Teaching Guide				
Identifying Data				2020/21
Subject (*)	Heat transfer and steam generators		Code	631G02353
Study programme	Grao en Tecnoloxías Mariñas			
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.			

Contingency plan	1. Modifications to the contents No changes will be done 2. Methodologies *Teaching methodologies that are maintained Keynote speech (takes into account in the evaluation) Problem solving (takes into account in the evaluation) Document analysis. Objective test (takes into account in the evaluation) Laboratory practices (takes into account in the evaluation). *Teaching methodologies that are modified Laboratory practices. The necessary procedures will be developed to guarantee the acquisition of the associated competencies following the recommendations of higher authorities. Problem solving activity will be ?supervised projects? activity. 3. Mechanisms for personalized attention to students E-mail: To carry out inquiries, solve theoretical and problem-solving doubts and follow up on supervised work. - Moodle: Through the forums, students can ask questions about theoretical content and problem-solving. Led discussions can be raised on certain contents of the subject. - Teams: Sessions in the official schedule for the development of the theoretical-practical contents and the supervised works. Additional sessions if necessary or on student demand, for the resolution of doubts and support in supervised work. 4. Modifications in the evaluation Problem-solving and Supervised projects account for 30 % of the total mark Objective test accounts for 60 % of the total mark *Evaluation observations: The same requirements are maintained in the 2nd evaluation computing attendance both, personal and on-line if applicable (according to the attendee list downloaded from Teams). For students with recognition of part-time dedication and academic exemption from attendance exemption, the grade obtained in the activities associated with the personalized tutoring system will correspond to the evaluation of the supervised projects methodology and objective tests, with a weighting of 40 and 60%, respectively. 5. Modifications to the bibliography or webgraphy. No changes will be done. Students can access digitized content, both theoretical and practical in Moodle.

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.
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.
A30	CE42 - Operar, reparar, manter, reformar, optimizar a nivel operacional as instalacións industriais relacionadas coa enxeñaría mariña, como motores alternativos de combustión interna e subsistemas; turbinas de vapor, caldeiras e subsistemas asociados; ciclos combinados; propulsión eléctrica e propulsión con turbinas de gas; equipos eléctricos, electrónicos, e de regulación e control do buque; as instalacións auxiliares do buque, tales como instalacións frigoríficas, sistemas de goberno, instalacións de aire acondicionado, plantas potabilizadoras, separadores de sentinas, grupos electróxenos, etc.
A32	CE44 - Coñecer o balance enerxético xeral, que inclúe o balance termo-eléctrico do buque, ou sistema de mantemento da carga, así como a xestión eficiente da enerxía respectando o medio.
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.
A55	Coñecer o balance enerxético xeral, incluíndo o balance termo-eléctrico, así como a xestión eficiente da enerxía respectando o medio.
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.
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 vanguardia 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

Analysis and synthesis of the theory of heat transfer.	A1	B2	C6
Capacity to resolve problems of heat transfer in industrial	A3	B7	C9
installations.	A6		C10
Critical reasoning of the distinct modes of heat transfer present	A7		C12
in the installations of the marine engineering.	A14		C13
Identify the typology and elements of steam generators.	A21		
Planning and making decisions in the design, management and operation of steam generators.	A29		
Energetic optimization of heat transfer equipment.	A30		
The following competences included in Table A-III / 1 of the STCW Code as amended by Manila; Function: Marine engineering	A32		
at operational level -1.1 Maintain a safe engineering watch -1.2 Operate main and auxiliary machinery and associated control	A40		
systems	A44		
	A46		
	A48		
	A55		
	A58		

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 A3 A6 A7 A14 A21 A29 A30 A32 A40 A44 A46 A48 A55 A58 B2 B7 C6 C9 C10 C12 C13	26	39	65
Objective test	A1 A3 A6 A7 A14 A21 A29 A30 A32 A40 A44 A46 A48 A55 A58 B2 B7 C6 C9 C10 C13	6	12	18
Laboratory practice	A1 A3 A6 A7 A14 A21 A29 A30 A40 A44 A46 B7 C6	9	9	18
Document analysis	A3 A14 A48 A58 B2 B7 C6 C9 C13	0	9.5	9.5
Problem solving	A1 A6 A7 A14 A21 A29 A32 A40 A55 B2 B7 C6 C9 C12	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**

Guest lecture / keynote speech Objective test Laboratory practice Problem solving	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**
Guest lecture / keynote speech	A1 A3 A6 A7 A14 A21 A29 A30 A32 A40 A44 A46 A48 A55 A58 B2 B7 C6 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. Assessed competencies: B2; B7; C6	5
Objective test	A1 A3 A6 A7 A14 A21 A29 A30 A32 A40 A44 A46 A48 A55 A58 B2 B7 C6 C9 C10 C13	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
Laboratory practice	A1 A3 A6 A7 A14 A21 A29 A30 A40 A44 A46 B7 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. Assessed competencies: A1; A3; A7; A14; A21; A29; A40; A44; A46; B2; B7; C6	45
Problem solving	A1 A6 A7 A14 A21 A29 A32 A40 A55 B2 B7 C6 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. 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 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.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