UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: ENGINEERING THERMODYNAMICS AND HEAT TRANSFER
Code: 56712
Type: CORE COURSE
ECTS credits: 6
Degree: 403 - UNDERGRADUATE DEGREE PROGRAMME IN AEROSPACE ENGINEERING
Academic year: 2023-24
Center: 303 - E.DE INGENIERÍA INDUSTRIAL Y AEROESPOACIAL DE TOLEDO
Group(s): 40
Year: 2
Duration: First semester
Main language: Spanish
Second language:
Use of additional languages:
English Friendly: Y
Web site: http://campusvirtual.uclm.es/
Bilingual: N

Lecturer: **OCTAVIO ARMAS VERGEL** - Group(s): **40**

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Lecturer: **MARIA REYES GARCIA CONTRERAS** - Group(s): **40**

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Lecturer: **MARIA ARANTZAZU GOMEZ ESTEBAN** - Group(s): **40**

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2. Pre-Requisites

Subject	Content
Physics	• Particle dynamics: Newton's laws. ◦ Circuits: Ohm's Law. Kirchhoff's laws. • Thermodynamics: Transformations with ideal gases. Expansion work. First principle for closed systems. Second principle. Carnot cycle.
Chemistry	• Electronic structure of the atom: The periodic table and periodic properties. ◦ States of aggregation: Ideal gases and real gases. State equations. Vapor pressure. Changes of state and phase diagram. • Thermodynamics: First principle. Enthalpy, entropy and spontaneity. Free energy.

Calculus I	• Real functions with real variables.
	  ◦ Differential calculus: Derivation. Taylor's theorem.
	  ◦ Integral calculus: Numerical integration. Improper integrals.
	• Introduction to differential equations: First order differential equations. Numerical methods.

Algebra	• Systems of linear equations: Resolution methods. • Difference equations: Calculation of solutions. Models.
Calculus II	• Functions with several variables. ◦ Differential calculus: Partial derivatives. Gradient of a function. • Introduction to differential equations in partial derivatives: First and second order linear equations.

3. Justification in the curriculum, relation to other subjects and to the profession

Technical Thermodynamics and Heat Transfer, as part of the Thermofluid dynamics subject, serves as introduction to this type of phenomena, introducing basic applications that ensure the management of engineering tools in this field.

4. Degree competences achieved in this course

Course competences

Code	Description
CA01	Ability to carry out bibliographic searches, use databases and other sources of information for its application in tasks related to Technical Aeronautical Engineering.
CA02	Ability to efficiently design experimentation procedures, interpret the data obtained and specify valid conclusions in the field of Aeronautical Technical Engineering.
CA03	Ability to autonomously select and carry out the appropriate experimental procedure, operating the equipment correctly, in the analysis of phenomena within the scope of Engineering.
CA04	Ability to select advanced tools and techniques and their application in the field of Aeronautical Technical Engineering.
CA05	Knowledge of the methods, techniques and tools as well as their limitations in the application for the resolution of problems typical of Aeronautical Technical Engineering.
CA06	Ability to identify and assess the effects of any solution in the field of Aeronautical Technical Engineering within a broad and global context and the ability to interrelate the solution to an engineering problem with other variables beyond the technological field, which must be considered.
CB02	Apply their knowledge to their job or vocation in a professional manner and show that they have the competences to construct and justify arguments and solve problems within their subject area.
CB03	Be able to gather and process relevant information (usually within their subject area) to give opinions, including reflections on relevant social, scientific or ethical issues.
CB04	Transmit information, ideas, problems and solutions for both specialist and non-specialist audiences.
CB05	Have developed the necessary learning abilities to carry on studying autonomously
CE02	Understanding and command of the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application to solve engineering problems.
CE08	knowledge of the thermodynamic cycles that generate mechanical power and thrust.
CE10	Knowledge of flight dynamics based on aerodynamic forces and the role of the different variables involved in the phenomenon of flight
CE16	Knowledge applied to Engineering of: The concepts and laws that govern the processes of energy transfer, the movement of fluids, the mechanisms of heat transmission and the change of matter and their role in the analysis of the main systems aerospace propulsion.
CE19	Applied knowledge of: materials science and technology; mechanics and thermodynamics; fluid mechanics; aerodynamics and mechanics of flight; air traffic and navigation systems; aerospace technology; structure theory; air Transport; economy and production; Projects; environmental impact.
CE22	Knowledge applied to Engineering: The concepts and laws that govern internal combustion, its application to rocket propulsion.
CG01	Capacity for the design, development and management in the field of aeronautical engineering that have as their object, in accordance with the knowledge acquired as established in section 5 of order CIN/308/2009, aerospace vehicles, propulsion systems aerospace, aerospace materials, airport infrastructures, air navigation infrastructures and any space, traffic and air transport management system.
CG02	Planning, drafting, direction and management of projects, calculation and manufacturing in the field of aeronautical engineering that have as their object, in accordance with the knowledge acquired as established in section 5 of order CIN/308/2009, aerospace vehicles , aerospace propulsion systems, aerospace materials, airport infrastructures, air navigation infrastructures and any space, traffic and air transport management system.
CG07	Ability to analyze and assess the social and environmental impact of technical solutions.
CT03	Correct use of oral and written communication.

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Knowledge of thermodynamic principles and substance models to evaluate state variations of the same.

Knowledge of energy and entropy balances.

6. Units / Contents

Unit 1: BASIC CONCEPTS OF THERMODYNAMICS.

Unit 2: FIRST PRINCIPLE OF THERMODYNAMICS FOR OPEN SYSTEMS.

Unit 3: THERMODYNAMIC STUDY OF PURE SUBSTANCES.

Unit 4: THERMODYNAMIC CYCLES.

Unit 5: INTRODUCTION TO HEAT TRANSFER.

Unit 6: HEAT TRANSFER BY CONDUCTION.

Unit 7: HEAT TRANSFER BY CONVECTION.

Unit 8: HEAT TRANSFER BY RADIATION.

ADDITIONAL COMMENTS, REMARKS

1. Review of Applied Thermodynamics taught in Physics I. (Theme 1)

2. Properties of pure substances: Concepts and basic models. Tables and diagrams of thermodynamic properties. (Theme 1 and Theme 3)

3. Energy and First Law of Thermodynamics: Mass and energy balances in a control volume. Application to devices of industrial/aeronautical interest. (Theme 1 and Theme 2)

4. Entropy and Second Law of Thermodynamics: Entropy balance and Second Law of Thermodynamics. Application to devices of interest. (Theme 1)

5. Thermodynamic processes of interest in the aeronautical industry, including the productive and airport sectors: Thermodynamic processes for power supply. Thermodynamic processes for refrigeration and air conditioning. Aeronautical ECS (Environmental Control System). (Theme 4)

6. Introduction to heat transfer: Phenomenological introduction to conduction, convection and radiation. (Theme 5)

7. Conduction: steady state regime, introduction to fins for heat dissipation, transient regime. Numerical Methods in conduction and convection. (Theme 6)

8. Convection: Introduction to convection: external and internal flow in forced or natural convection, introduction to correlations. Fundamentals of Numerical Methods in convection. (Theme 7)

9. Radiation: Introduction to radiation. Backwater magnitudes in incompressible and compressible fluids. (Theme 8)

The course will be divided into two blocks:

- Block I: Technical Thermodynamics (Themes 1, 2, 3 and 4).

- Block II: Heat transfer (Themes 5, 6, 7 and 8).

The contents of the course may be modified, with the authorization of the Teaching Vice rector, in alarm situations. In any case, the acquisition of the competences of the subject will be ensured.

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB03 CB04 CB05 CE02 CE08 CE16 CE19 CE22 CG01 CG02 CT03	1.6	40	N	-	The teacher will explain those aspects of the theoretical development of each topic that he/she considers necessary so that the student can later work independently. He/she will also present practical examples.
Problem solving and/or case studies [ON-SITE]	Problem solving and exercises	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB03 CB04 CB05 CE02 CE08 CE10 CE16 CE19 CE22 CG01 CG02 CT03	0.4	10	N	-	Classes of exercises in the classroom. The teacher, after solving some typical problems, he/she will solve those problems from the collection of proposals that the students can ask to him/her.
Laboratory practice or sessions [ON-SITE]	Practical or hands-on activities	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB03 CB04 CB05 CE02 CE08 CE10 CE16 CE19 CE22 CG01 CG02 CG07 CT03	0.12	3	Y	Y	Attendance and delivery of the report is mandatory. Thermodynamics module. Practice 1: Determination of the Critical Point of a Substance. Heat Transmission Module. Practice 3: Determination of the coefficient of conductivity of different materials. The minimum grade for this part to be compensable will be 2 points (with respect to 10).
Computer room practice [ON-SITE]	Practical or hands-on activities	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB03 CB04 CB05 CE02 CE08 CE10 CE16 CE19 CE22 CG01 CG02 CG07 CT03	0.12	3	Y	Y	Attendance and delivery of the report is mandatory. Thermodynamics Module Practice 2: Graphic Representation Systems in Thermodynamics Heat Transmission Module. Practice 4: Computer simulation of internal forced convection in a tube. The minimum grade for this part to be compensable will be 2 points (with respect to 10).
Mid-term test [ON-SITE]	Assessment tests	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB03 CB04 CB05 CE02 CE08 CE10 CE16 CE19 CE22 CG01 CG02 CG07 CT03	0.06	1.5	Y	N	Eliminatory exam of the Thermodynamics block. The exam will consist of theory and problems. Theoretical knowledge and the correct assimilation of important concepts will be evaluated. The minimum grade for this part to be compensable will be 4 points (with respect to 10).
Final test [ON-SITE]	Assessment tests	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB03 CB04 CB05 CE02 CE08 CE10 CE16 CE19 CE22 CG01 CG02 CG07 CT03	0.1	2.5	Y	Y	Exam that will consist of theory and problems and that will evaluate the content of the subject. The minimum grade for this part to be compensable will be 4 points (out of 10).
Practicum and practical activities report writing or preparation [OFF-SITE]	Group Work	CA01 CA02 CA03 CA04 CA05 CA06 CB03 CB04 CB05 CE02 CE08 CE10 CE16 CE19 CE22 CG01 CG02 CG07 CT03	0.72	18	N	-	Preparation of practice reports.
Study and Exam Preparation [OFF-SITE]	Self-study	CA01 CA02 CA03 CA04 CA05 CA06 CB03 CB04 CB05 CE02 CE08 CE10 CE16 CE19 CE22 CG01 CG02 CG07 CT03	2.88	72	N	-	Autonomous personal study of theory and problems where the student uses the knowledge learned in the face-to-face classes in the classroom.
		Total:	**6**	**150**			
		Total credits of in-class work: 2.4					**Total class time hours: 60**
		Total credits of out of class work: 3.6					**Total hours of out of class work: 90**

As: Assessable training activity
Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Mid-term tests	40.00%	0.00%	EC. Eliminatory exam of the Thermodynamics block. The minimum grade for this part to be compensable will be 4 points (out of 10). The percentage of this test represents 50% of the percentage of the final test. ON: Does not apply
Final test	40.00%	80.00%	EC: If the student has passed the progress test, in the final test they can only be evaluated on the content of the Heat Transfer block. ENC: Final exam of theory and problems of the content of the entire subject. The minimum note for this part to be compensable will be 4 points (with respect to 10) in each one of the two blocks examined.
Practicum and practical activities reports assessment	20.00%	20.00%	Attendance at practices and the presentation of the report are mandatory to evaluate this activity. The minimum grade for this part to be compensable will be 2 points (with respect to 10).
Total:	**100.00%**	**100.00%**	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject , an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

The final grade in continuous assessment will be:
40% progress test + 40% final test + 20% laboratory/computer practices.

In the case that, in an evaluable part the minimum mark to compensate has not been reached, the final mark will not be higher than 4 points (out of 10)

The course is considered passed if the final grade is greater than or equal to 5 (with respec to 10 points).

Non-continuous evaluation:

It will consist of:
i) final test where the contents of the Thermodynamics and Heat Transmission block are evaluated, following the specifications indicated in the evaluation system.
ii) If the student has not carried out the larboratory or computer practices, or has not passed the evaluation of the reports, a laboratory practical exam will be carried out. The minimum note to compensate this part will be 4 points (with respect to 10).

The subject is considered passed if the final grade is greater than or equal to 5 points (with respect to 10).

Specifications for the resit/retake exam:

The qualifications obtained in each of the tests that have been passed in the ordinary call will be kept. The evaluation criteria will be the same as in the continuous evaluation of the ordinary call.

In the case of not passing the part of laboratory practices in the ordinary call, there will be an exam on the contents of this part (20% of the final grade). The minimum calification to compensate this part will be 4 points (with respect to 10).

Specifications for the second resit / retake exam:

In the final exam the same evaluation criteria will be applied as in the non-continuous ordinary call.

9. Assignments, course calendar and important dates

Not related to the syllabus/contents

Hours	hours
Class Attendance (theory) [PRESENCIAL][Lectures]	40
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	10
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	3
Computer room practice [PRESENCIAL][Practical or hands-on activities]	3
Mid-term test [PRESENCIAL][Assessment tests]	1.5
Final test [PRESENCIAL][Assessment tests]	2.5
Practicum and practical activities report writing or preparation [AUTÓNOMA][Group Work]	18
Study and Exam Preparation [AUTÓNOMA][Self-study]	72

Global activity

Activities	hours
Mid-term test [PRESENCIAL][Assessment tests]	1.5
Computer room practice [PRESENCIAL][Practical or hands-on activities]	3
Class Attendance (theory) [PRESENCIAL][Lectures]	40
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	3
Final test [PRESENCIAL][Assessment tests]	2.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	72
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	10
Practicum and practical activities report writing or preparation [AUTÓNOMA][Group Work]	18
Total horas:	150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description

Lapuerta, M.; Hernández, J.J.; Ballesteros. R.	Termodinámica	Universidad de Castilla-La Mancha	84-699-3109-1	2002	Bibliografía básica para el Bloque I: Termodinámica
Moran, Michael J.	Fundamentos de termodinámica técnica	Reverté	84-291-4313-0	2004	Bibliografía básica para el Bloque I: Termodinámica
Incropera, Frank P.	Fundamentos de transferencia de calor	Prentice hall	970-17-0170-4	1999	Bibliografía básica para el Bloque II: Transmisión de calor
Hernández, J.J.; Rodríguez, J.; Sanz, J.	Transmisión de calor para ingenieros	Universidad de Castilla-La Mancha	978-84-8427-737-8	2010	Bibliografía básica para el Bloque II: Transferencia de calor