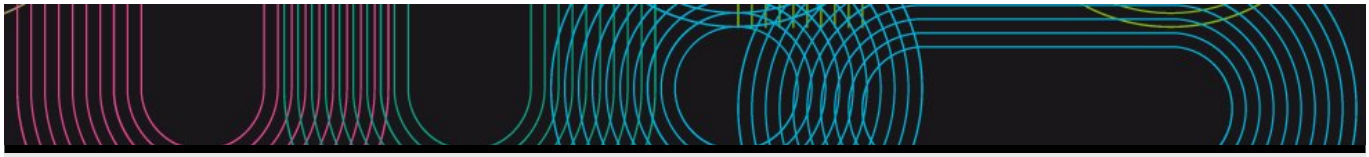

IDENTIFYING DATA				
Generation and distribution of conventional and renewable thermal energy				
Subject	Generation and distribution of conventional and renewable thermal energy			
Code	V09G291V01303			
Study programme	Grado en Ingeniería de la Energía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	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

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