ME-454

Modelling and optimization of energy systems

Maréchal François

Cursus	Sem.	Type
Energy Management and Sustainability	MA2, MA4	Opt.
Energy Science and Technology	MA2, MA4	Opt.
Energy minor	E	Opt.
Ing.-chim.	MA2, MA4	Opt.
Mechanical engineering	MA2, MA4	Opt.
Minor in Integrated Design, Architecture and Sustainability	E	Obl.
Systems Engineering minor	E	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

The goal of the lecture is to present and apply techniques for the modelling and the thermo-economic optimisation of industrial process and energy systems. The lecture covers the problem statement, the solving methods for the simulation and the single and multi-objective optimisation problems.

Content

- Concepts of Computer Aided Process System Engineering methods to tackle the problems of energy conversion systems modelling and optimisation. The students will acquire a methodology to state the problem, identify the solving procedure, solve the problem and analyse the results;
- Definition of the basic system modelling concepts : state variables, energy and mass balances, simulation parameters and equations, degree of freedom analysis, different types of specifications, inequalities, objective functions;
- Energy systems equipments models;
- System models : flowsheets, degrees of freedom, sequential or simultaneous solving approach, numerical methods and their implications;
- Measurement data reconciliation and parameter identification;
- Calculating systems performances : operating cost, efficiency, environmental impact, investments, thermo-economic and environomic performances;
- Stating and solving optimization problems : decision variables, objective functions and constraints, solving strategies, numerical methods and their implications;
- Realization of a case study.

Keywords

Process system engineering, Process simulation, optimization

Learning Prerequisites

Recommended courses

Prerequisite skills

- Master the concepts of mass, energy, and momentum balance, E1 (Thermodynamique et énergétique I)
- Compute the thermodynamic properties of a fluid, E2 (Thermodynamique et énergétique I)
- Master the concepts of heat and mass transfer, E3 (Heat and mass transfer)
- Understand the main thermodynamic cycles, E5 (Thermodynamique et énergétique I)
- Notion of optimization (Introduction à l'optimisation différentiable)

Learning Outcomes

By the end of the course, the student must be able to:

- Master the concepts of thermodynamic efficiency, E6
- Establish the flow diagram of an industrial process and calculate the corresponding energy and mass balance, E22
- Analyse the energy and exergy efficiency of industrial energy systems, E23
- Model, design and optimize energy conversion systems and ind ustrial processes, E24
- Establish the flow diagram of an industrial process and calculate the corresponding energy and mass balance, E20
- Explain and apply the concepts of thermodynamic efficiency, E6
- Analyze the energy and exergy efficiency of industrial energy systems, E21
- Model , design and optimize energy conversion systems and industrial processes, E22

Transversal skills

- Write a scientific or technical report.
- Make an oral presentation.
- Keep appropriate documentation for group meetings.
- Access and evaluate appropriate sources of information.

Teaching methods

The course is organised as theoretical sessions and the resolution of a real case study to be realised by a student team coached by an assistant.

Expected student activities

Participation to a team project and contribution to the report.
Active participation to the lectures and mastering the theoretical concepts applied to solve the project.

Assessment methods

An oral exam will concern the theory and its application in the case study.

Resources

Bibliography

All the material can be downloaded from the moodle website (http://moodle.epfl.ch/course/view.php?id=11).
Printed version of the lecture notes can be ordered.

Moodle Link

- http://moodle.epfl.ch/course/view.php?id=11

Videos

- http://www.klewel.com/conferences/epfl-energy-systems/