230728 – CONTROL AND APPLICATIONS IN POWER ELECTRONICS

Credits: 5 ECTS

LECTURER

Coordinating lecturer: Francesc Guinjoan

Others: Domingo Biel

PRIOR SKILLS

Basic knowledge on linear control systems and power electronics

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

- Apply the operating principles of power electronic systems in regulation, ripple and amplification applications.
- Apply the operating principles of current control and its applications to battery charging, power supply for LED-type lighting, power factor correction, low consumption power supplies.
- Apply state control techniques to the design of controllers for power electronic systems.
- Analyze and design power factor correction circuits.

Transversal:

EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

TEACHING METHODOLOGY

- Lectures

- Exercises

- Extended answer test (Mid-term and Final Exams)

LEARNING OBJECTIVES OF THE SUBJECT

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

Hours large group: 39

Hours small group: 0

Hours self study: 86

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: 18h
   Theory classes: 6h
   Self study: 12h

2. **Control design for DC-DC voltage regulation**
   Description:
   - Single voltage loop control design
   - Average current loop control design
   - Peak current mode control

   Full-or-part-time: 58h
   Theory classes: 18h
   Self study: 40h

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: 21h
   Theory classes: 6h
   Self study: 15h

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: 16h
   Theory classes: 5h
   Self study: 11h

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.
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:

- Robert W. Erickson, D. Maksimovic. Fundamentals of Power Electronics. 2nd ed. Kluwer Academic Publishers, 2001.

- K. Ogata, Modern Control Engineering, 5th Ed, Pearson, 2010.

Complementary:

- Phillip T. Krein. Elements of power electronics. Oxford University Press. 1998.

- K. J. Åström and R.M. Murray, Feedback Systems: An Introduction for Scientists and Engineers, 2on Ed, Princeton University Press, 2020.

- F. Golnaraghi and B.C. Kuo, Automatic Control Systems, Ed. Wiley, 2009.