COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

Syllabus
2024 - 2025

GENERAL INFORMATION

Data of the subject	
Subject name	Thermodynamics
Subject code	DIM-GITI-213
Mainprogram	Bachelor's Degree in Engineering for Industrial Technologies
Involved programs	Grado en Ingeniería en Tecnologías Industriales [Second year]
Level	Intercambio
Quarter	Semestral
Credits	7,5 ECTS
Type	Obligatoria (Grado)
Department	Department of Mechanical Engineering

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DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Prerequisites

There are not prerequisites strictly speaking. However, the subject is supported in concepts seen in previous subjects:

- Physics
  - Kinematics and dynamics of a particle
  - Work and energy
  - Variation of mechanical energy
- Calculus
  - Implicit equations solving

Course contents

Contents

Fundamentals

Unit 1: Introduction

1. Background and object.
2. Thermodynamic systems.
3. Energy forms.
4. Thermodynamic properties.
5. State and equilibrium.
6. Processes and cycles.
7. State law.
8. Common state variables.

Unit 2: Properties of pure substances

1. Introduction.
2. Phase and pure substance.
3. p-v-T surface.
4. Properties tables.
5. Approximations and models.

Unit 3: The first law in closed systems

1. Introduction.
2. Heat transfer.
3. Work transfer.
4. The first law.
5. Specific heats.

Unit 4: The first law in open systems

1. Introduction.
2. Mass balance.
3. Energy balance.
4. Steady-state systems.

Unit 5: The second law

1. Introduction.
2. **Part I: Classic formulation**
    1. Heat sources/sinks and thermal machines.
    2. Second law enunciates.
    3. Reversible and irreversible processes.
    4. Carnot cycle.
    5. Carnot theorems.
    6. Maximal performance of thermal machines.
3. **Part II: Entropy**
    1. Clausius inequality.
    2. Entropy.
    3. Entropy balance in closed systems.
    4. Entropy balance in open systems.
    5. Entropy assessment.
    6. Cuasi-static processess representation.
    7. Isentropic efficiencies.
4. **Part III: Exergy**
    1. Definitions.
    2. Exergy balance in open systems.
    3. Sankey diagram.
    4. Exergy efficiency.

Applications

Unit 6: Thermal power stations

1. Introduction.
2. Basic Rankine cycle.
3. Procedures to enhance efficiency in a Rankine cycle.
4. Actual Rankine cycles.
5. Basic Brayton cycle.
6. Combined cycle.

Unit 7: Volumetric thermal machines

1. Introduction.
2. **Part I: Reciprocating internal combustion engines**
    1. Introduction.
    2. Thermodynamic model.
    3. Indicator diagram.
    4. Fundamental parameters.
    5. Thermodynamic cycles.
3. **Part II: Reciprocating compressors**
    1. Introduction.
    2. Thermodynamic model.
    3. Volumetric efficiency.
    4. Multi-step compression.
    5. Indicator diagram.
    6. Works, powers and efficiencies.

Unit 8: Gases mixtures and psychrometry

1. Introduction.
2. Description of the mixture composition.
3. Thermodynamic properties of the mixtures.
4. Psychrometry.
    1. Humid air composition.
    2. Psychrometric properties.
    3. Psychrometric chart.
    4. Psychrometric processes

EVALUATION AND CRITERIA

Evaluation activities	Evaluation criteria	Weight
Exams • Mid term exam • Final exam	• Concepts understanding. • Concepts application to problem solving. • Discussion of results obtained in problem solving. • Presentation and written comunication.	85
Progess exams Exams performed at the classroom at the end of certain units (2 exams in all the course).	• Concepts understanding. • Concepts application to problem solving.	15

Grading

Ordinary summon

Final grade is obtained as:

- 85% comes from exams grading. Final exam will contribute with 60% to the final grade of the subject, whereas mid term exam will contribute with 25%.
- 15% comes from progress exams. There will be 2 exams, after units 3 and 5, which will be performed at classroom.

If the resulting average grade is higher than 5.0 the subject grade will be such average; otherwise, the subject grade will be the minimum grade between such average and the final exam grade.

Extraordinary summon

In the extraordinary summon the grade will come exclusively from the final exam performed in this summon.

Rules

Neither programmable calculators nor formulae summary, books and notes are allowed. In the final exam of each summon a formulae summary covering
unit 7 will be supplied. Such summary is available at Moodle.

Attendance: The absence of more than 15% of the total amount of classes can entail to fail the ordinary summon.

WORK PLAN AND SCHEDULE

Activities	Date of realization	Delivery date
Reading of the slides shown at classroom.	Before session	
Study of the slides shown at classroom	After session	
Complementary study of the textbook.	After session	
Attempted resolution of proposed problems.	Before session	
Review and study of solved problems at classroom.	After session	
Attempted resolution of not solved iat classroom problems. Moodle published solution consulting and question solving session appoinment if necessary.	At the end of each unit	
Preparation of the exams performed during sessions.	After units 3 and 5	
Preparation of mid term and final exams. The work will be focused especially on the reviewing sessions done by the teacher at classroom.	Early October and end November	

BIBLIOGRAPHY AND RESOURCES

Basic References

Basic material is available at Moodle

- Slides of each unit.
- Notes (chapter of textbook) of each unit.
- Solved problems.
- Solved exams of previous years.

Supplementary References

- Y.A. Çengel, M.A. Boles. Thermodynamics. Mc Graw-Hill International edition). Last edition.
- M.J. Moran, H.N. Shapiro. Fundamentals of engineering thermodynamics. Wiley. Last edition.