Course guide
230728 - CAPE - Control and Applications in Power Electronics

Last modified: 30/05/2025

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2022). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: DOMINGO BIEL SOLE - FRANCISCO JUAN GUINJOAN GISPERT

Others: Primer quadrimestre:
DOMINGO BIEL SOLE - 20
FRANCISCO JUAN GUINJOAN GISPERT - 20

PRIOR SKILLS

Basic knowledge on linear control systems and power electronics

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CMEE1. Understand and apply the principles of operation of power electronic systems in regulation, ripple and amplification applications.
CMEE3. Apply state control techniques to the design of controllers for power electronic systems.
CMEE2. Understand and apply the operating principles of current control and its applications to battery charging, power supply for LED lighting, power factor correction, low consumption power supplies.
CMEE4. Analyze and design power factor correction circuits.

Transversal:
CTMEE4. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically assess the results of said management.

TEACHING METHODOLOGY

- Lectures
- Exercises
- Other activities

LEARNING OBJECTIVES OF THE SUBJECT

The aim of this course is to introduce the students in several techniques of modelling, design and control of power processing systems for regulation, wide-band amplification and waveform generation in different applications.
Requisites: Students coming from academic studies other than B. Sc.in Electronics Engineering or equivalent ones, should have successfully passed the examinations of the bridging course Principles of Control and Power Electronics (PCPE)
Learning results of the subject:
- Know how to obtain state models of power converters.
- Know how to design state linear controllers for power converters in regulation, ripple and amplification applications and verify their performance by numerical simulation.
- Know how to analyze and design power factor correction circuits.

STUDY LOAD

Type	Hours	Percentage
Hours large group	39,0	31.20
Self study	86,0	68.80

Total learning time: 125 h

CONTENTS

1.Introduction to control in power electronics

Description:
- Control goals in power electronics. Examples: voltage regulation in DC-DC power converters, grid-connected power inverters, PFC in AC-DC converters.
- Power converters modelling

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

2.Control design for DC-DC switching voltage regulation

Description:
- Single voltage loop control design
- Average current loop control design
- Peak current mode control

Full-or-part-time: 56h
Theory classes: 18h
Self study : 38h

3.Power factor correction

Description:
- Power and harmonics in systems with nonsinusoidal (but periodic) signals
- Pulse width modulated (PWM) rectifiers

Full-or-part-time: 12h
Theory classes: 4h
Self study : 8h

4.DC-AC conversion principles and control

Description:
- Principles on DC-AC single phase voltage conversion
- Resonant control applied to inverters
- Grid-connected inverters

Full-or-part-time: 18h
Theory classes: 6h
Self study : 12h

5. Applications of power electronics

Description:
- Study of integrated circuits for switching converters applied to voltage regulation, power factor correction and other power electronics applications.

Full-or-part-time: 15h
Theory classes: 5h
Self study : 10h

Deliverables

Description:
Deliverables are a set of exercises proposed in advance that must be returned throughout the course. The deliverables focus on:
1- Modeling of DC-DC converters
2- Single-loop control of DC-DC converters
3- Sustainability in power circuits
4- Average and peak current control in DC-DC converters

Full-or-part-time: 8h
Self study : 8h

Exams

Description:
For grading purposes, the course is divided in two parts, namely:
Part 1: Subjects 1 and 2, excluding the peak-current mode control.
Part 2: subject 2 only the peak-current control part, and subjects 3,4,5

Students are graded by:
1) Solving a set of deliverables (D) consisting in proposed exercises to be done at home, uploading them in the digital campus before the established dead-line.
2) Solving a mid-term exam (ME) dealing with Part 1
3) Solving a final exam (FE), including two parts noted as FE1 and FE2, dealing with Parts 1 and 2 of the course respectively.

The final mark (FM) is given by the expression FM = 25% * D + 75% * FE, where D is the mark for the deliverables and FE is the mark obtained applying the formula FE = 50% MAX(ME , FE1) + 50% FE2, being FE1, FE2 the final exam marks of parts 1 and 2 and ME the mid-term exam mark. A student can decide to solve only the part 2 of the final exam (FE2) if he/she considers that his/her mid-term exam mark (ME) is high enough.

Full-or-part-time: 5h
Theory classes: 5h

ACTIVITIES

Lectures and exercises

Full-or-part-time: 39h
Theory classes: 39h

Mid-term and Final exams

Description:
Final examination.

Full-or-part-time: 5h
Theory classes: 5h

GRADING SYSTEM

For grading purposes, the course is divided in two parts, namely:
Part 1: Subjects 1 and 2, excluding the peak-current mode control.
Part 2: subject 2 only the peak-current control part, and subjects 3,4,5

Students are graded by:
1) Solving a set of deliverables (D) consisting in proposed exercises to be done at home, uploading them in the digital campus before the established dead-line. Ono deliverable is specifically devoted to sustainability in power electronics circuits.
2) Solving a mid-term exam (ME) dealing with Part 1
3) Solving a final exam (FE), including two parts noted as FE1 and FE2, dealing with Parts 1 and 2 of the course respectively.

The final mark (FM) is given by the expression FM = 25% * D + 75% * FE, where D is the mark for the deliverables and FE is the mark obtained applying the formula FE = 50% MAX(ME , FE1) + 50% FE2, being FE1, FE2 the final exam marks of parts 1 and 2 and ME the mid-term exam mark. A student can decide to solve only the part 2 of the final exam (FE2) if he/she considers that his/her mid-term exam mark (ME) is high enough.

BIBLIOGRAPHY

Basic:
- Åström, K.J.; Murray, R.M. Feedback systems: an introduction for scientists and engineers. Princeton: Princeton University Press, 2008. ISBN 9780691135762.
- Erickson, R.W.; Maksimovic, D. Fundamentals of power electronics [on line]. 3rd ed. Cham: Springer, 2020 [Consultation: 28/09/2023]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-030-43881-4. ISBN 9783030438814.

Complementary:
- Golnaraghi, F.; Kuo, B.C. Automatic control systems. 10th ed. New York: McGraw Hill Education, 2017. ISBN 9781259643835.