



Teaching Guide

Teaching Guide				
Identifying Data				2018/19
Subject (*)	Thermodynamics		Code	730G03014
Study programme	Grao en Enxeñaría Mecánica			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Second	Obligatory	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Ciencias da Navegación e Enxeñaría MariñaEnxeñaría Naval e Industrial			
Coordinador	Calvo Diaz, Jose Ramon		E-mail	jose.ramon.calvo@udc.es
Lecturers	Calvo Diaz, Jose Ramon		E-mail	jose.ramon.calvo@udc.es
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Web	www.udc.es			
General description	Heat, work, and energy.			

Study programme competences

Code	Study programme competences
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 demostraren 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		
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
Os bloques ou temas seguintes desenrolan os contidos establecidos na ficha da Memoria de Verificación, que son:	Introdución Conservación da enerxía Propiedades das sustancias puras Análise de volume de control Segundo principio. Entropía Análise exerxética
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.
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Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student's personal work hours	Total hours
Problem solving	A7 A7 B1 B1 B3 B5 B7 B9 C4 C6	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
Problem solving	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
Problem solving	Personal attention will be provided to the students. Academic dispense is allowed. Students who request it must contact teacher to realize additional homework.

Assessment			
Methodologies	Competencies	Description	Qualification
Problem solving	A7 A7 B1 B1 B3 B5 B7 B9 C4 C6	Students may deliver some exercises and lab work	30
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.	70
Others			

Assessment comments
Students who request academic dispense must realize other activities proposed by the teacher. The qualification is the same as the practice.

Sources of information



Basic	- 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
Industrial Heat Transfer/730G03020
Fluid and Thermal Machines/730G03023

Other comments

proposed to correct them.

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