Course guides
820020 - TTC - Thermodynamics and Heat Transfer

Last modified: 19/06/2020

Unit in charge:	Barcelona East School of Engineering
Teaching unit:	729 - MF - Department of Fluid Mechanics.
Degree:	BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject). BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject). BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject). BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Compulsory subject). BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2020 **ECTS Credits:** 6.0 **Languages:** Catalan, English, Spanish

LECTURER

Coordinating lecturer: 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 YOUCEF NASSIM BENABDELOUED - M11, M12, M51, M52, M54
ALBERTO ANTONIO CARBO BECH - M21, M22
JOSE ALEJANDRO CARRILLO CORTES - T12
ALFRED FONTANALS GARCIA - M31, M32, M33, M34, M35
MARCEL GARCIA COROMINAS - M34, M42
RAUL GARCÍA SANJURJO - M41
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

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

Total learning time: 150 h

CONTENTS

1.- INTRODUCTION TO THERMODYNAMICS

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.

Full-or-part-time: 29h
Theory classes: 11h 30m
Laboratory classes: 2h 30m
Self study : 15h

2.- FIRST LAW OF THERMODYNAMICS

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.

Full-or-part-time: 29h
Theory classes: 11h 30m
Laboratory classes: 2h 30m
Self study : 15h

3.- SECOND LAW OF THERMODYNAMICS

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.

Full-or-part-time: 26h 30m
Theory classes: 11h 30m
Self study : 15h

4.- CONDUCTIVE HEAT TRANSFER

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.

Full-or-part-time: 23h 30m
Theory classes: 6h
Laboratory classes: 2h 30m
Self study : 15h

5.- CONVECTIVE HEAT TRANSFER

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.

Full-or-part-time: 21h
Theory classes: 6h
Self study : 15h

6.- RADIATIVE HEAT TRANSFER

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.

Full-or-part-time: 21h
Theory classes: 6h
Self study : 15h

GRADING 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)

EXAMINATION RULES.

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 [on line]. 7a ed. México, D.F: McGraw-Hill Interamericana, cop. 2012 [Consultation: 17/06/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=3214360. ISBN 9781456213381.
- 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.