2EL1315 – Electrical Energy Conversion for renewable energy sources and electromobility

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Department: DÉPARTEMENT SYSTÈMES D'ÉNERGIE ÉLECTRIQUE
Language of instruction: ANGLAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 60
On-site hours (HPE): 35,00
Elective Category : Engineering Sciences
Advanced level : Yes

Description

Considering the decarbonation objectives at worldwide level, the European Commission has planned an ambitious program to reach a net zero emission in 2050. In that way, several scenarios have been built, among them a larger electrification of the energy sector, a better energy efficiency, and development of hydrogen. These scenarios have been also organized in seven strategic priorities. Two of them are the development of renewable energy (with a target of 80% of electricity generated from renewable sources in 2050) and a more electrified mobility. Thus electrical (or electromechanical) converters will be at the heart of this evolution, with the following applications: windmills, PV generation, battery storage, electric powertrain for electric vehicles (EV), more electric aircrafts, all electric ships, new DC lines for electrical grids, power converters for electrolysers and for fuel-cells, energy harvesting for autonomous systems, …

Whatever the application, an important step will be the design of the optimal solution and its operation in a complex and fully interconnected environment. Thus a deep understanding of the devices and sub-systems is a key point. It means: what is the structure? how does it work? how can the devices be connected together? how to design a more complex system with several devices? How to model them for the optimization and the sizing?

Quarter number
SG8

Prerequisites (in terms of CS courses)
basics about electrical circuits, 3-phase systems, and electrical powers

Syllabus

- Basics about electromechanical converters (AC machines) for generation (wind turbine and hydro power plants) and motor applications (pumping, electric propulsion). Modelling for the sizing, and for simulations

- Basics about power electronic converters for EV (battery BEV and plug-in hybrid PHEV) charging, and electric propulsion (EV, ships, trains). Modelling for the sizing, and for simulations.

- Applications:

a) Connection of an AC generator to an AC power network. Operating point setting in the P,Q diagram.

b) Electronic power converters design for charging an EV battery

Class components (lecture, labs, etc.)
slides of the lecture (with their detailed and written comments)

Grading
75% of the mark is from a 2h individual examination (knowledge questions + exercice)
25% of the mark is based on the lab session reports.

Resources
lectures (15h) + lab sessions (9h) + exercices (9h)

Learning outcomes covered on the course
Based on selected applications (such as charging system for EV battery, variable speed drive for industrial application or electric propulsion, electrical generator for hydro power plant), we aim at presenting the basics about electromechanical converters and power electronic converters.

Description of the skills acquired at the end of the course
The students will know the basic components to build some widely used electric energy converters. They will be able to make a first sizing of such system, and they will be able to analyze the integration of such system in a wider environment
skills: C1.1 ; C1.2 ; C1.4