

Course Syllabus

1. Course number and name: **020CA2ES4 – Switch-mode power converters 2**
2. Credits and contact hours: **2 credits, 35 contact hours**
3. Instructor's or course coordinator's name: **Hadi Kanaan**
4. Text book : Francis Labrique, Guy Séguier et Robert Bausière, *Les Convertisseurs de l'Electronique de Puissance : La Conversion Continu-Alternatif*, Volume 4, Technique et Documentation Lavoisier, 1995
 - a. other supplemental materials: Notes, exercises, lab assignments
5. Specific course information
 - a. brief description of the content of the course (catalog description)

This course is dedicated to modeling and control issues regarding switch-mode inverters. Different Pulse-Width-Modulation (PWM) control strategies are introduced and studied: carrier-based PWM, space-vector modulation, pre-calculated modulation, sigma-delta and delta modulations. Modeling techniques for simulation and control design purposes are also exposed and applied to single-phase and three-phase inverters: large and small-signal modeling, time or frequency-domain modeling. Model-based feedback control design is also developed and applied. Numerical simulations are performed to verify the theoretical concepts.
 - b. prerequisites or co-requisites: **020CA1ES3-Switch Mode Power Converters 1**
 - c. Required/Elective/Selected Elective: **Required for EE – Industrial Systems option, Selected Elective for EE – Electromechanical option**
6. Specific goals for the course
 - a. specific outcomes of instruction

The students will be able to:

 - ✓ Apply and analyze the features of each modulation technique applied to a switch-mode inverter
 - ✓ Establish the one-cycle waveforms of each state or variable describing the converter
 - ✓ Elaborate a performance analysis et deduce the operation limits
 - ✓ Select properly the devices and components depending on the operating conditions
 - ✓ Perform a comparative evaluation between different modulation techniques and highlight the benefits and drawbacks of each
 - ✓ Develop the mathematical model of a switch-mode converter in both time and frequency domain

- ✓ Apply feedback control and design proper regulators based on the mathematical model of the converter
- ✓ Simulate a converter with a modulation technique in Matlab

b. KPIs addressed by the course.

KPI	a2	c1	c2	c3	e3	g1	g2	h1	i2	k3
Covered	x					x	x			x
Assessed	x	x	x	x	x	x	x	x	x	x
Give Feedback		x	x	x	x		x	x	x	x

7. Brief list of topics to be covered and approximate lecture hours :

- ✓ Introduction to PWM control (1.25 hour)
- ✓ Carrier-based PWM for single inverters (7.5 hours)
- ✓ Carrier-based PWM for three-phase inverters (3.75 hours)
- ✓ Space-vector modulation (2.5 hours)
- ✓ Pre-calculated modulation for single and three-phase inverters (2.5 hours)
- ✓ Sigma-delta and delta modulations (1.25 hour)
- ✓ Modeling techniques applied to switch-mode converters: averaging techniques, state model, small-signal model, transfer functions (2.5 hours)
- ✓ Model-based feedback control design (2.5 hours)
- ✓ Exercises (7.5 hours)
- ✓ Simulations on Matlab (3.75 hours)