



## Teaching Guide

| Teaching Guide      |                                                                                                                                                                                                                                                                                                                                                              |       |          |                                          |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------|------------------------------------------|
| Identifying Data    |                                                                                                                                                                                                                                                                                                                                                              |       |          | 2019/20                                  |
| Subject (*)         | Thermal Marine Machinery                                                                                                                                                                                                                                                                                                                                     |       | Code     | 631G02361                                |
| Study programme     | Grao en Tecnoloxías Mariñas                                                                                                                                                                                                                                                                                                                                  |       |          |                                          |
| Descriptors         |                                                                                                                                                                                                                                                                                                                                                              |       |          |                                          |
| Cycle               | Period                                                                                                                                                                                                                                                                                                                                                       | Year  | Type     | Credits                                  |
| Graduate            | 1st four-month period                                                                                                                                                                                                                                                                                                                                        | Third | Optional | 6                                        |
| Language            | SpanishGalician                                                                                                                                                                                                                                                                                                                                              |       |          |                                          |
| Teaching method     | Face-to-face                                                                                                                                                                                                                                                                                                                                                 |       |          |                                          |
| Prerequisites       |                                                                                                                                                                                                                                                                                                                                                              |       |          |                                          |
| Department          | Ciencias da Navegación e Enxeñaría Mariña                                                                                                                                                                                                                                                                                                                    |       |          |                                          |
| Coordinador         | Costa Rial, Ángel Martín                                                                                                                                                                                                                                                                                                                                     |       | E-mail   | angel.costa@udc.es                       |
| Lecturers           | Costa Rial, Ángel Martín<br>Rodriguez Fernandez, Angel A.                                                                                                                                                                                                                                                                                                    |       | E-mail   | angel.costa@udc.es<br>a.rodriguez@udc.es |
| Web                 |                                                                                                                                                                                                                                                                                                                                                              |       |          |                                          |
| General description | Taking into account that this is a core subject, it is intended that the student acquire the necessary and sufficient theoretical and practical knowledge, leading to the attainment of the academic title that he/she intends; and in the exercise of his profession, he/she can solve all the questions that arise in the field of marine thermal engines. |       |          |                                          |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                                     |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1   | CE1 - Capacidade para a realización de inspeccións, medicións, valoracións, taxacións, peritacións, estudos, informes, planos de labores e certificacións nas instalacións do ámbito da súa especialidade.                      |
| A11  | CE11 - Observar prácticas de seguridade no traballo, no ámbito da súa especialidade.                                                                                                                                            |
| A17  | CE17 - Modelizar situacións e resolver problemas con técnicas ou ferramentas físico-matemáticas.                                                                                                                                |
| A18  | CE18 - Redacción e interpretación de documentación técnica.                                                                                                                                                                     |
| A69  | CE59 - Manter e reparar os sistemas de control automático da máquina propulsora principal e das máquinas auxiliares                                                                                                             |
| B2   | CT2 - Resolver problemas de forma efectiva.                                                                                                                                                                                     |
| B4   | CT4 - Traballar de forma autónoma con iniciativa.                                                                                                                                                                               |
| B5   | CT5 - Traballar de forma colaboradora.                                                                                                                                                                                          |
| B10  | CT10 - Comunicar por escrito e oralmente os coñecementos procedentes da linguaxe científica.                                                                                                                                    |
| B11  | CT11 - Capacidade para resolver problemas con iniciativa, toma de decisións, creatividade, razoamento crítico e de comunicar e transmitir coñecementos habilidades e destrezas.                                                 |
| C3   | C3 - Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.                                            |
| C6   | C6 - Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.                                                                                          |
| C8   | C8 - Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.                                                                              |
| C10  | CB2 - Aplicar os coñecementos no seu traballo ou vocación dunha forma profesional e poseer competencias demostrables por medio da elaboración e defensa de argumentos e resolución de problemas dentro da área dos seus estudos |
| C12  | CB4 - Poder transmitir información, ideas, problemas e solucións a un público tanto especializado como non especializado.                                                                                                       |
| C13  | CB5 - Ter desenvolvido aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores con un alto grao de autonomía.                                                                                          |

## Learning outcomes

| Learning outcomes | Study programme competences |
|-------------------|-----------------------------|
|-------------------|-----------------------------|



|                                                                                                                |                  |                       |                        |
|----------------------------------------------------------------------------------------------------------------|------------------|-----------------------|------------------------|
| Perform energy balances of thermal engines, and make decisions from the point of view of energy optimization.  | A1<br>A17        | B2<br>B4<br>B5<br>B11 | C3<br>C6<br>C8         |
| Analysis of the thermodynamic processes that take place in thermal engines.                                    | A1<br>A17<br>A18 | B2<br>B10<br>B11      | C3<br>C6<br>C8<br>C10  |
| Operation, repair and maintenance of thermal engines, and auxiliary equipment thereof.                         | A1<br>A11<br>A18 | B2<br>B11             | C3<br>C6<br>C10<br>C12 |
| Calculation of the components that intervene in the installations of the thermal engines.                      | A1<br>A17        | B2<br>B11             | C3<br>C8               |
| Supervision, interpretation and diagnosis of the variables that intervene in the operation of thermal engines. | A1<br>A18<br>A69 | B2<br>B11             | C3<br>C6<br>C8<br>C13  |

| Contents                                                                                           |                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                                                                                              | Sub-topic                                                                                                                                                                                                                               |
| 1. Heat Engine Mechanics.                                                                          | Classification and basic principles.                                                                                                                                                                                                    |
| 2. Anti-pollution systems for installations with alternative engines.                              | NOx, CO and the volatiles burned Reduction.                                                                                                                                                                                             |
| 3. Engine test. Test benches. Operation and selection.                                             | Characteristic curves.                                                                                                                                                                                                                  |
| 4. Calculation of elements of auxiliary services of industrial engines.                            | Auxiliary equipment circuits.                                                                                                                                                                                                           |
| 5. Calculation of the constructive elements of the alternative engines. Efforts                    | Study of forces and moments.                                                                                                                                                                                                            |
| 6. Reciprocating compressors. Types. Principle of operation and selection criteria.                | Operation of compressible fluid equipment.                                                                                                                                                                                              |
| 7. Thermal Turbomachines: turbines and turbochargers. Constructive elements. Characteristic curves | Introduction. Types. Fundamentals concepts of turbomachines. Energy analysis. Turbochargers. Gas turbines. Dynamics of turbomachines. Parts of turbomachines. Lubricants.                                                               |
| 8. Industrial and aviation gas turbines. Components.                                               | Introduction. Thermodynamic cycles. Characteristic curves Combustion chambers. Blade cooling. Applications. Fuels used. Advanced high performance installations. Components of gas turbines. Aeronautical applications of gas turbines. |
| 9. Power plants based on steam turbines.                                                           | Introduction. Thermodynamic cycles of the steam plant. Technological diagram of the steam cycle plants. Operating parameters. Main features.                                                                                            |
| 10. Variation of power in the turbines.                                                            | Introduction. Methods of power variation. Power regulation. Speed regulation. Control of the combustion process.                                                                                                                        |
| 11. Combined cycles.                                                                               | Introduction. Types of combined cycles. Combined cycles with various levels of pressure. Recovery boilers. Main parameters. Yields.                                                                                                     |
| 12. Cogeneration cycles.                                                                           | Introduction. General aspects of cogeneration. Thermodynamics of cogeneration plants. Types of cogeneration plants. High-tech cogeneration plants. Economic aspects of cogeneration. Regulations.                                       |
| 13. Driving thermal installations.                                                                 | Driving alternative engine installations. Commissioning Operation during the march. Withdrawal of service.<br>Driving turbomachinery facilities. Commissioning Operation during the march. Withdrawal of service.                       |



## Planning

| Methodologies / tests          | Competencies                    | Ordinary class hours | Student's personal work hours | Total hours |
|--------------------------------|---------------------------------|----------------------|-------------------------------|-------------|
| Objective test                 | A11 A17 B2 B4 B10<br>C3 C10 C12 | 4                    | 0                             | 4           |
| Case study                     | A1 B5 B11                       | 7                    | 28                            | 35          |
| Problem solving                | A11 B4 C3 C10                   | 14                   | 49                            | 63          |
| Guest lecture / keynote speech | A1 A18 A69 C6 C8<br>C13         | 21                   | 21                            | 42          |
| Personalized attention         |                                 | 6                    | 0                             | 6           |

(\*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

## Methodologies

| Methodologies                  | Description                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Objective test                 | Written tests will be carried out, consisting of theoretical and practical questions.                                                                                                                                                                                                                                                           |
| Case study                     | Real case studies related to the processes object of the subject to study will be carried out. There will be a sharing of the studies carried out and the discussion of the different solutions adopted to the determined problem.                                                                                                              |
| Problem solving                | They will propose and solve a series of problems referred to the contents of the subject matter, and oriented as far as possible to real cases.                                                                                                                                                                                                 |
| Guest lecture / keynote speech | The detailed explanation of the contents of the subject distributed in subjects will be made. The student will have bibliographical material of support of the subject in each master session. The participation of the student in class will be encouraged, through comments that bring to relate the eoric contents with the real experience. |

## Personalized attention

| Methodologies                                                                     | Description                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Objective test<br>Problem solving<br>Case study<br>Guest lecture / keynote speech | It is about guiding the student in the custiones related to the subject taught and that they are especially difficult to understand and apply to practical cases. Also included are exam reviews.<br><br>The communication channels will be through the Moodle, email and individualized tutorials that will be developed during the scheduled time for each academic year. |

## Assessment

| Methodologies   | Competencies                    | Description                                                                                                                           | Qualification |
|-----------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Objective test  | A11 A17 B2 B4 B10<br>C3 C10 C12 | The degree of knowledge acquired on the subject will be assessed, both in the theoretical part and in the practical knowledge.        | 80            |
| Problem solving | A11 B4 C3 C10                   | Participation in problem solving will be valued, as well as the presentation of the results thereof.                                  | 10            |
| Case study      | A1 B5 B11                       | The solutions provided to the study of proposed cases, the originality of the same, and their exposure and defense will be evaluated. | 10            |

## Assessment comments

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| The evaluation criteria contemplated in Table A-III / 6 of the STCW Code, and included in the Quality Assurance System, will be taken into account when designing and carrying out the evaluation. |
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## Sources of information



|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"><li>- R. W. Haywood (2000). Ciclos termodinámicos de potencia y refrigeración. México. Ed. LIMUSA, S.A</li><li>- Claudio Mataix (2000). Turbomáquinas Térmicas. Madrid. DOSSAT</li><li>- Manuel Muñoz Torralbo (2001). Turbomáquinas Térmicas. Madrid. Sec. public. ETS Ingenieros Industriale</li><li>- Santiago Sabugal García (2006). Centrales Térmicas de Ciclo Combinado. Ed. Díaz de Santos</li><li>- Rolf Kehlofer (2009). Combined-Cycle Gas &amp;&amp;&amp; Steam Turbine Power Plants. Tulsa, Oklahoma. PennWell</li><li>- José M. Sala Lizarraga (1999). Cogeneración. Bilbao. Servic. Edit. de la Unuversidad del Pais Vasco</li><li>- Mariano Muñoz Rodríguez (1999). Turbomáquinas Térmicas. Zaragoza. Ed. PRENSAS UNIVERSITARIAS DE ZARAGOZA</li><li>- Consuelo Sánchez Naranjo (2010). Tecnología de las centrales termoeléctricas convencionales. Madrid. Librería UNED</li><li>- J. H. Horlock (2002). Combiner Power Plants. Malabar, Florida. Krieger Publishing Company</li></ul> |
| <b>Complementary</b> | <ul style="list-style-type: none"><li>- Mario Villares Martín (2003). Cogeneración. Madrid. Fundación Confemetal</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| Recommendations                                          |
|----------------------------------------------------------|
| Subjects that it is recommended to have taken before     |
| Maritime Installations and Propulsion Systems/631G02354  |
| Thermodynamics and Engineering Thermodynamics/631G02254  |
| Internal Combustion Engines/631G02351                    |
| Steam and Gas Turbines/631G02352                         |
| Heat transfer and steam generators/631G02353             |
| Subjects that are recommended to be taken simultaneously |
| Maritime Installations II/631G02359                      |
| Subjects that continue the syllabus                      |
|                                                          |
| 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.