



## Teaching Guide

| Teaching Guide           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                                             |           |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|---------------------------------------------|-----------|
| Identifying Data         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                                             | 2020/21   |
| Subject (*)              | Heat Exchanger Design                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        | Code                                        | 631480216 |
| Study programme          | Mestrado Universitario en Enxeñaría Mariña                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |                                             |           |
| Descriptors              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                                             |           |
| Cycle                    | Period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Year   | Type                                        | Credits   |
| Official Master's Degree | 2nd four-month period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | First  | Optional                                    | 3         |
| Language                 | SpanishGalicianEnglish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |                                             |           |
| Teaching method          | Face-to-face                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |                                             |           |
| Prerequisites            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                                             |           |
| Department               | Ciencias da Navegación e Enxeñaría Mariña                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |                                             |           |
| Coordinador              | Carbia Carril, Jose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | E-mail | jose.carbia@udc.es                          |           |
| Lecturers                | Carbia Carril, Jose<br>Romero Gómez, Manuel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | E-mail | jose.carbia@udc.es<br>m.romero.gomez@udc.es |           |
| Web                      | http://www.udc.es/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                                             |           |
| General description      | In all industrial processes there is heat exchange between fluids, so its study is essential. In this matter heat transmission mechanisms, especially focused on conduction and convection, are applied, applying the thermal analysis to the exchangers.<br><br>Using software tools, the design of heat exchangers for various industrial applications will be carried out, leading to a rigorous study of the types of existing heat exchangers.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |                                             |           |
| Contingency plan         | 1. Modifications to the contents<br>No modifications are made<br>2. Methodologies<br>Teaching methodologies are maintained<br>3. Mechanisms of personalized attention to students<br>They will be the same.<br>When, due to unforeseen circumstances, they cannot be carried out in the classroom or in the teacher's office, they will be carried out remotely by any of the means that the UDC makes available to teachers and students, such as e-mail, Moodle, Teams, etc.<br>4. Modifications in the evaluation<br>There is no modification<br>* Evaluation comments:<br>When, due to unforeseen circumstances, they cannot be carried out in person in the classroom, they will be carried out remotely by any of the means that the UDC makes available to teachers and students, such as e-mail, Moodle, Teams, etc.<br>5. Modifications to the bibliography or webography<br>There are no modifications |        |                                             |           |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                                |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A2   | Detectar e definir a causa dos defectos de funcionamento das máquinas e reparalas, a nivel de xestión.                                                                                                                     |
| A3   | Efectuar as operacións de combustible e lastre, a nivel de xestión.                                                                                                                                                        |
| A6   | Facer arrancar e parar a máquina propulsora principal e a maquinaria auxiliar, incluídos os sistemas correspondentes, a nivel de xestión.                                                                                  |
| A8   | Facer funcionar a máquina, controlar, vixiar e avaliar o seu rendemento e capacidade, a nivel de xestión.                                                                                                                  |
| A9   | Manter a seguridade dos equipos, sistemas e servizos da maquinaria, a nivel de xestión.                                                                                                                                    |
| A10  | Manter a seguridade e protección do buque, a tripulación e os pasaxeiros, así como o bo estado de funcionamento dos sistemas de salvamento, de loita contra incendios e demais sistemas de seguridade, a nivel de xestión. |
| A14  | Probar o equipo eléctrico e electrónico, detectar avarías e mantelo en condicións de funcionamento o reparalo, a nivel de xestión.                                                                                         |
| A16  | Vixiar e controlar o cumprimento das prescricións lexislativas e das medidas para garantir a seguridade da vida humana no mar e a protección do medio mariño, a nivel de xestión.                                          |



|     |                                                                                                                                                                                                                                                                                                |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A17 | Coñecer e ser capaz de aplicar os códigos, normas e regulamentos relativos á operación de buques e artefactos relacionados coa explotación dos recursos mariños, prestando especial atención aos sistemas de seguridade abordo e á protección ambiental.                                       |
| A18 | Planificar e programar un proxecto no ámbito de investigación operativa e controlar a súa execución e futuro mantemento estimando a influencia dos custos de explotación durante o ciclo de vida para especificar as condicións óptimas de eficiencia e seguridade. Xestionar inventarios.     |
| A19 | Regular, controlar, diagnosticar e supervisar sistemas, procesos e máquinas para a toma de decisións en condución e operación.                                                                                                                                                                 |
| A20 | Capacidade para desenrolar tarefas de análise e síntese de problemas teórico-prácticos en base a conceptos adquiridos noutras disciplinas do ámbito marítimo, mediante fundamentos físico-matemáticos.                                                                                         |
| A24 | Capacidade para detectar necesidades de mellora e innovar sistemas enerxéticos buscando alternativas viables aos sistemas convencionais e implementar cos métodos, técnicas e tecnoloxías emerxentes máis eficientes para o apoio, asistencia e supervisión da Enxeñaría Mariña.               |
| B1  | Aprender a aprender.                                                                                                                                                                                                                                                                           |
| B2  | Resolver problemas de forma efectiva.                                                                                                                                                                                                                                                          |
| B3  | Comunicarse de maneira efectiva nun entorno de traballo.                                                                                                                                                                                                                                       |
| B4  | Traballar de forma autónoma con iniciativa.                                                                                                                                                                                                                                                    |
| B5  | Traballar de forma colaborativa.                                                                                                                                                                                                                                                               |
| B6  | Comportarse con ética e responsabilidade social como cidadán e como profesional.                                                                                                                                                                                                               |
| B7  | Capacidade para interpretar, seleccionar e valorar conceptos adquiridos noutras disciplinas do ámbito marítimo, mediante fundamentos físico-matemáticos.                                                                                                                                       |
| B10 | Comunicar por escrito e oralmente os coñecementos procedentes da linguaxe científica.                                                                                                                                                                                                          |
| B11 | Capacidade para resolver problemas con iniciativa, toma de decisións, creatividade, razoamento crítico e de comunicar e transmitir coñecementos, habilidades e destrezas.                                                                                                                      |
| B12 | Posuír e comprender coñecementos que aporten unha base ou oportunidade de ser orixinais no desenvolvemento e/ou aplicación de ideas, a miúdo nun contexto de investigación                                                                                                                     |
| B13 | Que os estudantes saiban aplicar os coñecementos adquiridos e a súa capacidade de resolución de problemas en contornas novas ou pouco coñecidas dentro de contextos máis amplos (ou multidisciplinares) relacionados coa súa área de estudo                                                    |
| B14 | Que os estudantes sexan capaces de integrar coñecementos e enfrontarse á complexidade de formular xuízos a partires dunha información que, sendo incompleta ou limitada, inclúa reflexións sobre as responsabilidades sociais e éticas vencelladas á aplicación dos seus coñecementos e xuízos |
| B15 | Que os estudantes saiban comunicar as súas conclusións e os coñecementos e razóns últimas que as sustentan a públicos especializados e non especializados dun xeito claro e sin ambigüidades                                                                                                   |
| B16 | Que os estudantes posúan as habilidades de aprendizaxe que lles permitan continuar estudando dun xeito que haberá de ser en grande medida autodirixido ou autónomo.                                                                                                                            |
| C1  | Expresarse correctamente, tanto de forma oral coma escrita, nas linguas oficiais da comunidade autónoma.                                                                                                                                                                                       |
| 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.                                                                                                                |
| C5  | Entender a importancia da cultura emprendedora e coñecer os medios ao alcance das persoas emprendedoras.                                                                                                                                                                                       |
| C6  | Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.                                                                                                                                                              |
| C7  | Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.                                                                                                                                                                                                               |
| C9  | Falar ben en público                                                                                                                                                                                                                                                                           |

## Learning outcomes

| Learning outcomes                                                                                                                                                                                                     | Study programme competences |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--|--|
| Detect and define the cause of the malfunctions of the machines and repair them, at the management level.                                                                                                             | AC2                         |  |  |
| Carry out fuel and ballast operations at the management level.                                                                                                                                                        | AC3                         |  |  |
| Start and stop the main propulsion machine and the auxiliary machinery, including the corresponding systems, at the management level.                                                                                 | AC6                         |  |  |
| Operate the machine, control, monitor and evaluate its performance and capacity, at the management level. Make the machine work, control, monitor and evaluate its performance and capacity, at the management level. | AC8                         |  |  |



|                                                                                                                                                                                                                                                                                |      |                                                                                                       |                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------|-------------------|
| Mantener la seguridad de los equipos, sistemas y servicios de la maquinaria, a nivel de gestión.                                                                                                                                                                               | AC9  |                                                                                                       |                   |
| Maintain the security and protection of the ship, the crew and passengers, as well as the good state of operation of the rescue systems, firefighting and other security systems, at the management level.                                                                     | AC10 |                                                                                                       |                   |
| Test the electrical and electronic equipment, detect faults and keep it in working condition or repair it, at the management level.                                                                                                                                            | AC14 |                                                                                                       |                   |
| Monitor and control compliance with legislative requirements and measures to ensure the safety of human life at sea and the protection of the marine environment, at the management level.                                                                                     | AC16 |                                                                                                       |                   |
| Know and be able to apply the codes, rules and regulations related to the operation of vessels and artifacts related to the exploitation of marine resources, paying special attention to on-board safety systems and environmental protection.                                | AC17 |                                                                                                       |                   |
| Plan and program a project in the field of operational research and control its execution and future maintenance estimating the influence of operating costs during the life cycle to specify the optimal conditions of efficiency and safety                                  | AC18 |                                                                                                       |                   |
| Regulate, control, diagnose and supervise systems, processes and machines for decision making in driving and operation.                                                                                                                                                        | AC19 |                                                                                                       |                   |
| Ability to develop tasks of analysis and synthesis of theoretical-practical problems based on concepts acquired in other disciplines of the maritime field, through physical-mathematical foundations.                                                                         | AC20 |                                                                                                       |                   |
| Ability to detect improvement needs and innovate energy systems looking for viable alternatives to conventional systems and implement with the most efficient methods, techniques and emerging technologies for the support, assistance and supervision of Marine Engineering. | AC24 |                                                                                                       |                   |
| Learn to learn.<br>Solve problems effectively.<br>Ability to solve problems with initiative, decision making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities.                                                                  |      | BC1<br>BC2<br>BC3<br>BC4<br>BC5<br>BC6<br>BC7<br>BC10<br>BC11<br>BC12<br>BC13<br>BC14<br>BC15<br>BC16 | CC5<br>CC6<br>CC9 |
| Use the basic tools of information and communication technologies (ICT) necessary for the exercise of their profession and for learning throughout their lives<br>To assume as a professional and citizen the importance of learning throughout life.                          |      |                                                                                                       | CC3<br>CC7        |
| Express oneself correctly, both orally and in writing, nas lingua officia da autonomia comunidade                                                                                                                                                                              |      |                                                                                                       | CC1               |

| Contents                                           |                                                                             |
|----------------------------------------------------|-----------------------------------------------------------------------------|
| Topic                                              | Sub-topic                                                                   |
| 1.-Types and applications two heat exchangers      | 1.1 Disposition of flows<br>1.2 Applications                                |
| 2.-Thermal and hydraulic design of heat exchangers | 2.1 Manufacturing<br>2.2 Heat transfer and flow.<br>2.3 Modeling            |
| 3.- Mechanical properties.                         | 3.1 Effects of pressure<br>3.2 Thermal expansion<br>3.3 Vibration and noise |



|                                              |                                                                                                                              |
|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 4.- Maintenance and operation.<br>Normative. | 4.1 Most frequent failures<br>4.2 Maintenance Strategies<br>4.3 Tests and operation<br>4.4. TEMA Standards<br>4.5. ISO 15747 |
|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|

| Planning                                                                                                                        |                                                        |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies                                           | Ordinary class hours | Student's personal work hours | Total hours |
| Guest lecture / keynote speech                                                                                                  | A2 A3 A6 A8 A9 A10<br>A14 A19 B1 B2 B7<br>B11 B14      | 14                   | 14                            | 28          |
| Problem solving                                                                                                                 | A14 A19 A24 B1 B13<br>B14 C7 C9                        | 7                    | 14                            | 21          |
| Supervised projects                                                                                                             | A16 A17 A18 A20<br>A24 B5 B6 B7 B11<br>B12 C3 C5 C6 C7 | 7                    | 7                             | 14          |
| Objective test                                                                                                                  | A20 B2 B3 B4 B10<br>B14 B15 B16 C1 C9                  | 2                    | 6                             | 8           |
| Personalized attention                                                                                                          |                                                        | 4                    | 0                             | 4           |
| (*)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 | The detailed explanation of the contents of the subject will be made and distributed in topics. The student will have at all times a typed copy of the topic to be discussed in each master's session. Participation in class is encouraged, through comments that relate the theoretical contents with real life experiences.                               |
| Problem solving                | The collections of exercises proposed for each topic will be solved, allowing the application of the most appropriate mathematical models for each case, including software management, application of the most appropriate hypotheses, relationship with the theoretical contents developed in the lectures and relationship with the professional exercise |
| Supervised projects            | Resolution of problems of greater demands than those solved in class or subjects of special relevance.                                                                                                                                                                                                                                                       |
| Objective test                 | The degree of knowledge acquired on the subject matter is valued, taking into account both the theoretical part and the problems                                                                                                                                                                                                                             |

| Personalized attention                 |                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                          | Description                                                                                                                                                                                                                                                                                                         |
| Problem solving<br>Supervised projects | It is about guiding the student in those issues related to the subject taught and that are especially difficult to understand. The corresponding exam reviews are also included. The information and contact channels will be the Virtual Faculty and the individualized tutorials that take place during the week. |

| Assessment                     |                                                   |                                                                             |               |
|--------------------------------|---------------------------------------------------|-----------------------------------------------------------------------------|---------------|
| Methodologies                  | Competencies                                      | Description                                                                 | Qualification |
| Guest lecture / keynote speech | A2 A3 A6 A8 A9 A10<br>A14 A19 B1 B2 B7<br>B11 B14 | Attendance at the face-to-face sessions will count towards the final grade. | 10            |
| Problem solving                | A14 A19 A24 B1 B13<br>B14 C7 C9                   | Troubleshooting, if possible, with appropriate software                     | 10            |



|                     |                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |    |
|---------------------|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Objective test      | A20 B2 B3 B4 B10<br>B14 B15 B16 C1 C9                  | Evaluation of knowledge and understanding of the basic contents of the subject, considering the skills and abilities of the student, their strategies and approaches in solving problems.<br><br>The degree of evolution of the student and his / her capacity to analyze, judge and solve specific problems will be expressly assessed, requiring a balanced theoretical-practical training.<br><br>Each partial test (at least two partial) will provide 35% and the overall objective test (average score of both) will report 70% of the total evaluation of the subject | 70 |
| Supervised projects | A16 A17 A18 A20<br>A24 B5 B6 B7 B11<br>B12 C3 C5 C6 C7 | Presentation and defense of the work carried out. Structure, neatness, expository method and originality will be valued.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10 |

## Assessment comments

A final exam will be proposed for those students who do not participate in the continuous evaluation of the subject throughout the course (compliance will require a minimum of 80% attendance and have delivered 85% of the proposed works to the group or individually). It allows to evaluate and verify the expected results in terms of the global content of the subject and verify the degree of scope of the proposed objectives. The overall final exam, as a single evaluation, will consist of a test composed of 2 parts: a) theoretical (50%); b) practice (50%); with independent valuation, in which it will be necessary to obtain a minimum of 3 points in each one for the purposes of the average.

The evaluation criteria in TableA-III / 2 of the STCW Code, and included in the Quality Assurance System, will be taken into account when designing and carrying out the evaluation.

Students with recognition of part-time dedication and academic exemption of attendance exemption, according to the "NORM THAT REGULATES THE REGIME OF DEDICATION TO THE STUDY OF GRADUATE STUDENTS IN THE UDC (Arts 2.3, 3.b; 4.3 e 7.5 ) (04/05/2017):

- Attendance / participation in the activities of minimum class: 80% to be considered by the teacher, considering that in these cases it can be compensated with specific works, assistance to tutorials ... For example, in some subjects this 80% could be the corresponding to the hours of practices in laboratory / workshop, and allow the exemption to attend the master sessions.

- Qualification:

a) Elaboration of works: up to 80%

c) Problem solving: up to 80%

b) Written exam on the contents of the subject: up to 100%

d) Other methodologies considered: up to 100%

## Sources of information

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b> | <ul style="list-style-type: none"> <li>- Andreone, Carl F. (1997). Tubular heat exchanger inspection, maintenance, and repair. New York : McGraw-Hill</li> <li>- Fraas, Arthur P. (1980). Heat exchanger desing. New York : John Wiley &amp; Sons</li> <li>- Kadaç, Sadik (2002). Heat exchangers selection, rating and thermal design. Boca Raton : CRC Press</li> <li>- (2007). TEMA 9TH EDITION.</li> <li>- (2005). ISO 15747.</li> </ul> |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Complementary**

## Recommendations

Subjects that it is recommended to have taken before

Subjects that are recommended to be taken simultaneously

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.