



## Teaching Guide

| Teaching Guide           |                                                                                                                                                                                                                                                                                                                                                          |        |                     |           |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|---------------------|-----------|
| Identifying Data         |                                                                                                                                                                                                                                                                                                                                                          |        |                     | 2020/21   |
| Subject (*)              | Thermal Engineering                                                                                                                                                                                                                                                                                                                                      |        | Code                | 730497205 |
| Study programme          | Mestrado Universitario en Enxeñaría Industrial (plan 2018)                                                                                                                                                                                                                                                                                               |        |                     |           |
| Descriptors              |                                                                                                                                                                                                                                                                                                                                                          |        |                     |           |
| Cycle                    | Period                                                                                                                                                                                                                                                                                                                                                   | Year   | Type                | Credits   |
| Official Master's Degree | 1st four-month period                                                                                                                                                                                                                                                                                                                                    | First  | Optional            | 4.5       |
| Language                 | Spanish                                                                                                                                                                                                                                                                                                                                                  |        |                     |           |
| Teaching method          | Face-to-face                                                                                                                                                                                                                                                                                                                                             |        |                     |           |
| Prerequisites            |                                                                                                                                                                                                                                                                                                                                                          |        |                     |           |
| Department               | Ciencias da Navegación e Enxeñaría MariñaEnxeñaría Naval e Industrial                                                                                                                                                                                                                                                                                    |        |                     |           |
| Coordinador              | Arce Ceinos, Alberto                                                                                                                                                                                                                                                                                                                                     | E-mail | alberto.arce@udc.es |           |
| Lecturers                | Arce Ceinos, Alberto                                                                                                                                                                                                                                                                                                                                     | E-mail | alberto.arce@udc.es |           |
| Web                      |                                                                                                                                                                                                                                                                                                                                                          |        |                     |           |
| General description      | This subject provides a fundamental approach for designing thermal systems in industrial processes and termal enviroments for people in buildings. Specific topics include refigeration cycles and systems, psychrometric principles, processes and applications, heating and cooling loads in buildings, themal confort, and air quality.               |        |                     |           |
| Contingency plan         | 1. Modifications to the contents<br><br>2. Methodologies<br>*Teaching methodologies that are maintained<br><br>*Teaching methodologies that are modified<br><br>3. Mechanisms for personalized attention to students<br><br>4. Modifications in the evaluation<br><br>*Evaluation observations:<br><br>5. Modifications to the bibliography or webgraphy |        |                     |           |

## Study programme competences / results

| Code | Study programme competences / results                                                                                                                                                                                                                                               |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A4   | ETI4 - Capacity for the analysis and design of chemical processes.                                                                                                                                                                                                                  |
| A5   | ETI5 - Knowledge and skills for the design and analysis of machines and thermal engines, hydraulic machines and industrial installations of heat and cold.                                                                                                                          |
| B2   | CB7 - That students know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.                                                                   |
| B3   | CB8 - That students are able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments. |
| B5   | CB10 - That students have the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.                                                                                                                                       |
| B6   | G1 - Have adequate knowledge of the scientific and technological aspects in Industrial Engineering.                                                                                                                                                                                 |
| B7   | G2 - Project, calculate and design products, processes, facilities and plants.                                                                                                                                                                                                      |
| B13  | G8 - Apply the knowledge acquired and solve problems in new or unfamiliar environments within broader and multidisciplinary contexts.                                                                                                                                               |
| B14  | G9 - Be able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments.                     |
| B16  | G11 - Possess the learning skills that allow to continue studying in a self-directed or autonomous way.                                                                                                                                                                             |



|     |                                                                                                                                                                                                                                           |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C1  | ABET (a) - An ability to apply knowledge of mathematics, science, and engineering.                                                                                                                                                        |
| C3  | ABET (c) - An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. |
| C5  | ABET (e) - An ability to identify, formulate, and solve engineering problems.                                                                                                                                                             |
| C6  | ABET (f) - An understanding of professional and ethical responsibility.                                                                                                                                                                   |
| C8  | ABET (h) - The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.                                                                                    |
| C9  | ABET (i) - A recognition of the need for, and an ability to engage in life-long learning.                                                                                                                                                 |
| C11 | ABET (k) - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.                                                                                                                     |

| Learning outcomes                                                                                                                                                                                                                                                                               |  |                                       |           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------------------------|-----------|
| Learning outcomes                                                                                                                                                                                                                                                                               |  | Study programme competences / results |           |
| A materia ten por obxectivo proporcionar unha formación xeral, aunque de suficiente profundidade e complementar a adquirida polos alumnos dos graos en aspectos relacionados co deseño e análise de máquinas e motores térmicos, máquinas hidráulicas e instalacións de calor e frío industrial |  | AJ4                                   | BJ2 CJ1   |
|                                                                                                                                                                                                                                                                                                 |  | AJ5                                   | BJ3 CJ3   |
|                                                                                                                                                                                                                                                                                                 |  |                                       | BJ5 CJ5   |
|                                                                                                                                                                                                                                                                                                 |  |                                       | BJ6 CJ6   |
|                                                                                                                                                                                                                                                                                                 |  |                                       | BJ7 CJ8   |
|                                                                                                                                                                                                                                                                                                 |  |                                       | BJ13 CJ9  |
|                                                                                                                                                                                                                                                                                                 |  |                                       | BJ14 CJ11 |
|                                                                                                                                                                                                                                                                                                 |  |                                       | BJ16      |

| Contents                                                                                                |                                                                                                                                |
|---------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Topic                                                                                                   | Sub-topic                                                                                                                      |
| 0 Os temas seguintes desenrolan os contidos establecidos nas fichas da Memoria de Verificación que son: | Deseño e análise de:<br>- Máquinas e motores térmicos.<br>- Máquinas hidráulicas.<br>- Instalacións de calor e frío industrial |
| 1 Thermodynamic and heat transfer revision                                                              | Termodinámica<br>Transferencia de calor                                                                                        |
| 2 Introduction to the exergy analysis of thermal systems                                                | Balance de exergía<br>Sistemas abertos                                                                                         |
| 3 Heat exchangers                                                                                       | 3.1 Design<br>3.2 Simulation                                                                                                   |
| 4 Fundamentals of psicrometry and applications                                                          | 4.1 Drying<br>4.2 Comfort and air conditioning                                                                                 |
| 5 Refrigeration systems                                                                                 | Refrigerantes<br>Ciclo de compresión de calor<br>Coeficiente de rendemento<br>Bomba de calor                                   |
| 6 Air and vapor motor cycles                                                                            | Ciclo Rankine<br>Ciclo Brayton                                                                                                 |
| 7 Introduction to optimization techniques and simulation of thermal systems                             | Optimización<br>Simulación                                                                                                     |

| Planning              |                        |                                      |                               |             |
|-----------------------|------------------------|--------------------------------------|-------------------------------|-------------|
| Methodologies / tests | Competencies / Results | Teaching hours (in-person & virtual) | Student's personal work hours | Total hours |



|                                                                                                                                 |                                                              |    |      |      |
|---------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|----|------|------|
| Guest lecture / keynote speech                                                                                                  | A4 A5 B2 B3 B5 B13<br>B14 B16 B7 B6 C1<br>C3 C5 C6 C8 C9 C11 | 10 | 25.5 | 35.5 |
| Problem solving                                                                                                                 | A4 A5 B2 B3 B5 B13<br>B14 B16 B7 B6 C1<br>C3 C5 C6 C8 C9 C11 | 17 | 56   | 73   |
| Objective test                                                                                                                  | A4 A5 B2 B3 B5 B13<br>B14 B16 B7 B6 C1<br>C3 C5 C6 C8 C9 C11 | 3  | 0    | 3    |
| 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 | Oral presentation audiovisually aided and the introduction of questions with the aim of transmitting knowledge and assisting the learning.                                                                                                                                                                                                                                                                           |
| Problem solving                | Oral presentation audiovisually aided and the introduction of questions with the aim of transmitting knowledge and assisting the learning.                                                                                                                                                                                                                                                                           |
| Objective test                 | Proba escrita utilizada para a avaliación da aprendizaxe, cuxo trazo distintivo é a posibilidade de determinar se as respostas dadas son ou non correctas. Constitúe un instrumento de medida, elaborado rigorosamente, que permite avaliar coñecementos, capacidades, destrezas, rendemento, aptitudes, actitudes, intelixencia, etc. É de aplicación tanto para a avaliación diagnóstica, formativa como sumativa. |

| Personalized attention                            |                               |
|---------------------------------------------------|-------------------------------|
| Methodologies                                     | Description                   |
| Guest lecture / keynote speech<br>Problem solving | Tutoring and email assistance |

| Assessment      |                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                      |               |
|-----------------|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Methodologies   | Competencies / Results                                       | Description                                                                                                                                                                                                                                                                                                                                                                                                          | Qualification |
| Objective test  | A4 A5 B2 B3 B5 B13<br>B14 B16 B7 B6 C1<br>C3 C5 C6 C8 C9 C11 | Proba escrita utilizada para a avaliación da aprendizaxe, cuxo trazo distintivo é a posibilidade de determinar se as respostas dadas son ou non correctas. Constitúe un instrumento de medida, elaborado rigorosamente, que permite avaliar coñecementos, capacidades, destrezas, rendemento, aptitudes, actitudes, intelixencia, etc. É de aplicación tanto para a avaliación diagnóstica, formativa como sumativa. | 70            |
| Problem solving | A4 A5 B2 B3 B5 B13<br>B14 B16 B7 B6 C1<br>C3 C5 C6 C8 C9 C11 | Exam                                                                                                                                                                                                                                                                                                                                                                                                                 | 30            |

| Assessment comments |
|---------------------|
|---------------------|



Exam:

100% of the qualification

210 min

Consists on solving 3 or 4 problems similar to those proposed in each chapter. The use of textbook and solved exercises could be allowed during the exam.

## Sources of information

|                      |                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"><li>- Incropera, F. P. y DeWitt, D. P. (). Fundamentos de transferencia de calor.</li><li>- Moran y Shapiro (). Fundamentos de termodinámica técnica.</li><li>- Stoecker y Jones (). Refrigeration and air conditioning.</li><li>- Eastop &amp; Maconky (). Applied thermodynamics for Engineering and Technologists.</li></ul> |
| <b>Complementary</b> |                                                                                                                                                                                                                                                                                                                                                                   |

## Recommendations

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

### Subjects that are recommended to be taken simultaneously

### Subjects that continue the syllabus

Final Year Dissertation /730497219

## Other comments

?Para ayudar a conseguir un entorno inmediato sostenido y cumplir con el objetivo de la acción número 5: ?Docencia e investigación saludable y sustentable ambiental y social? del "Plan de Acción Green Campus Ferrol":

La entrega de los trabajos documentales que se realicen en esta materia:

? Se solicitarán en formato virtual y/o soporte informático

? Se realizará a través de Moodle, en formato digital sin necesidad de imprimirlos

? En caso de ser necesario realizarlos en papel:

- No se emplearán plásticos
- Se realizarán impresiones a doble cara.
- Se empleará papel reciclado.
- Se evitará la impresión de borradores.

? Se debe de hacer un uso sostenible de los recursos y la prevención de impactos negativos sobre el medio natural

? Se debe tener en cuenta la importancia de los principios éticos relacionados con los valores de la sostenibilidad en los comportamientos personales y profesionales

? Se incorpora perspectiva de género en la docencia de esta materia (se usará lenguaje no sexista, se utilizará bibliografía de autores de ambos sexos, se propiciará la intervención en clase de alumnos y alumnas?)

? Se trabajará para identificar y modificar prejuicios y actitudes sexistas, y se influirá en el entorno para modificarlos y fomentar valores de respeto e igualdad.

? Se deberán detectar situaciones de discriminación y se propondrán acciones y medidas para corregirlas.

(\*)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.