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

2021/22 - 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	2021-22

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Gabriel Noe Mujica Rojas (Subject coordinator)		gabriel.mujica@upm.es	Sin horario. Solicitar cita previa por correo electrónico
Airan Frances Roger		airan.frances@upm.es	Sin horario. Solicitar cita previa por correo electrónico

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

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Digital System Design

- Power Electronics

- Microprocessor based systems

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

CT01 - Uso de la lengua inglesa

4.2. Learning outcomes

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

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

* 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. The power 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 the architecture that are 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 them. Thus, this subject is structured in three parts. In the first one, the basic aspects of power consumption of electronic systems in CMOS technology are studied. In the second part techniques for reducing power are analyzed from the point of view of the circuit structure, their application and some techniques for estimating the power and energy consumption in digital electronic systems. In the third part of the subject the power supply strategies for low-power systems will be studied.

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. Application examples: WSNs and IoT
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. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	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: 02:00			
3	**2.a. Optimizing power at design time** Duration: 02:00			
4	**2.b. Optimizing power at run time** Duration: 02:00			
5	**2.c. Optimizing power at standby** Duration: 02:00			
6	**3. Estimating Power Consumption** Duration: 02:00			
7	**4. Application examples: WSNs and IoT** Duration: 02:00			
8	**5. Power supply perspective** Duration: 01:00 **5.a. Introduction to power converters: synchronous Buck converter** Duration: 01:00			
9	**5.b. Basic control theory: dynamic modelling and basic concepts** Duration: 02:00			
10	**5.b. Basic control theory: dynamic modelling and basic concepts** Duration: 01:00 **5.c. Design trade-offs for Dynamic Voltage Scaling** Duration: 01:00			

11	**5.c. Design trade-offs for Dynamic Voltage Scaling** Duration: 02:00			
12	**5.d. Losses in a power converter: ZVS, light load techniques** Duration: 02:00			
13	**5.d. Losses in a power converter: ZVS, light load techniques** Duration: 01:00 **5.e. Switched Capacitors** Duration: 01:00			
14	**5.e. Switched Capacitors** Duration: 02:00			
15				**Final exam** Continuous assessment and final examination Presential Duration: 02:00
16				
17				

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 schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
15	Final exam		Face-to-face	02:00	100%	5 / 10	CE03 CE04 CT01 CB10 CB06

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
15	Final exam		Face-to-face	02:00	100%	5 / 10	CE03 CE04 CT01 CB10 CB06

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. The subject hast two different contents, digital systems content and power electronics content, and the exam will have two parts as well.

To pass the subject it is mandatory to get at least 5 out of 10 in the total score of the exam, and at least a 35% of the maximum mark of each part.

FM is the Final Mark of the exam

PM is the Mark in the Power Electronics part

DM is the Mark in the Digital Systems part

FM = 0.5*PM + 0.5*DM if PM > 3.5 and DM > 3.5; else FM

If January exam is failed but one of the parts is passed (PM>5 or DM>5), this mark will be kept for the July Exam and the student must only do the failed part in the July Exam.

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