Teaching Guide				
Identifying Data				2015/16
Subject (*)	TERMODINÁMICA TECNICA		Code	730G02115
Study programme	Grao en Enxeñaría en Propulsión e Servizos do Buque			
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 Diaz, Jose Ramon	E-mail	jose.ramon.calvo@udc.es	
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General description				

Study programme competences / results	
Code	Study programme competences / results
A1	Capacidade para a resolución dos problemas matemáticos que poidan formularse na enxeñaría. Aptitude para aplicar os coñecementos sobre: álxebra lineal; xeometría; xeometría diferencial; cálculo diferencial e integral; ecuacións diferenciais e en derivadas parciais; métodos numéricos; algorítmica numérica; estatística e optimización.
A2	Comprensión e dominio dos conceptos básicos sobre as leis xerais da mecánica, termodinámica, campos e ondas e electromagnetismo e a súa aplicación para a resolución de problemas propios da enxeñaría.
A14	Coñecemento da termodinámica aplicada e da transmisión da calor.
B1	Aprender a aprender.
B2	Resolver problemas de forma efectiva.
C7	Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.

Learning outcomes			
Learning outcomes	Study programme competences / results		
(1) Modelar matematicamente sistemas e procesos relacionados a la utilización y generación de la energía	A1 A2 A14	B1 B2	C7
(2) Aprender a aprender	A1 A2 A14	B1 B2	C7
(3) Resolver problemas de forma efectiva.	A1 A2 A14	B1 B2	C7
(7) Capacidad de abstracción, comprensión y simplificación de problemas complejos.	A1 A2 A14	B1 B2	C7

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-Plank 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	A1 A2 A14 B1 B2 C7	30	40	70
Guest lecture / keynote speech	A1 A2 A14 B1 B2 C7	40	30	70
Long answer / essay questions	A1 A2 A14 B1 B2 C7	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	A1 A2 A14 B1 B2 C7	Students may deliver some exercises and lab work	20
Long answer / essay questions	A1 A2 A14 B1 B2 C7	First exam: 30% Second exam: 70%	80
Others			

Assessment comments

Sources of information	
Basic	- J. Mª Sáiz Jabardo (2008). Introducción a la Termodinámica. - M. Moran y H. N Shapiro (2004). Fundamentals of Engineering Thermodynamics. John Willey & 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.