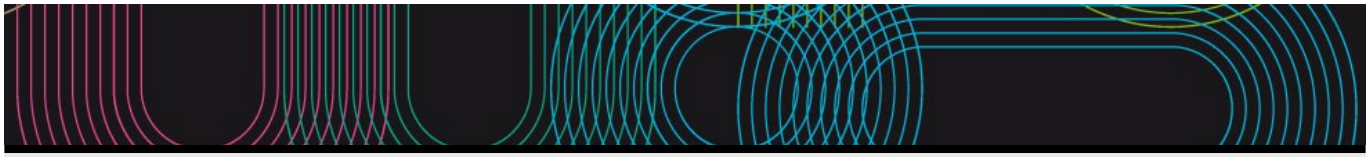

IDENTIFYING DATA				
Thermal engines and turbo-machines				
Subject	Thermal engines and turbo-machines			
Code	V09G291V01308			
Study programme	Grado en Ingeniería de la Energía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish English			
Department				
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	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

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