Course guide
240EN32 - 240EN32 - Electric Drives with High Efficiency and Low Environmental Impact

Last modified: 16/05/2023

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).
MASTER'S DEGREE IN ELECTRIC POWER SYSTEMS AND DRIVES (Syllabus 2021). (Optional subject).
MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2022). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: Francisco Díaz González

Others:

PRIOR SKILLS

Basic knowledge on electrical machines and drives.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEEELEC2. Calculate and design machines and electric actuators, with suitable knowledge on the efficient management of electrical systems and effective control of electrical actuators.

TEACHING METHODOLOGY

The following teaching methodologies are adopted for the course:
- Magistral classes or conferencies (CM): dissertations by the professor or by eventual collaborators.
- Participative classes (PART): joint discussions, as well as the resolution of exercises in the room and at the laboratory.
- Project (PA): knowledge based on the design, planning and deployment of a project of relatively long extension about a particular topic and applying the knowledge gained in the subject.
- Final exam (PECC).

LEARNING OBJECTIVES OF THE SUBJECT

To gain knowledge on how to design and operate an electric drive --which is typically composed by an electrical motor / generator and its associated power electronics and control systems--, with special emphasis on maximizing technical performance and reducing the environmental impact. At the end of the course, the student:

- Should be able to identify the main components and characteristic metrics for electric drives, and range them according to the application field and power.
- Should be able to identify the main calculation procedures and international standards to size an electric drive with special emphasis on maximizing technical performance (i.e. energy efficiency, dynamic response) and reducing the environmental impact.
- Should be able to identify the main operating strategies (i.e. speed control through the application of power electronics and associated control systems), to maximize technical performance (i.e. energy efficiency, dynamic response).
- Should be able to design an electric drive based on main mechanical / electrical / economic and environmental constraints.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours large group	45,0	36.00

Total learning time: 125 h

CONTENTS

TOPIC 1.- Overview about electric drives

Description:
1.1.- Electric drives. Definition and types.
1.2.- Dynamics of the system motor-load. Mechanical considerations.
1.3.- Applications addressing power range.

Related activities:
Exercises in the room.

Full-or-part-time: 16h
Theory classes: 6h
Self study : 10h

TOPIC 2.- Performance and environmental aspects on electric drives.

Description:
2.1. Classification and mathematical modeling of the main elements that constitute an electric drive.
2.1.1 DC / DC and DC / AC converters.
2.1.2 Three-phase induction motors.
2.1.3 Permanent magnet synchronous motors.
2.2. Losses assessment. Performance. Energy efficiency classes. Tests.
2.3. Possibilities for performance improvement.
2.4. Variable speed and energy saving.
2.5. Environmental considerations. Life cycle analysis (LCA).

Specific objectives:
Study and demonstrate the potential of three-phase induction motor drives, permanent magnet synchronous and their associated power electronics converters, as high-performance drives. Identify the different parameters of energy saving of electric motors and drives. Explain losses in motors and electric drives. Apply a calculation methodology in the energy and environmental assessment of electric motors and drives.

Related activities:
Exercises in the classroom, mathematical modeling with Matlab Simulink software and laboratory experimentation.

Full-or-part-time: 73h
Theory classes: 18h
Guided activities: 5h
Self study : 50h

TOPIC 3.- Sizing of electric drives from a performance and environmental perspective

Description:
3.1. Revision of rules and standards for the optimal sizing of AC and DC drives.
3.2. Application of the necessary calculation procedures for the sizing of electric drives.

Specific objectives:
Know how to apply the necessary calculation procedures to size the electric drives from a perspective of maximizing performance and with a minimum environmental impact, and on the basis of international standards that address this aspect.

Related activities:
Exercises in the classroom and with Matlab Simulink simulation software.

Full-or-part-time: 36h
Theory classes: 6h
Guided activities: 25h
Self study : 5h

GRADING SYSTEM

La nota final de la asignatura se obtendrá mediante la fórmula siguiente:

FINAL GRADE = 0.20*GRADE FOR THE PARTIAL EVALUATION OF THE PROJECT + 0.30*GRADE FOR THE FINAL EVALUATION OF THE PROJECT + 0.50*GRADE FOR THE FINAL EXAM

In case the FINAL GRADE is lower than 5.0 points, there exists the option of a RE-TAKE EXAM.

The PROJECT should be done INDIVIDUALLY, and should deal with the design of an electrical drive, with special emphasis in the optimization of the technical provision and reduction of the environmental impact. The aim is to deep into some of the technologies of electric motors and related control aspects that are explained in the subject, to encourage autonomous work, the improvement of oral and written expression and the solvent use of information. The expected dedication is 60 hours (autonomous learning: 55 hours; and guided activities: 5 hours).

EXAMINATION RULES.

For the FINAL EXAM, no other material than a pen and a calculator is permitted.

The PARTIAL EVALUATION TEST OF THE PROJECT is a written questionnaire that is carried out on an intermediate date of the semester (and that will be reported at the beginning of the course), in which the students will report the progress obtained to date and the planning of the next tasks to be done.

The FINAL EVALUATION TEST OF THE PROJECT consists of the oral defense and presentation of the final report of the project, on a date close to the end of the semester (and which will be reported at the beginning of the course).

ABOUT RE-TAKE EXAM: Re-take exam is just an option for those students who did not pass the subject at the end of the course (this means getting a final mark for the subject lower than 5 points out 10 points.) In case of opting for and passing the re-take exam, the final mark for the whole subject will be 5 out 10 points.

BIBLIOGRAPHY

Basic:
- Filizadeh, S. Electric machines and drives : principles control, modeling and simulation [on line]. Boca Raton, FL: CRC Press, 2013 [Consultation: 03/02/2022]. Available on: https://www-taylorfrancis-com/books/mono/10.1201/9781315169651/electric-machines-drives-shaahin-filizadeh. ISBN 9781439858073.
- Fraile Mora, Jesús ; Fraile Ardanuy, J. Accionamientos Eléctricos. Madrid: Garceta, 2016. ISBN 9788416228492.
- Pyrhönen, J.; Jokinen, T.; Hrabovcova, V. Design of rotating electrical machines [on line]. 2nd ed. Chichester, UK: John Wiley & Sons, 2013 [Consultation: 23/09/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1414122. ISBN 9781118701621.
- Jufer, Marcel. Electric Drives : Design Methodology. New York: Wiley, 2010. ISBN 9781848212176.
- Sul, Seug-Ki. Control of Electric Machine Drive Systems. New York: IEEE-Wiley, 2011. ISBN 9780470590799.