2EL1320 – Energy conversion

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

Description

The design of systems for the production and use of energy must now be done with respect for the environment and with strict criteria for sustainable development. In addition, the availability of energy in a suitable form is the key to developing new applications in all areas, from transportation to mobile device design. Thus, all sectors of activity must today be given the means to master electrical energy, the only vector capable of meeting these needs.The energy conversion course introduces the main objects, motors and generators, allowing transformations between electrical energy and mechanical energy. It also deals with principles and electronic devices to optimize the transfer of energy between source and electric load. The converters concerned are ubiquitous in the transport of energy and renewable energies, but also in most modern objects consuming electricity.

The course begins with the positioning of the principles and systems that will be studied in relation to the basics already acquired by students in the field of electrical energy. The focus is on the industrial and economic stakes of energy management.The first part of the course is devoted to the study of AC rotating electrical machines, which are today major players in the production and consumption of electrical energy. Based on the basics of low-frequency electromagnetism and mechanics, the principles of synchronous and asynchronous machine operation are introduced in order to obtain a circuit model that can be used in a steady state. It then becomes possible to draw up an energetic balance of the conversion and to present some modes of piloting.In a second part, we discuss the components and electronic power converters. The importance of electronic switching operation and its connection with the topological and thermal aspects of the design is emphasized. The various structures are then presented using a methodology that allows classification of the converters according to the sources and electrical loads concerned and the possible reversibility of the energy transfer.

Quarter number

SG6

Prerequisites (in terms of CS courses)

SPI course 1A "Electric energy" or equivalent

Syllabus

Introduction
Energy conversion and electrical engineering
General Concepts on AC Machines
Sinusoidal field distribution - Rotating field creation - Practical realization
Synchronous machine in steady state
Principle and practical realization - Fundamental equations - Equivalent diagram - Alternator operation - Motor use
Asynchronous motor in steady state
Principle and practical realization - Fundamental equations - Equivalent scheme - Implementation on a fixed frequency network - Variable frequency power supply
Basics of power electronics
Principles of static converters: realized functions, classical structures - Ideal switch, real switches: switching regime, losses - Main components: fundamental properties, control principles, areas of use, limits
DC-DC converters
Objectives - Chopper: fundamental structures - Different operating regimes - Reversibility - Applications
DC to AC converters
Objectives - Single-phase inverters: fundamental structures - Operation modes, control laws - Three-phase inverters
AC-DC converters
Objectives - Rectifier bridges: single-phase and three-phase basic assemblies - Reversibility, line commutated inverter - Impact on the power source, power factor

Class components (lecture, labs, etc.)

L(1-6) // T1-TL(7-10) // L(11-12) // T2-TL(13-16) // L(17-18) //T3-TL(19-22)// EE

Grading

The evaluation will be done by a written examination of 2 hours with documents. The teaching laboratory will be taken into account for 30% in the final grade of the module. Absence from a session will give the score 0 to the relevant TP.

Course support, bibliography

Théodore Wildi, « Electrical machines, drives and power systems »

Resources

Teaching staff (names of lecturers): Bruno Lorcet
Size of Tutorial (default 35 students): 18
Teaching laboratory (department and capacity): TL at the Energy Department

Learning outcomes covered on the course

At the end of this course, students will be able to:

• analyze or build an energy conversion chain
• to master all the basic components of electrical engineering
• to choose and implement an AC machine in the context of a stabilized speed application
• to make a choice of power converter and to adapt structure and control to a problem of energy conversion

Description of the skills acquired at the end of the course

C1.3 Apply problem-solving through approximation, simulation and experimentation.
C1.4 Design, detail and corroborate a whole or part of a complex system.
C2.1 Deepen a field of engineering sciences or a scientific discipline