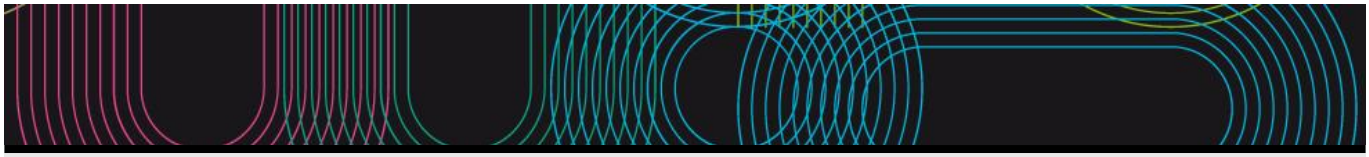

# (*)Centro Universitario da Defensa na Escola Naval Militar de Marín (Pontevedra)

## (*)Grao en Enxeñaría Mecánica

| **Subjects** | | | |
|---|---|---|---|
| **Year 2nd** | | | |
| Code | Name | Quadmester | Total Cr. |
| P52G381V01201 | Mathematics: Calculus II and differential equations | 1st | 6 |
| P52G381V01202 | Materials science and technology | 1st | 6 |
| P52G381V01203 | Thermodynamics and heat transfer | 1st | 6 |
| P52G381V01204 | Resistance of materials | 1st | 6 |
| P52G381V01205 | Fundamentals of electrical engineering | 2nd | 6 |
| P52G381V01206 | Mechanism and machine theory | 2nd | 6 |
| P52G381V01207 | Environmental technology | 2nd | 6 |
| P52G381V01208 | Fluid mechanics | 2nd | 6 |
| P52G381V01209 | English I | 2nd | 6 |

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Matemáticas: cálculo II e ecuacións diferenciais** | | | | |
| Subject | Matemáticas: cálculo II e ecuacións diferenciais | | | |
| Code | P52G381V01201 | | | |
| Study programme | Grao en Enxeñaría Mecánica | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Basic education | 2 | 1c |
| Teaching language | Castelán | | | |
| Department | Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín | | | |
| Coordinator | Alvarez Hernandez, Maria | | | |
| Lecturers | Alvarez Hernandez, Maria | | | |
| E-mail | maria.alvarez@cud.uvigo.es | | | |
| Web | http://faitic.uvigo.es | | | |
| General description | O obxectivo que se persegue con esta materia é que o alumno coñeza as técnicas básicas do cálculo integral en varias variables, cálculo vectorial, ecuacións diferenciais ordinarias e as súas aplicacións. | | | |

| 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. |
| 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. |
| C1 | Capacidade para a resolución dos problemas matemáticos que poidan presentarse na enxeñaría. Aptitude para aplicar os coñecementos sobre: álxebra lineal; xeometría; xeometría diferencial; cálculo diferencial e integral; ecuacións diferenciais e en derivadas parciais; métodos numéricos; algorítmica numérica; estatística e optimización. |
| D1 | Análise e síntese. |
| D2 | Resolución de problemas. |
| D3 | Comunicación oral e escrita de coñecementos. |
| D6 | Aplicación da informática no ámbito de estudo. |
| D9 | Aplicar coñecementos. |
| D15 | Obxectivación, identificación e organización. |
| D16 | Razoamento crítico. |

| Resultados de aprendizaxe | | | |
|---|---|---|---|
| Expected results from this subject | Training and Learning Results | | |
| Comprensión dos conceptos básicos do cálculo integral en varias variables. | B3 | C1 | D1 |
| Coñecemento das principais técnicas de integración de funcións de varias variables | B3<br>B4 | C1 | D1<br>D2<br>D9 |
| Coñecemento dos principais resultados do cálculo vectorial e aplicacións. | B3<br>B4 | C1 | D1<br>D2<br>D9 |
| Adquirir e consolidar un repertorio léxico avanzado da lingua inglesa | | | |
| RESULTADOS DE APRENDIZAXE ENAEE: COÑECEMENTO E COMPRENSIÓN: RA1.1 - Coñecemento e comprensión das matemáticas e outras ciencias básicas inherentes á sua especialidade de enxeñaría, nun nivel que permita adquirir o resto das competencias do título [nivel de desenvolvemento (básico (1), adecuado (2) e avanzado (3)) deste su-resultado: Adecuado (2)]. | B3 | C1 | |
| Comprensión da importancia do cálculo integral, cálculo vectorial e das ecuacións diferenciais para o estudo do mundo físico. | | C1 | D9<br>D16 |
| Aplicación dos coñecementos de cálculo integral, cálculo vectorial e de ecuacións diferenciais. | | C1 | D2<br>D6<br>D9<br>D16 |
| Adquisición da capacidade necesaria para utilizar estes coñecementos na resolución manual e informática de cuestións, exercicios e problemas. | | C1 | D1<br>D2<br>D3<br>D6<br>D9<br>D15<br>D16 |

| | | | |
|---|---|---|---|
| Adquisición dos coñecementos básicos para a resolución de ecuacións e sistemas diferenciais lineais. | B3 | C1 | |
| RESULTADO DE APRENDIZAXE ENAEE: ANÁLISE EN ENXEÑARÍA: RA2.2 - A capacidade de identificar, formular e resolver problemas de enxeñaría na súa especialidade; elixir e aplicar de forma adecuada métodos analíticos, de cálculo e experimentais xa establecidos; recoñecer a importancia das restricións sociais, de saúde e seguridade, ambientais, económicas e industriais [Adecuado (2)]. | B4 | C1 | D1<br>D2<br>D9<br>D16 |
| RESULTADOS DE APRENDIZAXE ENAEE: INVESTIGACIÓN E INNOVACIÓN: RA4.3 - Capacidade e destreza para proxectar e levar a cabo investigacións experimentais, interpretar resultados e chegar a conclusións no seu campo de estudo [Adecuado (2)]. | | | D9 |

## Contidos

| Topic | |
|---|---|
| Integración en varias variables. | Curvas e superficies. Integración no plano. Integración no espazo. Cambio de variables. Aplicacións xeométricas e físicas da integral múltiple. |
| Cálculo vectorial | Integración de campos ao longo dunha curva. Integración de campos sobre unha superficie. Teoremas clásicos do cálculo vectorial. Aplicacións. |
| Ecuacións diferenciais | Conceptos xerais. Métodos de resolución de ecuacións diferenciais ordinarias de primeira orde. Ecuacións diferenciais lineais de segunda orde. Sistemas de ecuacións diferenciais lineais. |
| Métodos numéricos para problemas de valor inicial | Métodos de Euler e de Runge-Kutta. |

## Planificación

| | Class hours | Hours outside the classroom | Total hours |
|---|---|---|---|
| Lección maxistral | 28 | 28 | 56 |
| Resolución de problemas | 10 | 10 | 20 |
| Traballo tutelado | 7 | 0 | 7 |
| Prácticas con apoio das TIC | 3 | 2 | 5 |
| Seminario | 14 | 14 | 28 |
| Resolución de problemas e/ou exercicios | 4 | 4 | 8 |
| Práctica de laboratorio | 1 | 1 | 2 |
| Exame de preguntas de desenvolvemento | 9 | 15 | 24 |
| *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 | O profesor exporá nas clases teóricas os contidos da materia. Os alumnos terán textos básicos de referencia para o seguimento da materia. |
| Resolución de problemas | O profesor resolverá problemas e exercicios e o alumno terá que resolver exercicios similares para adquirir as capacidades necesarias. |
| Traballo tutelado | O alumno deberá resolver exercicios e problemas que serán corrixidos polo profesor. Os exercicios serán abordados en grupos e traballarase sobre eles en esas horas. |
| Prácticas con apoio das TIC | O profesor resolverá problemas e exercicios de forma manual e/ou mediante o uso de ferramentas informáticas e o alumno terá que resolver exercicios similares para adquirir as capacidades necesarias. |
| Seminario | Curso intensivo de 14 horas para aqueles alumnos que suspenderon a materia en primeira convocatoria, previo ao exame en segunda convocatoria. |

## Atención personalizada

| Methodologies | Description |
|---|---|
| Resolución de problemas | 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 FAITIC, etc.) baixo a modalidade de cita previa. Nas sesións destinadas á resolución de exercicios e problemas, o profesor atenderá de forma personalizada as dúbidas expostas polos alumnos. |
| Prácticas con apoio das TIC | Nas sesións destinadas á realización de prácticas de informática, o profesor atenderá de forma personalizada as dúbidas expostas polos alumnos. |
| Traballo tutelado | Nas tutorías en grupo, o profesor atenderá de forma personalizada as dúbidas dos alumnos, expondo exercicios complementarios ou outra clase de actividades que redunden no mellor aproveitamento das clases do alumnado. |

| | |
|---|---|
| Seminario | No curso intensivo, o profesor atenderá de forma personalizada as dúbidas dos alumnos, expondo exercicios complementarios ou outra clase de actividades que redunden no mellor aproveitamento das clases do alumnado. |

**Avaliación**

| | Description | Qualification | Training and Learning Results | | |
|---|---|---|---|---|---|
| Resolución de problemas | Realizarase unha actividade complementaria consistente na resolución de exercicios. | 15 | B3<br>B4 | C1 | D1<br>D2<br>D3<br>D6<br>D9<br>D15<br>D16 |
| Resolución de problemas e/ou exercicios | Realizaranse dous exames parciais dos Temas 1 e 2. | 30 | B3<br>B4 | C1 | D1<br>D2<br>D3<br>D9<br>D15<br>D16 |
| Práctica de laboratorio | Realizaranse unha práctica de resolución de problemas con Matlab | 15 | B3<br>B4 | C1 | D2<br>D6<br>D9 |
| Exame de preguntas de desenvolvemento | Realizarase un exame final de avaliación continua sobre os contidos de toda a materia. | 40 | B3<br>B4 | C1 | D1<br>D2<br>D3<br>D9<br>D15<br>D16 |

**Other comments on the Evaluation**

**OBSERVACIÓNS XERAIS SOBRE O CÁLCULO DA NOTA:**

A avaliación continua consistirá na realización de dúas probas escritas, para os dous primeiros temas, cun peso do 15% cada un, unha práctica de Laboratorio de Matlab puntuable, cun peso dun 15% e unha entrega de exercicios a desenvolver, cun peso dun 15%, sendo o peso do exame final do 40%.

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

- A non realización ou entrega dalgún dos puntuables anteriores.

- Obter unha nota inferior a 4 puntos sobre 10 no exame final de avaliación continua.

- Obter unha nota inferior a 5 puntos na avaliación continua.

Nas circunstancias descritas nos dous primeiros apartados da anterior listaxe, a nota de avaliación continua será asignada como o valor mínimo entre un 4.5 e a nota calculada segundo as ponderacións descritas previamente.

En calquera caso, o alumno que supere a avaliación continua terá a posibilidade de presentarse ao exame ordinario para subir nota. A avaliación dos alumnos en segunda e sucesivas convocatorias consistirá nun exame sobre os contidos da materia que suporá o 100% da nota.

**COMPROMISO ÉTICO:**

Espérase que os alumnos teñan un comportamento ético adecuado. Se se detecta un comportamento pouco ético (copia, plaxio, uso de dispositivos electrónicos non autorizados ou outros) penalizarase automaticamente cunha cualificación de 0.0 na convocatoria en curso.

**Bibliografía. Fontes de información**

**Basic Bibliography**

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

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

**Complementary Bibliography**

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

## Recomendacións

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

Matemáticas: Álxebra e estatística/P52G381V01104
Matemáticas: Cálculo I/P52G381V01103

### Other comments

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

## Plan de Continxencias

### Description

=== MEDIDAS EXCEPCIONAIS PLANIFICADAS ===
Modificacións en caso de situacións extraordinarias que impliquen a suspensión da actividade académica presencial

=== ADAPTACIÓN DAS METODOLOXÍAS ===
Sesión maxistral e sesión práctica virtual síncrona: Impártese a través dunha plataforma de videoconferencia web. Cada aula virtual contén diversos paneis de visualización e compoñentes e un deseño que podese personalizar para que se adapte mellor ás necesidades da clase. Na aula virtual, os profesores (e aqueles participantes autorizados) poden compartir a pantalla ou arquivos do seu equipo, empregar un encerado, chatear, transmitir audio e vídeo ou participar en actividades en liña interactivas (enquisas, preguntas, etc.).

=== ADAPTACIÓN DA AVALIACIÓN ===
As probas de avaliación realizaríanse combinando a plataforma de teledocencia FAITIC-Moodle e o Campus Remoto da Universidade de Vigo.

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Materials science and technology** | | | | |
| Subject | Materials science and technology | | | |
| Code | P52G381V01202 | | | |
| Study programme | (*)Grao en Enxeñaría Mecánica | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Mandatory | 2nd | 1st |
| Teaching language | Spanish | | | |
| Department | | | | |
| Coordinator | Alfonsín Pérez, Víctor Ángel | | | |
| Lecturers | Alfonsín Pérez, Víctor Ángel<br>Maceiras Castro, María del Rocío | | | |
| E-mail | valfonsin@cud.uvigo.es | | | |
| Web | http://faitic.uvigo.es | | | |
| General description | Currently, it is interesting to look for material properties that not only provide benefits in mechanical behavior, but also other characteristics such as appearance, shine, touch, etc., that can become important when selecting a material or another with similar mechanical characteristics. Many of these parameters are variable and could even depend on social trends. The unstoppable advance of society and the importance of some properties of materials at different scales, make their study especially relevant within the field of Engineering. The aim of this course is to introduce the main concepts of materials technology as well as to study the applications of the most common materials<br>In addition, in this subject skills will be developed to apply theoretical and practical knowledge in order to solve problems in reference to materials from a basic and multidisciplinary point of view | | | |

| Competencies | |
|---|---|
| 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. |
| B6 | Capacity for handling specifications, regulations and mandatory standards. |
| C9 | Knowledge of the fundamentals of the science, technology and chemistry of materials. Understand the relationship between microstructure, the synthesis, processing and properties of materials. |
| D1 | Analysis and synthesis |
| D5 | Information Management. |
| D9 | Apply knowledge. |
| D10 | Self learning and work. |

| Learning outcomes | | | |
|---|---|---|---|
| Expected results from this subject | Training and Learning Results | | |
| Understanding the mechanical behavior of metallic, ceramic, plastics and composites materials | B4<br>B6 | | |
| Knowing how the properties can be modified using mechanical processes and thermal treatments | B4 | C9 | D9 |
| Knowing the basic techniques of the structural characterization of materials | B3<br>B6 | C9 | |
| Ability in the handling of diagrams and graphics | | | D1<br>D5 |
| Ability in performing experiments | B6 | C9 | D10 |
| To analyse the obtained results and their conclusions | | | D1<br>D9 |
| Ability to apply standards of material testing | B6 | | D1<br>D9 |
| ENAEE LEARNING OUTCOME. KNOWLEDGE AND UNDERSTANDING: LO1.2 - knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront. [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)]. | B3 | C9 | |
| ENAEE LEARNING OUTCOME. KNOWLEDGE AND UNDERSTANDING: LO1.3 - Awareness of the wider multidisciplinary context of engineering [Intermediate (2)]. | | C9 | |

| | | | |
|---|---|---|---|
| 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 | | D1<br>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. [Intermediate (2)]. | B6 | | D5 |
| ENAEE LEARNING OUTCOME. INVESTIGATIONS: LO4.2.- Ability to consult and apply codes of practice and safety regulations in their field of study; [Basic (1)] | B6 | | |
| ENAEE LEARNING OUTCOME. INVESTIGATIONS: LO4.3.- Laboratory/workshop skills and ability to design and conduct experimental investigations, interpret data and draw conclusions in their field of study .[Intermediate (2)]. | | C9 | 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: [Basic (1)]. | | | 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 | | 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)]. | | C9 | D9 |
| ENAEE LEARNING OUTCOME. ENGINEERING PRACTICE: LO5.4.- Ability to apply norms of engineering practice in their field of study. [Basic (1)]. | B6 | | D9 |
| ENAEE LEARNING OUTCOME. MAKING JUDGMENTS: LO6.1.- Ability to gather and interpret relevant data and handle complexity within their field of study, to inform judgements that include reflection on relevant social and ethical issues [Basic (1)]. | B6 | | |
| ENAEE LEARNING OUTCOME.COMMUNICATION AND TEAM-WORKING: LO7.1.- ability to communicate effectively information, ideas, problems and solutions with engineering community and society at larg [Intermediate (2)]. | B4 | | D1<br>D5 |
| 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)]. | | | D10 |

**Contents**

| Topic | |
|---|---|
| Introduction to materials. | Definition of material. Present, past and future of materials. What is Materials Science and Technology and its multidisciplinary nature. Importance of materials in society: Ethical-social and environmental commitment.<br>Material properties. Material trends. Relationship between structure and properties. Selection of materials: technical-economic commitment and market value. |
| Types of atomic bonds and derived properties | Types of bonds. Classification of materials. Atomic bond strength and derived properties. |
| Structure of crystalline materials | Crystalline and amorphous materials. Main crystalline systems. Metallic crystalline structures: Cristal systems (BCC,FCC,HCP, polymorphism and alotropy). Covalent and ionic main structures. Determination of crystal structure (X-Ray diffraction) |
| Imperfections of crystal structure | Crystal defects: Point defects, line defects, planar defects. Importance of crystal defects in the metal and ceramic properties. Microscopic techniques for the crystal defects identificacion. |
| Solid atomic diffusion and solidification process | Diffusion mechanisms. Fick's laws. Diffusion factors. Industrial applications of diffusion processes: synthesis, doping of semiconductors, solidification (nucleation and growth). Basic concepts |
| Equilibrium phase diagrams (I). Introduction | Gibbs law. Lever rule. Binary equilibrium diagrams. Types. Invariant solidification reactions. |
| Equilibrium phase diagrams (II): Solid state phase transformations in equilibrium | Equilibrium solid-state transformations: Metallic and ceramic. Examples: Fe-C phase diagram. Microestructure evolution for cooling: steel and foundries. Types based on the carbon content. |
| Hardness tests | Hardness: Concept. Shore test. Macrohardness test: Brinell, Rockwell and Vickers. Microhardness test: Vickers y Knoop. Standarization. Comparison between different test procedures. |
| Basic deformation characteristics | Types of deformation: elastic, anelastic, viscoelastic and plastic. Mechanisms of deformation: viscous flow, slip and crystal twinning. |

| | |
|---|---|
| Tensile test, compression and flexion | Tensile test: Standarization. Conventional tensile test curve. Mechanical properties derived. Real tensile-deformation curve. Acritude coefficient. Comparison of tensile behaviour in different materials. Compression and flexion tests: Standarizarion. Characteristics. Comparison of their behaviour between different materials. |
| Polymeric materials | Plastic composition. Properties of the most important polymers. Applications. Recycling. Adhesives. |
| Ceramic and composite materials | Vitreous ceramics. Clay products. Structural ceramics and porcelain. Refractory ceramics. Abrasive Ceramics. Cements and concretes. Advanced technological ceramic. |
| Laboratory session 1. Webquest | Introduction to materials: Search for information in order to complete sheets about different materials, which must be presented orally for evaluation. The student must use different online databases, whose use and quality will be later qualified by the teacher. |
| Laboratory session 2. Mechanical tests: Hardness | Hardness coefficient determination of different metallic materials: Brinell, Rockwell and Vickers. Micro-hardness profile (Vickers) of a cemented test probe. Hardness coefficient determination for different plastic materials. Shore test (A and D) |
| Laboratory session 3. Mechanical tests: Tensile | Introduction to tensile tests. Tensile-Elongation diagrams. Young's modulus determination and resilient modulus through Tensile-elongation diagrams. |
| Laboratory session 4-5. Metallographic study of metals, iron and aluminum alloys. | Introduction to metallography. Test probes preparation and optical microscope handling. Metallographic observation of test probes: monophasic-biphasic alloys, steel, iron and aluminium. |
| Laboratory session 5. Phase diagrams. | Development of phase diagrams for a binary alloy using the cooling curves. |
| Laboratory session 6. Synthesis and properties | Addition and condensation polymerization. Characteristics observation. Observation of temperature increase behaviour |

**Planning**

| | Class hours | Hours outside the classroom | Total hours |
|---|---|---|---|
| Lecturing | 26 | 39 | 65 |
| Laboratory practical | 14 | 7 | 21 |
| Problem solving | 7 | 7 | 14 |
| Seminars | 15 | 0 | 15 |
| Objective questions exam | 1 | 2 | 3 |
| Problem and/or exercise solving | 1 | 2 | 3 |
| Report of practices, practicum and external practices | 0 | 7 | 7 |
| Essay questions exam | 3 | 4 | 7 |
| Essay questions exam | 3 | 2 | 5 |
| Essay questions exam | 3 | 2 | 5 |
| Essay | 3 | 2 | 5 |

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

**Methodologies**

| | Description |
|---|---|
| Lecturing | Teaching in the classroom of the key concepts and procedures for learning the syllabus contents. The students have a textbook with the contents of the subject, in addition to the information of the web that contains the file with the subject's slides. It is recommended a dedication of half hour or an hour per class period. |
| Laboratory practical | Application of the knowledge acquired to the resolution of problems of materials science and technology. A series of practices have been designed in accordance with the content of the subject in order to assimilate concepts explained in this class.<br>All the practices will be carried out in the corresponding laboratories (materials, chemistry and computer) by the students in small groups (3-4 students). |
| Problem solving | In the seminars, the student will have to solve exercises and problems that will be corrected by the lecturer. Likewise, they will have to do exercises in individual way. |
| Seminars | |

**Personalized assistance**

| Methodologies | Description |
|---|---|

| | |
|---|---|
| Problem solving | In the field of tutorial action, academic tutoring actions are distinguished, as well as personalized tutoring. In the first case, the students will have at their disposal hours of tutorials in which you can consult any questions related to the contents, organization and planning of the subject, etc. In the personalized tutorials, each student, individually, can discuss with the teacher any problem that is preventing him/her from properly monitoring the subject, in order to find between them some type of solution. By combining both types of tutorial action, it is intended to compensate the different learning rhythms through attention to diversity. The lecturers will answer the questions of the students, both in person, according to the schedule that will be published on the website of the center, and telematically (email, videoconference, FAITIC forums, etc. .) by previous appointment. |
| Seminars | |

## Assessment

| | Description | Qualification | Training and Learning Results |
|---|---|---|---|
| Objective questions exam | Several short tests consisting of theoretical questions will be carried out through the semester, with a maximum weight total of 10% | 10 | B3 C9 D1<br>B4 D5<br>B6 D9<br>D10 |
| Problem and/or exercise solving | Two written exams (with a maximum weight total of 25%) consisting of the resolution of problems will be carried out through the semester. | 25 | B3 C9 D1<br>B4 D5<br>B6 D9<br>D10 |
| Report of practices, practicum and external practices | Attendance, participation and reports that will be delivered periodically | 15 | B3 C9 D1<br>B4 D5<br>B6 D9<br>D10 |
| Essay questions exam | A final continuous assessment consisting of all theoretical and practical contents will be carried out at the end of the semester. This exam will be graded over 10 points. Moreover, in this exam it will be necessary to overcome the 40% in each part (theory and problems) | 40 | B3 C9 D1<br>B4 D5<br>B6 D9<br>D10 |
| Essay | An individual work corresponding to the activities carried out in seminars will be carried out (5%). A collaborative work in groups related to the contents of the subject will also be carried out (5%), considering the communication and the capacity for teamwork . | 10 | B4 C9 D1<br>D5<br>D9 |

## Other comments on the Evaluation

CONTINUOUS ASSESSMENT:

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

- The no realisation or delivery of any of the activities.
- Obtain a grade to inferior 4.0 points over 10 in any of the parts (theory and problems) of the final exam.

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

INTENSIVE COURSE

In the case that the students do not pass the ordinary exam, they have to attend the extraordinary exam in July. The Defense University Center proposes for these students an intensive course of reinforcement during the months of June and July of 15 hours in three weeks, with the aim to prepare the exam.

ETHICAL COMMITMENT:

It is expected that students have an adequate ethical behaviour:

- If is detected an unethical behaviour (cheating, plagiarism, use of unauthorised electronic devices or others) during written exams, the student will be penalized with the impossibility to pass the course by the modality of continuous assessment, obtaining a qualification of 0.0.
- If this kind of behaviour is detected in ordinary or extraordinary exam, the student will obtain a qualification of 0.0.
- In the case of the practices reports, the total or partial copy in a report (according to the opinion of the lecturers), will

be penalized in the final note of the practices with a qualification of 0.0.

## Sources of information

### Basic Bibliography


Callister, William, **Introducción a la Ciencia e Ingeniería de los Materiales I y II**, Tercera, Reverté, 2003

Askeland, Donald R, **Ciencia e Ingeniería de los Materiales**, Primera, Paraninfo- Thomson Learning, 2001

Smith, William F, **Ciencia e Ingeniería de los Materiales**, Cuarta, McGraw-Hill, 2006


### Complementary Bibliography


Pero-Sanz Elorz, J. A., **Ciencia e Ingeniería de los Materiales: estructura y propiedades**, Cuarta, Dossat, 2006

Mangonon, P. L., **Ciencia de Materiales: selección y diseño**, Primera, Prentice Hall, 2001

Shackelford, James F, **Introducción a la Ciencia de Materiales para ingenieros**, Sexta, Prentice-Hall, 2007

Krauss, G., **Steels: heat treatment and processing principles**, Primera, ASM International, 2015


## Recommendations

### Other comments

In order to pass this subject, the student must know the basic fundamentals of Physics and General Chemistry.

In case of discrepancy in the information contained in this guide it will be understood that the edited version prevails in Spanish.

## Contingency plan

### Description

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

=== MODIFICATIONS IN CASE OF VIRTUAL TEACHING ===
CONTENTS
Due to the experimental nature of the practices of the subject (PL2, PL3, PL4, PL5, PL6 and PL7), the majority of the sessions of Materials Science and Technology are carried out, in part, in laboratories by the students using specific equipment and reactives difficult to access for students.
In order that the student acquire most of the knowledge and skills necessary to pass this part of the subject, the use of demonstration videos supported by virtual classrooms will be offered to the students, where the teacher can explain the processes that the student made in the face-to-face case.
In addition, a large number of these practices (PL2, PL3, PL6, PL7) require a part of work in non-experimental practice sessions, which the student can do without being in person in the laboratory. The teacher will facilitate the experimental part so that the student can easily complete various practices.

TEACHING METHODOLOGY
A new teaching methodology is added:
Master session and / or synchronous online meeting (theory or practical session): It is taught through a web video conferencing platform. Each virtual classroom contains a variety of display panels and components, its layout can be customized to the needs of the classroom. In the virtual classroom, teachers (and those authorized participants) can share their team's screen or files, use a whiteboard, chat, stream audio and video, or participate in interactive online activities (surveys, questions, etc.)

EVALUATION
The evaluation tests will be carried out by combining the FAITIC-Moodle remote teaching platform and the Remote Campus of the University of Vigo.

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Termodinámica e transmisión da calor** | | | | |
| Subject | Termodinámica e transmisión da calor | | | |
| Code | P52G381V01203 | | | |
| Study programme | Grao en Enxeñaría Mecánica | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Mandatory | 2 | 1c |
| Teaching language | Castelán | | | |
| Department | Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín | | | |
| Coordinator | Lareo Calviño, Guillermo | | | |
| Lecturers | Cacabelos Reyes, Antón<br>González Gil, Lorena<br>Lareo Calviño, Guillermo | | | |
| E-mail | guillermo@cud.uvigo.es | | | |
| Web | http://faitic.uvigo.es | | | |
| General description | Na práctica totalidade dos procesos industriais requírese a aplicación dos Principios da Termodinámica e da Transferencia de Calor. O coñecemento destes principios é básico en Enxeñaría Térmica. Por exemplo, para a realización dunha análise enerxética (con determinación do rendemento enerxético e esergxético) de sistemas de potencia para a xeración de electricidade (ciclo combinado con turbina de vapor e de gas), un ciclo de potencia mecánica, un ciclo en bomba de calor, etc. O coñecemento de si un proceso termodinámico pode ocorrer ou non na realidade é imprescindible para o deseño de novos procesos, así como o coñecemento das máximas prestacións que se poden obter nos diferentes dispositivos que compoñen unha instalación enerxética, e cales son as causas que imposibilitan obter esas máximas prestacións. Ademais, o estudo das propiedades termodinámicas dos fluídos de traballo que circulan polos dispositivos, auga, aire, refrigerantes, gases e mestura de gases, é indispensable para analizar o comportamento dos sistemas térmicos. Así mesmo, o estudo do procedemento a seguir para a análise enerxética de instalacións enerxéticas de sistemas de refrixeración, acondicionamento de aire e en procesos de combustión é de gran interese.<br><br>Doutra banda, é interesante para o alumno coñecer os mecanismos polos cales se produce a transferencia da enerxía, principalmente debido a unha diferenza de temperaturas, centrándose en determinar a maneira e a velocidade á que se produce ese intercambio de enerxía. Neste sentido preséntanse o tres modos de transferencia de calor e os modelos matemáticos que permiten calcular as velocidades de transferencia de calor. Así se pretende que os alumnos sexan capaces de expor e resolver problemas enxeñeriles de transferencia de calor mediante o uso de ecuacións alxebraicas. Tamén se pretende que os alumnos coñezan outros métodos matematicamente máis complexos de resolución de problemas de transferencia de calor e saiban onde atopalos e como usalos en caso de necesitalos. | | | |

| 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. |
| B7 | Capacidade para analizar e valorar o impacto social e ambiental das solucións técnicas. |
| B11 | Coñecemento, comprensión e capacidade para aplicar a lexislación necesaria no exercicio da profesión de Enxeñeiro Técnico Industrial. |
| C7 | Coñecementos de termodinámica aplicada e transmisión de calor. Principios básicos e a súa aplicación á resolución de problemas de enxeñaría. |
| D2 | Resolución de problemas. |
| D7 | Capacidade para organizar e planificar. |
| D9 | Aplicar coñecementos. |
| D10 | Aprendizaxe e traballo autónomos. |
| D17 | Traballo en equipo. |

| Resultados de aprendizaxe | |
|---|---|
| Expected results from this subject | Training and Learning Results |

| | | | |
|---|---|---|---|
| Capacidade para coñecer, entender e utilizar os principios e fundamentos da termodinámica aplicada | B4<br>B5<br>B6<br>B7 | C7 | D2<br>D7<br>D9<br>D10<br>D17 |
| Capacidade para coñecer e entender os principios e fundamentos da transmisión da calor | B5<br>B6<br>B7<br>B11 | C7 | D2<br>D7<br>D9<br>D10<br>D17 |
| Capacidade para coñecer e entender os principios e fundamentos de equipos e xeradores térmicos | B4<br>B6<br>B7<br>B11 | C7 | D2<br>D7<br>D9<br>D10<br>D17 |
| Analizar o funcionamento de sistemas térmicos, como sistemas de bomba de calor e ciclos de refrixeración ou ciclos de potencia, identificando compoñentes, así como os ciclos empregados para obter altas prestacións | B4<br>B5<br>B6<br>B7<br>B11 | C7 | D2<br>D7<br>D9<br>D17 |
| Resultado de aprendizaxe ENAEE: COÑECEMENTO E COMPRENSIÓN: RA1.2 - Coñecemento e comprensión das disciplinas de enxeñaría propias da súa especialidade, no nivel necesario para adquirir o resto de competencias do título, incluíndo nocións dos últimos adiantos. [nivel de desenvolvemento (básico (1), adecuado (2) e avanzado (3)) deste sub-resultado: Avanzado (3)]. | | C7 | |
| Resultado de aprendizaxe ENAEE: ANÁLISE EN ENXEÑARÍA: RA2.2 - A capacidade de identificar, formular e resolver problemas de enxeñaría na súa especialidade; elixir e aplicar de forma adecuada métodos analíticos, de cálculo e experimentais xa establecidos; recoñecer a importancia das restricións sociais, de saúde e seguridade, ambientais, económicas e industriais. [Avanzado (3)]. | B4<br>B7 | | D2<br>D9 |
| Resultado de aprendizaxe ENAEE: INVESTIGACIÓN E INNOVACIÓN: RA4.1 - Capacidade para realizar procuras bibliográficas, consultar e utilizar con criterio basees de datos e outras fontes de información, para levar a cabo simulación e análise co obxectivo de realizar investigacións sobre temas técnicos da súa especialidade. [Básico (1)]. | B6<br>B11 | | |
| Resultado de aprendizaxe ENAEE: INVESTIGACIÓN E INNOVACIÓN: RA4.2 Capacidade para consultar e aplicar códigos de boa práctica e de seguridade da súa especialidade. [Básico (1)]. | B6<br>B7<br>B11 | | |
| Resultado de aprendizaxe ENAEE: INVESTIGACIÓN E INNOVACIÓN: RA4.3 Capacidade e destreza para proxectar e levar a cabo investigacións experimentais, interpretar resultados e chegar a conclusións no seu campo de estudo. [nivel de desenvolvemento (básico (1), adecuado (2) e avanzado (3)) deste sub-resultado: Adecuado (2)]. | | C7 | D9 |
| Resultado de aprendizaxe ENAEE: APLICACIÓN PRÁCTICA DA ENXEÑARÍA: RA5.4 - Capacidade para aplicar normas da práctica da enxeñaría da súa especialidade. [nivel de desenvolvemento (básico (1),adecuado (2) e avanzado (3)) deste sub-resultado: Básico (1)]. | B6<br>B7<br>B11 | | D9 |
| Resultado de aprendizaxe ENAEE: APLICACIÓN PRÁCTICA DA ENXEÑARÍA: RA5.5 -Coñecemento das implicacións sociais, de saúde e seguridade, ambientais, económicas e industriais da práctica da enxeñaría. [Básico (1)] | B7 | | |
| Resultado de aprendizaxe ENAEE: ELABORACIÓN DE XUÍZOS: RA6.1 - Capacidade de recoller e interpretar datos e manexar conceptos complexos dentro da súa especialidade, para emitir xuízos que impliquen reflexión sobre temas éticos e sociais. [Básico (1)]. | B6<br>B7<br>B11 | | |

| **Contidos** |
|---|
| Topic |

| | |
|---|---|
| BLOQUE 1 (B1)<br>Propiedades de sustancias puras, simples e compresibles | B1-1. Repaso de conceptos básicos e definicións:<br>-O uso da termodinámica<br>-Definición dos sistemas<br>-Descrición dos sistemas e do seu comportamento<br>-Medida da temperatura. Principio cero<br>-Calor e calor específica<br>-Cambio de fase e calor latente<br>-Mecanismos de transferencia de calor<br>-Gas ideal. Ecuacións de estado<br>-Primeiro principio da termodinámica<br>-Transformacións termodinámicas dun gas ideal<br>-Segundo principio da termodinámica<br><br>B1-2. Propiedades dunha sustancia pura, simple e compresible:<br>-Definición do estado termodinámico<br>-A relación p-v-T<br>-O cálculo das propiedades termodinámicas<br>-O modelo de gas ideal<br>-Enerxía interna, entalpía e calores específicas de gases ideais<br>-Cálculo de variación de enerxía interna e de entalpía en gases ideais<br>-Procesos politrópicos dun gas ideal |
| BLOQUE 2 (B2)<br>Análise enerxética de sistemas segundo o 1º e 2º Principio | B2-1. Análise enerxética nun volume de control:<br>-Conservación da masa para un volume de control<br>-Conservación da enerxía para un volume de control<br>-Análise de volumes de control en estado estacionario<br>-Análise de transitorios<br><br>B2-2. O segundo principio da Termodinámica:<br>-Utilización do 2º principio<br>-Formulacións do 2º principio<br>-Identificación de irreversibilidades<br>-Aplicación do 2º principio aos ciclos termodinámicos<br>-A escala Kelvin de temperatura<br>-Medidas de rendemento máximo para ciclos que operan entre dous focos térmicos<br>-O ciclo de Carnot<br><br>B2-3. A entropía e a súa utilización<br>-A desigualdade de Clausius<br>-Definición de variación de entropía<br>-Obtención de valores de entropía<br>-Variación de entropía en procesos internamente reversibles<br>-Balance de entropía para sistemas pechados<br>-Balance de entropía para volumes de control<br>-Procesos isoentrópicos<br>-Rendementos isoentrópicos de turbinas, tobeiras, compresores e bombas<br>-Transferencia de calor e traballo en procesos de fluxo estacionario internamente reversibles<br><br>B2-4. Análise exergética<br>-Introdución á exerxía<br>-Definición de exerxía<br>-Balance de exerxía para un sistema pechado<br>-Exerxía de fluxo<br>-Balance de exerxía para volumes de control<br>-Eficiencia exerxética (segundo principio) |

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|---|---|
| BLOQUE 3 (B3)<br>Introdución á análise termodinámica de motores e máquinas térmicas | B3-1 Instalacións de produción de potencia:<br>-Introdución ás instalacións de produción de potencia<br>-Produción de potencia mediante vapor vs produción de potencia mediante gas<br>-Ciclo combinado<br><br>B3-2 Introdución á produción de potencia mediante vapor:<br>-Instalacións de potencia con vapor: o ciclo de Rankine<br><br>B3-3 Instalacións de produción de potencia mediante turbinas de gas:<br>-As centrais de turbinas de gas: O ciclo de Brayton<br><br>B3-4. Ciclos de gas en motores alternativos de combustión interna<br><br>B3-5 Ciclos termodinámicos de refrixeración:<br>-Refrixeración. Máquina frigorífica e bomba de calor. |
| BLOQUE 4 (B4)<br>Conceptos e principios fundamentais en transmisión de calor | B4-1 Introdución á transmisión de calor e á condución:<br>-Mecanismos de *trasmisión de calor. Condución, convección e radiación.<br>-Requirimentos de conservación da enerxía.<br>-Análise de problemas de transferencia de calor.<br>-Conductividade térmica.<br>-Ecuación de difusión de calor.<br><br>B4-2 Condución en réxime estacionario e en réxime transitorio:<br>-Condución unidimensional en réxime estacionario. Parede plana. Sistemas radiais: cilindro e esfera.<br>-Condución estacionaria con xeración de enerxía térmica.<br>-Condución en superficies estendidas.<br>-Condución bidimensional.<br>-Condución en estado transitorio.<br><br>B4-3 Introdución á convección: Convección forzada e convección libre.<br>-Capas límites de convección: hidráulica e térmica. Fluxo laminar e turbulento.<br>-Ecuacións fundamentais da convección.<br>-Análise Dimensional.<br>-Convección forzada e convección libre ou natural.<br>-Convección forzada en fluxo externo<br>-Convección forzada en fluxo interno.<br>-Convección libre<br><br>B4-4 Intercambiadores de calor<br>-Intercambiadores de calor. Consideracións xerais.<br>-Clasificación dos intercambiadores de calor.<br>-Tipos de intercambiadores e características.<br>-Coeficiente global de transferencia de calor.<br>-Distribución de temperaturas en equicorriente, contracorriente e fluxos cruzados.<br>-Fluxo de calor intercambiada. Diferenza de temperaturas logarítmica media.<br>-Método da diferenza de temperaturas logarítmica media (DTLM)<br>-Método da eficiencia-número de unidades de transferencia (Epsilon-N.O.T.)<br><br>B4-5 Introdución á radiación.<br>-Conceptos fundamentais. Definicións: intensidade de radiación, potencia emisiva, irradiación e radiosidade.<br>-Radiación de corpo negro. Distribución de Planck. Emisividad, absortividad e reflectividad superficiais.<br>-Lei de Kirchhoff. Superficies grises.<br>-Intercambio radiativo entre superficies. Factor de forma de radiación. Relacións entre os factores de forma.<br>-Intercambio de radiación de corpo negro.<br>-Intercambio de radiación entre superficies grises difusas nun recinto. |

| | |
|---|---|
| CONTIDOS PRÁCTICOS | PL 1. Equivalente mecánico da calor<br>Nesta práctica preténdese determinar o equivalente mecánico da calor, é dicir, a relación entre a unidade de enerxía joule (julio) e a unidade de calor caloría.<br>Mediante esta experiencia simulada, preténdese pór de manifesto a gran cantidade de enerxía que é necesario transformar en calor para elevar apreciablemente a temperatura dun volume pequeno de auga.<br>PL 2. Dilatación térmica lineal de sólidos<br>Estudo da dilatación térmica lineal en tubos delgados de ferro, latón e aluminio e estimación dos coeficientes de dilatación de devanditos materiais para a súa comparación posterior.<br>PL 3. Iniciación a técnicas termográficas<br>Preténdese iniciar ao alumno na utilización de cámaras termográficas como ferramenta aplicada ao estudo de illamentos en edificacións e mantemento predictivo.<br>PL 4. Conductividad térmica de metais<br>Determinarase o fluxo de calor que se produce a través de barras metálicas en forma de U cuxos extremos se mergullan en auga fría e quente a partir do incremento de temperatura observado na auga fría. Observarase así mesmo que a contía do fluxo calorífico depende da composición do material, así como da súa sección transversal e a súa lonxitude.<br>PL 5. Determinación de propiedades de illantes<br>Preténdese observar as propiedades térmicas de diferentes materiais illantes para o manexo e a comprensión de conceptos como illamento térmico, conductividade térmica e capacidade calorífica.<br>PL 6. Intercambiador de calor de dobre tubo<br>Determinarase o coeficiente de transferencia dun intercambiador de calor de dobre tubo en contracorriente e equicorrente. Validación dos métodos DTLM e Epsilon-NUT.<br>PL 7. Enerxías alternativas. Estudo dun colector solar.<br>Preténdese iniciar ao alumno no estudo dun colector solar, analizar a enerxía recibida por radiación e facer un balance enerxético da enerxía aproveitada para ACS ou calefacción. |

| **Planificación** | | | |
|---|---|---|---|
| | Class hours | Hours outside the classroom | Total hours |
| Lección maxistral | 28 | 34.5 | 62.5 |
| Prácticas de laboratorio | 14 | 15 | 29 |
| Seminario | 15 | 15 | 30 |
| Resolución de problemas | 7 | 0 | 7 |
| Resolución de problemas e/ou exercicios | 5 | 3 | 8 |
| Exame de preguntas de desenvolvemento | 6 | 7.5 | 13.5 |
| *The information in the planning table is for guidance only and does not take into account the heterogeneity of the students. | | | |

| **Metodoloxía docente** | |
|---|---|
| | Description |
| Lección maxistral | Nas clases de teoría explícanse os fundamentos de cada tema. Os alumnos dispoñen na bibliografía dos libros de texto recomendados onde se atopa desenvolvido o tema que se está estudando, ademais da información da web que contén o arquivo coa presentación do tema. |
| Prácticas de laboratorio | Nas clases prácticas aplicaranse os conceptos desenvolvidos en cada tema á resolución de problemas. Deseñáronse unha serie de prácticas acorde co desenvolvemento da materia de teoría co fin de fixar conceptos explicados nesa clase e así o alumno vaia desenvolvendo a súa habilidade para expor solucións técnicas, e ir desenvolvendo a súa creatividade |
| Seminario | Trátase dun curso intensivo que se realiza ao final do mes de xullo destinado aos alumnos que non superaron a materia en primeira convocatoria, cuxos obxectivos son por unha banda, a consolidación, co adecuado rigor conceptual e formal, de coñecementos previamente adquiridos ao longo do curso, e, por outra, o establecemento das bases necesarias para o estudo ulterior doutras disciplinas, de carácter básico ou fundamental.<br>Realízase de forma presencial en en sesións de traballo en clase. Alí abordarase a resolución de dúbidas e problemas relacionados cos contidos teóricos da materia. |
| Resolución de problemas | Ao alumno proporánselle exercicios e problemas que deberá resolver e que serán corrixidos e avaliados polo profesor/a.<br>Actividade na que se formulan problemas e/ou exercicios relacionados coa materia. O alumno debe desenvolver a análise e resolución dos problemas e/ou exercicios de forma autónoma. |

## Atención personalizada

| Methodologies | Description |
|---|---|
| Lección maxistral | Nas clases de teoría explícanse os fundamentos de cada tema. Os alumnos dispoñen na bibliografía dos libros de texto recomendados onde se atopa desenvolvido o tema que se está estudando, ademais da información da web que contén o arquivo coa presentación do tema. |
| Prácticas de laboratorio | Nas clases prácticas aplicaranse os conceptos desenvolvidos en cada tema á resolución de problemas. Deseñáronse unha serie de prácticas acorde co desenvolvemento da materia de teoría co fin de fixar conceptos explicados nesa clase e así o alumno vaia desenvolvendo a súa habilidade para expor solucións técnicas, e ir desenvolvendo a súa creatividade |
| Resolución de problemas | Ao alumno proporánselle exercicios e problemas que deberá resolver e que serán corrixidos e avaliados polo profesor/a. |
| Seminario | O desenvolvemento do curso estrutúrase en sesións dunha hora de clases teórico-prácticas. Os métodos didácticos adoptados baséanse maioritariamente na participación activa do alumno, protagonista destas sesións presenciais. O método didáctico a seguir consiste en que o profesor repasará brevemente conceptos teóricos relativos ás unidades das que se compón a presente materia e proporá de forma individualizada a resolución de problemas a todos e cada un dos alumnos. Así mesmo, o profesor tutelará o traballo que realice cada alumno de maneira individual. A metodoloxía empregada pode verse, dado o reducido número de alumnos, como unha acción tutorial continua, de apoio constante por parte do profesor ao proceso de aprendizaxe do alumno. Os profesores da materia atenderán as dúbidas e consultas dos alumnos de forma síncrona en despachos físicos ou virtuais baixo a modalidade de concertación previa ou *asíncrona por medios telemáticos (correo electrónico, foros de FAITIC, etc.). |

## Avaliación

| | Description | Qualification | Training and Learning Results |
|---|---|---|---|
| Prácticas de laboratorio | Nas prácticas desenvolveranse as competencias en expresión oral e escrita coa presentación de informes de prácticas polos alumnos.<br>Para obter a avaliación positiva, o alumno deberá realizar o 100% das sesións de prácticas de laboratorio, e ter unha participación activa no desenvolvemento das mesmas | 20 | B4 C7 D2<br>D7<br>D9<br>D10<br>D17 |
| Resolución de problemas e/ou exercicios | A nota correspondente á Avaliación Continua estará baseada en probas escritas de resposta curta<br><br>Resultados de aprendizaxe: Capacidade para coñecer, entender e utilizar os principios e fundamenots da termodinámica aplicada e a transmisión de calor<br><br>Aquí inclúense as Probas Parciais (PP,30%) e Probas de Avaluacion en Seminarios (ES,10%) | 40 | B4 C7 D2<br>B5 D7<br>B6 D9<br>B7 D10<br>B11 |
| Exame de preguntas de desenvolvemento | A nota correspondente á Avaliación Continua estará baseada en probas escritas de resposta longa<br><br>Aquí inclúese a proba final (PF,40%) | 40 | B4 C7 D2<br>B5 D7<br>B6 D9<br>B7 D10<br>B11 |

## Other comments on the Evaluation

As probas PF, PP e ES teñen como obxectivo a avaliación da aprendizaxe de todos os contidos teóricos seleccionados para a materia. Confeccionaranse para xulgar o que o alumno sabe de toda a materia (PF), ou dunha parte dela (PP, ES). En segundo lugar, deben consistir nunha serie de cuestións que primen o razoamento conceptual e lóxico, a fin de verificar a madurez intelectual dos alumnos para obter conclusións a partir das nocións ondas teorías expostas en clase.
A avaliación en seminarios (ES) e das prácticas de laboratorio (CP) levará acabo mediante cuestionarios expostos a través Moodle,onde se avaliará ao alumno sobre los coñecementos adquiridos en clase e no laboratorio. En particular, os cuestionarios de prácticas de laboratorio deberán incluír no seu contido fontes de información, como referencias bibliográficas de calidade que axuden á comprensión da problemática exposta. A nota de cada memoria de prácticas será sobre 10 puntos. A nota das memorias de prácticas será a media das notas de todas as prácticas realizadas.
A proba final de avaliación continua realizarase na semana de avaliación e valorarase sobre10 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.Realizaranse duas (2)probas parciais de avaliación continua. Cada control suporá un 15% na nota de avaliación continua.Para superar a materia por Avaliación Continua a nota final (NEC) deberá ser maior ou igual a 5 e calcularase do seguinte modo:NEC = 0,4·PF +0,3·PP + 0,1·ES + 0,2·CPO alumno deberá presentarse ao exame ordinario de todos os contidos da materia, que suporá o 100% da nota, si a nota final de avaliación continua é menor que 5 puntos sobre 10.Tamén terá que presentarse ao exame ordinario nos seguintes supostos:

- A non realización ou entrega dalgún dos puntuables anteriores.
- Obter unha nota inferior a 4 puntos sobre 10 no exame final de avaliación continua.

En calquera destes supostos, a cualificación da avaliación continua será o mínimo da nota de avaliación continua e 4 puntos (o alumno neste caso obterá como máximo 4 puntos). En calquera caso, o alumno que supere a avaliación continua, terá a posibilidade de presentarse ao exame ordinario para subir nota.

No caso de que se detecte fraude académica por parte dun alumno ou grupo de alumnos seguiranse as seguintes normas:

Si a fraude académica prodúcese nalgunha das memorias de prácticas, a nota total de prácticas será cero independentemente da obtida no resto das mesmas.Si o devandito fraude académica prodúcese nalgunha das probas intermedias de control ou no exame de avaliación continua, o alumno suspenderá a avaliación continua cun cero e deberá presentarse directamente á convocatoria ordinaria.

Si a fraude académica ten lugar nunha convocatoria oficial (ordinaria ou extraordinaria) suspenderá dita convocatoria cun cero.

## Bibliografía. Fontes de información

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### Complementary Bibliography


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

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

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Aguirrezabalaga López de Eguilaz, Valentín; Prieto González, M. M., **Transferencia de calor: problemas**, Serv., Publicaciones Universidad de Oviedo, 2006

Manuel Vázquez, **Problemas resueltos de Termodinámica Técnica, 1er y 2º Principio**, Serv. Publicaciones Universidad de Vigo,


## Recomendacións

### Subjects that continue the syllabus

Enxeñaría térmica I/P52G381V01403

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

Física: Física I/P52G381V01102
Matemáticas: Cálculo I/P52G381V01103
Química: Química/P52G381V01108

### Other comments

A materia Termodinámica e Transmisión de Calor constitúe o estudo de sistemas térmicos e enerxéticos, como base a utilizar para o desenvolvemento doutras competencias dentro do campo da enxeñaría térmica. Esta disciplina require da base conceptual necesaria para a súa correcta comprensión. É por iso que para cursar con éxito esta materia o alumno debe:

Cursar e superado as materias de primeiro curso Química, Física I, así como Cálculo I.

Ter coñecementos de termodinámica e transferencia de calor adquiridos na materia Física II do primeiro curso do grao de Enxeñaría Mecánica (recoméndase a seu repaso).

Ter capacidade de comprensión escrita e oral.

Ter capacidade de abstracción, cálculo básico e síntese da información.

## Plan de Continxencias

**Description**

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

No caso de que por circunstancias extraordinarias suspéndase a actividade presencial, proponse as seguintes modificacións aos apartados descritos anteriormente:
- Apartado 6. Contidos
Neste apartado proponse a substitución das prácticas descritas no apartado 6, que en lugar de realizarsepresencialmente basearanse en información e documentación exposta a través da plataforma Moodle, manténdose a avaliación de ditas prácticas coa realización de cuestionarios (CP) a través de dita plataforma: Estas prácticas coas seguintes:
PL 1. Equivalente mecánico da calor
Estudo do equivalente mecánico da calor baseándose en esquemas, vídeos e información web.
PL 2. Dilatación térmica lineal de sólidos
Estudo da dilatación térmica lineal de sólidos baseándose en esquemas, vídeos e información web.
PL 3. Iniciación a técnicas *termográficas
Estudo da iniciación a técnicas termográficas baseándose en esquemas, vídeos e información web.
PL 4. Conductividade térmica de metais
Estudo da conductividade térmica de metais baseándose en esquemas, vídeos e información web.
PL 5. Determinación de propiedades de illantes
Estudo da conductividade térmica de illantes baseándose en esquemas, vídeos e información web.
PL 6. Intercambiador de calor de dobre tubo
Estudo dun intercambiador de calor de dobre tubo baseándose en esquemas, vídeos e información web.
PL 7. Enerxías alternativas. Estudo dun colector solar.
Estudo dun colector solar baseándose en esquemas, vídeos e información web.

- Apartado 8. Metodoloxías docentes
Neste apartado detállase unha nova metodoloxía docente:
Sesión maxistral e/ou sesión práctica virtual síncrona. Impártese a través dunha plataforma de videoconferencia web. Cada aula virtual contén diversos paneis de visualización e compoñentes, cuxo deseño se pode personalizar para que se adapte mellor ás necesidades da clase. Na aula virtual, os profesores (e aqueles participantes autorizados) poden compartir a pantalla ou arquivos do seu equipo, empregar unha lousa, chatear, transmitir audio e vídeo ou participar en actividades en liña interactivas (enquisas, preguntas, etc.).
- Apartado 10. Avaliación
Nun escenario de docencia virtual, as probas de avaliación realizaranse combinando a plataforma de teledocencia FAITIC-Moodle e o Campus Remoto da Universidade de Vigo.

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Resistencia de materiais** | | | | |
| Subject | Resistencia de materiais | | | |
| Code | P52G381V01204 | | | |
| Study programme | Grao en Enxeñaría Mecánica | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Mandatory | 2 | 1c |
| Teaching language | Castelán | | | |
| Department | Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín | | | |
| Coordinator | Rodríguez Rodríguez, Francisco Javier | | | |
| Lecturers | Regueiro Pereira, Araceli<br>Suárez García, Andrés | | | |
| E-mail | fjavierrodriguez@cud.uvigo.es | | | |
| Web | http://faitic.uvigo.es | | | |
| General description | Nesta materia abórdase o estudo do comportamento dos materiais reais en relación coas súas características de resistencia, rixidez e estabilidade, con vistas á comprobación ou dimensionamiento dos elementos que forman as estruturas e as máquinas. | | | |

| 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. |
| 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. |
| C14 | Coñecemento e utilización dos principios da resistencia de materiais. |
| D1 | Análise e síntese. |
| D2 | Resolución de problemas. |
| D9 | Aplicar coñecementos. |
| D10 | Aprendizaxe e traballo autónomos. |
| D16 | Razoamento crítico. |
| D17 | Traballo en equipo. |

| Resultados de aprendizaxe | | | |
|---|---|---|---|
| Expected results from this subject | Training and Learning Results | | |
| Coñecer as diferenzas entre sólido ríxido e sólido elástico | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D10<br>D16<br>D17 |
| Coñecer os estados de tensións e de deformacións nun sólido deformable e a relación entre eles. | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D10<br>D16<br>D17 |
| Aplicar o coñecemento adquirido á determinación dos valores máximos da tensión nun punto dun sólido deformable. | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D10<br>D16<br>D17 |
| Coñecer os principios básicos que rexen a Resistencia de Materiais. | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D10<br>D16<br>D17 |

| | | | |
|---|---|---|---|
| Coñecer as relacións entre as diferentes solicitacións e as tensións que estas orixinan. | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D10<br>D16<br>D17 |
| Aplicar os coñecementos adquiridos á determinación de solicitacións. | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D10<br>D16<br>D17 |
| Aplicar o coñecemento adquirido sobre tensións ao cálculo das mesmas en elementos varra | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D10<br>D16<br>D17 |
| Coñecer os fundamentos das deformacións dos elementos barra | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D10<br>D16<br>D17 |
| Aplicar os coñecementos adquiridos ao dimensionamento de elementos barra | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D10<br>D16<br>D17 |
| RESULTADO DE APRENDIZAXE ENAEE: COÑECEMENTO E COMPRENSIÓN. RA 1.2: Coñecemento e comprensión das disciplinas de enxeñaría propias da súa especialidade, no nivel necesario para adquirir o resto das competencias do título, incluíndo nocións dos últimos adiantos. Nivel de desenvolvemento: Adecuado (2). NOTA: Os posibles valores do nivel de desenvolvemento son: Básico (1), Adecuado (2) e Avanzado (3). | B3 | C14 | |
| RESULTADO DE APRENDIZAXE ENAEE: ANÁLISE EN ENXEÑARÍA. RA 2.2: A capacidade de identificar, formular e resolver problemas de enxeñaría na súa especialidade; elixir e aplicar de forma adecuada métodos analíticos, de cálculo e experimentais xa establecidos; recoñecer a importancia das restricións sociais, de saúde e seguridade, ambientais, económicas e industriais. Nivel de desenvolvemento: Adecuado (2). | B4 | | D1<br>D2<br>D9<br>D16 |
| RESULTADO DE APRENDIZAXE ENAEE: INVESTIGACIÓN E INNOVACIÓN. RA 4.3: Capacidade e destreza para proxectar e levar a cabo investigacións experimentais, interpretar resultados e chegar a conclusións no seu campo de estudo. Nivel de desenvolvemento: Básico (1). | | C14 | D9 |

## Contidos

| Topic | |
|---|---|
| 1. Reforzo de conceptos de estática. Sólido elástico. Tensións e deformacións. | 1.1. Equilibrio estático:<br>- Condicións de equilibrio<br>- Centros de gravidade<br>- Momentos de inercia<br><br>1.2. Introdución ao estudo da resistencia de materiais:<br>- Obxecto e finalidade da resistencia de materiais<br>- Concepto de sólido elástico<br>- Definición de prisma mecánico<br>- Equilibrio estático e equilibrio elástico<br>- Solicitacións sobre unha sección dun prisma mecánico<br><br>1.3. Tensións e deformacións:<br>- Estado tensional dun prisma mecánico<br>- Estado de deformación dun prisma mecánico<br>- Principios xerais da resistencia de materiais<br>- Relacións entre os estados tensional e de deformación<br>- Tipos de solicitacións exteriores sobre un prisma mecánico<br>- Reaccións nas ligaduras. Tipos de apoios<br>- Sistemas isostáticos e hiperestáticos<br>- Coeficiente de seguridade. Tensión admisible. |

| | |
|---|---|
| 2. Tracción-Compresión | 2.1. Tracción ou compresión monoaxial:<br>- Introdución<br>- Esforzo normal e estado tensional<br>- Concentración de tensións<br>- Estado de deformacións<br><br>2.2. Tensións e deformacións<br>- Varra prismática sometida a tracción ou compresión. Influencia do propio peso.<br>- Concepto de sólido de igual resistencia.<br>- Barra ou anel de pequeno espesor por forza centrífuga.<br>- Tracción e compresión hiperestática<br>- Tensións orixinadas por variacións térmicas ou defectos de montaxe<br>- Tracción e compresión máis aló do límite elástico. Tensión residual<br>- Fundamentos de pandeo.<br>- Equilibrio en fíos e cables.<br><br>2.3. Tracción ou compresión biaxial e triaxial:<br>- Tensións en aneis xiratorios<br>- Tensións en depósitos de parede delgada sometidos a presión<br>- Deformacións en esforzos biaxiais e triaxiais |
| 3. Cortadura | 3.1. Teoría elemental da cortadura:<br>- Introdución<br>- Cortadura pura<br>- Deformacións producidas por cortadura<br><br>3.2. Medios de unión<br>- Unións remachadas e atornilladas<br>- Unións soldadas |
| 4. Flexión | 4.1. Flexión. Análise de tensións:<br>- Vigas e diagramas de solicitacións<br>- Introdución á flexión<br>- Flexión pura. Lei de Navier<br>- Flexión Simple<br>- Rendemento xeométrico<br>- Estudo do perfil en dobre T<br>- Enerxía de deformación almacenada en flexión pura<br>- Flexión desviada<br>- Esforzo cortante en flexión simple. Relacións entre esforzo, momento flector e carga<br>- Enerxía interna de deformación producida polo esforzo cortante en flexión simple<br>- Tensións principais. Liñas isostáticas.<br>- Vigas compostas<br><br>4.2. Flexión. Análise de deformacións:<br>- Introdución<br>- Ecuación da liña elástica<br>- Ecuación universal da deformada dunha viga de rixidez constante<br>- Teoremas de Mohr<br>- Teoremas da viga conxugada<br>- Deformacións por esforzos cortantes<br>- Vigas de sección variable<br>- Vigas de materiais diferentes<br>- Flexión hiperestática<br>- Vigas continuas |
| Práctica1: Equilibrio estático | Nesta práctica, revisaranse conceptos relaciones co equilibrio estático (p.e. Centro de Gravidade), así como o seu cálculo experimental. |
| Práctica 2: Módulo de elasticidade | Proponse o cálculo experimental do módulo de elasticidade. A montaxe consta dun bastidor onde se suxeita unha barra plana. A barras de distintos materiais e/ou seccións aplícaselles unha forza coñecida no seu centro e o módulo de elasticidade calcúlase co desprazamento que se produce e os datos xeométricos da barra. |
| Práctica 3: Práctica de software F-Tool (I) | Esta práctica tratará de familiarizar ao alumno co cálculo de valores de esforzos normais e cortantes en diferentes supostos mediante o emprego dun software de cálculo estrutural. |
| Práctica 4: Práctica de software F-Tool (II) | Tratará de introducir ao alumno no cálculo de estruturas planas de complexidade crecente, obtendo esforzos normais, cortantes e flectores, así como a deformada ante diferentes tipos de carga. |

| | |
|---|---|
| Práctica 5: Práctica de software F-Tool (III) | Tratará de introducir ao alumno no cálculo de estruturas planas de complexidade crecente, obtendo esforzos normais, cortantes e flectores, así como a deformada ante diferentes tipos de carga. |
| Prácticas 6 e 7: Introdución á análise estrutural mediante software | Realización de exemplos de análise estrutural mediante métodos analíticos e computacionais. |

**Planificación**

| | Class hours | Hours outside the classroom | Total hours |
|---|---|---|---|
| Lección maxistral | 28 | 28 | 56 |
| Prácticas de laboratorio | 14 | 14 | 28 |
| Seminario | 7 | 0 | 7 |
| Exame de preguntas de desenvolvemento | 13 | 26 | 39 |
| Práctica de laboratorio | 15 | 5 | 20 |

*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 | Nas clases de teoría explícanse os fundamentos de cada tema. Os alumnos dispoñen na bibliografía dos libros de texto recomendados onde se atopa desenvolvido o tema que se está estudando, ademais da información da web que contén o arquivo coa presentación do tema. |
| Prácticas de laboratorio | Nas clases prácticas aplicaranse os conceptos desenvolvidos en cada tema á resolución de problemas. Deseñáronse unha serie de prácticas acorde co desenvolvemento da materia de teoría co fin de fixar conceptos explicados nesa clase e así o alumno vaia desenvolvendo a súa habilidade para expor solucións técnicas, e ir desenvolvendo a súa creatividade. |
| Seminario | Nos seminarios analízanse e propoñen unha serie de problemas que teñen que realizar individualmente ou en grupo. O alumno deberá resolver exercicios e problemas baixo a supervisión e corrección do profesor. |

**Atención personalizada**

| Methodologies | Description |
|---|---|
| Lección maxistral | No ámbito da acción titorial, distínguense accións de tutoría académica así como de tutoría personalizada. No primeiro dos casos, o alumnado terá á súa disposición horas de tutorías nas que pode consultar calquera dúbida relacionada cos contidos, organización e planificación da materia, co desenvolvemento do proxecto, etc. As tutorías poden ser individualizadas, pero fomentaranse tutorías grupales para a resolución de problemas relacionados coas actividades a realizar en grupo, ou simplemente para informar ao docente da evolución do traballo colaborativo. Nas tutorías personalizadas, cada alumno, de maneira individual, poderá comentar co profesor calquera problema que lle estea impedindo realizar un seguimento adecuado da materia, co fin de atopar entre ambos algún tipo de solución. Conxugando ambos os tipos de acción titorial, preténdense compensar os diferentes ritmos de aprendizaxe mediante a atención á diversidade. Os profesores da materia atenderán persoalmente ás dúbidas e consultas dos estudantes, tanto de xeito presencial, segundo o horario que se publicará na páxina web do centro, e a través de medios telemáticos (correo electrónico, videoconferencia, foros FAITIC, etc.). .) baixo a modalidade de cita previa. |

**Avaliación**

| | Description | Qualification | Training and Learning Results | | |
|---|---|---|---|---|---|
| Exame de preguntas de desenvolvemento | Proba Final (PF) que representa o 40% da EC.<br><br>2 Controis Teórico-Prácticos (PT) que representan: 2x15%=30% da EC. | 70 | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D10<br>D16 |
| Práctica de laboratorio | Memorias de Prácticas (PL) que representan o 20% da EC.<br><br>Memorias de Entregables (PE) que representan o 10% da EC. | 30 | B3<br>B4 | C14 | D1<br>D2<br>D9<br>D16<br>D17 |

**Other comments on the Evaluation**

**Convocatoria ordinaria: avaliación continua**

O método de avaliación continua (EC) valorará os resultados alcanzados polos alumnos nas diferentes actividades realizadas ao longo do curso, agrupándose en tres partes: Controis Teórico-Prácticos (PT), Memorias de Prácticas (PL), Memorias de Entregables (PE) e Proba Final (PF).

A nota da avaliación continua (NEC) será o resultado de aplicar a media aritmética ponderada da nota de cada unha das partes (PF, PT, PL e PE), tal e como se reflicte a continuación:
NEC=0,4 PF+0,3 PT+0,2 PL+0,1 PE
Para aprobar a avaliación continua, deberanse cumprir dúas condicións: ter unha NEC maior ou igual a 5 e unha PF maior ou igual a 4. En caso de incumprirse a última condición, ignorarase a cualificación PL e PE, pasando a obter unha cualificación de suspenso na avaliación continua da materia, cunha puntuación igual ao mínimo de 4.0 e a media ponderada de PF e PT.

**Convocatoria ordinaria: exame ordinario**

Aqueles alumnos que non consigan superar a materia polo método de avaliación continua, deberán presentarse ao exame ordinario, onde se avaliarán todas as competencias da materia. Os resultados deste exame suporán o 100% da nota final do alumno, sendo requisito imprescindible para superar a materia obter unha cualificación maior ou igual ao 5. Por último, cabe destacar a opción que todo alumno ten para subir o seu NEC. Noutras palabras, os alumnos que superen a materia por avaliación continua terán a posibilidade de presentarse ao exame ordinario para mellorar a súa nota.

**Convocatoria extraordinaria**

Os alumnos que non superen a materia na convocatoria ordinaria, realizarán un exame extraordinario que terá o mesmo formato e os mesmos requisitos que o exame ordinario.

**Compromiso ético**

Na súa dobre condición de militar e alumno da Universidade de Vigo, este está suxeito ás obrigacións derivadas de ambas as institucións. No que a alumno universitario concierne, o Estatuto do Estudante Universitario, aprobado polo Real Decreto 1791/2010 de 30 de decembro, establece no seu artigo 12, punto 2d, que o estudante universitario ten o deber de absterse da utilización ou cooperación en procedementos fraudulentos nas probas de avaliación, nos traballos que se realicen ou en documentos oficiais da universidade. Así mesmo, a LCM, no seu artigo 4 concernente ás regras de comportamento do militar, establece na súa décimo quinta regra que este cumprirá con exactitude os seus deberes e obrigacións impulsado polo sentimento da honra,[].
Por iso, espérase que o alumno teña un comportamento ético adecuado. Si detectásese un comportamento pouco ético durante o curso (copia, plaxio, uso de dispositivos electrónicos non autorizados ou outros), penalizarase ao alumno cunha nota de 0,0 na proba escrita ou entregable onde se detectase devandita fraude.

## Bibliografía. Fontes de información

**Basic Bibliography**

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

**Complementary Bibliography**

González Taboada, J. Antonioa, **Tensiones y deformaciones en materiales elásticos**,
Gere y Timoshenko, **Resistencia de Materiales**,
Vázquez Fernández M, **Resistencia de Materiales**,
Ortiz Berrocal, Luis, **Elasticidad**,
Feodosiev, V.I., **Resistencia de Materiales**,
Rodríguez Avial, F., **Problemas resueltos de resistencia de materiales**,
Rodríguez Avial, M y Zubizarreta, V., **Problemas de elasticidad y resistencia de materiales**,
Miroliúbov, I, **Problemas de Resistencia de Materiales**,

## Recomendacións

**Other comments**

A materia Resistencia de Materiais constitúe o estudo do comportamento dos materiais reais en relación coas súas características de resistencia, rixidez e estabilidade. Esta disciplina require da base conceptual necesaria para a súa correcta comprensión. É por iso que para cursar con éxito esta materia o alumno debe ter:

- Capacidade de comprensión escrita e oral.

- Capacidade de abstracción, cálculo básico e síntese da información.

## Plan de Continxencias

**Description**

=== MEDIDAS EXCEPCIONAIS PLANIFICADAS ===
Ante a incerta e imprevisible evolución da alerta sanitaria provocada polo *COVID-19, a Universidade de Vigo establece unha planificación extraordinaria que se activará no momento en que as administracións e a propia institución determíneno atendendo a criterios de seguridade, saúde e responsabilidade, e garantindo a docencia nun escenario non presencial ou parcialmente presencial. Estas medidas xa planificadas garanten, no momento que sexa preceptivo, o desenvolvemento da docencia dun modo máis áxil e eficaz ao ser coñecido de antemán (ou cunha ampla antelación) polo alumnado e o

profesorado a través da ferramenta normalizada e institucionalizada das guías docentes.

A continuación, reflíctense os apartados da presente guía docente que sufrirán modificación no caso ter que abordar a docencia en modalidade virtual:

a) Apartado 6 (CONTIDOS)

Cambios nos contidos prácticos:

- Práctica 1. Equilibrio estático e Práctica 2. Módulo de elasticidade.

En caso necesario substituiríanse con sesións de clase maxistral que se realizarían por medios telemáticos (vídeo conferencia) e nas que sería o profesor o que resolvería as actividades prácticas.

- Prácticas 3 a 7: As Prácticas mediante o Software F-Tool e outros métodos analíticos e computacionales.

Mantéñense, pero en caso necesario realizaríanse de modo non presencial por parte dos alumnos.

b) Apartado 8 (METODOLOXÍA DOCENTE)

Engádense dúas novas metodoloxías docentes:

8.4. Sesión maxistral e/ou sesión práctica virtual síncrona

Impártese a través dunha plataforma de videoconferencia web. Cada sala contén diversos paneis de visualización e compoñentes, cuxo deseño se pode personalizar para que se adapte mellor ás necesidades da clase. Na aula virtual, os profesores (e aqueles participantes autorizados) poden compartir a pantalla ou arquivos do seu equipo, empregar unha lousa, chatear, transmitir audio e vídeo ou participar en actividades en liña interactivas (enquisas, preguntas, etc.).

8.5 Foros de discusión

Actividades desenvolvidas nunha contorna virtual para resolución de dúbidas e/ou debater sobre cuestións que xurdan durante o estudo da materia.

c) Apartado 10 (AVALIACIÓN DA APRENDIZAXE)

As probas de avaliación realizaranse empregando plataformas de teledocencia.

En caso de impartición da docencia en modalidade non presencial, a actividade docente impartirase combinando a plataforma de teledocencia FAITIC-Moodle e o Campus Remoto da Universidade de Vigo, para garantir a accesibilidade do alumnado aos contidos docentes.

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Fundamentals of electrical engineering** | | | | |
| Subject | Fundamentals of electrical engineering | | | |
| Code | P52G381V01205 | | | |
| Study programme | (*)Grao en Enxeñaría Mecánica | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Mandatory | 2nd | 2nd |
| Teaching language | Spanish | | | |
| Department | | | | |
| Coordinator | Núñez Ortuño, José María | | | |
| Lecturers | Falcón Oubiña, Pablo<br>González Prieto, José Antonio<br>Núñez Ortuño, José María | | | |
| E-mail | jnunez@cud.uvigo.es | | | |
| Web | http://faitic.uvigo.es | | | |
| General description | The knowledge of electricity, its use and its protections is basic for the development of any kind of engineer, regardless of his branch. That is why Fundamentals of Electrical Engineering represents one of the most important pillars of the knowledge of the future technician, and given its broad spectrum, it will contain a theoretical part and a further part eminently practical.<br><br>The main objective of this course is to transmit the fundamental concepts of the Theory of Circuits and Electrical Machines for application in the design of electrical distribution systems and electronic circuits. These concepts represent the basis of electrical engineering which brings together different aspects and technical sciences such as, among others, Electronics, Power Electronics, Control and Regulation, Automation Systems and Electrical Machines. All this forms the basis of the current field of action of industrial electricity. | | | |

| Competencies | |
|---|---|
| Code | |
| B3 | Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations. |
| C10 | Knowledge and use of the principles of circuit theory and electrical machines. |
| D1 | Analysis and synthesis |
| D2 | Problems resolution. |
| D6 | Application of computer science in the field of study. |
| D10 | Self learning and work. |
| D14 | Creativity. |
| D16 | Critical thinking. |
| D17 | Working as a team. |

| Learning outcomes | | | |
|---|---|---|---|
| Expected results from this subject | Training and Learning Results | | |
| To understand the basics of the operation of circuits and electrical machines | B3 | C10 | |
| Familiarisation with current techniques for the analysis of electrical circuits | | C10 | D6 |
| Know the techniques of measure of electrical circuits | | | D6<br>D10 |
| To acquire skills on the process of analysis of electrical circuits | | | D1<br>D2<br>D6<br>D10<br>D14<br>D16<br>D17 |
| ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.2.- knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)]. | B3 | | |
| ENAEE learning outcome: KNOWLEDGE and UNDERSTANDING: LO1.3.- awareness of the wider multidisciplinary context of engineering [level of achievement (basic (1), intermediate (2) and advanced (3)) for this learning outcome: Intermediate (2)]. | | C10 | |

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

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

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

| | |
|---|---|
| Practices Block II | The purpose of this group of practices is for the student to understand the basic concepts of motors and electric machines. Panels with different electrical machines will be used, as well as simulation software.<br><br>In the practices of this block, tests or assemblies of machines without previous assembly guide will be proposed.<br><br>Practice 6: Single-phase transformer tests<br>The aim of this practice is to make the student aware of the main characteristics of a single-phase transformer. To this end, he will experimentally determine the parameters that govern its operation, using the so-called vacuum and short-circuit tests. The student must be able to carry out the appropriate assembly to perform these tests, measuring voltages, currents and powers.<br>From the result of the measurements the student has to be able to interpret the obtained data and extract from them the necessary information to know and quantify the different power losses in a real transformer. With these data he must build the equivalent model of a real transformer.<br>In this practice, the precautions to be taken when manipulating circuits and using electrical machines will be emphasized. In this sense, part of the practice will be dedicated to make the student aware of the dangers related to the electrical current, showing him the basic measures of electrical safety, the operation of the protection and safety devices, and teaching him how to manage the danger.<br><br>Practice 7: Three-phase asynchronous motor<br>The objective of this practice is that the student makes contact with an industrial asynchronous three-phase motor, identifying its windings, proposing its star and triangle connection, verifying its operation in no-load and making a change in the direction of rotation. Likewise, the problems originated by the loss of a phase in permanent regime and at the start will be analyzed. |

**Planning**

| | Class hours | Hours outside the classroom | Total hours |
|---|---|---|---|
| Lecturing | 28 | 38 | 66 |
| Laboratory practical | 14 | 7 | 21 |
| Seminars | 7 | 3 | 10 |
| Seminars | 15 | 12 | 27 |
| Essay questions exam | 13 | 13 | 26 |

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

**Methodologies**

| | Description |
|---|---|
| Lecturing | Participatory master classes.<br>In these sessions, the basic theoretical contents of the programme will be explained in detail, giving explanatory examples with which to deepen the understanding of the subject.<br><br>Computer presentations and blackboard will be used. A copy of the slides will be given to the students prior to the exhibition, focusing lecturer's and student's efforts in the understanding of the topics. Anyway, the paper reproductions of slides should never be considered as substitutes for texts or notes, but as complementary material. |
| Laboratory practical | Practical set-ups corresponding to the contents seen in the classroom will be carried out in the laboratory, or complementary aspects not covered in the theoretical classes will be treated.<br><br>The methodology used consists of the lecturer supervising the work carried out by the different groups into which the students are divided. The laboratory practices are aimed at reinforcing the theoretical concepts covered in the classroom sessions. |
| Seminars | Since the tutorial action is approached as a group support action to the learning process of the student, these sessions, carried out in seminars and under the format of small group meetings, will serve to solve questions and to raise problems and exercises that will be solved by the students themselves. |
| Seminars | Intensive course that is carried out as preparation for the extraordinary exams. |

**Personalized assistance**

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

**Assessment**

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

| | | | | |
|---|---|---|---|---|
| Laboratory practical | Laboratory practical will be evaluated on the basis of the work done by the student during the practice sessions and by evaluating the technical reports produced at the end of each one.<br>The grade for this block of practices will represent 20% of the total grade end of continuous evaluation. The student must reach 40% of the score assigned to the practices of each of the blocks of the subject. | 20 | B3 C10 | D1<br>D6<br>D10<br>D16<br>D17 |

**Other comments on the Evaluation**

**Qualification Assurance Plan**

***Recovery plan of the final qualification in the First Call***

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

- Have not passed the subject during the Continuous Assessment (NEC < 5.0)
- Wish to improve the grade obtained by the Continuous Assessment method.
- Have not fulfilled the ethical commitment that is developed below.

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

The ordinary examination will contain a theoretical part and a practical part. The student will pass the course when the Note of the Ordinary Examination (NEO) is greater or equal to 5.0 points out of 10, being also necessary to overcome the minimums established in the following table:

| Minimum Score | | |
|---|---|---|
| Theory (T)<br>80% | Block I | 40% |
| | Block II | 40% |
| Practice(P)<br>20% | Blocks I+II | 40% |

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

NEO = 0.8-T + 0.2-P

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

NEO = min {4.0, NEO}

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

NPC = max {NEC, NEO}

***Recovery plan of the final qualification in the Second Call***

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

NEE = 0.8-T + 0.2-P

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

NEE = min {4.0, NEE}

***Plan to improve the final rating***

Each and every student can access a plan to improve their final grade. The improvement plan consists of the right to take a

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

**Ethical commitment**

If unethical behavior (copying, plagiarism, use of unauthorized electronic devices or others) is detected, either during a written test or in the completion of practice reports, you will be penalized as follows:

- *Continuous evaluation*: Given the diverse teaching methodology followed to evaluate each of the two blocks that make up the subject, different considerations will be taken into account. In this way:
- *Scoring tests (partial exams, short questionnaires and final exam)*: All points obtained up to this point will be automatically eliminated, without the possibility of recuperation, and will be excluded from the continuous assessment method. The student must pass the subject in the ordinary exam.

*Practice reports*: all students involved in copying all or part of a report (at the discretion of the subject's teachers) will be penalized in the final grade of the practice block with a mark of 0.0.

*Ordinary exam*: A grade of 0 will be given in all parts of the exam, and students must take the extraordinary exam.

*Extraordinary exam*: A grade of 0 will be given in all parts of the exam.

## Sources of information

### Basic Bibliography

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

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

### Complementary Bibliography

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

Conejo, A, **Circuitos eléctricos para la ingeniería**, 1ª, McGraw-Hill, 2004

Gabladon, A, **Problemas de circuitos eléctricos**, 1ª, Editorial Diego Marín, 2000

Garrido, C. y Cidrás, J., **Problemas de Circuitos Eléctricos**, 1ª, Editorial Reverte, 1992

Espinosa, J. y Belenguer, **Problemas resueltos de máquinas eléctricas rotativas**, 1ª, Universidad Jaume I, 2012

Chapman, S.J, **Máquinas Eléctricas**, 5ª, McGraw Hill, 2012

Corrales Martín, J., **Cálculo Industrial de Máquinas Eléctricas, Tomo II**, 1ª, Marcombo Boixerau Editores, 1982

Duncan Glover, J. y Sarma, M., **Sistemas de Potencia. Análisis y Diseño**, 3ª, Cengage Learning Editores S.A., 2003

Kosow, I.L., **Máquinas Eléctricas y Transformadores**, 1ª, Pearson Educación, 1993

Casals Torrens, Pau, **Máquinas eléctricas. Aplicaciones de ingeniería eléctrica a instalaciones navales y marinas**, 1ª, Ediciones UPC, 2010

## Recommendations

### Subjects that continue the syllabus

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

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

Physics: Physics II/P52G381V01106

### Other comments

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

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

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

the means of this Centre

## Contingency plan

### Description

In case of the possible appearance of extraordinary situations that imply the suspension of the face-to-face teaching activity and the change to an offline/online scenario, the following changes will be made:

CONTENTS

Programming: theoretical credits

The teaching of the theoretical content of the subject should not be affected by the transfer to non-presential online mode. If the number of hours to be taught is considerably reduced, the contents of each of the subjects in a way that ensures that learning outcomes and competences are achieved.

Programming: practical credits

Where appropriate, in the section on practical contents, the replacement of some laboratory practice will be proposed that can't be moved to the virtual stage.
Faced with an extraordinary situation, the replacement of the laboratory sessions with the following ones is considered:

Practice 1: Introduction to PSIM and basic circuit simulation example
The aim of this practice is to familiarize the student with the PSIM simulation software. This software is characterized by its simplicity, allows to mount a circuit and check its operation in an easy and fast way. At This practice will introduce the student to the use of this software with examples and proposed exercises.

Practice 2: Simulation of direct current circuits This practice aims to make more advanced circuits than the previous practice and to check the operation of these with the PSIM software. In this practice the student will be able to check concepts introduced in the master classes like Ohm's law, Thevenin's theorem, Boucherot's theorem, etc.

Practice 3: Simulation and measurement of AC circuits In this practice, non-resistive passive elements are introduced in the simulations of electrical circuits, such as coils and capacitors.

Practice 4: Simulation of PSIM circuits in AC The student will continue with the analysis of AC circuits with the electrical circuit simulator and will introduce power measurement elements, power factor, etc.

Practice 5: Practice of three-phase systems The student will learn to analyze three-phase AC circuits using the of PSIM circuit simulation, extending the concepts seen in previous practices and emphasizing the differences between three-phase and single-phase systems.

Practice 6: Simulation of single-phase transformer tests
The aim of this practice is to make the student aware of the main characteristics of a single-phase transformer. For This will determine by simulation with the PSIM tool, the parameters that govern its operation, using the performance of so-called open and short-circuit tests. The student must be able to carry out the assembly suitable for the realization of these tests, measuring voltages, currents and powers.
From the results of the simulated measurements the student must be able to interpret the data obtained and also know and quantify the different power losses in an actual transformer. With this data the student must compose the equivalent model of a real transformer.

Practice 7: Simulation of the behaviour of the three-phase asynchronous machine
The aim of this practice is that the student is able to verify the behaviour of a three-phase asynchronous machine, making its simulated connection to the grid, obtaining its current, power and nominal torque, and determining its Torque-speed characteristic. Finally, you will check the operation of the machine in its various modes.

TEACHING METHODOLOGY

A new teaching methodology will be incorporated into the existing ones.

Synchronous online meeting (theory or practical session):

These sessions will be given through a web videoconference platform within a virtual classroom. Each virtual classroom will

contain various display panels and components, whose design can be customized by the lecturer to adapt it to the needs of the class. In the virtual classroom, any presenter can share the screen or files of your computer, use a whiteboard, chat, stream audio and video or participate in interactive online activities (surveys, questions, etc.).

LEARNING ASSESSMENT

Faced with a change of scenario due to the emergence of extraordinary situations, learning assessment is will remain unchanged with respect to the contents described above in this teaching guide, weightings, minimum requirements, type and number of tests.
The only difference will be in the evaluation format, which in the online modality will take place by combining the FAITIC-Moodle online teaching platform with the Remote Campus of the University of Vigo (and/or similar platforms)

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Mechanism and machine theory** | | | | |
| Subject | Mechanism and machine theory | | | |
| Code | P52G381V01206 | | | |
| Study programme | (*)Grao en Enxeñaría Mecánica | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Mandatory | 2nd | 2nd |
| Teaching language | Spanish | | | |
| Department | | | | |
| Coordinator | González Gil, Arturo | | | |
| Lecturers | Cacabelos Reyes, Antón<br>González Gil, Arturo | | | |
| E-mail | arturogg@cud.uvigo.es | | | |
| Web | http://faitic.uvigo.es | | | |
| General description | The main objective of Mechanism and Machine Theory is to provide the cinematic and dynamic fundamentals of machines and mechanisms and their application in the field of the Mechanical Engineering. | | | |

| Competencies | |
|---|---|
| Code | |
| B3 | Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations. |
| B4 | Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of Industrial Engineering in Mechanical specialty. |
| C13 | Knowledge of the principles of the theory of machines and mechanisms. |
| D2 | Problems resolution. |
| D6 | Application of computer science in the field of study. |
| D9 | Apply knowledge. |
| D10 | Self learning and work. |
| D16 | Critical thinking. |

| Learning outcomes | | | |
|---|---|---|---|
| Expected results from this subject | Training and Learning Results | | |
| Know the basic foundations of the Theory of Machines and Mechanisms and their application in Engineering Mechanics to solve related problems in the field of Industrial Engineering. | B3<br>B4 | C13 | D2<br>D9<br>D10<br>D16 |
| Know, understand and apply the concepts related with the Theory of Machines and Mechanisms. | | C13 | D2<br>D9<br>D10<br>D16 |
| Know and apply the cinematic and dynamic analyses of mechanical systems. | | C13 | D2<br>D9<br>D10<br>D16 |
| Know and use effectively the software related with the analysis of mechanisms. | | C13 | D2<br>D6<br>D9<br>D10<br>D16 |
| 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: Basic (1)]. | B3 | C13 | |
| ENAEE learning outcome: ENGINEERING ANALYSIS: LO2.2.- ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical societal, health and safety, environmental, economic and industrial constraints [Advanced (3)]. | B4 | | D2<br>D9<br>D16 |

| | | |
|---|---|---|
| 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 [Basic (1)]. | B4 | D2<br>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)]. | | D6<br>D9 |

**Contents**

| Topic | |
|---|---|
| Unit 1: Introduction to the topology of the mechanisms | Basic concepts: link, cinematic pair, cinematic chain, mechanism, machine<br>Types of mechanisms<br>Degrees of freedom<br>Grashof theorem<br>Kinematic inversion<br>Mechanical advantage<br>Mechanisms of straight line and fast return<br>Mechanism schematization |
| Unit 2: Position analysis | Graphic method<br>Graphic-analytical method<br>Analytical method: closed loop equations<br>Four-bar mechanism |
| Unit 3: Velocity analysis | Elementary movements: rotation and translation<br>Analysis of relative velocity<br>Calculation of instantaneous centres of rotation<br>Graphic method<br>Analytical method |
| Unit 4: Acceleration analysis | Basic moves: rotation, translation<br>General movement with relative speed. Coriolis acceleration<br>Relation between the acceleration of two points of the same element<br>Graphic methods<br>Analytical methods |
| Unit 5: Statics | Foundations<br>Force system reduction to a point |
| Unit 6: Force Analysis and dynamics of the flat movement | Systems dynamically equivalent<br>Inertial forces in the flat movement, principle of D' Alembert. |
| Unit 7: Rotation dynamics | Static balancing<br>Dynamic balancing<br>Balancing analysis |
| Unit 8: Dynamic control: the flywheel | Load cycles<br>Flywheel calculation |
| Unit 9: Cams | The cam follower mechanism<br>Displacement diagram<br>Cinematic analysis<br>Graphic design of cam profiles |
| Unit 10: Gears | Transmission mechanisms<br>Types of gears and applications<br>Cylindrical gears. Geometric parameters. Normalization.<br>Gear basic law<br>Forces and power transmission of the cylindrical gears<br>Gear train |
| Laboratory Practices (LP) | PL1 - Machinery analysis<br>PL2 and PL3 - Assembly and kinematic analysis of basic mechanisms<br>PL4 - Kinematic analysis and cam design<br>PL5 - Assembly and analysis of dynamic systems with pulleys and belts<br>PL6 - Assembly and analysis of gear trains<br>PL7 - Defense of the project on the design of a mechanism |

**Planning**

| | Class hours | Hours outside the classroom | Total hours |
|---|---|---|---|
| Lecturing | 28 | 42 | 70 |
| Laboratory practical | 14 | 0 | 14 |
| Seminars | 7 | 7 | 14 |
| Mentored work | 0 | 8 | 8 |

| | | | |
|---|---|---|---|
| Problem solving | 28 | 16 | 44 |

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

## Methodologies

| | Description |
|---|---|
| Lecturing | In lecture sessions, the foundations of each topic are explained. The students can access to the topic information in the bibliography books or the lecture slides uploaded in the subject repository. |
| Laboratory practical | During the laboratory sessions, the students apply the theory to problem resolution. A series of practices are proposed in accordance with the topic to settle the concepts. Hence, the creative proposal of solutions is promoted. |
| Seminars | A series of applied exercises are proposed for the students to solve, edither individually or in groups, under the supervision of the lecturer. |
| Mentored work | Final work on the analysis and design of a mechanism, which will also take into account social, health and industrial safety aspects. The work will be carried out in groups of three or four people. Oral and written justification of the proposed design are required. This work will be proposed at the beginning of the course and the deadline will be the last session of laboratory. |
| Problem solving | Intensive course (15 hours) for those students who have failed the subject at first call, prior to theexam in second call. Group tutoring with the lecturer. Doing examans. Assessment tasks and reinforcement hours. |

## 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 teledoaching platforms, etc.). |

## Assessment

| | Description | Qualification | Training and Learning Results |
|---|---|---|---|
| Lecturing | Written tests: theoretical questions and problems.<br>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 20% 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 C13 D2<br>B4 D6<br>D9<br>D10<br>D16 |
| 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. | 15 | B3 C13 D2<br>B4 D6<br>D9<br>D10<br>D16 |
| Seminars | Throughout the course (in particular during the seminar sessions), 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. | 5 | B3 C13 D2<br>B4 D6<br>D9<br>D10<br>D16 |
| 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 C13 D2<br>B4 D6<br>D9<br>D10<br>D16 |

## Other comments on the Evaluation

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

A numerical 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 assessment method (EC) will assess the results achieved by students in the different activities carried out throughout the course, grouping into five parts: Final Test (PF), Theoretical-Practical Controls (CT), Memories of Practices(MP), Evaluable Exercises (EE), and Final Work (TF). 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 (TC) 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 theoretical class hours, the student may be offered the completion and delivery of different exercises, which will be evaluated in item EE. In the event that a student is unable to attend a session in which carry out exercises that can be evaluated due to force majeure, the latter must notify the teachers by e-mail so that there is a record and this circumstance is taken into account at the time of the evaluation. In addition, students must carry out and present a group work on the design of a mechanism (see practice 7) that will be evaluated in item TF (10% of the final mark of continuous evaluation). The final continuous assessment test (PF) will include all the contents of the subject and will have a weight of 40% in the final grade of continuous assessment.

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

$NEC= 0.4 \cdot PF+0.15 \cdot CT1+0.15 \cdot CT2+0.15 \cdot MP+0.05 \cdot EE+0.1 \cdot TF$

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

Ordinary call: ordinary exam

Those students who fail to pass the subject through the continuous assessment method, must take the ordinary exam, where all the competences of the subject will be assessed. The results of this exam will represent 100% of the student's final grade, being an essential requirement to pass the course to obtain a grade greater than or equal to 5 points out of 10. Finally, it should be noted that every student has the option of improving their grade obtained by continuous evaluation (NEC) taking the ordinary exam.

Extraordinary call

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

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 (copying, 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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**Complementary Bibliography**

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A. Simón, A. Bataller, J. Guerra, A. Ortiz, J.A. Cabrera, **Fundamentos de teoría de máquinas**, Bellisco, 2005

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M. Khamashta, L. Álvarez, R. Capdevila, **Problemas resueltos de cinemática de mecanismos planos**, UPC, 1992

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

## Recommendations

## Contingency plan

**Description**

=== EXCEPTIONAL PLANNING ===

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

MODIFICATIONS IN CASE OF EXTRAORDINARY SITUATIONS THAT INVOLVE THE SUSPENSION OF THE PRESENTIAL ACADEMIC ACTIVITY

CONTENTS

The first six laboratory sessions are held in laboratories and equipment, machines and tools are used. As far as possible, these practices will be replaced by demonstration tasks, solving exercises and/or practical cases that allow the student to achieve the objectives set for said practices.

TEACHING METHODOLOGY

A new teaching methodology is added: Synchronous online meeting (theory or practical session): It is taught through a web video conferencing platform. Each virtual classroom contains a variety of display panels and components, the design of which can be customized to best suit the needs of the class. In the virtual classroom, lecturers (and those authorized participants) can share their computer screen or files, use a whiteboard, chat, stream audio and video, or participate in interactive online activities (surveys, questions, etc.).

EVALUATION

The evaluation tests would be carried out by combining the FAITIC-Moodle remote teaching platform and the Remote Campus of the University of Vigo.

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Environmental technology** | | | | |
| Subject | Environmental technology | | | |
| Code | P52G381V01207 | | | |
| Study programme | (*)Grao en Enxeñaría Mecánica | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Mandatory | 2nd | 2nd |
| Teaching language | Spanish | | | |
| Department | | | | |
| Coordinator | González Gil, Lorena | | | |
| Lecturers | Alfonsín Pérez, Víctor Ángel<br>González Gil, Lorena<br>Maceiras Castro, María del Rocío | | | |
| E-mail | lorena.gonzalez@cud.uvigo.es | | | |
| Web | http://faitic.uvigo.es | | | |
| General description | This syllabus collects the competencies that the students must acquire in this course, the calendar of planned educational activities, the contents and its distribution, an estimate of the volume of work of the student and the specific criteria of assessment.<br>The aim of this subject is to form future graduates in Bachelor Mechanical Engineering with the ability to identify the environmental impacts of industrial and human activities, with the aim to minimize, prevent and solve them. In fact, the increase in legal requirements related to environmental protection, together with the interest of society in the application of more environmentally friendly technological solutions enhance the need for professionals capable of solving environmental problems within multidisciplinary contexts. To achieve this, in this subject it is carried out an approach to Environmental Engineering in combination with other knowledge fields, such as Mechanical Engineering, Chemistry (study of pollutants and their behavior), Biology (biotechnological processes) and Process Engineering (design of physical, chemical and biological processes to mitigate contamination).<br>More specifically, in this subject some technical and practical knowledge about environmental pollution in different ecosystems and their flows of matter and energy will be needed, to later study all the vectors of pollution and evaluate the most appropriate technologies to minimize them, complying whit the current legislation. Lastly, basic knowledge is given on the main policies, tools and indicators developed within the framework of environmental management for the prevention of industrial pollution. | | | |

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

| Learning outcomes | | |
|---|---|---|
| Expected results from this subject | Training and Learning Results | |
| To know the available environmental technologies for control of gaseous pollutants | C16 | D2<br>D3<br>D10 |
| To know the basic processes for the conditioning of water and wastewater treatment | C16 | D2<br>D3<br>D10 |
| To know the performance of wastewater treatment plants | C16 | D2<br>D3<br>D10 |
| To know the integrated process of industrial waste treatment | C16 | D2<br>D3<br>D10<br>D19 |

| | | | |
|---|---|---|---|
| To know and be able to apply the different tools for preventing industrial pollution | | C16 | D1<br>D2<br>D3<br>D9<br>D10<br>D12<br>D17<br>D19 |
| Ability to analyze and determine the social and environmental impact of the technical solutions to environmental problems | B7 | | D1<br>D3<br>D9<br>D10<br>D17<br>D19 |
| ENAEE LEARNING OUTCOMES. KNOWLEDGE AND UNDERSTANDING LO1.3.- awareness of the wider multidisciplinary context of engineering (level of development this sub-resulted of learning: Intermediate (2)) | | C16 | |
| ENAEE LEARNING OUTCOME. ENGINEERING ANALYSIS LO2.2.- ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical societal, health and safety, environmental, economic and industrial constraints (Intermediate (2)) | B7 | | D1<br>D2<br>D9<br>D19 |
| ENAEE LEARNING OUTCOME. ENGINEERING DESIGN LO3.1.- ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical societal, health and safety, environmental, economic and industrial considerations; to select and apply relevant design methodologies (Intermediate (2)) | B7 | | D2<br>D9<br>D19 |
| ENAEE LEARNING OUTCOMES. INVESTIGATIONS LO4.2.- ability to consult and apply codes of practice and safety regulations in their field of study (Intermediate (2)) | B7 | | |
| ENAEE LEARNING OUTCOMES. 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<br>D12 |
| ENAEE LEARNING OUTCOMES. ENGINEERING PRACTICE LO5.4.- ability to apply norms of engineering practice in their field of study (Basic (1)) | B7 | | D9 |
| ENAEE LEARNING OUTCOMES. ENGINEERING PRACTICE LO5.5- awareness of non-technical - societal, health and safety, environmental, economic and industrial implications of engineering practice (Intermediate (2)) | B7 | C16 | D19 |
| ENAEE LEARNING OUTCOMES. MAKING JUDGEMENTS LO6.1.- ability to gather and interpret relevant data and handle complexity within their field of study, to inform judgements that include reflection on relevant social and ethical issues (Intermediate (2)) | B7 | | D19 |

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

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

**Planning**

| | Class hours | Hours outside the classroom | Total hours |
|---|---|---|---|
| Lecturing | 28 | 45 | 73 |
| Laboratory practical | 14 | 7 | 21 |
| Problem solving | 7 | 7 | 14 |
| Seminars | 15 | 7 | 22 |
| Objective questions exam | 4 | 0 | 4 |
| Essay | 0 | 5 | 5 |
| Systematic observation | 0 | 0 | 0 |
| Essay questions exam | 3 | 2 | 5 |
| Essay questions exam | 3 | 0 | 3 |
| Essay questions exam | 3 | 0 | 3 |

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

**Methodologies**

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

**Personalized assistance**

| Methodologies | Description |
|---|---|
| Laboratory practical | Academic tutoring and personalized tutoring. |

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

**Assessment**

| | Description | Qualification | Training and Learning Results |
|---|---|---|---|
| Laboratory practical | Evaluation of the work in the laboratory and of the summary report with the data obtained in the practices, its analysis and discussion.<br>At the end of each practice, the student must prepare a detailed report including aspects such as: objectives and theoretical fundaments of the practice, experimental procedure, materials used, the results obtained and their discussion. In addition, the comprehension of the practice, the student's synthesis capacity, the writing style and the presentation of the report, as well as the student's personal contribution, are evaluated. These reports will be compulsory and rated, each of them, on 10 points. | 15 | B7 C16 D1 D3 D9 D12 D17 D19 |
| Objective questions exam | The theoretical and practical knowledge acquired by the student during the masterclasses and seminars will be monitored. There will be two continuous assessment tests of theory and problems (P1 and P2), with a weight of 15% each. Such tests will be compulsory and scored on 10 points. | 30 | B7 C16 D1 D2 D3 D9 D10 D12 D17 |
| Essay | The students, in pairs or groups of 3, will carry out a written essay on contents related to Topic 8 "Environmental impact assessment and management" or on key aspects of other lessons that it is appropriate to further study. Part of the work will focus on seeking the real application of the addressed topic in different industrial or social fields, evidencing the multidisciplinary application of environmental engineering. Moreover, the students will have to reflect on the ethical and social implications of the studied content. Finally, each group will present their work orally and the peer-assessment among students will be encouraged. | 7 | C16 D1 D3 D9 D10 D12 D17 D19 |
| Systematic observation | During class hours, individual tasks (IT, 5%) and other tasks (TO, 3%) that may be in groups will be proposed in order to monitor the contents taught. These activities will be compulsory and scored, each of them, on 10 points. | 8 | C16 D1 D3 D9 D10 D12 D17 D19 |
| Essay questions exam | Final Exam (FE)<br>At the end of the course, the knowledge acquired by the student will be evaluated by means of a written test with theoretical contents (4 points) and problems (6 points). Such exam will be compulsory and scored on 10 points. | 40 | B7 C16 D1 D2 D3 D9 D10 D12 D17 |
| Essay questions exam | Ordinary Exam<br>If the students do not pass the continuous evaluation, they will have an ordinary exam after the final exam. In this exam the students will be evaluated of all the contents taught, both theoretical and practical. It will be necessary to obtain a grade higher than 4 points out of 10 in each of the parts (theory and problems) in such exam. Besides, there will be a test related to the laboratory practices (with a weight of 10%). | 100 | B7 C16 D1 D2 D3 D9 D10 D12 D17 |
| Essay questions exam | Extraordinary Exam<br>The student will be examined of all the theoretical / practical contents taught in the subject during the ordinary course. In addition, it will be necessary to obtain a grade higher than 4 points out of 10 in each of the parts (theory and problems) evaluated in such exam. | 100 | B7 C16 D1 D2 D3 D9 D10 D12 D17 |

**Other comments on the Evaluation**

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

- If the weighted average of tests P1, P2, TI and FE is less than 5.
- The non-completion or delivery of any of the proposed tests/activities.
- If the obtained grade is lower than 4 points out of 10 in some of the parts (theory and problems) of the Final Exam.

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

**ETHICAL COMMITMENT:**

It is expected that the students have an adequate ethical behaviour.

- If it is detected an unethical behaviour (copy, plagiarism, use of unauthorised electronic devices or others) during the final or partial exams, the student will be punished with the impossibility to pass the subject by the modality of continuous evaluation, obtaining a qualification of 0.0.
- If this type of behaviour is detected in the ordinary or extraordinary exam, the student will obtain a qualification of 0.0.
- In the case of the documents delivered to evaluate the laboratory practices, the total or partial copy in the report (according to the opinion of the teachers of the subject), will be penalized in the final grade of the practices with a qualification of 0.0.

**INTENSIVE COURSE:**

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

## Sources of information

### Basic Bibliography


Guillermo Calleja, Francisco García, Antonio de Lucas, Daniel Prats, José M. Rodríguez, **Introducción a la Ingeniería Química**, Sintesis, 2008

Juan J. Rodríguez Jiménez, **La Ingeniería Ambiental: Entre el reto y la oportunidad**, Sintesis, 2002

Stanley E. Manahan., **Introducción a la Química Ambiental**, Reverté, 2007

Castells et al, **Reciclaje de reidusos industriales: residuos sólidos urbanos y fangos de depuradora**, 2ª ed., Díaz de Santos, 2009


### Complementary Bibliography


Domingo Gómez Orea, **Evaluación de Impacto Ambiental**, 2ª ed., Mundi-Prensa, 2003

David M. Himmelblau, **Principios Básicos y Cálculos en Ingeniería Química**, 6ª ed., Prentice Hall Inc., 1997

Gerard Kiely, **Ingeniería Ambiental: Fundamentos, entornos, tecnologías y sistemas**, Mc Graw Hill, 1999

Glynn Henry, Gary W. Heinke, **Ingeniería Ambiental**, 2ª ed., Prentice Hall Inc., 1999

Metcalf & Eddy Inc., **Wastewater Engineering: Treatment and Resource Recovery.**, 5ª ed., Mc-Graw Hill, 2013

Tang Zhongchao, **Air Pollution and Greenhouse Gases: From Basic Concepts to Engineering Applications for Air Emission Control**, (eBook), Springer, 2014


## Recommendations

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

Physics: Physics 1/P52G381V01102
Physics: Physics II/P52G381V01106
Chemistry: Chemistry/P52G381V01108

## Contingency plan

**Description**

MODIFICATIONS IN CASE OF SUSPENSION OF PRESENTIAL ACADEMIC ACTIVITY

== ADAPTATION OF THE CONTENTS ==

Practices 1-5 are designed to be carried out in laboratories, since they require specific equipment, reagents and materials. In order for the students to achieve the competences associated with these practices, as far as possible, demonstrative content, virtual visits, videos and other audiovisual media will be provided. In addition, some of the practices can be complemented with small domestic experiments. At the same time, the students will be provided with data mimicking what they could experimentally obtain in the laboratory, thus they can process them and draw conclusions. In the event that it is not possible to perform any of these practices in a demonstrative manner, practices similar to 6 will be carried out using a computer software to strengthen concepts of process and equipment design for treating pollution.
The order of the practical contents may be altered to favour their adaptation to the online teaching, which may also lead to variations in the order of the theoretical lessons.

== ADAPTATION OF THE TEACHING METHODOLOGY ==

A new teaching methodology is added:
Synchronous online meeting (theory or practical session): taught through an online conferencing platform. Each virtual classroom contains a variety of display panels and components, whose layout can be customized to best suit the needs of the session. In the virtual classroom, teachers (and those authorized participants) can share their screen or files, use a whiteboard, chat, stream audio and video, or participate in interactive online activities (surveys, questions, etc.).

== ASSESSMENT ADAPTATION ==

The evaluation test/activities will be carried out by combining the FAITIC-Moodle remote teaching platform and the Campus Remoto of the University of Vigo.

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Mecánica de fluídos** | | | | |
| Subject | Mecánica de fluídos | | | |
| Code | P52G381V01208 | | | |
| Study programme | Grao en Enxeñaría Mecánica | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Mandatory | 2 | 2c |
| Teaching language | Castelán | | | |
| Department | Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín | | | |
| Coordinator | Lareo Calviño, Guillermo | | | |
| Lecturers | Lareo Calviño, Guillermo<br>Suárez García, Andrés | | | |
| E-mail | guillermo@cud.uvigo.es | | | |
| Web | http://faitic.uvigo.es | | | |
| General description | A materia de Mecánica de Fluídos ten un carácter básico, onde se aplican os principios fundamentais da física e a mecánica á materia fluída. Trátase de que os alumnos da titulación de grao en enxeñaría mecánica adquiran os coñecementos e ferramentas necesarias para saber analizar e comprender problemas fluídos de distinta categoría, para servir de apoio a outras materias do plan de estudos relacionadas coas propiedades e o movemento dos fluídos, de carácter tanto básico como máis orientadas a problemas reais no campo da enxeñaría. Foméntase así mesmo o desenvolvemento de habilidades e competencias xenéricas como o traballo en equipo e a aprendizaxe autónoma.<br>A Mecánica de Fluídos describe os fenómenos físicos relevantes do movemento dos fluídos, describindo as ecuacións xerais dos devanditos movementos. Este coñecemento proporciona os principios básicos necesarios para analizar calquera sistema no que o fluído sexa o medio de traballo. O campo de aplicacións da Mecánica de Fluídos en enxeñaría é moi amplo: transporte de fluídos en condución, aeronáutica, motores, barcos, fluxos biolóxicos, etc. Os principios da Mecánica de Fluídos son necesarios para campos tan diversos como:<br>- Deseño de maquinaria hidráulica.<br>- Lubricación.<br>- Sistemas de calefacción e ventilación, calor e frío.<br>- Deseño de sistemas de tubaxes.<br>- Medios de transporte: transmisión, climatización, sistema de escape, aerodinámica e hidrodinámica, refrixeración, etc.<br>- Aerodinámica de estruturas e edificios<br>- Centrais térmicas e de fluídos de produción de enerxía convencionais e renovables | | | |

| 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. |
| C8 | Coñecementos dos principios básicos da mecánica de fluídos e a súa aplicación á resolución de problemas no campo da enxeñaría. Cálculo de tubaxes, canais e sistemas de fluídos. |
| D2 | Resolución de problemas. |
| D9 | Aplicar coñecementos. |
| D10 | Aprendizaxe e traballo autónomos. |

| Resultados de aprendizaxe | | | |
|---|---|---|---|
| Expected results from this subject | Training and Learning Results | | |
| Entender os principios básicos do movemento de fluídos | B4<br>B5 | C8 | D2<br>D9<br>D10 |
| Capacidade para calcular tubaxes e canles | B4<br>B5 | C8 | D2<br>D9<br>D10 |
| Capacidade para manexar medidores de magnitudes fluídas | B4<br>B5 | C8 | D2<br>D9<br>D10 |
| Capacidade para coñecer e dominar as ferramentas coas que se abordan os problemas de fluxos de fluídos. | B4<br>B5 | C8 | D2<br>D9<br>D10 |

| | | | |
|---|---|---|---|
| RESULTADOS DE APRENDIZAXE ENAEE: 1. COÑECEMENTO E COMPRENSIÓN:<br>Subresultado: 1.2 Coñecemento e comprensión das disciplinas de enxeñaría propias da súa especialidade, no nivel necesario para adquirir o resto de competencias do título, incluíndo nocións dos últimos adiantos.<br>Nivel de desenvolvemento: Adecuado (2) | | C8 | |
| RESULTADOS DE APRENDIZAXE ENAEE: 2. ANÁLISE EN ENXEÑARÍA:<br>Subresultado: 2.1 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.<br>Nivel de desenvolvemento: Adecuado (2) | B4 | | D2<br>D9 |
| RESULTADOS DE APRENDIZAXE ENAEE: 2. ANÁLISE EN ENXEÑARÍA:<br>Subresultado: 2.2 A capacidade de identificar, formular e resolver problemas de enxeñaría na súa especialidade; elixir e aplicar de forma adecuada métodos analíticos, de cálculo e experimentais xa establecidos; recoñecer a importancia das restricións sociais, de saúde e seguridade, ambientais, económicas e industriais.<br>Nivel de desenvolvemento: Adecuado (2) | B4 | | D2<br>D9 |
| RESULTADOS DE APRENDIZAXE ENAEE: 3. PROXECTOS DE ENXEÑARÍA:<br>Subresultado: 3.1 Capacidade para proxectar, deseñar e desenvolver produtos complexos (pezas, compoñentes, produtos acabados, etc.), procesos e sistemas da súa especialidade, que cumpran cos requisitos establecidos, incluíndo ter conciencia dos aspectos sociais, de saúde e seguridade, ambientais, económicos e industriais; así como seleccionar e aplicar métodos de proxecto apropiados.<br>Nivel de desenvolvemento: Básico (1) | B4<br>B5 | C8 | D2<br>D9 |
| RESULTADOS DE APRENDIZAXE ENAEE: 3. PROXECTOS DE ENXEÑARÍA:<br>Subresultado: 3.2 Capacidade de proxecto utilizando algún coñecemento de vangarda da súa especialidade de enxeñaría.<br>Nivel de desenvolvemento: Adecuado (2) | B4<br>B5 | | |
| RESULTADOS DE APRENDIZAXE ENAEE: 4. INVESTIGACIÓNS E INNOVACIÓN.<br>Subresultado: 4.3 Capacidade e destreza para proxectar e levar a cabo investigacións experimentais, interpretar resultados e chegar a conclusións no seu campo de estudo.<br>Nivel de desenvolvemento: Adecuado (2) | | C8 | D9 |
| RESULTADOS DE APRENDIZAXE ENAEE: 5. APLICACIÓN PRÁCTICA DA ENXEÑARÍA.<br>Subresultado: 5.2 Competencia práctica para resolver problemas complexos, realizar proxectos complexos de enxeñaría e levar a cabo investigacións propias da súa especialidade.<br>Nivel de desenvolvemento: Adecuado (2) | B4<br>B5 | | D2<br>D9 |
| RESULTADOS DE APRENDIZAXE ENAEE: 5. APLICACIÓN PRÁCTICA DA ENXEÑARÍA:<br>Subresultado: 5.3 Coñecemento de aplicación de materiais, equipos e ferramentas, tecnoloxía e procesos de enxeñaría e as súas limitacións no ámbito da súa especialidade.<br>Nivel de desenvolvemento: Básico (1) | | | D9 |
| RESULTADOS DE APRENDIZAXE ENAEE: 7. COMUNICACIÓN E TRABALLO EN EQUIPO.<br>Subresultado: 7.2 Capacidade para funcionar eficazmente en contextos nacionais e internacionais, de forma individual e en equipo e cooperar tanto con enxeñeiros como con persoas doutras disciplinas.<br>Nivel de desenvolvemento: Adecuado (2) | | | D10 |
| RESULTADOS DE APRENDIZAXE ENAEE: 8. FORMACIÓN CONTINUA:<br>Subresultado: 8.1 Capacidade de recoñecer a necesidade da formación continua propia e de emprender esta actividade ao longo da súa vida profesional de forma independente.<br>Nivel de desenvolvemento: Básico (1) | | | D10 |
| RESULTADOS DE APRENDIZAXE ENAEE: 8. FORMACIÓN CONTINUA:<br>Subresultado: 8.2 Capacidade para estar ao día nas novidades en ciencia e tecnoloxía.<br>Nivel de desenvolvemento: Básico (1) | | | D10 |

| **Contidos** | |
|---|---|
| Topic | |
| UD I. INTRODUCIÓN | I.1. Conceptos fundamentais. Concepto de fluído<br>I.2. O fluído como medio continuo<br>I.3. Características dos fluídos<br>I.4. Propiedades termodinámicas dun fluído. Fluídos newtonianos e non *newtonianos<br>I.5. Viscosidade e outras propiedades secundarias |
| UD II. FLUIDOESTÁTICA | II.1. Presión e gradiente de presión<br>II.2. Equilibrio dunha partícula fluída<br>II.3. Distribución de presións en hidrostática<br>II.4. Forzas hidrostáticas sobre superficies planas<br>II.5. Forzas hidrostáticas sobre superficies curvas<br>II.6. Flotación e estabilidade<br>II.7. Distribución de presións en movemento como sólido ríxido<br>II.8. Medidores de presión |

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|---|---|
| UD III. FUNDAMENTOS DO MOVEMENTO DE FLUÍDOS | III.1. Propiedades do campo de velocidade. Método Euleriano e Lagranxiano<br>III.2. Patróns de fluxo: liñas de corrente, sendas e liñas de traza<br>III.3. Clases de fluxos<br>3.1. Segundo condicións cinemáticas<br>3.2. Segundo condicións xeométricas<br>3.3. Segundo condicións mecánicas de contorno<br>3.4. Segundo condicións do movemento interno<br>3.5. Segundo forma de reaccionar ante obstáculos<br>III.4. Sistemas e volume de control<br>III.5. Integrais estendidas a volumes fluídos<br>5.1. Teorema do transporte de Reynolds |
| UD IV. RELACIÓNS INTEGRAIS PARA UN VOLUME DE CONTROL | IV.1. Conservación da masa<br>IV.2. Conservación da cantidade de movemento<br>IV.3. Teorema do momento cinético<br>IV.4. Ecuación da enerxía<br>IV.5. Fluxo sen fricción: a ecuación de Bernoulli |
| UD V. RELACIÓNS DIFERENCIAIS PARA UNHA PARTÍCULA FLUÍDA | V.1. O campo de aceleracións dun fluído<br>V.2. Ecuación diferencial de conservación da masa<br>V.3. Ecuación da cantidade de movemento en forma diferencial<br>V.4. Ecuación diferencial do momento cinético<br>V.5. Ecuación diferencial da enerxía<br>V.6. Condicións de contorno para as ecuacións básicas<br>V.7. A función de corrente<br>V.8. Vorticidade e irrotacionalidade<br>V.9. Fluxos *irrotacionales non viscosos |
| UD VI. ANÁLISE DIMENSIONAL E SEMELLANZA | VI.1. Parámetros adimensionais<br>VI.2. Natureza da análise dimensional<br>VI.3. Teorema Pi de Buckinghan. Aplicacións<br>VI.4. Grupos adimensionais de importancia na Mecánica de Fluídos<br>4.1. Significado físico dos números adimensionais<br>VI.5. Semellanza<br>5.1. Semellanza parcial<br>5.2. Efecto de escala<br>VI.6. Medidores en fluídos |
| UD VII. MOVEMENTO LAMINAR CON VISCOSIDADE DOMINANTE | VII.1. Introdución<br>VII.2. Movemento laminar permanente<br>2.1. Correntes de Hagen-Poiseuille<br>2.2. En condutos de sección circular<br>2.3. Outras seccións<br>VII.3. Efecto de lonxitude finita do tubo<br>VII.4. Perda de carga<br>4.1. Coeficiente de fricción<br>VII.5. Estabilidade de corrente laminar. |
| UD VIII. MOVEMENTO TURBULENTO | VIII.1 Réximes en función do número de Reynolds<br>VIII.2 Modelización da turbulencia<br>VIII.3 Fluxos internos e fluxos externos<br>VIII.4 Perda de carga en fluxos turbulentos en condutos.<br>4.1. Diagrama de Nikuradse<br>4.2. Diagrama de Moody<br>VIII.5 Noción de capa límite<br>VIII.6 Fórmulas empíricas para fluxo en tubaxes |
| UD IX. INTRODUCCION Á CAPA LÍMITE | IX.1 Noción da capa límite<br>IX.2 Ecuacións da capa límite bidimensional incompresible<br>IX.3 Espesor da capa límite |
| UD X. MOVEMENTOS DE LIQUIDOS EN CONDUTOS DE SECCION VARIABLE | X.1. Introdución<br>X.2. Perdas locais<br>2.1. Perda á entrada dun tubo<br>2.2. Perda nun tubo á saída<br>2.3. Perda por contracción<br>2.4. Perda por ensanche<br>2.5. Perda en cóbados<br>X.3. Tubaxes ramificadas<br>X.4. Tubaxes en serie<br>X.5. Tubaxes en paralelo<br>X.6. Redes de tubaxes |

| | |
|---|---|
| PRACTICAS DE LABORATORIO | Práctica PL1. Principio de Arquímedes<br>Obxectivos: Determinar o empuxe que sofren os corpos mergullados en líquidos.<br><br>Práctica PL2. Medición da presión hidrostática<br>Obxectivos: Medición da presión hidrostática cun manómetro en U.<br><br>Práctica PL3. Ecuación de Bernoulli<br>Obxectivos: Estudo da presión en tubaxe con treitos de diámetro variable e constante pola que flúe líquido. Os tubos verticais indican a presión estática.<br><br>Práctica PL4. Demostración da medición de fluxos<br>Obxectivos: Comparación da medida do fluxo por medio de diferentes fluxómetros. Medición do caudal de paso con boquilla/diafragma. Medición do caudal de paso con venturímetro. Medición do caudal de paso con fluxómetro flotador. Calibración de fluxómetros<br><br>Práctica PL5. Demostración de perdas en tubaxes e conectores<br>Obxectivos: Estudo das perdas de presión en tubaxes e accesorios. Determinación do efecto da velocidade de fluxo na perda de presión. Determinación das perdas de presión e liñas características de apertura dos órganos de peche. Determinación dos índices de resistencia. Estudo do funcionamento e principio de diferentes métodos de medición do caudal.<br><br>Práctica PL6. Traballo tutelado<br>Obxectivos: A partir de problemas expostos polos propios alumnos, seguindo as directrices establecidas polo profesor, os alumnos divididos en grupos deberán realizar un traballo baseado nun persoal preestablecida baseada no Traballo Fin de Grao. Preténdese que se familiaricen con estrutúraa tipo dun artigo científico, o traballo con formatos, referencias, índices, etc., así como a distribución de tarefas, traballo en equipo, etc. Ademais das sesións de prácticas ás que se alude neste punto, tamén se utilizará tempo de sesións de teoría como complemento para o desenvolvemento do traballo.<br><br>As prácticas de laboratorio ou de aula de informática programadas poderán variar en contidos e en orde dependendo do material dispoñible para a súa realización, así como das necesidades organizativas do curso académico. |

| **Planificación** | | | |
|---|---|---|---|
| | Class hours | Hours outside the classroom | Total hours |
| Lección maxistral | 28 | 42 | 70 |
| Prácticas de laboratorio | 14 | 14 | 28 |
| Resolución de problemas | 7 | 7 | 14 |
| Exame de preguntas de desenvolvemento | 5 | 0 | 5 |
| Traballo | 15 | 12 | 27 |
| Exame de preguntas de desenvolvemento | 6 | 0 | 6 |
| *The information in the planning table is for guidance only and does not take into account the heterogeneity of the students. | | | |

| **Metodoloxía docente** | |
|---|---|
| | Description |
| Lección maxistral | Nestas sesións, explicaranse detalladamente os contidos teóricos básicos do programa, expondo exemplos aclaratorios cos que profundar na comprensión da materia.<br>Utilizaranse presentacións informáticas e a pizarra. Na medida do posible, proporcionarase copia das diapositivas aos alumnos con anterioridade á exposición, centrando o esforzo do profesor e do alumnado na exposición e comprensión dos coñecementos. De todos os xeitos, as reproducións en papel das diapositivas nunca deben ser consideradas como substitutos dos textos ou apuntamentos, senón como material complementario. |

| | |
|---|---|
| Prácticas de laboratorio | Nas clases prácticas aplicaranse os conceptos desenvolvidos en cada tema á realización de prácticas de laboratorio. Deseñáronse unha serie de prácticas (PL1 a PL5) acorde co desenvolvemento da materia de teoría co fin de fixar conceptos explicados nesa clase.<br><br>Metodoloxías integradas<br> Aprendizaxe baseada en proxectos. Algunhas sesións prácticas (PL6: Traballo tutelado) dedicaranse ao seguimento dos traballos expostos aos diversos grupos nos que se divide o alumnado. Proporcionarase sempre material e bibliografía, aínda que tamén se pretende fomentar a capacidade de procura de información, capacidade de síntese, etc. |
| Resolución de problemas | Formularanse problemas e/ou exercicios relacionados coa materia. O alumno deberá desenvolver solucións adecuadas ou correctas mediante a aplicación de fórmulas ou algoritmos, a aplicación de procedementos de transformación da información dispoñible e a interpretación dos resultados. Utilizarase como complemento da lección maxistral.<br><br>Metodoloxías integradas<br> Aprendizaxe colaborativo. Preténdese motivar ao estudante na actividade de investigación, e fomentar as relacións persoais compartindo problemas e solucións. Reservarase unha fracción das clases de aula á resolución por equipos de problemas expostos. Esta dedicación poderá variar ao longo do cuadrimestre e en función das necesidades puntuais da materia.<br> Aprendizaxe baseada en problemas. Método de ensino-aprendizaxe cuxo punto de partida é un problema que, deseñado polo profesor, o estudante ha de resolver para desenvolver determinadas competencias. Utilizarase esta metodoloxía docente para resolución de problemas sinxelos. |

**Atención personalizada**

| Methodologies | Description |
|---|---|
| Lección maxistral | Cada alumno, de maneira individual, poderá comentar co profesor calquera problema que lle estea impedindo realizar un seguimento adecuado da materia, co fin de atopar entre ambos algún tipo de solución. |
| Resolución de problemas | Cada alumno, de maneira individual, poderá comentar co profesor calquera problema que lle estea impedindo realizar un seguimento adecuado da materia, co fin de atopar entre ambos algún tipo de solución. Os profesores da materia atenderán as dúbidas e consultas dos alumnos de forma síncrona en despachos físicos ou virtuais baixo a modalidade de concertación previa ou asíncrona por medios telemáticos (correo electrónico, foros de FAITIC, etc.). |
| Prácticas de laboratorio | Cada alumno, de maneira individual, poderá comentar co profesor calquera problema que lle estea impedindo realizar un seguimento adecuado da materia, co fin de atopar entre ambos algún tipo de solución. |

**Avaliación**

| | Description | Qualification | Training and Learning Results |
|---|---|---|---|
| Prácticas de laboratorio | A avaliación das prácticas de laboratorio (PL1-PL5) levará a cabo mediante cuestionarios expostos a través de Moodle onde se avaliará ao alumno sobre os coñecementos adquiridos en clase e no laboratorio. A nota das memorias de prácticas (MP) será a media das notas de todos os cuestionarios de prácticas realizados. | 10 | B4 C8 D2<br>B5 D9<br>D10 |
| Resolución de problemas | Avaliación en Seminarios (ES):<br><br>A avaliación en seminarios realizarase a través de traballo en grupos de alumnos. Proporanse exercicios para a súa resolución en grupos, durante o tempo do seminario. Tanto a resolución conxunta do exercicio, como a contribución individual serán valoradas.<br><br>Realizaranse, como mínimo, dous (2) seminarios avaliables durante o curso. | 10 | B4 C8 D2<br>B5 D9<br>D10 |

| | | | |
|---|---|---|---|
| Exame de preguntas de desenvolvemento | Proba final (PF):<br><br>A proba PF ten como obxectivo a avaliación da aprendizaxe de todos os contidos teóricos seleccionados para a materia. Confeccionaranse para xulgar o que o alumno sabe de toda a materia. En segundo lugar, debe consistir nunha serie de cuestións que primen o razoamento conceptual e lóxico, a fin de verificar a madurez intelectual dos alumnos para obter conclusións a partir das nocións ou as teorías expostas en clase.<br><br>A proba final de avaliación continua 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. | 40 | B4 C8 D2<br>B5 D9<br>D10 |
| Traballo | Dado que o traballo tutelado debe ser avaliado de maneira que se garanta a exigibilidade individual e a interdependencia positiva (isto é, todos os membros do grupo deben traballar e contribuído ao produto final e deben dominar, minimamente, todos os aspectos do traballo), na sesión de presentación oral e defensa, intervirán todos os membros do grupo e, calquera membro do grupo debe poder responder a preguntas do traballo, independentemente da parte na que estaba especializado. Todos deben demostrar, por tanto, coñecemento profundo do produto entregado, independentemente da parte na que centrasen os seus esforzos. | 10 | B4 C8 D2<br>B5 D9<br>D10 |
| Exame de preguntas de desenvolvemento | Probas parciais (P1 e P2):<br><br>As probas parciais P1 e P2 teñen como obxectivo a avaliación da aprendizaxe de todos os contidos teóricos seleccionados para a materia. Confeccionaranse para xulgar o que o alumno sabe dunha parte da materia. En segundo lugar, deben consistir nunha serie de cuestións que primen o razoamento conceptual e lóxico, a fin de verificar a madurez intelectual dos alumnos para obter conclusións a partir das nocións ou as teorías expostas en clase.<br>Realizaranse duas (2) probas parciais de avaliación continua. Cada control suporá un 15% na nota de avaliación continua. | 30 | B4 C8 D2<br>B5 D9<br>D10 |

**Other comments on the Evaluation**

Para superar a materia por Avaliación Continua a nota final (NEC) deberá ser maior ou igual a 5 e calcularase do seguinte modo:

NEC = 0,40·PF +0,15·P1 +0,15 P2+ 0,10·TT+0,10·ES + 0,10·MP
O alumno deberá presentarse ao exame ordinario de todos os contidos da materia, que suporá o 100% da nota, si a nota final de avaliación continua é menor que 5 puntos sobre 10.Tamén terá que presentarse ao exame ordinario nos seguintes supostos:
- A non realización ou entrega dalgún dos puntuables anteriores.
- Obter unha nota inferior a 4 puntos sobre 10 no exame final de avaliación continua.- Obter menos dun 5 sobre 10 na avaliación do traballo tutelado.
En calquera destes supostos, a cualificación da avaliación continua será o mínimo da nota de avaliación continua e 4 puntos (o alumno neste caso obterá como máximo 4 puntos). En calquera caso, o alumno que supere a avaliación continua, terá a posibilidade de presentarse ao exame ordinario para subir nota.
COMPROMISO ÉTICO No caso de que se detecte fraude académica por parte dun alumno ou grupo de alumnos seguiranse as seguintes normas:- Si a fraude académica prodúcese nalgunha das memorias de prácticas, a nota total de prácticas será cero independentemente da obtida no resto das mesmas.- Si a fraude académica prodúcese nalgunha das probas intermedias de control ou no exame de avaliación continua, o alumno suspenderá a avaliación continua cun cero e deberá presentarse directamente á convocatoria ordinaria.- Si o alumno comete a fraude académica nunha convocatoria oficial (ordinaria ou extraordinaria) suspenderá dita convocatoria cun cero.

**Bibliografía. Fontes de información**

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## Recomendacións

### Other comments

Para cursar con éxito esta materia o alumno debe seguir as seguintes recomendacións:
- Asistencia regular e activa ás clases, tanto teóricas como prácticas.
- Manter un estudo diario mínimo.

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

## Plan de Continxencias

### Description

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

=== ADAPTACIÓN DAS METODOLOXÍAS ===

ANEXO: MODIFICACIÓNS EN CASO DE SITUACIÓNS EXTRAORDINARIAS QUE IMPLIQUEN A SUSPENSIÓN DA ACTIVIDADE ACADÉMICA PRESENCIAL
No caso de que por circunstancias extraordinarias suspéndase a actividade presencial, proponse as seguintes modificacións aos apartados descritos anteriormente:
-Apartado 6. Contidos
Neste apartado proponse a substitución das prácticas descritas no apartado 6, que en lugar de realizarse presencialmente basearanse en información e documentación exposta a través da plataforma Moodle, manténdose a avaliación de ditas prácticas coa realización de cuestionarios (MP) a través de dita plataforma: Estas prácticas son as seguintes:
PL 1. Principio de Arquímedes
Estudo do principio de *Arquímedes baseándose en esquemas, vídeos e información web.
PL 2. Medición da presión hidrostática
Estudo da presión hidrostática baseándose en esquemas, vídeos e información web.
PL 3. Ecuación de Bernoulli
Estudo da ecuación de Bernoulli baseándose en esquemas, vídeos e información web.
PL 4. Demostración da medición de fluxos
Estudo de métodos de medición de fluxos baseándose en esquemas, vídeos e información web.
PL 5. Demostración de perdas en tubaxes e conectores
Estudo das perdas de carga en tubaxes e conectores baseándose en esquemas, vídeos e información web.

-Apartado 8. Metodoloxías docentes
Neste apartado detállase unha nova metodoloxía docente:
Sesión maxistral e/ou sesión práctica virtual síncrona. Impártese a través dunha plataforma de videoconferencia web. Cada aula virtual contén diversos paneis de visualización e compoñentes, cuxo deseño se pode personalizar para que se adapte mellor ás necesidades da clase. Na aula virtual, os profesores (e aqueles participantes autorizados) poden compartir a pantalla ou arquivos do seu equipo, empregar unha lousa, chatear, transmitir audio e vídeo ou participar en actividades en liña interactivas (enquisas, preguntas, etc.).
-Apartado 10. Avaliación
Nun escenario de docencia virtual, as probas de avaliación realizaranse combinando a plataforma de *teledocencia FAITIC-Moodle e o Campus Remoto da Universidade de Vigo.

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **English I** | | | | |
| Subject | English I | | | |
| Code | P52G381V01209 | | | |
| Study programme | (*)Grao en Enxeñaría Mecánica | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Mandatory | 2nd | 2nd |
| Teaching language | English | | | |
| Department | | | | |
| Coordinator | Tomé Rosales, María de los Ángeles | | | |
| Lecturers | Beasley , Jeffrey<br>Foley , Mary Christina<br>Rich Stephens, Christopher Martin<br>Tomé Rosales, María de los Ángeles | | | |
| E-mail | externo.angelestome@cud.uvigo.es | | | |
| Web | http://faitic.uvigo.es | | | |
| General description | In this subject, students are expected to improve their mastery of the four basic skills of English (listening, speaking, reading, writing) at B1+ Level CEFR (Common European Framework of Reference for Languages) in order to foster the use of the language in the professional military environment. | | | |

| Competencies | |
|---|---|
| Code | |
| B10 | Ability to work in a multidisciplinary and multilingual environment. |
| C34 | 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 | | |
| OVERALL ORAL PRODUCTION<br>To sustain a straightforward description of one of a variety of subjects within his/her field of interest, presenting it as a linear sequence of points.<br><br>SUSTAINED MONOLOGUE: DESCRIBING EXPERIENCE<br>To give straightforward descriptions on a variety of familiar subjects within his/her field of interest.<br><br>SUSTAINED MONOLOGUE: PUTTING A CASE<br>To develop an argument well enough to be followed without difficulty most of the time.<br><br>ADDRESSING AUDIENCES<br>To give a prepared straightforward presentation on a familiar topic within his/her field which is clear enough to be followed without difficulty most of the time, and in which the main points are explained with reasonable precision.<br>To take follow up questions, but s/he may have to ask for repetition if the speech was rapid.<br><br>OVERALL SPOKEN INTERACTION<br>To communicate with some confidence on familiar routine and non-routine matters related to his/her interests and professional field. To exchange, check and confirm information, deal with less routine situations and explain why something is a problem. To express thoughts on more abstract, cultural topics such as films, books, music, etc. | B10 | C34 | D4<br>D5<br>D7<br>D8<br>D9<br>D15<br>D17<br>D18 |

| | | | |
|---|---|---|---|
| OVERALL WRITTEN PRODUCTION<br>To write straightforward connected texts on a range of familiar subjects within his/her field of interest, by linking a series of shorter discrete elements into a linear sequence.<br><br>REPORTS AND ESSAYS<br>To write short, simple essays on topics of interest.<br>To summarise, report and give his/her opinion about accumulated factual information on familiar routine and non-routine matters within his/her field with some confidence. | B10 | C34 | D4<br>D5<br>D7<br>D8<br>D9<br>D15<br>D17<br>D18 |
| OVERALL LISTENING COMPREHENSION<br>To understand straightforward factual information about common everyday or job related topics, identifying both general messages and specific details, provided speech is clearly articulated in a generally familiar accent.<br><br>UNDERSTANDING CONVERSATION BETWEEN NATIVE SPEAKERS<br>To generally follow the main points of extended discussion around him/her, provided speech is clearly articulated in standard dialect.<br><br>LISTENING AS A MEMBER OF A LIVE AUDIENCE<br>To follow a lecture or talk within his/her own field, provided the subject matter is familiar and the presentation straightforward and clearly structured.<br><br>LISTENING TO ANNOUNCEMENTS AND INSTRUCTIONS<br>To understand simple technical information, such as operating instructions for everyday equipment.<br><br>LISTENING TO AUDIO MEDIA AND RECORDINGS<br>To understand the information content of the majority of recorded or broadcast audio material on topics of personal interest delivered in clear standard speech. | B10 | C34 | D4<br>D5<br>D7<br>D8<br>D9<br>D15<br>D17<br>D18 |
| OVERALL READING COMPREHENSION<br>To read straightforward factual texts on subjects related to his/her field of interest with a satisfactory level of comprehension.<br><br>READING FOR ORIENTATION<br>To scan longer texts in order to locate desired information, and gather information from different parts of a text, or from different texts in order to fulfil a specific task.<br><br>READING INSTRUCTIONS<br>To understand clearly written, straightforward instructions for a piece of equipment. | B10 | C34 | D4<br>D5<br>D7<br>D8<br>D9<br>D15<br>D17<br>D18 |
| ENAEE Learning Outcome: KNOWLEDGE AND UNDERSTANDING: LO1.3.- Critical 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 critically use databases and other appropriate sources of information, to carry out simulation 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<br>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<br>D7<br>D8<br>D17<br>D18 |
| ENAEE Learning Outcome: LIFELONG LEARNING: LO8.1.- Ability to recognise the need for and to engage in independent lifelong 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 1 | 1.1. Questions and answers<br>1.2. Do you believe in it? |
| Unit 2 | 2.1. Call the doctor?<br>2.2. Older and wiser? |
| Unit 3 | 3.1. The truth about air travel<br>3.2. Incredibly short stories |
| Unit 4 | 4.1. Eco-guilt<br>4.2. Are you a risk taker? |

| Planning | | | |
|---|---|---|---|
| | Class hours | Hours outside the classroom | Total hours |
| Lecturing | 20 | 20 | 40 |
| Mentored work | 20 | 20 | 40 |
| Essay questions exam | 30 | 24 | 54 |
| 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 | |
|---|---|
| **Methodologies** | **Description** |
| Mentored work | 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, FAITIC forums, etc.) on appointment. |
| **Tests** | **Description** |
| 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, FAITIC 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, FAITIC 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:<br>Reading - 20%<br>Listening - 20%<br>Writing - 30%<br>Speaking - 30%<br>Global - 100%<br><br>Exams (2 per term) 70%<br>Exam 1 - 30%<br>Exam 2 - 40% | 70 | B10 | C34 | D4<br>D8<br>D9<br>D15<br>D17<br>D18 |
| Essay | Activity (15%) | 15 | B10 | C34 | D4<br>D5<br>D7<br>D8<br>D9<br>D15<br>D17<br>D18 |

| | | | | | |
|---|---|---|---|---|---|
| Oral exam | Activity 2 (15%) | 15 | B10 | C34 | D4<br>D5<br>D7<br>D8<br>D9<br>D15<br>D17<br>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 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 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 and, therefore, of the 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).
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 of the same compulsory subject of the Degree in Mechanical Engineering of the Defense College, English I. 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.

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**The Washington Post**,
**The BBC**,
**The CNN**,
**English Listening**,
**Lingo Rank**,
**The British Council**,
**The Naked Scientists**,
**The United Nations**,
**NATO**,
**The UK Ministry of Defence**,
**The UK Foreign and Commonwealth Office**,
**The British Army**,
**The Royal Air Force**,
**The British Forces Broadcasting Service**,
**US Department of Defence Dictionary of Military and Associated Terms**,
**US-based military English website**,
**Military definitions**,
**The National Army Museum**,
**Airforce magazine**,

## Recommendations

**Subjects that continue the syllabus**

English II/P52G381V01406

**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 have taken the subject will allow them to be able to succeed in subjects taken later, because at the end of the academic year students are expected to be able to acquire CEFR Level B1+.
Therefore, to be able to succeed, it is advisable to have the following skills:
-Reading and listening skill
-Writing and speaking skill
-Skill to think abstractly and summarise information
-Skills for group work and communication

## Contingency plan

**Description**

=== EXCEPTIONAL PLANNING ===

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

Teaching methodology:
Classes would become synchronous online sessions, taught by combining FAITIC-Moodle and Campus Remoto of the University of Vigo.

Assessment:
Assessable activities and exams would be carried out by combining FAITIC-Moodle and Campus Remoto of the University of Vigo.

IMPORTANT NOTES:
1. When doing assessable activities or exams, teachers should be able to see students on the screen all the time (except during breaks, when teachers should be able to see the computer screen, the desk and the chair). If teachers are not able to see a student, that student's mark will be 0 in those activities they have done while hiding from teachers.

2. If when doing assessable activities or exams students are systematically looking at a point which is not on the screen just before answering the items of the assessable task or of a task from the exam, the mark of that task will be 0.

3. If when doing assessable activities or exams FAITIC-Moodle registers a student is using two different IP addresses, the mark of those activities will be 0.

4. It is forbidden to use a translation extension on the browser students are using to do activities on FAITIC-Moodle. If students use them, they will be responsible for the consequences derived from its use (for instance, automatic translation into a different language).

5. Unless students are using their mobiles to get connected to Campus Remoto, their mobile must not be in the room where they are doing the exam.

6. If in any of the production activities, examiners realise that a student has plagiarised and they can prove it, that student's mark will be 0.