COURSE PROGRAM

Academic Year: 2025/2026

Identification and characteristics of the course			
Code	402133	ECTS Credits	4,5
Course name (English)	Design of systems and thermal machines		
Course name (Spanish)	Diseño de sistemas y máquinas térmicas		
Degree programs	Master Universitario en Ingeniería Industrial		
Faculty/School	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
Subject Area	Machines and Thermal Engines		
Department	Mechanical, Thermal and Materials Engineering		
Coordinating Lecturer (If more than one)	Awf Al-Kassir		

Competencies*

Basic Competences	Check With an " "	General Competences	Check With an " X"	Transversal Competences	Check With an " X"	Competences EFM	Check With an " X"	Competences ET	Check With an " X"	Competences EG	Check With an " X"	Competences EI	Check With an " X"
CB6	X	CG1	X	CT1	X	CEFM1		CET1		CEG1		CEI1	
CB7	X	CG2	X	CT2	X			CET2		CEG2		CEI2	
CB8	X	CG3		CT3	X			CET3		CEG3		CEI3	
CB9	X	CG4	X	CT4	X			CET4		CEG4		CEI4	X
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								

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

Contents

Course outline*

Compressible fluids. Thermal machine analysis. Thermal engine analysis. Industrial heating and cooling. Thermal systems: heat exchangers, boilers, furnaces and dryers. Design of refrigeration systems. Refrigerating installations. Design of air conditioning and ventilation systems.

* The sections concerning competencies, course outline, educational activities, teaching methodologies, learning outcomes and assessment systems must conform to that included in the ANECA verified document of the degree program.

Course syllabus

Name of lesson 1: Machines and thermal engines.
Contents of lesson 1: Compressible fluids. Analysis of thermal machines and engines. Characteristics of refrigerant fluids.
Description of the practical activities of lesson 1:
AP1: Refrigerant nomenclature exercises (1h) in the Classroom.

Name of lesson 2: Industrial heating and cooling systems.
Contents of lesson 2: Systems and processes of cooling production and their industrial applications. Two-phase and mixing heat exchangers, boilers, ovens and design of industrial dryers.
Description of the practical activities of lesson 2:
AP2: Thermal design of two-phase heat exchangers (2h) in the Classroom.
AP1: Identification of the main elements of a boiler and a dryer (2h) in the Laboratory.

Name of lesson 3: Design of refrigerating systems.
Contents of lesson 3: Vapour compression cycle. Absorption cycle. Positive displacement machines. Expansion valves.
Description of the practical activities of lesson 3:
AP1: Calculation of the performance of cooling compression machines (2h) in the Classroom.
AP1: Determination of operating temperatures of a cold production machine (2h) in the Laboratory.

Name of lesson 4: Refrigerating installations and air conditioning and ventilation systems.
Contents of lesson 4: Thermal loads. Design of cold rooms. Design of air conditioning and ventilation systems.
Description of the practical activities of lesson 4:
AP1: Project for calculating a refrigerating installation (4h) in the Classroom.
AP2: Calculation of an air conditioning and ventilation system (2h) in the Classroom.

Educational activities *

Student workload in hours by lesson		Lectures	Practical activities				Monitoring activity	Homework
Lesson	**Total**	**L**	**HI**	**LAB**	**COM**	**SEM**	**SGT**	**PS**
1	17	6				1		10
2	26	7		2		2		15
3	23	7		2		2		12
4	29	8				6		15
Assessment	17,2	2						15,5
TOTAL	**112,5**	**30**		**4**		**11**		**67,5**

L: Lectures (85 students)
HI: Hospital internships (7 students)
LAB: Laboratory or field practices (15 students)
COM: Computer room or language laboratory practices (20 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*

Among the teaching methodologies included in the study plan of the degree, the following are used in this subject:

Teaching methodologies	Those used are indicated with an "X"
1. Master class. Presentation of contents by the teacher.	X
2. Work sessions using case methodology.	
3. Work sessions in the classroom to solve exercises.	X
4. Development of practices in spaces with specialized equipment (laboratories, computer rooms, field work).	X
5. Technical visits to facilities.	
6. Development, writing and analysis, individually or in groups, of works, memories, exercises, problems, and case studies, on contents and techniques, theoretical and practical, related to the subject.	X
7. Tests, exams, work defenses, practices, etc. It can be oral or written and individual or in group.	X
8. Student study. Preparation and individual analysis of texts, cases, problems, etc.	X
9. Training in ICTs 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. Learning supervised and supervised by the teacher, through individual interaction between student and tutor, to detect possible problems in the training process, learn about the results of learning outside the classroom setting and program the student's work processes in non-face-to-face activities such as reports, Master's thesis, preparation of its defence, etc..	X

Learning outcomes *

Carry out the analysis and design of thermal machines.
Carry out the analysis and design of alternative thermal engines.
Carry out the design of industrial heating and cooling systems.
Carry out the design of air conditioning and ventilation systems.

Assessment systems *

Evaluation criteria

The evaluation of learning 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 CG1, CG2, CG4, CG8, CG9, CB6-CB10, CT1-CT13competencies.

C2. Know the most important data and results related to the subject (10%). Related to the CT5 and CT13 competencies.

C3. Solve problems applying theoretical knowledge or based on experimental results (40%). Related to the CET5, CEI4, CB6-CB10, CT1-CT13 competencies.

C4. Clearly present the results obtained (10%). Related to the CB6-CB10, CT1-CT13 competencies.

Evaluation activities:

Among the assessment activities included in the study plan of the degree, in the This course uses the following:

	Established range	Ordinary announcement	Extraordinary announcement	Global evaluation
1. Exams (final exam and/or cumulative and/or eliminatory partial exams).	0%–80%	80%	80%	80%
2. Resolution and delivery of activities (cases, problems, reports, assignments, projects, etc.), individually and/or in groups.	0%–80%	10%	10%	20%
3. Attendance and use, in classes, practices and other face-to-face activities.	0%–20%	10%	10%	0%
4. Presentation and defense of proposed papers and reports.	0%–30%	0%	0%	0%

Description of evaluation activities:

The evaluation will be carried out through the following activities:

A1. Final Exam (8 points).

A written test will be carried out on the syllabus of the subject, in which some practical laboratory questions could be included, in the period set aside for exams. To pass this part of the subject it will be necessary to obtain a grade of at least 4 points out of 8 in this evaluation activity. This activity is RECOVERABLE in the extraordinary call.

A2. Practical laboratory and classroom activities (2 points).

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 as NOT 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 it was not approved in the activity (A1).

Final grade (10 points):

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

$$CF=A1+A2$$

To pass the subject it will be necessary to obtain a total CF grade of at least 5 points out of 10.

Global evaluation:

The global evaluation will take place on the same day assigned to the final exam of each call by the Subdirectorate of Academic Planning of the E.II.II. It will consist of the following tests:

A1. Final Exam (8 points).

A written test will be carried out on the syllabus of the subject, in which some practical laboratory questions could be included, in the period set aside for exams. To pass this part of the subject it will be necessary to obtain a grade of at least 4 points out of 8 in this evaluation activity. This activity is RECOVERABLE in the extraordinary call.

A2. Practical laboratory and classroom activities (2 points).
Resolution and delivery of activities related to the theoretical and practical agenda of the signature. This activity is carried out during the course, but is delivered, at most, in a month prior to the final exam. This activity is considered as NON-RECOVERABLE, that is, it cannot be carried out in the extraordinary call. The points of this activity (A2) will NOT be added to the points of the activity (A1) if it was not approved in the activity (A1).

Final grade (10 points):
The final grade CF of the subject will be calculated using the formula:

CF=A1+A2

To pass the subject it will be necessary to obtain a total CF grade of at least 5 points out of 10.

Bibliography (basic and complementary)

Basic bibliography:

Awf Al-Kassir, Class notes of the subject, files posted on virtual campus.
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:

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/

http://www.bombas-ideal.com/Bombas-Ideal-Index.asp
http://www.casals.tv/producto.html
https://www.cofrico.com
https://roquesola.es/instalaciones/refrigeracion/