



## Teaching Guide

| Teaching Guide      |                                                                       |        |            |                                                      |
|---------------------|-----------------------------------------------------------------------|--------|------------|------------------------------------------------------|
| Identifying Data    |                                                                       |        |            | 2019/20                                              |
| 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<br>Lamas Galdo, Isabel                         |        | E-mail     | jose.ramon.calvo@udc.es<br>isabel.lamas.galdo@udc.es |
| Web                 | www.udc.es                                                            |        |            |                                                      |
| General description | Heat, work, and energy.                                               |        |            |                                                      |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                                                                                                                                            |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A7   | CR1 - Coñecementos de termodinámica aplicada e transmisión de calor. Principios básicos e a súa aplicación á resolución de problemas de enxeñaría.                                                                                                                                                                                     |
| B1   | CB01 - 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   | CB03 - 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   | CB05 - Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprenderen estudos posteriores cun alto grao de autonomía                                                                                                                                                                                     |
| B7   | B5 - Ser capaz de realizar unha análise crítica, avaliación e síntese de ideas novas e complexas                                                                                                                                                                                                                                       |
| B9   | B8 - 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   | C6 - Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.                                                                                                                                                                                                 |
| C6   | C8 - 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 |                            |          |
|--------------------------------------------------------------------------------------|-----------------------------|----------------------------|----------|
| Learn thermodynamics and heat transfer. Fundamentals and application to engineering. | A7                          | B1<br>B3<br>B5<br>B7<br>B9 | C4<br>C6 |

## Contents

| Topic | Sub-topic |
|-------|-----------|
|-------|-----------|



|                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The following blocks or chapters develop the contents established in the verification memory, which are: | Fundamentals<br>Energy and conservation of energy<br>Entropy<br>Exergy<br>Problems applied to engineering                                                                                                                                                                                                                                                                                                                      |
| 1. Introduction to thermodynamics                                                                        | Thermodynamics and energy<br>Systems and control volumes<br>Properties<br>States<br>Processes<br>Energy and enthalpy<br>Specific heat and thermal capacity<br>Phases<br>Ideal gases<br>Temperature and Zeroth Law of Thermodynamics<br>Density<br>Pressure                                                                                                                                                                     |
| 2. Work, energy and the 1st Law of Thermodynamics (conservation of energy)                               | Energy<br>Energy transfer by heat<br>Energy transfer by work<br>The First Law of Thermodynamics for closed systems, energy balance                                                                                                                                                                                                                                                                                             |
| 3. Propiedades de una sustancia pura                                                                     | Introduction<br>Phase-change processes of pure substances<br>Property diagrams<br>Property tables<br>Properties of incompressible substances<br>Properties of ideal gases<br>Reference states                                                                                                                                                                                                                                  |
| 4. Conservation of energy and 1st law of Thermodynamics                                                  | Introduction<br>Conservation of mass in control volumes<br>Conservation of energy in control volumes<br>Examples                                                                                                                                                                                                                                                                                                               |
| 5. 2nd Law of Thermodynamics and introduction to thermodynamic cycles                                    | Introduction<br>Thermal energy reservoirs<br>Thermodynamic cyclic devices: heat engines, refrigerators and heat pumps<br>Kelvin-Planck and Clausius statements for the Second Law of Thermodynamics<br>Maximum thermal efficiency of thermodynamic cyclic devices                                                                                                                                                              |
| 6. Entropy                                                                                               | A Clausius inequality<br>Entropy<br>Entropy tables<br>Entropy diagrams<br>Tds relations<br>Entropy change of thermal energy reservoirs<br>Entropy change of incompressible substances<br>Entropy change of ideal gases<br>Entropy generation<br>Isentropic processes<br>Entropy balance for closed systems and control volumes<br>Entropy of the universe<br>Isentropic efficiency of pumps, compressors, turbines and nozzles |



## Planning

| Methodologies / tests           | Competencies               | Ordinary class hours | Student?s personal work hours | Total hours |
|---------------------------------|----------------------------|----------------------|-------------------------------|-------------|
| ICT practicals                  | A7 B1 B3 B5 B7 B9<br>C4 C6 | 22                   | 44                            | 66          |
| Guest lecture / keynote speech  | A7 B1 B3 B5 B7 B9<br>C4 C6 | 21                   | 42                            | 63          |
| Introductory activities         | A7 B1 B3 B5 B7 B9<br>C6 C4 | 10                   | 0                             | 10          |
| Mixed objective/subjective test | A7 B1 B3 B5 B7 B9<br>C4 C6 | 4                    | 6                             | 10          |
| 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                  | Classes using computers           |
| Guest lecture / keynote speech  | Classes                           |
| Introductory activities         | Partial exam with initial aspects |
| Mixed objective/subjective test | Exam/s                            |

## Personalized attention

| Methodologies                   | Description                                                                                                |
|---------------------------------|------------------------------------------------------------------------------------------------------------|
| ICT practicals                  | Personal attention will be provided by tutorials and e-mail.                                               |
| Mixed objective/subjective test | Academic dispense is allowed. Students who request it must contact teacher to realize additional homework. |
| Introductory activities         |                                                                                                            |

## Assessment

| Methodologies                   | Competencies               | Description                          | Qualification |
|---------------------------------|----------------------------|--------------------------------------|---------------|
| ICT practicals                  | A7 B1 B3 B5 B7 B9<br>C4 C6 | Students may deliver some exercises. | 20            |
| Mixed objective/subjective test | A7 B1 B3 B5 B7 B9<br>C4 C6 | Exam/s.                              | 70            |
| Introductory activities         | A7 B1 B3 B5 B7 B9<br>C6 C4 | Partial exam with initial aspects.   | 10            |
| Others                          |                            |                                      |               |

## Assessment comments



## Students

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

The evaluation criteria of the 2nd opportunity are the same as those of the 1st opportunity except that, in case of partial exams, the mark obtained in these will not be taken into account in the 2nd opportunity.

In order to pass it is necessary to obtain at least 4 in the final exam and 5 in the global score.

## Sources of information

|       |                                                                                       |
|-------|---------------------------------------------------------------------------------------|
| Basic | - J. M <sup>a</sup> Sáiz Jabardo (). Introducción a la Termodinámica.                 |
|       | - M. Moran y H. N Shapiro (). Fundamentos de Termodinámica Técnica. John Wiley & Sons |
|       | - Y. A. Çengel; M. A. Boles. (). Thermodynamics. McGraw-Hill                          |
|       | - Y. A. Çengel (). Ecuaciones Diferenciales para Ingeniería y Ciencias. 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.

5/5