# Design elements of static converters

Component
École Nationale Supérieure d'Électrotechnique d'Électronique

## In brief

- **Ametys Code:** N9EE28B
- **Open to exchange students:** Yes

# Presentation

## Objectives

To acquire the knowledge necessary to contribute to the design of the inverter powering an AC machine, integrating aspects such as architecture, control, and semiconductor selection.

+ To be able to justify the power structure of the power converter (three-phase inverter) and identify the main sizing parameters.

+ To identify the degrees of freedom provided by the three-phase inverter structure and understand their variation at different time scales (instantaneous, in the low-frequency range relative to the switching frequency).

+ To know how to use the degrees of freedom to control the currents injected into the machine windings.

+ To understand power reversibilities (at the time scales of the switching period, the machine current period, and steady state).

+ To understand the operating constraints of the inverter's power supply stage, related to the inverter's power reversibilities.

+ To understand the inverter's filtering principle (DC stage) and size the filter components.

+ To understand the instability phenomenon resulting from the "constant power load" behavior of the inverter with its associated regulation

+ Understand the stabilization principle and design a dedicated circuit

+ Identify the losses generated in the semiconductor components of the inverter's switching cell, their nature (conduction or switching), and their location (transistor or diode)

+ Understand the datasheet content of a power transistor and a heat sink

+ Know how to size the number of power modules to use for a given current range

+ Know how to use a transistor and diode loss model in PLECS and analyze the simulation results

+ Understand the sizing of a heat sink and know how to simulate the dynamic thermal behavior of the circuit for several operating points

## Description

2 lecture volumes: Architecture and Control (3 x 1.75 hours)

- HP Semiconductor Components (2 x 1.75 hours)

- MC
1 Design Office module (2 x 3.5 hours), based on the use and improvement of a simulation model (PLECS software):

+ Study of the architecture and implementation of the control system for a drive (permanent magnet synchronous machine)

+ Study and dimensioning of the filtering stage (DC side of the inverter)

+ Study of the reversibilities of the current drawn by the inverter from the DC source

+ Identification of the instability phenomenon and dimensioning of a stabilizing solution

+ Study of the losses generated in the semiconductor components constituting the inverter's switching cell

+ Analysis of the datasheet for a SiC MOSFET and Si IGBT power transistor

+ Dimensioning of the number of power modules to be used based on a target operating point

+ Use of PLECS models of transistor and SiC and Si diode losses

+ Dimensioning of the heat sink and thermal simulation of the assembly

## Pre-requisites

+ Understanding of switching cells and connection functions; Static and dynamic characteristics of semiconductor components (2A-NRJ course: N7EE02A)

+ concepts of switching and conduction losses in semiconductor components (2A-NRJ course: N7EE02A - Energy approaches to CVS design)