are academic tutoring actions, as well as personalized tutoring. In the first case, students will have at their disposal hours of tutorials in which they can ask any question related to the contents, organization and planning of the course. In the personalized tutorials, each student, individually, will be able to discuss with the lecturer any problem that is preventing him/her from following the course properly, in order to find some kind of solution between both of them. By combining both types of tutorial action, the aim is to compensate the different learning rhythms through attention to diversity. The lecturers of the course will answer the questions and consultations of the students in a synchronous way in physical or virtual offices under the modality of previous arrangement or asynchronous by telematic means (e-mail, Moovi forums, etc.).
Mentored work	The lecturers will answer the questions and consultations of the students in the hours dedicated to the work, as well as synchronously in physical or virtual offices under the modality of previous arrangement or asynchronously by telematic means (e-mail, Moovi forums, etc.).

Assessment

	Description	Qualification	Training and Learning Results		
Lecturing	Intermediate tests: theoretical questions and problems. The objective of these tests is to evaluate the learning of all the theoretical contents selected for the course. - Intermediate tests (PI): 15% + 15%.	30	B3	C15	D2 D8 D9 D17 D20
Laboratory practical	The evaluation of the practises will be based on the evaluation of the practises reports (MP) that the student must submit.	10	B3	C15	D2 D8 D9 D10 D17
Mentored work	Evaluation of the mentored work (TT). Percentage of the final grade: - Submission 1. Initial version of the report: 6%. - Submission 2. Intermediate version of the report: 6%. - Submission 3. Final version of the final report: 8%.	20	B3	C15	D2 D8 D9 D10 D17 D20
Essay questions exam	Writing final test (PF) final to evaluate the global knowledge of the subject (official date of evaluation)	40	B3	C15	D2 D8 D9 D10 D17

Other comments on the Evaluation

The final evaluation of the student will be the sum of the score awarded to each of the parts mentioned above and taking

into account the requirement of a minimum of 4 in the final exam.

Being, therefore, the continuous evaluation grade:

NEC = 0.40·PF + 0.15·PI1 + 0.15·PI2 + 0.20·TT + 0.10·MP

The student must attend to the ordinary examination of all the contents of the subject, which will be 100% of the grade, in the following cases:

- The non-completion or delivery of any of the previous points.

- Get a grade below 4 points out of 10 in the final exam.

- Not having passed the continuous assessment with a 5.

In any case, the student who has passed the continuous assessment, will have the possibility of attending the ordinary exam to raise the grade.

ETHICAL COMMITMENT: Students are expected to have adequate ethical behavior. If unethical behavior is detected (cheating, plagiarism, use of unauthorized electronic devices or others), the student will be penalized with the impossibility of passing the subject by the continuous assessment modality (in which he/she will obtain a grade of 0.0). If this type of behavior is detected in ordinary or extraordinary exam, the student will obtain in the call a score in 0.0.

Sources of information
Basic Bibliography
Kalpakjian, Serope, **Manufactura, ingeniería y tecnología**, Pearson, 2002
Todd, R.H.; Allen, D.K.; Alting, L., **Fundamental principles of manufacturing processes**, Industrial Press Inc., 2011
Alting, L., **Procesos para ingenieria de manufactura**, Alfaomega, 1990
Faura, F., **Prácticas de tecnología mecánica**, Ed. Universidad de Murcia, 1994
Groover, M. P., **Fundamentos de manufactura moderna: materiales, procesos y sistemas**, Prentice Hall,
Dieguez, J.L.; Pereira, A.; Ares, J.E:, ´**Fundamentos de fabricación mecánica**,
De Garmo; Black; Kohser, **Materiales y procesos de fabricación**, Reverté, 1988
Lasheras, J.M., **Tecnología mecánica y metrotecnia**, Donostiarra, 2000
Complementary Bibliography

Recommendations
Subjects that continue the syllabus
Manufacturing engineering and dimensional quality/P52G381V01407

IDENTIFYING DATA				
Thermal engineering I				
Subject	Thermal engineering I			
Code	P52G381V01403			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Cacabelos Reyes, Antón			
Lecturers	Cacabelos Reyes, Antón González Gil, Arturo			
E-mail	acacabelos@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This document shows the competences that the students must acquire with the subject Advanced Thermodynamics. It contains the program contents, an estimation of the students working load and the evaluation criteria. This subject, taken by fourth-year students of the mechanical engineering bachelor degree, explains the fundamentals of combustion, the mixture of air and water vapor and the main processes occurred in thermal systems.			

Skills	
Code	
B1	Skills for writing, signing and developing projects in the field of industrial engineering, whose purpose is, specializing in Mechanics, according to the knowledge acquired pursuant to paragraph 5 of this order, construction, alteration, repair, maintenance, demolition, manufacturing, installation, assembly or operation of: structures, mechanical equipments, energy facilities, electrical systems and electronic installations and industrial plants, and manufacturing processes and automation.
C21	Knowledge applied to thermal engineering.
D1	Analysis and synthesis
D2	Problems resolution.
D6	Application of computer science in the field of study.
D8	Decision making.
D10	Self learning and work.
D14	Creativity.
D16	Critical thinking.
D17	Working as a team.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Understanding the processes in which humid air is involved and managing of the psychrometric chart.	B1	C21	D1 D2 D10
Argue key ideas about the public policy process.			
Understanding the fundamentals of combustion.	B1	C21	D1 D2 D6 D10 D16 D17
Understanding the power production cycles.		C21	D1 D2 D6 D10 D14 D16

Ability to assess any basic thermal process.	B1	C21	D1 D2 D6 D8 D10 D14 D16 D17
To acquire basic knowledge about thermal machines.	B1	C21	D1 D2 D8 D10 D17
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- Knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [Level of achievement (Basic (1), Intermediate (2) and Advanced (3)) for this learning outcome: Intermediate (2)].		C21	
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.1.- Awareness of the multidisciplinary context of the engineering [Intermediate (2)].	B1		D2 D8
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.2.- Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical societal, health and safety, environmental, economic and industrial constraints [Intermediate (2)].			D1 D2 D8 D14 D16
ENAEE learning outcome: ENGINEERING PROJECTS: LO3.1.- The ability to apply their knowledge to plan and carry out projects that meet previously specified requirements [Basic (1)].			D2
ENAEE learning outcome: RESEARCHING AND INNOVATION: LO4.3.- Ability to design and conduct experiments, interpret data and draw conclusions [Basic (1)].		C21	
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.1.- Understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study [Intermediate (2)].		C21	
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.3.- Understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study [Intermediate (2)].			D6 D8
ENAEE learning outcome: COMMUNICATION AND TEAM-WORKIN: LO7.2.- Ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers [Basic (1)].	B1		D8 D10 D17

Contents

Topic	
BLOCK 1 (B1): Gas-vapor mixtures.	B1-1. Dry air and atmospheric air. Specific and relative humidity of the air. B1-2 Dew point temperature. Psychrometric charts. B1-3 Air conditioning.
BLOCK 2 (B2): Combustion and fuels properties.	B2-1. Fuels. Description and characteristics. Boilers and burners. B2-2 The combustion process. Theoretical and actual combustion. B2-3 Enthalpy of formation, enthalpy of combustion and heating values. B2-4 First-law analysis of reacting systems. B2-5 Second-law analysis of reacting systems.
BLOCK 3 (B3) Power production cycles.	B3-1 Gas power cycles I: Otto, Diesel, Stirling and Ericsson ideal cycles. Air standard cycles. B3-2 Gas power cycles II: Brayton cycle. Actual cycles. Intercooling reheating and regeneration. Ideal jet-propulsion cycles. B3-3 Vapor and combined power cycles: Rankine cycle. Actual vapor cycles. Reheating and regeneration. Open and closed feedwater heaters. B3-4 Combined gas-vapor power cycles.

BLOCK 4 (B4) Refrigeration cycles.	B4-1 Vapor-compression refrigeration systems: Actual cycles. Refrigerant properties. B4-2 Heat pumps. B4-3 Innovative vapor-compression refrigeration systems: Cascade refrigeration systems. Multistage compression refrigeration systems. Multipurpose refrigeration systems with a single compressor. B4-4 Gas refrigeration cycles. B4-5 Absorption refrigeration systems.
Practices of laboratory	PL 1. Introduction to thermal comfort and indoor air quality. The aim of this practice is to determine the air humidity in different indoor stays of buildings and in the outside. Besides, the concept of thermal comfort and indoor air quality are introduced, features that are related with the health and the welfare of the users of buildings. Equipment of measurement employed: hygrometers, sensors of temperature, measurers of quality of indoor air, etc. PL 2. Visit to the boiler room of the students residence. The students will make a technical visit to the boiler room in Francisco Moreno residence, that consists of two boilers of natural gas and provides domestic hot water (DHW) and heating to the students residence. The aim of the visit is to identify the equipments involved in a heeating system and to make a simplified diagram of the installation. Besides, this practice includes the study of conditions of security and health in a boiler room: identification of risks, measures of emergency, risks prevention, control of the Legionella, etc. PL 3. Development and presentation of works on social, health and security features related to Thermal Engineering. In this practice the students have to present the work developed during the first weeks of course. The works are proposed by the lecturers at the beginning of the course and they will be made by groups of 4 or 5 students. The subjects will treat on social, health and industrial security of related to Thermal Engineering. For example: energy efficiency in buildings, energy efficiency in ships, storage and transport of liquid fuels, maritime transport of fuels, thermal solar energy in buildings, renewable energies, cogeneration and trigeneration, etc. PL 4. Analysis of thermodynamic cycles with computer software. This practice consists of learning to use a computer tools for the simulation of power and refrigeration cycles (CYCLEPAD). The practice is oriented to the resolution of problems of cycles (ideal and real) used in the more usual thermal machines. PL 5. Quantitative analysis of Stirling cycle. By means of an experimental Stirling engine, the studdents will analyse different variables that affect the operation of the engine, the developed cycle, and its performance. Also, they will study the operation of the engine in reverse cycle like thermal cooling machine. PL 6. Experimental study of a heat pump In this practice the students will study the operation of an experimental installation of a heat pump. They will make energy balances in each one of its components to determine the coefficient of operation (COP), working as heating machine and cooling machine. Likewise, they will study its behaviour working as water - water heatpump and air - water heatpump. PL 7. Introduction to the design of solar refrigeration installations. It is a theoretical and demo practice on installations of production of cold by means of thermal solar energy. It pretends that the students know an efficient alternative to the use of conventional equipmente, whose refrigerants are highly hurtful for the environment.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Laboratory practical	14	0	14
Seminars	7	7	14
Problem solving	26	26	52

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

Methodologies	
	Description
Lecturing	In these sessions, the lecturer will explain in detail the basic theoretical contents of the course, exposing clarifying examples that help to better understand the concepts. Computer presentations and the blackboard will be used, especially to transmit information like definitions, charts, algorithms, schematics etc.
Laboratory practical	Supervised laboratory and computer practices. The didactic method to be followed in the teaching of the practical classes consists in that the lecturer supervises the work and progress done by the different groups. The practices of laboratory are headed to strengthen the theoretical concepts tackled in the sessions in the classroom.
Seminars	In the seminars, the lecturer analyses and proposes a series of problems that have to make individually or in group. The student will have to solve exercises and problems under the supervision and correction of the lecturer.
Problem solving	Intensive course of 15 hours for those students that have failed the subject in first announcement, previous to the examination in second announcement. Tutorships in groups with the lecturer. Realisation of examinations. Tasks of evaluation and hours of reinforcement.

Personalized assistance	
Methodologies	**Description**
Lecturing	Attention to student will be personalized both in the office hours and through email. Tutorial actions can be classified into academic or personalized tutoring. In the first case, students will have available office hours in which they can ask any questions regarding the contents, organization and planning of the course. Tutoring can also be individualized, but solving problems related to the activities carried out in groups will be encouraged. In personalized tutoring, each student, individually, can discuss with the lecturer any problem that is blocking an adequate progress in the course, in order to find some kind of solution. Combining both types of action tutorial students are intended to compensate for the different rates of learning through attention to diversity. The lecturers will answer the questions and queries of the student in person or by telematic means (email, videoconference, forums of Moovi, etc.) in the schedule published in the web or under the modality of previous appointment.
Problem solving	Attention to student will be personalized both in the office hours and through email. Tutorial actions can be classified into academic or personalized tutoring. In the first case, students will have available office hours in which they can ask any questions regarding the contents, organization and planning of the course. Tutoring can also be individualized, but solving problems related to the activities carried out in groups will be encouraged. In personalized tutoring, each student, individually, can discuss with the lecturer any problem that is blocking an adequate progress in the course, in order to find some kind of solution. Combining both types of action tutorial students are intended to compensate for the different rates of learning through attention to diversity. The lecturers will answer the questions and queries of the student in person or by telematic means (email, videoconference, forums of Moovi, etc.) in the schedule published in the web or under the modality of previous appointment.
Laboratory practical	Attention to student will be personalized both in the office hours and through email. Tutorial actions can be classified into academic or personalized tutoring. In the first case, students will have available office hours in which they can ask any questions regarding the contents, organization and planning of the course. Tutoring can also be individualized, but solving problems related to the activities carried out in groups will be encouraged. In personalized tutoring, each student, individually, can discuss with the lecturer any problem that is blocking an adequate progress in the course, in order to find some kind of solution. Combining both types of action tutorial students are intended to compensate for the different rates of learning through attention to diversity. The lecturers will answer the questions and queries of the student in person or by telematic means (email, videoconference, forums of Moovi, etc.) in the schedule published in the web or under the modality of previous appointment.

Seminars	Attention to student will be personalized both in the office hours and through email. Tutorial actions can be classified into academic or personalized tutoring. In the first case, students will have available office hours in which they can ask any questions regarding the contents, organization and planning of the course. Tutoring can also be individualized, but solving problems related to the activities carried out in groups will be encouraged. In personalized tutoring, each student, individually, can discuss with the lecturer any problem that is blocking an adequate progress in the course, in order to find some kind of solution. Combining both types of action tutorial students are intended to compensate for the different rates of learning through attention to diversity. The lecturers will answer the questions and queries of the student in person or by telematic means (email, videoconference, forums of Moovi, etc.) in the schedule published in the web or under the modality of previous appointment.

Assessment

	Description	Qualification	Training and Learning Results
Lecturing	A final test of continuous evaluation will be done during the evaluation week and will be graded over 10 points. A minimum grade of 4 points in this exam will be necessary to pass the subject in the continuous evaluation. This proof will have a weight of 40% of the grade of continuous evaluation. Two partial exams of continuous evaluation will be done, which will suppose 30% of the grade of continuous evaluation (15% each one of them).	70	B1 C21 D1 D2 D8 D10 D14 D16
Laboratory practical	Lab practices will be performed in small groups. Each group will have to deliver a memory of practices at the end of each practice, or group of practices. The memories of practices will have a weight of 10% of the grade of continuous evaluation.	10	B1 C21 D1 D2 D6 D8 D10 D14 D16 D17
Seminars	A group work will be done about social, health and industrial security features related to Thermal Engineering, that will be presented by the students in the practice 3 of the subject. The group work will have a weight of 10% of the grade of continuous evaluation.	10	B1 C21 D1 D2 D8 D10 D14 D16 D17
Problem solving	Seminars will be graded through individual or group tests or resolution of exercises performed in some of the seminar sessions when the lecturer request. These will mean 10% of the final grade.	10	B1 C21 D1 D2 D8 D14 D16 D17

Other comments on the Evaluation

The evaluation will be considered positive when a score of 5 is reached for the continuous evaluation. The students must attend the ordinary exam, which addresses the whole subject contents, if the total grade of continuous evaluation is lower than 5. They also will have to attend the ordinary exam if any of the following cases happens:

- Any of the tests or exams is missed.

- A grade lower than 4 points in the final theory exam is obtained.

For these cases, the continuous evaluation grade will be the minimum of 4 points and total continuous evaluation grade. In any case, the student who has passed the continuous evaluation, will be allowed to attend to the ordinary exam to increase the grade.

Detection of cheating in any kind of evaluation activity (midterms, final terms, laboratory work, test in seminars, etc.) will be penalized with a zero in the evaluated item and, in those evaluations with a mandatory minimum grade to pass the course, the student will not be evaluated by continuous evaluation. This sanction will affect both students cheating during the evaluation tests, and those that facilitate cheating. Cheating in ordinary or extraordinary evaluation will be penalized with a zero so the students must attend the next evaluation. Detection of copies will imply the immediate expulsion of the classroom in the day in which it has been detected. Also, there will be equally penalized those students using unauthorized material during the evaluation exams (unauthorized calculators or other electronic devices, documents, notes, etc.).

Sources of information
Basic Bibliography
Çengel Y.A., Boles M.A., **Termodinámica**, 7ª edición, Mc Graw-Hill, 2012
Morán, M.J. Shapiro, H.N., **Fundamentos de Termodinámica Técnica**, 2ª edición (4ª en español), Reverte, 2018
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Incropera, F.P., De Witt, D.P., **Fundamentos de Transferencia de Calor**, 4ª edición, Pearson, 2000
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Baehr, H.D., **Tratado moderno de termodinámica**, Tecnilibro, 1987
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Alarcón Aguín, J.M., **SISCECT, Simulación y Cálculo de Sistemas Termodinámicos**, Bellisco, 1999
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Lienhard IV, J.H., **A Heat Transfer Textbook**, Phlogiston Press, 2005
Segura, J., Rodríguez, J., **Problemas de Termodinámica Técnica**, Reverte, 1990
Lacalle, Nieto, **Problemas de Termodinámica**, Serv Pub. ETSII Madrid,
Aguirrezabalaga, V., **Transferencia de Calor: Problemas**, Serv Pub. Oviedo, 2006
Vázquez, M, **Problemas Resueltos de Termodinámica Técnica**, Serv Pub. Universidad de Vigo,

Recommendations
Subjects that continue the syllabus
Naval engines and machines/P52G381V01409

Subjects that it is recommended to have taken before

Thermodynamics and heat transfer/P52G381V01203

Other comments

It is strongly recommended to review the "Thermodynamics and heat transfer" course, especially those topics related to energy balances, thermal properties of materials and ideal gases behavior. It is also recommended to review the chemical reactions fundamentals.

IDENTIFYING DATA

Theory of structures and industrial constructions

Subject	Theory of structures and industrial constructions			
Code	P52G381V01404			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	1st
Teaching language	Spanish			
Department				
Coordinator	González Gil, Arturo			
Lecturers	González Gil, Arturo Regueiro Pereira, Araceli			
E-mail	arturogg@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The main objective of the subject of Theory of Structures and Industrial Constructions is to provide the student with the basic knowledge for the analysis and design of structural elements and systems more frequent in industrial constructions. To do this, the structural typologies and the most common elements in the industrial buildings will be identified. In addition, different tools will be studied for their analysis and design. The students will be also introduced in the management of the current regulations, and in particular the standars for structures made of steel and reinforced concrete, respectively. It is, therefore, a subject that will provide fundamental knowledge for the professional exercise of the graduate in mechanical engineering. In fact, knowledge and ability to calculate and design structures and industrial constructions is one of the competencies that, according to Ministerial Order CIN / 351/2009, of February 9, must be acquired in the official degrees which, as in this case, qualify for the exercise of the Industrial Technical Engineer profession.			

Skills

Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
B4	Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of Industrial Engineering in Mechanical specialty.
B5	Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
B6	Capacity for handling specifications, regulations and mandatory standards.
B11	Knowledge, understanding and ability to apply the necessary legislation in the exercise of the profession of Industrial Technical Engineer.
C23	Knowledge and ability to calculate and design of structures and industrial buildings.
D2	Problems resolution.
D5	Information Management.
D8	Decision making.
D9	Apply knowledge.
D10	Self learning and work.
D17	Working as a team.

Learning outcomes

Expected results from this subject	Training and Learning Results		
1. Identify the influence of the society in the daily life			
1. Identify the influence of the society in the daily life			
Knowing the requirements that the structures must meet to fulfill their functions, taking into account the external loads, the security criteria and the bases of calculation	B3 B4 B5 B6 B11	C23	D2 D5 D8 D9 D10 D17

Acquire capacity to convert a real structure into a model for analysis, and vice versa	B3 B4 B5 B6 B11	C23	D2 D5 D8 D9 D10 D17
Identifying the most important typologies and elements used in industrial structures and constructions	B3 B4 B5 B6 B11	C23	D2 D5 D8 D9 D10 D17
Ability to determine stress laws, stresses and deformations in the elements of structures	B3 B4 B5 B6 B11	C23	D2 D5 D8 D9 D10 D17
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	B3	C23	
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.2.- ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical (societal, health and safety, environmental, economic and industrial) constraints [Intermediate (2)].	B4	C23	D2 D8 D9
ENAEE learning outcome: ENGINEERING DESIGN: LO3.1.- ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical (societal, health and safety, environmental, economic and industrial) considerations; to select and apply relevant design methodologies [Intermediate (2)].	B4 B5	C23	D2 D9
ENAEE learning outcome: ENGINEERING DESIGN: LO3.2.- ability to design using some awareness of the forefront of their engineering specialisation [Basic (1)].	B4 B5	C23	D9
ENAEE learning outcome: INVESTIGATIONS: LO4.1.- ability to conduct searches of literature, to consult and to critically use scientific databases and other appropriate sources of information, to carry out simulation and analysis in order to pursue detailed investigations and research of technical issues in their field of study [Basic (1)].	B6 B11		D5
ENAEE learning outcome: INVESTIGATIONS: LO4.2.- ability to consult and apply codes of practice and safety regulations in their field of study [Advanced (3)].	B6 B11		
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.1.- understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study [Intermediate (2)].		C23	D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.2.- practical skills for solving complex problems, realising complex engineering designs and conducting investigations in their field of study [Basic (1)].	B4 B5		D2 D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.3.- understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study [Basic (1)].			D8 D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.4.- ability to apply norms of engineering practice in their field of study [Intermediate (2)].	B6 B11		D9

Contents
Topic

Unit 1. Introduction to the analysis and design of structures	Objectives and development: This theme will serve like an introduction to the structural analysis. It will present the fundamental considerations for the idealisation and the analysis of a structure, will identify the main types of structures and their elements and, finally, will describe the different types of loads in a structure. Index: 1.1 Analysis and structural design 1.2 Classification of structures 1.3 Types of loads on structures 1.4 Idealisation of structures 1.5 Structural behaviour: load distribution 1.6 Basic principles of the structural analysis
Unit 2. Industrial Constructions: Typology and Constructive Elements	Objectives and development: This theme will introduce the concept of industrial urbanism and identify the different types of structures used in industrial buildings, as well as their basic constructive elements. Also, the student will be introduced to the systems and construction processes used in industrial buildings. Index: 2.1 General information on architecture and industrial urbanism 2.2 Types of structures in industrial buildings 2.3 Building elements: Foundations 2.4 Building elements: Beams, pillars and slabs 2.5 Building elements: Enclosures and covers
Unit 3. Normative frame in the calculation and design of structures and industrial constructions	Objectives and development: The codes currentluy in force for the design of industrial constructions and the calculation of their structures will be presented. The criteria of structural security that govern the calculation of structures in Spain and in the European Union will be studied. This includes the determination of the loads on a structure. Besides, an apporach to different criteria that must be taken into account in the design and the construction of industrial buildings: evaluation and prevention of risks in the construction phase, security of utilisation and accessibility, energy saving and use of renewable energies, healthy indoor environment, noise protection, etc. Index: 3.1 Regulatory framework for industrial constructions 3.2 The Technical Building Code (CTE) 3.3 Loads according to the CTE 3.4 Structural security according to the CTE: verification of Limit States 3.5 Load combination 3.6 Social, environmental, security and health aspects in industrial buildings
Unit 4. Introduction to the design of metal structures	Objectives and development: The fundamentals of the design and calculation of metal structures will be explained. The main characteristics of steel structures used in industrial buildings will be presented. An introduction will be made to the sizing and verification of the main elements of steel structures. Index: 4.1 Introduction to metal structures 4.2 Steel: classes and main characteristics 4.3 Standard steel sections 4.4 Introduction to the calculation of steel elements subjected to tensile, compression and bending forces
Unit 5. Introduction to the design of concrete structures	Objectives and development: The main characteristics and behavior of the concrete structures used in industrial buildings will be described. The properties and applications of concrete as a construction material (bulk, reinforced and prestressed concrete) will be studied. Concrete selection and identification criteria will be introduced. Index: 5.1 Introduction to concrete structures 5.2 Types of concrete used in buildings 5.3 Reinforced concrete: components and structural behavior 5.4 Selection and identification of concrete as a building material

Unit 6. Analysis of reticular structures with articulated knots	Objectives and development: The main features of bar structures with articulated knots will be defined and their main types will be identified. Different analytical methods will be studied to determine stresses and deformations in both isostatic and hyperstatic structures. The results obtained with this type of analysis will be related to the fundamentals of metal structures design, seen in unit 4. Index: 6.1 Characteristics of structures with articulated knots 6.2 Analysis of isostatic structures: method of knots 6.3 Analysis of isostatic structures: method of sections 6.4 Analysis of isostatic structures: determining deformations 6.5 Analysis of hyperstatic structures 6.6 Anlaysis of articulated frames and articulated beams
Unit 7. Analysis of reticular structures with rigid knots	Objectives and development: The behavior of bar structures with rigid knots will be analysed. The fundamentals of the method of Cross of distribution of moments will be presented as tool of analysis of this type of structures. This method will be applied to determine the internal forces in hyperstatic beams and frames. The results obtained with this type of analysis will be related to the fundamentals of design of metal and concrete structures, seen in unit 4 and 5, respectively. Index: 7.1 Characteristics of structures with rigid knots 7.2 Fundamentals of the Cross method 7.3 Analysis of hyperestatic beams using the Cross method 7.4 Analysis of frames using the Cross method
Unit 8. Cables and Arches	Objectives and development: The fundamentals of the structural analysis of cables and arches will be studied. Both the cables supporting to puntual and distributed vertical loads will be analysed. Three-Hinged arches will be studied as a basic case of the analysis of arches. Index: 81 General characteristics of cables 8.2 Analysis of cables supporting vertical concentrated loads 8.3 Analysis of cables supporting vertical distributed loads 8.4 General characteristics of arches 8.5 Analysis of three-hinged arches
Unit 9. Buildings in the Spanish Navy	Objectives and development: Some of the most relevant aspects of constructions in the Armed Forces, and in particular the Spanish Navy, will be estudied. Different cases of buildings present in military units and bases will be analyzed from the constructive and structural point of view. It is intended that this unit serves to review and apply some of the most relevant content of the course through its contextualization in a more familiar environment, and if possible more motivating, for the students. Index: 9.1 Examples of buildings in military environments 9.2 Management of building projects in the Navy
Practice 1. Identification and idealization of structures	Objectives and development: With this practice, it is intended to complement the contents of the first two units of the subject, as well as to review basic knowledge of structural stability, acquired in previous courses. Different examples of real structures will be proposed for the student to idealize, determine their external loads and analyze their stability. In addition, this practice will be complemented with a visit to several buildings of the ENM in which students will be able to identify different types and structural elements studied during the course.
Practice 2. Determining design loads on industrial buildings	Objectives and development: This practice aims to introduce the student to the management of the current regulations applicable to the design of structures, in particular to determining loads according to CTE. For this, an exercise is proposed in which the students must determine the loads actuating on different structural elements of an industrial warehouse. This practice is related to the first three units of the subject.

Practice 3. Sizing structural steel elements	Objectives and development: With this practice, the students are expected to complement and expand their knowledge on calculation and combination of loads, applying them to the dimensioning of different elements of steel structures. For this, the student will solve one practical case raised by the lecturer. This practice is related to units 2, 3 and 4.
Practice 4. Introduction to reticular structures with articulated and rigid knots	Objectives and development: This practice intends to introduce the student to the study of structures based on bars with articulated knots or with rigid knots, which will be approached, respectively, in units 6 and 7 of the subject. Different demonstrative assemblies of models of articulated knot and rigid knot bar structures will be carried out, in such a way that students can visualize and understand the behavior of these structural typologies under different external loads.
Practice 5. Analysis of deformations in trusses	Objectives and development: In this practice, deformation measurements will be made in a truss model under different load conditions. Likewise, a theoretical approach to the experimentally measured results will be carried out. The main objective is to reinforce the knowledge acquired in unit 6 of the subject.
Practice 6. Introduction to the use of professional structural calculation software	Objectives and development: In this practical session, the student will be introduced to the management of professional structural calculation programs with a dual objective: i) to promote the consolidation of basic knowledge on design and calculation of structures acquired throughout the course; ii) show the possibilities offered by a professional structure calculation software. There will be a brief presentation of the software available at the center (Autodesk Robot Structural Analysis) and the sizing of different structural elements and simple structures will be carried out
Practice 7. Social, environmental, safety and health aspects in the design and construction of industrial buildings	Objectives and development: Students, working in groups of three to five people, must present and defend a work on different social, environmental, safety and health aspects that according to the Technical Building Code and other reference regulations must be taken into account in the design and the construction of industrial buildings. These works will be raised by the lecturers of the subject during the teaching of unic 3. The result of this practice will be evaluated within the Group Work item (TG), according to what is established in the Assesment item of this teaching guide.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Laboratory practical	14	7	21
Seminars	7	0	7
Problem solving	28	16	44
Mentored work	0	8	8

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

Methodologies

	Description
Lecturing	The methodology of these classes will approximate to a masterful participatory session. The fundamentals of each topic will be explained and explanatory examples will be presented. Also, the student will be guided to study the contents of the subject in an autonomous way. As an expository method, the digital screen available in the classroom will preferably be used. As far as possible, copies of the presentation slides will be provided to the students prior to the class, focusing the efforts of the lecturer and students on the exposition and understanding of the knowledge. Additionally, collaborative learning will be encouraged in the classroom through group activities. The aim is to motivate the student in the research activity, and encourage personal skills while sharing problems and solutions. With a dedication that will vary throughout the course and depending on the specific needs of the subject, part of the classroom classes will be dedicated to solving problems by teams (problem-based learning).

Laboratory practical	The practical teaching will aim to apply, expand and consolidate the concepts studied in the theoretical classes. With the idea of promoting both the creativity and technical skills of the student, a series of sessions are presented, which include, on the one hand, the performance of laboratory practices, and on the other, the study of cases and the resolution of problems and/or exercises. These sessions will deal with the experimental analysis of deformations in structures, the resolution of exercises of structural analysis by classical methods and with computer software, the handling of specifications, regulations and obligatory standards in the design of industrial buildings. These classes will begin with a presentation of the practice by the lecturer, and if necessary, with an explanation of new theoretical concepts that are necessary for its realisation. Subsequently, the students will carry out the practice in question working in small groups, and under the supervision of the lecturer. At the end of each practice, each group of students must submit a summary report with the results obtained.
Seminars	Classes designed to solve problems and/or exercises and to study cases, which students must carry out individually or in group. The fact that the number of students in these classes is reduced (around 10), allows a greater proximity between lecturer and student, which facilitates the understanding and the comprehension of the fundamental concepts of the subject
Problem solving	Intensive course (15 hours) for those students who have failed the subject at first call, prior to the exam in second call. Group tutoring with the lecturer. Doing examans. Assessment tasks and reinforcement hours.
Mentored work	Students, working in groups of three to five people, must present and defend a work on different social, environmental, safety and health aspects that according to the Technical Building Code and other reference regulations must be taken into account in the design and the construction of industrial buildings. These works will be proposed by the teaching staff of the subject during the teaching of unit 3 and will be presented in the hours allocated to the 7th laboratory practice.

Personalized assistance

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

Assessment

	Description	Qualification	Training and Learning Results		
Lecturing	Written tests: theoretical questions and problems The written tests aim to evaluate the learning of all the theoretical contents of the subject. There will be two partial tests and one final exam. Each partial test will contribute 15% of the final grade of the student. The final exam, which will cover all the subject matter, will have a weight of 40% in the final grade. The written tests will consist of a series of questions and exercises that give priority to the conceptual and logical reasoning, in order to verify the intellectual maturity of the students to obtain conclusions from the notions or theories exposed in class. All tests will be evaluated for a total of 10 points.	70	B3 B4 B5 B6 B11	C23	D2 D5 D8 D9 D10
Laboratory practical	The students must present a report of practices for each laboratory practice performed (in case the practice is done in group, only one practice will be delivered per group). Each report will be evaluated on 10 points. The final grade of practices will be the average value of the grades obtained in each practice delivered.	10	B3 B4 B5 B6 B11	C23	D2 D5 D8 D9 D10 D17
Seminars	Throughout the course (in particular during the seminar hours), different exercises will be proposed to students, who may do them in groups or individually. Each of these exercises will be evaluated over 10 points. The grade of this item will be the average value of the grades obtained in each deliverable.	10	B3 B4 B5 B6 B11	C23	D2 D5 D8 D9 D10 D17

Mentored work	Group work that must be accompanied with a memory and an oral presentation. The work will be valued on a maximum of 10 points.	10	B3 B4 B5 B6 B11	C23	D2 D5 D8 D9 D10 D17

Other comments on the Evaluation

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

Ordinary call: continuous evaluation

The continuous evaluation method (EC) will assess the results achieved by the students in the different activities carried out throughout the course, which will be grouped as follows: Final Test (PF), Theoretical-Practical Controls (CT), Lab Reports (MP), Evaluables Exercises (EE), and Group Work (TG). The grade of each part will be calculated as the arithmetic mean of the items made up to the moment of the evaluation in that part.

There will be two tests of evaluation of theoretical-practical knowledge (CT) throughout the course. The student must present a report for each laboratory practice provided that it is indicated in the realization of the same, which will be evaluated in item MP. In the seminar and / or theory class hours, the student may be offered the completion and delivery of different exercises, which will be evaluated in item EE. In the event that a student is unable to attend a session (due to a justified reason) in which exercises that can be evaluated are carried out, the student must notify the lecturers by email so that they have a record and this circumstance is taken into account at the time of the evaluation. In addition, the students must carry out and present a group work on the social, environmental, safety and health aspects in the design and construction of industrial buildings (see practice 7), which will be evaluated in item TG. The final continuous assessment test (PF) will include all the contents of the subject and will have a weight of 40% in the final grade of continuous assessment.

The grade of the continuous evaluation (NEC), will be the result of applying the weighted average to all the evaluated parts; that is, it will be calculated as follows:

NEC= 0.4 PF + 0.15 CT1 + 0.15 CT2 + 0.1 MP + 0.1 EE + 0.1 TG

The student will pass the subject by continuous evaluation when each and every one of the following requirements is met:

1. Have completed all evaluable tasks (except duly justified cases)
2. Have a score of at least 4 points out of 10 in the continuous assessment final exam (PF)
3. Have a NEC value greater than or equal to 5 points (out of 10)

In case of not fulfilling any of the first two requirements, the final grade of continuous evaluation will be equal to the minimum value between NEC and 4 points.

Ordinary call: ordinary exam

Those students who fail to pass the subject by the continuous assessment method, must do the ordinary exam, where all the competences of the subject will be assessed. The results of this exam will suppose 100% of the student's final grade, being an essential requirement to pass the course to obtain a grade of at least 5 points out of 10.

Students who have passed the subject by continuous evaluation will have the possibility of taking the ordinary exam to improve their grade.

Extraordinary call

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

Ethical commitment

In their double condition of military and student of the University of Vigo, students are subject to the obligations derived from both institutions. As regards a university student, the University Student Statute, approved by Royal Decree 1791/2010 of December 30, establishes in its article 12, point 2d, that the university student has the duty to abstain from using or cooperation in fraudulent procedures in assessment tests, in the work carried out or in official university documents. Likewise, the LCM, in its article 4 concerning the rules of behavior of the military, establishes in its fifteenth rule that the latter will carry out his duties and obligations exactly, driven by the feeling of honor, ...

Therefore, the student is expected to have adequate ethical behavior. If during the course unethical behavior is detected in the performance of any evaluable test or exercise (cheating, plagiarism, use of unauthorized electronic devices or others), the student in question will not pass the subject by continuous evaluation (in which he will obtain a rating of 0.0). Likewise, if this type of behavior were detected in the ordinary exam or in the extraordinary exam, the student would obtain a grade of 0.0 in such call.

Sources of information

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Montalvá Subirats, J.M, Hospitaler Pérez, A, Saura Arnau, H, **Proyecto Estructural de Edificio Industrial: diseño y cálculo de estructura metálica**, 2ª ed., Universidad Politécnica de Valencia, Servicio de P, 2014

Montalvá Subirats, J.M, Saura Arnau, H., **Construcción y arquitectura industrial: Colección de problemas resueltos**, 2ª ed., Universidad Politécnica de Valencia, Servicio de P, 2014

Urbán Brotóns, P., **Construcción de estructuras metálicas**, 5ª ed., Ed. Club Universitario, 2015

Recommendations

Subjects that it is recommended to have taken before

Materials science and technology/P52G381V01202
Resistance of materials/P52G381V01204
Elasticity and additional topics in resistance of materials/P52G381V01303

Other comments

For a correct follow-up of this subject, the students must have solid knowledge of vector calculus and master the concept of static equilibrium. In addition, they must have the ability to analyse tensions and deformations in elementary structures. They should also be familiar with the mechanical properties of structural materials such as steel. It is therefore highly recommended that the students have completed and passed the following subjects of the curriculum: Physics I, Materials Science and Technology, Resistance of materials and Elasticity and Advanced strength of materials.
The knowledge acquired in the structural analysis part of this subject can be useful to the student in the follow-up of subjects such as Machine design (second term of the fourth year) or Theory of the ship and shipbuilding (first term of the fifth year). Also, the knowledge acquired in the construction part will be complemented by the subject of Basics of topography, which is only taught to students of Marine Corps.

IDENTIFYING DATA				
Deseño de máquinas				
Subject	Deseño de máquinas			
Code	P52G381V01405			
Study programme	Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4	2c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín			
Coordinator	Casqueiro Placer, Carlos			
Lecturers	Casqueiro Placer, Carlos Núñez Nieto, Xavier			
E-mail	ccasqueiro@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Esta materia permitirá ao alumno aplicar os fundamentos básicos da Teoría de Máquinas e Mecanismos ao Deseño de Máquinas e coñecer, comprender, aplicar os conceptos relacionados co Deseño de Máquinas e a súa aplicación na Enxeñaría Mecánica. Achegaralle coñecementos, sobre os conceptos máis importantes relacionados co Deseño de Máquinas. Coñecerá e aplicará as técnicas de análises para Deseño de Máquinas, tanto analíticas como mediante a utilización eficaz de software de simulación.			

Competencias	
Code	
B4	Capacidade de resolver problemas con iniciativa, toma de decisións, creatividade, razoamento crítico e de comunicar e transmitir coñecementos, habilidades e destrezas no campo da Enxeñaría Industrial na especialidade de Mecánica.
B5	Coñecementos para a realización de medicións, cálculos, valoracións, taxacións, peritaxes, estudos, informes, planes de labores e outros traballos análogos.
B6	Capacidade para o manexo de especificacións, regulamentos e normas de obrigado cumprimento.
B9	Capacidade de organización e planificación no ámbito da empresa, e outras institucións e organizacións.
B10	Capacidade para traballar nun medio multilingüe e multidisciplinar.
B11	Coñecemento, comprensión e capacidade para aplicar a lexislación necesaria no exercicio da profesión de Enxeñeiro Técnico Industrial.
C13	Coñecemento dos principios de teoría de máquinas e mecanismos.
C20	Coñecementos e capacidades para o cálculo, deseño e ensaio de máquinas.
D2	Resolución de problemas.
D9	Aplicar coñecementos.
D10	Aprendizaxe e traballo autónomos.
D17	Traballo en equipo.

Resultados de aprendizaxe			
Expected results from this subject	Training and Learning Results		
Que o alumnado demostre posuir e comprender coñecementos nunha área de estudo que parte da base da educación secundaria xeral, e adoita encontrarse a un nivel que, se bien se apoia en libros de texto avanzados, inclúe tamén algúns aspectos que implican coñecementos procedentes da vangarda do seu campo de estudo. Analizar, sintetizar, resolver problemas e tomar decisións xestionando a información e o tempo. Identificar as principais teorías e enfoques da Ciencia Política, da Administración e Xestión Pública. Identificar o significado e aplicar a perspectiva de xénero nos distintos ámbitos de coñecemento e na práctica profesional co obxectivo de acadar unha sociedade máis xusta e igualitaria. Integrar a aprendizaxe autónoma.			
Aplicar os fundamentos básicos da Teoría de Máquinas e Mecanismos ó Deseño de Máquinas.	B4 B5 B6 B9 B10 B11	C13 C20	D2 D9 D10 D17
Coñecer, comprender, aplicar os conceptos relacionados co Deseño de Máquinas.	B4 B5 B6 B9 B10 B11	C13 C20	D2 D9 D10 D17

Resultado de aprendizaxe ENAEE: 1.2 Coñecemento e comprensión das disciplinas de enxeñaría propias da su especialidad, no nivel necesario para adquirir o resto de competencias do título, incluíndo nocións dos últimos adelantos. Nivel: adecuado.		C13 C20	
Resultado de aprendizaxe ENAEE: 2.2 Capacidade para identificar, formular e resolver problemas de enxeñaría na súa especialidade; escoller e aplicar métodos analíticos, de cálculo e experimentos adecuadamente establecidos, e coñecer a importancia das restricións sociais, de saúde e seguridade, ambientais, económicas e industriais. Nivel: adecuado.	B4	C20	D2 D9
Resultado de aprendizaxe ENAEE: 3.1 Capacidade para deseñar, deseñar e desenvolver produtos complexos (pezas, compoñentes, produtos acabados, etc.), procesos e sistemas da súa especialidade, que cumpran os requisitos establecidos, incluíndo o coñecemento dos aspectos sociais, de saúde e seguridade, e ambientais económico e industrial; así como seleccionar e aplicar métodos de proxecto apropiados. Nivel: adecuado.	B4 B5	C20	D2 D9
Resultado de aprendizaxe ENAEE: 3.2 Capacidade do proxecto utilizando algúns coñecementos avanzados da súa especialidade de enxeñaría. Nivel: adecuado.	B4 B5	C20	D9
Resultado de aprendizaxe ENAEE: 4.1 Capacidade para realizar buscas bibliográficas, consultar e utilizar bases de datos de criterios e outras fontes de información, para realizar simulacións e análises co obxectivo de realizar investigacións sobre temas técnicos da súa especialidade. Nivel: básico.	B6 B11		
Resultado de aprendizaxe ENAEE: 4.2 Capacidade para consultar e aplicar códigos de boa práctica e de seguridad na súa especialidade. Nivel: básico.	B6 B11		
Resultado de aprendizaxe ENAEE: 4.3 Capacidade e destreza para proxectar e levar a cabo investigacións experimentais, interpretar resultados e obter conclusións no seu campo de estudo. Nivel: adecuado.		C13 C20	D9
Resultado de aprendizaxe ENAEE: 5.2 Competencia práctica para resolver problemas complexos, realizar proxectos complexos de enxeñaría e realizar investigacións específicas para a súa especialidade. Nivel: adecuado.	B4 B5		D2 D9
Resultado de aprendizaxe ENAEE: 5.3 Coñecemento da aplicación de materiais, equipos e ferramentas, procesos de tecnoloxía e enxeñería e as súas limitacións no ámbito da súa especialidade. Nivel: adecuado.			D9
Resultado de aprendizaxe ENAEE: 5.4 Capacidade para aplicar normas da práctica da enxeñaría da súa especialidade. Nivel: adecuado.	B6 B9 B11		D9
Resultado de aprendizaxe ENAEE: 6.2 Capacidade para xestionar actividades ou proxectos técnicos ou profesionais complexos da súa especialidade, asumindo a responsabilidade da toma de decisións. Nivel: básico.	B9		

Contidos	
Topic	
Tema 1. Predición de falla por carga estática. (T1)	Resistencia estática. Concentración do esforzo. Teorías de falla. Selección de criterios de falla. Introducción á Fatiga. Esfuerzos cíclicos. Resistencia á fatiga e límite de fatiga. Factores de modificación do límite de fatiga. Esforzos variables e fluctuantes: dano por fatiga acumulada.
Tema 2. Vibracións en deseño de máquinas. (T2)	Frecuencia natural e vibracións forzadas en sistemas de 1GL. Frecuencias naturais e modos de vibración en sistema de máis de 1GL. Frecuencias naturais e modos de vibración en sistemas continuos.
Tema 3. O uso do MEF no deseño mecánico. (T3)	Mallado. Aplicación de condicións de contorno.
Tema 4. Enxeñaría inversa e prototipado. (T4)	Adquisición e tratamento de xeometría. Prototipado e impresión 3d.
Tema 5. Eixos e árbores. (T5)	Deseño de árbores segundo tensións. Velocidades críticas de árbores.
Tema 6. Rodamientos e coxinetes. (T6)	Comparación entre coxinetes e rodamientos. Tipos de rodamientos. Deseño de rodamientos. Selección de rodamientos por catálogo. Tipos de coxinetes. Teoría da lubricación hidrodinámica. Deseño de coxinete hidrodinámico.
Tema 7. Engrenaxes. (T7)	Condición de engrane. Tipos de engrenaxes. Parámetros xeométricos. Interferencia. Análise de forzas. Deseño e dimensionamiento de engrenaxes. Trens de engrenaxes.
Tema 8. Embragues e freos. (T8)	Freos de cinta, de tambor e de disco. Embragues cónicos e de disco. Par transmisible. Enerxía disipada.
Tema 9. Unións roscadas e parafusos de potencia. (T9)	Morfoloxía das unións roscadas. Normas. Dimensionamiento. Parafuso de potencia.
Tema 10. Sistemas flexibles de transmisión de potencia. (T10)	Correas e cadeas de transmisión. Cálculo e dimensionamiento.
Tema 11. Resortes (T11)	Cálculo e dimensionamento de resortes.

T12. Acoplamentos (T12).	Deseño de acoplamentos. Cálculo e dimensionamento.
Prácticas 1, 2 e 3. Análise estática mediante FEM con software CAE. (PL1, PL2 e PL3)	Mallado da/s xeometría/s, aplicación de materiais, restricións e cargas. Análise de resultados.
Práctica 4. Análise de vibracións mediante FEM con software CAE. (PL4)	Mallado da/s xeometría/s, aplicación de materiais, restricións e cargas. Análise de resultados.
Práctica 5, e 6. Adquisición de xeometrías e o seu tratamento. (PL5 e PL6)	Emprego de escáner tridimensional para a adquisición de xeometrías. Tratamento das nubes de puntos. Deseño a partir de mallas. Análise e redeseño de elementos mecánicos.
Práctica 7. Presentación e discusión do traballo realizado.	Presentación de cada traballo polos autores ó resto do alumnado.

Planificación

	Class hours	Hours outside the classroom	Total hours
Resolución de problemas	7	7	14
Prácticas con apoio das TIC	14	7	21
Resolución de problemas de forma autónoma	11	14	25
Seminario	15	10	25
Lección maxistral	28	37	65
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente

	Description
Resolución de problemas	Resolución de problemas utilizando os conceptos teóricos presentados en aula.
Prácticas con apoio das TIC	Realización de tarefas prácticas en aula informática.
Resolución de problemas de forma autónoma	Empregados nas probas de avaliación con obxecto de verificar as capacidades adquiridas polo alumno.
Seminario	Curso intensivo de 15 horas para aqueles alumnos que suspenderon a materia en primeira convocatoria, previo ao exame en segunda convocatoria. Titorías grupais co profesor.
Lección maxistral	Clase maxistral na que se expoñen os contidos teóricos.

Atención personalizada

Methodologies	Description
Prácticas con apoio das TIC	O alumno recibe atención personalizada durante a realización das prácticas. O profesor da materia atenderá persoalmente as dúbidas e consultas dos alumnos, tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.
Seminario	Titorias grupais co profesor da materia. O profesor da materia atenderá persoalmente as dúbidas e consultas dos alumnos, tanto de forma presencial, segundo o horario que se publicará na páxina web do centro, como a través de medios telemáticos (correo electrónico, videoconferencia, foros de Moovi, etc.) baixo a modalidade de cita previa.

Avaliación

	Description	Qualification	Training and Learning Results		
Prácticas con apoio das TIC	Valorarase as memorias das prácticas de laboratorio (10%) e os traballos realizados empregando os mesmos medios e metodoloxías (20%).	30	B4 B5 B9	C13 C20	D2 D9
Resolución de problemas de forma autónoma	Realizaranse dous Controis teórico-prácticos de avaliación continua (15% cada un). A súa valoración realizarase sobre 10 puntos cada un. A Proba Final (PF) de avaliación continua (cun peso do 40%) realizarase na semana de avaliación e valorarase sobre 10 puntos. Será necesario obter unha nota maior ou igual a 4 puntos sobre 10 no exame final de avaliación continua para poder optar ao aprobado por avaliación continua.	70	B4 B5 B6 B9 B11	C13 C20	D2 D9 D10

Other comments on the Evaluation

O alumno deberá presentarse ao exame ordinario de todos os contidos da materia, que suporá o 100% da nota, nos

seguintes supostos:

- A nota final de avaliación continua (NEC) é menor de 5.
- A non realización ou entrega da memoria de prácticas, salvo que sexa eximido por causa xustificada, ou a non superación do mínimo de 4 puntos nas mesmas.
- Obter unha nota inferior a 4 puntos sobre 10 no exame final de avaliación continua.

A nota de avaliación continua en caso de non cumprir algún do tres últimos requisitos será obtida mediante a expresión: NECS = min (4, NEC).

En calquera caso, o alumno que superase a avaliación continua, terá a posibilidade de presentarse ao exame ordinario para subir nota.

Nota importante: Un dos deberes de cada estudante universitario é "Absterse de empregar ou cooperar en procedementos fraudulentos nas probas de avaliación, nos traballos que se realicen ou nos documentos oficiais da universidade". (Real decreto 1791/2010, do 30 de decembro, polo que se aproba o Estatuto do Estudante Universitario). A participación en calquera procedemento fraudulento, así como a posesión de material non autorizado durante a realización de calquera das probas (como dispositivos electrónicos, notas ou calquera outra documentación relacionada co asunto) conducirá á suspensión na convocatoria actual (valorada 0) e informar á Dirección do Centro.

Bibliografía. Fontes de información

Basic Bibliography

Budinas, Richard, **Diseño en Ingeniería Mecánica de Shigley**, 9ª, McGraw Hill,

Norton, Robert L, **Diseño de Máquinas**, 4ª, Editorial Pearson,

Complementary Bibliography

Budinas, Richard, **Shigley□s Mechanical Engineering Design**, 9ª, McGraw Hill,

Norton, Robert L, **Machine Design**, 5ª, Editorial Pearson,

Juvinall, Robert C, **Diseño de Elementos de Máquinas,**, 2ª, Wiley,

Juvinall, Robert C, **Fundamentals of Machine Component Design**, 5ª, Wiley,

Mott, Robert, **Diseño de elementos de máquinas**, 4ª, Editorial Pearson,

Mott, Robert, **Machine Elements in Mechanical Design**, 5ª, Editorial Pearson,

Recomendacións

IDENTIFYING DATA				
English II				
Subject	English II			
Code	P52G381V01406			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	English			
Department				
Coordinator	Douglas , Heidi Jennifer Diane			
Lecturers	Douglas , Heidi Jennifer Diane Gómez Garrido, Sandra Hawthorne , Kaye Louise Muradás Sanromán, Macarena			
E-mail	externo.hdouglas@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	In this subject, students are expected to improve their mastery of the four basic skills of English (listening, speaking, reading, writing) at B2 Level CEFR (Common European Framework of Reference for Languages) in order to foster the use of the language in the professional military environment.			

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

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Identify the basic elements of the political system Spaniard			
OVERALL ORAL PRODUCTION To give clear, systematically developed descriptions and presentations, with appropriate highlighting of significant points, and relevant supporting details. SUSTAINED MONOLOGUE: DESCRIBING EXPERIENCE To give clear, detailed descriptions on a wide range of subjects related to his/her field of interest. SUSTAINED MONOLOGUE: PUTTING A CASE To develop an argument systematically with appropriate highlighting of significant points, and relevant supporting detail. ADDRESSING AUDIENCES To give a clear, prepared presentation, giving reasons in support of or against a particular point of view and giving the advantages and disadvantages of various options. To take a series of follow up questions with a degree of fluency and spontaneity which poses no strain either him/herself or the audience. OVERALL SPOKEN INTERACTION To use the language fluently, accurately and effectively on a wide range of general, academic, vocational or leisure topics, marking clearly the relationships between ideas. To communicate spontaneously with good grammatical control without much sign of having to restrict what s/he wants to say, adopting a level of formality appropriate to the circumstances.	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18

OVERALL WRITTEN PRODUCTION To write clear, detailed texts on a variety of subjects related to his/her field of interest, synthesising and evaluating information and arguments from a number of sources. REPORTS AND ESSAYS To write an essay or report which develops an argument systematically with appropriate highlighting of significant points and relevant supporting detail.	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18
OVERALL LISTENING COMPREHENSION To understand standard spoken language, live or broadcast, on both familiar and unfamiliar topics normally encountered in personal, social, academic or vocational life. Only extreme background noise, inadequate discourse structure and/or idiomatic usage influences the ability to understand. UNDERSTANDING CONVERSATION BETWEEN NATIVE SPEAKERS To keep up with animated conversation between native speakers. LISTENING AS A MEMBER OF A LIVE AUDIENCE To follow the essentials of lectures, talks and reports and other forms of academic/professional presentation which are propositionally and linguistically complex. LISTENING TO ANNOUNCEMENTS AND INSTRUCTIONS To understand announcements and messages on concrete and abstract topics spoken in standard dialect at normal speed. LISTENING TO AUDIO MEDIA AND RECORDINGS To understand recordings in standard dialect likely to be encountered in social, professional or academic life and identify the speaker viewpoints and attitudes as well as the information content.	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18
OVERALL READING COMPREHENSION To read with a large degree of independence, adapting style and speed of reading to different texts and purposes, and using appropriate reference sources selectively. READING FOR ORIENTATION To scan quickly through long and complex texts, locating relevant details. READING INSTRUCTIONS To understand lengthy, complex instructions in his/her field, including details on conditions and warnings, provided s/he can reread difficult sections.	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18
ENAEE Learning Outcome: KNOWLEDGE AND UNDERSTANDING: LO1.3.- Awareness of the wider multidisciplinary context of engineering [Intermediate (2)].	B10		
ENAEE Learning Outcome: INVESTIGATIONS: LO4.1.- Ability to conduct searches of literature, to consult and to critically use scientific databases and other appropriate sources of information, to carry out simulation and analysis in order to pursue detailed investigations and research of technical issues in their field of study [Intermediate (2)].			D5
ENAEE Learning Outcome: COMMUNICATION AND TEAM-WORKING: LO7.1.- Ability to communicate effectively information, ideas, problems and solutions within the engineering community and society at large [Intermediate (2)].		C34	D4 D18
ENAEE Learning Outcome: COMMUNICATION AND TEAM-WORKING: LO7.2.- Ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers [Intermediate (2)].		C34	D4 D7 D8 D17 D18
ENAEE Learning Outcome: LIFELONG LEARNING: LO8.1.- Ability to recognise the need for and to engage in independent life-long learning [Basic (1)].			D8
ENAEE Learning Outcome: LIFELONG LEARNING: LO8.2.- Ability to follow developments in science and technology [Basic (1)].			D8

Contents

Topic	
Unit 6	6.1. Night night 6.2. Music to my ears
Unit 7	7.1. Let's not argue 7.2. It's all an act
Unit 8	8.1. Cutting crime 8.2. Fake news
Unit 9	9.1. Good business 9.2. Supercities
Unit 10	10.1. Science fact, science-fiction 10.2. Free speech

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	22	20	42
Mentored work	22	20	42
Essay questions exam	30	20	50
Essay	4	4	8
Oral exam	4	4	8

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

Methodologies	
	Description
Lecturing	The communicative approach is based on the idea that language learning successfully comes through interspersing different didactic methods. Theory lessons will consist of checking the theoretical knowledge students have and, consequently, teaching the contents designed for completing the knowledge students have previously acquired.
Mentored work	Theory lessons will be completed with practical sessions in which different activities will be done in order to develop students' competence in the four linguistic skills and, therefore, reach the abovementioned goals.

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

Assessment					
	Description	Qualification	Training and Learning Results		
Essay questions exam	Taking into account both the methodologies and the different activities done throughout the whole term (whose main objective is the acquisition of the learning outcomes), the following is the percentage of the global mark corresponding to each part of the exam: Reading - 20% Listening -20% Writing - 30% Speaking - 30% Global - 100% Exams (2 per term) 70% Mid-term exam - 30% Final exam - 40%	70	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18
Essay	Activity 1 (15%)	15	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18
Oral exam	Activity 2 (15%)	15	B10	C34	D4 D5 D7 D8 D9 D15 D17 D18

Other comments on the Evaluation

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

1. Obtain at least 40% on each of the 4 parts of the exam, corresponding to the four linguistic skills.
If the student does not fulfil the abovementioned requirement, the mark of the part of the exam where the student has got the highest mark will become the mark of the final exam and, therefore, of the continuous assessment. This mark will never be higher than 3/10 (3 out of 10) since this is the highest possible mark in each of the two parts of the exam whose marks are the highest (writing and speaking). To pass the subject via continuous assessment, the student should get at least 5 points as a whole.
Ordinary and/or extraordinary exam
In order to pass this exam, it will be necessary to fulfil the following condition:
1. Pass (get at least half of the points on) each of the four parts of the exam, corresponding to the four linguistic skills.
If the student does not fulfil the abovementioned requirement, the mark of the part of the exam where the student has got the highest mark will become the mark of the exam (Exam 2) and, therefore, of the continuous assessment. This mark will never be higher than 3/10 (3 out of 10) since this is the highest possible mark in each of the two parts of the exam whose marks are the highest (writing and speaking). To pass the subject via continuous assessment, the student should get at least 5 points as a whole.
Both in the exams which make up the continuous assessment (mid-term exam and final exam) and in the ordinary and extraordinary exams, all of the students, independently of the class group (1, 2, 3 or 4) they belong to, are being assessed on the same compulsory subject of the Degree in Mechanical Engineering of the Defense College, English II. Consequently, for the speaking part of the exam, students will be grouped by following objective and consistent criteria. Although, if possible, the grouping of students to do the abovementioned part of the exam will aim to be similar to class groups, this will not be compulsory.
IMPORTANT NOTES:1. During the time students are sitting exams, they will be banned from using electronic devices (except the student on duty, who will put her/his mobile on the desk, in sight of the teachers invigilating the exam at issue). If the teachers invigilating the exam realise that a student (except the student on duty, who will be allowed to have the regulatory mobile) has, handles or uses an electronic device, her/his mark will be 0 in the exam as a whole and, if they do so during the ordinary/extraordinary exam, their mark will be 0 in the assessment as a whole. Under no circumstances will there be any special permission to allow the students to have electronic devices during the time they will be sitting exams.
2. The organisation of exam procedures, which is published both on the "orden diaria" and the virtual platform of the subject, will be only and exclusively designed by the coordinator of the subject, who will have reached an agreement with the governing body of the Defense College. Under no circumstances will there be any changes derived from decisions made by people different from the coordinator or the members of the governing body of the Defense College. The mark of those students who do not fulfil the abovementioned requirements will be 0 on the exam and, if they do not fulfil the above mentioned requirements during the ordinary/extraordinary exam, their mark will be 0 on the assessment as a whole.

Sources of information

Basic Bibliography

Latham-Koenig, C. et al., **English File. Upper-intermediate. B2.2. Student's Book**, 4ª, Oxford University Press, 2020

Complementary Bibliography

Collie, J. and S. Slater, **Cambridge Skills for Fluency: Listening**, 1ª, Cambridge University Press, 2008
Collie, J. and S. Slater, **Cambridge Skills for Fluency: Speaking**, 1ª, Cambridge University Press, 2008
Collie, J. and S. Slater, **Cambridge Skills for Fluency: Reading**, 1ª, Cambridge University Press, 2008
Collie, J. and S. Slater, **Cambridge Skills for Fluency: Writing**, 1ª, Cambridge University Press, 2008
Comfort, J., **Effective Presentations**, 1ª, Oxford University Press, 1995
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Ibbotson, M., **Cambridge English for Engineering**, 1ª, Cambridge University Press, 2008
Ibbotson, M., **Professional English in Use. Engineering**, 1ª, Cambridge University Press, 2009
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Redman, S., **Idioms and Phrasal Verbs. Advanced**, 1ª, Oxford University Press, 2011
Swan, M., **Practical English Usage**, 1ª, Oxford University Press, 2005
Thomas, B. and B. Matthews, **Vocabulary for First Certificate**, 1ª, Cambridge University Press, 2007
Vince, M., **First Certificate Language Practice**, 1ª, Macmillan, 2009

Cambridge Dictionary of American English, Cambridge University Press, 2001
Cambridge Dictionary of American Idioms, Cambridge University Press, 2003
Cambridge Phrasal Verbs Dictionary, Cambridge University Press, 2006
Collins Cobuild Active English Dictionary, Collins Cobuild, 2003
Longman Dictionary of Contemporary English, Pearson Longman, 2009
Macmillan English Dictionary, Macmillan, 2004
Oxford Dictionary of English, Oxford University Press, 2010
Oxford Wordpower Dictionary, Oxford University Press, 2001
Random House Webster Unabridged Dictionary, Random House Reference Publishing, 2005
The BBC,
The British Army,
The British Council,
The British Forces Broadcasting Service,
The CNN,
The Guardian,
The Naked Scientists,
The National Army Museum,
The New York Times,
The Royal Air Force,
English Listening,
Lingo Rank,
NATO,
US Department of Defence Dictionary of Military and Associated Terms,
US-based military English website,
Military definitions,
Airforce magazine,
Dudley Knox library, a directory of military information,

Recommendations

Subjects that it is recommended to have taken before

English I/P52G381V01209

Other comments

To take this subject, students are highly encouraged to have taken the subject English Language of the Naval College. Both the knowledge and skills acquired once students haven taken the subject will allow them to be able to succeed in subjects taken later, because at the end of the academic year students are expected to be able to acquire CEFR Level B2. Therefore, to be able to succeed, it is advisable to have the following skills:
-Reading and listening skills
-Writing and speaking skills
-Skill to think abstractly and summarise information
-Skill for group work and communication

IDENTIFYING DATA				
Manufacturing engineering and dimensional quality				
Subject	Manufacturing engineering and dimensional quality			
Code	P52G381V01407			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Suárez García, Andrés			
Lecturers	Carrasco Pena, Pedro Jesús Suárez García, Andrés Troncoso Pastoriza, Francisco Manuel			
E-mail	asuarez@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The main objective of Manufacturing Engineering and Dimensional Quality is to complement the knowledge acquired in the subject "Fundamentals of Systems and Manufacturing Technologies" on manufacturing processes. The student will acquire skills to identify and plan the different stages of the production process from the product design specifications, selecting the different phases, machines, equipment, tools, and verification techniques more convenient. In addition, the knowledge of the student in the development of simple computer numerical control computer-aided design and manufacturing techniques programs will be strengthened.			

Skills	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
B8	Ability to apply the principles and methods of quality.
C26	Applied knowledge of systems and manufacturing processes, metrology and quality control.
D2	Problems resolution.
D8	Decision making.
D9	Apply knowledge.
D10	Self learning and work.
D17	Working as a team.
D20	Ability to communicate with people not expert in the field.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Identify the basic conceptual elements on which bases the European integration and the European Union			
To know the technological base and basic aspects of manufacturing processes.	B3 B8		D2 D8 D9 D10 D17 D20
To understand basic aspects of manufacturing systems.	B3 B8		D2 D8 D9 D10 D20
To acquire skills to select manufacturing processes and to plan manufacturing.	B3 B8	C26	D2 D8 D9 D10 D20
To develop skills to manufacture groups and elements in CAD-CAM environments.	B3	C26	D8 D9 D10

Application of CAQ technologies	B3	C26	D2 D8 D9 D10 D17 D20
ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING LO1.2.- Knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes. Advanced (3).	B3	C26	
ENAEE learning outcome: ENGINEERING ANALYSIS LO2.1.- Ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses. Intermediate (2).		C26	D2 D8 D9
ENAEE learning outcome: ENGINEERING DESIGN LO3.1.- Ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical (societal, health and safety, environmental, economic and industrial) considerations; to select and apply relevant design methodologies. Intermediate (2).	B8	C26	D2 D9
ENAEE learning outcome: ENGINEERING DESIGN LO3.2.- Ability to design using some awareness of the forefront of their engineering specialisation. Advanced (3).		C26	D9
ENAEE learning outcome: ENGINEERING PRACTICE LO5.3.- Understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study. Intermediate (2).			D8 D9
ENAEE learning outcome: ENGINEERING PRACTICE LO5.4.- Ability to apply norms of engineering practice in their field of study. Basic (1).			D9
ENAEE learning outcome: LIFELONG LEARNING LO8.1.- Ability to recognise the need for and to engage in independent life-long learning. Basic (1).			D8

Contents	
Topic	
THEORY	
1. Introduction to industrial production	- Productive system - Industrial revolutions - Concurrent Engineering - Lean manufacturing - Lean Six Sigma
2. Process analysis, simulation and optimization	- Shaping of materials by removal, deformation and molding - CAD, CAE, CAM systems - Additive manufacturing - Software slicer
3. Implementation of manufacturing processes	- Transfer systems - Production lines and systems - Flexible manufacturing systems and cells - Integrated Manufacturing
4. Planning of manufacturing systems	- Design plan analysis - Selection of processes and determination of the manufacturing sequence - Definition of process sheet - Manufacturing technology management
5. Design quality	- Kano model - Fault tree analysis - Failure mode and effects analysis - Design of experiments
6. Manufacturing quality	- Ishikawa diagram - Pareto chart - Statistical process control - Variable control charts - Attribute control charts - Machine and process capacity
7. Inspection and metrology	- Measurement uncertainty - Errors and measurement chains - Traceability and dissemination - Calibration - Calibration plan - The field of dimensional metrology - The metrological organization - Metrological techniques and systems

8. Quality of measurements in industry	- Precision in the industry - Legal and industrial metrology - Evaluation of the quality of the measurements - Tools and techniques to evaluate dimensional quality and its costs. - Modeling and measurement of surface quality. - Systems, machines, inspection and verification equipment in mechanical manufacturing.
PRACTICE	
Practical Sessions 1 and 2: Statistical Process Control	Practical cases of analysis of productive systems through control charts by variables, control charts by attributes and the study of machine and process capacities will be carried out.
Practical sessions 3, 4 and 5: Quality in industry	Tools and techniques will be studied to evaluate the dimensional quality and its costs. In addition, the importance and principles of continuous improvement will be presented through the analysis of real cases. All this will allow to train students for the maintenance and improvement of the basic stability in the organizations.
Practical sessions 6 and 7: Computer Aided Manufacturing	These practical sessions are aimed at the computer-aided design of Personal Protective Equipment (PPE) in accordance with Royal Decree 773/1997 (Directive 89/656/EEC) on the use of PPE and Regulation (EU) 2016/425 on its marketing. The PPE designed will be printed in 3D, and the students must select the material, the manufacturing characteristics, as well as carry out the rapid prototyping of these parts. With these practices, the aim is to apply theoretical knowledge to the machining of parts using Autodesk Inventor software.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	34	62
Practices through ICT	14	0	14
Mentored work	0	14	14
Seminars	7	5	12
Seminars	15	8	23
Essay questions exam	2	0	2
Report of practices, practicum and external practices	0	13	13
Essay questions exam	9	0	9
Problem and/or exercise solving	0	1	1

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

Methodologies

	Description
Lecturing	In these sessions, the basic theoretical contents of the subject will be explained in detail, exposing explanatory examples to deepen the understanding of the subject. The slides and the blackboard will be used in combination. As far as possible, a copy of the slides will be provided to the students prior to the lesson, focusing the effort of the lecturer and students on the exposure and understanding of the knowledge. In any case, paper reproductions of slides should never be considered as substitutes for texts or notes, but as complementary material.
Practices through ICT	In order to contribute to the acquisition of generic competences, the evaluation of practice sessions is proposed either with the preparation of individual reports or with reports by group. When the elaboration of the report is collective and in order to ensure that the interdependence is positive, all the members of the group must have worked and contributed to the final product and must dominate, minimally, all aspects of the practical session.
Mentored work	The didactic method to follow in the delivery of practical classes is that the lecturer mentored the work carried out by the groups in which the students are divided. The practices are aimed at strengthening the theoretical concepts addressed in the lecturing sessions and facilitate the assimilation of the concepts with regard to their application in the design of structures and elements of machines.
Seminars	Given that the tutorial action is addressed as a group support action to the student's learning process by solving problems and exercises, the sessions will be carried out preferably in seminars and in the format of small meeting groups.
Seminars	Intensive course of 15 hours for those students who did not pass the subject in the first call, prior to the examination of the second call. Tutorial groups with the lecturer.

Personalized assistance

Methodologies	Description

Seminars	In the seminars lecturers propose the resolution of problems and study cases related with the lecturing sessions. The faculty will personally answer the questions and queries of the students, both in person (the timetable will be published on the centre's website) and through telematic means (e-mail, videoconference, MooVi forums, etc.) by appointment.
Mentored work	During the practical sessions of the subject different mentored works will be implemented in groups of students. The lecturer will answer personally questions and queries of the students.

Assessment

	Description	Qualification	Training and Learning Results		
Essay questions exam	PI. Two mandatory intermediate tests will be held during the course (PI1 and PI2). PI1 for subjects T1-T4 and PI2 for subjects T5-T7. Each test has a weight of 15% on the final grade.	30	B3 B8	C26	D2 D9 D10 D20
Report of practices, practicum and external practices	MP Delivery of reports to evaluate the knowledge acquired in the practical sessions and mentored works (P1-P7)	20	B3	C26	D2 D8 D9 D10 D17 D20
Essay questions exam	PF Writing final test final to evaluate the global knowledge of the subject (official date of evaluation)	40	B3 B8	C26	D2 D8 D9 D10 D20
Problem and/or exercise solving	CT. Questionnaires and tests will be carried out through online teaching platforms corresponding to the subject matter taught. These will be done during class hours.	10	B3 B8	C26	D2 D9 D10 D20

Other comments on the Evaluation

The final evaluation of the student will be the sum of the score awarded to each of the parts mentioned above and taking into account the requirement of a minimum of 4 in the final exam.

Being, therefore, the continuous evaluation grade:

- In case of meeting the requirements, NEC = 0.40·PF + 0.15·PI1 + 0.15·PI2 + 0.20·MP + 0.1·CT
- In case of not meeting the requirements, the maximum grade obtained will be a 4.

The student must attend to the ordinary examination of all the contents of the subject, which will be 100% of the grade, in the following cases:

- The non-completion or delivery of any of the previous points.
- Get a grade below 4 points out of 10 in the final exam.
- Not having passed the continuous assessment with a 5.

In any case, the student who has passed the continuous assessment, will have the possibility of attending the ordinary exam to raise the grade.

ETHICAL COMMITMENT: Students are expected to have adequate ethical behavior. If unethical behavior is detected (cheating, plagiarism, use of unauthorized electronic devices or others), the student will be penalized with the impossibility of passing the subject by the continuous assessment modality (in which he/she will obtain a grade of 0.0). If this type of behavior is detected in ordinary or extraordinary exam, the student will obtain in the call a score in 0.0.

Sources of information

Basic Bibliography

Kalpakjian, S.; S. R. Schmid, **Manufactura, ingeniería y tecnología**,

Lasheras Esteban, José, **Tecnología Mecánica y Metrotecnia**,

Todd, R., **Fundamental Principles of Manufacturing Processes**,

Complementary Bibliography

Groover, M., **Fundamentos de Manufactura Moderna: Materiales, Procesos y Sistemas**,

Recommendations

Subjects that it is recommended to have taken before

Resistance of materials/P52G381V01204
Fundamentals of manufacturing systems and technologies/P52G381V01402

Other comments

The student who accesses the fourth year of the mechanics engineering bachelor degree, and in particular to this subject, should have a minimum capacity to:
- Written and oral comprehension.
- Abstraction, basic calculation and synthesis of information.
- Use dimensional measurement and verification instruments in the laboratory/workshop.
- Use statistics in the Quality control.
- Dimension and define tolerances adequately and precisely to mechanical elements.
- Represent using 3D CAD parts and basic sets.
- Use and know the manual machine tools and their basic operations.
- Develop basic programs of numerical control in lathe and milling machine, and select the tools.
- Plan processes of machining, deformation and welding to produce parts and/or basic sets.
- Apply the theory of Elasticity and know how to represent tension states through Mohr circles.

If the student accesses without these competences, he/she will not be able to have an optimal learning process and will need a longer time to acquire and update their skills so that the final training is as expected.

IDENTIFYING DATA				
Radio-communication systems				
Subject	Radio-communication systems			
Code	P52G381V01408			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Nocelo López, Rubén			
Lecturers	Nocelo López, Rubén Núñez Ortuño, José María			
E-mail	rubennocelo@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This course, which is part of the specialization module in Naval Technology, introduces the basic principles of radio communication, so much theoretical as practical. During the course we will review the physical phenomena and technological developments that made possible the transmission of information using electromagnetic waves. We discuss the propagation of radio-waves, the organization of the radio-electric spectrum, the operation and design of antennas, and the design criteria for a radio link. Finally, we review the radio-communication systems in use nowadays, with focus on those used in the Navy.			

Skills	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
C27	CITN1 To acquire the ability to understand the mechanisms of propagation of electromagnetic waves and the corresponding organization of the radioelectric space.
C28	CITN2 To know the mechanism of operation of antennas and their different types.
C29	CITN3 To acquire the ability to select equipment, media and transmission systems.
D1	Analysis and synthesis
D2	Problems resolution.
D3	Oral and written proficiency
D8	Decision making.
D9	Apply knowledge.
D10	Self learning and work.
D16	Critical thinking.
D17	Working as a team.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Identify, organize and analyze economic information of critical and systematic form.			
To know the technological base of telecommunication systems	B3	C27 C29	D1 D2 D3 D8 D9 D10 D16 D17
To understand the fundamentals of electromagnetic wave propagation and the organisation of the radio-electric spectrum.	B3	C27	D1 D2 D3 D9 D10 D16 D17

To understand the basic mechanisms of operation of antennas	B3	C28 C29	D1 D2 D3 D9 D10 D16 D17
To understand the basic operation of naval communication systems	B3	C29	D1 D3 D8 D10 D16
ENAEE learning outcome: KNOWLEDGE AND UNDERSTANDING: LO1.3.- Be aware of the multidisciplinary context of engineering [level of achievement (basic (1), intermediate (2) and advanced (3)) of this learning outcome: Basic (1)].		C27 C28 C29	
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.2.- Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognize the importance of non-technical societal, health and safety, environmental, economic and industrial constraints [Intermediate (2)].			D1 D2 D8 D9 D16
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.3.- understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study [Advanced (3)].		C27 C28 C29	D8 D9
ENAEE learning outcome: COMMUNICATION AND TEAM-WORKING: LO7.2.- ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers [Basic (1)].			D3 D8 D10 D17
ENAEE learning outcome: CONTINUOUS TRAINING: LO8.1.- Ability to recognize the need of continuous training, to be carried out along a their own career in an independent way [Advanced (3)].			D8 D10
ENAEE learning outcome: CONTINUOUS TRAINING: LO8.2.- Ability to be keep updated on the last developments in science and technology [Intermediate (2)].			D8 D10

Contents

Topic	
Chapter 1. Introduction	Aims and development: The aim of this chapter is to introduce basic concepts needed to understand the propagation of electromagnetic waves, and the tools needed to analyse the operation and characteristics of radio systems, tools such as spectral analysis and decibels units. Index of the subject 1.1 Historical Perspective: from Oersted to Marconi 1.2 Review of fundamental concepts 1.3 Equation of the travelling wave 1.4 Electromagnetic spectrum 1.5 Decibels
Chapter 2. Antennas	Aims and development: The aim of this chapter is to present the operation of antennas and how to characterize their performance, numerically and graphically. We will see different types of antennas and their application. Index of the subject 2.1 Radiation in free space 2.2 Parameters of the antennas 2.3 Radiation pattern 2.4 Types of antennas
Chapter 3. Link	Aims and development: The aim of this chapter is to present the radio communication system as a whole, and to quantify its feasibility and performance in real circumstances using the link budget. Index of the subject 3.1 Friis Equation 3.2 Noise 3.3 Interference 3.4 Availability

Chapter 4. Radio-propagation	Aims and development: The aim of this chapter is to introduce the mechanisms of propagation of electromagnetic waves in more complex and realistic scenarios. Different strategies are discussed for communication over long distances Index of the subject 4.1 Influence of the terrain. 4.2 Surface wave 4.3 Ionospheric wave 4.4 Space wave
Chapter 5. Modulations	Aims and development: The aim of this chapter is to explain how can electromagnetic propagation be harness to transport information. We introduce the concept of modulation, we discuss its types, characteristics and limitations. Index of the subject 5.1 Basic concepts 5.2 Analog modulation 5.3 A/D conversion 5.4 Digital modulation 5.5 Multiplexing
Chapter 6. Current systems	Aims and development: The aim of this chapter is to present and discuss some of the radio communication systems that are currently in use. Index of the subject 6.1 Management of radio-electric spectrum 6.2 Mobile communication systems 6.3 Satellite communication systems 6.4 Radio-navigation systems 6.5 Radio-communication systems in the Navy
R&D project	Aims and development: The aim of the R&D project is give the student the opportunity to tackle the study of a subject of his election, as long as it is compatible with the contents of the course. We encourage the student to find solutions to open problems using the methods and tools at hand. The R&D project encourages the student to synthesize the acquired results into a multimedia format. During this session the class will review and discuss a selection of the results of the R&D project. The selection criteria will be: quality and compatibility with the course curriculum.
Lab session 1. Introduction	Aims: This first session poses a number of challenges and open exercises that will reinforce some fundamental concepts and units. Virtual laboratories will be used to visualize the propagation of electromagnetic waves, and other fundamental parameters. Students will practice operation with natural and logarithmic units, often making conversions between them, using either manual calculator and Matlab for verification.
Lab session 2. Antennas	Aims: The Lucas-Nülle training station will be used to study the characteristic parameters of a number of antennas (monopole, dipole, Yagi-Uda, slot antenna, etc.). Array antenna will be experiences using simulation software.
Lab session 3. Link	Aims: The students will practice evaluating the radio link budget, identifying and manipulating all the terms involved in Friis equation, as well as other parameters that are used to characterize the performance and overall quality of a radio link, such as SNR, CIR, availability. A practical case will be considered using simulation software.
Lab session 4. Satellite	Aims: The students will establish communication with one or several geostationary satellites. They will have to locate the position of the satellite, aim the antenna, and describe the characteristics of the received signal.

Lab session 5. Radio-propagation	Aims: Students will experience the various modes of propagation of electromagnetic waves, and how that can impact the communication. Several modes of propagation will be studied. The students will identify the propagation mode with the help of a calibrated antenna and a field measuring unit. In case the instrumentation is not available, simulation software will be used to study radio propagation via ionospheric and surface wave.
Lab session 6. Analog modulation	Aims: Basic concepts such as base-band or transmission bandwidth will be reviewed from a practical perspective. Software-defined-radio (SDR) software will be used to compare various analog modulations in terms of quality and bandwidth efficiency. We will review also the demodulation AM and FM signals.
Lab session 7. Digital modulation	Aims: Using SDR software a number of concepts will be reviewed, such as the impact that the digital modulation has on the bit error rate (BER). The students will compare different modulation schemes (ASK, QPSK and QAM) and the differences between their respective characteristic parameters.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	26	26	52
Laboratory practical	14	14	28
Seminars	7	5	12
Project based learning	2	13	15
Seminars	14	8	22
Essay questions exam	13	8	21

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

Methodologies

	Description
Lecturing	Participatory master class. In these sessions, the contents of the program are presented. Examples are used to help students understand the matter. Computer presentations and the blackboard will be used as the main media for content transmission. As much as possible, results will be supported by experiments, either done inside the classroom or shown via videos or other interactive content. A copy of the slides will be available for students prior to the lecture, so that both the lecturer and the students can focus, respectively, on the transmission and reception of the concepts. The slides are provided not as a substitute for textbooks or lecture notes, but as supplementary material. Project-based learning. Two masterclass sessions are programmed to visualize and discuss the results of the R&D projects. A number of projects will be selected according to quality and fitness to the course curriculum, and discussed with the class. Resolution of problems and/or exercises. With these sessions we engage the student in problem solving activities, while boosting skills in collaborative work and interpersonal relations. Active methodologies will be used, as stated in section 4 of this Guide. The student will be presented with a number of problems and challenges that involve other engineering disciplines. This way, students will gain a transversal vision of the contents of the course and will see how it can help addressing the problems in other disciplines. If possible, some time each week will be reserved to group work, although the actual amount of time may vary along the course depending on the current load. During those activities a problem-solving learning method will be followed.

Laboratory practical	Small participatory lectures. Sometimes, it will be convenient to tackle some concepts before the laboratory sessions in this form, to review and expand on the concepts that will be used during the session. Guided laboratory sessions. The procedure in these sessions is as follows: smaller groups of students are formed to solve a number of challenges and problems, with minimal intervention by the lecturer. The aim is to let students arrive to solutions using the knowledge and the tools at their disposal. The lecturer will merely guide the work of the students, by adjusting the difficulty of the tasks to the capacity of each group.
Seminars	Problems sessions. These sessions seek to support the learning process by means of problem solving, either as a group activity or individually. Problems and challenges will be posed to the group. Students will have to reach a solution through discussion and collaboration. Sessions will be preferably held in groups of around 10 students, although individual sessions can also be arranged.
Project based learning	We propose a R&D project with an open topic to be carried out by a group of 2 students. The procedure is as follows: we provide the students with a list of videos, as reference. Said videos show demonstrations or tutorials related to the course curriculum; for example: the design and implementation of a AM receptor or an experimental demonstration of ionospheric refraction using a scale model. We ask the students to make a similar video, with free topic but within the course contents. The aim of this project is to encourage students to acquire knowledge by themselves, employing any tool or method at their disposal. On top of that, we boost skills for autonomous investigation, problem solving, and capabilities in synthesis and presentation.
Seminars	This corresponds to an intensive course that reviews the main concepts and problems in preparation for the extraordinary exam.

Personalized assistance

Methodologies	Description
Seminars	We offer students both group and individualized tutoring. In the former, students have access to tutoring hours where lecturers are available to discuss any topic related to the course content, organisation, and planning. During these hours the lecturer can propose problems related to the course curriculum, either to reinforce the contents already presented or to challenge and deepen the student mastery of the subject. In the latter, the lecturer is available to each student to address any issue that may be hindering the student performance, or preventing him/her to follow the course. The aim of these sessions is to find, between both, some solution to these problems. Using both types of tutoring we adapt for the different learning speeds, and we address diversity outreach. The course lecturers will respond personally to all the doubts and questions that the students may rise. This will be done either in face-to-face meetings, according to the schedule published in the website of the center, or through telematic means (such as email, videoconference, Moovi forums, etc.) if the course is held online

Assessment

	Description	Qualification	Training and Learning Results		
Lecturing	It consists of 3 written exams: containing theoretical questions and problems covering the curriculum of the course. The distribution of the three exams is as follows: First mid-term: it covers chapters 1 and 2, and has a weight of 15% of the final grade. Second mid-term: covers chapters 3 and 4, and has a weight of 15% of the final grade. Final examination: covers all chapters (from 1 to 6) and has a weight of 40% of the evaluation. The R&D project grade is awarded by the lecturer in terms of quality and relevance to course curriculum. It has a weight of 10% of the final grade.	80	B3	C27 C28 C29	D1 D2 D3 D8 D9 D10 D16
Laboratory practical	Groups of 2/3 students follow the laboratory procedures and deliver a log of the work done in each lab session. The lecturers will grade each deliverable, in terms of correctness and mastery of the session contents. The lab grade, calculated as the arithmetic mean of the grades of all deliverable, has a weight of 20% of the final grade.	20	B3	C27 C28 C29	D1 D3 D9 D10 D17

Other comments on the Evaluation

On the lab sessions

If a lab session is missed, or if the log is not delivered before deadline, the grade for that deliverable would be 0.0. The student will be responsible for notifying the reason of absence before the publication of the session grades. It is up to the lecturer to decide whether the provided reason constitutes proper justification.

In case one session is missed, and it is properly justified, the final lab grade will be computed using the remaining grades. If more than one session is missed, and all are properly justified, the student will be given de opportunity to carry out the lab work on another date, or, alternatively, deliver an essay that covers the contents of the relevant lab work.

A minimum grade of 4,0 points over 10 is required in the lab sessions to pass the course.

Final grade and requirements to pass the course in continuous evaluation

To ensure that the student acquires the skills specified in the course plan a minimum grade is required in the following sections:

- 4,0 points over 10 in the final exam grade, and
- 4,0 points over 10 in the lab sessions grade.

The student will pass the course if, having complied with the requirements above, the calculation of the continuous evaluation grade (CEG) is equal or higher than 5,0 points over 10. Failing to comply with the requirements, the CEG cannot be greater than 4,0. If a student does no pass the course in the continuous evaluation modality, he/she will have to attend the regular exam. Students may decide to attend the regular exam to improve their grade.

Regular exam

The regular examination grade (REG) uses the same weights as in continuous evaluation: 80% for the theory and 20% for lab sessions.

It will consist of a single written exam, that will cover all the course curriculum, both theory and practical. The exam will have a duration of 3 hours, and can take the form of a multiple-choice test, a short answers test, a problem exam, or a combination of the former.

The student will pass the course if the REG is equal or greater than 5,0 points over 10. The student that fails the regular exam has to attend the make-up exam.

First call grade

The grade of the first call is calculated as the maximum of the continuous evaluation grade (CEG) and the regular examination grade (REG)

Second call grade (Make-up exam)

A make-up exam is offered for those that have not reached the course requirements in the first call. The format and requirements are the same than those of the regular exam.

Ethical commitment: The Center is both a military academy and a university center, and the student must therefore comply with the obligations imposed by both institutions.

As a university student, he/she must "abstain of the use of fraudulent means, or cooperation with, in any examination, deliverable, or official document from/to the university" as stated in the Statute of the University Student ("Estatuto del Estudiante Universitario"), approved by the Royal decree 1791/2010 of 30 December, in article 12, point 2nd.

As a military student, he/she "will fulfill with accuracy his duties and obligations promoted by a feeling of honor, [...]" as stated in the Military Career Law ("Ley de la Carrera Militar"), in its fifteenth rule.

If an unethical behavior is detected (either copy, plagiarism, use of unauthorized electronic devices, or any other mean) in any examination or deliverable, during continuous evaluation, all the students involved in the deed will be awarded a 0.0 grade in that test (either theoretical or practical). If unethical behavior is detected in a regular or make-up exam, the students involved in the deed will be awarded a 0.0 grade in said call.

Sources of information

Basic Bibliography

Hernando Rábanos, José María, **Transmisión por radio**, 6ª, Centro de Estudios Ramón Areces, 2008

Arias Acuña, Alberto Marcos; Rubiños López, José Oscar, **Radiocomunicación**, Andavira, 2011

Apuntes da asignatura,

Complementary Bibliography

Balanis, Constantine A., **Antenna Theory. Analysis and Design**, 4ª, John Wiley & Sons, 2016

Griffiths, John, **Radio wave propagation and antennas: an introduction**, Prentice Hall, 1987

Couch, Leon W., **Digital & analog communication systems**, 8ª, Pearson Education, 2013

Burillo Martínez, Vicente [et. al., **Comunicaciones analógicas y digitales Vol. I**, 1ª, UPM, Dpto. Ing. Sistemas Telem., 1991

Kim, John C.; Muehldorf, Eugene I., **Naval shipboard communications systems**, 1ª, Prentice Hall, 1995

Recommendations

Subjects that it is recommended to have taken before

Fundamentals of electrical engineering/P52G381V01205
Mathematics: Calculus II and differential equations/P52G381V01201
Electronic technology/P52G381V01301

IDENTIFYING DATA				
Naval engines and machines				
Subject	Naval engines and machines			
Code	P52G381V01409			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Pérez Collazo, Carlos			
Lecturers	Álvarez Feijoo, Miguel Ángel Pérez Collazo, Carlos			
E-mail	carlos.perez.collazo@cud.uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	This learning guide presents the information relative to the subject of Naval Engines and Machines of the 4th course of the Bachelor Degree in Mechanical Engineering. The guide collects the skills that the students have to acquire in this course, the calendar of planned educational activities, the contents and their temporal programme, an estimation of the student's volume of work and the specific criteria of evaluation. Naval Engines and Machines will cover the propulsion and auxiliary systems that can be find in the Navy ships. Besides, combustion engines thermal cycles will be studied, mainly Otto and Diesel; then Marine Diesel engines will be covered in a deeper way, studying the parts of the engines in existent engines in the laboratory, observing material and manufacturing processes of the different parts, realising the multidisciplinary aim of the subject. This subject of the Bachelor Degree in Mechanical Engineering showcases to the student the main types of naval engines, the configurations of the control and propulsion systems, and the auxiliary systems of heat pumps, water and waste treatment, etc.			

Skills	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
B4	Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of Industrial Engineering in Mechanical specialty.
B5	Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
B6	Capacity for handling specifications, regulations and mandatory standards.
B7	Ability to analyze and assess the social and environmental impact of the technical solutions.
C35	CITN9/OPT5 Applied knowledge of energy systems and naval propulsion.
C36	CITN10/OPT6 Knowledge of naval equipment and naval auxiliary systems.
C37	CITN11/OPT7 Applied knowledge of naval electrical systems.
D1	Analysis and synthesis
D2	Problems resolution.
D3	Oral and written proficiency
D5	Information Management.
D7	Ability to organize and plan.
D8	Decision making.
D9	Apply knowledge.
D10	Self learning and work.
D15	Objectification, identification and organization.
D16	Critical thinking.
D17	Working as a team.
D20	Ability to communicate with people not expert in the field.

Learning outcomes	
Expected results from this subject	Training and Learning Results
New	
New	

Get to know the technological base that supports internal combustion engines.	B3 B4 B5	C35 C36	D3 D5 D7 D8 D9 D10 D15 D17 D20
Get to know and understand the operation of a propulsion plant of the Navy Vessels.	B3 B4	C35 C36 C37	D1 D2 D3 D5 D7 D9 D10 D15 D17 D20
Get to know the main auxiliary systems that support the propeller plants on Navy vessels.	B3 B4 B6 B7	C35 C36 C37	D1 D2 D3 D5 D7 D9 D10 D15 D16 D17 D20
ENAEE learning outcomes: KNOWLEDGE AND UNDERSTANDING: LO1.3 - Be aware of the multidisciplinary context of the engineering. [Level of development (basic (1), intermediate (2) and advanced (3)) of this sub-result: intermediate (2)].		C35 C36 C37	
ENAEE learning outcomes: ANALYSIS IN ENGINEERING: LO2.2.- The capacity to identify, formulate and resolve problems of engineering in his speciality; choose and apply of suitable form analytical methods, of calculation and experimental already established; recognise the importance of the social restrictions, of health and security, environmental, economic and industrial. [Level of development (basic (1), intermediate (2) and advanced (3)) of this sub-result: Intermediate (2)].	B4		D1 D2 D8 D9 D16
ENAEE learning outcomes: PRACTICAL APPLICATION OF THE ENGINEERING: LO5.3.- Knowledge of application of materials, equipment and tools, technology and processes of engineering and its limitations in the field of its speciality. Level of development (basic (1), intermediate (2) and advanced (3)) of this sub-result: Intermediate (2)].		C35 C36 C37	D8 D9
ENAEE learning outcomes: PRACTICAL APPLICATION OF THE ENGINEERING: LO5.5.- Knowledge of the social implications, of health and safety, environmental, economic and industrial practice of the engineering. [Level of development (basic (1), intermediate (2) and advanced (3)) of this sub-result: Intermediate (2)].	B7		

Contents	
Topic	
Block 1: Engines of internal combustion.	T1.1. Review of thermal engines. T1.2. Diesel engines. - Classification of the diesel engines. - 2 and 4 strokes diesel engines. - Diagrams. - Otto-Diesel comparative. T1.3. Main components of marine diesel engines. T1.4. Refrigeration and lubrication systems. T1.5. Fuel injection system. T1.6. Marine gas turbines.

Block 2: Current marine propulsion systems.	T2.1. Introduction to marine propulsion systems. - Classification of the marine propulsion systems. - Types of propellers. - Cavitation. - The MARPOL agreement and the emissions reduction commitments. - Future trends in marine propulsion systems. T2.2. Combined propulsion systems. - CODAD. - CODOG/CODAG. - COGAG. - CODEOG. T2.3. Electrical propulsion systems. T2.4. Azipodal propulsion. T2.5. Nuclear propulsion and propulsion in submarines. T2.6. Vessel electrical systems. - Electrical power plant of an F-100. - Integrated control platform system(SICP). - General diagram of the electrical power plant of an F-100 and working modes. T2.7. Propulsion plant support systems. - Centrifugal treatment systems. - Fresh and salt water cooling systems. - Refrigeration systems for vessels.
Block 3: Auxiliary systems.	T3.1. Data acquisition systems. - Temperature, pressure and flow. - Level and angular velocity. T3.2. Marine air compressors. T3.3. Heat exchangers. T3.4. Marine pumping systems. - Continuous flow and positive displacement pumps. T3.5: Water discharge systems. - Vacuum faecal plants. - Faecal water treatment. - Decantation and electrolytic cell treatment plants. - Separation of bilges by decantation. - Coalescent bilge separator. T3.8. Vessel steering and stabilisation systems. - Electrohydraulic power transmission systems. - Electrohydraulic rudder servomotor. - Electromechanical power transmission. - Electromechanical rudder servomotor. - Basics of stabiliser fins. - Anti-balance tanks. - Gyro-stabilisers. - Stabiliser rudders.
PL1: Combustion engines.	Study of the operation of combustion engines.
PL2: Diesel engines.	Study of the operation of marine diesel engines.
PL3: 2-stroke engines.	Study and analysis of the operation of 2-stroke engines. For this, students will work in groups disassembling 2-stroke engines with the available tools.
PL4: 4-stroke engines.	Study and analysis of the operation of 4-stroke engines. For this, students will work in groups disassembling 4-stroke engines with the available tools.
PL5: Gas turbines.	Parametric study and operation of gas turbines.
PL6: Vessel electrical systems.	Study and analysis of the configuration and operation of the electrical installation in military vessels, as well as the process to connect and disconnect them to an onshore power supply.
PL7: Vessel auxiliary systems.	Parametric study and operation of various auxiliary systems in vessels.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	28	56
Laboratory practical	14	14	28
Project based learning	5	19	24
Problem solving	2	0	2
Seminars	15	9	24

Essay questions exam	16	0	16

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

Methodologies

	Description
Lecturing	The lecturer presents the fundamental contents of the matter object of study, on a theoretical basis and/or the guidelines for a personal work, exercise or project to develop by the student.
Laboratory practical	Activities of application of the knowledge to concrete situations and of acquisition of basic skills and procedures related with the matter object of study. To be developed in special spaces with specialised equipment (laboratories, computer classrooms, etc.).
Project based learning	Method in which the students develop a project over a fix period to resolve a problem or tackle a task by means of the planning, design and completion of a series of activities.
Problem solving	Activity in which problems and/or exercises related with the subject are proposed. The student has to develop the suitable or correct solutions by means of the application of routines, equations or algorithms, the application of procedures of transformation of the available information and the interpretation of the results. To be used as suport of lectures.
Seminars	Intensive course of 15 hours for those students who did not pass the subject in the ordinary announcement, previous to the examination in second announcement. These will involve group tutorials with the lecturer.

Personalized assistance

Methodologies	Description
Lecturing	The tutorial action distinguishes actions of academic attention as well as personalised attention. In the first one, students will have available attention hours in which they can ask any question related with the contents, organisation and planning of the subject. In the personalised attention, each student, in an individual way, would be able to comment with the lecturer any problem that may prevents him to make a suitable follow-up of the subject, aiming to find between both some type of solution. Bringing together both types of attention, aims to compensate the different learning rhythms by means of the attention to the diversity. The lecturers of the subject will answer the questions and queries of the students in a synchronous form in physical or virtual offices under the modality of a previous appointment or asynchronous by online means (email, forums of MOOVI, etc.).

Assessment

	Description	Qualification	Training and Learning Results		
Lecturing	Written assessments: theoretical questions and problems. The written assessments have the aim of evaluating the learning of all the theoretical contents of the subject. These must consist in questions where conceptual and logical reasoning should prevail, to verify the intellectual maturity of the students by obtaining conclusions from the notions or the exposed theories in class.	25	B3 B4 B5 B6 B7	C35 C36 C37	D1 D2 D7 D9 D15 D16
Laboratory practical	The evaluation of the labs will involve laboratory reports (MP) which the student will have to submit.	10	B3 B4 B5 B6 B7	C35 C36 C37	D1 D2 D3 D7 D9 D10 D15 D16 D17 D20
Project based learning	The project will consist in a work in groups of students. This will be evaluated in a way that individual work is assessed, together with the positive independence (i.e., each member of the group should have to had participated and collaborated to the final version of the project).	25	B3 B4 B5 B6	C35 C36 C37	D3 D5 D7 D8 D9 D10 D15 D16 D17 D20

Essay questions exam	Final assessment of the continuous evaluation (assess all the contents of the matter).	40	B3 C35 D1 B4 C36 D2 B7 C37 D7 D9 D15 D16

Other comments on the Evaluation

The final assessment will have to the following characteristic. In the first place, it has to be complete, that is to say, will cover all given matter, since it judges what the student knows of a subject, no of a single part of it. Second, it has to contain problems and questions, to verify the intellectual maturity of the students to obtain conclusions from the notions and exposed theories in class. In third place, has to provide a greater weight to that part of the matter that has not been already evaluated in the previous continuous evaluation. In fourth place, the assessment will consist on two different parts, one covering the contents of Parts (1, 2 and 3) and the second one for Parts (4, 5 and 6). It will be carried out during the assessment week and will be marked over 10 points.

The interim assessments (2) aims to better follow the matter by the student, and in these part of the contents will be assessed. Each one of the interim assessments will have a proportional weight (12,5%).
The project based learning will be carried out in groups of students, and will represent the 25% of the final mark. The project will have to be evaluated so that it guarantees the individual requirements and a positive independence, this means that all the members of the group have to have worked and contributed to the final product and have to dominate, up to a minimum, all the aspects of the project. All have to show, therefore, a deep knowledge of the product delivered, independently of the part in which they had centred their efforts.

The evaluation of the labs will be carried out by means of reports, where the knowledge acquired by the students during the laboratory classes will be assessed. This will represent the 10% of the total mark.

The overall final mark of the student will represent the sum of the marks awarded to each one of the before commented parts, being the continuous evaluation mark (NEC). To pass the matter by Continuous Evaluation, the final mark (NEC) will have to be greater or the same to 5, and will be calculated in the following way:
NEC = 0,40*PF + 0,25*PI + 0,25*EBP + 0,10*MP
If the NEC is lower than 5, the student will have to go to the ordinary examination of all the contents of the subject, that will represent 100% of the mark. Besides, the student will have to go to the ordinary examination in the following assumptions:

- The no realisation or delivery of any of the previous interim assessments.
- To obtain a lower mark to 4 over 10 in any one of the two parts of the final written assessment of the continuous evaluation.

In any one of these assumptions, the mark of continuous evaluation will be calculated as:

NEC FINAL = min (4, NEC)

Furthermore, all those students that wish to improve their mark obtained at the continuous evaluation will be able to attend the ordinary examination.

In both, the ordinary call as well as in the extraordinary (July call) all the competencies of the subject will be assessed.

ETHICAL COMMITMENT:

It is expected that students will follow a suitable ethical behaviour. If it is detected the minimum little ethical misbehaviour (cheating, plagiarism, use of unauthorised electronic devices or others) the student will be penalised with the impossibility to pass the subject by the modality of continuous evaluation (in which it will obtain a mark of 0.0). If this type of behaviour is detected during an ordinary or extraordinary assessment, the student will obtain in such call a mark of 0,0.

Sources of information

Basic Bibliography

Muñoz M. y Payri F., **Motores de combustión interna alternativos**, Reverté, 2011

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Manzarredo Beutel, L., **Evolución de la propulsión naval mecánica**, Fondo editorial de ingeniería naval, 1992

Delgado Lallemand, L., **De proa a popa. Tomo 2: Equipos del barco**, Thomson, 2007

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Heywood J.B., **Internal Combustion Engine Fundamentals**, McGraw Hill, 1988
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Cabronero Mesas y Payri F., **Motores de combustión interna alternativos**, 2ª Ed, Servicio de Publicaciones de la Universidad de Val, 1992
Haywood, R.W., **Ciclos termodinámicos de potencia y refrigeración**, Limusa, 2000
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Basshuysen, R., **Internal Combustion Engine Handbook**, SAE Internacional, 2004
Mollenhauer, K. y Tschöke, H., **Handbook of Diesel Engines**, Springer, 2010
OMI, **Convenio internacional para prevenir la contaminación por los buques (MARPOL)**, 1978

Recommendations

Subjects that it is recommended to have taken before

Thermodynamics and heat transfer/P52G381V01203
Thermal engineering I/P52G381V01403

Other comments

The subject Machines and Naval Engines constitutes the culmination of the studies of thermal and energetic systems already initiated in Thermodynamics and Heat Transfer, and continued in Thermal Engineering I. This discipline requires of a necessary conceptual base for its correct understanding.
Besides, the student has to possess:
- Capacity of written and oral understanding very developed.
- Capacity of abstraction, basic calculation and synthesis of the information.
- Skills for group work and for public speaking.

IDENTIFYING DATA				
Basics of topography				
Subject	Basics of topography			
Code	P52G381V01410			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Puente Luna, Iván			
Lecturers	Puente Luna, Iván			
E-mail	ipuente@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The course of Basics of Topography is composed of a total of seven units (theoretical teaching) that are complemented with practical classes. Depending on the objectives of the units, this course is divided into two different sections: - Section I: Topography. Composed of four units including basics aspects of topography, preparation of plans and their application to land works. - Section II. Other geomatic techniques. Composed of three units, including complementary techniques most commonly used for the recognition and representation of the terrain.			

Skills	
Code	
B3	Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
B4	Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of Industrial Engineering in Mechanical specialty.
B5	Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
C42	CITN16/OPT12 The level of topographic skills to trace and follow trails over unknown terrain
C43	CITN17/OPT13 Acquire knowledge of topography and its application to the representation of the land and works.
D2	Problems resolution.
D3	Oral and written proficiency
D7	Ability to organize and plan.
D8	Decision making.
D9	Apply knowledge.
D10	Self learning and work.
D17	Working as a team.
D20	Ability to communicate with people not expert in the field.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Identify the basic elements of the political model-territorial Spaniard			
To know the technological base on which the topography and elaboration of plans are based.	B3 B4 B5	C42 C43	D2 D3 D7 D8 D9 D10 D17 D20
To understand the basic aspects of the application of Topography to land works.	B3 B4	C42 C43	D2 D9
To know other complementary geomatic techniques for the recognition and representation of the land.	B3 B4 B5	C42 C43	D2 D3 D7 D8 D9 D10

ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)].	B3		
ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.2.- ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical societal, health and safety, environmental, economic and industrial constraints [Intermediate (2)].	B4		D2 D8 D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.1.- understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study [Intermediate (2)].			D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.2.- practical skills for solving complex problems, realising complex engineering designs and conducting investigations in their field of study [Intermediate (2)].	B4 B5		D2 D9
ENAEE learning outcome: ENGINEERING PRACTICE: LO5.3.- understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study [Intermediate (2)].		C42 C43	D8 D9
ENAEE learning outcome: COMMUNICATION AND TEAM-WORKING: LO7.1.- ability to communicate effectively information, ideas, problems and solutions with engineering community and society at large [Intermediate (2)].	B4		D3 D20
ENAEE learning outcome: COMMUNICATION AND TEAM-WORKING: LO7.2.- ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers [Intermediate (2)].			D7 D8 D10 D17

Contents

Topic	
Unit 1. Introduction to Topography. Objectives: to update and review the concepts acquired by the students in the previous subjects of Topography within the specific military training. To consolidate a scientific knowledge of the basics of Topography.	1.1 Definitions. Relation of Topography with other sciences. Geodesy and Topography. Shape of the Earth: geoid and ellipsoid. Geodesic methods. Geodesic reference systems. Datum or fundamental astronomical point. Base and geodesic triangulation. Geodesy by satellite. Limit of a topographic survey. Influence of the Earth curvature in planimetry and altimetry. 1.2 Graphic representation systems. Projections. Orthogonal projection and system. Graphic representation of the terrain. Maps, charts and planes. Graphic and numerical scales. Triangulation, geodesic and topographic networks. 1.3 Cartography. Cartographic projections. Deformations and local scale. Classification of the projections. Mercator's Projection. UTM Projection. UTM grid. 1.4 Coordinates: Cartesian and polar coordinates. Geographic coordinates. Transformation of coordinates. Lines and distances. Concept of geodesic line. Angles and alignments. The terrestrial magnetic field. Magnetic declination. Magnetic and grid azimuths.
Unit 2. Instruments and systems used in Topography. Objectives: To identify and know the different instruments and systems commonly used in Topography. To acquire the necessary ability and skills for a basic management of real Topographic equipment to be used by the students during the practical sessions of the subject.	2.1 Topographic observations. Uncertainty and errors in Topography. General concepts of geometrical optics. Optical instruments. Prisms and lens. Telescopes. Topographic telescope. 2.2 Auxiliary Topographic elements: tripods, levels, platforms for levelling, plummets. Theodolites and tachymeters. Horizontal and vertical circles, vernier and micrometers. Goniometers. 2.3 Total Station. Operation of the Total Station. 2.4 Global Positioning System (GPS). Application of the GPS in geodesy and topography. 2.5 Units of measure: length, surface, angular units. Centesimal and sexagesimal systems. Transformation of units between systems. 2.6 Horizontal and vertical angles. Errors.
Unit 3. Topographic methods: planimetry and altimetry. Objectives: To know and apply the planimetric methods to properly represent a terrain into a flat surface. To know and apply the altimetric methods to properly represent the altitude and morphology of a terrain.	3.1 Planimetric methods. Method of abscissas and ordinates to an unique axis. Method of decomposition in triangles. Method of alignments. Method of radiation. Itinerary or poligonation. Method of intersections: direct and inverse intersection, mixed intersection, graphic and numerical solutions. 3.2 Altimetric methods. Levels and telescopic sights: description. Comparison plane: heights, differences of level and altitude. Trigonometric levelling. Geometrical levelling. 3.3 Digital Model of the Terrain (MDT). Contour lines. 3.4 Interpretation of planes. Visibility between two points in the terrain.

Unit 4. Applications of the Topography. Objectives: To be able to apply the theoretical and practical contents of the topography for the realisation of the different topographic works and its applications on construction as well as in other fields.	4.1 Topographic, cadastral and urban surveys. Topography in mining and tunnelling. Surveying for engineering projects. Design of a topographic project. 4.2 Profiles: longitudinal and transversal. Land movement: slope and land clearing. Civil work. Construction stakeout surveys. 4.3 Defensive organisation of the terrain. Construction of tracks and forest paths.
Unit 5. Introduction to Geomatic. Objectives: To know the different geomatic techniques for cartographic production.	5.1 Definition and fundamentals of the geomatic as source of data for cartographic production. 5.2 Introduction to long-range systems: spatial remote sensing. Landsat and Spot sensors. 5.3 Introduction to close-range systems: photogrammetry and LiDAR technology (aerial and terrestrial systems). 5.4 Introduction to the geophysical prospection: georadar and acoustic (sonar). Bathymetries.
Unit 6. Geographic Information Systems (GIS). Objectives: To know and apply the fundamentals of Geographic Information Systems, as well as the management of large amounts of cartographic and geographic data in different formats.	6.1 Concept of Geographic Information System (GIS). Differences between GIS, database and CAD. 6.2 Concepts about geographic and spatial information: data and metadata. Raster and vectorial models. Geoprocessing. Digitization and georeferencing of data. 6.3 Main applications of GIS for the management and planning of the territory. Military GIS. 6.4 Phases of a GIS project. Basic concepts of Thematic Cartography. 6.5 Cartographic data sources. Web GIS and Spatial Data Infrastructure (SDI).
Unit 7. Photogrammetry and its applications. Objectives: To know the techniques of the photogrammetry and its applications, both in civil and military fields. To understand the importance of the photogrammetry as a tool to produce maps and plans, as well as its utility for georeferencing a territory.	7.1 Aerial photogrammetry and its applications. The photography as a conical perspective. Types of aerial photographs. Aerial photography and plane: comparison. Photogrammetry. Generalities and definitions. Applications. The problem of the photogrammetry. Perspective beams. The aerial and the metric cameras. Internal data of the projective beams. Identification of homologous rays. External data of the projective beams. Control points. Intersection of homologous rays. Photogrammetric restitution. Accuracy of photogrammetric surveys. 7.2 The orthophoto. Close-range photogrammetry. Instruments and data acquisition: cameras. Measuring instruments. Methods. Applications: industrial photogrammetry, photogrammetry applied to civil engineering and architecture.
Practical Activity 1. First contact with topographic instrumentation.	Total Station and the measurement of areas.
Practical Activity 2. Planning a topographic survey in the field and design of a closed itinerary.	Method of itinerary in the field.
Practical Activity 3. Method of radiation in the field.	Acquisition of strategic and filling points.
Practical Activity 4. Elaboration of the point cloud and calculation of coordinates.	Generation of planimetry.
Practical Activity 5. MDT. Contour lines. Longitudinal and transversal profiles.	Generation of altimetry.
Practical Activity 6. Development of a GIS case study.	Geoprocessing and Thematic Cartography.
Practical Activity 7. Session dedicated to the presentation of the final projects.	Evaluation of the field project regarding the elaboration of a topographic survey.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	35	63
Field practice	6	6	12
Problem solving	7	7	14
Practices through ICT	4	4	8
Seminars	15	16	31
Project based learning	4	4	8
Essay questions exam	14	0	14
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Lecturing	The lecturer will expose in the theoretical classes the contents of the subject. The presentations will be screened and the blackboard will be simultaneously used, as well as to the sporadically use of computerized systems. The student will have copies of the material projected, to facilitate them for taking notes and follow-up the sessions. The students will be able to consult basic bibliography for the follow-up of the subject. The participation will be encouraged through questions, motivational techniques such as intentional errors, incomplete solutions, etc.
Field practice	During the field sessions, the student will use topographic instrumentation in groups of 3-4, in order to learn the process of data acquisition. The students have to deliver, individually or as a group according to previous indication by the lecturer, the resolution of some practical case studies proposed at the end of each session. The lecturer will evaluate both the deliver of the proposed exercise as well as the results presented. If the report is delivered blank with the name of the student, it will be failed (0,0). If the report is a plagiarism of another one, the evaluation for all the practical section (outdoor study and Project) will be failed (0,0). These deliveries will serve to evaluate the phase of development of a topographic survey and data processing in the final Project. The lecturer will establish the deadline for each deliver at the end of the sessions, although it should not be extended more than two weeks from their realization.
Problem solving	The lecturer will propose activities to solve exercises related to the contents explained in the theoretical sessions, following a learning methodology based on problems.
Practices through ICT	The practical sessions in the computer room will be carried out using the means available in the center. For some sessions, Topocal software will be necessary to manage different tools for the generation of plans and other concepts explained in the theoretical sessions, and AutoCAD software will be needed for the edition of plans. The software gvSIG will be also used for the geospatial analysis of geographic data, as well as for the elaboration of thematic cartography.
Seminars	Intensive course (15 hours) for those students who have failed the subject at first call, prior to the exam in second call. Group tutoring with the lecturer.
Project based learning	The students have to submit, at the end of the semester, a final Project. This Project must include all the practical procedures carried out during the outdoor study in order to perform a topographic survey, the data processing in laboratory and the elaboration of the planimetric and altimetric planes. The Project will be carried out in group (3-4 students) and the results will be presented in both forms: (1) a Project report and (2) a public presentation to the lecturer and the rest of the students in the subject. The lecturer will evaluate both the content on the report and the quality in the presentation. All the students have to participate in the public presentation. Otherwise, the project assessment will be failed (0,0).

Personalized assistance

Methodologies	Description
Problem solving	The lecturer will solve the questions of the students both in person, according to the tutoring schedule published on the web page of the CUD, as well as through telematic means (email, videoconference, MooVi forums, etc.) with previous appointment.
Project based learning	The lecturer will solve the questions of the students both in person, according to the tutoring schedule published on the web page of the CUD, as well as through telematic means (email, videoconference, MooVi forums, etc.) with previous appointment.
Seminars	Group tutoring with the lecturer, either personally or through telematic means.

Assessment

	Description	Qualification	Training and Learning Results		
Lecturing	A mid-term exam, in a continuous assessment, to evaluate the knowledge acquired by the students in the theoretical sessions of initiation to the topography and topographic surveys.	15	B3 B4	C42 C43	D2 D8 D9
Problem solving	Practical tests of laboratory/seminar to evaluate the resolution of exercises or case studies and the implementation of the theoretical knowledge acquired.	15	B3 B4 B5	C42 C43	D2 D7 D9 D10
Project based learning	Project evaluation. The development of the project is evaluated, as well as the final report delivered, results and quality of the public presentation.	30	B3 B4 B5	C43	D2 D3 D7 D8 D9 D17 D20

Essay questions exam	A final exam, in a continuous assessment, covering all the contents of the subject.	40	B3 B4	C42 C43	D2 D8 D9

Other comments on the Evaluation

A numerical rating system with values from 0.0 to 10.0 points will be used according to current legislation (R.D. 1125/2003 of September 5, B.O.E. No. 224 of September 18). The subject will be considered passed when the student achieves a minimum qualification of 5.0 points.

The evaluation techniques of the subject will be:

- Final exam in continuous assessment (up to 40% of the total qualification): a final exam will be carried out covering all the contents of the subject, both theoretical and practical. It is required to achieve a minimum score of 4.0 points over 10 possible to pass the subject. The action of cheating in an exam will be penalized, and the student will be qualified in this component with 0.0 (failed).
- Mid-term test in continuous assessment (up to 15% of the total qualification): An evaluation test will be carried out throughout the semester. The test will be carried out, proposed by the lecturer, at the most appropriate times within the theory classes of the subject. This test will be mandatory and required to pass the subject. The action of cheating in an exam will be penalized, and the student will be qualified in this component with 0.0 (failed).
- Individual work based on a GIS case study (up to 15% of the total qualification): The students, individually, have to present a work based on a practical case study to be solved with GIS tools, including: purpose of the analysis, input data, analysis tools and / or geoprocessing, the results obtained and the thematic cartography elaborated.
- Development of a project (up to 30% of the total qualification): During the semester, the students have to develop a topographic survey in groups of 3-4 students. At the end of the semester, the students have to present the project in a public presentation. The presentation will be planned on the day and time previously communicated to the students and with the evaluation criteria previously indicated by the lecturer (evaluation rubric). All the students have to participate in the public presentation. Otherwise, the Project qualification will be 0.0 (failed).

Regarding the evaluation criteria and qualification of the project-based learning, the total score of the activity (30%) will be the sum of the following partial evaluations: project development (10%), content of the project report (10%) and contents and quality of the presentation (10%). In the project development, the delivery of the partial results of the project, which are obtained after each field session, will be taken into account. Both the delivery of documents and the calculation procedures and the correct resolution will be assessed. The deliveries have to be presented on time (except for properly justified reasons). Otherwise, the student will be qualified in this component with 0.0. The final qualification of this component will be reduced depending on the number of deliveries not presented on time.Those students who have not reached the minimum score in any of the qualifying tests in continuous assessment will obtain a maximum score of 4.5 in continuous evaluation.
All the students who have not passed the subject during the continuous evaluation will have the right to recover the subject in an ordinary call. Those students who wish to raise their score in continuous assessment may present this ordinary call, in which case the final exam will constitute 100% of the final score, being necessary to reach a minimum of 5.0 points to pass the subject. It is understood that the score obtained in the ordinary exam substitutes, if higher, the one obtained in the continuous evaluation.
Similarly, all the students who have not passed the subject during the first call will have the right to recover the subject in an extraordinary exam (second call). This exam will constitute 100% of the final score, being necessary to reach a minimum of 5.0 points to pass the subject.
The action of cheating in an exam will be penalized, and the student will be qualified in this component with 0.0 (failed).

Sources of information

Basic Bibliography

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FERRER R. Y PIÑA B., **Topografía aplicada a la ingeniería**, ETSICCP Universidad de Cantabria, 1992

CHUECA PAZOS M., **Topografía**, Dossat S.A., 1983

RUIZ MORALES M., **Problemas Resueltos de Geodesia y Topografía**, Comares, 1992

RUIZ MORALES M., **Nociones de topografía y fotogrametría aérea**, 2003

Recommendations

Subjects that continue the syllabus

Technical Office/P52G381V01501

Subjects that it is recommended to have taken before

Graphic engineering/P52G381V01304

Other comments

In order to successfully pass the subject, the student must consider the following recommendations:
1. A regular and active attendance to classes, both theoretical and practical.
2. To maintain a minimum daily study.

It is recommended that the student of the subject Basics of Topography have completed and passed previous subjects of design and spatial vision such as Graphic Expression and Graphic Engineering.
For the correct development of the theoretical classes, as well as laboratory and seminars sessions, it is recommended to have the basic calculation tools.