



| Teaching Guide      |   |        |  |           |  |  |
|---------------------|---|--------|--|-----------|--|--|
| Identifying Data    |   |        |  | 2022/23   |  |  |
| 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            | SpanishGalicianEnglish  |        |  |           |  |  |
| Teaching method     | Face-to-face  |        |  |           |  |  |
| Prerequisites       |   |        |  |           |  |  |
| Department          | Ciencias da Navegación e Enxeñaría MariñaEnxeñaría Naval e Industrial |        |  |           |  |  |
| Coordinador         | Lamas Galdo, Isabel   | E-mail | isabel.lamas.galdo@udc.es                          |           |  |  |
| 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                          | CB01 - 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 vanguarda 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 aquellas 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 vanguarda do coñecemento   |
| C4                          | C6 - Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrentarse.  |
| 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 application to engineering. |  |  | A7    B1    C4<br>B3    C6<br>B5<br>B7<br>B9 |

| 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. Properties of pure substances   | 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   | AClausius 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 | 28                   | 48                            | 76          |
| Guest lecture / keynote speech  | A7 B1 B3 B5 B7 B9<br>C4 C6 | 28                   | 35                            | 63          |
| 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                  | Software    |
| Guest lecture / keynote speech  | Classes     |
| Mixed objective/subjective test | Exam/s      |

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

| Assessment                      |                            |                                      |               |
|---------------------------------|----------------------------|--------------------------------------|---------------|
| Methodologies                   | Competencies               | Description                          | Qualification |
| ICT practicals                  | A7 B1 B3 B5 B7 B9<br>C4 C6 | Students may deliver some exercises. | 30            |
| Mixed objective/subjective test | A7 B1 B3 B5 B7 B9<br>C4 C6 | Exam/s.                              | 70            |
| Others                          |                            |                                      |               |

| Assessment comments  |  |
|--|--|
| Students   |  |
| who request academic dispense will be evaluated as the other students.                                 |  |
| The evaluation criteria of the 2nd and extra opportunity are the same as those of the 1st 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                  | <ul style="list-style-type: none"> <li>- J. Mª Sáiz Jabardo (). Introducción a la Termodinámica.</li> <li>- M. Moran y H. N Shapiro (). Fundamentos de Termodinámica Técnica. John Wiley &amp; Sons</li> <li>- Y. A. Çengel; M. A. Boles. (). Thermodynamics. McGraw-Hill</li> <li>- Y. A. Cengel (). Ecuaciones Diferenciales para Ingeniería y Ciencias. McGraw-Hill</li> </ul> |
| 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



To help achieve a sustained immediate environment and meet the objective of action number 5:

"Healthy and sustainable environmental and social teaching and research" of the "Green Campus Ferrol Action Plan":

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Will be requested in virtual format and / or computer support

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It will be done through Moodle, in digital format without the need to print

them

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If it is necessary to make them on paper:

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Plastics will not be used

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Double-sided prints will be made.

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Recycled paper will be used.

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Printing of drafts will be avoided.

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A sustainable use of resources and the prevention of negative impacts on the

natural environment must be made

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The importance of ethical principles related to the values ??of sustainability in personal and professional behaviors must be taken into account

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Gender perspective is incorporated into the teaching of this subject

(non-sexist language will be used, bibliography of authors of both sexes will

be used, intervention in class of students will be encouraged ...)

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Work will be done to identify and modify prejudices and sexist attitudes, and

the environment will be influenced to modify them and promote values ??of respect and equality.

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Discrimination situations must be detected and actions and measures will be

proposed to correct them.

(\* )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.