# Thermal engineering

**Academic Year: ( 2024 / 2025 )** **Review date: 22-03-2024**

**Department assigned to the subject: Thermal and Fluids Engineering Department**

**Coordinating teacher: LAPORTE AZCUE, MARTA**

**Type: Compulsory ECTS Credits : 6.0**

**Year : 3 Semester : 2**

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- Calculus I
- Calculus II
- Physics I

## SKILLS AND LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Analyze and synthesize basic problems related to physics and engineering, solve them and communicate them efficiently.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CE6. Solve problems of applied thermodynamics, heat transmission and fluid mechanics in the field of engineering.
CE20. Understand and address the general problems of the field of Energy, as well as the scientific and technological foundations of its generation, conversion, transport and storage.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects

relevant in their field of study.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

## OBJECTIVES

At the end of this course, students will be able to:
1. Know and understand about thermodynamics and heat transfer.
2. Apply their knowledge and understanding to identify, formulate and solve thermodynamic and heat transfer problems using the established methodology.
3. Design and carry out experiments, understand experimental data and obtain conclusions.
4. Have technical and laboratory knowledge.
5. Select and use adequate equipments, tools and methods.
6. Combine theory and practice to solve thermodynamic and heat transfer problems.
7. Understand the limitations of the techniques and methodology applied to thermodynamics and heat transfer.

## DESCRIPTION OF CONTENTS: PROGRAMME

This is a basic course of Thermodynamics and an introduction to Heat Transfer.
The program can be divided in 2 main blocks, one about thermodynamics and another about heat transfer.

FIRST PART (THERMODYNAMICS AND CYCLES):
- Review of previous concepts of thermodynamics acquired by the student, thermodynamic properties, T-s diagram of water, incompressible liquid and ideal gas models.
- Mass, energy and entropy balance for closed systems.
- Mass, energy and entropy balance for open systems.
- Equipments under steady state: nozzles, diffusers, pumps, compressors, turbines, open and closed heat exchangers, and valves.
- Thermal engines. Carnot cycle.
- Rankine cycle.
- Brayton cycle.
- Internal combustion engines.
- Inverse Carnot cycle. Refrigeration cycle.

SECOND PART (HEAT TRANSFER):
- Introduction to heat transfer: Fourier's law, Newton's law, Stefan-Boltzmann's law.
- One-dimensional steady state conduction with and without heat generation. Plane wall, cyclindrical and spherical geometries. Thermal resistances.
- Transient conduction.
- Fins: formulation, design and performance analysis. Finned surfaces.

## LEARNING ACTIVITIES AND METHODOLOGY

The learning methodology includes:
(1) Lectures covering the main topics described within the course outline. To facilitate the sessions, the students will have available the lecture's notes as well as reference books to complete their learning.
(2) Case study and problem solving lectures, where some issues are addressed from a practical point of view.
(3) Exercises solved by the student to self-assess their knowledge and acquire the necessary skills.
(4) Group projects.

## ASSESSMENT SYSTEM

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|---|---|
| **% end-of-term-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

- Labs (continuous assessment): 15%
- Midterm exam (continuous assessment): 25%
- Final Exam: 60% (25% thermodynamics + 35% heat transfer)

For those students who pass the partial exam (grade >= 5) the weight of each part will be the following:
- Labs (continuous assessment): 15%
- Midterm exam (continuous assessment): 50% (thermodynamics)

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|---|---|
| **% end-of-term-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

- Final Exam: 35% (heat transfer)

In any case, a minimum grade of 3.5 in each part will be required to pass the course.

## BASIC BIBLIOGRAPHY


- F.P. Incropera and D.P. DeWitt Fundamentals of Heat and Mass Transfer, John Wiley & Sons. 6th edition, 2007

- M.J. Moran , H.N. Shapiro Fundamentals of Engineering Thermodynamics, John Wiley & Sons. 6th edition, 2010


## ADDITIONAL BIBLIOGRAPHY


- A. Bejan Heat Transfer, John Willey & Sons, 1993

- J.P. Holman Heat Transfer, McGraw Hill, 1998

- F. Kreith y M.S. Bohn Principles of Heat Transfer, Thomson, 2002

- Y.A. Çengel Termodinámica, McGraw Hill, 1996.