Course guides
230668 - ACSA - Advanced Control of Sensors and Actuators

Last modified: 13/05/2015

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Optional subject).
DEGREE IN ELECTRONIC ENGINEERING (Syllabus 1992). (Optional subject).
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2009). (Optional subject).

Academic year: 2015 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: MANEL DOMINGUEZ, VICENTE JIMÉNEZ

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:
1. 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.

2. 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
- Application classes
- Laboratory classes
- Exercises
- Oral presentations

LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

The aim of this course is to train students in the design of control strategies of sensors and actuators for system performance optimization. The variables to optimize include sensitivity, reliability, speed, absence of cross-dependence with undesired variables, etc. Application examples will be provided in the field of thermal and inertial sensors.

Learning results of the subject:

- Ability to specify, design and analyze closed loop control strategies for sensors and actuators.
- Ability to design and analyze closed-loop strategies aimed at optimizing sensor speed, sensitivity and/or reliability.
- Ability to design, analyze and implement advanced control techniques for sensor and actuators systems.

STUDY LOAD

Type	Hours	Percentage
Hours large group	26,0	20.80
Self study	86,0	68.80
Hours small group	13,0	10.40

Total learning time: 125 h

CONTENTS

1. Introduction

Description:
- Introduction to the design of sensor and actuators
- Closed-loop control of sensor variables

Full-or-part-time: 8h
Theory classes: 2h
Self study : 6h

2. Data conversion

Description:
- Introduction to data conversion
- ADC and DAC characteristics
- Noise and dithering
- Oversampling
- ADC/DAC Topologies
- Coupled converter-sensing methods

Full-or-part-time: 30h
Theory classes: 6h
Laboratory classes: 4h
Self study : 20h

3. Thermal Feedback Sensors

Description:
- Thermal definitions
- Hot wire sensors in open and closed loop
- Sensors based on digital feedback
- Thermal Sigma-Delta Loops

Full-or-part-time: 29h
Theory classes: 6h
Laboratory classes: 3h
Self study : 20h

4. Application of Sigma-Delta modulation to the control of sensors and actuators

Description:
- Oversampling principles. Noise Transfer function.
- First-order sigma-delta:
- exact solution for the bitstreams. Analysis of the effects of leaky integration.
- Existence of limit-cycles of finite number of points in piecewise contrative dynamical systems
- Application to thermal sensors: closed-loop control of sensors
- Application to inertial sensors
- Second-order modulators. Higher order modulator topologies. Multi-stage and Multi-bit S-D modulators. Stability and performance.
- Pulsed actuation of MEMS resonators (Pulsed Digital Oscillators).
- Gravimetric sensors.
- Example of application of sigma-delta modulation: control of dielectric charging in electrostatic MEMS (RF switches, etc.).

Full-or-part-time: 29h
Theory classes: 6h
Laboratory classes: 3h
Self study : 20h

5. Introduction to compressed sensing

Description:
- Sampling beyond Nyquist: sparse signals
- L1 minimization optimization
- Application to A/D conversion.

Full-or-part-time: 29h
Theory classes: 6h
Laboratory classes: 3h
Self study : 20h

ACTIVITIES

LABORATORY

Description:
Simulation with Matlab or PSPICE of different circuit topologies and control strategies for sensors and actuators

ORAL PRESENTATION

Description:
Presentation of a work group.

GRADING SYSTEM

Exercises: 66%
Laboratory assessments: 33%

BIBLIOGRAPHY

Basic:
- Bourdopoulos, G.I. [et al.]. Delta-Sigma modulators: modeling, design and applications [on line]. London: World Scientific Publishing Company, 2003 [Consultation: 28/09/2015]. Available on: http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10255883. ISBN 978-1860943690.

Complementary:
- Eldar, Y.C.; Kutyniok, G. (ed.). Compressed sensing: theory and applications [on line]. Cambridge: Cambridge University Press, 2012 [Consultation: 28/09/2015]. Available on: http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10578314. ISBN 9781139339995.