



## Teaching Guide

| Teaching Guide      |                                                                                                                                                                                                             |        |                             |           |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------------|-----------|
| Identifying Data    |                                                                                                                                                                                                             |        |                             | 2017/18   |
| Subject (*)         | Power Stations                                                                                                                                                                                              |        | Code                        | 770G02024 |
| Study programme     | Grao en Enxeñaría Eléctrica                                                                                                                                                                                 |        |                             |           |
| Descriptors         |                                                                                                                                                                                                             |        |                             |           |
| Cycle               | Period                                                                                                                                                                                                      | Year   | Type                        | Credits   |
| Graduate            | 1st four-month period                                                                                                                                                                                       | Third  | Obligatoria                 | 6         |
| Language            | Spanish                                                                                                                                                                                                     |        |                             |           |
| Teaching method     | Face-to-face                                                                                                                                                                                                |        |                             |           |
| Prerequisites       |                                                                                                                                                                                                             |        |                             |           |
| Department          | Enxeñaría Industrial                                                                                                                                                                                        |        |                             |           |
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| Lecturers           | Casteleiro Roca, José Luis                                                                                                                                                                                  | E-mail | jose.luis.casteleiro@udc.es |           |
| Web                 |                                                                                                                                                                                                             |        |                             |           |
| General description | This subject aims to give students theoretical knowledge of various types of the power stations, and its operation ways, in order to achieve the necessary knowledge for their manage, analysis and design. |        |                             |           |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                        |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1   | Capacidade para planificar, presupostar, organizar, dirixir e controlar tarefas, persoas e recursos.                                                                                                               |
| A2   | Capacidade para a redacción, firma, desenvolvemento e dirección de proxectos no ámbito da enxeñaría industrial, e en concreto da especialidade de electricidade.                                                   |
| A4   | Capacidade de xestión da información, manexo e aplicación das especificacións técnicas e da lexislación necesarias no exercicio da profesión.                                                                      |
| A5   | Capacidade para analizar e valorar o impacto social e medioambiental das solucións técnicas actuando con ética, responsabilidade profesional e compromiso social, e buscando sempre a calidade e mellora continua. |
| A32  | Capacidade para o deseño de centrais eléctricas.                                                                                                                                                                   |
| B1   | Capacidade de resolver problemas con iniciativa, toma de decisións, creatividade e razoamento crítico.                                                                                                             |
| B2   | Capacidade de comunicar e transmitir coñecementos, habilidades e destrezas no campo da enxeñaría industrial.                                                                                                       |
| B4   | Capacidade de traballar e aprender de forma autónoma e con iniciativa.                                                                                                                                             |
| B5   | Capacidade para empregar as técnicas, habilidades e ferramentas da enxeñaría necesarias para a práctica desta.                                                                                                     |
| C6   | Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.                                                                                  |

## Learning outcomes

| Learning outcomes                                                                               | Study programme competences |          |    |
|-------------------------------------------------------------------------------------------------|-----------------------------|----------|----|
| Knowing the different energy systems that can be used in power stations                         | A1<br>A4                    | B1       |    |
| Understanding the processes of power generation from traditional energy sources                 | A2<br>A5                    | B4       | C6 |
| Knowing the selection and resize of the elements of the generation system of the power stations | A1<br>A5<br>A32             | B1<br>B5 |    |
| Knowing the selection and resize of the auxiliary systems of the power stations                 | A5<br>A32                   | B1<br>B5 |    |
| Knowing the principles of operation of the electricity market                                   | A4                          | B2       |    |
| Knowing the principles of operation of energy markets                                           | A4                          | B2       |    |

## Contents

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



|                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic 1: Electric energy and sustainable development -<br>Environmental impact and more efficient technologies<br>electricity production | <ul style="list-style-type: none"><li>1.1. Introduction to sustainable development</li><li>1.2. CO2 emission costs</li><li>1.3. Combustion processes</li><li>1.4. Environmental impact of different technologies</li><li>1.5. Techniques improved efficiency</li><li>1.6. New technologies of coal use</li><li>1.7. Technology coal gasification</li><li>1.8. CO2 capture and storage</li></ul>                                                                                                                   |
| Topic 2: Energy resources and electricity production -<br>Coverage of the electricity demand                                             | <ul style="list-style-type: none"><li>2.1. Reservations and energy resources</li><li>2.2. Classification and types of power plants</li><li>2.3. Study of different types of primary energy sources</li><li>2.4. Study of the electricity demand</li><li>2.5. Power System configuration</li><li>2.6. Configuration and operation of the Spanish electricity market</li><li>2.7. Rates, prices and costs of electricity</li><li>2.8. Generation scheduling</li><li>2.9. Parameters related to production</li></ul> |
| Topic 3: Coal power plants                                                                                                               | <ul style="list-style-type: none"><li>3.1. Water-steam circuit. Steam turbines</li><li>3.2. Air-gas circuit</li><li>3.3. Fuel-ash circuit</li><li>3.4. Cooling water circuit</li><li>3.5. Regulation of the power station</li></ul>                                                                                                                                                                                                                                                                               |
| Topic 4: Nuclear power plants                                                                                                            | <ul style="list-style-type: none"><li>4.1. Nuclear fission</li><li>4.2. Elements of a nuclear reactor</li><li>4.3. Nuclear reactor control</li><li>4.4. Types of nuclear reactors</li></ul>                                                                                                                                                                                                                                                                                                                       |



|                                                              |                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic 5: Wiring diagrams. Auxiliary services                 | <p>5.1. Study of different electrical diagrams</p> <p>5.2. Auxiliary services of the power stations. Energy consumption</p> <p>5.3. Reserve supply</p>                                                                                                                                                     |
| Topic 6: Gas power plants. Combined cycle. cogeneration      | <p>6.1. Brayton thermodynamic cycle</p> <p>6.2. Gas turbines. Components</p> <p>6.3. Otto-Diesel thermodynamic cycle</p> <p>6.4. Internal combustion engines</p> <p>6.5. Combined cycle. Heat Recovery Steam Generator</p> <p>6.6. Regulation and control of a combined cycle</p> <p>6.7. Cogeneration</p> |
| Topic 7: Conventional and pumping hydroelectric plants       | <p>7.1. Description of the components of a hydroelectric plant</p> <p>7.2. Hydraulic turbines. Control and regulation</p> <p>7.3. Reversible hydroelectric power plants. Types</p>                                                                                                                         |
| Topic 8: Introduction to power plants with renewable sources | Wind, thermal, photovoltaic, biomass, marine, geothermal and mini hydro power stations                                                                                                                                                                                                                     |

| Planning                                                                                                                        |                       |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies          | Ordinary class hours | Student's personal work hours | Total hours |
| Guest lecture / keynote speech                                                                                                  | A2 A4 A5 A32 B2 B4    | 31                   | 40                            | 71          |
| Problem solving                                                                                                                 | A4 A32 B1 B5 C6       | 20                   | 16                            | 36          |
| Supervised projects                                                                                                             | A1 A4 A32 B1 B2 B4 C6 | 0                    | 20                            | 20          |
| Objective test                                                                                                                  | A4 A5 A32 B1 B5       | 3                    | 15                            | 18          |
| Personalized attention                                                                                                          |                       | 5                    | 0                             | 5           |
| (*)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 | <p>Keynote speech complemented with the use of audiovisual media and the introduction of some questions to students, in order to transmit knowledge and facilitate learning.</p> <p>The order of the topics covered will not have to be the one described in the teaching guide. In addition, there will be topics that can be seen together on the development of others, and the division between them may not be strict.</p> |
| Problem solving                | Solving exercises and specific problems in the classroom, from the knowledge explained.                                                                                                                                                                                                                                                                                                                                         |
| Supervised projects            | Performing a bulletin individual character problems, similar to those solved in the classroom exercises. In addition, within the supervised projects can include a small work of specific subjects of the assignment to ensure the correct understanding of the subject.                                                                                                                                                        |
| Objective test                 | It consists in carrying out an objective test of approximately 3 hours, in which the acquired knowledge will be evaluated.                                                                                                                                                                                                                                                                                                      |

| Personalized attention |
|------------------------|
|------------------------|



| Methodologies       | Description                                                                                                                                                 |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Problem solving     | The student has the relevant meetings of personalized tutorials, to resolve the concerns arising from the matter.                                           |
| Supervised projects | The realization of the problems set is individual, and each student may attend the tutoring sessions it deems appropriate to resolve the doubts that arise. |

| Assessment          |                          |                                                                                 |               |
|---------------------|--------------------------|---------------------------------------------------------------------------------|---------------|
| Methodologies       | Competencies             | Description                                                                     | Qualification |
| Objective test      | A4 A5 A32 B1 B5          | Exam type objective test                                                        | 75            |
| Supervised projects | A1 A4 A32 B1 B2 B4<br>C6 | Some tasks established in the subject, within the framework of this methodology | 25            |

| Assessment comments                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| As part of the "Supervised projects" may include aspects such as attendance, personal work, proposed personal work, attitude, etc., to help to pass the subject.                                                                   |
| The "Objective test" will be divided into a theoretical and practical part. The grade obtained by the student with the "Supervised projects" will be weighted with the mark obtained in the practical part of the "Objective test" |
| It is necessary to exceed 50% of the score in the theoretical part of the "Objective test" to approve, as well as having made and approved the work proposed in the "Supervised projects".                                         |

| Sources of information                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b> <ul style="list-style-type: none"> <li>- Sanz Feito, J. (1990). Centrales Eléctricas. UPM</li> <li>- Orille Fernández, Á. L. (1993). Centrales Eléctricas I, II y III. UPC</li> <li>- Barrero, F. (2004). Sistemas de energía eléctrica. Thomson</li> <li>- Sabugal García, S. (2006). Centrales térmicas de ciclo combinado: teoría y proyecto. Díaz de Santos</li> <li>- Rojas Rodríguez, S. (1997). Centrales hidroeléctricas teoría y problemas. UNEX</li> </ul> |
| <b>Complementary</b> <ul style="list-style-type: none"> <li>- Gómez Expósito, A. (2003). Sistemas eléctricos de potencia problemas y ejercicios resueltos. Prentice Hall</li> <li>- Lapuerta Amigo, M. (1998). Tecnologías de la combustión. Universidad de Castilla-La Mancha</li> <li>- García Ybarra, P. L. (2001). Tecnologías energéticas e impacto ambiental. McGraw-Hill</li> </ul>                                                                                        |

| Recommendations                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Subjects that it is recommended to have taken before                                                                                                                                                                                                                                |
| Termodinámica/770G02012<br>Mecánica de Fluidos/770G02016                                                                                                                                                                                                                            |
| Subjects that are recommended to be taken simultaneously                                                                                                                                                                                                                            |
| Subjects that continue the syllabus                                                                                                                                                                                                                                                 |
| Installations of Renewable Energies/770G02033<br>Acquisition techniques of electrical measurements/770G02030<br>Efficient management of electric power/770G02040<br>Industrial Maintenance/770G02041<br>Industrial Instrumentation/770G02042<br>Industrial Communications/770G02043 |
| Other comments                                                                                                                                                                                                                                                                      |
|                                                                                                                                                                                                                                                                                     |



(\*)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.