Teaching Guide					
Identifying Data					2016/17
Subject (*)	Termodinámica e Termotecnia			Code	631G02254
Study programme	Grao en Tecnoloxías Mariñas				
Descriptors					
Cycle	Period	Year		Type	Credits
Graduate	1st four-month period	Second		Obligatoria	6
Language	SpanishEnglish				
Teaching method	Face-to-face				
Prerequisites					
Department	Enerxía e Propulsión Mariña				
Coordinador	Baaliña Insua, Alvaro		E-mail	alvaro.baalina@udc.es	
Lecturers	Baaliña Insua, Alvaro		E-mail	alvaro.baalina@udc.es	
Web	www.udc.es/grupos/gifc				
General description	This subject developes basic concepts for the understanding of the greater part of the processes related with energy in an installation, both on board and ashore. As an example, allows to know, analyse and optimise the operation of an internal combustion engine,a boiler or a turbine. Without the knowledge of the thermodynamic principles results very difficult the understanding of many subjects of the study plan, as Gas and Steam Turbines, Internal Combustión Engines, Auxiliary Systems of ship, Steam Generators, Refrigeration, etc. To attend the course is advisable to have previous knowledges of Physics and Mathematics.				

Study programme competences	
Code	Study programme competences
A2	CE2 - Capacidade para a dirección, organización e operación das actividades obxecto das instalacións marítimas no ámbito da súa especialidade.
A6	CE6 - Coñecementos e capacidade para a realización de auditorías enerxéticas de instalacións marítimas.
A7	CE7 - Capacidade para a operación e posta en marcha de novas instalacións ou que teñan por obxecto a construción, reforma, reparación, conservación, instalación, montaxe ou explotación, realización de medicións, cálculos, valoracións, taxacións, peritacións, estudos, informes, e outros traballos análogos de instalacións enerxéticas e industriais mariñas, nos seus respectivos casos, tanto con carácter principal como accesorio, sempre que quede comprendido pola súa natureza e característica na técnica propia da titulación, dentro do ámbito da súa especialidade, é dicir, operación e explotación.
A17	CE17 - Modelizar situacións e resolver problemas con técnicas ou ferramentas físico-matemáticas.
A20	CE20 - Ser capaz de identificar, analizar e aplicar os coñecementos adquiridos nas distintas materias do Grao, a unha situación determinada formulando a solución técnica máis axeitada dende o punto de vista económico, ambiental e de seguridade.
A21	CE37 - Capacidad para ejercer como Oficial de Máquinas de la Marina Mercante, una vez superados los requisitos exigidos por la Administración Marítima.
A30	CE42 - Operar, reparar, manter, reformar, optimizar a nivel operacional as instalacións industriais relacionadas coa enxeñaría mariña, como motores alternativos de combustión interna e subsistemas; turbinas de vapor, caldeiras e subsistemas asociados; ciclos combinados; propulsión eléctrica e propulsión con turbinas de gas; equipos eléctricos, electrónicos, e de regulación e control do buque; as instalacións auxiliares do buque, tales como instalacións frigoríficas, sistemas de goberno, instalacións de aire acondicionado, plantas potabilizadoras, separadores de sentinas, grupos electróxenos, etc.
A32	CE44 - Coñecer o balance enerxético xeral, que inclúe o balance termo-eléctrico do buque, ou sistema de mantemento da carga, así como a xestión eficiente da enerxía respectando o medio.
A55	Coñecer o balance enerxético xeral, incluíndo o balance termo-eléctrico, así como a xestión eficiente da enerxía respectando o medio.
B2	CT2 - Resolver problemas de forma efectiva.
B7	CT7 - Capacidade para interpretar, seleccionar e valorar conceptos adquiridos noutras disciplinas do ámbito marítimo, mediante fundamentos físico-matemáticos.
C6	C6 - Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.

C10	CB2 - Aplicar os coñecementos no seu traballo ou vocación dunha forma profesional e poseer competencias demostrables por medio da elaboración e defensa de argumentos e resolución de problemas dentro da área dos seus estudos
C11	CB3 - Ter a capacidade de reunir e interpretar datos relevantes para emitir xuicios que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética

Learning outcomes			
Learning outcomes	Study programme competences		
Analysis and synthesis of the thermodynamic concepts.	A2	B2	C6
Capacity to reason and comprise the energetic interactions in diverse systems.	A6	B7	C10
Capacity to solve energetic and optimisation problems through the	A7		C11
concept of entropy and irreversibility.	A17		
Planning and decision making regarding the energetic management of	A20		
industrial installations.	A21		
Critical reasoning about the applicable physical models	A30		
Habit of study and structuring of the information through tables and	A32		
two-dimensional diagrams of thermodynamic parameters	A55		

Contents	
Topic	Sub-topic
1.- INTRODUCTION	1.1.- OBJECTIVES OF THE THERMODYNAMICS. 2.1.- THERMODYNAMIC SYSTEM AND PROPERTIES 2.1.1.- Thermodynamic system. 2.1.2.- Thermodynamic properties. Primitive-Derived. Intensive-Extensive. 2.1.3.- States of a system. Postulate I (of state). Postulate II (of equilibrium). 2.1.4.- Thermodynamic processes.

2.- WORK, ENERGY AND HEAT.	1.2.- WORK. FORMS OF QUASI STATIC WORK . 1.2.1.- Mechanical forms of work 1.2.2.- Thermodynamic definition of work. Forms of quasi static work . 2.2.- ADIABATIC INTERACTION OF WORK. TOTAL ENERGY 2.2.1.- Adiabatic interactions of work. 2.2.2.- Total energy. Postulate III. 2.2.3.- Internal energy. First Law for a closed system. 3.2.- INTERACTIONS OF HEAT. 3.2.1.- Postulate III and non adiabatic work . 3.2.2.- Thermal equilibrium. Postulate IV. 3.2.3.- Postulate IV. Thermometry. Thermometric scales 4.2.- LAWS OF THE GASES. 4.2.1.- Equation of state of ideal gas. 4.2.2.- Mixtures of ideal gases.
3.- STATES AND PROPERTIES OF PURE SUBSTANCES	1.3.- PURE SUBSTANCES. 1.3.1.- Simple Compressible system. 1.3.2.- pVT surface of a pure substance. Proyections. 1.3.3.- Thermal Properties. 2.3.-PROPERTY VALUES. 2.3.1.- Tables of properties of pure substances. 2.3.2.- Mixtures of two phases (liquid-vapor). 2.3.3.- Approximations for compressed liquid and model of incompresible substance . 2.3.4.- Real gas. Factor of compressibility. Equations of state Generalised Chart. Law of corresponding states.
4.- THE FIRST LAW FOR OPEN SYSTEMS	1.4.- THE FIRST LAW OF THERMODYNAMICS FOR OPEN SYSTEMS. 1.4.1.- Mass, volume and surface of control. Equation of the First Law. 2.4.2.- Balances of mass and energy in a volume of control. Energy of flow. 3.4.3.- Integral and differential analysis. 3.4.4.- Balances of mass and energy in stationary and no stationary state.

5.- THE SECOND LAW OF THE THERMODYNAMICS	1.5.- ENTROPY AND SECOND LAW. 1.5.1.- Limitations of the First Law. 1.5.2.- Heat Engine. Energetic interactions between two reservoirs. 1.5.3.- Statements of the Second Law. Kelvin-Plank. Clausius. Equivalence of both statements. 1.5.4.- Reversibility. Statement of Carnot. 1.5.5.- Thermodynamic scale of temperature. 1.5.6.- Cycle of Carnot.
6.- ENTROPY AND IRREVERSIBILITY	1.6.- THEOREM OF CLAUSIUS. FUNCTION ENTROPY. 2.6.- ENTROPY 3.6.- PRINCIPLE OF INCREASE OF ENTROPY IRREVERSIBILITY. 3.6.1.- Balance of entropy for an enclosed system. 3.6.2.- Principle of increase of entropy. 4.6.- CHANGE OF ENTROPY. 4.6.1.- Equations Tds. Ideal gas Model. Liquid-vapor mixtures. Hypothesis of constant or variable specific heats. Model of incompressible substance. 5.6.- DIAGRAMS T-s and h-s. Graphic interpretation of the transfer of heat in an internally reversible process. Diagram of Mollier. 6.6.- BALANCE OF ENTROPY FOR CONTROL VOLUME 6.6.1.- Balance of entropy for control volume. Application to stationary and non-stationary flow. 7.6.- WORK IN PROCESSES OF STATIONARY FLOW INTERNALLY REVERSIBLE. 8.6.- ISOENTPROPIC EFFICIENCY 7.6.1.- Turbines. 7.6.2.- Compressors and pumps. 7.6.3.- Nozzles and diffusers.
7.- COMPRESSIBLE FLOW	1.7.- ADIABATIC STAGNATION OF A FLUID 2.7.- SOUND VELOCITY AND MACH NUMBER. 3.7.- EFFECT OF AREA FLOW CHANGES. 4.7.- RELATIONS BETWEEN FLOW PROPERTIES AND MACH NUMBER. 5.7.- EFFECT OF BACK PRESSURE ON NOZZLES.

8.- STEAM AND GAS CYCLES	1.8.- Rankine Cycle, efficiency and improvements. 2.8.- Gas Cycle. 2.8.1.-Otto and Diesel Cycles. 2.8.2.- Brayton Cycle, improvements. Combined Cycle 3.8.- Cycles of refrigeration..
9.- Humid air thermodynamics. Psychrometry	1.9.- Properties. Psychrometric chart. 2.9.- Aplications. Air conditioning
10.- REACTIVE MIXTURES. COMBUSTION	1.10.- Combustion, calculations

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Introductory activities	C6	2	0	2
Guest lecture / keynote speech	A2 A6 A7 A17 A20 A21 A32 A55 B2 B7 C6	28	42	70
Problem solving	A6 A7 A17 A20 A21 A32 A55 B2 B7 C6	11	22	33
Collaborative learning	A2 A6 A20 B2 B7 C6 C10 C11	8	0	8
Supervised projects	A2 A6 A7 A17 A20 A21 A30 A32 A55 B2 B7 C6 C10 C11	5	15	20
Document analysis	A20 B7 C6 C10 C11	0	5	5
Objective test	A2 A6 A7 A17 A20 A21 A30 A32 A55 B2 B7 C6 C10 C11	3	6	9
Personalized attention		3	0	3
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Introductory activities	There will be a presentation of the course, emphasizing the importance of this matter as a basis for learning other subjects in the Degree and for professional activities in the field of Marine Engineering. The standards of teaching, qualification and most important bibliographical sources will be set.
Guest lecture / keynote speech	There will be a detailed explanation of the contents of the material, distributed across topics. The student will have a typed copy of the subject matter in each keynote session. Students are encouraged to participate in class, through comments linking the theoretical with real life experiences.
Problem solving	Problems will be solved for each item proposed, allowing the application of mathematical models appropriate to each case, including managing tables, applying the most appropriate assumptions, the theoretical relation developed in lectures and relation with professional practice
Collaborative learning	Problem solving in groups, with the possibility of exposing results.
Supervised projects	Problems more difficult than those solved in class or issues of special relevance.
Document analysis	By means using bibliographical sources of different types, the student will get used to finding information in order to deepen or focus learning from other points of view that are not exclusively those from the professor. It is like a training to the future needs of students in their professional development.

Objective test	There will be a midterm exam so that students become familiar with the type of issues raised in the written tests. It will consist of a theoretical and practical part, so that both computed for 50% of the grade. Regular and special examinations shall be governed by the same format.

Personalized attention	
Methodologies	**Description**
Problem solving Guest lecture / keynote speech Collaborative learning Supervised projects	Exposition and solution of questions individually or in groups

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Problem solving	A6 A7 A17 A20 A21 A32 A55 B2 B7 C6	Ploblem solving with EES (Engineering Equation Solver).	5
Guest lecture / keynote speech	A2 A6 A7 A17 A20 A21 A32 A55 B2 B7 C6	Attendance at the sessions will count as part of the final grade. The student must sign a sheet of attendance to every lecture as an evidence for the assessment of this methodology.	5
Objective test	A2 A6 A7 A17 A20 A21 A30 A32 A55 B2 B7 C6 C10 C11	The student will demonstrate proficiency in the theoretical and practical learning of issues.	80
Supervised projects	A2 A6 A7 A17 A20 A21 A30 A32 A55 B2 B7 C6 C10 C11	Presentation and defense of the work. It will be valued structure, neatness, originality and expository method. This is an optional methodology. For students who don't do the project, the qualification percentage of this methodology will be added to the objective test.	10

Assessment comments
There will be a final exam to collect the methodologies used during the course, for students who have not followed the teaching and representing 100% of the grade.

Sources of information	
Basic	- Moran, M. J. ; Shapiro, H. N (2004). Fundamentos de Termodinámica Técnica . Barcelona.. Reverte - Çengel, Y. A.; Boles, M. A. (2006). Termodinámica. México. McGrawHill - Agüera, J.: (1999). Termodinámica Lógica y Motores Térmicos. Madrid. Ciencia 3. - Rogers, G.; Mayhew, Y. (1992). Engineering Thermodynamics. Work and Heat Transfer. Singapore. Longman
Complementary	- Sonntag, R.; Borgnakke, C (2007). Introduction to engineering thermodynamics.. USA. Wiley - Segura, J. (1990). Termodinámica Técnica. Barcelona. Reverté

Recommendations
Subjects that it is recommended to have taken before
Matemáticas 1/631G02151 Física I/631G02153 Matemáticas II/631G02156 Química/631G02157 Física II/631G02158
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus

Motores de Combustión Interna/631G02351
Turbinas de Vapor e Gas/631G02352
Técnicas de Frío e Aire acondicionado/631G02355
Máquinas Térmicas Mariñas/631G02361
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.