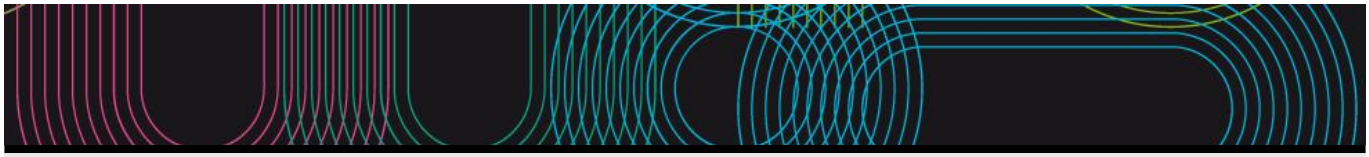

(*)Escola de Enxeñaría de Minas e Enerxía

Presentation

At the School of Mining and Energy Engineering of the University of Vigo we offer comprehensive training (undergraduate and master's degree level) in the field of mining, materials and energy engineering. The training offer of the center for the 2023/24 academic year is as follows:

Degree in Energy Engineering

In the Bachelor's Degree in Energy Engineering, we train professionals who contribute to achieve one of the Sustainable Development Goals of the 2030 Agenda: ensuring universal access to energy services while mitigating the climate impacts of energy production and use.

To meet this need, we offer the Bachelor's Degree in Energy Engineering, the only undergraduate program in Galicia. We educate engineers capable of designing, optimizing, and technically managing the technological processes in the energy sector, ranging from energy generation to the end-user level of thermal or electrical energy (production, storage, transportation, distribution, markets). In the current context, two areas of training are particularly relevant: (i) renewable energy generation technologies (such as wind, geothermal, hydroelectric, tidal, solar, wave, biomass, and biofuels, among others) and (ii) technological processes associated with energy efficiency.

Degree in Mining and Energy Resources Engineering

The Bachelor's Degree in Mining and Energy Resources Engineering is a **unique** program in Galicia and has been **declared as exceptional** within the Galician University System. It also has another distinctive feature: **it enables graduates to practice as regulated** mining engineers.

A regulated profession is that requiring specific accredited training. For certain regulated professions, this training corresponds to a university degree. This is the case for the Bachelor's Degree in Mining and Energy Resources Engineering, which qualifies graduates to practice as regulated Mining Engineers in three areas of technology (Order CIN 306/2009):

- Specialization in "Mining Operations": We educate engineers capable of designing and technically managing the processes that ensure the supply of mineral raw materials for the industry. This includes prospecting rocks and minerals, extraction, and preparation for material manufacturing.
- Specialization in "Materials Engineering": We educate engineers capable of designing and technically managing the manufacturing processes of materials (metals, plastics, ceramics, composites, new materials), as well as technological processes related to recycling, repair, reuse, quality control, and valorization of materials and waste.
- Specialization in "Energy Resources, Fuels, and Explosives": We educate engineers who have knowledge of and can characterize energy resources (such as wind, solar radiation, etc.) and are capable of designing and directing the technological processes in the energy sector, from energy generation to consumption. They also handle technological processes related to the use of fuels and explosives.

Master's Degree in Mining Engineering

Certain regulated professions require a higher level of education, and therefore, a master's degree is required to practice them. The Master's Degree in Mining Engineering **qualifies graduates as Mining Engineers (Order CIN 310/2009)**. This program **is also unique in Galicia** and provides advanced and specialized training in the fields of mining engineering, materials, and energy.

Both bachelor's degrees offered at the institution have direct access to the Master's Degree in Mining Engineering.

Interuniversity Master's Degree in Sustainable Water Management

This interuniversity master's degree is part of the G2030 catalogue of new degrees in the Galician University System (SUG), identified as essential for the training of future professional profiles in Galician society.

Specifically, graduates of this master's degree will be able to pursue careers as technical personnel, managers, or experts in sustainable water management, addressing future challenges in the water sector (water conservation, seawater desalination, collection and storage of rainwater, groundwater decontamination, use of new water processing technologies, digitalization, etc.).

This degree is interuniversity in nature, with a collaboration agreement between the three public universities in Galicia: UDC, USC, and UVigo.

School of Mining and Energy Engineering. Our Identity

We form engineers

At the School of Mining and Energy Engineering of the University of Vigo, we educate engineers who are professionals capable of addressing specific problems in the industry and society providing that these technological solutions are sustainable. This translates into education that goes beyond technological processes and includes training in economics, business, environment, safety, and health.

In addition, the education of engineers requires us to be in constant contact with the industry to understand its needs and the latest technologies. For this reason, the School maintains a permanent collaboration with industrial and business sectors, which includes students' participation in internships and numerous visits to industrial facilities to gain firsthand knowledge of technological processes.

Internacionalization

Our engineers will develop their professional activities in an international context. This is why we offer an Internationalization Plan that allows students to take up to 10 subjects, if desired, entirely in English. Furthermore, we actively work to facilitate student and faculty mobility abroad by establishing agreements with universities and research centers worldwide.

Equality

We want to emphasize our commitment to promoting equal values as a hallmark of our institution. We organize numerous activities with different objectives, including raising awareness about equality, promoting vocations in STEM disciplines, particularly in engineering, and providing mentorship and support to women in their professional activities, among others.

Scientific and Technological Outreach

A defining activity of the institution is our commitment to scientific and technological outreach. We work specifically with secondary schools (ESO) and high schools (Bachillerato), conducting conferences, workshops, award programs, competitions, and other activities aimed at showcasing our field of work and disseminating knowledge to society. Notably, we have the "Open Classroom for TechnoScience" initiative, which is a dedicated space for outreach activities.

Our University Community

The size of our institution encourages and facilitates interpersonal relationships among all members of the university community: students, faculty, and administrative staff. This is particularly relevant in the student-faculty relationship, which allows for personalized attention to students in the learning process. Our student body is especially dynamic and organizes numerous activities through student associations they participate in, such as the Student Delegation, Energy and Mining Sports Club, Technological Employment Forum, Uvigo Motorsport, CES Uvigo, and Uvigo SPACELAB.

Management Team and Coordination

MANAGEMENT TEAM:

Director

Elena Alonso Prieto (eme.direccion@uvigo.es)

Secretary

Guillermo García Lomba (eme.secretaria@uvigo.es)

Deputy Director of Economic Affairs, Infrastructure, and International Relations

Francisco Javier Deive Herva (eme.infraestructuras@uvigo.es, eme.internacional@uvigo.es)

Deputy Director of Planning and Academic Organization

María Araújo Fernández (eme.orgdocente@uvigo.es)

Deputy Director of Scientific Outreach and Student Recruitment

Raquel Pérez Orozco (eme@uvigo.es)

COORDINATION:

The Coordinating Procedure of the School of Mining and Energy Engineering is the instrument through which the content and implementation of various actions related to the coordination of the programs offered at the school are designed. Coordination of all activities is essential for the proper development of students. The coordination system is a fundamental element in the introduction of new objectives and methodologies, and it serves to enhance connections between faculty members and between faculty members and the school.

Bachelor's Degree in Energy Engineering (EI): Francisco Javier Deive Herva (deive@uvigo.es)

Bachelor's Degree in Mining and Energy Resources Engineering (IRME): Iria Feijoo Vázquez (ifeijoo@uvigo.es)

Master's Degree in Mining Engineering (UIM): Elena Alonso Prieto (ealonso@uvigo.es)

Master's Degree in Sustainable Water Management (IGSA): María Araújo Fernández (maraujo@uvigo.es)

1st Year of Bachelor's Degree Programs: Iria Feijoo Vázquez (ifeijoo@uvigo.es)

2nd Year of Bachelor's Degree Programs: Raquel Pérez Orozco (rporozco@uvigo.es)

3rd Year of Bachelor's Degree in IE: Pablo Eguía Oller (peguia@uvigo.es)

4th Year of Bachelor's Degree in IE: Ana María Rodríguez Rodríguez (aroguez@uvigo.es)

3rd & 4th Year of IRME: Fernando García Bastante (bastante@uvigo.es)

External Internships: Javier Taboada Castro (jtaboada@uvigo.es)

1st Year of UIM: Guillermo García Lomba (guille@dma.uvigo.es)

2nd Year of UIM: Marta Cabeza Simó (mcabeza@uvigo.es)

Extracurricular Activities: Ana María Rodríguez Rodríguez (aroguez@uvigo.es)

Follow-up of Graduates: Eduardo Liz Marzán (eliz@uvigo.es)

ICT: Joaquín Martínez Sánchez (aroguez@uvigo.es)

Scientific Outreach: Raquel Pérez Orozco (rporozco@uvigo.es)

Quality Assessment of the School: Guillermo García Lomba (guille@dma.uvigo.es)

Equality: Generosa Fernández Manín (gmanin@uvigo.es)

PAT/PIUNE: Ángeles Domínguez Santiago (admguez@uvigo.es)

School Web Page

http://minasyenergia.uvigo.es/es/

Assessment

Regarding assessment procedures, as stated in the Regulations for Students of the University of Vigo, students have the right (Art. 3.10) "to be evaluated through continuous assessment, with the option of global assessment tests in all subjects and evaluation opportunities throughout the academic year."

The teaching guides provide information about the development of continuous assessment and global assessment tests, detailing how continuous assessment is conducted in the first and second opportunities. The guides also explain how global assessment is conducted if a student has opted out of continuous assessment.

Regarding opting out of continuous assessment, each subject establishes a deadline for requesting this option. The minimum deadline for opting out cannot be less than one month from the start of the subject.

If a student provides justification (documentary evidence and following the procedures established by the school) that they cannot attend a mandatory face-to-face activity due to one of the reasons stated in Article 15 of the Evaluation Regulations, the situation regarding the student's grades, teaching quality, and learning progress will be reviewed by the Standing Committee (Comisión Permanente), which will consider alternative solutions in coordination with the teaching team responsible for the subject.

If a student justifies that they cannot attend an evaluation test due to one of the reasons stated in Article 15 of the Evaluation Regulations, they have the right to take the evaluation test on another date determined by the faculty member responsible for the subject, aiming to reach a consensus with the student regarding the new date.

Any aspect or circumstance related to the content of the teaching guides or the development of assessment systems and tests that is not detailed in the guides or raises doubts of interpretation will be evaluated by the School's Standing Committee.

Grado en Ingeniería de la Energía

Subjects

Year 3rd

Code	Name	Quadmester	Total Cr.
V09G291V01301	Systems and Control Engineering	1st	6
V09G291V01302	Basic operations and processes of refining, petrochemicals and carbo-chemicals	1st	9
V09G291V01303	Generation and distribution of conventional and renewable thermal energy	1st	9
V09G291V01304	Electric Power Plants	1st	6
V09G291V01305	Hydraulic resources, installations and hydro-power plants	2nd	6
V09G291V01306	Electric Power Systems	2nd	6
V09G291V01307	Renewable and Conventional Electricity Generation	2nd	6
V09G291V01308	Thermal engines and turbo-machines	2nd	6
V09G291V01309	Alternative Fuels Technology	2nd	6

IDENTIFYING DATA				
Systems and Control Engineering				
Subject	Systems and Control Engineering			
Code	V09G291V01301			
Study programme	Grado en Ingeniería de la Energía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Pereira Martínez, Moisés Nicolás			
Lecturers	Pereira Martínez, Moisés Nicolás			
E-mail	moisnico@yahoo.es			
Web	http://moovi.uvigo.gal			
General description	In this matter, the basic concepts of industrial automation systems and control methods are presented, considering the programmable automaton and the industrial regulator, respectively, as their central elements			

Training and Learning Results	
Code	
A1	That the students demonstrate to possess and understand knowledge in an area of study that is part of the general education (second level), and often found at a level that, although based on advanced textbooks, also includes some aspects that involve knowledge from the avant-garde of the field of study
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A4	That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized audience
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Ability to draw links between the different elements of all the knowledge acquired, understanding them as components of a body of knowledge with a clear structure and strong internal cohesion.
B3	To suggest and develop practical solutions, using the relevant theoretical knowledge, to phenomena and problems-situations of ordinary reality that are specific to engineering, developing appropriate strategies.
B4	To foster collaborative working, communication, organization and planning skills, along with the ability to take responsibilities in a multilingual, multidisciplinary work environment that promotes education for equality, peace and respect for fundamental rights.
B5	To be familiar with the relevant sources of information, including constant updating, in order to practice one□s profession competently, accessing all the present and future tools of information search, constantly adapting to technological and social changes.
C16	Knowledge of the fundamentals of the electrical power system: generation of energy, transportation, distribution and delivery networks, along with the types of lines and conductors. Knowledge of the regulations of high and low tension. Basic knowledge of electronics and control systems.
C38	Knowledge about modelling and simulation of systems.
D1	To be familiar with and to be able to use the legislation applicable in this sector, to be acquainted with the social and business environments and to be able to deal with the relevant administration, integrating this knowledge into the drawing up of engineering projects and into the implementation of every aspect of their professional work.
D2	Ability to organize, understand, assimilate, produce and handle all the relevant information to develop their professional work, using appropriate computing, mathematics, physics tools, etc. when these are required.
D3	Understanding engineering within a framework of sustainable development with environmental awareness.
D4	Understanding the importance of safety issues and being able to foster awareness about safety among people within their environment.
D5	To become aware of the need for continuous training and the constant improvement of quality, developing the values that are characteristic of scientific thinking, showing flexible, open and ethical attitudes in the face of different situations and opinions, particularly as regards non-discrimination on the grounds of gender, race or religion, respect for fundamental rights, accessibility, etc.

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

General knowledge about control and simulation of dynamic systems, both continuous and sampled.			C16 C38	
Capacity to design basic systems of regulation and control.			C16 C38	D1 D2 D3 D4 D5
Basic notions of optimum control.			C16 C38	
Skill to conceivimg, developing and modeling automatic systems.	A1 A2 A3 A4 A5		C16 C38	D1 D2 D3 D4 D5
Capacity to analyse the needs of a project of automation and fix its specifications.			C16 C38	D1 D2 D3 D4 D5
Ability to size and select an industrial programmable controller for a specific automation application as well as determine the type and characteristics of the required sensors and actuators.			C16 C38	D1 D2 D3 D4 D5
Being able to integrate different technologies (electronic, electrical, pneumatic, etc.) in a single automation.		B1 B3 B4 B5	C16 C38	D1 D2 D3 D4 D5

Contents

Topic	
1. Introduction to industrial automation.	1.1 Introduction to tasks automation. 1.2 Types of control. 1.3 The programmable logic controller. 1.4 Blocks diagram. Elements of the programmable logic controller. 1.5 Cycle of operation of the PLC. Cycle time. 1.6 Ways of operation.
2. Introduction to PLC programming.	2.1 Binary, Octal, Hexadecimal and BCD systems. Real numbers. 2.2 Addresing and access to periphery. 2.3 Instructions, variables and operands. 2.4 Forms of representation of one plan. 2.5 Types of modules of program. 2.6 Linear and structured programming.
3. PLC Programming with Inputs/Outputs.	3.1 Binary variables. Inputs, outputs and memory. 3.2 Binary combinations. 3.3 Operations of assignment. 3.4 Creation of simple program. 3.5 Timers and counters. 3.6 Arithmetic operations. 3.7 Examples.
4. Systems modelling for PLC programming.	4.1 Basic principles. Modelling techniques. 4.2 Petri nets modelling. 4.2.1 Definition of places and transitions. Rules of evolution. 4.2.2 Conditional election between varied alternatives. 4.2.3 Simultaneous sequences. Concurrency. Resource shared. 4.3 Petri nets implantation. 4.3.1 Direct implantation. 4.3.2 Normalized implantation (Grafcet). 4.4 Examples.
5. Basic concepts of automatic control. Representation and modelling of continuous systems.	5.1 Control systems in open and closed loop. 5.2 Typical loop of control. Nomenclature and definitions. 5.3 Physical systems and mathematical models. 5.3.1 Mechanical systems. 5.3.2 Electric systems. 5.3.3 Others. 5.4 State space modelling. 5.5 Transfer function modelling. Laplace transform. Properties. Examples.

6. Analysis of dynamic systems.	6.1 Stability. 6.2 Transient response. 6.2.1 First order systems. Differential equation and transfer functions. Examples 6.2.2 Second order systems. Differential equation and transfer functions. Examples 6.2.3 Effect of the addition of poles and zeros. 6.3 Reduction of systems of upper order. 6.4 Permanent response. 6.4.1 Errors. 6.4.2 Input signals and type of a system. 6.4.3 Error constants.
7. Industrial controllers and parameter tuning.	7.1 Basic control actions. Proportional, integral and derivative effects,. 7.2 PID controller. 7.3 Tuning empirical methods. 7.3.1 Open loop tuning: Ziegler-Nichols and others. 7.3.2 Closed loop tuning: Ziegler-Nichols and others. 7.4 State space design. Poles assignment.
P1. STEP7 introduction.	Introduction the program STEP7, that allows to create and modify programs for Siemens PLCs S7-300 and S7-400.
P2. STEP7 programming.	Simple automation problem modelling and implantation in STEP7 using binary operations.
P3. RdP modelling and STEP7 implantation.	RdP modelling of complex automation example and STEP7 implantation.
P4. GRAFCET modelling and S7-Graph implantation.	RdP normalized modelling and automatitation with S7-Graph.
P5. Control systems analysis with MATLAB.	Introduction to the specific instructions of systems of control of MATLAB program.
P6. Introduction to SIMULINK.	Introduction to the program SIMULINK, extension of MATLAB for dynamic systems simulation.
P7. Transient response modelling in SIMULINK.	Modelling and simulation of control systems with SIMULINK.
P8. Empirical tuning of industrial controllers	Determination of the parameters of a PID industrial controller poles methods studied and implantation of the control calculated in an industrial controller.

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	16	30	46
Problem solving	4	10	14
Lecturing	30	25	55
Report of practices, practicum and external practices	0	8	8
Essay questions exam	2.5	24.5	27

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

Methodologies

	Description
Laboratory practical	Activities of application of the knowledge acquired in the theory classes to specific situations that can be developed in the laboratory of the subject
Problem solving	The teacher will solve problems and exercises in the classroom and the students will have to solve similar exercises to acquire the necessary skills
Lecturing	Exposition by the teaching staff of the contents of the subject.

Personalized assistance

Methodologies	Description
Lecturing	For an effective use of the students dedicatio, the teaching staff will personally attend to the doubts and queries of the student. This attention will take place both in the theory, problems and laboratory classes as well as in the tutorials (at a predetermined time). For all teaching modalities, tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the prior agreement modality.
Laboratory practical	For an effective use of the students dedicatio, the teaching staff will personally attend to the doubts and queries of the student. This attention will take place both in the theory, problems and laboratory classes as well as in the tutorials (at a predetermined time). For all teaching modalities, tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the prior agreement modality.

Problem solving	For an effective use of the students dedicatio, the teaching staff will personally attend to the doubts and queries of the student. This attention will take place both in the theory, problems and laboratory classes as well as in the tutorials (at a predetermined time). For all teaching modalities, tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the prior agreement modality.

Tests	Description
Essay questions exam	For an effective use of the students dedicatio, the teaching staff will personally attend to the doubts and queries of the student. This attention will take place both in the theory, problems and laboratory classes as well as in the tutorials (at a predetermined time). For all teaching modalities, tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the prior agreement modality.

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	Each laboratory practice will be evaluated between 0 and 10 points, depending on the fulfillment of the objectives set in the statement of the same and the previous preparation and attitude of the students. Each practice may have different weighting in the total grade. Expected results from this subject: All of them.	25	A1 B1 C16 D1 A2 B3 C38 D2 A3 B4 D3 A4 B5 D4 A5 D5
Report of practices, practicum and external practices	The memories of the selected practices will be evaluated between 0 and 10 points, taking into account the adequate reflection of the results obtained in the execution of the practice, its organization and quality of presentation. Expected results from this subject: All of them.	5	A1 B1 C16 D1 A2 B3 C38 D2 A3 B4 D3 A4 B5 D4 A5 D5
Essay questions exam	Final exam of the contents of the subject, which may include problems and exercises, with a score between 0 and 10 points. Expected results from this subject: All of them.	70	A1 B1 C16 D1 A2 B3 C38 D2 A3 B4 D3 A4 B5 D4 A5 D5

Other comments on the Evaluation

- A Continuous Evaluation of the work of the students in the practices will be carried out throughout the laboratory sessions established in the semester, being the assistance to them of obligatory character. In the case of not passing it, a practice exam will be carried out in the second call.
- Prerequisites may be required to carry out each practice in the laboratory, in such a way that they limit the maximum qualification to be obtained.
- The evaluation of the practices for the students who officially renounce the Continuous Evaluation, will be carried out in a practice exam in the two calls.
- Both tests (written and practical) must be passed to pass the subject, obtaining the total mark according to the percentage indicated above. In the case of not exceeding two or one of the parts, a scaling may be applied to the partial grades so that the total grade does not exceed 4.5.
- In the final exam, a minimum score may be established in a set of questions to pass it.
- In the second call of the same course, students must examine the tests not passed in the first call, with the same criteria as that.
- According to the Continuous Assessment Regulations, students subject to Continuous Assessment who attend any assessable activity reflected in the Course Teaching Guide will be considered as "presented".

Calendar of examinations:

It can be accessed in the web page of the School of Mining and Energy Engineering:

http://minaseenerxia.uvigo.es/es/docencia/examenes

Sources of information

Basic Bibliography

E.MANDADO, J.MARCOS, C. FERNANDEZ, J.I.ARMESTO, **Autómatas Programables y Sistemas de Automatización**, 1ª Edición, Marcombo, 2009
MANUEL SILVA, **Las Redes de Petri en la Automática y la Informática**, 1ª Edición, AC, 1985
R. C. DORF, R. H. BISHOP, **Sistemas de Control Moderno**, 10ª edición, Prentice Hall, 2005

Complementary Bibliography

PORRAS A., MONTANERO A., **Autómatas programables : fundamento, manejo, instalación y prácticas**, McGraw-Hill, 2003
ROMERA J.P., LORITE J.A., MONTORO S., **Automatización : problemas resueltos con autómatas programables**, 4ª edición, Paraninfo, 2002
BARRIENTOS, ANTONIO, **Control de sistemas continuos: Problemas resueltos**, 1ª Edición, McGraw-Hill, 1997
OGATA, KATSUIKO, **Ingeniería de Control Moderna**, 1ª Edición, Pearson, 2010

Recommendations

Subjects that it is recommended to have taken before

Computing: Computing for Engineering/V09G291V01110
Circuits and Electrical Machines/V09G291V01201

IDENTIFYING DATA

Basic operations and processes of refining, petrochemicals and carbo-chemicals

Subject	Basic operations and processes of refining, petrochemicals and carbo-chemicals			
Code	V09G291V01302			
Study programme	Grado en Ingeniería de la Energía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Domínguez Santiago, María de los Ángeles			
Lecturers	Domínguez Santiago, María de los Ángeles			
E-mail	admguez@uvigo.es			
Web	http://https://moovi.uvigo.gal/			
General description	In this subject, the basic concepts of mass and energy balances, chemical reactors and unit operations based in mass transfer more employed in the industry are explained. the fundamentals of the processes to which fossil energy resources are subjected before their use and the synthesis of organic compounds widely used in daily life are also explained English Friendly subject: International students may requestfrom the teachers: a) materials and bibliographic references, b) tutoring sesions in English c) exams and assessments in English			

Training and Learning Results

Code	
A1	That the students demonstrate to possess and understand knowledge in an area of study that is part of the general education (second level), and often found at a level that, although based on advanced textbooks, also includes some aspects that involve knowledge from the avant-garde of the field of study
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A4	That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized audience
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Ability to draw links between the different elements of all the knowledge acquired, understanding them as components of a body of knowledge with a clear structure and strong internal cohesion.
B3	To suggest and develop practical solutions, using the relevant theoretical knowledge, to phenomena and problems-situations of ordinary reality that are specific to engineering, developing appropriate strategies.
B5	To be familiar with the relevant sources of information, including constant updating, in order to practice one□s profession competently, accessing all the present and future tools of information search, constantly adapting to technological and social changes.
C24	Ability to design and manage procedures of applied experimentation, especially for the determination of transmission and thermodynamic properties, and for the modelling of systems and phenomena in the field of chemical engineering, fluid systems, heat transmission, matter transference operations, kinetics of chemical reactions and reactors.
C25	Knowledge about material and energy balance, biotechnology, matter transference, separation operations, engineering of chemical reactions, design of reactors, and assessment and transformation of raw materials and energy resources.
C26	Applied knowledge of the fundamentals of basic process operations.
C27	Applied knowledge of the fundamentals of processes of refining, petrochemicals and carbon chemicals.
D3	Understanding engineering within a framework of sustainable development with environmental awareness.
D5	To become aware of the need for continuous training and the constant improvement of quality, developing the values that are characteristic of scientific thinking, showing flexible, open and ethical attitudes in the face of different situations and opinions, particularly as regards non-discrimination on the grounds of gender, race or religion, respect for fundamental rights, accessibility, etc.

Expected results from this subject

Expected results from this subject	Training and Learning Results

Know and understand the basics of operations of separation and of the chemical reactors	A1 A2 A3 A4 A5	B1 B3 B5	C24 C25 C26	D3
Know the processes used to obtain fuel products and petrochemical raw materials	A2 A3 A4 A5	B1 B5	C27	D3 D5
Know the techniiques for measuring the properties of fuels		B1 B3 B5	C24	

Contents	
Topic	
Subject 1.- Introduction	Introduction. General concepts.
Subject 2.- Material and energy balances.	Material balances in systems with and without chemical reaction. Energy balances in systems with chemical reaction.
Subject 3.- Operations of separation	Distillation.Rectification. Liquid-liquid extraction. Absorption.
Subject 4.- Introduction to chemical reactors	Design of ideal chemical reactors
Subject 5.- Natural gas and oil refining	Natural gas: constitution and conditioning. Characterisation of the oil. Fractionation, craquing, reformed, alquilation and coquization.Blending of products.
Subject 6.- Petrochemical processes.	Main compound derivatives of the methane, ethene, propene and benzene.
Subject 7.- Coal processes	Technological use of coal: pyrolisis, gasification,etc.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	40.3	80	120.3
Problem solving	20	7.2	27.2
Laboratory practical	8	0	8
Practices through ICT	8	6	14
Problem and/or exercise solving	1.5	30	31.5
Essay questions exam	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Presentation, by the teaching staff, of the main knowledge corresponding to the subject topics.
Problem solving	The teacher proposes a series of problems to the students to work on at home or in the classroom
Laboratory practical	The students will carry out practices related to basic operations
Practices through ICT	A process simulation program is used to simulate the unit operations studied: rectification, liquid-liquid extraction, absorption, etc.

Personalized assistance	
Methodologies	**Description**
Problem solving	Students can consult the teacher, during tutorial hours, with any questions about theoretical or practical aspects of the subject.

Assessment				
	Description	Qualification	Training and Learning Results	
Lecturing	Activities will be carried out in Moovi and exercises in class or related to each of the topics. Expected results from this subject: Know the processes used to obtain fuel products and petrochemical raw materials. To know the measurement techniques of the properties of fuels. To know the measurement techniques of the properties of fuels.	15	B1 B3	D5

Laboratory practical	The work and the report made by the students will be assessed. Expected results from this subject: Know and understand the basic aspects of separation operations and chemical reactors.	10	A3 A4	B3 B5	C25 C26	D5
Practices through ICT	The work and the report made by the students will be evaluated. Expected results from this subject: Know and understand the basics of the operations of separation and chemical reactors.	10	A3 A4	B3 B5	C25 C26	D5
Problem and/or exercise solving	An examination of basic operations problems will be carried out, which will take place on the date established in the official calendar of the center. Expected results from this subject: Know and understand the basics of the operations of separation and chemical reactors.	40	A2 A5	B1 B3	C25 C26	
Essay questions exam	An exam will be held in the last week of the semester tackling natural gas and refining, petrochemicals and carbochemicals Expected results from this subject: Know the processes used to obtain fuel products and petrochemical raw materials Know the techniiques for measuring the properties of fuels	25		B1	C25 C27	D3 D5

Other comments on the Evaluation

Considerations on continuous assessment

To pass the subject, a minimum of 3.5/10 is required in each of the evaluable sections. In case that after adding all the marks, the value is equal to or greater than 5, but the minimum score is not reached in any of the evaluable sections, the final mark will be 4.

Considerations on global assessment

Students will have a maximum period of two months from the start of the course to refuse to continuous assessment.

This global test can include questions from laboratory practices and practices with the support of ICT, therefore, the student will be allowed to reach 100% of the mark.

Considerations on second opportunity:

In the second opportunity, the marks of the laboratory practices and practices with ICT support will be kept for those students who have passed these methodologies. For those students who have not passed them or have refused to carry out the continuous assessment, the second opportunity exam may include questions from these methodologies.

Sources of information

Basic Bibliography

Himmelblau, D.M., **Basis principles and calculations in chemical engineering**, 6, Prentice-Hall, 1996

McCabe, W.L., Smith, J.C., Harriot, P., **Operaciones unitarias en Ingeniería Química**, 7, McGraw-Hill, 2007

Gary, J.H., Handwerk, G.E., Kaiser, M.J., **Petroleum refining technology and economics**, 5, CRC Press, 2007

Complementary Bibliography

Izquierdo, J.F., Costa, J., Martinez, E., Izquierdo, M., **Introducción a la Ingeniería Química: problemas resueltos de balances de materia y energía**, 1, Reverté, 2011

Recommendations

IDENTIFYING DATA				
Generation and distribution of conventional and renewable thermal energy				
Subject	Generation and distribution of conventional and renewable thermal energy			
Code	V09G291V01303			
Study programme	Grado en Ingeniería de la Energía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Pérez Orozco, Raquel			
Lecturers	Pérez Orozco, Raquel			
E-mail	rporozco@uvigo.gal			
Web	http://moovi.uvigo.gal			
General description	The subject "Generation and distribution of conventional and renewable thermal energy" collects a wide variety of different topics as the name indicates, by bringing together various specific competences collected in the memory of the Degree in EE and the Degree in ERME. Subject of the English Friendly program. The international students will be able to request to the teaching staff: a) materials and bibliographical references for following the subject in English, b) attend to the tutorials in English, c) tests and evaluations in English.			

Training and Learning Results	
Code	
A1	That the students demonstrate to possess and understand knowledge in an area of study that is part of the general education (second level), and often found at a level that, although based on advanced textbooks, also includes some aspects that involve knowledge from the avant-garde of the field of study
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A4	That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized audience
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Ability to draw links between the different elements of all the knowledge acquired, understanding them as components of a body of knowledge with a clear structure and strong internal cohesion.
B3	To suggest and develop practical solutions, using the relevant theoretical knowledge, to phenomena and problems-situations of ordinary reality that are specific to engineering, developing appropriate strategies.
B5	To be familiar with the relevant sources of information, including constant updating, in order to practice one□s profession competently, accessing all the present and future tools of information search, constantly adapting to technological and social changes.
C23	Ability to design electrical power plants.
C24	Ability to design and manage procedures of applied experimentation, especially for the determination of transmission and thermodynamic properties, and for the modelling of systems and phenomena in the field of chemical engineering, fluid systems, heat transmission, matter transference operations, kinetics of chemical reactions and reactors.
C28	Applied knowledge of the fundamentals of alternative energies and efficient use of energy.
C29	Applied knowledge of thermal engineering.
C30	Applied knowledge of renewable energies.
C31	Applied knowledge of the fundamentals of energy logistics and distribution.
C32	To know, understand and apply the principles of use, transformation and management of energy resources.
C33	Applied knowledge of the fundamentals of industries of generation, transmission, transformation and management of thermal and electrical power.
D3	Understanding engineering within a framework of sustainable development with environmental awareness.
D5	To become aware of the need for continuous training and the constant improvement of quality, developing the values that are characteristic of scientific thinking, showing flexible, open and ethical attitudes in the face of different situations and opinions, particularly as regards non-discrimination on the grounds of gender, race or religion, respect for fundamental rights, accessibility, etc.

Expected results from this subject	Training and Learning Results			
To understand the basics of boilers and thermal energy production.	A1 A2 A3 A4 A5	B1 B3 B5	C24 C29 C32 C33	D3
To understand the basics of conventional thermal power plants.	A1 A2 A3 A4 A5	B1 B3 B5	C24 C29 C31 C32 C33	D3 D5
To understand the basic aspects of control systems and variables for thermal machines in electric power generation processes.	A1 A2 A3 A4 A5	B1 B3 B5	C23 C24 C29 C31 C32 C33	D3 D5
To deepen in the techniques of utilization of fossil fuels and renewable fuels for their use in a thermal power plant.	A1 A2 A3 A4 A5	B1 B3 B5	C24 C28 C29 C30 C32 C33	D3 D5
To understand the basic aspects of solar radiation and its use for thermal energy production.	A1 A2 A3 A4 A5	B1 B3 B5	C24 C28 C29 C30 C31 C32 C33	D3 D5
To know the technological basis on which the most recent research on the use of renewable energies is based, particularly to produce thermal energy.	A1 A2 A3 A4 A5	B1 B3 B5	C24 C28 C29 C30 C32 C33	D3 D5

Contents	
Topic	
1. Energy conversion and transport	- Energy sources - Consumption structure - Demand forecasting
2. Conventional thermal power plant	- Rankine, Brayton and Combined Cycle thermodynamic cycles. - Diagram of conventional and nuclear thermal power plants. - Diagram of a Combined Cycle thermal power plant. - Operation of power plants. Control systems for thermal machines. Environmental impacts
3. Humid air	- Fundamentals of psychrometry - Cooling towers and air conditioning systems
4. Fuels and combustion processes	- Nature and use of different fuels: solid, liquid, and gaseous fuels - Study of combustion processes
5. Boilers, furnaces, and burners	- Types of boilers -Energy balance - Burners according to the type of fuel they use - Furnaces and dryers
6. Renewable energies for thermal use	- Biomass - MSW - Geothermal - Solar
7. Solar thermal technology	- Low temperature solar thermal applications - Solar thermal power plants

Planning	Class hours	Hours outside the classroom	Total hours

Lecturing	34.3	82.2	116.5
Problem solving	22	53	75
Laboratory practical	6	5	11
Practices through ICT	4	6	10
Studies excursion	4	0	4
Case studies	6	0	6
Objective questions exam	1	0	1
Problem and/or exercise solving	1	0	1
Self-assessment	0.5	0	0.5

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

Methodologies

	Description
Lecturing	Presentation by the professor of the contents of the subject matter, theoretical bases and/or guidelines of a work, exercise that the student has to develop.
Problem solving	Activity in which problems and/or exercises related to the subject are formulated. The student must develop the ideal or correct solutions through the exercise of routines, the application of formulas or algorithms, the application of transformation procedures of the available information and the interpretation of the results. It is usually used as a complement to the master class.
Laboratory practical	Activities of application of knowledge to particular situations and acquisition of basic and procedural skills related to the subject matter. They are developed in special spaces with specialized equipment (laboratories, computer rooms, etc...).
Practices through ICT	Activities for the application of knowledge in a given context and the acquisition of basic and procedural skills in relation to the subject, through ICT.
Studies excursion	Activities of application, contrast and observation of knowledge in a given context in an external space.
Case studies	Analysis of an event, issue or actual event in order to know, interpret, solve, generate hypotheses, comparing data, reflect, complete knowledge, diagnose and training in alternative dispute resolution procedures.

Personalized assistance

Methodologies	Description
Lecturing	Time dedicated by the teacher to meet the needs and queries of students related to the study and / or topics related to the subject and activities developed. This activity will be developed in person (directly in the office and schedules assigned by the teacher) or by telematic means (e-mail, videoconference, Moovi forums, ...) under the modality of prior arrangement.
Studies excursion	Time dedicated by the teacher to meet the needs and queries of students related to the study and / or topics related to the subject and activities developed. This activity will be developed in person (directly in the office and schedules assigned by the teacher) or by telematic means (e-mail, videoconference, Moovi forums, ...) under the modality of prior arrangement.
Problem solving	Time dedicated by the teacher to meet the needs and queries of students related to the study and / or topics related to the subject and activities developed. This activity will be developed in person (directly in the office and schedules assigned by the teacher) or by telematic means (e-mail, videoconference, Moovi forums, ...) under the modality of prior arrangement.
Laboratory practical	Time dedicated by the teacher to meet the needs and queries of students related to the study and / or topics related to the subject and activities developed. This activity will be developed in person (directly in the office and schedules assigned by the teacher) or by telematic means (e-mail, videoconference, Moovi forums, ...) under the modality of prior arrangement.
Practices through ICT	Time dedicated by the teacher to meet the needs and queries of students related to the study and / or topics related to the subject and activities developed. This activity will be developed in person (directly in the office and schedules assigned by the teacher) or by telematic means (e-mail, videoconference, Moovi forums, ...) under the modality of prior arrangement.
Case studies	Time dedicated by the teacher to meet the needs and queries of students related to the study and / or topics related to the subject and activities developed. This activity will be developed in person (directly in the office and schedules assigned by the teacher) or by telematic means (e-mail, videoconference, Moovi forums, ...) under the modality of prior arrangement.
Tests	**Description**
Objective questions exam	Time dedicated by the teacher to meet the needs and queries of students related to the study and / or topics related to the subject and activities developed. This activity will be developed in person (directly in the office and schedules assigned by the teacher) or by telematic means (e-mail, videoconference, Moovi forums, ...) under the modality of prior arrangement.

Problem and/or exercise solving	Time dedicated by the teacher to meet the needs and queries of students related to the study and / or topics related to the subject and activities developed. This activity will be developed in person (directly in the office and schedules assigned by the teacher) or by telematic means (e-mail, videoconference, Moovi forums, ...) under the modality of prior arrangement.
Self-assessment	Time dedicated by the teacher to meet the needs and queries of students related to the study and / or topics related to the subject and activities developed. This activity will be developed in person (directly in the office and schedules assigned by the teacher) or by telematic means (e-mail, videoconference, Moovi forums, ...) under the modality of prior arrangement.

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	Delivery of results report. Attendance as a requirement for the evaluation of the report. Expected results: To understand the basics of boilers and thermal energy production. To understand the basics of conventional thermal power plants. To understand the basic aspects of control systems and variables for thermal machines in electric power generation processes. To know the technological basis on which the most recent research on the use of renewable energies is based, particularly to produce thermal energy.	10	A1 B1 C24 D3 A2 B3 C29 D5 A3 B5 A4 A5
Practices through ICT	Delivery of results report. Expected results: To understand the basics of conventional thermal power plants. To understand the basic aspects of solar radiation and its use for thermal energy production.	5	A1 B1 C28 D3 A2 B3 C29 D5 A3 B5 C30 A4 C32 A5
Objective questions exam	Written exam of short answer questions, test type or to develop. Expected results:To understand the basics of boilers and thermal energy production. To understand the basics of conventional thermal power plants. To understand the basic aspects of control systems and variables for thermal machines in electric power generation processes. To deepen in the techniques of utilization of fossil fuels and renewable fuels for their use in a thermal power plant. To understand the basic aspects of solar radiation and its use for thermal energy production. To know the technological basis on which the most recent research on the use of renewable energies is based, particularly to produce thermal energy.	30	A1 B1 C23 D3 A2 B3 C24 D5 A3 B5 C28 A4 C29 A5 C30 C31 C32 C33
Problem and/or exercise solving	Written exam of problem solving and case studies. Expected results:To understand the basics of boilers and thermal energy production. To understand the basics of conventional thermal power plants. To understand the basic aspects of control systems and variables for thermal machines in electric power generation processes. To deepen in the techniques of utilization of fossil fuels and renewable fuels for their use in a thermal power plant. To understand the basic aspects of solar radiation and its use for thermal energy production. To know the technological basis on which the most recent research on the use of renewable energies is based, particularly to produce thermal energy.	35	A1 B1 C23 D3 A2 B3 C24 D5 A3 B5 C28 A4 C29 A5 C30 C31 C32 C33
Self-assessment	Multiple-choice tests, carried out autonomously by students through the e-learning platform throughout the term. Expected results:To understand the basics of boilers and thermal energy production. To understand the basics of conventional thermal power plants. To understand the basic aspects of control systems and variables for thermal machines in electric power generation processes. To deepen in the techniques of utilization of fossil fuels and renewable fuels for their use in a thermal power plant. To understand the basic aspects of solar radiation and its use for thermal energy production. To know the technological basis on which the most recent research on the use of renewable energies is based, particularly to produce thermal energy.	20	A1 B1 C23 D3 A2 B3 C24 D5 A3 B5 C28 A4 C29 A5 C30 C31 C32 C33

Other comments on the Evaluation

Continuous evaluation - First assessment: During the first period there will be a first partial written test (P1) with contents of the lectures and problem solving sessions, which will represent 30% of the grades. The contents evaluated in the P1 will not be evaluated in the second partial exam (P2). The P2 will take place on the official date of the exam and will

represent 35% of the grades.To pass the subject, students must obtain a grade equal to or higher than 3 points out of 10 in each of the partial tests (P1 and P2) and an overall grade equal to or higher than 5 points out of 10. If the minimum grade is not reached in each partial test, the subject will be considered as failed and the final grade will appear as 4.5.In order to facilitate the continuous evaluation and the follow-up of the contents seen in the lecture sessions, self-evaluation tests (PAV) will be carried out throughout the term through the teledocency platform (20% of the grades).Laboratory practices (PL) will represent 10% of the grade of the subject. The evaluation of the reports of results obtained in each practice will be subject to the attendance of these sessions.

Continuous evaluation - Second assessment: The exam of the second opportunity will consist of a written test (65%), whose content will be determined by the agenda of the lectures and problem-solving sessions. The grade corresponding to the self-evaluation tests (PAV-20%), laboratory practices (PL-10%) and ICT (PTIC-5%) will be kept. Those students who request it, will be re-evaluated of the contents corresponding to PL and/or PTIC by means of a written test, which will take place on the official date of the exam of the second opportunity. To pass the subject, students must obtain a qualification equal to or higher than 5 points out of 10.

Global evaluation: Those students who waive the continuous evaluation will be entitled to a global test, written, with a score of 100%. To pass the subject, the student must obtain a qualification equal or superior to 5 points out of 10.

Sources of information

Basic Bibliography

J. Moran Michael / N. Shapiro, Howard, **Fundamentals of Engineering Thermodynamics**, 5ª ed., Reverté, 2004

Complementary Bibliography

Glassman, Irvin, **Combustion**, 5ª ed., Academic Press, 2014

Romero Sedó, Antonio Manuel / Arrué Burillo, Paloma, **Diseño y cálculo de instalaciones de gases combustibles. Redes**, 1ª ed., Pearson, 2007

Mokhatab, Saeid / Y. Mak, John / V. Valappil, Jaleel / A. Wood, David, **Handbook of liquefied natural gas**, 1ª ed., Elsevier, 2014

Míguez Tabares, José Luis / Ortiz Torres, Luis / Váquez Alfaya, Eusebio, **Producción Industrial de Calor**, 1ª ed., Tórculo, 1994

Márquez Martínez, Manuel, **Combustión y quemadores**, 1ª ed., Marcombo, 2005

L. Klass, Donald, **Biomass for Renewable Energy, Fuels, and Chemicals**, 1ª ed., Academic Press, 1998

Duffie, John A., **Solar engineering of thermal processes, Wiley Intersciencie**, 4ª ed., Wiley, 2013

Kehlfhofer, Rolf / Rukes, Bert / Hannemann, Frank / Stirnimann Franz, **Combined-Cycle Gas Steam turbine power plants**, 1ª ed., PennWell, 2009

Wang, Shan K., **Handbook of air conditioning and refrigeration**, 2ª ed., McGraw-Hill, 2001

Recommendations

Subjects that continue the syllabus

Renewable and Conventional Electricity Generation/V09G291V01307
Thermal engines and turbo-machines/V09G291V01308
Energy Efficiency: Sustainability and Certification/V09G291V01413
Thermal Energy Management/V09G291V01401

Subjects that it is recommended to have taken before

Thermal Systems/V09G291V01205
Heat transmission/V09G291V01206

IDENTIFYING DATA				
Instalacións eléctricas				
Subject	Instalacións eléctricas			
Code	V09G291V01304			
Study programme	Grao en Enxeñaría da Enerxía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	1c
Teaching language	Castelán Galego			
Department	Enxeñaría eléctrica			
Coordinator	Manzanedo García, José Fernando			
Lecturers	Fernández Otero, Luis Ángel Manzanedo García, José Fernando			
E-mail	manzaned@uvigo.es			
Web	http://https://moovi.uvigo.gal/			
General description	Nesta materia trátanse os aspectos básicos da xeración e distribución final da enerxía eléctrica, centrándose inicialmente a materia na xeración eléctrica convencional (con máquina síncrona) e as centrais asociadas aos devanditos xeradores, para posteriormente estudar detalladamente o deseño, cálculo e implementación das instalacións eléctricas, tanto industriais como residenciais, de acordo ao REBT.			

Resultados de Formación e Aprendizaxe	
Code	
A1	Que os estudantes demostrasen posuír e comprender coñecementos nunha área de estudo que parte da base da educación secundaria xeral, e adóitase atopar a un nivel que, aínda que se apoia en libros de texto avanzados, inclúe tamén algúns aspectos que implican coñecementos procedentes da vangarda do seu campo de estudo
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A4	Que os estudantes poidan transmitir información, ideas, problemas e solucións a un público tanto especializado coma non especializado
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B1	Capacidad de interrelacionar todos los conocimientos adquiridos, interpretándolos como componentes de un cuerpo del saber con una estructura clara y una fuerte coherencia interna.
B3	Propoñer e desenvolver solucións prácticas, utilizando os coñecementos teóricos, a fenómenos e situacións-problema da realidade cotiá propios da enxeñería, desenvolvendo as estratexias adecuadas.
B5	Coñecer as fontes necesarias para dispoñer dunha actualización permanente e continua de toda a información precisa para desenvolver o seu labor, accedendo a todas as ferramentas, actuais e futuras, de procura de información e adaptándose aos cambios tecnolóxicos e sociais.
C22	Coñecemento sobre sistemas eléctricos de potencia e as súas aplicacións.
C23	Capacidade para o deseño de centrais eléctricas.
C28	Coñecemento aplicado dos fundamentos de enerxías alternativas e uso eficiente da enerxía
C30	Coñecemento aplicado sobre enerxías renovables
C32	Coñecer, comprender e empregar os principios de aproveitamento, transformación e xestión dos recursos enerxéticos
C33	Coñecemento aplicado dos fundamentos de industrias de xeración, transporte, transformación e xestión da enerxía eléctrica e térmica
D1	Coñecer e manexar a lexislación aplicable ao sector, coñecer a contorna social e empresarial e saber relacionarse coa administración competente integrando este coñecemento na elaboración de proxectos de enxeñería e no desenvolvemento de calquera dos aspectos do seu labor profesional.
D2	Capacidade para organizar, interpretar, asimilar, elaborar e xestionar toda a información necesaria para desenvolver o seu labor, manexando as ferramentas informáticas, matemáticas, físicas, etc. necesarias para iso
D3	Concibir a enxeñería nun marco de desenvolvemento sostible con sensibilidade cara a temas ambientais.

Resultados previstos na materia				
Expected results from this subject	Training and Learning Results			
Comprender os aspectos básicos de xeración, transporte e distribución da enerxía eléctrica.	A1 A2 A3 A4 A5	B1 B3 B5	C22 C32 C33	D1 D2 D3

Coñecer o tipo de instalacións e equipamento eléctrico a nivel industrial.	A1 A2 A3 A4 A5	B1 B3 B5	C22 C32 C33	D1 D2 D3
Coñecer os diferentes tipos e o funcionamento das centrais eléctricas convencionais			C23 C28 C30	
Coñecer os elementos das centrais clásicas de xeración da enerxía eléctrica.			C23 C28 C30	
Ser capaz de deseñar e calcular instalacións de BT.			C22 C33	

Contidos
Topic
Principios da xeración eléctrica con xeradores síncronos e asíncronos
Descripcón básica das centrais eléctricas convencionais. Tipos. Protecciións
Instalacións e equipamentos habituais en instalacións industriais.
Cables e liñas de transporte de enerxía eléctrica
Deseño e cálculo de instalacións en BT

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	30	84	114
Prácticas de laboratorio	10	8.5	18.5
Saídas de estudo	6	0	6
Seminario	4	5	9
Exame de preguntas obxectivas	2.5	0	2.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente	
	Description
Lección maxistral	Exposición por parte do profesorado do contido da materia na aula.
Prácticas de laboratorio	Realizaranse nos Laboratorios do Dpto. de Enxeñaría Eléctrica da Escola de Enxeñaría Industrial (Sede Campus).
Saídas de estudo	Procurarase facer -dependendo da receptividade das empresas eléctricas- unha visita a unha central de xeración eléctrica.
Seminario	Dentro das horas C tratarase de maneira máis detallada e personalizada algún tema ou aspecto que se considere adecuado para o bo desenvolvemento da materia.

Atención personalizada	
Methodologies	**Description**
Lección maxistral	O profesorado atenderá persoalmente as dúbidas e consultas do alumnado durante as clases e no horario de titorías. Para todas as modalidades de docencia, as sesións de titorización poderán realizarse por medios telemáticos baixo a modalidade de concertación previa.
Prácticas de laboratorio	O profesorado atenderá persoalmente as dúbidas e consultas do alumnado durante as clases e no horario de titorías. Para todas as modalidades de docencia, as sesións de titorización poderán realizarse por medios telemáticos baixo a modalidade de concertación previa.
Saídas de estudo	O profesorado atenderá persoalmente as dúbidas e consultas do alumnado durante as clases e no horario de titorías. Para todas as modalidades de docencia, as sesións de titorización poderán realizarse por medios telemáticos baixo a modalidade de concertación previa.
Seminario	O profesorado atenderá persoalmente as dúbidas e consultas do alumnado durante as clases e no horario de titorías. Para todas as modalidades de docencia, as sesións de titorización poderán realizarse por medios telemáticos baixo a modalidade de concertación previa.

Avaliación

	Description	Qualification	Training and Learning Results
Lección maxistral	Durante o cuadrimestre realizaranse dous exames para avaliar os coñecementos adquiridos polos alumnos -tanto nas clases teóricas como nos casos prácticos descritos nelas- sobre os aspectos básicos da materia. Cada un deles valerá o 40% da nota final, sendo necesario obter un mínimo de 3 puntos en cada un deles para superar a materia. Polo tanto, avaliaranse todos os resultados previstos na materia.	80	A1 B1 C22 D1 A2 B3 C23 D2 A3 B5 C28 D3 A4 C30 A5 C32 C33
Prácticas de laboratorio	As cuestións relacionadas coas prácticas desenvolvidas ao longo do cuadrimestre formularanse nunha proba independente, cuxo valor será de 2 puntos sobre a nota final da materia. Dita proba poderá ser substituída, se é o caso e sempre co visto e prace do profesorado, por outro tipo de avaliación como a entrega de informes, un exame práctico sobre a súa montaxe, a entrega dun proxecto, etc. Polo tanto, avaliaranse todos os resutados previstos na materia.	20	A1 B1 C22 D1 A2 B3 C23 D2 A3 B5 C28 D3 A4 C30 A5 C32 C33
Saídas de estudo	Na proba correspondente ás prácticas da materia poderá suscitarse algunha cuestión relacionada con dita saída polo que non se especifica unha porcentaxe concreta para a avaliación da devandita metodoloxía, senón que se incluiría na anterior. Así, avalíanse todos os resultados previstos na materia.	0	
Seminario	A avaliación da materia impartida neles incluirase nas probas correspondentes ás clases expositivas e, polo tanto, non se especifica unha porcentaxe específica para a avaliación da devandita metodoloxía. Polo tanto, avaliaranse todos os resultados previstos na materia.	0	

Other comments on the Evaluation

Avaliación continua primeira oportunidade

A segunda proba, cun peso do 40% da nota final, coincidirá coa data oficial do exame de primeira oportunidade que estableza o centro.

Segunda oportunidade de avaliación continua

O alumnado que optase pola Avaliación Continua e non superase ningunha das probas terá a posibilidade de repetilas o día oficial do exame, conservando as notas das xa superadas e tamén as mínimas necesarias en cada unha delas.

Avaliación global

O alumnado que opte pola modalidade de Avaliación Global será avaliado no 100% da materia nun único exame que se celebrará o día oficial sinalado pola Dirección da EME, tanto na primeira como na segunda oportunidade.

A documentación correspondente á materia explicada en clase poderá estar dispoñible en calquera momento na plataforma Moovi, entendéndose esta como documentación de apoio e, polo tanto, os exames non están necesariamente vinculados a dita documentación.

Calendario de exames. Verificar/consultar información actualizada na páxina web do centro:

http://minaseenerxia.uvigo.es/es/docencia/examenes

Bibliografía. Fontes de información

Basic Bibliography

J. Fraile Mora, **Máquinas Eléctricas**, Servicio Publicaciones E.T.S.I.C - UPM,

Paulino Montané, **Protecciones en las instalaciones eléctricas**, Ed. Marcombo,

Ministerio de Industria y Energía, **Reglamento Electrotécnico para BT**, RD 842/2002, Ministerio de Industria y Energía, 2002

Moreno Alfonso, Narciso; Cano González, Ramón, **Instalaciones eléctricas en baja tensión**, Paraninfo, 2017

García Trasancos, José, **Instalaciones eléctricas en media y baja tensión**, Paraninfo, 2009

Complementary Bibliography

Stephen J. Chapman, **Máquinas Eléctricas**, McGraw Hill,

Grupo Formación Empresas Eléctricas, **Centrales Hidroeléctricas I y II**, Paraninfo,

Asociación de Investigación Industrial Eléctrica (ASINEL), **Colección de textos sobre centrales termoeléctricas convencionales y nucleares**, ASINEL,

Recomendacións

Subjects that continue the syllabus

Xeración eléctrica renovable e convencional/V09G291V01307

Subjects that it is recommended to have taken before

Física: Física I/V09G291V01102
Circuitos e máquinas eléctricas/V09G291V01201

IDENTIFYING DATA

Hydraulic resources, installations and hydro-power plants

Subject	Hydraulic resources, installations and hydro-power plants			
Code	V09G291V01305			
Study programme	Grado en Ingeniería de la Energía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Conde Fontenla, Marcos Molares Rodríguez, Alejandro			
Lecturers	Conde Fontenla, Marcos Molares Rodríguez, Alejandro Vence Fernández, Jesús			
E-mail	mfontenla@uvigo.gal a.molares@uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	The main goal of this course is to acquire the scientific knowledge and the study of the technical application concerning energy conversion devices that employ water as the exchanger fluid. The application of fluid mechanics to hydropower systems is revisited here from an industrial point of view, dealing with the most common types of water pumps and turbines.			

Training and Learning Results

Code	
A1	That the students demonstrate to possess and understand knowledge in an area of study that is part of the general education (second level), and often found at a level that, although based on advanced textbooks, also includes some aspects that involve knowledge from the avant-garde of the field of study
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A4	That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized audience
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Ability to draw links between the different elements of all the knowledge acquired, understanding them as components of a body of knowledge with a clear structure and strong internal cohesion.
B2	Ability to develop a project to completion in any field of this branch of engineering, combining appropriately the knowledge acquired, consulting the relevant sources of information, carrying out any required inquiries, and joining interdisciplinary work teams.
B3	To suggest and develop practical solutions, using the relevant theoretical knowledge, to phenomena and problems-situations of ordinary reality that are specific to engineering, developing appropriate strategies.
B4	To foster collaborative working, communication, organization and planning skills, along with the ability to take responsibilities in a multilingual, multidisciplinary work environment that promotes education for equality, peace and respect for fundamental rights.
B5	To be familiar with the relevant sources of information, including constant updating, in order to practice one□s profession competently, accessing all the present and future tools of information search, constantly adapting to technological and social changes.
C20	Applied knowledge of the fundamentals of hydraulic services and facilities. Planning and management of hydraulic resources.
C21	Applied knowledge of the fundamentals of mechanical and fluid systems and machines.
C23	Ability to design electrical power plants.
D5	To become aware of the need for continuous training and the constant improvement of quality, developing the values that are characteristic of scientific thinking, showing flexible, open and ethical attitudes in the face of different situations and opinions, particularly as regards non-discrimination on the grounds of gender, race or religion, respect for fundamental rights, accessibility, etc.

Expected results from this subject

Expected results from this subject	Training and Learning Results			
To understand the basic laws about the fundamentals of fluid machines	A1	B1 B5	C20 C21 C23	D5
Acquire skills on the process of hydraulic installations sizing	A2 A3 A4 A5	B1 B2 B3 B4 B5	C20 C21 C23	D5

Contents

Topic	
1.- Machines of fluid	1.1 Introduction. 1.2 Classification of fluid machines. 1.3 Main parts of a positive displacement machine. 1.4 Positive displacement principle for a machine. 1.5 Main parts of a turbo-machine. 1.6 Classification of turbo-machines. 1.7 Continuity equation. 1.8 Angular momentum conservation law. Euler's theorem. 1.9 Euler's equation. 1.10 Bernoulli's equation (relative movement) 1.11 Degree of reaction. 1.12 Losses in fluid machines: hydraulic, volumetric, mechanical. Efficiencies and power diagram. 1.13 Similarity in hydraulic turbo-machines. Specific speed.
2.- Hydraulic pumps. Classification and constituent elements. Pumping facilities.	2.1 Classification and constituent elements of hydraulic pumps. 2.2 One-dimensional theory of turbo-pumps: radial and axial flow. 2.3 Two-dimensional theory for turbo-pumps: radial and axial flow. 2.4 Basic design parameters of radial turbo-machines. 2.5 Basic design parameters of axial turbo-machines. 2.6 Characteristic curve of radial pumps. 2.7 Characteristic curve of axial and diagonal pumps. 2.8 Similarity in turbo-pumps. Particular cases. 2.9 Impeller trim on radial turbo-machines. 2.10 Pump-installation coupling. Selection of machines. Arrangement of pumps in series and in parallel. 2.11 Priming a pump. 2.12 Cavitation in centrifugal pumps 2.13 Introduction to the phenomenon of water hammer in pumping installations.
3.- Hydraulic turbines and hydroelectric power stations	3.1 Classification of hydraulic turbines. 3.2 Pelton Turbine. 3.3 Francis Turbine: Slow, normal and fast. 3.4 Axial turbines: Kaplan and propeller. Bulb groups. 3.5 Basic aspects on the regulation of hydraulic turbines. 3.6 Similarity in hydraulic turbines. Parameters of interest.
4.- Hydroelectric facilities: use of hydraulic energy.	4.1 Introduction 4.2 Classification and types of uses 4.3 Singular elements: dam, reliefs, water pipes and penstocks. 4.4 Accessory devices. 4.5 Water hammer in penstocks. 4.6 Surge tanks and other elements of protection.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	16	28	44
Practices through ICT	4	4	8
Laboratory practical	10	15	25
Problem solving	20	3	23
Autonomous problem solving	0	47.5	47.5
Essay questions exam	1	0	1
Problem and/or exercise solving	1.5	0	1.5

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

Methodologies

	Description
Lecturing	Oral presentations and dissertations in the classroom, developing the different topics of the course. It is strongly recommended that the student has previously read the material at home in order to contribute with questions or doubts during class-time.
Practices through ICT	Some basic method of solving problems associated with the coupling of pumps, application of the laws of similarity and calculation of installations and networks using generic calculation programs will be addressed: spreadsheet and/or mathematical software. The licenses will be GNU GPL, or a commercial one funded by the school/university.
Laboratory practical	Up to three laboratory practices will be carried out in order to clarify knowledge acquired in the classroom. The relevant guides will be provided for each practice in such a way that, after data collection, they can return to the teacher the results and conclusions of the experimental work, after a deep analysis of them.
Problem solving	Exercises are previously given to the students, bringing them a try to solve by themselves. Later, some of them will be solved in class by the students and/or the teacher
Autonomous problem solving	The students will solve the proposed problems. They can ask for support during the scheduled tutorship hours.

Personalized assistance

Methodologies	Description
Autonomous problem solving	Personalized attention will be given to the students during class (throughout the possible questions that could arise) and during the specific timetable of the teacher for tutorship. Updated information of the tutorship timetables will be given to the students during first week of class. Tutorshiping will take place both in face-to-face or distance modes, by means of the e-learning applications offered by the University of Vigo or equivalent methods.

Assessment

	Description	Qualification	Training and Learning Results			
Laboratory practical	Delivery of a report/questionnaire and/or completion of an oral test of at least two experimental/ICT practices throughout the course EXPECTED RESULTS FROM THIS SUBJECT: Comprise the fundamental laws about the basics in fluid machines. Acquire skills on the process of hydraulic installations sizing.	10	A1 A2 A3 A4	B1 B3 B4 B5	C20 C21 C23	D5
Problem solving	These are two continuous assessment tests that will be carried out throughout the school year. They will consist of written exercises/problem solving tests. Each one will have a weight of 12.5% of the total grade. Consult detailed methodology in the "other comments on the evaluation". EXPECTED RESULTS FROM THIS SUBJECT: Comprise the fundamental laws about the basics in fluid machines. Acquire skills on the process of hydraulic installations sizing.	25	A1 A2 A3 A4 A5	B1 B2 B3	C20 C21 C23	D5
Essay questions exam	It will consist of two written tests that may consist of: theoretical / practical questions that include resolution of exercises and problems and/or topic to be developed. Each test will represent 12.5% of the total grade. For more information, see the detailed methodology in the section "other comments on the evaluation" EXPECTED RESULTS FROM THIS SUBJECT: Understand the basics of Fluid Mechanics Comprise the fundamental laws about the basics in fluid machines. Acquire skills on the process of hydraulic installations sizing.	25	A1 A2 A3 A4 A5	B1 B2 B3 B4 B5	C20 C21 C23	D5
Problem and/or exercise solving	This test will coincide with the official exam established in the center's calendar. It will consist of a written test for the resolution of exercises / problems. Consult the detailed methodology in the "other comments on the evaluation" section. WITH THIS METHODOLOGY ALL THE EXPECTED RESULTS FROM THIS SUBJECT WILL BE TACKLED	40	A1 A2 A3 A4 A5	B1 B2 B3 B4 B5	C20 C21 C23	D5

Other comments on the Evaluation

The student will be able to freely choose the evaluation methodology (Global or Continuous) within the established deadline and procedure set by the school, and in any case in accordance with current regulations.

The problem of students choosing one evaluation methodology or another, according to the maximum weights established, is most dramatically manifested in the case of two students who take the final exam/retest and obtain exactly the same grade (for example, 6/10); one passes because he has chosen the global evaluation, while the other fails because of selecting the continuous evaluation and only obtained a 4.2 out of 10 in the average of the continuous evaluation tests.

To mitigate this contradiction derived from the application of the current regulations in the case of continuous assessment mode, two grades will be calculated for each student, and the higher of the two will be selected.

Continuous Evaluation Mode

In the calculation of the final grade, four evaluation blocks will be considered with the following weights:

· First partial test of continuous evaluation, weight: 25%. Test consisting of theoretical/practical questions, including problem-solving and/or a topic to develop. It may include multiple-choice questionnaires.

· Second partial test of continuous evaluation, weight: 25%. Test consisting of theoretical/practical questions, including problem-solving and/or a topic to develop. It may include multiple-choice questionnaires.

· Final test of continuous evaluation (retest), weight: 40%. Test consisting of theoretical/practical questions, including problem-solving and/or a topic to develop. It may include multiple-choice questionnaires.

· Practical work, weight: 10%. Submission of a report/questionnaire and/or oral examination of at least two experimental/IT practices to be carried out throughout the course.

In the spirit of the above paragraph, the final course grade will be assigned to all students using the following formula:

Final Grade = max {0.6 NC + 0.4 NF , NF + (1/20)NC(10 - NF)}

where NC is the weighted average of the two continuous evaluation tests and practical (in the range of 0 to 10) and NF is the grade of the final exam (retest) (also out of 10).

Global Evaluation Mode

A final exam will be held on the official date approved by the school, with a maximum score of 100%.

Second opportunity call

In the second opportunity call (extraordinary in July), the same methodology as in the first opportunity will apply, with a new final evaluation test for students who choose continuous evaluation and a new final exam for those following the global evaluation. In the continuous evaluation mode, therefore, the grades of the partial tests and practical work are retained.

Exam calendar. Check/consult the center's web page for updates:

http://minaseenerxia.uvigo.es/é/docencia/examenes

Sources of information

Basic Bibliography

Round, George F, **Incompressible Flow Turbomachines. Design, Selection, Applications, and Theory**, 1ª ed., Elsevier - Gulf Professional Publishing, 2004

Agüera Soriano, José, **Mecánica de fluidos imcompresibles y turbomáquinas hidráulicas**, 5ª ed., Editorial Ciencia 3, S.L., 2002

Mataix Plana, Claudio, **Mecánica de fluidos y máquinas hidraúlicas**, 2ª ed., Ediciones del castillo, S.A., 1986

Hussian, Z. and Abdullah, Z. and Alimuddin, Z., **Basic Fluid Mechanics and Hydraulic Machines**, 1ª ed., CRC Press, 2009

Modi, P. N. and Seth, S. M., **Hydraulics and Fluid Mechanics Including Hydraulic Machines (In SI Units)**, 15ª ed., Standard Book House, 2004

Complementary Bibliography

Mataix Plana, Claudio, **Turbomáquinas hidráulicas**, 2ª ed., ICAI, 2009

Girdhar, P. and Moniz, O, **Practical Centrifugal Pumps. Design, Operation and Maintenance**, 1ª ed., Elsevier - Newnes, 2005

Hernandez Krahe, Jose Maria, **Mecánica de Fluidos y Máquinas Hidráulicas/Unidades Didácticas V y VI**, 1ª ed., UNED, 1995

Kothandaraman, C. P. and Rudramoorthy, R., **Fluid Mechanics and Machinery**, 2ª ed., New Age International (P) Ltd., Publishers, 2007
Vasandani, V. P., **Theory and Design of Hydraulic Machines Including Basic Fluid Mechanics**, 11ª ed., Khanna Publishers, 2010
Gülich, Johann F., **Centrifugal Pumps**, 3ª ed., Springer, 2014
Kumar, P., **Hydraulic Machines: Fundamentals of Hydraulic Power Systems**, 1ª ed, CRC Press, 2012
Bansal, R. K., **A Textbook of Fluid Mechanics and Hydraulic Machines (in SI units)**, 1ª ed., Laxmi Publications, 2005
Gupta, S. C., **Fluid Mechanics and Hydraulic Machines**, 1ª ed., Pearson Education Canada, 2006
Patra, K. C., **Engineering Fluid Mechanics and Hydraulic Machines**, 1ª ed., Alpha Science Intl Ltd, 2012
de Lamadrid Martínez, Abelardo, **Máquinas hidráulicas. Turbinas Pelton. Bombas centrífugas**, 1ª ed., Servicio de Publicaciones, ETSII - UPM, 1986

Recommendations

Subjects that are recommended to be taken simultaneously

Thermal engines and turbo-machines/V09G291V01308

Subjects that it is recommended to have taken before

Circuits and Electrical Machines/V09G291V01201
Fluid mechanics/V09G291V01204

Other comments

It is recommended to have previously passed a Fluid Mechanics course.

IDENTIFYING DATA

Sistemas eléctricos de potencia

Subject	Sistemas eléctricos de potencia			
Code	V09G291V01306			
Study programme	Grao en Enxeñaría da Enerxía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	2c
Teaching language	Castelán			
Department	Enxeñaría eléctrica			
Coordinator	Fernández Otero, Antonio			
Lecturers	Fernández Otero, Antonio			
E-mail	afotero@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	O obxetivo de esta asignatura é proporcionar ao alumnado os coñecementos necesarios sobre os sistemas de transporte e distribución da enerxía eléctrica. Además de describir a sua estructura e os diferentes elementos que os constituen tamén se tratan os aspectos necesarios para comprender as técnicas utilizadas na súa análise e operación.			

Resultados de Formación e Aprendizaxe

Code	
A1	Que os estudantes demostrasen posuír e comprender coñecementos nunha área de estudo que parte da base da educación secundaria xeral, e adóitase atopar a un nivel que, aínda que se apoia en libros de texto avanzados, inclúe tamén algúns aspectos que implican coñecementos procedentes da vangarda do seu campo de estudo
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A4	Que os estudantes poidan transmitir información, ideas, problemas e solucións a un público tanto especializado coma non especializado
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B1	Capacidad de interrelacionar todos los conocimientos adquiridos, interpretándolos como componentes de un cuerpo del saber con una estructura clara y una fuerte coherencia interna.
B3	Propoñer e desenvolver solucións prácticas, utilizando os coñecementos teóricos, a fenómenos e situacións-problema da realidade cotiá propios da enxeñería, desenvolvendo as estratexias adecuadas.
B5	Coñecer as fontes necesarias para dispoñer dunha actualización permanente e continua de toda a información precisa para desenvolver o seu labor, accedendo a todas as ferramentas, actuais e futuras, de procura de información e adaptándose aos cambios tecnolóxicos e sociais.
C22	Coñecemento sobre sistemas eléctricos de potencia e as súas aplicacións.
C23	Capacidade para o deseño de centrais eléctricas.
D1	Coñecer e manexar a lexislación aplicable ao sector, coñecer a contorna social e empresarial e saber relacionarse coa administración competente integrando este coñecemento na elaboración de proxectos de enxeñería e no desenvolvemento de calquera dos aspectos do seu labor profesional.
D2	Capacidade para organizar, interpretar, asimilar, elaborar e xestionar toda a información necesaria para desenvolver o seu labor, manexando as ferramentas informáticas, matemáticas, físicas, etc. necesarias para iso
D3	Concibir a enxeñería nun marco de desenvolvemento sostible con sensibilidade cara a temas ambientais.

Resultados previstos na materia

Expected results from this subject	Training and Learning Results			
Dominar as técnicas para a análise de sistemas eléctricos de potencia en réxime estacionario.	A1 A2 A3 A5	B1 B5	C22	D1
Coñecer a normativa e os principios da operación nos sistemas eléctricos	A2 A3 A5	B1 B3 B5	C22 C23	D1 D2
Coñecer os elementos que constitúen as redes eléctricas.	A1 A4		C22	D1 D2
Comprender os procesos de regulación nas redes eléctricas	A2 A3	B1 B3	C22 C23	D1 D2

Adquirir habilidades sobre a análise de sistemas eléctricos en réxime estacionario.	A1 A2 A5	B3	C22	D1 D2
Adquirir habilidades sobre a análise de sistemas eléctricos en réxime dinámico.	A2 A5	B1	C22	D1 D2
Comprender os aspectos básicos da operación óptima da xeración e as perdas no sistema eléctrico	A1 A2	B1	C22 C23	D2 D3

Contidos	
Topic	
Estructuración das redes de enerxía eléctrica	Produción Transporte Distribución Consumos
Elementos construtivos das R.E.E. Circuítos equivalentes estacionarios. Regulación. Límites de funcionamento.	Modelo das liñas Modelos dos transformadores. Modelos de xeradores. Modelos de consumos.
Análise da REE en réxime estacionario.	Introdución ao fluxo de potencia. Fluxo de potencia de Gauss-Seidel. Fluxo de potencia de Newton Raphson.
Control e operación da REE	Control p-f Control q-v. Análise de continxencias

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	20	36	56
Resolución de problemas	16	33.5	49.5
Prácticas con apoio das TIC	14	28	42
Exame de preguntas de desenvolvemento	2.5	0	2.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente	
	Description
Lección maxistral	Exposición por parte do profesorado dos contidos sobre a materia obxecto de estudo, bases teóricas e/ou directrices dun traballo, exercicio que o/a estudante ten que desenvolver
Resolución de problemas	Actividade na que se formulan problema e/ou exercicios relacionados coa materia. O alumnado debe desenvolver as solucións adecuadas ou correctas mediante a exercitación de rutinas, a aplicación de fórmulas ou algoritmos, a aplicación de procedementos de transformación da información dispoñible e a interpretación dos resultados. Adóitase utilizar como complemento da lección maxistral.
Prácticas con apoio das TIC	Actividades de aplicación do coñecemento nun contexto determinado e de adquisición de habilidades básicas e procedimentales en relación coa materia a través do TIC.

Atención personalizada	
Methodologies	**Description**
Lección maxistral	Despois deste tipo de clases o alumnado pode consultar ao profesorado de forma individual as súas posibles dúbidas no horario de titorías establecido.
Resolución de problemas	Despois deste tipo de clases o alumnado pode consultar ao profesorado de forma individual as súas posibles dúbidas no horario de titorías establecido.
Prácticas con apoio das TIC	Despois deste tipo de clases o alumnado pode consultar ao profesorado de forma individual as súas posibles dúbidas no horario de titorías establecido.

Avaliación			
	Description	Qualification	Training and Learning Results

Prácticas con apoio das TIC	Tras cada clase práctica o alumnado debe entregar no prazo establecido unha memoria coa resolución do caso práctico exposto. Resultados previstos na materia: Dominar as técnicas para a análise de sistemas eléctricos de potencia en réxime estacionario. Coñecer a normativa e os principios da operación nos sistemas eléctricos Coñecer os elementos que constitúen as redes eléctricas. Comprender os procesos de regulación nas redes eléctricas Adquirir habilidades sobre a análise de sistemas eléctricos en réxime estacionario. Adquirir habilidades sobre a análise de sistemas eléctricos en réxime dinámico. Comprender os aspectos básicos da operación óptima da xeración e as perdas no sistema eléctrico	20	A1 A2 A3 A4 A5	B1 B3 B5	C22 C23	D1 D2 D3
Exame de preguntas de desenvolvemento	Realízanse dúas probas con preguntas teóricas e exercicios prácticos de desenvolvemento, unha durante o cuadrimestre e outra na data do exame oficial prevista no calendario do centro. Cada proba ten un peso do 40% da nota total. É necesario obter unha nota mínima de 3,5 sobre 10 en cada unha das probas. De non acadarse este mínimo, a nota final será como máximo de 4,5. Resultados previstos na materia: Dominar as técnicas para a análise de sistemas eléctricos de potencia en réxime estacionario. Coñecer a normativa e os principios da operación nos sistemas eléctricos Coñecer os elementos que constitúen as redes eléctricas. Comprender os procesos de regulación nas redes eléctricas Adquirir habilidades sobre a análise de sistemas eléctricos en réxime estacionario. Adquirir habilidades sobre a análise de sistemas eléctricos en réxime dinámico. Comprender os aspectos básicos da operación óptima da xeración e as perdas no sistema eléctrico	80	A1 A2 A3 A4 A5	B1 B3 B5	C22 C23	D1 D2 D3

Other comments on the Evaluation

CONSIDERACIONS SOBRE A AVALIACIÓN CONTINUA

A avaliación continua realizarase a partir da suma das cualificacións obtidas nas metodoloxías antes mencionadas.

CONSIDERACIÓNS DE SEGUNDA OPORTUNIDADE

O alumnado realizará un exame con cuestións teóricas e exercicios prácticos de desenvolvemento que lle permitirán acadar o 100% da nota**.CONSIDERACIÓNS SOBRE A AVALIACIÓN GLOBAL**O alumnado que renuncie á avaliación continua realizará un exame sobre todo o contido da materia, que lle permitirá acadar o 100% da nota total.

Bibliografía. Fontes de información

Basic Bibliography

J. J. Grainger y W.D. Stevenson,, **Análisis de sistemas de potencia, 1ª edición,**, McGraw-Hill, 1996

A. Gómez Expósito y otros, **Análisis y Operación de Sistemas de Energía Eléctrica**, McGraw-Hill, 2002

A. Gómez Expósito y otros, **Sistemas eléctricos de potencia: problemas y ejercicios resueltos**, McGraw-Hill, 2002

Complementary Bibliography

J. D. Glover y M. S. Sarma, **Sistemas de potencia**, Thompson, 2003

Recomendacións

Subjects that it is recommended to have taken before

Circuitos e máquinas eléctricas/V09G291V01201

IDENTIFYING DATA				
Xeración eléctrica renovable e convencional				
Subject	Xeración eléctrica renovable e convencional			
Code	V09G291V01307			
Study programme	Grao en Enxeñaría da Enerxía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	2c
Teaching language	Castelán			
Department	Enxeñaría eléctrica			
Coordinator	Manzanedo García, José Fernando			
Lecturers	Manzanedo García, José Fernando			
E-mail	manzaned@uvigo.es			
Web	http://https://moovi.uvigo.gal/			
General description	Esta materia céntrase fundamentalmente no estudo das instalacións de xeración eólica e fotovoltaica. Nesta materia adquírense as competencias para o deseño e cálculo deste tipo de instalacións renovables, así como as condicións técnicas para a súa conexión á rede.			

Resultados de Formación e Aprendizaxe	
Code	
A1	Que os estudantes demostrasen posuír e comprender coñecementos nunha área de estudo que parte da base da educación secundaria xeral, e adóitase atopar a un nivel que, aínda que se apoia en libros de texto avanzados, inclúe tamén algúns aspectos que implican coñecementos procedentes da vangarda do seu campo de estudo
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A4	Que os estudantes poidan transmitir información, ideas, problemas e solucións a un público tanto especializado coma non especializado
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B1	Capacidad de interrelacionar todos los conocimientos adquiridos, interpretándolos como componentes de un cuerpo del saber con una estructura clara y una fuerte coherencia interna.
B3	Propoñer e desenvolver solucións prácticas, utilizando os coñecementos teóricos, a fenómenos e situacións-problema da realidade cotiá propios da enxeñería, desenvolvendo as estratexias adecuadas.
B5	Coñecer as fontes necesarias para dispoñer dunha actualización permanente e continua de toda a información precisa para desenvolver o seu labor, accedendo a todas as ferramentas, actuais e futuras, de procura de información e adaptándose aos cambios tecnolóxicos e sociais.
C23	Capacidade para o deseño de centrais eléctricas.
C30	Coñecemento aplicado sobre enerxías renovables
D1	Coñecer e manexar a lexislación aplicable ao sector, coñecer a contorna social e empresarial e saber relacionarse coa administración competente integrando este coñecemento na elaboración de proxectos de enxeñería e no desenvolvemento de calquera dos aspectos do seu labor profesional.
D2	Capacidade para organizar, interpretar, asimilar, elaborar e xestionar toda a información necesaria para desenvolver o seu labor, manexando as ferramentas informáticas, matemáticas, físicas, etc. necesarias para iso
D3	Concibir a enxeñería nun marco de desenvolvemento sostible con sensibilidade cara a temas ambientais.

Resultados previstos na materia				
Expected results from this subject	Training and Learning Results			
Coñecer a operación das centrais eléctricas	A1 A2 A3 A4 A5	B1 B3 B5	C23	D1 D2 D3
Comprender os esquemas de funcionamento dos servizos auxiliares en centrais térmicas e hidráulicas			C23	
Comprender os aspectos básicos da xeración eléctrica con enerxías renovables.	A1 A2 A3 A4 A5	B1 B3 B5	C30	D1 D2 D3

Adquirir habilidades para o deseño de instalacións eólicas	C30
Adquirir habilidades para o deseño de instalacións fotovoltaicas	C30
Adquirir habilidades para a avaliación técnico/económica das instalacións de enerxías renovables	C30
Coñecer a normativa aplicable á xeración de enerxía, e máis especificamente á xeración de enerxía con fontes non convencionais	C30
Coñecer os sistemas de almacenamento de enerxía e a súa relación coa operación do sistema eléctrico.	C30

Contidos	
Topic	
Operación de Centrais Eléctricas	
Servicios Auxiliares en Centrais y Grupos de Xeneración	
Instalacións eólicas de produción de enerxía eléctrica	Recurso eólico e avaliación do mesmo Tecnoloxía de Aeroxeradores Control de potencia e estimación da enerxía producida nun Aeroxerador Sistemas de conexión a rede de Aeroxeradores
Instalacións fotovoltaicas	Radiación solar Modelado da célula fotovoltaica Sistemas fotovoltaicos Dimensionado dunha instalación fotovoltaica
Sistemas de almacenamento de enerxía	Baterías de acumuladores Outros tipos de almacenamentos
Condicións técnicas e réxime económico das enerxías renovables.	
Viabilidade económica das instalacións de enerxía renovable.	
Instalacións de produción eléctrica con outras fontes renovables	

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	31	84	115
Prácticas de laboratorio	10	8.5	18.5
Saídas de estudo	5	0	5
Seminario	4	5	9
Exame de preguntas obxectivas	2.5	0	2.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente	
	Description
Lección maxistral	Exposición por parte do profesorado do contido da materia na aula.
Prácticas de laboratorio	Realizaranse nos Laboratorios do Dpto. de Enxeñaría Eléctrica da Escola de Enxeñaría Industrial (Sede Campus).
Saídas de estudo	Procurarase facer -dependendo da receptividade das empresas eléctricas- unha visita a algún centro de xeración eólica ou fotovoltaica.
Seminario	Dentro das horas C tratarase de maneira máis detallada e personalizada algún tema ou aspecto que se considere adecuado para o bo desenvolvemento da materia.

Atención personalizada	
Methodologies	**Description**
Lección maxistral	O profesorado atenderá persoalmente as dúbidas e consultas do alumnado durante as clases e no horario de titorías. Para todas as modalidades de docencia, as sesións de titorización poderán realizarse por medios telemáticos baixo a modalidade de concertación previa.
Prácticas de laboratorio	O profesorado atenderá persoalmente as dúbidas e consultas do alumnado durante as clases e no horario de titorías. Para todas as modalidades de docencia, as sesións de titorización poderán realizarse por medios telemáticos baixo a modalidade de concertación previa.
Saídas de estudo	O profesorado atenderá persoalmente as dúbidas e consultas do alumnado, pero nesta metodoloxía quen proporcionará unha mellor explicación será o propio persoal da empresa ou centro que se visite.

Seminario	O profesorado atenderá persoalmente as dúbidas e consultas do alumnado durante as clases e no horario de titorías. Para todas as modalidades de docencia, as sesións de titorización poderán realizarse por medios telemáticos baixo a modalidade de concertación previa.

Avaliación

	Description	Qualification	Training and Learning Results			
Lección maxistral	Durante o cuadrimestre realizaranse dous exames para avaliar os coñecementos adquiridos polos alumnos -tanto nas clases teóricas como nos casos prácticos descritos nelas- sobre os aspectos básicos da materia. Cada un deles valerá o 40% da nota final, sendo necesario obter un mínimo de 3 puntos en cada un deles para superar a materia. Polo tanto, avaliaranse todos os resultados previstos na materia.	80	A1 A2 A3 A4 A5	B1 B3 B5	C23 C30	D1 D2 D3
Prácticas de laboratorio	As cuestións relacionadas coas prácticas desenvolvidas ao longo do cuadrimestre formularanse nunha proba independente, cuxo valor será de 2 puntos sobre a nota final da materia. Dita proba poderá ser substituída, se é o caso e sempre co visto e prace do profesorado, por outro tipo de avaliación como a entrega de informes, un exame práctico sobre a súa montaxe, a entrega dun proxecto, etc. Polo tanto, avaliaranse todos os resultados previstos na materia.	20	A1 A2 A3 A4 A5	B1 B3 B5	C23 C30	D1 D2 D3
Saídas de estudo	Na proba correspondente ás prácticas da materia poderá suscitarse algunha cuestión relacionada con dita saída polo que non se especifica unha porcentaxe concreta para a avaliación da devandita metodoloxía, senón que se incluiría na anterior. Así, avalíanse todos os resultados previstos na materia.	0				
Seminario	A avaliación da materia impartida neles incluirase nas probas correspondentes ás clases expositivas e, polo tanto, non se especifica unha porcentaxe específica para a avaliación da devandita metodoloxía. Polo tanto, avaliaranse todos os resultados previstos na materia.	0				

Other comments on the Evaluation

Avaliación continua primeira oportunidade

A segunda proba, cun peso do 40% da nota final, coincidirá coa data oficial do exame de primeira oportunidade que estableza o centro.

Segunda oportunidade de avaliación continuaO alumnado que optase pola Avaliación Continua e non superase ningunha das probas terá a posibilidade de repetilas o día oficial do exame, conservando as notas das xa superadas e tamén as mínimas necesarias en cada unha delas.**Avaliación global**O alumnado que opte pola modalidade de Avaliación Global será avaliado no 100% da materia nun único exame que se celebrará o día oficial sinalado pola Dirección da EME, tanto na primeira como na segunda oportunidade.
A documentación correspondente á materia explicada en clase poderá estar dispoñible en calquera momento na plataforma Moovi, entendéndose esta como documentación de apoio e, polo tanto, os exames non están necesariamente vinculados a dita documentación.Calendario de exames. Verificar/consultar información actualizada na páxina web do centro:http://minaseenerxia.uvigo.es/es/docencia/examenes

Bibliografía. Fontes de información

Basic Bibliography

Rodríguez Amenedo, Burgos Diaz, Arnalte Gómez, **SISTEMAS EÓLICOS DE PRODUCCIÓN DE ENERGÍA ELÉCTRICA**, Rueda S. L., 2003

Varios, **FUNDAMENTOS, DIMENSIONADO Y APLICACIONES DE LA ENERGIA SOLAR FOTO VOLTAICA**, CIEMAT, 2005

Complementary Bibliography

Recomendacións

Subjects that it is recommended to have taken before

Circuítos e máquinas eléctricas/V09G311V01201
Instalacións eléctricas/V09G311V01305

IDENTIFYING DATA

Thermal engines and turbo-machines

Subject	Thermal engines and turbo-machines			
Code	V09G291V01308			
Study programme	Grado en Ingeniería de la Energía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish English			
Department				
Coordinator	Patiño Vilas, David			
Lecturers	Chapela López, Sergio Gómez Rodríguez, Miguel Ángel Moya Rico, José Domingo Patiño Vilas, David			
E-mail	patinho@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Increase the knowledge of internal combustion engines and turbomachinery (heat engines)			

Training and Learning Results

Code	
A1	That the students demonstrate to possess and understand knowledge in an area of study that is part of the general education (second level), and often found at a level that, although based on advanced textbooks, also includes some aspects that involve knowledge from the avant-garde of the field of study
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A4	That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized audience
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Ability to draw links between the different elements of all the knowledge acquired, understanding them as components of a body of knowledge with a clear structure and strong internal cohesion.
B3	To suggest and develop practical solutions, using the relevant theoretical knowledge, to phenomena and problems-situations of ordinary reality that are specific to engineering, developing appropriate strategies.
B5	To be familiar with the relevant sources of information, including constant updating, in order to practice one□s profession competently, accessing all the present and future tools of information search, constantly adapting to technological and social changes.
C21	Applied knowledge of the fundamentals of mechanical and fluid systems and machines.
C23	Ability to design electrical power plants.
C29	Applied knowledge of thermal engineering.
C35	Ability to apply the knowledge about thermal engines and machines to problems that might arise in engineering.
C36	Ability to apply Environmental Technologies to problems that might arise in Thermal Engineering.
D1	To be familiar with and to be able to use the legislation applicable in this sector, to be acquainted with the social and business environments and to be able to deal with the relevant administration, integrating this knowledge into the drawing up of engineering projects and into the implementation of every aspect of their professional work.
D2	Ability to organize, understand, assimilate, produce and handle all the relevant information to develop their professional work, using appropriate computing, mathematics, physics tools, etc. when these are required.
D3	Understanding engineering within a framework of sustainable development with environmental awareness.

Expected results from this subject

Expected results from this subject	Training and Learning Results			
To know the technological fundamentals on which the most recent investigations in thermal engines are supported	A1 A2 A3 A4 A5	B1 B5	C21 C23 C29 C35	D1 D2 D3

To know the types, operation and applications of thermal machines and engines	A1 A2 A3 A4 A5	B1 B5	C21 C23 C29 C35	D1 D2 D3
To solve problems related with the subject in an autonomous way and in collaboration with other colleagues	A1 A2 A3 A4 A5	B1 B3 B5	C21 C23 C29 C35	D1 D2 D3
To explain on the environmental implications and sustainability of a given problem	A1 A2 A3 A4 A5	B1	C29 C36	D1 D2 D3
To solve problems inherent to thermal machines	A1 A2 A3 A4 A5	B3	C21 C23 C29 C35	D1 D2 D3
To carry out experimental analyses to evaluate the characteristic curves of operation of thermal engines at a full load	A1 A2 A3 A4 A5	B3	C21 C23 C29 C35 C36	D1 D2
To write reports about calculations and assays justifying the results, extracting conclusions	A1 A2 A3 A4 A5	B3 B5	C21 C23 C29 C35 C36	D1 D2 D3

Contents	
Topic	
1. Introduction to Heat Engines	1.1 Presentation of the subject 1.2 Energetic context 1.3 Decarbonizing energetic market 1.4 Trends ans scope
2. Characteristics of the Internal Combustion Engines (ICE)	2.1 Classification of the heat engines 2.2 Fundamentals of the Internal Combustion Engines (ICE) 2.3 Parts of the ICEs 2.4 Nomenclature and basic parameters
3. Air Cycle	3.1 Thermodynamic Cycle 3.2 The Otto Cycle 3.3 The Limited Pressure Cycle 3.4 The Diesel Cycle
4. The Actual Cycle	4.1 The mixture of real gas 4.2 Evolution of the adiabatic coefficient 4.3 Pumping Loss 4.4 Combustion Loss 4.5 Expansion Loss 4.6 Quality Factor of the Cycle
5. Auxiliar Circuits	5.1 Refrigeration System 5.2 Lubricacion System
6. Gas exchange processes in 4 Stroke Engines	6.1 The Valve Train 6.2 The Volumetric Efficiency 6.3 Pumping loss 6.4 Timing 6.5 Variable Distribution Systems 6.6 Dynamic Air admition systems
7. Supercharging	7.1 Advantages of the supercharging in ICE 7.2 Volumetric superchargers 7.3 Turbochargers 7.4 Intercooler

8. Combustion in Spark Ignition Engines (SIE)	8.1 Stoichiometry of SIE 8.2 Characteristic Curves 8.3 The Carburettor 8.4 Injection System 8.5 Closed loop (lambda control) 8.6 Combustion phases in SI 8.7 Abnormal Combustion: knock 8.8 Abnormal Combustion: superficial ignition 8.9 Influential factors in SI combustion
9. Combustion in Compression Ignition Engines (CIE)	9.1 Delay time 9.2 Phases of CI combustion 9.3 Influential Factors 9.4 Injection system
10. Pollutant Emissions	10.1 SI Emissions 10.2 Diesel Emissiones 10.3 Catalytic converter 10.4 EGR systems 10.5 Regulations (EURO)
11. Future trends	11.1 Alternative Fuels 11.2 Hybrid and Electrical Systems
12. Thermal turbomachinery	12.1 Brayton Cycle 12.2 Parts of the Gas Turbine 12.3 Compressors 12.4 Combustion Chamber 12.5 Turbine 12.6 Architecture

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	25	57.5	82.5
Laboratory practical	16	0	16
Mentored work	4	20	24
Problem solving	5	20	25
Objective questions exam	2.5	0	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	Theoretical lectures in large groups
Laboratory practical	Practical experiences in laboratory
Mentored work	Supervision of a report related with the subject
Problem solving	Resolution of actual thermal engines' problems

Personalized assistance

Methodologies	Description
Lecturing	The professor will attend personally the doubts and queries of the students during the class and in the scheduled tutories. For all the different teaching methodologies, the tutories could be telematic (email, Campus Remoto, forums in Moovi...) with an appointment.
Laboratory practical	The professor will attend personally the doubts and queries of the students during the class and in the scheduled tutories. For all the different teaching methodologies, the tutories could be telematic (email, Campus Remoto, forums in Moovi...) with an appointment.
Mentored work	The professor will attend personally the doubts and queries of the students during the class and in the scheduled tutories. For all the different teaching methodologies, the tutories could be telematic (email, Campus Remoto, forums in Moovi...) with an appointment.
Problem solving	The professor will attend personally the doubts and queries of the students during the class and in the scheduled tutories. For all the different teaching methodologies, the tutories could be telematic (email, Campus Remoto, forums in Moovi...) with an appointment.

Assessment

	Description	Qualification	Training and Learning Results

Lecturing	Short answer, objective tests and/or quizs EXPECTED RESULTS: All the expected results are evaluated with this methodology	45	A1 A2 A3 A4 A5	B1 B3 B5	C21 C23 C29 C35 C36	D1 D2 D3
Laboratory practical	Delivery of the reports of the work carried out during the practices EXPECTED RESULTS: All the expected results are evaluated with this methodology	10	A1 A2 A3 A4 A5	B1 B3 B5	C21 C23 C29 C35 C36	D1 D2 D3
Mentored work	Reports and/or oral presentation of the final report EXPECTED RESULTS: All the expected results are evaluated with this methodology	15	A1 A2 A3 A4 A5	B1 B3 B5	C21 C23 C29 C35 C36	D1 D2 D3
Problem solving	Problem resolution EXPECTED RESULTS: All the expected results are evaluated with this methodology	30	A1 A2 A3 A4 A5	B1 B3 B5	C21 C23 C29 C35 C36	D1 D2 D3
Objective questions exam	Final exam (theoretical content and problems) for the students with the whole grades pending or for those in continuous evaluation with pending partials. His weight on the final grade varies between the 0-100% depending of the case. EXPECTED RESULTS: All the expected results are evaluated with this methodology	0	A1 A2 A3 A4 A5	B1 B3 B5	C21 C23 C29 C35 C36	D1 D2 D3

Other comments on the Evaluation

CONTINUOUS ASSESSMENT

There will be a series of mid-term exams that serve to release content from the final exam established in the center's calendar. The students under continuous assessment must fill a student card provided with a photo before the first partial exam. Students who fail a mid-term may only make up that part of the exam in the global exam (first opprtunity). If they fail again, they should do the global exam (second oportunity) with the whole subject. Attendance to the laboratory practical sessions is not compulsory, but it represents 10% of the continuous assessment grade (review of deliverables in each session).

The supervised work makes up 15% of the continuous assessment, leaving the final exam (85%) being exempt from this topic. The mark for the work will only be added to the overall grade once the final exam or all the mid-term exams have been passed. If the overall average mark without work is higher than 5 but the student has not succeeded in all the mid-terms, the final grade on the transcript will be 4.9 (fail).

GLOBAL ASSESSMENT

Students who waive the continuous assessment are entitled to a final exam with a 100% mark, the content of which will be determined by the syllabus of the lectures (theory), problem solving, practical sessions and the content of the reports of the supervised work delivered by their classmates.

SECOND OPPORTUNITY

Students who do not pass the subject at the first opportunity will have the right to take another final exam with a 100% mark, on the date established in the official calendar of the center.

Exam Timetable: Exam dates and rooms must be verified in the official webpage of the school:

http://minaseenerxia.uvigo.es/es/docencia/examenes

Sources of information

Basic Bibliography

Heywood, J.B., **Internal combustion engines fundamentals**, McGraw-Hill, 1988

Payri F. and Desantes J.M., **Motores de combustión interna alternativos**, Reverté, 2011

Muñoz M. y Payri F, **Motores de combustión interna alternativos**, Publicaciones de la UP Valencia, 1984

Complementary Bibliography

Mollenhauer K. y Tschöke H, **Handbook of Diesel Engines.**, Springer, 2010

Taylor C.F., **The internal combustion engine in theory and practice: vol. 1. Thermodynamics, fluid flow, performance.**, MIT press, 1998
Taylor C.F., **The internal combustion engine in theory and practice: vol. 2. Combustions, fuels, materials, design**, MIT press, 1998
Gordon P. Blair, **Design and simulation of four-stroke engines**, SAE Internacional, 1999
Arias-Paz M, **Manual del automóvil**, Dossat, 2006
Moran M.J. y Shapiro H.N, **Fundamentos de Termodinámica Técnica**, Reverté, 2004
Heisler H, **Advanced Engine Technology**, SAE Internacional, 1995
Robinson John, **Motocicletas. Puesta a punto de motores de dos tiempos.**, Paraninfo, 2011
Agüera Soriano J., **Termodinámica Lógica y Motores Térmicos**, 6ª ed, Ciencia, 1993

Recommendations

Subjects that it is recommended to have taken before

Thermal Systems/V09G291V01205
Heat transmission/V09G291V01206
Generation and distribution of conventional and renewable thermal energy/V09G291V01303

IDENTIFYING DATA				
Tecnoloxía de combustibles alternativos				
Subject	Tecnoloxía de combustibles alternativos			
Code	V09G291V01309			
Study programme	Grao en Enxeñaría da Enerxía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	2c
Teaching language	Castelán			
Department	Enxeñaría química			
Coordinator	Rodríguez Rodríguez, Ana María			
Lecturers	Deive Herva, Francisco Javier Rodríguez Rodríguez, Ana María			
E-mail	aroguez@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Os combustibles alternativos (directiva 2014/94/UE) son aqueles combustibles ou fontes de enerxía que substitúen completa ou parcialmente aos combustibles fósiles clásicos (petróleo, carbón e gas natural). Considéranse combustibles deste tipo: a electricidade, o hidróxeno, os combustibles sintéticos e o gas natural. Nesta materia desenvólvense os sistemas de produción de biocombustibles a partir de biomasa e a produción de enerxía eléctrica mediante o uso de pilas de combustible. Estes métodos de obtención de enerxía desenvolvéronse nos últimos anos e xorden como alternativa que no incrementa as emisións de dióxido de carbono á atmosfera e teñen unha gran importancia dada a situación enerxética actual a nivel mundial. Cobren así unha dobre vertente enerxética e ambiental, contribuíndo ao desenvolvemento sustentable do planeta. O obxectivo da materia é que o alumnado adquira os coñecementos xerais sobre a produción de biocombustibles e a obtención de electricidade con células de combustible, así como as aplicacións que teñen nos distintos sectores e o potencial que poden supor as investigacións futuras nestes sectores e os seus campos de aplicación.			

Resultados de Formación e Aprendizaxe	
Code	
A1	Que os estudantes demostrasen posuír e comprender coñecementos nunha área de estudo que parte da base da educación secundaria xeral, e adóitase atopar a un nivel que, aínda que se apoia en libros de texto avanzados, inclúe tamén algúns aspectos que implican coñecementos procedentes da vangarda do seu campo de estudo
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A4	Que os estudantes poidan transmitir información, ideas, problemas e solucións a un público tanto especializado coma non especializado
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B1	Capacidad de interrelacionar todos los conocimientos adquiridos, interpretándolos como componentes de un cuerpo del saber con una estructura clara y una fuerte coherencia interna.
B3	Propoñer e desenvolver solucións prácticas, utilizando os coñecementos teóricos, a fenómenos e situacións-problema da realidade cotiá propios da enxeñería, desenvolvendo as estratexias adecuadas.
B5	Coñecer as fontes necesarias para dispoñer dunha actualización permanente e continua de toda a información precisa para desenvolver o seu labor, accedendo a todas as ferramentas, actuais e futuras, de procura de información e adaptándose aos cambios tecnolóxicos e sociais.
C24	Capacidade para o deseño e xestión de procedementos de experimentación aplicada, especialmente para a determinación de propiedades termodinámicas e de transporte, e modelado de fenómenos e sistemas no ámbito da enxeñería química, sistemas con fluxo de fluídos, transmisión de calor, operacións de transferencia de materia, cinética das reaccións químicas e reactores
C25	Coñecementos sobre balances de materia e enerxía, biotecnoloxía, transferencia de materia, operacións de separación, enxeñería da reacción química, deseño de reactores, e valoración e transformación de materias primas e recursos enerxéticos.
C28	Coñecemento aplicado dos fundamentos de enerxías alternativas e uso eficiente da enerxía
C32	Coñecer, comprender e empregar os principios de aproveitamento, transformación e xestión dos recursos enerxéticos
D1	Coñecer e manexar a lexislación aplicable ao sector, coñecer a contorna social e empresarial e saber relacionarse coa administración competente integrando este coñecemento na elaboración de proxectos de enxeñería e no desenvolvemento de calquera dos aspectos do seu labor profesional.
D2	Capacidade para organizar, interpretar, asimilar, elaborar e xestionar toda a información necesaria para desenvolver o seu labor, manexando as ferramentas informáticas, matemáticas, físicas, etc. necesarias para iso

D3	Concibir a enxeñería nun marco de desenvolvemento sostible con sensibilidade cara a temas ambientais.
D6	Capacidade para comprender o significado e aplicación da perspectiva de xénero nos distintos ámbitos de coñecemento e na práctica profesional co obxectivo de alcanzar unha sociedade máis xusta e igualitaria.
D8	Sustentabilidade e compromiso ambiental. Uso equitativo, responsable e eficiente dos recursos.

Resultados previstos na materia

Expected results from this subject	Training and Learning Results			
Coñecer os procesos de produción dos biocombustibles para integralos no marco normativo ambiental actual	A1 A3	B3	C24	D1 D2 D3
Identificar e comprender as etapas clave dos procesos fermentativos	A3	B5	C28	D3 D8
Comprender as vantaxes inherentes da biotecnoloxía fronte aos procesos de produción convencionais	A1 A2 A4	B1	C24	D1 D2 D3
Identificar os distintos residuos agrícolas e industriais que poden converterse en materias primas na produción de biocombustibles	A3 A4	B5	C24 C25 C32	D3 D6
Saber avaliar de manera crítica a información bibliográfica necesaria para deseñar adecuadamente un proceso de produción de biocombustibles	A4 A5	B3 B5	C24	D1 D2
Saber integrar os principios de igualdade de xénero para constituír grupos de traballo en enxeñaría	A2 A3 A5	B3	C24	D3 D8

Contidos

Topic	
A Biomasa e a súa transformación como fonte de enerxía	Tipos e clasificación da biomasa. Situación actual da biomasa como fonte de enerxía. Procesos de aproveitamento enerxético da biomasa: valorización de residuos agroforestais Caracterización de biomasas para produción de biocarburantes. Concepto de biorrefinería
Introdución aos biocombustibles	Panorama enerxético actual. Fontes de enerxía emerxentes: biorrefinerías. Produción. Clasificación. Materias primas para a para a obtención de biocombustible: aceites vexetais, residuos de biomasa e cultivos enerxéticos
Produción de Biogás e biometano para obter enerxía	Situación actual e futura. Tecnoloxías para a dixestión anaerobia. Tecnoloxías para a purificación do biogás a biometano
Produción de Biodiesel como combustible: procesos, catalizadores e reactores	Composición e propiedades como combustible. Norma UNE EN 1424 de calidade do Biodiesel Uso directo de emulsions. Problemas de almacenamento. Obtención de biodiesel. Materias primas: Cultivos enerxéticos e microalgas: extracción de aceite Pirólisis de aceites vexetais. Transesterificación: mecanismo e cinética, requirimentos da alimentación, catálisis homoxénea e catálisis heteroxénea, tecnoloxías de reacción e condicións de operación. Viabilidade económica da utilización do biodiesel Valorización de glicerol como residuo de produción de biodiesel.
Produción de Bioetanol como combustible de primeira e segunda xeración	Obtención e purificación do etanol a partir de biomasa. Estado tecnolóxico da fermentación de biomasa. Purificación do bioetanol. Propiedades como combustible. Transformación a olefinas e combustibles de automoción.
Produción de Hidróxeno e almacenamento	Introdución ao uso do hidróxeno como combustible: Problemas do sistema enerxético actual. Métodos de obtención de hidróxeno: Electrolísis e fotoelectrolísis da auga. Descomposición térmica da auga. Descomposición térmica de hidrocarburos. Descomposición fotocatalítica da auga. Descomposición fotobiológica Acumulación de hidróxeno: Características do sistema acumulador. Métodos de acumulación.

Planificación

	Class hours	Hours outside the classroom	Total hours

Lección maxistral	26	60	86
Saídas de estudo	4	0	4
Prácticas de laboratorio	8	8	16
Simulación	8	14.5	22.5
Traballo tutelado	4	15	19
Exame de preguntas obxectivas	1.5	0	1.5
Resolución de problemas e/ou exercicios	1	0	1

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

Metodoloxía docente	
	Description
Lección maxistral	Exposición de contidos mediante presentación e/ou explicación por parte do profesorado en sesións de 2 h por semana até un total das 30 h que indica a guía docente. Nas sesións se intercalarán preguntas curtas, estudos de casos e cuestións como a interpretación científica de noticias de actualidade.
Saídas de estudo	No noso caso son visitas a industrias que serven de apoio á docencia presencial. O alumnado pode comprobar a aplicación real dalgúns aspectos apresos nas clases teóricas ou no laboratorio, analiza outras formas de traballar, toma conciencia das dimensións e funcionamento dos equipos, achegándose á realidade industrial. Estas visitas están planificadas adecuadamente cos contidos da materia.
Prácticas de laboratorio	De forma xeral, en cada unha das prácticas o estudantado realizan a parte experimental en grupos de dous ou tres membros para favorecer o traballo en equipo; así como, para simplificar a toma de datos experimentais. En cada un dos postos do laboratorio o alumnado dispón dun guion que favorece o seguimento das instrucións que se dan no mesmo, tomando os datos experimentais que se indiquen e, aplicando as expresións matemáticas correspondentes ao fundamento teórico no que se basea o desenvolvemento experimental. Así, cada unha das prácticas que desenvolve o alumnado, divídese en catro pasos, organizándose o período de experimentación (presencial, P) e as sesións non presenciais (NP): Contextualización polo profesorado; e Experimentación, Realización de cálculos e Realización de informe polo grupo de traballo
Simulación	Realizarase a simulación mediante software comercial dun proceso de produción dun biocombustible en grupos de varios estudantes. Esta metodoloxía é o colofón ao proceso de aprendizaxe tras a adquisición do fundamento teórico na lección maxistral, a experimentación nas prácticas de laboratorio e a visión industrial nas saídas de estudo. Nesta actividade foméntase que o grupo busque bibliografía e lembre as instalacións e/ou equipos cos que se traballa na empresa. Unha vez recompilada toda a información, o estudantado realizará, coa supervisión do profesorado, o deseño da planta para obter unha visión integral da produción industrial.
Traballo tutelado	Nesta actividade o persoal docente expón un problema real que deben resolver o estudantado en grupos de traballo nun tempo determinado. Para abordar a tarefa, é necesario que o estudantado leve a cabo as diferentes fases do proxecto, é dicir, que planifiquen, deseñen e executen unha serie de tarefas de forma coordinada e organizada, o que esixe a aplicación dos coñecementos adquiridos e un uso eficiente dos recursos dispoñibles.

Atención personalizada	
Methodologies	**Description**
Prácticas de laboratorio	O persoal docente introduce a formulación teórica da práctica, o problema a resolver e os pasos que deben realizarse para abordalo. Ademais, levará a cabo algúns pasos a modo demostrativo, aínda que deixará ao estudantado que traten de resolver partes concretas, cuxa solución mostrará tras un tempo, para proseguir cos seguintes pasos até finalizar a práctica.
Traballo tutelado	O persoal docente expón un proxecto e os seus principais obxectivos e o grupo de estudantes debe tratar de abordalo en varias sesións. As solucións enviaranse ao profesorado para a súa posterior avaliación. En concreto, na materia exponse un proxecto final que o estudantado ten que abordar cos coñecementos adquiridos durante o proceso de aprendizaxe.
Simulación	O persoal docente indica ao grupo de estudantes o proceso de produción do biocombustible seleccionado que se deseñará en varias sesións. O manexo do software científico abordarase nunha sesión teórica e as diferentes cuestións tecnolóxicas resolveranse en titorías solicitadas polos grupos de traballo. O proxecto final defréndese nunha exposición oral e a avaliación realizarase seguindo unha rúbrica proposta con antelación.

Avaliación			
	Description	Qualification	Training and Learning Results

Prácticas de laboratorio	Ao finalizar cada práctica deberase responder a un cuestionario por parte do grupo. Valorarase, ademais do contido, a comprensión da práctica, a capacidade de síntese, a redacción e a presentación do informe. A cualificación final, comprendida entre 0 e 10 e será a media das cualificacións obtidas nos diferentes informes realizados de cada práctica. Resultados previstos na materia: - Coñecer os procesos de produción dos biocombustibles para integralos no marco normativo ambiental actual - Identificar e comprender as etapas crave dos procesos fermentativos - Comprender as vantaxes inherentes da biotecnoloxía fronte aos procesos de produción convencionais - Identificar os distintos residuos agrícolas e industriais que poden converterse en materias primas na produción de biocombustibles - Saber avaliar críticamente a información bibliográfica necesaria para deseñar adecuadamente un proceso de produción de biocombustibles - Saber integrar os principios de igualdade de xénero para constituír grupos de traballo en enxeñaría	10	A3 A5	B1 B3	C25 C28 C32	D3 D6 D8
Simulación	A avaliación desta actividade realizarase mediante o envío ao persoal docente do diagrama de fluxo da planta de produción do biocombustible, así como do arquivo que utilizaron durante as sesións prácticas. Resultados previstos na materia: - Coñecer os procesos de produción dos biocombustibles para integralos no marco normativo ambiental actual - Identificar e comprender as etapas crave dos procesos fermentativos - Comprender as vantaxes inherentes da biotecnoloxía fronte aos procesos de produción convencionais - Identificar os distintos residuos agrícolas e industriais que poden converterse en materias primas na produción de biocombustibles - Saber avaliar críticamente a información bibliográfica necesaria para deseñar adecuadamente un proceso de produción de biocombustibles - Saber integrar os principios de igualdade de xénero para constituír grupos de traballo en enxeñaría	10	A5	B1 B3	C24 C25 C28 C32	D2 D3 D6
Traballo tutelado	O alumnado elabora un proxecto directamente relacionado cos temas teóricos. Ao finalizar o mesmo deberán entregar unha pequena memoria e expor publicamente o traballo durante un máximo de 10 minutos. Por último, posto que o informe e o proxecto realizouse en grupo a avaliación complétase cun exame oral, durante o cal o profesorado formula preguntas aos/as estudantes que lle sirvan para profundar e aclarar os aspectos necesarios e para comprobar cal foi a contribución de cada un dos membros do grupo nese informe. Resultados previstos na materia: - Coñecer os procesos de produción dos biocombustibles para integralos no marco normativo ambiental actual - Identificar e comprender as etapas crave dos procesos fermentativos - Comprender as vantaxes inherentes da biotecnoloxía fronte aos procesos de produción convencionais - Identificar os distintos residuos agrícolas e industriais que poden converterse en materias primas na produción de biocombustibles - Saber avaliar críticamente a información bibliográfica necesaria para deseñar adecuadamente un proceso de produción de biocombustibles - Saber integrar os principios de igualdade de xénero para constituír grupos de traballo en enxeñaría	15	A1 A2 A3 A4 A5	B1 B3 B5	C25 C28 C32	D1 D3 D6 D8
Exame de preguntas obxectivas	A avaliación dos coñecementos alcanzados polo alumnado nas leccións maxistrais farase mediante unha proba escrita na data oficial de exames. Esta actividade consta dun cuestionario de preguntas tipo test relacionadas coa materia. A proba cualificarase, segundo a lexislación vixente, cunha nota final comprendida entre 0 e 10. Resultados previstos na materia: - Coñecer os procesos de produción dos biocombustibles para integralos no marco normativo ambiental actual - Identificar e comprender as etapas crave dos procesos fermentativos - Comprender as vantaxes inherentes da biotecnoloxía fronte aos procesos de produción convencionais - Identificar os distintos residuos agrícolas e industriais que poden converterse en materias primas na produción de biocombustibles - Saber avaliar críticamente a información bibliográfica necesaria para deseñar adecuadamente un proceso de produción de biocombustibles	40	A1 A5	B1	C25 C28 C32	D2 D3 D8

Resolución de problemas e/ou exercicios	Esta avaliación consta de 3 probas que se enmarcan entre o temario da materia e nela procédese á resolución dun problema de forma autónoma. A proba realízase nos primeiros 10 min da clase. Resultados previstos na materia: - Coñecer os procesos de produción dos biocombustibles para integralos no marco normativo ambiental actual - Identificar e comprender as etapas crave dos procesos fermentativos - Comprender as vantaxes inherentes da biotecnoloxía fronte aos procesos de produción convencionais - Identificar os distintos residuos agrícolas e industriais que poden converterse en materias primas na produción de biocombustibles - Saber avaliar críticamente a información bibliográfica necesaria para deseñar adecuadamente un proceso de produción de biocombustibles	25	A2 A5	B1 B3	C24 C25 C28 C32	D1 D2 D3 D8

Other comments on the Evaluation

1.- Avaliación continua:O alumnado poderá renunciar ao sistema de avaliación continua no prazo fixado o día de presentación da materia.Nesta modalidade de avaliación:- O exame de preguntas obxectivas deberá acadar un mínimo do 50% da nota máxima para superar a materia.- A cualificación final incluirá a realización das prácticas de laboratorio, o traballo dirixido, a resolución de problemas e/ou exercicios, a simulación e o exame de preguntas obxectivas.

2.- Segunda oportunidade:2.1. Cando a cualificación da simulación, das prácticas de laboratorio e do traballo supervisado sexa superior a 5 puntos sobre 10, conservarase con vistas a esta oportunidade, sendo polo tanto só necesario realizar o exame de preguntas obxectivas.2.2 Cando a cualificación da simulación, das prácticas de laboratorio e do traballo supervisado sexa inferior a 5 puntos sobre 10, a cualificación basearase unicamente na realización dun exame final, que incluirá cuestións correspondentes ás prácticas de laboratorio, a simulación. e traballo supervisado. Para superar a materia será necesario acadar unha puntuación superior a 5 puntos sobre 10.

3.- Avaliación global:Cando se renuncie á avaliación continua, a cualificación basearase unicamente na realización dun exame final, que incluirá cuestións correspondentes a prácticas de laboratorio, simulación e traballos tutelados. Para superar a materia será necesario acadar unha puntuación superior a 5 puntos sobre 10.Calendario de exames: Consulta/consulta actualizacións na páxina web do centro: http://minaseenerxia.uvigo.es/es/docencia/examenes/

Bibliografía. Fontes de información

Basic Bibliography

Camps Michelena M, Marcos Martín F, **Los biocombustibles**, Mundi-Prensa, 2008

Costa A, **Biomasa y biocombustibles**, AMV, 2013

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Deublein D, Steinhauser A, **Biogas from waste and renewable resources : an introduction**, Wiley-VCH, 2011

Complementary Bibliography

Mariano Martín M, **Industrial chemical process analysis and design**, Elsevier, 2016

Bajpai P, **Pretreatment of Lignocellulosic Biomass for Biofuel Production**, Springer, 2016

Rodríguez Bachiller, A, **Tecnología del hidrógeno y pilas de combustible**, E-learning, 2019

APPA Asociación de Productores de Energías Renovables, **http://www.appa.es**,

CIEMAT - Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, **http://www.ciemat.es**,

Recomendacións

Subjects that continue the syllabus

Operacións básicas e procesos de refinado, petroquímicos e carboquímicos/V09G291V01302

Subjects that are recommended to be taken simultaneously

Tecnoloxía ambiental/V09G291V01207

Subjects that it is recommended to have taken before

Química: Química/V09G291V01105