

Course guide

820749 - DSCMEM - Design, Simulation and Control of Electrical Machinery

Last modified: 13/03/2025

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.
Degree: MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Optional subject).
Academic year: 2025 **ECTS Credits:** 5.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Córcoles López, Felipe

Others: Córcoles López, Felipe
Pedra Durán, Joaquín
Monjo i Mur, Lluís

PRIOR SKILLS

The students should domain the Electrical Engineering fundamentals.

REQUIREMENTS

Adequate mathematical and computer skills are required to address the subject contents.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CEMT-4. Efficiently collect data on renewable energy resources and their statistical treatment and apply knowledge and endpoint criteria in the design and evaluation of technology solutions for using renewable energy resources, for both isolated systems and those connected to networks. They will also be able to recognise and evaluate the newest technological applications in the use of renewable energy resources.

CEMT-6. Employ technical and economic criteria to select the most appropriate electrical equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technology applications in the field of production, transport, distribution, storage and use of electric energy.

CEMT-7. Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.

CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

TEACHING METHODOLOGY

The course development includes the following teaching methods:

- Master class (EXP): knowledge exposition and exercises solution by the teacher through master classes.
- Oriented individual works (TD): individual works of reduced complexity or extensión. The acquired knowledge will be applied in these works, and the results will be presented. Their elaboration will start in the classroom (with the teacher guidance) and will end out of the classroom.
- Evaluation activities (EV).

LEARNING OBJECTIVES OF THE SUBJECT

To provide the student with a global point of view of the electrical machines and drives, as well as their control, making special emphasis in their transient modelling and simulation.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours small group	30,0	24.00
Guided activities	15,0	12.00

Total learning time: 125 h

CONTENTS

1. Electrical machines design and simulation

Description:

- 1.1. Introduction to the electrical machines. Electromechanical conversion.
- 1.2. Magnetic field in uniform air-gap machines. Winding induced voltage and self- and mutual-inductance calculation.
- 1.3. Electrical equations and electromagnetic torque in uniform air-gap machines.

Specific objectives:

The student must be capable of calculate the air-gap magnetic field, the electromagnetic torque (electromechanical conversion) and the voltage-current relationships in order to derive the dynamic and steady-state equations (without variables transformation) of the analyzed electrical machines. The dynamic and steady-state simulation require a brief introduction to their implementation in commercial software like PSpice, Matlab or Simulink.

Related activities:

- A1. Squirrel-cage induction motor (or wound-rotor induction motor with short-circuited slip rings) simulation .
- A2. Squirre-cage induction generator (or wound-rotor induction generator with short-circuited slip rings) simulation. Doubly-fed induction generator simulation.

Full-or-part-time: 100h

Laboratory classes: 20h

Guided activities: 60h

Self study : 20h

2. Electrical machines control

Description:

- 2.1. Variables transformation: Park, Ku and symmetrical components.
- 2.2. Steady-state and dynamic equations for the electrical machines.
- 2.3. Stator- or rotor-flux oriented vector control.
- 2.4. Electrical machines control.

Specific objectives:

The student gets a global view of the electric machines state equations and the variables transformation required to simulate their dynamic and steady-state behaviors, as well as the most common control algorithms.

Related activities:

A3. Laboratory measurement of the magnitudes of a frequency converter fed induction motor.

Full-or-part-time: 26h

Laboratory classes: 10h

Guided activities: 6h

Self study : 10h

ACTIVITIES

A1. Squirrel-cage induction motor (or wound-rotor induction motor with short-circuited slip rings) simulation

Description:

The aim of this work is the dynamic behavior simulation of the squirrel-cage induction motor in Simulink, as well as the equivalent circuit parameters determination (by means of Matlab) and other steady-state behaviors calculation.

Full-or-part-time: 30h

Guided activities: 30h

A2. Squirrel-cage induction generator (or wound-rotor induction generator with short-circuited slip rings) simulation. Doubly-fed induction generator simulation

Description:

The aim of this work is the dynamic behavior simulation of the squirrel-cage induction generator in Simulink, as well as the equivalent circuit parameters determination (by means of Matlab) and other steady-state behaviors calculation. Optionally, the students may choose the doubly-fed induction generator simulation (instead of the squirrel-cage generator), which should lead to a higher score.

Full-or-part-time: 30h

Guided activities: 30h

A3. Laboratory measurement of an induction motor fed by a frequency converter

Description:

The aim of this work is the laboratory measurement (and subsequent data processing) of the voltage, current, torque and speed of a frequency converter fed induction motor when the speed and torque references are modified and when supply network perturbations are produced.

Full-or-part-time: 6h

Guided activities: 6h



GRADING SYSTEM

Written test (final examination) (PE): 60 %

Oriented individual works (TD): 40 %

EXAMINATION RULES.

The final examination (PE) will have two parts: (1) exercises on the theoretical and practical course content, weighting the 30% of the final course mark, (2) validation of the oriented individual works (TD), weighting the 30% of the final course mark.

BIBLIOGRAPHY

Basic:

- Krause, Paul C.. Analysis of electric machinery and drive systems [on line]. 4th ed. New Jersey: Hoboken, 2025 [Consultation: 12/09/2025]. Available on: <https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/9781394293896>. ISBN 9781394293872.

- Novotny, D. W.; Lipo, T. A. Vector control and dynamics of AC drives. New York: Clarendon Press, 1996. ISBN 0198564392.

- Lesenne, J.; Notelet, Francis; Séguier, Guy. Introduction a l'electrotechnique approfondie. Paris: Technique et Documentation, cop. 1981. ISBN 2852060892.