ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

593000401 - Advanced digital architectures

DEGREE PROGRAMME

59AF - Master Univ. Ing. Sistemas Y Servicios Para La Sociedad De La Informacion

ACADEMIC YEAR & SEMESTER

2018/19 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	593000401 - Advanced digital architectures
No of credits	5 ECTS
Type	Compulsory
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	59AF - Master univ. ing. sistemas y servicios para la sociedad de la informacion
Centre	59 - Escuela Tecnica Superior de Ingenieria y Sistemas de Telecomunicacion
Academic year	2018-19

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Mariano Ruiz Gonzalez (Subject coordinator)	A4206	mariano.ruiz@upm.es	M - 15:30 - 17:30 The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge

Eduardo Juarez Martinez	A4204	eduardo.juarez@upm.es	M - 15:30 - 17:30 The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge

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3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

El plan de estudios Master Univ. Ing. Sistemas y Servicios para la Sociedad de la Informacion no tiene definidas asignaturas previas recomendadas para esta asignatura.

3.2. Other recommended learning outcomes

- Operating Systems

- Basic use of Linux OS

- Microprocessor

- C Language Programming

4. Skills and learning outcomes *

4.1. Skills to be learned

CB.06 - To have knowledge that provides the basis or the opportunity of being original to develop and/or to apply ideas, usually in a research context.

CB.07 - To be capable of applying the students' acquired knowledge, as well as their problem solving abilities, to new or not well-known environments in broader (or multidisciplinary) contexts that are in the framework of their expertise area.

CB.10 - To have the learning abilities to continue studying in a mostly self-guided or autonomous manner.

CE.01 - To be capable of analyzing, interpreting and applying standards related to the ICT.

CE.07 - To be capable of proposing, organizing and executing research works in the framework of the Information Society engineering.

CESI.03 - To be capable of analyzing and developing embedded systems integrating operating systems.

CGEN.03 - To be capable of elaborating, planning strategically, leading, coordinating and managing, both technically and economically, projects in the framework of the Information Society engineering, according to ethical, quality and environmental criteria.

CGEN.04 - To be capable of planning, calculating and designing systems and services for the Information Society.

4.2. Learning outcomes

RA62 - Analyze the embedded systems, the technologies they use and the theoretical aspects involved in the systematic design of this type of systems.

RA68 - Implement an embedded system project using Embedded Linux

RA69 - Integrate digital sensors in an Open Hardware platform using standardized interfaces

RA64 - Apply the software tools to built an embedded Linux operating system

RA63 - Analyze and evaluate operating systems that can be integrated into an embedded system

RA66 - Deploy an embedded Linux system in a Open Hardware platform

RA67 - Develop and debug software applications for embedded Linux systems using GNU tools

RA11 - Ability to analyze and design systems and services for the Information Society

RA10 - Improvement of the skills for autonomous learning

* 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

The primary subject objective is to present to the students the use of the fundamental technologies in the embedded electronic systems development.
After an introduction to the subject where the basic concepts of advanced digital architectures are presented (processors, DSPs and FPGAs), the course focuses on the use of GPPs (General Purpose Processors) and how the embedded Linux operating system can be executed on them using an Open Hardware platform such as the BeagleBone Black. The topics discussed include ARM processors, the use of a hardware platform such as the BeagleBone, and the use of Buildroot to generate an embedded Linux distribution.

5.2. Syllabus

1. Introduction to embedded systems. Technologies used in the design of these systems. General purpose processor architectures (GPP)

1.1. Advanced Digital Architectures

1.1.1. GPP Processors

1.1.2. Digital Signal Processors

1.1.2.1. VLIW Architecture

1.1.2.2. DSP Specific peripherals: DMA, High Speed Serial Lines

1.1.3. Architectures using FPGAs and SoCs

1.1.3.1. FPGA Architecture

1.1.3.2. FPGA-based SoC architecture and ARM processor

1.2. Embedded system inroduction

1.3. Overview of ARM processors

1.3.1. Basic architecture of an ARM processor

1.3.2. Reduced instructions set

1.3.3. Pipeline

1.3.4. Memory levels

1.4. Embedded operating systems. Embedded Linux

1.4.1. Basic features

1.4.2. Operating systems main elements

1.4.2.1. Bootloader

1.4.2.2. Kernel

1.4.2.3. Filesystem

1.4.2.4. OS Initialization. Applications

1.4.3. Buildroot concept

1.5. Beaglebone Black description

1.5.1. Beaglebone Black

1.5.1.1. Hardware architecture

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	**Course Introdcution** Duration: 01:00 **Advanced Digital Architectures** Duration: 02:00			
2	**Introduction to embedded systems** Duration: 01:00 **ARM processors family overview** Duration: 02:00			
3	**Introducción a la familia ARM de procesadores** Duration: 01:00 **ARM processors family overview** Duration: 02:00			
4	**Embedded operating systems** Duration: 03:00			
5	**Embedded operating systems** Duration: 03:00			
6	**BeagleBone platform description. Software tools** Duration: 01:00	**Basic tutorial to use BeagleBone** Duration: 01:00		**Midterm exam** Continuous assessment Duration: 01:00
7		**BeagleBone and Buildroot. Embedded Linux Tutorial** Duration: 03:00		
8		**BeagleBone and Buildroot. Embedded Linux Tutorial** Duration: 02:00		**Midterm exam. Embedded Linux** Continuous assessment Duration: 01:00
9		**Course Project Presentation** Duration: 01:00 **Application development** Duration: 02:00		

10		**Application development** Duration: 03:00		
11		**Project revision and sharing** Duration: 03:00		
12		**Project revision and sharing** Duration: 03:00 **Application Development** Duration: 03:00		
13		**Application development** Duration: 03:00		
14		**Application development** Duration: 03:00		
15				**Written exam** Continuous assessment Duration: 01:00 **LAB exam** Continuous assessment Duration: 01:00 **LABs revision. Report revision** Continuous assessment Duration: 00:00
16				**written exam** Final examination Duration: 01:00 **LABs and project course exam** Final examination Duration: 02:00
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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
6	Midterm exam		Face-to-face	01:00	25%	5 / 10	CGEN.04 CESI.03 CGEN.03
8	Midterm exam. Embedded Linux		Face-to-face	01:00	15%	5 / 10	CGEN.03 CB.10
15	LAB exam		Face-to-face	01:00	25%	5 / 10	CE.07 CGEN.04 CB.10
15	Written exam		Face-to-face	01:00	10%	5 / 10	CB.07 CGEN.03 CE.01
15	LABs revision. Report revision		Face-to-face	00:00	25%	5 / 10	CB.10 CE.07 CGEN.04 CE.01 CESI.03 CB.06

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
16	written exam		Face-to-face	01:00	50%	5 / 10	CESI.03 CB.07 CGEN.03 CB.10 CGEN.04 CE.01
16	LABs and project course exam		Face-to-face	02:00	50%	5 / 10	CESI.03 CB.06 CB.10 CE.07

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
written exam		Face-to-face	01:00	50%	5 / 10	CESI.03 CB.07 CGEN.03 CB.10 CGEN.04 CE.01
LABs and Project course exam		Face-to-face	02:00	50%	5 / 10	CESI.03 CB.06 CB.10 CE.07

7.2. Assessment criteria

Components of the evaluation

The evaluation will be based on the following components:

Individual deliverables (25%): they contain the results of the LAB and and their corresponding reports made within an activity. They must bedelivered to the instructor using Moodle platform in a timely manner. The weight assigned to the laboratory deliverables is 25%.

Individual laboratory tests (40%): these are tests carried out in the laboratory and aimed at students giving an account of the skills used in carrying out a project.

Written exams (35%): these are two individual exams aimed at students giving an account of the concepts necessary for the correct understanding of a project. .

Students who request a final evaluation (in writing during the first two weeks of the course) will have a test that will take place during the last week of the course, which will consist of:

A written exam of 1 hour.

A practical exam where the student must develop a two-hour hardware/software application project for the BeagleBone.

The extraordinary exam will have this same format

To pass the subject, it will be necessary that the student meets the following conditions:

Exceed all indicators of achievement indicated as a mandatory acquisition.

Perform the two individual laboratory exams and the two written exams.

Obtain 5 points or more in all the components of the final grade of the subject.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Open Hardware embedded system	Equipment	Beaglebone Black
Moodle UPM	Web resource	Moodle UPM
Buildroot	Others	Buildroot software tools
Virtual Machine with Linux OS	Equipment	Linux in a virtual machine