ESIROI
ÉCOLE D'INGÉNIEURS
UNIVERSITÉ DE LA RÉUNION

DEPARTMENT : *CPI*
SEMESTER : *S3*

IDENTIFICATION

Course code :	E2CP3PC3
ECTS :	2

DURATION

Lectures :	14
Tutorial classes :	16
Labs :	0
Total :	30

Project :
Personnal work :

ASSESSMENT

2 Written exams (2h/2h)

TEACHING MATERIALS

moodle

LANGUAGE

English

CONTACT

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UE : PHYSIQUE-CHIMIE

COURSE : Thermodynamics II

SCOPE OF THE COURSE

OBJECTIVES

The aim of the course is to provide students with the conceptual and methodological foundations of **classical thermodynamics** necessary for understanding and analyzing energy transformations. The course aims to :

- Understand the fundamental principles of thermodynamics (first and second laws) and their implications.
- Establish **energy and entropy balances** for closed or open systems.
- Describe and quantify **state changes** and **perfect gas transformations**.
- Analyze the operation of **thermal machines** (engines, receivers, reversible and real cycles).
- Develop a rigorous scientific approach to model and optimize energy systems.

COMPETENCE AND SKILLS

- Identify the modes of energy exchange : **work (W)** and **heat (Q)**.
- Apply the **first law** and calculate **Q**, **W**, ΔU, ΔH.
- Perform energy balances according to transformations (isobaric, isochoric, isothermal, adiabatic).

- Use **heat capacities** and perform a **calorimetric balance**.
- Relate heat, temperature, and internal energy in common cases.

- Interpret transformations on a **Clausius-Clapeyron diagram**.
- Apply **Joule's**, **Laplace's**, and **Dulong-Petit's** laws.

- State the **second law** and define **entropy**.
- Establish **entropy balances** for simple systems.

- Understand the operation of **heat engines** and calculate their **efficiency**.
- Describe **heat pumps** and **refrigerators**.
- Identify **phase changes** and use **Clapeyron relations**.

PROGRAM

1. Second law of thermodynamics

- State the **second law** and define the concept of **entropy**.

— Apply the principle to **isolated** or **steady-state systems**.
— Distinguish between **reversible and irreversible transformations**.
— Use the **fundamental identities** and derive **Laplace's laws** for isentropic cases.
— Perform simple **entropy balances** (Joule–Gay Lussac expansion, thermal contact).

2. Heat engines (motors)

— Define **heat engine**, **motor**, and **receiver**.
— Establish **energy and entropy balances**.
— Calculate **efficiency** and **effectiveness**.
— Identify **monothermal machines** (Kelvin statement) and **dithermal machines** (Raveau diagram).
— Explain the **Carnot cycle and efficiency** and compare it with real cycles (Beau de Rochas, Watt).
— Describe **heat pumps** and **refrigerators**.

3. Phase changes

— Identify the main **phase changes** (melting, vaporization, etc.).
— Use **phase diagrams** (P–T, P–V).
— Know the **triple point** and **critical point**.
— Apply **Clapeyron** and **Clausius–Clapeyron relations**.
— Relate phase changes to variations in **enthalpy** and **entropy**.

BIBLIOGRAPHY

— P. Perrot, *Thermodynamics for Engineers*, Dunod, 2018.
— M. Borel and J.-L. Battaglia, *Thermodynamics – Course and Corrected Exercises*, Dunod, 2021.
— H.B. Callen, *Thermodynamics and an Introduction to Thermostatistics*, Wiley, 1985.
— Online resources : FUN-MOOC Thermodynamics ; PhET Simulations ; NIST WebBook.

REQUIREMENTS

— **General Physics** : fundamental quantities (mass, volume, pressure, temperature, energy), SI units and reading diagrams (P–V, T–S).
— **Classical Mechanics** : work, mechanical energy and the fundamental principle of dynamics.
— **Applied Mathematics** : differentiation, integration, differential equations, logarithmic and exponential functions.
— **Chemistry and Condensed Matter** : physical states, phase changes and intermolecular bonds.
— **Scientific Culture** : orders of magnitude in energy, simple systems (ideal gas, solid, liquid) and the scientific approach.