



## Teaching Guide

Identifying Data					2017/18
Subject (*)	Thermodynamics	Code		730G05015	
Study programme	Grao en Enxeñaría Naval e Oceánica				
Descriptors					
Cycle	Period	Year	Type	Credits	
Graduate	1st four-month period	Second	Obligatoria	6	
Language	Spanish				
Teaching method	Face-to-face				
Prerequisites					
Department	Ciencias da Navegación e Enxeñaría MariñaEnxeñaría Naval e Industrial				
Coordinador	Calvo Díaz, Jose Ramon	E-mail	jose.ramon.calvo@udc.es		
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General description					

## Study programme competences

Code	Study programme competences

## Learning outcomes

Learning outcomes	Study programme competences		
Modelar matematicamente sistemas e procesos relacionados a la utilización y generación de la energía	A1	B1	C1
	A2	B2	C2
	A3	B3	C3
	A7	B4	C4
	A8	B5	C5
		B6	C6
		B7	
		B8	
		B9	
Aprender a aprender	A1	B1	C1
	A2	B2	C2
	A3	B3	C3
	A7	B4	C4
	A8	B5	C5
		B6	C6
		B7	
		B8	
		B9	
Resolver problemas de forma efectiva.	A1	B1	C1
	A2	B2	C2
	A3	B3	C3
	A7	B4	C4
	A8	B5	C5
		B6	C6
		B7	
		B8	
		B9	



Capacidad de abstracción, comprensión y simplificación de problemas complejos.	A1	B1	C1
	A2	B2	C2
	A3	B3	C3
	A7	B4	C4
	A8	B5	C5
		B6	C6
		B7	
		B8	
		B9	

Contents	
Topic	Sub-topic
Os bloques ou temas seguintes desenrolan os contidos establecidos na ficha da Memoria de Verificación, que son:	<p>Introdución</p> <p>Conservación da enerxía</p> <p>Propiedades das sustancias puras</p> <p>Análise de volume de control</p> <p>Segundo principio. Entropía</p> <p>Análise exerxética</p>
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
ICT practicals	A1 A2 A3 A7 A8 B1 B2 B3 B4 B5 B6 B7 B8 B9 C1 C2 C3 C4 C5 C6	30	40	70
Guest lecture / keynote speech	A1 A2 A3 A7 A8 B1 B2 B3 B4 B5 B6 B7 B8 B9 C1 C2 C3 C4 C5 C6	40	28	68
Long answer / essay questions	A1 A2 A3 A7 A8 B1 B2 B3 B4 B5 B6 B7 B8 B9 C1 C2 C3 C4 C5 C6	9	2	11
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	Description	Qualification
Long answer / essay questions	A1 A2 A3 A7 A8 B1 B2 B3 B4 B5 B6 B7 B8 B9 C1 C2 C3 C4 C5 C6	Exam/s. In order to pass it is necessary to obtain at least 3.5 at the final exam and 5 final score.	80
ICT practicals	A1 A2 A3 A7 A8 B1 B2 B3 B4 B5 B6 B7 B8 B9 C1 C2 C3 C4 C5 C6	Students may deliver some exercises and lab work	20



Others			
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### Assessment comments

### Sources of information

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

### 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

(\*)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.