



| Teaching Guide      |  |        |  |           |
|---------------------|--|--------|--|-----------|
| Identifying Data    |  |        |  | 2015/16   |
| Subject (*)         | Transferencia de Calor e Xeradores de Vapor  |        | Code   | 631G02353 |
| Study programme     | Grao en Tecnoloxías Mariñas  |        |  |           |
| Descriptors         |  |        |  |           |
| Cycle               | Period   | Year   | Type   | Credits   |
| Graduate            | 1st four-month period  | Third  | Obligatoria  | 6         |
| Language            | Spanish  |        |  |           |
| Teaching method     | Face-to-face   |        |  |           |
| Prerequisites       |  |        |  |           |
| Department          | Enerxía e Propulsión Mariña  |        |  |           |
| Coordinador         | Baaliña Insua, Alvaro  | E-mail | alvaro.baalina@udc.es                                  |           |
| Lecturers           | Baaliña Insua, Alvaro<br>Garcia-Bustelo Garcia, Enrique Juan   | E-mail | alvaro.baalina@udc.es<br>enrique.garcia-bustelo@udc.es |           |
| Web                 | www.udc.es/grupos/gifc   |        |  |           |
| General description | <p>Nesta materia desenrólanse conceptos necesarios para a comprensión da maior parte dos procesos que ocorren nun xerador de vapor, tanto a bordo dun buque como en instalacións terrestres.</p> <p>A descrición dos procesos e a súa análise crítica faculta ao alumno á hora de coñecer os detalles de deseño, operación e mantemento deste tipo de equipos, así como a súa influencia sobre a operación doutras instalacións ás que adoitan estar ligadas, como pode ser o caso de instalacións de propulsión, de xeración de enerxía eléctrica, calefacción, etc.</p> <p>Sen o coñecemento dos conceptos desenvolvidos nesta materia resulta dificultosa a comprensión doutras materias do plan de estudos, entre as que se atopan Turbinas de vapor e gas, Sistemas auxiliares do buque e Condución de Cámara de Máquinas.</p> <p>Para cursar a materia é conveniente ter coñecementos previos de Física e Matemáticas.</p> |        |  |           |

| Study programme competences / results |   |
|---------------------------------------|---|
| Code                                  | Study programme competences / results   |
| 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.  |
| A3                                    | CE3 - Capacidade para o manexo de especificacións, regulamentos e normas de obrigado cumprimento.   |
| A6                                    | CE6 - Coñecementos e capacidade para a realización de auditorías enerxéticas de instalacións marítimas.   |
| A7                                    | CE7 - Capacidade para a operación e posta en marcha de novas instalacións ou que teñan por obxecto a construción, reforma, reparación, conservación, instalación, montaxe ou explotación, realización de medicións, cálculos, valoracións, taxacións, peritacións, estudos, informes, e outros traballos análogos de instalacións enerxéticas e industriais mariñas, nos seus respectivos casos, tanto con carácter principal como accesorio, sempre que quede comprendido pola súa natureza e característica na técnica propia da titulación, dentro do ámbito da súa especialidade, é dicir, operación e explotación. |
| A14                                   | CE14 - Avaliación cualitativa e cuantitativa de datos e resultados, así como a representación e interpretación matemáticas de resultados obtidos experimentalmente.   |
| A21                                   | CE37 - Capacidad para ejercer como Oficial de Máquinas de la Marina Mercante, una vez superados los requisitos exigidos por la Administración Marítima.   |
| A29                                   | CE41 - Realizar operacións de explotación óptima das instalacións do buque.   |
| A40                                   | CE47 - Operar a maquinaria principal e auxiliar e os sistemas de control correspondentes.   |
| A44                                   | CE49 - Realizar unha garda de máquinas segura.  |
| A46                                   | CE51 - Utilizar as ferramentas manuais e o equipo de medida para o desmantelado, mantemento, reparación e montaxe das instalacións e o equipo da bordo.   |
| A48                                   | CE33 - Vigilar el cumplimiento de las prescripciones legislativas.  |
| A58                                   | Observar o cumprimento da lexislación vixente neste ámbito.   |
| B2                                    | CT2 - Resolver problemas de forma efectiva.   |
| B7                                    | CT7 - Capacidade para interpretar, seleccionar e valorar conceptos adquiridos noutras disciplinas do ámbito marítimo, mediante fundamentos físico-matemáticos.  |



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| C6  | C6 - Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.  |
| C9  | CB1 - Demostrar que posúen e comprenden coñecementos na área de estudo que parte da base da educación secundaria xeneral, e que inclúe coñecementos procedentes da vangardia do seu campo de estudo                             |
| 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 / results |    |     |
| Analysis and synthesis of the theory of heat transfer.  | A1                                    | B2 | C6  |
| Capacity to resolve problems of heat transfer in industrial installations.  | A3                                    | B7 | C9  |
| Critical reasoning of the distinct modes of heat transfer present in the installations of the marine engineering. | A6                                    |    | C10 |
| Identify the typology and elements of steam generators.   | A7                                    |    | C12 |
| Planning and making decisions in the design, management and operation of steam generators.                        | A14                                   |    | C13 |
| Energetic optimization of heat transfer equipment   | A21                                   |    |     |
|   | A29                                   |    |     |
|   | A40                                   |    |     |
|   | A44                                   |    |     |
|   | A46                                   |    |     |
|   | A48                                   |    |     |
|   | A58                                   |    |     |

| Contents                              |  |
|---------------------------------------|--|
| Topic                                 | Sub-topic  |
| PART I.- INTRODUCTION.                | 1.1.- IMPORTANCE OF THE HEAT TRANSFER IN STEAM GENERATORS.                 |
| 1.- PRESENTATION.                     | 2.1.- OBJECTIVES AND RELATION WITH OTHER SUBJECTS AND PROFESSIONAL CAREER. |
| PART II.- HEAT TRANSFER.              | 1.2.-ENERGY MODES. HEAT. THERMAL AND VOLUMETRICL PROPERTIES.               |
| CHAPTER 2.-INTRODUCTION.              | 2.2.- HEAT TRANSFER MODES.   |
| CHAPTER 3.- CONDUCTION HEAT TRANSFER. | 1.3.- GENERAL EQUIATION OF CONDUCTION HEAT TRANSFER.                       |
|                                       | 2.3.- ONE DIEMNSIONAL, STADY STATE CONDUCTION WITH NO HEAT GENERATION.     |
|                                       | 3.3.- ONE DIEMNSIONAL, STADY STATE CONDUCTION WITH HEAT GENERATION.        |
|                                       | 4.3.- FIN HEAT TRANSFER.   |
|                                       | 5.3.- MULTIDIMENSIONAL, STADY STATE CONDUCTION. APROXIMATE METHODS.        |



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| CHAPTER 4.- CONVECTION HEAT TRANSFER.                             | 1.4.-KEY CONCEPTS.<br><br>2.4.-DIFFERENTIAL EQUATIONS OF CONSERVATION.<br><br>3.4.- FORCED CONVECTION COEFFICIENT.<br><br>4.4.- NATURAL CONVECTION COEFFICIENT.<br><br>5.4.- CONVECTION WITH PHASE CHANGE. CONDENSATION.<br><br>6.4.- CONVECTION WITH PHASE CHANGE. BOILING. |
| CHAPTER 5.- RADIATION HEAT TRANSFER                               | 1.5.- KEY CONCEPTS.<br><br>2.5.- BLACK BODY RADIATION.<br><br>3.5.- RADIATION HEAT TRANSFER BETWEEN BLACK SURFACES.<br><br>4.5.- DIFFUSE-GRAY SURFACES.<br><br>5.5.- RADIATION IN GASES  |
| PART III.- DESCRIPTION OF BOILERS.                                | 1.6.- KEY CONCEPTS AND DEFINITIONS.  |
| CHAPTER 6.- INTRODUCTION.   | 2.6.- STEAM BOILERS CLASSIFICATION.  |
| CHAPTER 7.- WATER CIRCULATION IN BOILERS.                         | 1.7.- INTRODUCTION.<br><br>2.7.- RECIRCULATION BOILERS.<br><br>3.7.- FORCED CIRCULATION BOILERS.   |
| CHAPTER 8.- CLASSIFICATION ACCORDING TO THE BOILER DESIGN.        | 1.8.- CYLINDRICAL.<br><br>2.8.- FIRETUBE.<br><br>3.8.- WATERTUBE.<br><br>4.8.- SPECIAL BOILERS.  |
| CHAPTER 9.- CLASSIFICATION OF FURNACES ACCORDING TO THE USED FUEL | 1.9.- CLASSIFICATION.<br><br>2.9.- SOLID FUEL FURNACES.<br><br>3.9.- LIQUID FUEL FURNACES.<br><br>4.9.- GAS FUEL FURNACES.   |



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| CHAPTER 10.- WATER-STEAM SYSTEM                   | <p>1.10.- INTRODUCTION.</p> <p>2.10.- ECONOMIZER.</p> <p>3.10.- STEAM DRUM.</p> <p>4.10.- VAPORIZER WALLS.</p> <p>5.10.- SUPERHEATER AND REHEATER.</p> <p>6.10.- SOOTBLOWERS.</p> |
| CHAPTER 11.- AIR-FLUEGAS SYSTEM.                  | <p>1.11.- INTRODUCTION.</p> <p>2.11.- DRAUGHT. FANS AND STACKS.</p> <p>3.11.- AIR PREHEATER.</p> <p>4.11.- SOOT REMOVAL SYSTEMS.</p>  |
| CHAPTER 12.- NUCLEAR ENERGY FOR STEAM GENERATION  | <p>1.12.- APPLICATIONS.</p> <p>2.12.- NUCLEAR FUEL.</p> <p>3.12.- REACTOR.</p> <p>4.12.- REACTORS FOR STEAM GENERATION.</p> <p>5.12.- STEAM GENERATORS.</p>                       |
| PART IV.- WATER TREATMENT AND COMBUSTION.         | 1.13.- FOAMING AND CARRYOVER.   |
| CHAPTER 13.- BOILER WATER PROBLEMS.               | <p>2.13.- SCALE AND MUD.</p> <p>3.13.- WATER SIDE CORROSION.</p>  |
| CHAPTER 14.-WATER TREATMENT FOR STEAM GENERATION. | <p>1.14.- CHEMICAL CHARACTERISTICS OF WATER BOILER.</p> <p>2.14.- EXTERNAL TREATMENT. MAKE-UP AND CONDENSATE.</p> <p>3.14.- INTERNAL TREATMENT.</p>                               |
| CHAPTER 15.- COMBUSTION FUNDAMENTALS.             | <p>1.15.- INTRODUCTION.</p> <p>2.15.- STOICHIOMETRY OF COMBUSTION</p> <p>3.15.- ANALISYS OF COMBUSTION AND BOILER EFFICIENCY.</p>   |

Planning

| Methodologies / tests          | Competencies / Results   | Teaching hours (in-person & virtual) | Student?s personal work hours | Total hours |
|--------------------------------|--|--------------------------------------|-------------------------------|-------------|
| Guest lecture / keynote speech | A1 A3 A6 A7 A14 A21<br>A29 A40 A44 A46<br>A48 A58 B7 B2 C6<br>C9 C10 C12 C13 | 24                                   | 36                            | 60          |



|                        |  |    |    |    |
|------------------------|--|----|----|----|
| Objective test         | A1 A3 A6 A7 A14 A21<br>A29 A40 A44 A46<br>A48 A58 B2 B7 C6<br>C9 C10 C13 | 6  | 12 | 18 |
| Laboratory practice    | A1 A3 A6 A7 A14 A21<br>A29 A40 A44 A46 B7<br>C6                          | 8  | 12 | 20 |
| Document analysis      | A3 A14 A48 A58 B2<br>B7 C6 C9 C13  | 0  | 9  | 9  |
| Problem solving        | A1 A6 A7 A14 A21<br>A29 A40 B7 B2 C6<br>C9 C12                           | 12 | 24 | 36 |
| Personalized attention |  | 7  | 0  | 7  |

(\*)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 | There will be a detailed explanation of the contents of the subject which will be distributed on issues. The student will have got a typed copy of the issue to be addressed before each lesson. Class participation will be encouraged through comments that relate the theoretical contents with real life experiences     |
| Objective test                 | About 4 written partial tests will be conducted, including possibility to recover contents from the second test. Each test will consist of a theoretical and practical part, so that both account for 50% of the grade. Ordinary and extraordinary exams have got the same format.   |
| Laboratory practice            | Practical lessons will be conducted in two laboratories: Machinery and Engines, with a industrial type steam generator; Chemistry, where practices will be made with regard to the analysis and treatment of boiler water. Attendance and delivery of work practices is mandatory for passing the subject                    |
| Document analysis              | Using different literature sources, students will get used to the individual seeking information in order to deepen or focus on learning from other points of view that are not exclusively the professor's lessons. It is a training to future needs of the student in their professional development                       |
| Problem solving                | Proposed collections of exercises for each topic will be solved, allowing the application of mathematical models best suited to each case, including managing tables, applying the most appropriate assumptions, the relation with theoretical contents developed in the lessons and relationship with professional practice |

| Personalized attention   |   |
|--|---|
| Methodologies  | Description   |
| Guest lecture / keynote speech<br>Objective test<br>Laboratory practice<br>Problem solving | The student is guided in all contents, specially those specially difficult to understand. Also included are the corresponding revisions of examinations. Channels of information and contact will be the Virtual School together individualized tutoring for six hours throughout the week. |

| Assessment                     |  |   |               |
|--------------------------------|--|---|---------------|
| Methodologies                  | Competencies / Results   | Description   | Qualification |
| Guest lecture / keynote speech | A1 A3 A6 A7 A14 A21<br>A29 A40 A44 A46<br>A48 A58 B7 B2 C6<br>C9 C10 C12 C13 | Lessons attendance not less than 90 %, up to a maximum of 5% of the grade. It also takes into account participation through questions or comments on the explained contents.<br>Assessed competencies: B2; B7; C6 | 5             |



|                     |  |  |    |
|---------------------|--|--|----|
| Objective test      | A1 A3 A6 A7 A14 A21<br>A29 A40 A44 A46<br>A48 A58 B2 B7 C6<br>C9 C10 C13 | The degree of acquired knowledge about the learning contents is assessed, taking into account both the theoretical part and the problems.<br>Assessed competencies: A1; A3; A6; A7; A14; A21; A29; A48; A58; B2; B7; C6  | 45 |
| Laboratory practice | A1 A3 A6 A7 A14 A21<br>A29 A40 A44 A46 B7<br>C6                          | Practical lessons attendance and delivery of homeworks associated with them is mandatory. If such assistance does not exceed 90% of all sessions, the student fails the subject regardless of the results of the objective tests.<br>Assessed competencies: A1; A3; A7; A14; A21; A29; A40; A44; A46; B2; B7; C6 | 45 |
| Problem solving     | A1 A6 A7 A14 A21<br>A29 A40 B7 B2 C6<br>C9 C12                           | Problem solving attendance not less than 90% of all sessions together with participation through questions or comments on the explained concepts, up to a maximum of 5% of the total grade.<br>Assessed competencies: A1; A6; A7; A14; A21; A29; B2  | 5  |
| Others              |  |  |    |

**Assessment comments**

IT IS IMPORTANT TO HIGHLIGHT THAT THE ASSISTANCE TO LABORATORY PRACTICES IS NEEDED TO OVERCOME THE COURSE. ASSISTANCE TO THE DIFFERENT METHODOLOGIES ARE CERTIFIED BY SIGNING OF EACH STUDENT AN ATTENDANCE SHEET PROVIDED EVERY DAY BEFORE THE BEGINNING OF THE SESSION.

A final examination to collect all course methodologies and representing 100% of the grade, is planned for those students who do not follow the teaching , as long as they pass mandatory laboratory practices.

The evaluation criteria listed in Tables A-III / 1 and La-III / 2, of the STCW Code, as amended, relating to this matter will be taken into account when designing and conducting evaluation.

**Sources of information**

|                      |  |
|----------------------|--|
| <b>Basic</b>         | <ul style="list-style-type: none"> <li>- Holman, J. P (1998). Transferencia de Calor. McGrawHill</li> <li>- Bejan, A. (1993). Heat Transfer. John Wiley &amp; Sons, Nueva York</li> <li>- B Babcock &amp; Wilcox (1992). Steam: Its generation and use. Babcock &amp; Wilcox, USA</li> <li>- Mesny, M. (1976). Generación del Vapor. Marymar, Buenos Aires</li> <li>- Molina, L. A. I. y Alonso. J. M. G. (1996). Calderas de Vapor en la Industria (II). Cadem, Bilbao</li> </ul> |
| <b>Complementary</b> | <ul style="list-style-type: none"> <li>- Chapman, A. J. (1990). Transmisión del Calor. Bellisco, Madrid</li> <li>- Germain, L et al. (1982). Tratamiento de las Aguas. Omega, Barcelona</li> <li>- (). .</li> <li>- Kakaç, S. (1991). Boilers, Evaporators and Condensers. John Wiley &amp; Sons, Nueva York</li> <li>- Port, R. D. y Herro, H. M.: (1997). Guía Nalco para el Análisis de Fallas en Calderas. McGraw-Hill, México</li> </ul>                                      |

**Recommendations**

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

Termodinámica e Termotecnia/631G02254

**Subjects that are recommended to be taken simultaneously**



Instalacións Marítimas II/631G02359

Turbinas de Vapor e Gas/631G02352

Máquinas Térmicas Mariñas/631G02361

Subjects that continue the syllabus

Técnicas Enerxéticas aplicadas ao Buque/631G02453

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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.