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)
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 BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
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

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

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Content

1.- INTRODUCTION TO THERMODYNAMICS

Learning time: 29h
Theory classes: 11h 30m
Laboratory classes: 2h 30m
Self study : 15h

Description:
Thermodynamical systems. Temperature and the zeroth law of thermodynamics. Thermodynamic scales. Ideal gas. Simple, compressible pure substances: gasses and steam.

Specific objectives:
Understand the basic knowledge required for the study of thermodynamics.

2.- FIRST LAW OF THERMODYNAMICS

Learning time: 29h
Theory classes: 11h 30m
Laboratory classes: 2h 30m
Self study : 15h

Description:
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.

Specific objectives:
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.

3.- SECOND LAW OF THERMODYNAMICS

Learning time: 26h 30m
Theory classes: 11h 30m
Self study : 15h

Description:
Enthropy and irreversibilities. Second law of thermodynamics. Thermal engine. Carnot's efficiency. Isenthropical processes and isentrhropical efficiencies for thermal engines. Gas turbine: Brayton's cycle. Steam turbine: Rankine cycle. Steam compression refrigeration systems.

Specific objectives:
To understand the concept of enthropy 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 pumpling applications.

4.- CONDUCTIVE HEAT TRANSFER	Learning time: 23h 30m Theory classes: 6h Laboratory classes: 2h 30m Self study : 15h

Description:
General differential equation for conduction heat transfer. Conduction in a flat wall. Conduction in a cylindric wall. Thermal resistance. Overall heat transfer coefficient.

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:
Free and forced convection mechanism. Interior and exterior convection. Convection over flat surfaces. Convection over cylinders. Convections in pipe flow. Empirical correlations.

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

6.- RADIATIVE HEAT TRANSFER	Learning time: 21h Theory classes: 6h Self study : 15h

Description:
Electromagnetic spectrum and radiation physics. Kirchoff's law. Black-body radiation. Grey and real bodies. Radiation functions.

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 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)

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:

Çengel, Yunus A.; Boles, Michael A. Termodinámica. 6ª ed. México, D.F: McGraw-Hill Interamericana, cop. 2009. ISBN 9789701072868.

Llorens, Martín; Miranda, Ángel Luis. Ingeniería térmica. Barcelona: Marcombo, cop. 2009. ISBN 9788426715319.

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

Complementary:

Moran, Michael J.; Shapiro, Howard N. Fundamentos de termodinámica técnica. 2ª ed. Barcelona [etc.]: Reverté, cop. 2004. ISBN 8429143130.