Last update: 22-07-2019

320016 - ET - Thermal Engineering

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering

Teaching unit: 724 - MMT - Department of Heat Engines

Academic year: 2019

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

ECTS credits: 6 Teaching languages: Catalan, English

Teaching staff

Coordinator: 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:

1. IND_COMMON: Understanding of applied thermodynamics and heat transfer: Basic principles and their application to solving engineering problems.

Transversal:

2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
3. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
4. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

Last update: 22-07-2019

320016 - ET - Thermal Engineering

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

Total learning time: 150h	Hours large group:	45h	30.00%
	Hours medium group:	15h	10.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

Last update: 22-07-2019

320016 - ET - Thermal Engineering

Content

TOPIC 1: INTRODUCTION TO TECHNICAL THERMODYNAMICS

Learning time: 19h

Theory classes: 4h 30m
Practical classes: 1h 30m
Self study : 13h

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

Related activities:
Test
Applied exercises

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.

320016 - ET - Thermal Engineering

TOPIC 2: PURE SUBSTANCES	Learning time: 21h Theory classes: 6h Practical classes: 2h Self study : 13h

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

Related activities:
Test
Applied exercises

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.

320016 - ET - Thermal Engineering

TOPIC 3: THE FIRST PRINCIPLE	Learning time: 23h Theory classes: 7h 30m Practical classes: 2h 30m Self study : 13h

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

Related activities:
Test
Applied exercises

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.

320016 - ET - Thermal Engineering

TOPIC 4: THE SECOND PRINCIPLE AND ENTROPY	Learning time: 21h Theory classes: 6h Practical classes: 2h Self study : 13h

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

Related activities:
Test
Applied exercises
Assessment tests

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.

Last update: 22-07-2019

320016 - ET - Thermal Engineering

TOPIC 5: ENGINE CYCLES	Learning time: 23h Theory classes: 7h 30m Practical classes: 2h 30m Self study : 13h

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

Related activities:
Test
Applied exercises

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.

320016 - ET - Thermal Engineering

TOPIC 6: GENERATION CYCLES	Learning time: 21h Theory classes: 6h Practical classes: 2h Self study : 13h

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

Related activities:
Test
Applied exercises

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.

Last update: 22-07-2019

320016 - ET - Thermal Engineering

TOPIC 7: HEAT TRANSMISSION

Learning time: 23h

Theory classes: 7h 30m
Practical classes: 2h 30m
Self study : 13h

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

Related activities:
Test
Applied exercises
Assessment tests

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.

Planning of activities

(ENG) CONTROL DE COMPRENSIÓ

(ENG) EXERCICIS D'APLICACIÓ

(ENG) PROVES D'AVALUACIÓ

Last update: 22-07-2019

320016 - ET - Thermal Engineering

Qualification 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.

Regulations for carrying out activities

- 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]. 7ª ed. México: McGraw-Hill, 2009 [Consultation: 21/05/2014]. Available on: <http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10747893&p00=9781456213381>. ISBN 9786071507433.

Çengel, Yunus A. Transferencia de calor y masa: un enfoque práctico. 3a ed. México D.F: McGraw-Hill, 2007. ISBN 9789701061732.

Kreith, Frank; Bohn, Mark S. Principios de transferencia de calor. 6a ed. Madrid: International Thomson, 2002. ISBN 8497320611.

Moran, M.J; Shapiro, H.N. Fundamentos de termodinámica técnica, vol. 1 i 2. Barcelona: Reverté, 1993-1994. ISBN 8429141715.

Complementary:

Atkins, P. Las cuatro leyes del universo. Pozuelo de Alarcón: Espasa, 2008. ISBN 9788467028270.

Van Ness, H.C. Understanding thermodynamics. New York: McGraw-Hill, 1969.