Course guide
320016 - ET - Thermal Engineering

Last modified: 02/04/2024

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 724 - MMT - Department of Heat Engines.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Martí Rosas Casals

Others: Borja Borrás Quintanal
Roser Capdevila Paramio
Núria Garrido Soriano
John M. Hutchinson
Joaquim Rigola Serrano
Martí Rosas Casals
Francesc Xavier Trias Miquel

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE07-INDUS. Knowledge of applied thermodynamics and heat transfer. Basic principles and their application to solving engineering problems. (Common module for industrial engineering)

Transversal:
CT04 N2. Teamwork - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favour communication, task assignment and cohesion.

TEACHING METHODOLOGY

- Face-to-face lectures and problem solving sessions.
- Face-to-face practical work sessions and exercises.
- Independent learning, preparation of face-to-face sessions and exercises.
- The face-to-face sessions based on problem solving will introduce the theoretical fundamentals of the subject, concepts, methods and results by means of exercises solved step by step.
The practical (problem solving) sessions will basically include:
a) Sessions in which the lecturer will give students guidelines on how to solve problems by applying the knowledge they have acquired in the theoretical sessions (44%).
b) Session in which students will complete work from the subject syllabus (e.g. TEST, the Expert System for Thermodynamics, http://energy.sdsu.edu/testcenter/) (44%).
c) Examination sessions (12%).
Students will be expected to do independent study to:
a) Prepare face-to-face sessions (by reading handouts before attending class).
b) Study the theoretical and practical content of the subject so that they learn concepts by solving the set exercises that will then be handed in and marked.

LEARNING OBJECTIVES OF THE SUBJECT

The aim of the Thermal Systems subject is twofold. Firstly, the aim is to present the basic theoretical concepts in the fields of applied thermodynamics and heat transfer, and their applications in engineering. A second aim is to build up students' creativity and effectiveness in solving problems that require them to apply the concepts they have learnt. In addition, they will be expected to use the thermodynamics software program, TEST (http://energy.sdsu.edu/testcenter/), in order to enable them to solve open-ended problems.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	15,0	10.00
Hours large group	45,0	30.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

TOPIC 1: INTRODUCTION TO TECHNICAL THERMODYNAMICS

Description:
1.1. Thermodynamic systems
1.2. Thermodynamic properties, states, processes and cycles
1.3. Operating principles and the classification of heat engines
1.4. Historical background to heat engines
1.5. Energy, environment and climate change
1.6. Energy efficiency, consumption and renewable energies

Specific objectives:
For students to:
- Recognise the concepts of thermodynamic principles, processes and cycles.
- Differentiate and classify the operating principles of heat engines.
- Recognise the impact of the use of heat engines on the environment.

Related activities:
Test
Applied exercises

Full-or-part-time: 19h
Theory classes: 4h 30m
Practical classes: 1h 30m
Self study : 13h

TOPIC 2: PURE SUBSTANCES

Description:
2.1. T-v, p-v and p-T diagrams
2.2. The p-v-T surface
2.3. Determination of thermodynamic properties
2.4. Simple models of pure substances

Specific objectives:
For students to:
- Recognise pure substances and they thermodynamic characterisation.
- Develop the ability to determine the properties of pure substances based on the magnitudes that define their state.
- Recognise and apply the models that make it possible to determine these properties in liquids and solids.
- Understand the concepts of enthalpy and entropy.

Related activities:
Test
Applied exercises

Full-or-part-time: 21h
Theory classes: 6h
Practical classes: 2h
Self study : 13h

TOPIC 3: THE FIRST PRINCIPLE

Description:
3.1. Closed systems and thermal energy
3.2. Specific heat, enthalpy and internal energy in ideal gases, solids and liquids.
3.3. Open systems and enthalpy
3.4. The principles of the conservation of mass and energy
3.5. Steady flow devices

Specific objectives:
For students to:
- Recognise the equivalence between the first principle of thermodynamics and the principle of the conservation of energy.
- Develop the ability to prove the relationship between heat and work depending on the system under study.
- Apply the simplifications of the first principle to steady flow devices.

Related activities:
Test
Applied exercises

Full-or-part-time: 23h
Theory classes: 7h 30m
Practical classes: 2h 30m
Self study : 13h

TOPIC 4: THE SECOND PRINCIPLE AND ENTROPY

Description:
4.1. Heat machines, the Carnot cycle and formulations of the second principle
4.2. Clausius inequality and entropy
4.3. Entropy balance in open and closed systems
4.4. Property diagrams that include entropy Isentropic efficiency
4.5. Processes of entropy change in pure substances, solids, liquids and ideal gases

Specific objectives:
For students to:
- Recognise the second principle of thermodynamics as a result of the irreversibility of thermodynamic processes that occur in heat engines.
- Recognise entropy as a corollary of the second principle of thermodynamics.
- Develop the ability to derive entropy balance and work with diagrams that include it as a property.
- Demonstrate the isentropic efficiency of steady flow devices.

Related activities:
Test
Applied exercises
Assessment tests

Full-or-part-time: 21h
Theory classes: 6h
Practical classes: 2h
Self study : 13h

TOPIC 5: ENGINE CYCLES

Description:
5.1. Steam power cycles
5.2. Gas power cycles. Turbines, alternative internal and external combustion engines
5.3. Introduction to combustion processes and their environmental impact

Specific objectives:
For students to:
- Define engine cycles as a set of thermodynamic processes that can be studied with the help of the principles of thermodynamics.
- Develop the peculiarities of engine cycles with steam and gas turbines, and of alternative internal and external combustion engines
- Recognise and assess the huge environmental impact that the massive use of these cycles have on current society.

Related activities:
Test
Applied exercises

Full-or-part-time: 23h
Theory classes: 7h 30m
Practical classes: 2h 30m
Self study : 13h

TOPIC 6: GENERATION CYCLES

Description:
6.1. The Rankine and Brayton generation cycles
6.2. Introduction to cooling substances
6.3. Absorption and adsorption cycles

Specific objectives:
For students to:
- Define generation cycles as a set of thermodynamic processes that can be studied with the help of the principles of thermodynamics.
- Develop the particularities of generation cycles using vapour, turbine and gas compression, and absorption and adsorption.
- Recognise and assess the environmental impact that the use of cooling substances has on current society.

Related activities:
Test
Applied exercises

Full-or-part-time: 21h
Theory classes: 6h
Practical classes: 2h
Self study : 13h

TOPIC 7: HEAT TRANSMISSION

Description:
7.1 Relationship between heat transfer and thermodynamics
7.2. Heat and temperature
7.3. Forms of heat transfer and its physical mechanisms
7.4. Heat transfer by conduction
7.5. Heat transfer by convection
7.6. Heat transfer by radiation
7.7. Combined heat transfer

Specific objectives:
For students to:
- Recognise the difference between the approaches to thermodynamic and heat transfer, as well as their complementarity.
- Recognise the physical mechanisms of heat transfer in any phenomenon whatsoever.
- Identify the physical properties associated with heat transfer phenomena.
- Apply fundamental heat transfer equations in simple cases of one-dimensional flow.

Related activities:
Test
Applied exercises
Assessment tests

Full-or-part-time: 23h
Theory classes: 7h 30m
Practical classes: 2h 30m
Self study : 13h

ACTIVITIES

(ENG) CONTROL DE COMPRENSIÓ

(ENG) EXERCICIS D'APLICACIÓ

(ENG) PROVES D'AVALUACIÓ

GRADING SYSTEM

- 1st exam: 35%
- 2nd exam: 40%
- Questionaries / deliverables: 25%
- The unsatisfactory results of the part of problems of the 1st examination can be redirected through the 2nd examination. Students with a score of less than 3.5 points from the part of problems of the 1st exam will be able to access this redirection which will consist of a double score of a series of questions of the part of problems of the 2nd examination (clearly identified) that will allow to obtain 3.5 points if they are answered correctly. The grade obtained by the application of this redirection will replace the initial grade of the part of problems of the 1st examination as long as it is higher.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

EXAMINATION RULES.

- The evaluation exams (1st and 2nd exams) containing theory questions with multiple choice and / or development of short and problems. For each exam, the weights of the theory and problems will be 30% and 70% respectively.
- The theoretical part of the assessment will be made without any recourse other than paper and pen. The problems of the assessment can be made, moreover, in a form provided by the subject teachers and available to Athena.
- The tests will be conducted in a maximum time of 165 minutes.

BIBLIOGRAPHY

Basic:

- Rosas Casals, M.; Cendra Garreta, J.; Garrido Soriano, N. Apunts de termodinàmica tècnica. Terrassa: EET,
- Çengel, Yunus A.; Boles, Michael A. Termodinámica [on line]. 9ª ed. México: McGraw-Hill, 2019 [Consultation: 03/10/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5808940. ISBN 9781456269166.
- Çengel, Yunus A. Transferencia de calor y masa: fundamentos y aplicaciones [on line]. 6a ed. México D.F: McGraw-Hill, 2020 [Consultation: 15/10/2024]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=10213. ISBN 9781456277215.
- Kreith, Frank; Bohn, Mark S. Principios de transferencia de calor. 6a ed. Madrid: International Thomson, 2002. ISBN 8497320611.
- Moran, Michael J.; Shapiro, Howard N. Fundamentos de termodinámica técnica [on line]. 2ª ed. Barcelona: Reverté, 2018 [Consultation: 09/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5635437. ISBN 9788429194111.

Complementary:

- Atkins, P. Las cuatro leyes del universo. Pozuelo de Alarcón: Espasa, 2008. ISBN 9788467028270.
- Ness, Hendrick C. van. Understanding thermodynamics [on line]. New York: Dover, 1983 [Consultation: 25/07/2024]. Available on: https://search-ebscohost-com.recursos.biblioteca.upc.edu/login.aspx?direct=true&AuthType=ip,uid&db=nlebk&AN=1156236&site=ehost-live&ebv=EK&ppid=Page-___-1. ISBN 9780486632773.