ME-551

Engines and fuel cells

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Cursus	Sem.	Type
Energy Science and Technology	MA1, MA3	Opt.
Energy minor	H	Opt.
Mechanical engineering minor	H	Opt.
Mechanical engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Written
Workload	120h
Weeks	14
Hours	**3 weekly**
Courses	3 weekly
Number of positions	

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 (dynamics) and thermodynamic principles (ideal cycles), diesel and spark ignition engines (combustion process, load regulation, electronics regulation, supercharging), characterization of combustion gases, pollutant formation, means and methods of emissions reduction. New concepts: hybrids systems, downsizing.
Construction and architecture of fuel cell families, for application at ambient and high temperature. Operating principles, thermodynamics and kinetics. Advantages and challenges, highlighting the efficiency (electrical, cogeneration, part-load). Fuel choice and fuel treatment (hydrogen, hydrocarbons). Electrolysis (reverse fuel cell operation). Aspects of modeling in fuel cells. Exercices with numerical exemples.

Keywords

Efficiency, cycles, emissions, operation, regulation

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 calculte 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.
Invited seminars by industry experts.
Optional : excursion to Liebherr Motors, Bulle (on Tue or Thu, ex class hours)

Expected student activities

Solve the exercises by yourself.
Rehearse the previous course module for the following week.
Prepare for the theoretical tests during the semester (week 7 + week 14)
Optional : excursion to Liebherr Motors, to the town of Bulle (on a Tue or a Thu, ex class hours)

Assessment methods

One test in week 7 (1h), one test in week 14 (1h), general knowledge questions on the theory/understanding of both course parts Fuel Cells & Engines, counting for 20%+20% of the final grade (closed book).
During the regular exam session, written exam (open book), on the resolution of exercices, on both course subjects (50% engines - 50% fuel cells), counting for 60% of the final grade.

Resources

Bibliography

Thermodynamics and Energetics, Borel/Favrat (PPUR)
Fuel Cell Handbook (Seventh Edition): https://www.netl.doe.gov > netl file >FCHandbook7
Internal combustion engines: Dr V. Ganesan

Ressources en bibliothèque

- Find the references at the Library

Moodle Link

- https://go.epfl.ch/ME-551