Course guide
295452 - 295TM013 - Advanced Heat Transfer and Energy Technologies

Last modified: 28/10/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics.

Degree: MASTER'S DEGREE IN MECHANICAL TECHNOLOGIES (Syllabus 2024). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: FRANCESC FONT MARTÍNEZ - MARIO MIGUEL VALERO PÉREZ

Others:

LEARNING RESULTS

Knowledges:
K.06. Identify the most appropriate techniques, components and materials for the development of advanced applications in mechanical engineering.
K.01. Critically interpret the physical principles governing the behaviour of systems and advanced applications in the fields of mechanical design, manufacturing processes, strength of materials, fluid mechanics, thermodynamics and heat transfer.
K.03. Recognise the process and product design principles and methods that apply to smart manufacturing systems.
K.02. Identify the fundamental equations governing physical phenomena associated with complex problems in mechanical engineering.
K.07. Define appropriate analytical, experimental and/or computational models to study relevant problems in mechanical engineering.
K.09. Identify appropriate measuring devices for characterising the behaviour of systems of interest in mechanical engineering.

Skills:
S.08. Integrate knowledge from different areas of the mechanical field in the design and development of projects, systems and engineering solutions.
S.04. Incorporate sustainability and energy efficiency criteria into the design, planning, execution and operation phases of engineering projects.
S.05. Critically examine the results of the analysis of a process or product, taking into account the limitations of the techniques used.
S.07. Design flexible production/operation systems to improve the performance of industrial processes.
S.03. Use advanced numerical simulation and virtual prototyping techniques to solve complex mechanical problems.
S.01. Comprehensively apply experimental techniques, calculations, evaluations, appraisals, expert reports, studies, work plans and related tasks in the development of mechanical engineering projects, applying compulsory specifications, regulations and standards at each stage of the process.
S.06. Efficiently manage information collected during analytical, numerical and/or experimental studies and automate its analysis to facilitate knowledge extraction.

Competences:
C.03. Manage the acquisition, structuring, analysis and visualisation of data and information in the mechanical field and critically evaluate the results of this process.
C.01. Recognise the complexity of the economic and social phenomena typical of a welfare society in order to relate welfare to globalisation and sustainability, and use techniques, technology and principles of economics and sustainability in a balanced and compatible way.
C.04. Ensure, within the limits of one's professional competence, compliance with ethical standards, professional guidelines and current legislation regarding fundamental rights, taking into account the goal of reducing inequalities, the gender perspective, and the principles of accessibility, inclusion and non-discrimination in the design of technical solutions and in the management of projects and teams.
C.05. Propose advanced scientific and technological solutions to complex industrial challenges in the field of mechanical engineering.

TEACHING METHODOLOGY

LEARNING OBJECTIVES OF THE SUBJECT

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STUDY LOAD

Type	Hours	Percentage
Hours small group	27,0	18.00
Hours large group	27,0	18.00
Self study	96,0	64.00

Total learning time: 150 h

CONTENTS

Introduction

Description:
- Heat transfer by conduction, convection and radiation.
- Thermal transients.
- Equations of state beyond the ideal gas.
- Introduction to heat transfer equipment and the relevance of thermal management in 21st century technologies.

Full-or-part-time: 22h
Theory classes: 4h
Laboratory classes: 4h
Self study : 14h

Theoretical fundamentals of advanced heat transfer and computation

Description:
- Heat transfer and its coupling with mass and momentum transport. Parallelism between mass transfer and heat transfer.
- Heat transfer with phase changes, multiphase flow, combustion, composite and porous media.
- Heat transfer to the micro-nano ladder. Limit of validity and extensions of Fourier's law. Thermal resistance at interfaces.
- Computational simulation of heat transfer.

Full-or-part-time: 32h
Theory classes: 6h
Laboratory classes: 6h
Self study : 20h

Experimental heat transfer characterisation

Description:
- Sensors (infrared thermometers, thermal cameras, thermocouples, radiometers, pressure measurement, humidity measurement).
- Radiometry
- Data acquisition equipment
- Introduction to data acquisition systems (i.e., LabView software).

Full-or-part-time: 32h
Theory classes: 6h
Laboratory classes: 6h
Self study : 20h

Thermal systems analysis and modelling

Description:
- Introduction to thermal systems.
- Energy fluid transport networks. District heating/cooling networks.
- Thermal storage
- Thermal energy in industry
- Thermal energy in buildings.
- Modelling tools: Open Modelica, TRNSYS, ASPEN, EnergyPlus.

Full-or-part-time: 32h
Theory classes: 6h
Laboratory classes: 6h
Self study : 20h

title english

Description:
Study of energy technologies such as:
- Propulsion.
- Cryogenics.
- Aerothermics, geothermics.
- Renewable energies.
- Cogeneration and trigeneration.
- Climatization of date centers.

Full-or-part-time: 32h
Theory classes: 6h
Laboratory classes: 6h
Self study : 20h

GRADING SYSTEM

BIBLIOGRAPHY

Basic:
- Bergman, T. L. Fundamentals of heat and mass transfer. 7th ed. Hoboken, NJ: Wiley, cop. 2011. ISBN 9780470501979.
- Çengel, Yunus A.; Ghajar, Afshin J. Heat and mass transfer : fundamentals & applications. 4th ed. New York: McGraw-Hill, cop. 2011. ISBN 9780073398129.
- Poling, Bruce e.; O'Connell, John P.; Prausnitz, J. M. The properties of gases and liquids. 5th ed. New York: McGraw-Hill, 2001. ISBN 9786610913176.
- Naterer, Greg F. Advanced heat transfer. Second edition. Boca Raton: CRC Press, 2018. ISBN 9781138579323.