

EE-365

**Power electronics**

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Cursus	Sem.	Type
Electrical and Electrical Engineering	BA6	Opt.
HES - EL	E	Obl.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	During the semester
Workload	120h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Courses	2 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

The goal of the course is to present fundamentals of power electronics. The key focus is on the operating principles of power electronic converters, their modelling, sizing and design.

**Content**

- Power electronics and its role in energy conversion
- Power semiconductor devices (diodes, thyristors, BJT, MOSFET, IGBT, IGCT,...)
- AC-DC converters - diode rectifiers, phase-shift controlled thyristor rectifiers
- DC-DC converters (non-isolated) - Buck, Boost, Buck-Boost, Cuk, SEPIC
- DC-DC converters (isolated) - Flyback, Forward, Push-Pull, Dual Active Bridge, Resonant Converters
- DC-AC converters - single-phase and three-phase inverters
- AC-AC converters - single stage, double stage conversion, frequency converters
- Pulse Width Modulation (PWM) - basic principles, unipolar and bipolar PWM, three-phase PWM
- Passive components - design of inductors and transformers
- Thermal design - losses in semiconductors and passive devices, thermal networks, cooling system design
- Power electronics simulations, design and integration
- Power electronics applications: electrical drives, renewable electrical energy, electrical traction, power supplies

**Keywords**

electrical energy conversion, power electronics, converters, modeling and design

**Learning Prerequisites****Required courses**

Energy conversion

**Learning Outcomes**

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

- Understand a power electronics system
- Understand the operation of power electronics applications
- Design a power electronic converter for a given specifications
- Define a power electronic converter for a given application
- Develop a power electronic converter
- Model power electronics systems
- Characterize power semiconductors and power electronic converters

### Transversal skills

- Demonstrate the capacity for critical thinking
- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Access and evaluate appropriate sources of information.
- Use a work methodology appropriate to the task.
- Write a scientific or technical report.

### Teaching methods

Lectures will present relevant theoretical background, basic principles and new concepts, modeling and simulation examples (using PLECS simulation SW) as well as numerical examples to illustrate power electronic designs. Comprehensive slides will be available on Moodle.

Exercises are implemented as Project based assignment. Grouped in pairs, students will receive project assignment for the whole semester. Project will involve practical design of a small power electronic converter, with modest power ratings and utilizing commercially available IC for control (there is no need for programming of any kind). Written report and working prototype are expected at the end of a course.

Additional training sessions will be provided by Power Electronics Laboratory so support student's projects (e.g. PLECS and ALTIUM trainings).

### Expected student activities

In addition to attending lectures, where theoretical foundations will be presented, throughout the semester, student's work will involve several activities, required to finalize the assignment:

- understanding operating principles of the given topology
- simulations to verify operation and performances under given operating conditions
- design (inductors and/or transformers) and selection of components (semiconductors, resistors, capacitors)
- schematic and printed circuit board design (in Altium)
- practical assembly and testing (in PEL laboratory ELH-114)
- design documentation and final report writing

### Assessment methods

Project presentation including:

- written design and test report
- final oral presentation and discussion including demonstration of the converter operation

### Resources

#### Bibliography

Fundamentals of Power Electronics (Erickson, Robert W., and Dragan Maksimovic#), Kluwer Academic, 2001

Power Electronics. Converters, Applications and Design (Ned Mohan, Tore M. Undeland, William P. Robbins), John Wiley and Sons, Inc, 2003.

#### Ressources en bibliothèque

- [Power Electronics: converters, applications and design / Mohan](#)
- [Fundamentals of Power Electronics / Erickson](#)

### **Notes/Handbook**

All lecture slides will be available on Moodle

### **Moodle Link**

- <https://go.epfl.ch/EE-365>

### **Prerequisite for**

EE-465 Industrial Electronics 1  
EE-565 Industrial Electronics 2