ME-551  Engines and fuel cells
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**Summary**

The students describe and explain the thermodynamic and operating principles of internal combustion engines and all fuel cell types, identify the determining physical parameters for the operating regimes, the efficiencies and the polluting emissions, and compare the systems against each other.

**Content**

Operation principles of engines, mechanical (kinematics, dynamics) and thermodynamic principles (ideal cycles), diesel and spark ignition engines (combustion process, load regulation, noise analysis and prevention, electronics regulation, supercharging), characterization of combustion gases, pollutant formation, means and methods of emissions reduction, modeling (cycle modeling, time dependant combustion, sub-systems modeling), New concepts: hybrids systems, downsizing, direct injection, discussion.


**Keywords**

Efficiency, cycles, emissions, modeling

**Learning Prerequisites**

**Recommended courses**

- Thermodynamique et énergétique I
- Heat and mass transfer
- Thermodynamique et énergétique II

**Important concepts to start the course**

- Master the concepts of mass, energy, and momentum balance.
- Compute the thermodynamic properties of a fluid.
- Master the concepts of heat and mass transfer.
- Understand the main thermodynamic cycles.

**Learning Outcomes**

By the end of the course, the student must be able to:
• Compute the main thermodynamic transformations of compressible and incompressible fluids, E4
• Describe the involved thermodynamic cycles, E5
• Explain the concepts of thermodynamic efficiency, E6
• Design internal combustion engines, E15
• Compute fluid flows in energy conversion systems, compute pressure drops and heat losses and fluid-structure interactions, E10
• Design thermo-chemical and thermo-electric (fuel cells) conversion units, E18
• Explain and calculate the main emission sources of energy conversion processes, E23

Transversal skills
• Assess one’s own level of skill acquisition, and plan their on-going learning goals.
• Communicate effectively with professionals from other disciplines.
• Access and evaluate appropriate sources of information.

Teaching methods
Ex cathedra with frequent questions. Resolved exercices.

Expected student activities
Solve the exercises by yourself.
Rehearse the previous course module for the following week

Assessment methods
Written exam, general knowledge questions and numerical resolution of exercises, on both course subjects (50% engines - 50% fuel cells).

Supervision
Office hours Yes
Assistants Yes
Forum Yes

Resources
Bibliography
Thermodynamics and Energetics, Borel/Favrat (PPUR)

Ressources en bibliothèque
• Thermodynamique énergétique / Borel