



| Teaching Guide      |                                                                       |        |                                                    |           |
|---------------------|-----------------------------------------------------------------------|--------|----------------------------------------------------|-----------|
| Identifying Data    |                                                                       |        |                                                    | 2023/24   |
| Subject (*)         | TERMODINÁMICA                                                         |        | Code                                               | 730G04014 |
| Study programme     | Grao en Enxeñaría en Tecnoloxías Industriais                          |        |                                                    |           |
| Descriptors         |                                                                       |        |                                                    |           |
| Cycle               | Period                                                                | Year   | Type                                               | Credits   |
| Graduate            | 1st four-month period                                                 | Second | Obligatory                                         | 6         |
| Language            | SpanishGalicianEnglish                                                |        |                                                    |           |
| Teaching method     | Face-to-face                                                          |        |                                                    |           |
| Prerequisites       |                                                                       |        |                                                    |           |
| Department          | Ciencias da Navegación e Enxeñaría MariñaEnxeñaría Naval e Industrial |        |                                                    |           |
| Coordinador         |                                                                       | E-mail |                                                    |           |
| Lecturers           | Cartelle Barros, Juan José<br>Lamas Galdo, Isabel                     | E-mail | juan.cartelle1@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                          | CB1 Que os estudantes demostren 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                          | CB3 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                          | CB5 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 |    |
| Coñecementos de termodinámica aplicada e transmisión de calor. Principios básicos e a súa aplicación á resolución de problemas de enxeñaría. |  | A7                          | B1 |
|                                                                                                                                              |  |                             | B3 |
|                                                                                                                                              |  |                             | B5 |
|                                                                                                                                              |  |                             | B7 |
|                                                                                                                                              |  |                             | B9 |
|                                                                                                                                              |  |                             | C4 |
|                                                                                                                                              |  |                             | 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. Thermodynamic cycles and introduction to the 2nd law of thermodynamics                                | 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                                                                                               | 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 |
| Guest lecture / keynote speech                                                                                                  | A7 B1 B3 B5 B7 B9<br>C4 C6 | 28                   | 36                            | 64          |
| Mixed objective/subjective test                                                                                                 | A7 B1 B3 B5 B7 B9<br>C4 C6 | 4                    | 6                             | 10          |
| ICT practicals                                                                                                                  | A7 B1 B3 B5 B7 B9<br>C4 C6 | 28                   | 47                            | 75          |
| 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 |
| Guest lecture / keynote speech  | Classes     |
| Mixed objective/subjective test | Exam        |
| ICT practicals                  | Software    |

| Personalized attention                            |                                                                                                                                                                                               |
|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                                     | Description                                                                                                                                                                                   |
| Mixed objective/subjective test<br>ICT practicals | Attention will be provided by personalized attention, tutorials and e-mail.<br><br>Academic dispense is allowed. Students who request it must contact teacher to realize additional homework. |

| Assessment                      |                            |                                 |               |
|---------------------------------|----------------------------|---------------------------------|---------------|
| Methodologies                   | Competencies               | Description                     | Qualification |
| Mixed objective/subjective test | A7 B1 B3 B5 B7 B9<br>C4 C6 | Exam                            | 70            |
| ICT practicals                  | A7 B1 B3 B5 B7 B9<br>C4 C6 | Each exercise will have a score | 30            |
| Others                          |                            |                                 |               |

| Assessment comments                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Students who request academic dispense will be evaluated as the other students.</p> <p>The evaluation criteria of the 2nd and extra opportunity are the same as those of the 1st opportunity.</p> <p>In order to pass it is necessary to obtain at least 4 in the final exam and 5 in the global score.</p> |

| Sources of information |                                                                                                                                                                                                                                                                                                                               |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Basic                  | <ul style="list-style-type: none"> <li>- Y. A. Çengel; M. A. Boles. (). Thermodynamics. McGraw-Hill</li> <li>- M. Moran y H. N Shapiro (). Fundamentos de Termodinámica Técnica. Reverte</li> <li>- J. Mª Sáiz Jabardo (). Introducción a la Termodinámica. Servicio de Publicaciones de la Universidade da Coruña</li> </ul> |



|               |  |
|---------------|--|
| Complementary |  |
|---------------|--|

## Recommendations

### Subjects that it is recommended to have taken before

CÁLCULO/730G04001

FÍSICA II/730G04009

### Subjects that are recommended to be taken simultaneously

ECUACIÓNS DIFERENCIAIS/730G04011

### Subjects that continue the syllabus

Industrial Heat Transfer/730G04020

Fluid and Thermal Machines/730G04023

## Other comments

To help achieve an immediate sustainable environment and fulfill the objective of action number 5: "Healthy and sustainable environmental and social education and research" of the "Ferrol Green Campus Action Plan": The delivery of the documentary work done in this matter:- It will be requested in virtual format and/or computer support- It will be done through Moodle, in digital format without the need to print- If it is necessary to do them on paper: Plastics will not be used. Double sided printing will be done. Recycled paper will be used. Printing drafts will be avoided.- The sustainable use of resources and prevention of negative impacts on the natural environment must be carried out- The importance of ethical principles related to sustainability values ?? in personal and professional behavior must be taken into account- The gender perspective is incorporated into the teaching of this subject (non-sexist language will be used, the bibliography of authors of both sexes will be used, the intervention of students in class will be encouraged...)- Work will be carried out to identify and modify prejudices and sexist attitudes and the environment will be influenced to modify and promote values ?? of respect and equality.- Situations of discrimination must be detected and actions and measures will be proposed to correct them.- The full integration of students who, for physical, sensory, psychological or socio-cultural reasons, experience difficulties in accessing appropriate, equal and profitable university life will be facilitated. As stated in the different application regulations for university teaching, the gender perspective must be incorporated in this subject (non-sexist language will be used, bibliography by authors of both sexes will be used, male and female students will be encouraged to participate in class...). Work will be done to identify and modify prejudices and sexist attitudes and influence the environment to modify them and promote values ?? of respect and equality. Situations of discrimination based on gender must be detected and actions and measures will be proposed to correct them. In accordance with art.11.4.c of the UDC Student Disciplinary Regulations, in the event of plagiarism in the exam or evaluation test, the grade will be suspended in the call in which the offense is committed: the student will be graded with "Failed" (numerical grade 0) in the corresponding call of the academic year, whether the commission of the offense occurs on the first opportunity or on the second. For this, their qualification in the minutes will be modified, if necessary.

(\*)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.