Course guides
300266 - LOWPOW - Low-Power Systems with Energy Harvesting

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

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

Academic year: 2019 ECTS Credits: 3.0 Languages: English

LECTURER
Coordinating lecturer: 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

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.

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.

TEACHING METHODOLOGY
Lectures and laboratory hands-on work.
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

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group</td>
<td>23</td>
<td>30.67</td>
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<tr>
<td>Hours large group</td>
<td>4</td>
<td>5.33</td>
</tr>
<tr>
<td>Self study</td>
<td>48</td>
<td>64.00</td>
</tr>
</tbody>
</table>

**Total learning time:** 75 h

CONTENTS

**Ultra-low-power embedded systems**

*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

*Full-or-part-time:* 23 h
  - Theory classes: 2h
  - Practical classes: 6h
  - Self study: 15h

**Analog front and back ends**


*Related activities:* Lectures, laboratory exercises and project

*Full-or-part-time:* 10 h
  - Practical classes: 4h
  - Self study: 6h
Power management strategies

Description:
Analysis 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.

Specific objectives:
Desc

Related activities:
Lectures, laboratory exercises and project

Full-or-part-time: 8 h
Theory classes: 1h
Practical classes: 3h
Self study : 4h

Batteries and energy supervision

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

Full-or-part-time: 5 h
Theory classes: 0h 10m
Practical classes: 1h 50m
Self study : 4h

Energy harvesting and power conditioning

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

Full-or-part-time: 28 h
 Theory classes: 3h
 Practical classes: 6h
 Self study : 19h

GRADING SYSTEM

EXAMINATION RULES.

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

Basic:

RESOURCES

Audiovisual material:
- Nom recurs. Resource

Other resources:
MSP430FR5969 LaunchPad Evaluation KitPhotovoltaic panels illuminated by power LEDsLow-power solar energy harvesting board