Course guide
230675 - EDIS - Edison: Energy Management for Distributed and Integrated Systems

Last modified: 25/05/2023

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).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2022). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

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
- Exercises
- Other activities
- 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 several techniques of modelling, design and control of energy management architectures, particularly in an IC context, designing its subsystems and related modulation, control and management policies. The course focuses on energy management and supply subsystems specifically targeting communication and computing applications.
Requisites: Students coming from academic studies other than B. Sc. Electronics Systems Engineering or equivalent ones, should have successfully passed the examinations of the bridging courses "Control" and "POT".

Learning results of the subject:

- Ability to design energy management architectures, particularly in an IC context
- Ability to design energy management subsystems, including circuit and model aspects
- Ability to understand and apply energy management architectures for distributed and integrated applications
- Ability to understand and apply energy management subsystems, particularly in an IC context
- Ability to understand and apply modulations, control and energy management policies
- Ability to design integrated and distributed energy management systems in various ICT applications

STUDY LOAD

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

Total learning time: 125 h

CONTENTS

1. Introduction to energy management

Description:
- Basic concepts. Energy processing vs signal processing
- Energy processing architecture: source, processor and load
- Current applications

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

2. Efficient energy conversion subsystems

Description:
- Converter classification: linear converters, switched capacitor converters, switching power converters
- Switching power converters: fundamentals of synthesis and design-oriented analysis
- Switching power regulators
- Power processing modular architectures

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

3. Batteries and other energy sources

Description:
- Classification of batteries
- Battery modelling
- Other energy sources: Fuel cells, supercapacitors, photovoltaic cells

Full-or-part-time: 13h
Theory classes: 4h
Self study : 9h

4. Energy management in battery-operated mobile telephone portable terminals

Description:
- Energy management within the system-on-chip architecture
- Power converter miniaturization guidelines
- Improved efficiency techniques: adaptive power management for DSP and RF amplifiers
- On-chip energy distribution networks

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

5. Powering microprocessors

Description:
- Voltage regulator modules (VRM). Specifications.
- Decoupling issues
- Modular powering architectures for multi-processor systems.
- Other issues: UPS (Uninterruptible power supplies) and PFC (Power factor correction) circuits

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

6. Bus architectures for energy distribution in satellites

Description:
- Energy management architectures for aerospace applications.
- Effect of satellite orbit
- Energy bus classification: non-regulated, hybrid and regulated bus

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

7. Other applications

Description:
- Techniques for efficient DC to RF power conversion
- Efficient switching power audio amplifiers
- Power issues in line drivers
- Energy Harvesting circuits and systems

Full-or-part-time: 13h
Theory classes: 4h
Self study : 9h

8. Laboratory 1

Description:
Circuit-level simulation of a voltage regulator module (VRM) powering a microprocessor

Full-or-part-time: 13h
Laboratory classes: 5h
Self study : 8h

9. Laboratory 2

Description:
Experimental characterization of the energy management system in a Li-Ion battery-operated mobile phone

Full-or-part-time: 12h
Laboratory classes: 4h
Self study : 8h

10. Laboratory 3

Description:
CMOS on-chip power management for RF PA

Full-or-part-time: 12h
Laboratory classes: 4h
Self study : 8h

ACTIVITIES

LECTURES

EXERCISES

Description:
Exercises to strengthen the theoretical knowledge.

OTHER ACTIVITIES

Description:
Numerical simulation homework

EXTENDED ANSWER TEST (FINAL EXAM)

Description:
Final examination.

GRADING SYSTEM

Final examination: from 60% to 70%
Exercises: from 30% to 40%

BIBLIOGRAPHY

Basic:
- Bergveld, H.J.; Kruijt, W.S.; Notten, P.H.L. Battery management systems: design by modelling. Dordrecht: Kluwer Academic Publishers, 2002. ISBN 1402008325.
- Chandrakasan, A.; Brodersen, R. (eds.). Low power CMOS design. New York: IEEE press, 1998. ISBN 0780334299.
- Erickson, R.W.; Maksimovic, D. Fundamentals of power electronics [on line]. 3rd ed. Cham: Springer, 2001 [Consultation: 28/09/2023]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-030-43881-4. ISBN 9783030438814.

Complementary:
- Benini, L.; Micheli, G. de. Dynamic power management: design techniques and CAD tools. Boston: Kluwer Academic Publishers, 1998. ISBN 079238086X.
- Pedram, M.; Rabaey, J.M. (eds.). Power aware design methodologies [on line]. Boston: Kluwer Academic Publishers, 2002 [Consultation: 21/05/2020]. Available on: https://link.springer.com/book/10.1007/b101914. ISBN 1402071523.
- Mezhiba, A.V.; Friedman, E.G. Power distribution networks in high speed integrated circuits. Boston: Kluwer Academic Publishers, 2004. ISBN 1402075340.
- Wu, K.C. Transistor circuits for spacecraft power system. Boston, Mass.: Kluwer Academic Publishers, 2003. ISBN 1402072619.