Last update: 06-05-2019

230368 - MACA - Matlab Programed Arduino for Control Applications

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

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

ECTS credits: 2,5 Teaching languages: English

Teaching staff

Coordinator: Rosa M. Fernández / Jose A. Lázaro

Others: Jose A. Lázaro / Rosa M. Fernández

Teaching methodology

Application examples solved in class via Matlab/Simulink and Arduino
Laboratory Practices
Final work and oral exposition of the solution obtained to the proposed problem

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 case studies. The students will work with the Matlab/Simulink software. Finally, several laboratory experiments with ARDUINO will be performed.

Learning results of the subject:
- Ability to formulate the control problem specifications taking into account theoretical and practical constraints.
- Ability to design digital controllers by several software-based techniques: empirical methods, root locus, direct synthesis, and optimization.
- Ability to select, analyze and implement digital controllers by means of Arduino and Simulink.

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

Unit 1. Fundamentals of Control Theory

Learning time: 12h 30m

Theory classes: 4h
Self study : 8h 30m

Description:
1.1 Fundamentals of Control Theory.
1.2 Laplace modeling of dynamic systems. Linearization
1.3 System Response (time and frequency)
1.4 Feedback. Specifications
1.5 Matlab/Simulink tools for control systems analysis, design and implementation

Related activities:
Case Study 1. Antenna heading

Specific objectives:
Give minimum Control Theory concepts necessary to follow the course
Introduce Matlab/Simulink software for control systems analysis

Unit 2. PID, Digital and Optimal Controllers

Learning time: 10h 50m

Theory classes: 2h 20m
Self study : 8h 30m

Description:
2.1 PID regulators: P, I, D actions. Ziegler-Nichols tuning
2.2 Optimal tuning of PIDs
2.3 Design of optimal ITAE controllers by direct synthesis
2.4 Signal processing for digital control systems. Z Transform
2.5 Discretization of analog controllers
2.6 Deadbeat and Dahlin controllers

Related activities:
Case study 2: Temperature regulation of an industrial oven

Specific objectives:
Learn different approaches and techniques to design linear controllers (empirical methods, optimization)
Learn how to discretize analog controllers and how to select a proper sampling time
Learn to design pure digital controllers by direct synthesis

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Unit 3. Software-based controller design in the complex plane	Learning time: 12h 30m Theory classes: 4h Self study : 8h 30m

Description:
3.1 Analysis of Control Systems: Root locus
3.2 Stability analysis: Routh-Hurwitz, Nyquist, margins
3.3 Performance analysis: Steady State Error Constants
3.4 Sisotool: Design of P, I, and PI controllers

Related activities:
Case study 3: Magnetic levitator

Specific objectives:
Introduce the sisotool to design control systems in the complex plane

Unit 4. PRACTICE on MATLAB programed ARDUINO for Control Applications	Learning time: 25h Theory classes: 17h Self study : 8h

Description:
4.1 Basics on ARDUINO
4.2 Programming ARDUINO with MATLAB/Simulink
4.3 Actuating and Monitoring Hardware using ARDUINO & MATLAB
4.4 Developing a Controller in ARDUINO with MATLAB

Related activities:
Case study 4: Controlling a Tunable Laser or Electronic Circuit with ARDUINO & MATLAB.

Specific objectives:
Gain practical hands-on experience in building high-level examples by oneself
Design, simulate and test custom algorithms in Simulink
Implement these algorithms on low-cost embedded hardware such as Arduino

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:

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