820020 - TTC - Thermodynamics and Heat Transfer

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics
Academic year: 2019

Degree:
- 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 BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
- BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)

ECTS credits: 6

Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: LLUÍS JOFRE CRUANYES - CARLOS RUIZ MOYA - ALFREDO DE JESUS GUARDO ZABALETA - RICARDO JAVIER PRINCIPE RUBIO

Others:
- Primer quadrimestre:
  - ALBERTO ANTONIO CARBO BECH - M23
  - DAIBEL DE ARMAS ORAMAS - T13, T14
  - ALFRED FONTANALS GARCIA - M21, M22, M23
  - JOAN GRAU BARCELÓ - M11, M12, M13, M14
  - ALEJANDRO MARTINEZ ALEGRE - M21, M22
  - ROGER MAYNOU GIL - M21, M22, M23
  - RAUL OLEGARIO NAVARRETE ROMERO - T11, T12, T13, T14, T15
  - JOANA AINA ORTIZ FERRA - M11, M12, M13, M14
  - REYNA MERCEDES PEÑA AGUILAR - T11, T12
  - PEDRO RUFES MARTINEZ - M11, M12, M13, M14

- Segon quadrimestre:
  - BOUALEM YOUCIF NASSIM BENABDELOUED - M11, M12, M51, M52, M54
  - ALBERTO ANTONIO CARBO BECH - M21, M22
  - JOSÉ ALEJANDRO CARRILLO CORTES - T12
  - ALFRED FONTANALS GARCIA - M31, M32, M33, M34, M35
  - MARCEL GARCIA COROMINAS - M34, M42
  - RAUL GARCÍA SANJURJO - M31, M32, M33, M34, M35
  - LLUÍS JOFRE CRUANYES - M11, M12, M13, M21, M22, M23, M24
  - ROGER MAYNOU GIL - M51, M52, M53, M54
  - RAUL OLEGARIO NAVARRETE ROMERO - T11, T12, T13, T14
  - JOANA AINA ORTIZ FERRA - M13, M31, M32, M33
  - PEDRO RUFES MARTINEZ - M35, M43, M44
  - CARLOS RUIZ MOYA - M23, M24, M31, M32, M33, M34, M35, M41, M42, M43, M44, M51, M52, M53, M54
Degree competences to which the subject contributes

Specific:
CEI-07. Understand applied thermodynamics and heat transfer, their basic principles and their application to 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.

Teaching methodology

The contents of the subject will be developed using master classes and promoting the participation of students with active methodologies. The student must perform individual work while solving problems and preparing exams, and also teamwork to tackle complex problems and lab practices.

Learning objectives of the subject

Give the student basic knowledge in the analysis of thermodynamical systems (both power or refrigeration systems) as well as in the basic heat transfer mechanisms.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 45h 30.00%</th>
<th>Hours medium group: 0h 0.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours small group: 15h 10.00%</td>
<td>Guided activities: 0h 0.00%</td>
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<tr>
<td></td>
<td>Self study: 90h 60.00%</td>
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# 820020 - TTC - Thermodynamics and Heat Transfer

## Content

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<th>Learning time</th>
<th>Theory classes</th>
<th>Laboratory classes</th>
<th>Self study</th>
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<tr>
<td>1.- INTRODUCTION TO THERMODYNAMICS</td>
<td>Thermodynamical systems. Temperature and the zeroth law of thermodynamics. Thermodynamic scales. Ideal gas. Simple, compressible pure substances: gasses and steam.</td>
<td>Understand the basic knowledge required for the study of thermodynamics.</td>
<td>29h</td>
<td>11h 30m</td>
<td>2h 30m</td>
<td>15h</td>
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<tr>
<td>2.- FIRST LAW OF THERMODYNAMICS</td>
<td>Expansion work. Friction work. Internal energy. Heat. Enthalpy. Specific heats of gasses. Adiabatic, isothermal, isochoric and isobaric processes. Polytropic processes. First law of thermodynamics. Open and closed systems.</td>
<td>To know and to use different expressions of energy and work involved in a thermodynamical system. To study basic thermodynamical processes. To apply the first law of thermodynamics to the analysis of open and close systems.</td>
<td>29h</td>
<td>11h 30m</td>
<td>2h 30m</td>
<td>15h</td>
</tr>
<tr>
<td>3.- SECOND LAW OF THERMODYNAMICS</td>
<td>Entrophy and irreversibilities. Second law of thermodynamics. Thermal engine. Carnot's efficiency. Isentropical processes and isentrhropical efficiencies for thermal engines. Gas turbine: Brayton's cycle. Steam turbine: Rankine cycle. Steam compression refrigeration systems.</td>
<td>To understand the concept of entrophy and the second law of thermodynamics, and its application to thermal engines. To know the ideal power cycles for producing mechanical work. To know the ideal steam compression cycle for refrigeration and heat pumping applications.</td>
<td>26h 30m</td>
<td>11h 30m</td>
<td>15h</td>
<td></td>
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</tbody>
</table>
## Qualification system

| Mid-term exams (35%); Homework activities (10 %); Final exam (35 %); Lab practices (15 %); Generic skills (5 %). In order to pass the course it is mandatory to attend to all lab practices and deliver the correspondent lab reports. There is a re-evaluation test for this subject. The students will be able to access the re-assessment test that meets the requirements set by the EEBE in its Assessmentand Permanence Regulations (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf) |  

### 4.- CONDUCTIVE HEAT TRANSFER

**Learning time:** 23h 30m  
Theory classes: 6h  
Laboratory classes: 2h 30m  
Self study: 15h

**Description:**  

**Specific objectives:**  
To present the general differential equation for conduction heat transfer and its application in simple geometries. To show the concept of thermal resistance and its application to flat and cylindrical walls.

### 5.- CONVECTIVE HEAT TRANSFER

**Learning time:** 21h  
Theory classes: 6h  
Self study: 15h

**Description:**  

**Specific objectives:**  
To describe the convective heat transfer mechanism and its classification according to the nature of the flow. To use different empirical correlations that allow to estimate the convection heat transfer.

### 6.- RADIATIVE HEAT TRANSFER

**Learning time:** 21h  
Theory classes: 6h  
Self study: 15h

**Description:**  

**Specific objectives:**  
To understand the physical nature of electromagnetic radiation and its modelling and interaction studies.
Regulations for carrying out activities

The evaluation will be conducted through written tests both for the mid-terms and final exam. There will be 3 homework activities due during the term. These activities will be delivered online through the course's intranet. Practices will be graded based on a pre-test to be presented before the lab practice start, attendance (mandatory) and lab activity developed, together with the preparation and delivery of lab reports.

Bibliography

Basic:

Complementary: