COURSE PROGRAM[1]

Academic Year: 2021/2022

Identification and characteristics of the course			
Code[2]	401483	ECTS Credits	6
Course name (English)	Thermal and Fluid Technologies		
Course name (Spanish)	Tecnología Térmica y de Fluidos		
Degree programs[3]	Master Universitario en Ingeniería Industrial		
Faculty/School[4]	Escuela de Ingenierías Industriales		
Semester	2º	Type of course	Obligatory
Module	Industrial Technologies		
Matter	Thermal and Fluid Technologies		
Lecturer/s			
Name	Office	E-mail	Web page
Awf Al-Kassir	B1.15	aawf@unex.es	www.unex.es
Emilio J. Vega Rodríguez	C1.9	ejvega@unex.es	
Subject Area	Machines and Thermal Engines		
Department	Mechanical, Thermal and Materials Engineering		
Coordinating Lecturer[5] (Ifmore than one)	Awf Al-Kassir		

Competencies[6] (see table at http://bit.ly/competenciasMUII)

Basic Competences	Check With an "X"	General Competences	Check With an "X"	Transversal Competences	Check With an "X"	Specific Competences EC y ECM (I)	Check With an "X"	Specific Competences ET (II)	Check With an "X"	Specific Competences EG (III)	Check With an "X"	Specific Competences EI (IV)	Marcar con una "X"
CB6	X	CG1	X	CT1	X	CEC1		CET1		CEG1		CEI1	
CB7	X	CG2	X	CT2	X	CEFM1		CET2		CEG2		CEI2	
CB8	X	CG3		CT3	X			CET3		CEG3		CEI3	
CB9	X	CG4	X	CT4	X			CET4		CEG4		CEI4	
CB10	X	CG5		CT5	X			CET5	X	CEG5		CEI5	
		CG6		CT6	X			CET6		CEG6		CEI6	
		CG7		CT7	X			CET7		CEG7		CEI7	
		CG8	X	CT8	X			CET8		CEG8			
		CG9	X	CT9	X								
				CT10	X								
				CT11	X								
				CT12	X								
				CT13	X								

CEC: Competencias específicas complementarias

[1] In case of joint programmes, inter-faculty programmes, double degrees, etc., please collect information from all degrees and all faculties involved in the same document.
[2] In case there is more than one code for a given subject, please include all.
[3] In case the subject is delivered in more than one degree, please include all (also double degrees).
[4] In case the subject is delivered in more than one faculty, please include all.
[5] In case the subject is delivered in more than one faculty, please include name of responsible lecturer at each one.
[6] Competencies must conform to those specified in the "Degree's Verified Memory".

CET: Competencias específicas de tecnologías industriales
CEG: Competencias específicas de gestión
CEI: Competencias específicas de instalaciones, plantas y construcciones complementarias
CEFM: Competencias específicas de fin de máster

Competences EM1	Check With an "X"	Competences EM2	Check With an "X"	Competences EM3	Check With an "X"	Competences EM4	Check With an "X"	Competences EM5	Check With an "X"	Competences EM6	Check With an "X"
CEM1.1		CEM2.1		CEM3.1		CEM4.1		CEM5.1		CEM6.1	
CEM1.2		CEM2.2		CEM3.2		CEM4.2		CEM5.2		CEM6.2	
CEM1.3		CEM2.3		CEM3.3		CEM4.3		CEM5.3		CEM6.3	
CEM1.4		CEM2.4		CEM3.4		CEM4.4		CEM5.4		CEM6.4	
CEM1.5		CEM2.5		CEM3.5		CEM4.5		CEM5.5		CEM6.5	
		CEM2.6		CEM3.6				CEM5.6		CEM6.6	
								CEM5.7			
								CEM5.8			

CEM1: Competencias de especialidad: tecnologías de producción
CEM2: Competencias de especialidad: organización industrial
CEM3: Competencias de especialidad: energías renovables y eficiencia energética
CEM4: Competencias de especialidad: redes eléctricas inteligentes
CEM5: Competencias de especialidad: mecatrónica
CEM6: Competencias de especialidad: gestión integral de proyectos de innovación

Contents

Course outline[6]

Centrifugal pumps and fans. Tangential and diagonal turbines. Axial machines. Positive displacement machines. Thermal engine analysis. Compressible fluids. Thermal machine analysis. Heating and cooling system industries. Thermal systems: heat exchangers, boilers, furnaces and dryers. Design of refrigeration systems. Commercial refrigeration installations.

Course syllabus

Name of lesson 1: Introduction to the design of centrifugal and axial turbomachines
Contents of lesson 1: Design elements of a centrifugal turbomachine: suction mouth, impeller, guide ring and spiral case. Design elements of an axial turbomachine: model of the isolated profile and procedure for designing the impeller.
Description of the practical activities of lesson 1:
AP1: Complete test of a centrifugal pump: measurement of NPSHr (1.5h) in the Laboratory
AP2: Complete test of a centrifugal pump: performance measurement (1.5h) in the Laboratory.
AP3: Design of a blade of an axial pump (3h) in the Laboratory.

Name of lesson 2: Introduction to CFD simulation of hydraulic turbomachines.
Contents of lesson 2: El problema fluido-dinámico. La turbulencia. El flujo cerca de la pared. El método CFD. Ejemplos.

Name of lesson 3: Industrial installations for the Generation of Cooling and Heating Energy.
Contents of lesson 3: Heating and cooling Systems and their industrial applications. Characteristics of refrigerant fluids. Classification of boilers. Types of fuels used in industrial heat generation systems.
Description of the practical activities of lesson 3:
AP1: Analysis of the operation of refrigeration machines (2h) in the classroom.
AP2: Identification of the main elements of a boiler (2h) in the Laboratory.

Name of lesson 4: Engines and Thermal Systems
Contents of lesson 4: Classification of heat engines. Types and design of two-phasic heat exchangers. Positive displacement machines. Analysis and design of industrial dryers. Types of boilers and furnaces.

Description of the practical activities of lesson 4:
AP1: Thermal design of two-phasic heat exchangers (2h) in Classroom.
AP2: Analysis of the main elements and calculation of a drying room (2h) in Classroom.

Name of lesson 5: Refrigeration and Cooling Systems
Contents of lesson 5: Calculation of vapor compression machines and heat pumps. Calculation of absorption machines. Design of cooling towers of refrigeration systems.
Description of the practical activities of lesson 5:
AP1: Identification of the main elements of a refrigeration system (2h) in the Laboratory.

Name of lesson 6: Commercial Refrigeration Installation
Contents of lesson 6: Thermal loads. Refrigeration installation design.
Description of the practical activities of lesson 6:
AP1: Calculation a commercof ial refrigeration installation proyect (4h) in Classroom.

Educational activities[7]

Student workload in hours by lesson		Lectures	Practical activities				Monitoring activity	Homework
Lesson	**Total**	**L**	**HI**	**LAB**	**COM**	**SEM**	**SGT**	**PS**
1	21	6		6				9
2	15	6						9
Partial Assessment (1 y 2)	4	1						3
3	22	5		2		2		13
4	22	6				4		12
5	24	8		2				14
6	25	5				4		16
Final Assessment**	17	3						14
TOTAL	**150**	**40**		**10**		**10**		**9**

L: Lectures (100 students)
HI: Hospital internships (7 students)
LAB: Laboratory or field practices (15 students)
COM: Computer room or language laboratory practices (30 students)
SEM: Problem classes or seminars or case studies (40 students)
SGT: Scheduled group tutorials (educational monitoring, ECTS type tutorials)
PS: Personal study, individual or group work and reading of bibliography

Teaching Methodologies[6]

Among the teaching methodologies included in the formative program, in this course the following are used: Teaching methodology	Used methodologies labelled as "X"
1. Master class. Presentation of content by the teacher.	X
2. Work sessions using the methodology of the case.	
3. Work sessions in the classroom to solve exercises.	X
4. Development of practices inside rooms with specialized equipment (laboratories, computer rooms, field work).	X
5. Technical visits to installations	
6.Develop ment, writing and analysis, individually or in groups, of works, reports, exercises, problems, and case studies, on content and techniques, theoretical and practical, related to the subject.	X

[7] The contents of this table must literally conform to the information of document 12c.
** Indicar el número total de horas de evaluación de esta asignatura.

7. Tests, exams, work defenses, practices, etc. May be oral or written and individual or in groups.	X
8. Student study. Individual preparation and analysis of texts, cases, problems, etc.	X
9. ICT training and development of communication skills (oral, written, multimedia).	X
10. Learning outside the classroom, based on the link between academic training and business or professional experiences.	
11. Supervised learning under the supervision of the teacher, through individual interaction between student and tutor, to detect possible problems in the training process, to know the learning results outside the classroom setting and to program the student's work processes in non-contact activities such as memories, final master's work, preparation of the defense, etc.	X

Learning outcomes[6]

Perform the analysis and design of hydraulic machines (pumps, fans, turbines and positive displacement machines).
Carry out the analysis and design of thermal machines (steam turbines, gas turbines, turbochargers and positive displacement machines).
Carry out the analysis and design of alternative heat engines.
Carry out the design of industrial heating and cooling systems

Assessment systems[6]

Assessment criteria:
The learning evaluation will be carried out according to the following criteria:
C1. Demonstrate understanding of the concepts involved in the subject. The weighting of this evaluation criterion in the final quantitative grade is 40%. Related to the CB6-CB10, CG1, CG2, CG4, CG8, CG9, CT1-CT13, CET5 competencies
C2. Know the most important data and results related to the subject (10%). Related to CET5 competition.
C3. Solve problems applying theoretical knowledge or based on experimental results (40%). Related to the CB6-CB10, CG1, CG2, CG4, CG8, CG9, CT1-CT13 competencies
C4. Clearly state the results obtained (10%). Related to the CB6-CB10, CG1, CG2, CG4, CG8, CG9, CT1-CT13, CET5 competencies
Assessment activities:
Among the assessment activities included in the formative program, in this course the following are used:

	Range fixed	Ordinary call	Extraordinary call	Global assessment
1. Exam (final exam and/or partial examinations, cumulative and / or eliminatory).	0%–100%(1) 0%–80%(2)	73%	73%	73%
2. Solution and submission of activities (cases, exercises, assignments, projects, etc.), individually and/or in groups	0%–80%	27%	27%	27%
3. Attendance and use in practical classes and other learning activities	0%–20%	0%	0%	0%
4. Presentation and defense of proposed papers and reports	0%(1) 0%–30%(2)	0%	0%	0%

(1) Module courses: Complementary Technologies.
(2) Other courses.

Description of the assessment activities:
The evaluation of Topics 1 and 2 (Hydraulic Machines) will be carried out through the following activities:
A1. Final exam in ordinary and extraordinary calls (EF). It will consist of an objective test of 10 items of 4 multiple answers. The test will be graded with a grade between 0 and 10. Errors are penalized according to the proportion "3 wrong answers subtract 1 correct". Recoverable Activity.
A2. Laboratory practical activities (AP). The set of practical laboratory activities will be graded with a grade between 0 and 10. It is a non-recoverable evaluation activity. The qualification of the laboratory practices will be maintained indefinitely until the student returns to carry out, if he wishes, said practices in subsequent academic courses. Non-Recoverable Activity.
The qualification corresponding to Topics 1 and 2 (Hydraulic Machines) will be calculated with the following formula:
C1=0.6*EF+0.4*AP

Those students who wish to do so may substitute the part corresponding to Topics 1 and 2 of the final exam of the ordinary call for a partial exam to be taken at the end of said topics.

The evaluation of Topics 3, 4, 5 and 6 (Heat engines and machines) will be carried out through the following activities:
A1. Final Exam (EF).
There will be a written test on the syllabus of the subject, which could include some practical laboratory questions, in the period for examinations. To pass this part of the course it will be necessary to obtain a grade of at least 5 out of 10 in this evaluation activity. This activity is RECOVERABLE in the extraordinary call.
A2. Laboratory and classroom practical activities (AP).
Participation in laboratory practices, seminars and group and individual work will be assessed continuously and through some practical questions included in the written test. This activity is considered NON-RECOVERABLE, that is, it cannot be carried out in the extraordinary call, but the questions related to the practices carried out will be included in the extraordinary written test. The points of this activity (A2) will NOT be added to the points of the activity (A1) if they would not be approved in the activity (A1).

The qualification corresponding to Topics 3, 4, 5 and 6 (Heat engines and machines) will be calculated with the following formula:
C2=0.8*EF+0.2*AP
The final CF grade for the subject will be calculated using the formula:
CF=0.333*C1+0.666*C2
To pass the course it will be necessary to obtain a total CF grade of at least 5 points out of 10. In addition, it will be necessary to obtain a minimum grade of 4 points out of 10 in each of the parts "Hydraulic Machines" and "Thermal Machines and Engines"; that is, C1≥4 and C2≥4. If this last condition is not met, the final grade will be the minimum between CF and 4.

Those students who take the extraordinary call may keep the C1 and C2 grades obtained in the regular call (or in the midterm exam) of the same academic year, as long as they do not take the exam for the corresponding part ("Hydraulic Machines" and "Thermal Machines and Motors") in the extraordinary call.

Global assessment:
The global evaluation will take place on the same day assigned to the final exam of each call by the Subdirectorate of Academic Organization of the E.II.II. It will consist of the following tests:
A1. Final exam in ordinary and extraordinary calls (EF). It will consist of an objective test of 10 items of 4 multiple answers. The test will be graded with a grade between 0 and 10. Errors are penalized according to the proportion "3 wrong answers subtract 1 correct". Recoverable Activity.

A2. Laboratory practical activities (AP). The set of practical laboratory activities will be graded with a grade between 0 and 10. It is a non-recoverable evaluation activity. The qualification of the laboratory practices will be maintained indefinitely until the student returns to carry out, if he wishes, said practices in subsequent academic courses. Non-Recoverable Activity.
The qualification corresponding to Topics 1 and 2 (Hydraulic Machines) will be calculated with the following formula:
C1=0.6*EF+0.4*AP

The evaluation of Topics 3, 4, 5 and 6 (Heat engines and machines) will be carried out through the following activities:

A1. Final Exam (EF).
There will be a written test on the syllabus of the subject, which could include some practical laboratory questions, in the period for examinations. To pass this part of the course it will be necessary to obtain a grade of at least 5 out of 10 in this evaluation activity. This activity is RECOVERABLE in the extraordinary call.

A2. Laboratory and classroom practical activities (AP).
Participation in laboratory practices, seminars and group and individual work will be assessed continuously and through some practical questions included in the written test. This activity is considered NON-RECOVERABLE, that is, it cannot be carried out in the extraordinary call, but the questions related to the practices carried out will be included in the extraordinary written test. The points of this activity (A2) will NOT be added to the points of the activity (A1) if they would not be approved in the activity (A1).

The qualification corresponding to Topics 3, 4, 5 and 6 (Heat engines and machines) will be calculated with the following formula:

C2=0.8*EF+0.2*AP

The final CF grade for the subject will be calculated using the formula:

CF=0.333*C1+0.666*C2

To pass the course it will be necessary to obtain a total CF grade of at least 5 points out of 10. In addition, it will be necessary to obtain a minimum grade of 4 points out of 10 in each of the parts "Hydraulic Machines" and "Thermal Machines and Engines"; that is, C1≥4 and C2≥4. If this last condition is not met, the final grade will be the minimum between CF and 4.

Those students who take the extraordinary call may keep the C1 and C2 grades obtained in the regular call (or in the midterm exam) of the same academic year, as long as they do not take the exam for the corresponding part ("Hydraulic Machines" and "Thermal Machines and Motors") in the extraordinary call.

Bibliography (basic and complementary)

Basic Bibliography:

Awf Al-Kassir, Apuntes de clase de la asignatura, archivos puestos en el campus virtual.

Emilio Vega, Apuntes de clase de la asignatura, archivos puestos en el campus virtual.

Versteeg, H. K. y Malalasekera, W. (2007). An Introduction to Computational Fluid Dynamics: London: Addison-Wesley

DIXON, S.L. Y HALL, C. A. "Fluid Mechanics and Thermodynamics of Turbomachinery". Sixth Edition. Prentice Hall, 2010.

ASHRAE Handbook, "*HVAC Systems and Equipment*", American Society of Heating Refrigerating and Air-Conditioning Engineers, Atlanta, 2000.

ASINEL, "*Generadores de vapor*", Asociación de Investigación Industrial Eléctrica, 2ª ed. Barcelona, 1982.

FERNÁNDEZ, I. P., "*Turbomáquinas Térmicas*", Oviedo, 1993.

Complementary Bibliography:

WRIGHT, T. "Fluid machinery: performance, analysis and design". CRC Press. Boca Raton, 1999.
ASHRAE Handbook, "*Fundamentals*", American Society of Heating Refrigerating and Air-Conditioning Engineers, Atlanta, 2001.
BATHIE, W.W., "*Fundamentals of Gas Turbines*", 2ª Ed. John Wiley & Sons, 1996.
BEJAN, A., TSATASRONIS, G. & MORAN, M., "*Thermal Design and Optimization*", John Wiley & Sons, 1996.
BELSA, R., "*Conocimientos fundamentales sobre climatización*", CEAC, Barcelona, 1994.
ALARCÓN, J. M., GRANADA, E. y VÁZQUEZ, M. E., "*SISCECT, simulación y cálculo de Ciclos Termodinámicos*", Bellisco Ediciones Técnicas Científicas. Madrid, 1999.
BOEHM, R.F., "*Design Analysis of Thermal Systems*", John Wiley & Sons, 1987.
BONNEFILLE, R y ROBERT, J. "*Convertidores directos de energía*", Marcombo, Barcelona, 1976.
CARNICER ROYO, E., "*Aire acondicionado*", Paraninfo, 1999.
CARRERAS, R., COMAS, A. y CALVO, A., "*Motores de combustión interna. Fundamentos*", AULA, 1993.

Other resources and complementary educational materials

http://campusvirtual.unex.es
http://eii.unex.es/profesores/

Characteristisc of hydraulic pumps
http://www.itur.es/frames.htm
http://www.bombas-ideal.com/Bombas-Ideal-Index.asp

Characteristics of fans
http://www.casals.tv/producto.html

Heating and cooling installations, etc..
https://www.cofrico.com
https://roquesola.es/instalaciones/refrigeracion/
https://www.fenercom.com