DC-DC Power Conversion

1. **Course number and name:** 020CCCES3 – DC-DC 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. **Text book :** Francis Labrique, Guy Séguier et Robert Bausière, *Les Convertisseurs de l'Electronique de Puissance : La Conversion Continu-Continu*, Volume 3, 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-DC switch-mode power converters are presented. Two categories of converters are studied: the choppers for DC-motor drives and the DC power supplies. 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.

   b. **Prerequisites:** Industrial Electronics (020ELIES2)

   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-DC switch-mode power electronics converters.
   - ✓ Establish the operating sequence of a converter in both continuous and discontinuous current modes.
   - ✓ 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.
   - ✓ Select the components and devices according to voltage and current ratings.
   - ✓ Perform a comparative analysis between two or more converters and deduce the benefits and drawbacks of each topology.
   - ✓ Establish a mathematical model of switch-mode power converters.
   - ✓ Develop model-based control loop for switch-mode power converters.

- ✓ Apply DC-DC converters in high-power-factor single-phase rectifiers.
- ✓ Simulate a power converter using Matlab, and analyze the numerical results.

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:

- ✓ Introduction: Basic functions of power electronics, applications, course outcomes and topics (2.5 hours)
- ✓ Choppers: series and parallel structures, operation in case of an ideal or an inductive load, in continuous or discontinuous current mode, two and four-quadrants operation (3.75 hours)
- ✓ Thyristor-based choppers (2.5 hours)
- ✓ Non-isolated switch-mode power supplies: Classical Buck, Boost and Buck-Boost topologies (3.75 hours)
- ✓ Isolated power supplies: principles, review of the transformer operation and basic equations (1.25 hour)
- ✓ Forward converter with single or multi outputs: single-switch and asymmetric half-bridge topologies (2.5 hours)
- ✓ Push-Pull converters: parallel, series half-bridge and series full-bridge topologies (2.5 hours)
- ✓ Fly-back converter with single or multi outputs, single-switch, and asymmetric half-bridge topologies (2.5 hours)
- ✓ Modeling and control of DC-DC switch-mode power converters (2.5 hours)
- ✓ Harmonic distortion in conventional rectifiers (1.25 hour)
- ✓ DC-DC converter based high-power-factor single-phase rectifiers (1.25 hour)
- ✓ Exercises (3.75 hours)