



Teaching Guide

Identifying Data					2016/17
Subject (*)	TERMODINÁMICA	Code	730G03014		
Study programme	Grao en Enxeñaría Mecánica				
Descriptors					
Cycle	Period	Year	Type	Credits	
Graduate	1st four-month period	Second	Obligatoria	6	
Language	Spanish				
Teaching method	Face-to-face				
Prerequisites					
Department	Enxeñaría Naval e Oceánica				
Coordinador	Calvo Díaz, Jose Ramon	E-mail	jose.ramon.calvo@udc.es		
Lecturers	Calvo Díaz, Jose Ramon Lamas Galdo, Isabel Lema Rodríguez, Marcos	E-mail	jose.ramon.calvo@udc.es isabel.lamas.galdo@udc.es marcos.lemma@udc.es		
Web	www.udc.es				
General description					

Study programme competences / results

Code	Study programme competences / results
A7	Coñecementos de termodinámica aplicada e transmisión de calor. Principios básicos e a súa aplicación á resolución de problemas de enxeñaría.
B1	Que os estudantes demostren posuír e comprender coñecementos nunha área de estudo que parte da base da educación secundaria xeral e adoita encontrarse 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
B3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitiren xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
B5	Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprenderen estudos posteriores cun alto grao de autonomía
B7	Ser capaz de realizar unha análise crítica, avaliación e síntese de ideas novas e complexas
B9	Adquirir unha formación metodolóxica que garanta o desenvolvemento de proxectos de investigación (de carácter cuantitativo e/ou cualitativo) cunha finalidade estratéxica e que contribúan a situarnos na vangarda do coñecemento
C4	Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.
C6	Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.

Learning outcomes

Learning outcomes	Study programme competences / results		
Modelar matematicamente sistemas e procesos relacionados a la utilización y generación de la energía	A7	B1 B3 B5 B7 B9	C4 C6
Aprender a aprender	A7	B1 B3 B5 B7 B9	C4 C6



Resolver problemas de forma efectiva.	A7	B1 B3 B5 B7 B9	C4 C6
Capacidad de abstracción, comprensión y simplificación de problemas complejos.	A7	B1 B3 B5 B7 B9	C4 C6

Contents	
Topic	Sub-topic
1. Introduction to Thermodynamics	Applications of Thermodynamics. Continuum medium. Basic concepts: system, surroundings, state, thermodynamical property, equilibrium. Characterization and measurement of primitive properties: pressure, volume, temperature. Temperature scale. Gas thermometer.
2. Work, energy and the 1st law of Thermodynamics (conservation of energy)	Review of mechanical concepts of energy. Examples: energy balance. Concept of work. Electric work. Examples. Cuasi-equilibrium processes and work. Heat iteration. Examples of heat and work. Internal energy and total energy. Conservation of energy. Heat transfer at constant pressure and volume. Enthalpy. Internal energy and enthalpy of ideal gasses and compressible flows. Tables of ideal gasses.
3. Propiedades de una sustancia pura	Ideal gas equation of state and characterization of the state using two independent properties. Incompressible flows. Phase diagrams and phases of a pure substance. Pure simple compressible substances. Characterization of pure simple compressible substances. Equation of state and thermodynamical surfaces. (p, v) and (T, v) diagrams of a pure simple compressible substance. Tables of thermodynamic properties and reference states for water refrigerants. Examples.
4. Conservation of energy and 1st law of Thermodynamics	Vapor turbines, hydraulic turbines, compressors, nozzles, heat exchangers. Concept of control volume (open system). Conservation of mass. Examples. Conservation of energy and input/output works. Conservation of mass and energy applied to thermal machines. Steady and transient states. Filling and emptying of tanks.
5. 2nd law of Thermodynamics and introduction to thermodynamic cycles	Concept of reversibility. Irreversible processes. Spontaneous processes. Internally reversible processes. Thermal reservoir. Power cycles and refrigerators. Efficiency and coefficient of performance (COP). 2nd law of Thermodynamics: Kelvin-Planck and Clausius statements. Equivalence between both statements. Carnot cycle of an ideal gas inside a cylinder-piston system. Efficiency of a reversible power cycle. Corollaries of the 2nd law of thermodynamics. Kelvin temperature scale. Clausius inequality.
6. Entropy	Analogy between work-pressure and heat-temperature in reversible process. Entropy as thermodynamic property. Thermodynamic equations related to entropy. Equations for ideal gasses. Tables of properties for pure simple compressible substances. (T, s) and (h, s) diagrams. Generation of entropy in irreversible processes. Generation and transfer of entropy. Open system. Application to thermal machines. Efficiency in thermal machines: compressors, pumps, turbines, nozzles. Applications.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours



ICT practicals	A7 A7 B1 B1 B3 B5 B7 B9 C6 C4	30	40	70
Guest lecture / keynote speech	A7 B9 B1 B3 B5 B7 B9 C4 C6 C4 C6	40	30	70
Long answer / essay questions	A7 B3 B5 B7 B1 B3 B5	9	0	9
Personalized attention		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	
Methodologies	Description
ICT practicals	Students learn the software EES (Engineering Equation Solver). Thermodynamical problems will be solved using EES. There will also be lab work.
Guest lecture / keynote speech	Conventional classes.
Long answer / essay questions	Two exams

Personalized attention	
Methodologies	Description
ICT practicals	Personal attention will be provided to the students.

Assessment			
Methodologies	Competencies / Results	Description	Qualification
ICT practicals	A7 A7 B1 B1 B3 B5 B7 B9 C6 C4	Students may deliver some exercises and lab work	20
Long answer / essay questions	A7 B3 B5 B7 B1 B3 B5	Exam/s. In order to pass it is necessary to obtain at least 3.5 at the final exam and 5 final score.	80
Others			

Assessment comments

Sources of information	
Basic	<ul style="list-style-type: none"> - J. M^a Sáiz Jabardo (2008). Introducción a la Termodinámica. - M. Moran y H. N Shapiro (2004). Fundamentals of Engineering Thermodynamics. John Wiley & Sons - Y. A. Çengel y M. A. Boles. (2006). Thermodynamics. McGraw-Hill
Complementary	

Recommendations	
Subjects that it is recommended to have taken before	
CALCULUS/730G01101 PHYSICS I/730G01102 DIFFERENTIAL EQUATIONS/730G01110 MECHANICS/730G01118	
Subjects that are recommended to be taken simultaneously	



Subjects that continue the syllabus
FLUID MECHANICS/730G01119 CALOR E FRIO INDUSTRIAL/REFRIG/730G03020 MÁQUINAS TERMICAS E HIDRAULICAS/730G03023
Other comments

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.