DC-AC Power Conversion

1. **Course number and name:** 020CCAES4 – DC-AC Power Conversion

2. **Credits and contact hours**: 4 ECTS credits, 2x1:15 contact hours per week.

3. **Instructor's or course coordinator's name**: Hadi Kanaan

4. **Instructional materials:**
   a. **Textbook:** 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
   b. **Other supplemental materials:** PowerPoint presentations, exercises

5. **Specific course information**
   a. **Catalog description:**
   In this course, different topologies of DC-AC switch-mode power converters are presented: single and three-phase inverters, two and multilevel structures. A detailed analysis starting from the possible configurations, then the establishment of the mathematical equations, the waveforms and the input-output features, and the selection of the semiconductor devices and all other components is elaborated for each topology. Rating criteria based on the evaluation of the voltage and current stresses are elaborated.
   In addition, 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. Numerical simulations are performed to verify the theoretical concepts.

   b. **Prerequisites:** 020CCCES3 – DC-DC Power Conversion

   c. **Required** for EE students.

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   The students will be able to:
   - ✓ Identify the role and possible configurations of common DC-AC switch-mode power electronics converters.
   - ✓ Establish the operating sequence of a converter.
   - ✓ Develop mathematical equations describing the one-cycle behavior of the converter and draw the related waveforms.
   - ✓ Analyze the performance of the converter and derive the input-output characteristics.
   - ✓ Elaborate a performance analysis et deduce the operation limits.

- ✓ Select properly the devices and components depending on the operating conditions.
- ✓ Apply and analyze the features of each modulation technique applied to a switch-mode inverter.
- ✓ Perform a comparative evaluation between different modulation techniques and highlight the benefits and drawbacks of each.
- ✓ Simulate a converter with a modulation technique in Matlab.

b. PIs addressed by the course.

PI	1.3	2.2	2.5	3.1	3.2	6.3	6.4
Covered	x	x					x
Assessed	x	x	x	x	x	x	x

7. Brief list of topics to be covered:

- ✓ Switch-mode inverters: single-phase basic topologies (3.75 hours)
- ✓ Three-phase inverter (2.5 hours)
- ✓ Multilevel inverters (2.5 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)
- ✓ Exercises (2.5 hours)