



Course guides

230317 - DCA - Software-Based Digital Control Applications

Last modified: 06/05/2019

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Optional subject).

Academic year: 2019 **ECTS Credits:** 2.5 **Languages:** English

LECTURER

Coordinating lecturer: Jose A. Lázaro / Rosa M. Fernández

Others: Rosa M. Fernández / Jose A. Lázaro

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CE1. Ability to apply information theory methods, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing to communication and audiovisual systems.

CE6. Ability to model, design, implement, manage, operate, administrate and maintain networks, services and contents

CE7. Ability to plan networks and decision-making about services and applications taking into account: quality of service, operational and direct costs, implementation plan, supervision, security processes, scalability and maintenance. Ability to manage and assure the quality during the development process

CE15. Ability to integrate Telecommunication Engineering technologies and systems, as a generalist, and in broader and multidisciplinary contexts, such as bioengineering, photovoltaic conversion, nanotechnology and telemedicine.

CE16. Ability to develop, direct, coordinate, and technical and financial management of projects in the field of: telecommunication systems, networks, infrastructures and services, including the supervision and coordination of other's subprojects; common telecommunications infrastructures in buildings or residential areas, including digital home projects; telecommunication infrastructures in transport and environment; with corresponding energy supply facilities and assessment of electromagnetic emissions and electromagnetic compatibility.

TEACHING METHODOLOGY

- Lectures
- Application classes
- Laboratory practical work
- Group work
- Individual work
- Exercises
- Other activities
- Short answer test (Test)

Laboratory practical work:

- Magnetic levitator (D4-211)

Application classes:

- Application examples solved in class via Matlab/Simulink: Flexible arm, active suspension system, heading control of a ship, helicopter stabilization

Individual work:

- Remote control of the two case studies (magnetic levitator and segway) via Moodle.

Short answer test (Test):

- Partial evaluation test with theoretical questions and short exercises.

Final examination:

- Final work in pairs regarding the case studies or any other applications of interest for the students.

LEARNING OBJECTIVES OF THE SUBJECT

The aim of this course is to train students in methods for the design and analysis of digital controllers by means of the computer. The course includes a brief introduction to control theory for the students not familiar with this field and it is mainly developed on the basis of several application examples and two case studies (Magnetic Levitator and Segway™). The students will work with the Matlab/Simulink software in class and at home they will perform remote virtual experiments via Moodle. Finally, several laboratory experiments with a physical magnetic levitator will be performed.

Learning results of the subject:

- Ability to formulate the control problem specifications taking into account theoretical and practical constraints.
- Ability to describe and analyze the dynamical behavior of any system by means of transfer functions and state space descriptions.
- Ability to design digital controllers by several software-based techniques: root locus, direct synthesis, loop-shaping, and optimization.
- Ability to select, analyze and implement digital controllers.

STUDY LOAD

Type	Hours	Percentage
Hours large group	10,0	16.00
Self study	42,5	68.00
Hours small group	10,0	16.00

Total learning time: 62.5 h



CONTENTS

Unit 1. Digital controllers

Description:

- 1.1 Fundamentals of Control Theory. Feedback. Specifications
- 1.2 Signal processing for digital control systems. Z Transform
- 1.3 Discretization of analog controllers
- 1.4 Deadbeat and Dahlin controllers
- 1.5 Matlab/Simulink tools for digital control design and implementation

Full-or-part-time: 12h 30m

Theory classes: 4h

Self study : 8h 30m

Unit 2. Software-based controller design in the complex plane

Description:

- 2.1 Laplace modeling of dynamic systems. Linearization
 - 2.2 Design of pole-zero and PID controllers by means of the root locus
 - 2.3 Design of optimal ITAE controllers by direct synthesis
 - 2.4 Design of two degrees of freedom robust controllers by loop-shaping
- Applications: Flexible arm and active suspension system
Case study: Magnetic Levitator

Full-or-part-time: 25h

Theory classes: 8h

Self study : 17h

Unit 3. Software-based controller design in the state space

Description:

- 3.1 State space descriptions of dynamic systems. Controllability and observability
 - 3.2 State feedback. Design of state observers
 - 3.3 LQG (Linear Quadratic Gaussian) regulator. Integral action.
- Applications: Heading control of a ship and helicopter stabilization
Case study: Segway

Full-or-part-time: 25h

Theory classes: 8h

Self study : 17h

GRADING SYSTEM

Final examination: from 20% to 50%

Partial examinations and controls: from 0% to 50%

Exercises: from 0% to 20%

Laboratory assessments: from 0% to 50%



BIBLIOGRAPHY

Basic:

- Ogata, K. Discrete-time control systems. 2nd. ed. Englewood Cliffs, NJ: Prentice-Hall, 1995. ISBN 0133286428.
- Kuo, B.C. Digital control systems. Ft. Worth: Saunders College, 1992. ISBN 0030128846.

Complementary:

- Kailath, T. Linear Systems Linear systems. Englewood Cliffs, NJ: Prentice-Hall, 1980. ISBN 0135369614.
- Friedland, B. Control system design: an Introduction to state-space methods. New York: Dover, 2005. ISBN 0486442780.
- Landau, I.D.; Zito, G. Digital control systems: design, identification and implementation [on line]. New York: Springer, 2006 [Consultation: 11/05/2020]. Available on: <http://dx.doi.org/10.1007/978-1-84628-056-6>. ISBN 1846280559.