Teaching Guide				
Identifying Data				2019/20
Subject (*)	Power Stations		Code	730G04052
Study programme	Grao en enxeñaría en Tecnoloxías Industriais			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	Third	Obligatory	6
Language	Galician			
Teaching method	Face-to-face			
Prerequisites				
Department	Ciencias da Navegación e Enxeñaría MariñaEnxeñaría Naval e Industrial			
Coordinador	Calvo Diaz, Jose Ramon	E-mail	jose.ramon.calvo@udc.es	
Lecturers	Calvo Diaz, Jose Ramon Lamas Galdo, Isabel	E-mail	jose.ramon.calvo@udc.es isabel.lamas.galdo@udc.es	
Web				
General description				

Study programme competences / results	
Code	Study programme competences / results
A24	TEE9 Capacidade para o deseño de centrais eléctricas.
B2	CB2 Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
B3	CB3 Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitiren xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
B4	CB4 Que os estudantes poidan transmitir información, ideas, problemas e solucións a un público tanto especializado como leigo
B5	CB5 Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprenderen estudos posteriores cun alto grao de autonomía
B6	B3 Ser capaz de concibir, deseñar ou poñer en práctica e adoptar un proceso substancial de investigación con rigor científico para resolver calquera problema formulado, así como de comunicar as súas conclusións ?e os coñecementos e razóns últimas que as sustentan? a un público tanto especializados como leigo dun xeito claro e sen ambigüidades
B7	B5 Ser capaz de realizar unha análise crítica, avaliación e síntese de ideas novas e complexas
C1	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.
C4	C6 Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.
C5	C7 Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.
C6	C8 Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.

Learning outcomes			
Learning outcomes	Study programme competences / results		
Know how to design power plants.	A24	B2 B3 B4 B5 B6 B7	C1 C4 C5 C6

Contents	
Topic	**Sub-topic**
The following topics develop the contents indicated in the Verification Memory (Memoria de Verificación), which are:	Types of power plants Parts of power plants Design of power plants
1. Exergy analysis	Introduction to exergy. Closed system energy balance. Open system exergy balance. Flow exergy. Exergetic efficiency and thermoeconomics.
2. Gas, vapor and combined power cycles. Exergetic and energetic analysis	Rankine cycle. Brayton cycle. Combined cycles.
3. Psychrometrics	Fundamentals of psychrometrics. Psychrometric diagrams. Psychrometric charts. Analysis of air-conditioning processes. Cooling towers.
4. Power plants	Introduction. Types. Classification.
5. Spanish electrical system	Introduction. Participation of the energy sources in the electric power.
6. Thermal power plants	General description. Air-gasses system. Water-vapor system. Refrigeration system. Combustion system.
7. Steam generators	Classification. Fundamentals of steam generation. Parts of a steam generation. Auxiliary equipment. Heat transfer. Water treatment.
8. Gas treatment	Pollutants. Particulate reduction. SOx reduction. NOx reduction.
9. Condensers and heaters	Condensation. Types of condensers. Types of heaters. Deaeration. Heat transfer.
10. Gas and steam turbines	Steam turbines. Gas turbines.
11. Cogeneration	Principle of operation. Configurations. Trigeneration. Cogeneration in Spain.
12. Combustion	Combustion process. Ideal and real combustion. Enthalpy of formation, reaction, combustion and heating values. 1st law of Thermodynamics applied to reacting systems. Adiabatic flame temperature. Entropy in reacting systems. 2nd law of Thermodynamics applied to reacting systems. Equilibrium.

Planning				
Methodologies / tests	**Competencies / Results**	**Teaching hours (in-person & virtual)**	**Student?s personal work hours**	**Total hours**
Field trip	A24 B2 B3 B4 B5 B6 B7 C1 C4 C5 C6	5	11	16
Problem solving	A24 B2 B3 B4 B5 B6 B7 C1 C4 C5 C6	18	36	54
Mixed objective/subjective test	A24 B2 B3 B4 B5 B6 B7 C1 C4 C5 C6	4	6	10
Guest lecture / keynote speech	A24 B2 B3 B4 B5 B6 B7 C1 C4 C5 C6	22	44	66
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**
Field trip	Trips related to power plants
Problem solving	Problem solving
Mixed objective/subjective test	Exams
Guest lecture / keynote speech	Conventional classes

Personalized attention	
Methodologies	**Description**
Mixed objective/subjective test Field trip Problem solving	Academic dispense is allowed. Students who request it must contact teacher to realize additional homework.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
Mixed objective/subjective test	A24 B2 B3 B4 B5 B6 B7 C1 C4 C5 C6	Exams	70
Field trip	A24 B2 B3 B4 B5 B6 B7 C1 C4 C5 C6	Students must deliver a summary of the trip	15
Problem solving	A24 B2 B3 B4 B5 B6 B7 C1 C4 C5 C6	Students must deliver some problems/works	15
Others			

Assessment comments
Two exams will be realized before the final exam. The score must be higher than 3.5 in each partial exam. If the trip is not realized, the grade will be assigned to the problem solving part. Students who request academic dispense must realize other activities proposed by the teacher instead field trip and problem solving. The qualification is the same as the problem solving and field trip. The evaluation criteria for 2nd opportunity will be the same as 1st opportunity.

Sources of information

Basic	- Evaristo Rodríguez, Mª Sonia Zaragoza (2008). Centrales Energéticas. Reprografía Noroeste - Consuelo Sánchez Naranjo (). Tecnología de las Centrales Termoeléctricas Convencionales. - Steven C. Stultz, and J.B. Kitto (). Steam its Generation and Use. Babcock & Wilcox - A.G. Blokh, R. Viskanta (). Heat Transfer in Steam Boiler Furnaces. Hemisphere Publishing co - Charles E. Baukal Jr (2000). Heat Transfer in Indutrial Combustion. CRC Press New York - Joseph G. Singer (1991). Combustion Fossil Power. Combustion Engineering Inc - Irvin Glassman, Richard A. Setter and Nick G. Glumac (). Combustion. - ASINEL (). Calderas de vapor. - ASINEL (). Condensación, vacío y refrigeración. - ASINEL (). Desgasificador. - ASINEL (). Extracciones y Precalentadores de Agua. - ASINEL (). Turbinas de Vapor. - Pedro Fernández Díez (). Centrales Térmicas. - Pedro Fernández Díez (). Turbinas de Vapor. - Pedro Fernández Díez (). Turbinas de Gas. - Claudio Mataix (). Turbomáquinas Térmicas. - Gaffert (). Centrales de Vapor. - Lucien Vivier (). Turbinas de Vapor y Gas. - Eduardo Brizuela (). Turbomáquinas. - Edwin F. Church (). Turbinas de Vapor. - Cohen y Rogers (). Teoría de las Turbinas de Gas. - Santiago Sabugal (). Centrales Térmicas de Ciclo Combinado. - Rolf Kehlhofer (). Combined-Cycle Gas and Steam Turbine Power Plants. - Enrique Pallarés Huici (). Apuntes de Sistemas Energéticos. Tomo I y tomo II. - Consejería de Economía y Hacienda de la Comunidad de Madrid (). Guía de la Cogeneración. - Barberton (). Steam: its Generation and Use. - Chase, Malcolm W. (). NIST-JANAF thermochemical tables. - Moran, M.J y Shapiro H.N. (). Fundamentos de Termodinámica Técnica. John Willey & Sons - Cengel, Y.A y Boles, M.A. (). Termodinámica. McGraw-Hill
Complementary	- M. A. Glinkov, G. M. Glonkov (1990). A General Theory of Furnaces. Moscu. Mir - A. L. Kohan (1998). Boiler Operator?s Guide. McGraw-Hill - P. Chattopadhyay (2001). Boiler Operation Engineering. McGraw-Hill - E. Rodríguez, M. S. Zaragoza (2007). Tecnología Energética. SANTIAGO. Reprografía Noroeste - S. Kabac (1991). Boilers, Evaporators and Condensers. J. Wiley & Sons - R. M. Clapp (1990). Boilers and Ancillary Plant. Pergamon Press - J. A. Orlando (1991). Cogeneration Planner?s Handbook. The Fairmont Press - R. Kehlhofer (1999). Combined-Cycle Gas Steam Turbine Power Plants. PennWell - F. J. Barclay (1995). Combined Power and Process. An Exergy Approach. Mechanical Engineering Publications, Ltd - V. Ya. Rizking (1979). Centrales Termoeléctricas. Vol. 1 y 2. Moscu. Mir - A. Bürkholz (1989). Droplet Separation. CVH Weinheim (Germany) - H. A. Sorensen (1983). Energy Conversion Systems. Wiley - W C. Turner (2001). Energy Management Handbook. The Fairmon Press - Dr. C. Beggs (2002). Energy: Management, Supply and Conservation. Butterworth Heinemann - M. J. M., and H. N. S (1995). Fundamentals of Engineering Thermodynamics. Wiley - A. L. Lydersen (1993). Mass Transfer in Engineering Practice. Willey - A. Sherry (1979). Modern Power Station Practice. Vol. 2 and 3. Pergamon Press - G. G. Rajan (2003). Optimizing Energy Efficiencies in Industry. McGraw-Hill - A. Bejan (1998). Thermodynamic Optimization of Complex Energy Systems. NATO Sciences Series - A. V. Schegliaiev (1978). Turbinas de Vapor. Vol. 1 y 2. Moscu. Mir - P. Hambling (1991). Turbines, Generators and Associated Plant. Pergamon Press

Recommendations
Subjects that it is recommended to have taken before
CÁLCULO/730G04001 TERMODINÁMICA/730G04014 MECÁNICA DE FLUÍDOS/730G04018
Subjects that are recommended to be taken simultaneously
Industrial Heat Transfer/730G04020
Subjects that continue the syllabus
Other comments
To help achieve a sustained immediate environment and meet the objective of action number 5: "Healthy and sustainable environmental and social teaching and research" of the "Green Campus Ferrol Action Plan":   The delivery of the documentary works that are made in this matter: ? Will be requested in virtual format and / or computer support   ? It will be done through Moodle, in digital format without the need to print them   ? If it is necessary to make them on paper: - Plastics will not be used   - Double-sided prints will be made.   - Recycled paper will be used.   - Printing of drafts will be avoided.   ? A sustainable use of resources and the prevention of negative impacts on the natural environment must be made   ? The importance of ethical principles related to the values ??of sustainability in personal and professional behaviors must be taken into account   ? Gender perspective is incorporated into the teaching of this subject (non-sexist language will be used, bibliography of authors of both sexes will be used, intervention in class of students will be encouraged ...)   ? Work will be done to identify and modify prejudices and sexist attitudes, and the environment will be influenced to modify them and promote values ??of respect and equality.   ? Discrimination situations must be detected and actions and measures will be proposed to correct them.