Last update: 27-05-2019

# 300266 - LOWPOW - Low-Power Systems with Energy Harvesting

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering

Teaching unit: 710 - EEL - Department of Electronic Engineering

Academic year: 2019

Degree: MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Optional)
MASTER'S DEGREE IN APPLIED TELECOMMUNICATIONS AND ENGINEERING MANAGEMENT (MASTEAM) (Syllabus 2015). (Teaching unit Optional)

ECTS credits: 3 Teaching languages: English

## Teaching staff

Coordinator: OSCAR LOPEZ LAPEÑA

Others: Primer quadrimestre:
OSCAR LOPEZ LAPEÑA - NMAS2
JOSE POLO CANTERO - NMAS2

## Prior skills

Ansy C programming, analysis and design of basic analog and digital electronic circuits using passive and active electronic components and basic knowledge on microcontrollers.

## Requirements

No further requirements.

## Degree competences to which the subject contributes

Basic:

CB6. (ENG) CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación.
CB9. (ENG) CB9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades.
CB10. (ENG) CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

Generical:

03 DIS. (ENG) Diseñar aplicaciones de alto valor añadido basadas en las Tecnologías de la Información y las Comunicaciones (TIC), aplicadas a cualquier ámbito de la sociedad.

Transversal:

02 SCS. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

## Teaching methodology

Lectures and laboratory hands-on work.

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## Learning objectives of the subject

At the end of the course the student should be able to:
1. Program low-power Microcontrollers (MSP430) to implement a wireless sensor node.
2. Use power consumption monitoring tools during program debugging.
3. Identify the power consumption factors on a Microcontroller based system.
4. Understand power management strategies and propose design alternatives to reduce power consumption.
5. Understand the architecture of low-power energy harvesting systems.
6. Select energy transducers and secondary batteries to power autonomous systems.
7. Design power conditioner circuits for low-power energy harvesting systems.

## Study load

| | | | |
|---|---|---|---|
| Total learning time: 75h | Hours large group: | 4h | 5.33% |
| | Hours medium group: | 23h | 30.67% |
| | Hours small group: | 0h | 0.00% |
| | Guided activities: | 0h | 0.00% |
| | Self study: | 48h | 64.00% |

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## Content

### Ultra-low-power embedded systems

Learning time: 23h

Theory classes: 2h
Practical classes: 6h
Self study : 15h

Description:
Ultra-low-power microcontrollers: architecture, power consumption factors and operating modes. Programming basics, interrupts programming and software optimization.

Related activities:
Lectures, laboratory exercises and project

### Analog front and back ends

Learning time: 10h

Practical classes: 4h
Self study : 6h

Description:
Analog-to-digital converters. Comparator and digital input ports. Timers/counters and capture/compare registers. Digital-to-analog converters. Output digital ports and PWM outputs.

Related activities:
Lectures, laboratory exercises and project

### Power management strategies

Learning time: 8h

Theory classes: 1h
Practical classes: 3h
Self study : 4h

Description:
Analisys of energy consumption of CMOS circuits. Dynamic power management: break-even time and switching policies. Dynamic voltage and frequency scaling: supply voltage and frequency optimization.

Related activities:
Lectures, laboratory exercises and project

Specific objectives:
Desc

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| Batteries and energy supervision | Learning time: 6h<br>Theory classes: 0h 10m<br>Practical classes: 1h 50m<br>Self study : 4h |
|---|---|

Description:
Characteristics of secondary batteries. Overcharge and undercharge protection circuits. State of charge and state of health monitoring

Related activities:
Lectures, laboratory exercises and project

| Energy harvesting and power conditioning | Learning time: 28h<br>Theory classes: 3h<br>Practical classes: 6h<br>Self study : 19h |
|---|---|

Description:
Low-power DC/DC switching power converters. Photovoltaic energy harvesting: irradiation analysis and system design. Alternative power sources: mechanical, thermal and RF energy harvesting

Related activities:
Lectures, laboratory exercises and project

## Regulations for carrying out activities

Programming exam (20 %), laboratory project (60 %) and final exam (20 %).

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## Bibliography

Basic:

Benini, Luca. Dynamic power management: design techniques and CAD tools. Boston: Kluwer, 1998. ISBN 079238086X.

Jiménez, Manuel; Palomera, Rogelio; Couvertier, Isidoro. Introduction to Embedded Systems [Recurs electrònic]: using microcontrollers and the MSP430. New York: Springer, 2014. ISBN 9781461431435.

Luecke, Gerald. Analog and digital circuits for electronic control system applications: using the TI MSP430 microcontroller. Amsterdam: Elsevier/Newnes, 2005. ISBN 0750678100.

Davies, J. H. MSP430 microcontroller basics. Oxford: Newnes, 2008. ISBN 9780750682763.

Others resources:

MSP430FR5969 LaunchPad Evaluation Kit
Photovoltaic panels illuminated by power LEDs
Low-power solar energy harvesting board

Audiovisual material

Nom recurs

Resource