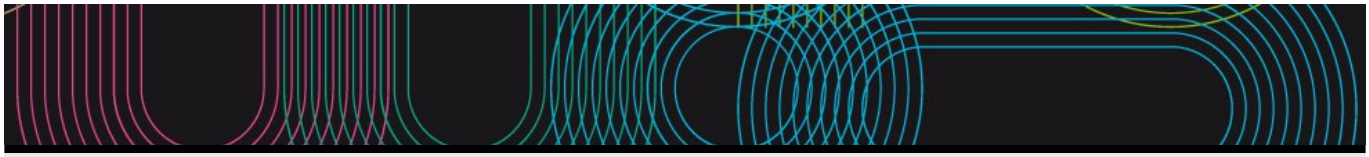

IDENTIFYING DATA				
Thermodynamics and heat transfer				
Subject	Thermodynamics and heat transfer			
Code	V12G380V01302			
Study programme	Degree in Mechanical Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Sieres Atienza, Jaime Santos Navarro, José Manuel			
Lecturers	Rodríguez Fernández-Arroyo, Juan Ignacio Román Espiñeira, Miguel Ángel Santos Navarro, José Manuel Sieres Atienza, Jaime Vidal López, Antonio José			
E-mail	jsieres@uvigo.es josanna@uvigo.es			
Web				
General description	Thermodynamics studies the energy, its transformations and the relationships among the properties of substances. Therefore, its knowledge is of primary importance for the analysis, design and construction of any thermal machine or equipment; and, in general, for the industrial applications of thermal engineering. On the other hand, it is interesting to know the mechanisms for energy transfer, mainly due to the existence of a temperature difference, with a focus in the three modes of heat transfer and the mathematical models that allow calculating the heat transfer rate. At the end of the course, students are expected to be able to properly state and solve heat transfer engineering problems.			

Competencies	
Code	
B4	CG4 Ability to solve problems with initiative, decision making, creativity, critical thinking and the ability to communicate and transmit knowledge and skills in the field of industrial engineering in Mechanical specialty.
B5	CG5 Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar works.
B6	CG6 Capacity for handling specifications, regulations and mandatory standards.
B7	CG7 Ability to analyze and assess the social and environmental impact of the technical solutions.
B11	CG11 Knowledge, understanding and ability to apply the necessary legislation in the exercise of the profession of Industrial Technical Engineer.
C7	CE7 Knowledge of applied thermodynamics and heat transfer. Basic principles and their application to solving engineering problems.
D2	CT2 Problems resolution.
D7	CT7 Ability to organize and plan.
D9	CT9 Apply knowledge.
D10	CT10 Self learning and work.
D17	CT17 Working as a team.

Learning outcomes	
Expected results from this subject	Training and Learning Results

Know and understand the Laws of Thermodynamics, the modes of heat transfer and the relations to calculate heat transfer rates	B4 B5 B6 B7	C7	D2 D7 D9 D10 D17
Know and understand the basic notions of the physics involved in the different modes of heat transfer	B5 B6 B7 B11	C7	D2 D7 D9 D10 D17
Identify the relevant heat transfer mechanisms involved in any heat transfer engineering application	B4 B6 B7 B11	C7	D2 D7 D9 D10 D17
Analyze thermal systems operation, such as heat pumps, refrigeration systems or power systems. Know the main components of these kinds of systems and the thermodynamic cycles used to model them	B4 B5 B6 B7 B11	C7	D2 D7 D9 D17

Contents
Topic
REVIEW OF THE FIRST And SECOND LAW OF THE THERMODYNAMICS
PROPERTIES OF PURE SUBSTANCES: TABLES And DIAGRAMS OF PROPERTIES
ANALYSIS OF OPEN SYSTEMS ACCORDING TO THE FIRST And SECOND LAW OF THE THERMODYNAMICS
APPLICATIONS OF THE ENGINEERING THERMODYNAMIC: POWER CYCLES And REFRIGERATION CYCLES
BASICS CONCEPTS And FUNDAMENTAL PRINCIPLES OF THE HEAT TRANSFER
HEAT TRANSFER BY CONDUCTION. ONE-DIMENSIONAL, STEADY-STATE HEAT FLOW
HEAT TRANSFER BY CONVECTION: FUNDAMENTALS And CORRELATIONS FOR CONVECTION HEAT TRANSFER COEFFICIENTS
HEAT TRANSFER BY RADIATION: FUNDAMENTALS. THERMAL RADIATION
INDUSTRIAL APPLICATIONS: HEAT EXCHANGERS

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	32.5	65	97.5
Laboratory practical	6	0	6
Autonomous problem solving	0	18.5	18.5
Problem solving	12	12	24
Problem and/or exercise solving	0	3	3
Objective questions exam	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	
	Description
Lecturing	Lectures introduction of the contents of the matter object of study

Laboratory practical	Real processes experimentations in the laboratory which complement the contents covered in the course. PRACTICAL CONTENTS (at least 3 of the following laboratory practices will be done): 1) Application of the First Law of Thermodynamics: experimental determination of isothermal and adiabatic processes. 2) Evaluating thermodynamic properties of pure substances by means of computer software. 3) Experimental study of a vapor cycle. 4) Experimental study of a vapor compression refrigeration cycle and heat pump cycle. 5) Experimental determination of thermal conductivity. 6) Evaluating heat transfer by radiation: the Stefan-Boltzmann law
Autonomous problem solving	Troubleshooting and / or exercises related to the subject that the student take place by consulting the literature
Problem solving	Troubleshooting and / or exercises related to the subject that the student take place in the classroom and/or laboratory. Examples of simple application of the contents studied as well as practical examples will be solved. The methodology will be focused on explaining how to solve the problems rather than on the determining the final numerical solution.

Personalized assistance

Methodologies	Description
Lecturing	Students questions or doubts about any of the course contents will be solved during the instructors office hours
Laboratory practical	Students questions or doubts about any of the course contents will be solved during the instructors office hours
Problem solving	Students questions or doubts about any of the course contents will be solved during the instructors office hours

Assessment

	Description	Qualification	Training and Learning Results		
Problem and/or exercise solving	Final exam consisting of solving problems of lengthy response , or exercises and / or theoretical questions concerning the contents of the developed material (theory sessions, labs, etc.), and time / conditions established / as by professor	80	B4 B5 B6 B7	C7	D2 D7 D9 D10
Objective questions exam	Throughout the semester several tests will be performed. The corresponding note to the different proofs of follow-up will be based in proofs written of short answer. This note will correspond with the denomination of Continuous Evaluation	20	B6	C7	D2 D7 D9 D10

Other comments on the Evaluation

Continuous Evaluation Mode .

The final qualification (CF) of the student is determined by adding the points obtained in the final exam (EF) and those obtained by Continuous Evaluation (EC).

A minimum number of points in the final exam is not required to take into account the points obtained during the course (Continuous Evaluation). In any case, it is necessary to obtain a final qualification greater or equal than 5 points in order to to pass the subject.

Each new enrollment in the course involves resetting the ratings in the continuous evaluation activities obtained in previous courses.

According to the Continuous Assessment Regulations, those students subject to the continuous evaluation mode that take part in any assessable activity included in theTeaching Guide of the subject, will be considered as "presented" and will be taken into account for the final qualification of the course.

To carry out the different tests considered in the continuous evaluation mode (along the course) students should bring the materials and / or documentation required to perform these tests, sucha as: calculator (non- programmable), tables and diagrams of properties of substances. Any kind of form or similar complementary document will not be allow during these tests.

For the continuous evaluation tests and the final exam, it is recommeded that students clearly justify all their results. None of the results obtained by the student will be "understood" by default. The procedure used by the students during the solution of the differernt problems will also be taken into account.

Non-continuous Evaluation Mode

Those students that have renounced to be evaluated during the course (Continuous Evaluation) using the official procedure established by the Center, will be evaluated in the official dates set in the two calls (same day and time) by a specific assesment. This specific assessment will take into account all contents (theory, problems and laboratory practices) of the course, and will account for 100% of the maximum score. It will take place as follows:

1.- Written test (EF), with a weight of 80% of the final qualification, identical to the final test of all other students that follow the continuous evaluation mode.

2.- A Specific test (EC) , with a weight of 20% of the final qualification. This specific test will include both the contents of laboratory practice and the contents covered during the master sessions of the course.

Qualification criteria:

First call: the final qualification is calculated as

CF=0.2·EC+0.8·EF

Second call: the final qualification is calculated as

CF=max(N1, N2), where

N1 = 0.2·EC + 0.8·EF

N2 = EF

A score system from 0 to 10 points will be used (RD 1125/2003 de 5 de septiembre, BOEde 18 de septiembre)

The exams for the "final de carrera" call may have a different format to the formerly detailed one.

All tests, either during the course (continuous evaluation) or the final exam, must be done wit a pen, preferably blue. The use of a pencil or a red pen is not allowed. The use of electronic devices such as tablets, smartphones, laptops, etc, are also not allowed.

Ethical Comminmnet:

The student is expected to present an adequate ethical behavior. In the event that an unethical behavior is detected (copying, plagiarism, unauthorized use of electronic devices, etc.), it will be considered that the student does not meet the necessary requirements to pass the subject. In that case, the overall rating in the current academic year will be 'fail (0.0)'.

The use of any electronic device during the different assesments or tests is not allowed, unless expressly authorized. The fact of introducing such an unauthorized device in the examination room will be considered as a reason for not passing the subject in the current academic year and the overall rating will be 'fail (0.0)'.

IMPORTANT NOTE: this is the english translation of the subject guide. In the event of any conflict between the English and Spanish versions, the Spanish version shall prevail.

Sources of information
Basic Bibliography
Çengel, Yunus y Boles, Michael, **Termodinámica**, 7ª Edición, McGraw-Hill, 2012
Çengel Yunus A., Boles Michael A., **Thermodynamics : an engineering approach**, 7th ed, McGraw-Hill, 2011
Çengel Y.A., y Ghajar A.J., **Transferencia de Calor y Masa. fundamentos y aplicaciones**, 4ª edición, McGraw-Hill, 2011
Çengel, Yunus A., **Heat and mass transfer: a practical approach**, 4th ed, McGraw-Hill, 2011
Complementary Bibliography
Çengel Y.A., **Introduction to Thermodynamics and Heat Transfer**, McGraw-Hill, 2008
Moran M.J. y Shapiro H.N., **Fundamentos de Termodinámica Técnica**, 2ª edición - castellano, Ed. Reverté, 2004
Merle C. Porter y Craig W. Somerton, **Termodinámica para ingenieros**, McGraw-Hill/Interamericana de España, 2004
Incropera F.P. y DeWitt D.P, **Introduction to Heat Transfer**, 2002
Wark, K. y Richards, D.E., **Termodinámica**, McGraw-Hill, 2010
Kreith J. y Bohn M.S, **Principios de Transferencia de Calor**, 2001,
Mills A.F., **Transferencia de calor**, 1995

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics 2/V12G340V01202
Mathematics: Calculus 1/V12G340V01104
Mathematics: Calculus 2 and differential equations/V12G340V01204

Other comments

To enrol in this subject it will be necessary to have surpassed or to be enrolled in all the subjects of inferior courses.

Given the limitation of time for the "Thermodynamic Heat Transfer" course, it is highly recommended that students have completed the course Física II or that they have the equivalent background in thermodynamics

IMPORTANT NOTE: this is the english translation of the subject guide. In the event of any conflict between the English and Spanish versions, the Spanish version shall prevail.

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* educational Methodologies that keep
UNCHANGED

* educational Methodologies that modify
If the classroom attendance is suspended, the teaching methodologies (master class, seminars, problem classes, supervised work, presentations, etc.) will be carried out through the virtual means that the University of Vigo makes available to teachers to such an effect.

* Mechanism no face-to-face of attention to the students (tutoríals)
The attention to the students in tutorials will be carried out at fixed and published time of the tutorials but through an "appointment" managed by email. In this way the tutoring will be carried out through the virtual means that the University of Vigo proposes and enables the teaching staff for this purpose, see virtual office of the teacher in Campus Remoto

* Modifications (if they proceed) of the contents to give
UNCHANGED

* additional Bibliography to facilitate the car-learning

* Other modifications

=== ADAPTATION OF THE EVALUATION ===

In case to exist a situation of sanitary alarm and by part of the competent authority (sanitary administrations and the own institution of Rectorado) decree the no classroom attendance, is possible that splits of the educational contents evaluate by means of other tasks that will have a weight of 20%, what does that the evaluation of the course remain with the following percentages:

Tests "Examination of objective questions" -> 20%

Tests "Resolution of problems and/or exercises" -> 60%

"Additional Tasks" -> 20%