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

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

Teaching unit: 710 - EEL - Department of Electronic Engineering

Academic year: 2017

Degree: DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 1992). (Teaching unit Optional)
DEGREE IN ELECTRONIC ENGINEERING (Syllabus 1992). (Teaching unit Optional)
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2009). (Teaching unit Optional)
MASTER'S DEGREE IN INFORMATION AND COMMUNICATION TECHNOLOGIES (Syllabus 2009). (Teaching unit Optional)
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: EDUARD ALARCON

Others: ALBERTO POVEDA

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

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- Ability to design integrated and distributed energy management systems in various ICT applications

Study load

Total learning time: 125h	Hours large group:	26h	20.80%
	Hours medium group:	0h	0.00%
	Hours small group:	13h	10.40%
	Guided activities:	0h	0.00%
	Self study:	86h	68.80%

Content

1. Introduction to energy management	Learning time: 7h Theory classes: 2h Self study : 5h

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

2. Efficient energy conversion subsystems	Learning time: 21h Theory classes: 6h Self study : 15h

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

3. Batteries and other energy sources	Learning time: 13h Theory classes: 4h Self study : 9h

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

4. Energy management in battery-operated mobile telephone portable terminals	Learning time: 20h Theory classes: 6h Self study : 14h

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

5. Powering microprocessors	Learning time: 7h Theory classes: 2h Self study : 5h

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

6. Bus architectures for energy distribution in satellites	Learning time: 7h Theory classes: 2h Self study : 5h

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

7. Other applications	Learning time: 13h Theory classes: 4h Self study : 9h

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

8. Laboratory 1	Learning time: 13h Laboratory classes: 5h Self study : 8h

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

9. Laboratory 2	Learning time: 12h Laboratory classes: 4h Self study : 8h
Description: Experimental characterization of the energy management system in a Li-Ion battery-operated mobile phone	

10. Laboratory 3	Learning time: 12h Laboratory classes: 4h Self study : 8h
Description: CMOS on-chip power management for RF PA	

Planning of activities

LECTURES

EXERCISES

Description:
Exercises to strengthen the theoretical knowledge.

OTHER ACTIVITIES

Description:
Numerical simulation homework

EXTENDED ANSWER TEST (FINAL EXAM)

Description:
Final examination.

Qualification system

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

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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]. 2nd ed. Dordrecht: Kluwer Academic Publishers, 2001 [Consultation: 11/02/2015]. Available on: <http://link.springer.com/book/10.1007/b100747/page/1>. ISBN 0792372700.

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. Boston: Kluwer Academic Publishers, 2002. 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.