Teaching Guide					
Identifying Data					2023/24
Subject (*)	Steam and Gas Turbines			Code	631G03021
Study programme	Grao en Máquinas Navais				
Descriptors					
Cycle	Period	Year		Type	Credits
Graduate	1st four-month period	Third		Optional	6
Language	SpanishGalician				
Teaching method	Face-to-face				
Prerequisites					
Department	Ciencias da Navegación e Enxeñaría Mariña				
Coordinador	Fraguela Díaz, Feliciano		E-mail	feliciano.fraguela@udc.es	
Lecturers	Antelo Gonzalez, Felipe Fraguela Díaz, Feliciano Garcia Galego, Jose Ramon		E-mail	felipe.antelo@udc.es feliciano.fraguela@udc.es jose.ramon.garcia@udc.es	
Web					
General description	Taking into account that it is a compulsory subject, it is intended that the student acquire the necessary and sufficient theoretical and practical knowledge, leading to obtaining an academic title that he intends and in the exercise of his profession, to be able to solve as many questions as he is asked. present in the driving engineering and maintenance of machines and facilities, either due to natural wear and tear, or due to breakdowns arising from various reasons.				

Study programme competences / results	
Code	Study programme competences / results
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.
A7	CE07 - Manter a navegabilidade do buque.
A8	CE08 - Vixiar o cumprimento das prescricións lexislativas.
A9	CE09 - Emprego do inglés escrito e falado.
A12	CE12 - Garantir o cumprimento das prescricións sobre prevención da contaminación.
A16	CE16 - Aplicar as calidades de liderado e de traballo en equipo.
A17	CE17 - Contribuír á seguridade do persoal e do buque
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.
A79	CE79 - Adquirir coñecementos de mecánica de fluídos e a súa aplicación á resolución de problemas no campo da enxeñería.
A80	CE80 - Coñecer as características e limitacións dos materiais utilizados para a reparación de buques e equipos.
A81	CE81 - Coñecer o funcionamento e operación dos equipos e sistemas auxiliares instalados en buques e instalacións marítimas.
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.
A91	CE91 - Redactar e interpretar documentación técnica.
A92	CE92 - Aplicar os protocolos de seguridade ante calquera tipo de incidencia.
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.
A97	CE97 - Óptima explotación de industrias relacionadas coa náutica e o transporte marítimo, tanto en competencias referidas á calidade, medio ambiente, seguridade mariña e prevención de riscos laborais.
A98	CE98 - Ter a capacidade para a xestión, dirección, control, organización e planificación de industrias ou explotacións relacionadas coas actividades da enxeñería mariña tanto en competencias referidas á calidade, medio ambiente, seguridade mariña e prevención de riscos laborais como todas as actividades relacionadas coa posta no mercado da súa produción.
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
B4	CB4 - Poder transmitir información, ideas, problemas e solucións a un público tanto especializado como non especializado.
B5	CB5 - Ter desenvolvido aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores con un alto grao de autonomía.
B6	CG01 - Capacidade para xestionar os propios coñecementos e utilizar de forma eficiente técnicas de traballo intelectual.
B7	CG02 - Resolver problemas de forma efectiva.
B8	CG03 - Comunicarse de maneira efectiva nunha contorna de traballo.
B9	CG04 - Traballar de forma autónoma con iniciativa.
B10	CG05 - Traballar de forma colaborativa.
B11	CG06 - Comportarse con ética e responsabilidade social como cidadán e como profesional.
B12	CG07 - Capacidade para interpretar, seleccionar e valorar conceptos adquiridos noutras disciplinas do ámbito mariño, mediante fundamentos físico-matemáticos.
B13	CG08 - Capacidade para a aprendizaxe de novos métodos e teorías, que lle doten dunha gran versatilidade para adaptarse a novas situacións.
B14	CG09 - Comunicar por escrito e oralmente os coñecementos procedentes da linguaxe científica.
B15	CG10 - Capacidade para resolver problemas con iniciativa, toma de decisións, creatividade, razoamento crítico e de comunicar e transmitir coñecementos habilidades e destrezas.
B16	CG11 - Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.
B17	CG12 - Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.
B18	CG13 - Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.
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.
C4	CT04 - Desenvolverse para o exercicio dunha cidadanía respectuosa coa cultura democrática, os dereitos humanos e a perspectiva de xénero.
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.
C8	CT08 - Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.
C9	CT09 - Ter a capacidade de xestionar tempos e recursos: desenvolver plans, priorizar actividades, identificar as críticas, establecer prazos e cumprilos.

Learning outcomes

Learning outcomes	Study programme competences / results		
Carrying out energy balances of turbomachines, and making decisions from the point of view of energy optimization.	A1 A2 A5 A7 A8 A17 A73 A74 A78 A79 A81 A89 A90 A91 A93 A95 A97 A98 A99	B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18	C3 C7 C8 C9
Analysis of the thermodynamic processes that take place in thermal turbomachines.	A1 A2 A5 A7 A8 A17 A73 A74 A78 A79 A81 A89 A90 A91 A93 A95 A96 A97 A98 A99	B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18	C3 C7 C8 C9

Operation, repair and maintenance of turbomachinery, and auxiliary equipment thereof.	A1 A2 A5 A6 A7 A8 A9 A12 A16 A17 A73 A74 A78 A79 A80 A81 A87 A89 A90 A91 A92 A94 A95 A96 A97 A98 A99	B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18	C3 C4 C7 C8 C9
Calculations of the components involved in thermal turbomachinery facilities	A1 A2 A5 A7 A8 A17 A73 A74 A78 A79 A81 A89 A90 A91 A93 A95 A96 A97 A98 A99	B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18	C3 C4 C7 C8 C9

Supervision, interpretation and diagnosis of the variables involved in the operation of thermal turbomachines.	A1 A2 A5 A6 A7 A8 A9 A12 A16 A17 A73 A74 A78 A79 A80 A81 A87 A89 A90 A91 A92 A93 A94 A95 A96 A97 A98 A99	B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18	C3 C4 C7 C8 C9

Contents	
Topic	**Sub-topic**
1. Cycles of steam and gas turbines.	Introduction. Study of the cycles of gas turbines: Ideal cycles. real cycles. open and closed loops. Determination of work and performance in gas turbine cycles. Steam turbine cycles. Rankine cycle. real cycles of steam turbines. Rankine cycle improvements. Determination of powers and yields in steam cycles.
2. Construction elements of steam and gas turbines	Introduction. Rotors: description and classification. stresses to which they are subjected. axial thrust. Stators: description and classification. Efforts to which they are subjected. Shutters. nozzles. Nozzle classes. Study of the nozzles. Nozzle project. Palettes: types, function and form. Nozzle vanes: Function and form. Gas turbine compressors. Heat exchangers.2. Construction elements of steam and gas turbines
3. Staggering.	Introduction. Turbines classification. Thermodynamic study of the staggering of action, reaction and action-reaction. Study of mixed action and reaction turbines. Calculation of performance in the ideal case. Maximum performance speed.
4. Dynamics of the turbines.	Introduction. Dynamics of action, reaction and action-reaction turbines. Force acting on the blades. engine torque Pressure and velocity jumps. Number of sections. Yields. Its calculation in the real case.
5. Economic study of turbine installations.	Introduction. Powers. Yields. Specific consumption. Economic study of the installation.
6. Variation of power in the turbines.	Introduction. Methods of power variation in turbines. Study in the h-s diagram according to the adopted system. Comparative criticism.

7. Condensers.	Introduction. The phenomenon of condensation. Ejectors and vacuum pumps. Accessories. Turbine condensers: Characteristics. optimal pressure. Types of capacitors. Ejectors: Your calculation. Heat transfer in condensers. Calculation of capacitors. Capacitor design criteria.7. capacitors.
8. Combustion in gas turbines.	Introduction. Chemical process of combustion, amount of air necessary for combustion, the rate of excess air. Fuels used in gas turbines. Fuel pumps and injection valves. Combustion chambers.
9. Combined cycles.	Introduction. Thermodynamic fundamentals of a combined cycle. Yields.
10. Driving installations of steam and gas turbines.	Driving turbine installations. Commissioning of the auxiliary devices necessary for the operation of the turbines. Warming up and getting ready to go out to sea. Driving during operation and stop.
STCW. The development and improvement of these contents, together with those corresponding to other subjects that include the acquisition of specific competences of the degree, guarantee the knowledge, understanding and sufficiency of the competences included in table AIII/2, of the STCW Agreement, related to the management level of First Engineer Officer of the Merchant Navy, without power limitation of the propulsion plant and Chief Engineer of the Merchant Navy up to a maximum of 3000 kW	Table A-III/2 of the STCW Convention.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Laboratory practice	A99 A98 A97 A96 A95 A94 A93 A92 A90 A89 A87 A81 A80 A79 A78 A74 A17 A16 A12 A8 A7 A6 A5 A2 A1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18 C3 C4 C7 C8 C9	15	42	57
Problem solving	A99 A98 A97 A96 A95 A94 A93 A92 A91 A90 A89 A87 A81 A80 A79 A78 A74 A73 A17 A16 A12 A9 A8 A6 A5 A2 A1 B18 B17 B16 B15 B14 B13 B12 B11 B10 B9 B8 B7 B6 B5 B4 B3 B2 C3 C4 C7 C8 C9	5	5	10

Objective test	A99 A98 A97 A96 A95 A94 A93 A92 A91 A90 A89 A87 A81 A80 A79 A78 A74 A73 A17 A16 A12 A9 A8 A7 A6 A5 A2 A1 B18 B17 B16 B15 B14 B13 B12 B11 B10 B9 B8 B7 B6 B5 B4 B3 B2 C3 C4 C7 C8 C9	3	0	3
Guest lecture / keynote speech	A99 A98 A97 A96 A95 A94 A93 A92 A91 A90 A89 A87 A81 A80 A79 A78 A74 A73 A17 A16 A12 A9 A8 A7 A6 A5 A2 A1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18 C3 C4 C7 C8 C9	25	52	77
Personalized attention		3	0	3
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	**Description**
Laboratory practice	Practices will be carried out related to the processes that are the object of the matter to be studied. There will be a sharing of what has been done and a discussion of the different solutions adopted to the given problem.
Problem solving	A series of problems related to the contents of the subject matter will be proposed and solved and oriented, as far as possible, to real cases.
Objective test	Written tests will be carried out, which will consist of theoretical and practical questions.
Guest lecture / keynote speech	The detailed explanation of the contents of the matter distributed in topics will be made. The student will have bibliographic material to support the subject in each master session. Student participation in class will be encouraged through comments that try to relate theoretical content to real experience.

Personalized attention	
Methodologies	**Description**
Laboratory practice	It is about guiding the student in matters related to the subject taught and that are particularly difficult to understand and apply to practical cases. The communication channels will be the virtual campus and the individualized tutorials that will take place during the hours indicated for each academic year.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**

Laboratory practice	A99 A98 A97 A96 A95 A94 A93 A92 A90 A89 A87 A81 A80 A79 A78 A74 A17 A16 A12 A8 A7 A6 A5 A2 A1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18 C3 C4 C7 C8 C9	The development and involvement in the practices will be valued, as well as the resolution of the proposed works on them.	20
Problem solving	A99 A98 A97 A96 A95 A94 A93 A92 A91 A90 A89 A87 A81 A80 A79 A78 A74 A73 A17 A16 A12 A9 A8 A6 A5 A2 A1 B18 B17 B16 B15 B14 B13 B12 B11 B10 B9 B8 B7 B6 B5 B4 B3 B2 C3 C4 C7 C8 C9	Participation in problem solving will be valued, as well as the presentation of their results.	10
Objective test	A99 A98 A97 A96 A95 A94 A93 A92 A91 A90 A89 A87 A81 A80 A79 A78 A74 A73 A17 A16 A12 A9 A8 A7 A6 A5 A2 A1 B18 B17 B16 B15 B14 B13 B12 B11 B10 B9 B8 B7 B6 B5 B4 B3 B2 C3 C4 C7 C8 C9	The degree of knowledge acquired on the subject will be valued, both from the theoretical part and from practical knowledge.	70

Assessment comments
The evaluation criteria contemplated in tables A-III / 1 and A-III / 3 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 from attendance exemption will not be required to have a minimum attendance to be able to take the partial exams, however, a series of tutorials (face-to-face or non-face-to-face) must be agreed with the teacher. throughout the course to accredit the follow-up of the matter.

Sources of information	
Basic	Claudio Mataix (2000). Turbomáquinas Térmicas. Madrid. DOSSATM. J. Moran; H. N. Shapiro (1999). Fundamentos de Termodinámica Técnica. Barcelona. Ed. REVERTÉ, S.A.Mariano Muñoz Rodríguez (1999). Turbomáquinas Térmicas. Zaragoza. Ed. PRENSAS UNIVERSITARIAS DE ZARAGOZAManuel Muñoz Torralbo (2001). Turbomáquinas Térmicas. Madrid. Sec. public. ETS Ingenieros IndustrialeSantiago Sabugal García (2006). Centrales Térmicas de Ciclo Combinado. Ed. Díaz de Santos

Complementary	A. V. Schegliáiev (1978). Turbinas de vapor (parte 1 y 2). Moscú. Ed. MIRJ. Pérez del Rio (1972). Tratado General de Máquinas Marinas (Tomo VII. Máquinas de vapor). Barcelona. Ed. PLANETARolf Kehlhofer et al. (2009). Combined-Cycle Gas & Steam Turnine Power Plants. Tulsa, Oklahoma. USA. PennWell CorporationSir John H. Horlock (2002). Combined Power Plants. Malabar, Florida. KRIEGER PUBLISHING COMPANYÁngel Luis Miranda Barreras (1998). Turbinas de gas. Barcelona. Ed. CEAC

Recommendations
Subjects that it is recommended to have taken before
Thermodynamics and Engineering Thermodynamics/631G03014
Subjects that are recommended to be taken simultaneously
Heat Transfer and Steam Generators/631G03022
Subjects that continue the syllabus
Other comments
To help achieve a sustainable immediate environment and meet the objective of action number 5: "Healthy and environmentally and socially sustainable teaching and research" of the "Green Campus Action Plan":a) The delivery of the documentary works carried out in this matter will preferably be requested in virtual format or computer support, and may be done through Moodle, in digital format, without the need to print them. In the case of being done on paper, plastics will not be used, the prints will be double-sided on recycled paper, and the printing of drafts will be avoided.b) The full integration of students who, for physical, sensory, mental, socio-cultural or gender reasons, experience difficulties in gaining suitable, equal and beneficial access to university life will be facilitated.c) The importance of ethical principles related to the values of sustainability in personal and professional behavior must be taken into account.d) As stated in the different regulations applicable to university teaching, the gender perspective must be incorporated in this area (non-sexist language will be used, bibliography of authors of both sexes will be used, intervention in class of students will be encouraged ...)e) Work will be done to identify and modify prejudices and sexist attitudes and influence the environment to modify them and promote values of respect and equality.f) Situations of gender discrimination should be identified, and actions and measures proposed to correct them.