Course Syllabus

1. Course number and name: **020ME2ES3 – Electric Machines 2**

2. Credits and contact hours: **3 credits, 49 contact hours + 9 lab hours**

3. Instructor's or course coordinator's name: **Flavia KHATOUNIAN RAJJI (EL)**

4. Text book
    a. R. P. BOUCHARD et G. OLIVIER, "*Electrotechnique : 2° éd*.", Presses internationales, Polytechnique, 1999.
    b. P. VAS, "*Parameter Estimation, Condition Monitoring, and Diagnosis of Electrical Machines*", Clarendon Press-Oxford, 1993.
    c. D. BAREILLE et J. P. DAUNIS, "*Electrotechnique – Transformateurs et machines tournantes*", Dunod, 2006.
    d. J. CHATELAIN, "*Les machines électriques, Tome 1&2*", Dunod, 1993&1984.
    e. other supplemental materials: PowerPoint presentations, Notes, Exercises, Lab experiments instructions

5. Specific course information
    a. brief description of the content of the course (catalog description)
    This course aims to extend the concepts of electrical engineering according to four axes: I) Transformers: Special transformers – Transformers in unbalanced mode – Transformers in transient mode – Parallel operation of transformers. II) DC machines: DC machines in transient mode - Application in unsaturated transient conditions. III) Induction Machines (IM): Generator and brake operation of a three-phase IM - Special types of IM: Deep-Bar Squirrel-Cage, Double-Cage rotors and Single-Phase IM – Modeling of the induction machine in transient mode and applications. IV) Synchronous machines: Rotating fields theory – Transient modeling of synchronous machines: with smooth poles, with salient poles, with or without damper bars – Applications.

    b. prerequisites or co-requisites: **020ME1ES2 – Electric Machines 1**

    c. Required/Elective/Selected Elective: **Selected Elective / Option required**

6. Specific goals for the course
    a. specific outcomes of instruction

- Explain the operation of special transformers (three windings transformers, autotransformers, current and voltage transformers) and the operation and drawbacks of parallel transformers.
- Understand the operation of transformers in unbalanced mode and apply the right models to calculate unbalanced components.
- Simulate and understand the operation of transformers in transient mode.

- Determine DC machines models in transient mode and apply results in unsaturated transient conditions.
- Describe the requirements for generator operation of an IM and calculate the minimum capacity value required for an independent generator operation with an inductive load.
- Describe the requirements for braking operation of an induction machine and calculate the resistance value required for this operation.
- Describe the operation of Deep-Bar Squirrel-Cage IM and Double-Cage rotors IM
- Calculate an approximate value of the capacity required to start a single-phase induction motor.
- Explain the transient models of an IM. Recommend the most appropriate one in a specific case.
- Calculate, where applicable, the values of the transient model parameters of an induction machine, using the manufacturer datasheet.
- Perform simulations of an induction machine operation in both transient and steady-states, using Matlab/Simulink software.
- Understand synchronous machines models in transient mode, describe the evolution of short-circuit currents in generator mode and calculate corresponding transient parameters from experimental results.

b. KPIs addressed by the course

KPI	**a1**	**a2**	**b2**	**b3**	**i2**	**k3**
Covered	x	x	x	x	x	x
Assessed	x	x	x	x		
Give Feedback	x	x	x	x		

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

- Course introduction (1.25 hours)
- Special transformers: three windings transformers, autotransformers, current and voltage transformers (5 hours)
- Transformers in unbalanced mode, transformers in transient mode, parallel operation of transformers (6.25 hours)
- DC machines in transient mode, application in unsaturated transient conditions (3.75 hours)
- Reminder on three-phase induction machine operating in steady-state (1.25 hours)
- Generator and braking operation of a three-phase IM. Special types of IM (2.5 hours)
- Transient models of a three-phase IM (Clarke, Concordia, Park transforms). Determination of the parameters of an IM model using the manufacturer datasheet (7.5 hours)
- Simulation of an induction machine operation in both transient and steady-states using Matlab/Simulink software (5 hours)
- Reminder on rotating fields theory and synchronous machines in steady-state (2.5 hours)
- Synchronous machines with salient poles model and synchronous machines characteristics in steady-state (2.5 hours)
- Transient modeling of a generalized synchronous machine (6.75 hours)
- Application on generators under short-circuit operation, transient parameters determination from short-circuit experimental results (5 hours)
- Lab experiments (9 lab hours)