# Variable Speed Drives

1. **Course number and name:** 020EVVES4 – Variable Speed Drives

2. **Credits and contact hours:** 6 ECTS credits, 3x1:15 contact hours per week.

3. **Instructor's or course coordinator's name:** Ragi GHOSN and Flavia KHATOUNIAN

4. **Instructional materials:**
   a. **Textbook**
      i. J.P. LOUIS, edited by, "*Control of synchronous motors*", ISTE – Wiley Edition, April 2011.
      ii. other supplemental materials: PowerPoint presentations, Notes, Lab experiments instructions
   b. **Other supplemental materials:** PowerPoint presentation, Exercises, Mini-project instructions, Lab experiments instructions

5. **Specific course information**
   a. **Catalog description:**
   This course aims to introduce the multiple control possibilities offered by variable speed drives for the three main types of motors in the electrical engineering field. I) Variable speed DC machine: Four-quadrant operation, Four-quadrant three-phase rectifier with no circulating current, Speed control using cascaded loops, Current loop and speed loop. II) Variable speed induction machine: Steady-state equivalent circuit at high frequencies, Torque harmonics, Scalar control of a squirrel-cage induction machine, Vector control of a squirrel-cage induction machine, introduction to DTC control of an induction machine. III) Variable speed synchronous drives: introduction to the scalar control and the vector control of synchronous drives. All three case studies are simulated and validated using Matlab/Simulink software.

   b. **Prerequisites**: 020ME2ES4 – Electric Machines 2 and 020AULES2 – Linear control.

   c. **Required** for EE students.

6. **Educational objectives for the course:**
   a. **Specific outcomes of instruction:**
      - Design a speed control of a separately excited DC machine and predict its performances using Matlab/Simulink software.
      - Design a speed control of a squirrel-cage induction machine and predict its performances using Matlab/Simulink software.
      - Design a cascaded speed control of a synchronous drive based on both classic scalar and vector current controls. Application on permanent magnet synchronous motors.

**b. PIs addressed by the course:**

| PI | 1.1 | 1.2 | 2.1 | 2.2 | 2.3 | 2.5 | 6.1 | 6.2 | 6.3 |
|---|---|---|---|---|---|---|---|---|---|
| **Covered** | x | x | x | x | x | x | x | x | x |
| **Assessed** | x | x | | | | | x | x | x |
| **Give Feedback** | | | | | | | | | |

**7. Brief list of topics to be covered:**
- Course introduction (1.25 hours)
- Variable speed DC machine: Four-quadrant operation, Four-quadrant three-phase rectifier with no circulating current, speed control using cascaded loops, current loop and speed loop (7.5 hours)
- Design a speed control of a separately excited dc machine and predict its performances using Matlab/Simulink software (6.25 hours)
- Variable speed induction machine: Steady-state equivalent circuit at high frequencies, Torque harmonics, Scalar control of a squirrel-cage induction machine, Vector control of a squirrel-cage induction machine, introduction to DTC control of an induction machine (10 hours)
- Design a speed control of a squirrel-cage induction machine and predict its performances using Matlab/Simulink software (7.5 hours)
- Advantages and drawbacks of synchronous motors connected to the grid (3.75 hours)
- Scalar current control of synchronous motors. Simulation on Matlab/Simulink (5 hours)
- Vector current control of synchronous motors. Simulation on Matlab/Simulink (5 hours)
- Speed control of synchronous motors. Simulation on Matlab/Simulink (2.5 hours)
- Lab experiments (9 lab hours)