ESIROI
ÉCOLE D'INGÉNIEURS
UNIVERSITÉ DE LA RÉUNION

DEPARTMENT : *CPI*
SEMESTER : *S2*

IDENTIFICATION

Course code :	E1CP2PC3
ECTS :	1.5

DURATION

Lectures :	10
Tutorial classes :	14
Labs :	0
Total :	24

Project :
Personnal work :

ASSESSMENT

Continuous assessment : 1 surprise test (≥ 20 min, 20 %), CA1 (≤ 2 h, 40 %, parts 1–2), CA2 (≤ 2 h, 40 %, full syllabus) ; final grade = 0.20 (surprise test) + 0.40 (CA1) + 0.40 (CA2).

TEACHING MATERIALS

Learning materials available on the Moodle platform.

LANGUAGE

English

CONTACT

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UE : PHYSIQUE-CHIMIE

COURSE : Thermodynamics I

SCOPE OF THE COURSE

OBJECTIVES

Establish the fundamentals of thermodynamics and the simple and conceptual application of the first law.

COMPETENCE AND SKILLS

- To know how to define the states of matter : fluid, solid, and mesomorphic.
- To know the characteristics of the fluid state. To know the concept of phase and the nomenclature of phase changes.
- To know the concept of thermodynamic system and to know the definitions of closed, open, and isolated systems.
- To be able to define the concept of state parameter.
- To know the zeroth law of thermodynamics and the first definition of temperature.
- To know the principle of a temperature scale and to know the Celsius and Kelvin scales.
- To be able to define the concepts of thermostat, thermodynamic equilibrium, state function (and its properties).
- Transformations and evolutions : isochoric, monothermal, isothermal, monobaric, isobaric, reversible, quasi-static, elementary, and adiabatic ; conservative and non-conservative quantities.
- To understand the inadequacy of mechanics and the necessity of the concept of total energy, kinetic temperature from microscopic kinetic energy.
- To be able to define the concept of molecular chaos and to justify the statistical approach.
- To be able to define the homogeneity of the velocity distribution and isotropy of velocities, and the concept of root-mean-square velocity.
- To know the three hypotheses of the ideal gas.
- To know the expression for kinetic pressure.
- To be able to define kinetic temperature and to know the equipartition theorem.
- To be able to derive the ideal gas equation of state.
- To know the extrapolation to polyatomic ideal gases : concept of rotational and vibrational degrees of freedom, consequences on internal energy and heat capacities at constant volume (CV).
- To be able to determine the expression for internal energy for a monatomic ideal gas and to define the heat capacity at constant volume (CV).
- To know some limitations of the ideal gas model : e.g., the Amagat diagram.
- To know the hypotheses of the Van der Waals gas model and its equation.
- To know the concept of ideal mixture (Dalton's Law).

PROGRAM

1. Thermodynamics language
2. The ideal gas
3. First Law applied to simple ideal-gas transformations

BIBLIOGRAPHY

Reference works (lectures and applications)

— J.-P. Pérez, *Thermodynamique. Fondements et applications*, Dunod. Reference for conceptual structure (language, principles, perfect gas).

— B. Diu, C. Guthmann, D. Lederer, B. Roulet, *Thermodynamique*, Hermann. Rigorous treatment of kinetic theory, kinetic pressure and temperature, and equipartition.

— C. Lhuillier, J. Rous, *Introduction à la thermodynamique*, Dunod. Progressive introduction adapted to the module level.

— M.-N. Sanz, A.-E. Badel, F. Clausset, *Physique tout-en-un*, collection « Tout-en-un », Dunod. For the first law and simple transformations of the perfect gas, numerous corrected exercises.

Further reading and physico-chemical aspects

— P. W. Atkins, J. de Paula, *Chimie physique*, De Boeck. Real gases (Van der Waals, Amagat diagrams), ideal mixtures, Dalton's law.

— O. Bonnefoy, *Thermodynamique*, course handout, École des Mines de Saint-Étienne (available online). Clear synthesis with statistical perspective.

Exercise collections

— H. Lumbroso, *Thermodynamique — Problèmes résolus*, Dunod.

REQUIREMENTS

Entry-level expectations for the module :

Mathematics
Differential and integral calculus in one variable ; partial derivatives and total differential of a function of several variables ; notion of differential form, distinction between exact differential (state function) and non-exact form (transfer quantity) ; integration along a path.

Point Mechanics
Work of a force, kinetic energy and the kinetic energy theorem, potential energy and mechanical energy ; momentum and momentum balance (useful for kinetic pressure and wall impacts).

General Physics
Concepts of force, pressure and units of the International System ; order of magnitude and dimensional homogeneity.

General Chemistry
States of matter, notion of mole, Avogadro's number, molar mass.

Elementary Statistical Tools
Concept of mean value and distribution of a quantity (foundation of the statistical approach to molecular chaos and root-mean-square speed).