Teaching Guide				
Identifying Data				2023/24
Subject (*)	Heat Transfer and Steam Generators		Code	631G03022
Study programme	Grao en Máquinas Navais			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Third	Optional	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Ciencias da Navegación e Enxeñaría Mariña			
Coordinador	Baaliña Insua, Alvaro	E-mail	alvaro.baalina@udc.es	
Lecturers	Baaliña Insua, Alvaro Garcia-Bustelo Garcia, Enrique Juan	E-mail	alvaro.baalina@udc.es enrique.garcia-bustelo@udc.es	
Web	https://estudos.udc.es/es/subject/631G02V02/631G02353			
General description	In this course concepts needed for the understanding of most of processes taking place in a steam generator, both on board ships and ground installations are developed. The processes description and critical analysis enables the student the knowledge of design details, operation and maintenance of this kind of equipment, as well as its influence on the operation of other facilities which are often linked, as propulsion, power generation or heating systems. Without knowledge of the concepts developed in this course is difficult understanding of other subjects in the curriculum, including steam and gas turbines, auxiliary systems of the ship and engine room simulator. To apply this subject is desirable to have prior knowledge of physics and mathematics.			

Study programme competences	
Code	Study programme competences
A1	CE01 - Realizar unha garda de máquinas segura
A2	CE02 - Facer funcionar a maquinaria principal e auxiliar e os sistemas de control correspondentes.
A5	CE05 - Utilizar debidamente as ferramentas de man, máquinas ferramenta e instrumentos de medición para as operacións de fabricación, detección de avarías e reparación a bordo do buque.
A6	CE06 - Mantemento e reparación das máquinas e o equipo de a bordo.
A8	CE08 - Vixiar o cumprimento das prescricións lexislativas.
A9	CE09 - Emprego do inglés escrito e falado.
A73	CE73 - Modelizar situacións e resolver problemas con técnicas ou ferramentas físico-matemáticas.
A74	CE74 - Avaliar de forma cualitativa e cuantitativa os datos e resultados, así como a representación e interpretación matemáticas de resultados obtidos experimentalmente.
A78	CE78 - Adquirir coñecementos de termodinámica aplicada e da transmisión da calor.
A87	CE87 - Realizar operacións de explotación óptima das instalacións do buque e marítimas e industriais.
A89	CE89 - Poñer en marcha e operar novas instalacións en buques, instalacións marítimas e industriais.
A90	CE90 - Operar, reparar, manter e optimizar a nivel operacional as instalacións industriais relacionadas coa enxeñería mariña, como motores alternativos de combustión interna e subsistemas; turbinas de vapor e de gas, caldeiras e subsistemas asociados; ciclos combinados; equipos eléctricos, electrónicos, e de regulación e control; as instalacións auxiliares, tales como instalacións frigoríficas, instalacións de aire acondicionado, plantas potabilizadoras, grupos electrógenos, etc.
A93	CE93 - Interpretar especificacións, regulamentos e normas de obrigado cumprimento.
A94	CE94 - Realizar inspeccións, medicións, valoracións, taxacións, peritacións, estudos, informes, planos de labores e certificacións nas instalacións do ámbito da súa especialidade.
A95	CE95 - Coñecer o balance enerxético xeneral, incluíndo o balance termo-eléctrico, así como a xestión eficiente da enerxía respectando o medio ambiente.
A96	CE96 - Realización de auditorías enerxéticas de instalacións marítimas.

A99	CE99 - Ter a capacidade para exercer como Oficial de Máquinas da Mariña Mercante, unha vez superados os requisitos esixidos pola Administración Marítima.
B2	CB2 - Aplicar os coñecementos no seu traballo ou vocación dunha forma profesional e posuír competencias demostrables por medio da elaboración e defensa de argumentos e resolución de problemas dentro da área dos seus estudos
B3	CB3 - Ter a capacidade de reunir e interpretar datos relevantes para emitir xuicios que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
B5	CB5 - Ter desenvolvido aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores con un alto grao de autonomía.
B7	CG02 - Resolver problemas de forma efectiva.
B12	CG07 - Capacidade para interpretar, seleccionar e valorar conceptos adquiridos noutras disciplinas do ámbito mariño, mediante fundamentos físico-matemáticos.
B16	CG11 - Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.
C3	CT03 - 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.
C7	CT07 - Desenvolver a capacidade de traballar en equipos interdisciplinares ou transdisciplinares, para ofrecer propostas que contribúan a un desenvolvemento sostible ambiental, económico, político e social.

Learning outcomes			
Learning outcomes	Study programme competences		
Analysis and synthesis of the theory of heat transfer.	A1	B2	C3
Capacity to resolve problems of heat transfer in industrial	A2	B3	C7
installations.	A5	B5	
Critical reasoning of the distinct modes of heat transfer present	A6	B7	
in the installations of the marine engineering.	A8	B12	
Identify the typology and elements of steam generators.	A9	B16	
Planning and making decisions in the design, management and operation of steam generators.	A73		
Energetic optimization of heat transfer equipment.	A74		
The following competences included in Table A-III / 1 of the STCW Code as amended by Manila; Function: Marine engineering	A78		
at operational level -1.1 Maintain a safe engineering watch -1.2 Operate main and auxiliary machinery and associated control	A87		
systems	A89		
	A90		
	A93		
	A94		
	A95		
	A96		
	A99		

Contents	
Topic	Sub-topic
PART I.- INTRODUCTION. 1.- PRESENTATION.	1.1.- IMPORTANCE OF THE HEAT TRANSFER IN STEAM GENERATORS. 2.1.- OBJECTIVES AND RELATION WITH OTHER SUBJECTS AND PROFESSIONAL CAREER.
PART II.- HEAT TRANSFER. CHAPTER 2.-INTRODUCTION.	1.2.-ENERGY MODES. HEAT. THERMAL AND VOLUMETRICL PROPERTIES. 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.
CHAPTER 4.- CONVECTION HEAT TRANSFER.	1.4.-.KEY CONCEPTS. 2.4.-.DIFFERENTIAL EQUATIONS OF CONSERVATION. 3.4.- FORCED CONVECTION COEFFICIENT. 4.4.- NATURAL CONVECTION COEFFICIENT. 5.4.- CONVECTION WITH PHASE CHANGE. CONDENSATION. 6.4.- CONVECTION WITH PHASE CHANGE. BOILING.
CHAPTER 5.- RADIATION HEAT TRANSFER	1.5.- KEY CONCEPTS. 2.5.- BLACK BODY RADIATION. 3.5.- RADIATION HEAT TRANSFER BETWEEN BLACK SURFACES. 4.5.- DIFFUSE-GRAY SURFACES. 5.5.- RADIATION IN GASES
PART III.- DESCRIPTION OF BOILERS. CHAPTER 6.- INTRODUCTION.	1.6.- KEY CONCEPTS AND DEFINITIONS. 2.6.- STEAM BOILERS CLASSIFICATION.
CHAPTER 7.- WATER CIRCULATION IN BOILERS.	1.7.- INTRODUCTION. 2.7.- RECIRCULATION BOILERS. 3.7.- FORCED CIRCULATION BOILERS.
CHAPTER 8.- CLASSIFICATION ACCORDING TO THE BOILER DESIGN.	1.8.- CYLINDRICAL. 2.8.- FIRETUBE. 3.8.- WATERTUBE. 4.8.- SPECIAL BOILERS.

CHAPTER 9.- CLASSIFICATION OF FURNACES ACCORDING TO THE USED FUEL	1.9.- CLASSIFICATION. 2.9.- SOLID FUEL FURNACES. 3.9.- LIQUID FUEL FURNACES. 4.9.- GAS FUEL FURNACES.
CHAPTER 10.- WATER-STEAM SYSTEM	1.10.- INTRODUCTION. 2.10.- ECONOMIZER. 3.10.- STEAM DRUM. 4.10.- VAPORIZER WALLS. 5.10.- SUPERHEATER AND REHEATER. 6.10.- SOOTBLOWERS.
CHAPTER 11.- AIR-FLUEGAS SYSTEM.	1.11.- INTRODUCTION. 2.11.- DRAUGHT. FANS AND STACKS. 3.11.- AIR PREHEATER. 4.11.- SOOT REMOVAL SYSTEMS.
CHAPTER 12.- NUCLEAR ENERGY FOR STEAM GENERATION	1.12.- APPLICATIONS. 2.12.- NUCLEAR FUEL. 3.12.- REACTOR. 4.12.- REACTORS FOR STEAM GENERATION. 5.12.- STEAM GENERATORS.
PART IV.- WATER TREATMENT AND COMBUSTION. CHAPTER 13.- BOILER WATER PROBLEMS.	1.13.- FOAMING AND CARRYOVER. 2.13.- SCALE AND MUD. 3.13.- WATER SIDE CORROSION.
CHAPTER 14.-WATER TREATMENT FOR STEAM GENERATION.	1.14.- CHEMICAL CHARACTERISTICS OF WATER BOILER. 2.14.- EXTERNAL TREATMENT. MAKE-UP AND CONDENSATE. 3.14.- INTERNAL TREATMENT.
CHAPTER 15.- COMBUSTION FUNDAMENTALS.	1.15.- INTRODUCTION. 2.15.- STOICHIOMETRY OF COMBUSTION 3.15.- ANALISYS OF COMBUSTION AND BOILER EFFICIENCY.

The previous topics fulfil with the column 2, "Knowledge, understanding and proficiency", of the Manila amendments to the STCW Code, of the following Table: (see sub-topics) The competences acquisition established in Column 1 of the respective STCW Table, are completed with the overcoming of the contents included in the following complementary subjects to this one: Internal Combustion Engines. Steam and Gas Turbines. Heat Transfer and Steam Boilers. Maritime Installations and Propulsion. Automatization of Maritime Installations Practical traineeship on board	1.- Table A-III/1 of Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-room Function: Marine engineering at operational level Competences -1.1 Maintain a safe engineering watch -1.2 Operate main and auxiliary machinery and associated control systems
The development and overcoming of these contents, together with those corresponding to other subjects that include the acquisition of specific competencies of the degree, guarantees the knowledge, comprehension and sufficiency of the competencies contained in Table AIII / 2, of the STCW Convention, related to the level of management of First Engineer Officer of the Merchant Navy, on ships without power limitation of the main propulsion machinery and Chief Engineer officer of the Merchant Navy up to a maximum of 3000 kW.	Table A-III / 2 of the STCW Convention. Specification of the minimum standard of competence for Chief Engineer Officers and First Engineer Officers on ships powered by main propulsion machinery of 3000 kW or more.

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A1 A2 A6 A8 A9 A78 A87 A90 A93 A94 A95 A96 A99 B2 B3 B5 B7 B12 B16 C3 C7	26	39	65
Objective test	A5 A73 A90 A93 A94 A95 A96 A99 B2 B3 B7 B12 B16	6	12	18
Laboratory practice	A1 A2 A5 A6 A8 A9 A74 A78 A87 A89 A90 A93 A94 A95 A96 A99 B3 B7 B12 C7	9	9	18
Document analysis	A8 A73 A78 A90 A93 A94 A96 A99 B2 B3 B7 B16 C3	0	9.5	9.5
Problem solving	A1 A2 A5 A6 A9 A73 A74 A78 A87 A89 A90 A93 A94 A95 A96 A99 B2 B3 B5 B7 B12 B16 C3 C7	13	19.5	32.5
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 has 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**
Problem solving Laboratory practice Objective test Guest lecture / keynote speech	The personalized attention related with the methodologies that contemplate it, aims to encourage maximum interaction with students, in order to optimize their effort and improve their learning. Through this interaction, together with the other evaluation processes, the degree of learning of the subject competences will be determined, allowing personalized attention to those students who most need it through individualized tutoring, whose convocation will be held in with involved students. Regardless of the face-to-face tutoring programmed by the teacher, the student can go to tutoring, as many times as he wants, and at a time compatible with teaching, research and management professor activities. In accordance with the "norma que regula o réxime de dedicación ao estudo dos estudantes de grao na UDC" (Art.3.b e 4.5) and ""normas de avaliación, revisión e reclamación das cualificacións dos estudos de grao e mestrado universitario? (Art. 3 e 8b), students with part-time recognition and academic exemption from attendance exemption may participate in a personalized and flexible system of mentoring and evaluation tutorials in order to determine the degree of competency learning achieved. Regarding with this matter, the tutorials will serve to carry out those activities included within the methodology of objective tests, problems solving and laboratory practice

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Problem solving	A1 A2 A5 A6 A9 A73 A74 A78 A87 A89 A90 A93 A94 A95 A96 A99 B2 B3 B5 B7 B12 B16 C3 C7	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. Assessed competencies: A1; A6; A7; A14; A21; A29; B2	5
Laboratory practice	A1 A2 A5 A6 A8 A9 A74 A78 A87 A89 A90 A93 A94 A95 A96 A99 B3 B7 B12 C7	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. Assessed competencies: A1; A3; A7; A14; A21; A29; A40; A44; A46; B2; B7; C6	45

Objective test	A5 A73 A90 A93 A94 A95 A96 A99 B2 B3 B7 B12 B16	The degree of acquired knowledge about the learning contents is assessed, taking into account both the theoretical part and the problems. Assessed competencies: A1; A3; A6; A7; A14; A21; A29; A48; A58; B2; B7; C6	45
Guest lecture / keynote speech	A1 A2 A6 A8 A9 A78 A87 A90 A93 A94 A95 A96 A99 B2 B3 B5 B7 B12 B16 C3 C7	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. Assessed competencies: B2; B7; C6	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 official tests of the first chance (May-June) will collect the different assessment methodologies and must be completed by those students who have not fully passed the continuous assessment. This test will be designed in such a way that the student can deal with the methodologies of problem-solving and objective test, where he has not reached 30% of the total rating.The students required to attend the official tests of the second chance (June-July) will retain the qualification achieved in all methodologies, except for the one obtained in the objective tests of the first chance, which will be replaced by the 2nd. In the same way, you can only opt for honours if the maximum number of these for the corresponding course is not covered in full at the first chance.For the students with recognition of part-time dedication and academic exemption of attendance exemption, the qualification obtained in the activities associated with the personalized tutoring system will correspond to the evaluation of the methodology of problem-solving and objective tests, with 30 % and 70 % of total rating, respectively.Fraudulent performance of the tests or evaluation activities, once verified, will directly imply a failing grade "fail" (numeric mark 0) in the subject and in the corresponding first or second call, besides invalidating any grade obtained in either evaluation activity for the extraordinary call. For that, the mark in the first chance will be modified if needed.The assessment system complies with the criteria for assessing competence set out in Column 4 of the following Tables of the STCW Convention as amended by Manila 2010:1.- Table A-III/1 of Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-roomFunction: Marine engineering at operational levelCompetences -1.1 Maintain a safe engineering watch-1.2 Operate main and auxiliary machinery and associated control systems

Sources of information	
Basic	- Holman, J. P (1998). Transferencia de Calor. McGrawHill - Bejan, A. (1993). Heat Transfer. John Wiley & Sons, Nueva York - B Babcock & Wilcox (1992). Steam: Its generation and use. Babcock & Wilcox, USA - Mesny, M. (1976). Generación del Vapor. Marymar, Buenos Aires - Molina, L. A. I. y Alonso. J. M. G. (1996). Calderas de Vapor en la Industria (II). Cadem, Bilbao Â
Complementary	- Chapman, A. J. (1990). Transmisión del Calor. Bellisco, Madrid - Germain, L et al. (1982). Tratamiento de las Aguas. Omega, Barcelona - (). . - Kakaç, S. (1991). Boilers, Evaporators and Condensers. John Wiley & Sons, Nueva York - Port, R. D. y Herro, H. M.: (1997). Guía Nalco para el Análisis de Fallas en Calderas. McGraw-Hill, México

Recommendations
Subjects that it is recommended to have taken before
Thermodynamics and Engineering Thermodynamics/631G02254
Subjects that are recommended to be taken simultaneously

Maritime Installations II/631G02359 Steam and Gas Turbines/631G02352 Thermal Marine Machinery/631G02361
Subjects that continue the syllabus
Energy Techniques Applied to Ship/631G02453 /
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.