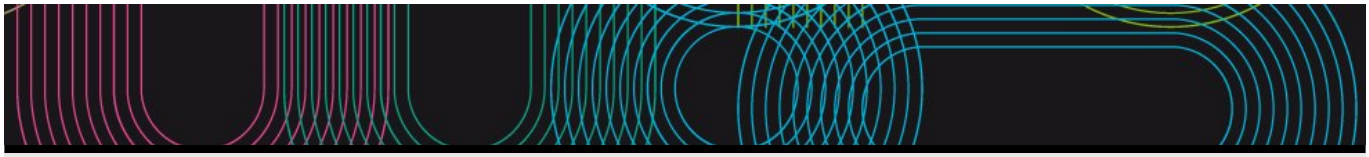

IDENTIFYING DATA				
Thermal engines and turbo-machines				
Subject	Thermal engines and turbo-machines			
Code	V09G290V01608			
Study programme	Degree in Energy Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish English			
Department				
Coordinator	Patiño Vilas, David			
Lecturers	Martínez Mariño, Sandra Patiño Vilas, David Pérez Orozco, Raquel			
E-mail	patinho@uvigo.es			
Web	http://faitic.uvigo.es/			
General description	Increase the knowledge of internal combustion engines and turbomachinery (heat engines)			

Competencies	
Code	
C21	Applied knowledge of the basics of fluid-mechanic systems and machines
C23	Ability to design electrical power plants
C29	Applied knowledge of thermal engineering
C35	Ability to apply knowledge of thermal motors and machines to problems that can arise in engineering
C36	Ability to apply environmental technologies to problems that can arise in thermal engineering
D1	Capacity to interrelate all the acquired knowledge and interpret it as components in a body of knowledge with a clear structure and strong internal coherence
D3	Propose and develop practical solutions, which develop suitable strategies based on theoretical knowledge, for problem phenomena and situations that arise as everyday realities in engineering
D5	Know what sources are available for ongoing and continual updating of all the information required to undertake their work, with access to all the current and future tools for seeking information and adapting it in the light of technological and social changes
D6	Know and handle legislation applicable to the sector, know the social and business environment and know how to work together with the Administration and use acquired knowledge to draw up engineering projects and develop any of the aspects of professional work required
D7	Capacity to organise, interpret, assimilate, create and manage all the information needed to organise their work, handling the I.T., mathematical, physical and other tools required
D8	Conceive engineering within a framework of sustainable development with an awareness of environmental issues

Learning outcomes		
Expected results from this subject	Training and Learning Results	
Know the technological basis supporting the latest research into thermal motors.	C21 C29 C35 C36	D5 D6 D7 D8
Know the types, operation and application of thermal motors and machines	C21 C23 C29 C35 C36	

Solve problems derived from the scope of the subject both autonomously and in collaboration with others		D1 D3 D5
Give explanations about the environmental implications and sustainability of a particular problem		D6 D7 D8
Solve problems that are inherent to thermal machines	C21 C23 C29 C36	
Carry out experimental analysis to assess the typical operational curves for thermal motors at full load.	C21 C23 C29	D5 D7
Write calculations and test reports that justify results and lead to conclusions		D1 D3 D5 D6 D7 D8

Contents	
Topic	
1. Introduction to Heat Engines	1.1 Presentation of the subject 1.2 Basic definitions
2. Characteristics of the Internal Combustion Engines (ICE)	2.1 Classification of the thermal 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 Real 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. Gas exchange processes in 4 Stroke Engines	5.1 The Valve Train 5.2 The Volumetric Efficiency 5.3 Pump loss 5.4 Timing 5.5 Variable Distribution Systems 5.6 Dynamic Air admition systems
6. Scavenging in 2 Stroke Engines	6.1 Ideal Scavenging 6.2 Scavenging proccess 6.3 Admision systems 6.4 Acoustic wave enhancement
7. Supercharging	7.1 Advantages of the supercharging in ICE 7.2 Volumetric superchargers 7.3 Turbochargers 7.4 Intercooler 7.5 Dynamic Systems (Comprex)
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 Combustion chambers 8.10 Influential factors in SI combustion

9. Combustion in Compression Ignition Engines (CIE)	9.1 Introduction 9.2 Phases of CI combustion 9.3 Influential Factors 9.4 Types of injection 9.5 Systems of injection 9.6 Future tendencies
10. Thermal turbomachinery	10.1 Brayton Cycle 10.2 Parts of the Gas Turbine 10.3 Compressors 10.4 Combustion Chamber 10.5 Turbine 10.6 Architecture
11. Auxiliar Circuits	11.1 Refrigeration System 11.2 Lubricacion System
12. Pollutant Emissions	12.1 SI Emissions 12.2 Diesel Emissiones 12.3 Regulations (EURO) 12.4 Catalytic converter 12.5 EGR systems 12.6 Lambda
13. Other heat engines	13.1 Rotary Engine (Wankel) 13.2 Stirling Engine 13.3 Modern Tendencies (HCCI, hybrids...) 13.4 New Fuels

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	25.5	47.5	73
Laboratory practises	18	10	28
Tutored works	1	20	21
Troubleshooting and / or exercises	8	20	28

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

Methodologies

	Description
Master Session	Theoretical lectures in large groups
Laboratory practises	Practical experiences in laboratory
Tutored works	Supervision of a report related with the subject
Troubleshooting and / or exercises	Resolution of practical exercices

Personalized attention

Methodologies	Description
Master Session	Theory lectures in large groups. The teacher will be also available to solve doubts during his personal tutor sessions and via email.
Laboratory practises	The students work in smaller groups (15-20 students). The division in subgroups allows a more personalised attention and a better utilisation of the laboratory resources.
Tutored works	C groups are small groups (5-10 students) used to follow-up the preparation of the general report for the subject and exercises.
Troubleshooting and / or exercises	Some examples and common exercices will be solved during C groups. The teacher will be also available to solve some doubts during his personal tutor sessions and via email.

Assessment

	Description	Qualification	Training and Learning Results	
Master Session	Short answer tests and quizs LEARNING RESULTS: All the learning results are evaluated with this methodology	60-70	C21 C23 C29 C35 C36	D1 D3 D5 D6 D7 D8

Tutored works	Text and oral presentation of the final report LEARNING RESULTS: All the learning results are evaluated with this methodology	15	C21 C23 C29 C35 C36	D1 D3 D5 D6 D7 D8
Troubleshooting and / or exercises	Problem (exercises) resolution and quizs LEARNING RESULTS: All the learning results are evaluated with this methodology	25-40	C21 C23 C29 C35 C36	D1 D3 D5 D6 D7 D8

Other comments on the Evaluation

The final report represents 15% of the final mark in the subject. The remaining 85% belongs to the tests and quizs (theory and practical exercises).

Those students who avoid continuous evaluation can assist the final exam with a global punctuation 100%. The content of this exam includes theory, exercises and all the presented reports of their classroom mates.

For the students following the continuous evaluation, there will be some partial exams (quizs). The final exam will be exent of the content passed in these mid-term exams. If these quizs are failed, the students should be evaluated again in the final exam.

To be considered as a continuous evaluation student it is necessary to inform about this intention to the teacher by filling a personal file (with photography) before the first mid-term exam.

Calendar of exams:

- End of Career: 22/09/2017

- Ordinary call 2º period: 21/05/2018

- Extraordinary call Julio: 02/07/2018

This information can verify /consult of up to date form in the page web of the centre:

http://minasyenergia.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

Physics: Thermal systems/V09G290V01306
Thermodynamics and heat transfer/V09G290V01302
Generation and distribution of conventional and renewable thermal energy/V09G290V01503