

## 230317 - DCA - Software-Based Digital Control Applications

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering  
Teaching unit: 739 - TSC - Department of Signal Theory and Communications  
Academic year: 2017  
Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)  
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional)  
MASTER'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Teaching unit Optional)  
DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 1992). (Teaching unit Optional)  
MASTER'S DEGREE IN INFORMATION AND COMMUNICATION TECHNOLOGIES (Syllabus 2009). (Teaching unit Optional)  
DEGREE IN ELECTRONIC ENGINEERING (Syllabus 1992). (Teaching unit Optional)  
ECTS credits: 2,5 Teaching languages: English

### Teaching staff

Coordinator: 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.

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### 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

Total learning time: 62h 30m	Hours large group:	10h	16.00%
	Hours small group:	10h	16.00%
	Self study:	42h 30m	68.00%

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### Content

<p>Unit 1. Digital controllers</p>	<p>Learning time: 12h 30m Theory classes: 4h Self study : 8h 30m</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>1.1 Fundamentals of Control Theory. Feedback. Specifications</li> <li>1.2 Signal processing for digital control systems. Z Transform</li> <li>1.3 Discretization of analog controllers</li> <li>1.4 Deadbeat and Dahlin controllers</li> <li>1.5 Matlab/Simulink tools for digital control design and implementation</li> </ul>	
<p>Unit 2. Software-based controller design in the complex plane</p>	<p>Learning time: 25h Theory classes: 8h Self study : 17h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>2.1 Laplace modeling of dynamic systems. Linearization</li> <li>2.2 Design of pole-zero and PID controllers by means of the root locus</li> <li>2.3 Design of optimal ITAE controllers by direct synthesis</li> <li>2.4 Design of two degrees of freedom robust controllers by loop-shaping</li> </ul> <p>Applications: Flexible arm and active suspension system Case study: Magnetic Levitator</p>	
<p>Unit 3. Software-based controller design in the state space</p>	<p>Learning time: 25h Theory classes: 8h Self study : 17h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>3.1 State space descriptions of dynamic systems. Controllability and observability</li> <li>3.2 State feedback. Design of state observers</li> <li>3.3 LQG (Linear Quadratic Gaussian) regulator. Integral action.</li> </ul> <p>Applications: Heading control of a ship and helicopter stabilization Case study: Segway</p>	

### Qualification 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%

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### Bibliography

#### Basic:

Kuo, B.C. Digital control systems. 2nd ed. New York: Oxford University Press, 1992. ISBN 0195120647.

Ogata, K. Discrete-time control systems. 2nd. ed. Englewood Cliffs, NJ: Prentice-Hall, 1995. ISBN 0133286428.

#### Complementary:

Friedland, B. Control system design: an Introduction to state-space methods. New York: Dover, 2005. ISBN 0486442780.

Kailath, T. Linear Systems Linear systems. Englewood Cliffs, NJ: Prentice-Hall, 1980. ISBN 0135369614.

Landau, I.D.; Zito, G. Digital control systems: design, identification and implementation. New York: Springer, 2006. ISBN 1846280559.