ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

53001534 - Energy management in electronic systems

DEGREE PROGRAMME

05BG - Master Universitario En Electronica Industrial

ACADEMIC YEAR & SEMESTER

2018/19 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	53001534 - Energy management in electronic systems
No of credits	3 ECTS
Type	Compulsory
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	05BG - Master universitario en electronica industrial
Centre	05 - Escuela Tecnica Superior de Ingenieros Industriales
Academic year	2018-19

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Pedro Alou Cervera	Electrónica	pedro.alou@upm.es	M - 10:00 - 11:00
Teresa Riesgo Alcaide (Subject coordinator)	Electrónica	teresa.riesgo@upm.es	Tu - 10:00 - 11:00

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

2.3. External faculty

Name and surname	Email	Institution
Eduard Alarcón Cot	eduard.alarcon@upc.edu	Universidad Politecnica de Catalunya

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

El plan de estudios Master Universitario en Electronica Industrial no tiene definidas asignaturas previas recomendadas para esta asignatura.

3.2. Other recommended learning outcomes

- Power Electronics

- Microprocessor based systems

- Digital System Design

4. Skills and learning outcomes *

4.1. Skills to be learned

CB06 - 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

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

CE03 - Optimizar la gestión energética de los sistemas electrónicos mediante la aplicación de técnicas avanzadas de diseño de circuitos y de métodos de control.

CE04 - Utilización de herramientas CAD para la simulación, modelado y diseño de circuitos electrónicos industriales con altas prestaciones y/o restricciones

CG02 - Saber aplicar e integrar sus conocimientos, la comprensión de estos, su fundamentación científica y sus

capacidades de resolución de problemas en entornos nuevos y definidos de forma imprecisa, incluyendo contextos de carácter multidisciplinar tanto investigadores como profesionales altamente especializados.

CT01 - Uso de la lengua inglesa

4.2. Learning outcomes

RA70 - Conocer y aplicar las técnicas de diseño de fuentes de alimentación para minimizar el consumo de energía, tanto a nivel de la etapa de potencia como el control del convertidor.

RA68 - Analizar los mecanismos de consumo de energía en los sistemas digitales y comprender los principios específicos para reducirlo

RA69 - Revisar las diferentes técnicas que existen para minimizar el consumo de energía, a nivel de circuito, de arquitectura y de sistema

RA1 - Comprensión de los principios de operación de la conversión de la energía y de las principales tecnologías de semiconductores

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

Power consumption and energy management are some of the most important issues in current electronic systems, particularly in areas such as consumer electronics, transport, communications, new devices for intelligent environments, etc. Consumption is, however, one of the most complex to estimate and optimize since it is closely linked to the implementation technology, the use of the system as well as other aspects of architecture not always obvious. A second aspect that must be taken into account in the design of ultra-low-power systems is the design of the power systems that provide power to systems. Thus, this subject is structured in three parts. In the first, the basic aspects of consumption in electronic systems in CMOS technology. In the second part will study techniques of reduction of consumption, both from the point of view of circuit structure and its use, as well as some techniques of estimation of consumption in systems. In the third part of the subject, we will study the power supplies of low-power systems.

5.2. Syllabus

1. Introduction
    1.1. Structure of the subject
    1.2. Evolution of power consumption in digital systems
    1.3. How an electronic system consumes power in CMOS technology
2. Optimizing power consumption
    2.1. @design time (circuit, architecture, system)
    2.2. @run time
    2.3. @standby
3. Estimating power consumption
    3.1. Tools and limitations
4. An application example: WSNs
5. Power Supply Perspective
    5.1. Introduction to power converters: Synchronous Buck converter
    5.2. Basic control theory: dynamic modeling and basic concepts
    5.3. Design trade-offs for Dynamic Voltage Scaling
    5.4. Losses in a power converter: ZVS, light load techniques
    5.5. Switched Capacitors
6. Energy harvesting seminar

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Other face-to-face activities	Assessment activities
1	**1.a. Introduction. Structure of the subject** Duration: 00:30 **1.b. Evolution of power consumption in digital systems** Duration: 01:30			
2	**1.c. How an electronic system consumes power in CMOS technology** Duration: 02:30			
3	**2.a. Optimizing Power @design time** Duration: 02:30			
4	**2.b. Optimizing power @run time** Duration: 01:00	**Using power simulators** Duration: 01:00		
5	**2.c. Optimizing power @standby** Duration: 01:00	**Using power simulators** Duration: 01:30		
6	**3. Estimating Power Consumption** Duration: 01:30 **4. An application example: WSNs** Duration: 01:30			
7	**5. Power supply perspective** Duration: 00:30 **5.a. Introduction to power converters: synchronous Buck converter** Duration: 02:30			
8	**5.b. Basic control theory: dynamic modelling and basic concepts** Duration: 03:00			
9	**5.c. Design trade-offs for Dynamic Voltage Scaling** Duration: 03:00			

10	**5.d. Losses in a power converter: ZVS, light load techniques** Duration: 03:00			
11	**5.e. Switched Capacitors** Duration: 03:00			
12	**Seminar on Energy Harvesting Techniques** Duration: 03:00			
13				
14				**Presentation of personal research work** Continuous assessment and final examination Duration: 03:00
15				
16				
17				**Final exam** Final examination Duration: 02:00

The independent study hours are training activities during which students should spend time on individual study or individual assignments.

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The subject schedule is based on a previous theorical planning of the subject plan and might go to through experience some unexpected changes along throughout the academic year.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
14	Presentation of personal research work		Face-to-face	03:00	20%	5 / 10	CB06 CB10 CG02 CT01 CE03 CE04

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
14	Presentation of personal research work		Face-to-face	03:00	20%	5 / 10	CB06 CB10 CG02 CT01 CE03 CE04
17	Final exam		No Presential	02:00	100%	5 / 10	CB06 CB10 CG02 CT01 CE03 CE04

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

The evaluation is based on a final exam that covers the whole subject. This mark is complemented with the class attendance and the participation in the labs, which is compulsory (at least to a 80% of the classes).

The grade is also complemented with a paersonal work that is a research work (mainly the analysis of a previously published paper), that has to be presented in front of the other students and the professors. The grade assigned to this activity is 20% and it is intended for increasing the final grade of the student.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Slides used in lectures	Others	The slides used at the lectures will be provided to the students
Low Power Design Essentials	Bibliography	The structure of the first part of the subject is inspired in this book