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 CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MECHANICAL 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 ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
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BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)

ECTS credits: 6
Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: 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
JOAN GRAU BARCELÓ - M11, M12, M13, M14
ALEJANDRO MARTINEZ ALEGRE - 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

Opening hours
Timetable: Check with each professor for office times

Requirements
Pre-requirements: Physics II, Numerical calculus-Differential equations
Co-requirements: Fluid Mechanics

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</th>
<th>30.00%</th>
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<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</tbody>
</table>
### Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Specific objectives</th>
</tr>
</thead>
<tbody>
<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: gases and steam.</td>
<td>Understand the basic knowledge required for the study of thermodynamics.</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>
</tr>
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**Learning time:**
- **29h**
  - Theory classes: 11h 30m
  - Laboratory classes: 2h 30m
  - Self study: 15h

- **26h 30m**
  - Theory classes: 11h 30m
  - Self study: 15h
### 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.

### 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 Assessment and Permanence Regulations (https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf)
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: