UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola Tècnica Superior d'Enginyeria de Telecomunicació de Barcelona

telecos BCN

230739 – PRINCIPLES OF CONTROL AND POWER ELECTRONICS

Credits: 5 ECTS

LECTURER

Coordinating lecturer: Domingo Biel

Others: Francesc Guinjoan

PRIOR SKILLS

Students should have good skills in electrical circuits theory and analysis, electronic components (diodes and transistors), fundamentals of electromagnetism, linear systems and signal processing.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:

TEAMWORK. Being able to work as a member of an interdisciplinary team, either as a member or carrying out management tasks, in order to contribute to developing projects with pragmatism and a sense of responsibility, assuming commitments taking into account the available resources.

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.
FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

TEACHING METHODOLOGY

- Lectures
- Exercises
- Extended answer test (Final Exam)

LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

The aim of this course is to introduce the students in the methods used to analyze and design control systems, as well as in the fundamentals of power electronics circuits, focusing on the analysis, modelling and design of DC-DC power converters.

Learning results of the subject:

- Understand and apply linear control theory in nonlinear and linear systems and know the operating principle of power converters and know. Synthesize, analyze and dynamically model energy processing circuits.

STUDY LOAD

Hours large group: 39

Hours small group: 0

Hours self study: 86

CONTENTS

1. **Introduction to control systems**
   Description:
   - Control goals in a feedback system
   - Continuous-time control vs discrete-time control

   Full-or-part-time: 4h
   Theory classes: 2h
   Self study: 2h

2. **System's modelling**
   Description:
   - State space models
   - Linear systems. Time response and frequency response of LTI systems.
   - Linearization of nonlinear systems
   - Block diagram transformation

   Full-or-part-time: 29h
   Theory classes: 9h
   Self study: 20h

3. **Stability of control systems**
   Description:
   - Internal and BIBO stability in LTI systems
   - The Routh criterion
   - Nyquist stability criterion
   - Gain and phase margins

   Full-or-part-time: 22h
   Theory classes: 7h
   Self study: 15h

4. **Design of control systems**
   Description:
   - Internal model principle
   - Phase-lead compensator
   - Phase-lag compensator
   - PID controller

Full-or-part-time: 21h
Theory classes: 6h
Self study: 15h

5. **Introduction to power electronics**
Description:
- Power conversion chain
- Control requirements in power electronics

Full-or-part-time: 2h
Theory classes: 1h
Self study: 1h

6. **Synthesis of power electronic circuits**
Description:
- Connection rules. Examples with SPDT switches
- Switch implementation fundamentals
- Elemental switching DC-DC voltage converters

Full-or-part-time: 7h
Theory classes: 2h
Self study: 5h

7. **Steady-state analysis and sizing of DC-DC switching converters**
Description:
- Fundamentals of steady-state analysis
- Design-oriented analysis of a boost converter
- Other switching converter topologies

Full-or-part-time: 20h
Theory classes: 6h
Self study: 14h

8. **Converters dynamic modelling**
Description:
- Converter modelling: state equations
- Bilinear switched model
- State-space averaged model
- Steady-state and transfer functions

Full-or-part-time: 20h
Theory classes: 6h
Self study: 14h

GRADING SYSTEM

Students are graded by delivering proposed exercises to be done at home and by a final exam. The final mark (FM) is given by the expression FM = 30% * D + 70% * FE, where D is the mark for the deliverables and FE is the mark obtained in the final exam.

BIBLIOGRAPHY

Basic:

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

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

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

Complementary:

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

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