UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: MICROPROCESSOR-BASED SYSTEM DESIGN
Code: 42335
Type: CORE COURSE
ECTS credits: 6
Degree: 347 - DEGREE PROGRAMME IN COMPUTER SCIENCE ENGINEERING (CR)
Academic year: 2023-24
Center: 108 - SCHOOL OF COMPUTER SCIENCE OF C. REAL
Group(s): 20
Year: 3
Duration: C2
Main language: Spanish
Second language: English
Use of additional languages:
English Friendly: Y
Web site: Available on https://campusvirtual.uclm.es
Bilingual: N

Lecturer: **JULIAN CABA JIMENEZ** - Group(s): **20**

Building/Office	Department	Phone number	Email	Office hours
3.05	TECNOLOGÍAS Y SISTEMAS DE INFORMACIÓN	6725	julian.caba@uclm.es	Available on https://esi.uclm.es/index.php/grado-en-ingenieria-informatica/profesorado/

Lecturer: **XAVIER DEL TORO GARCIA** - Group(s): **20**

Building/Office	Department	Phone number	Email	Office hours
Fermín Caballero/3.12	TECNOLOGÍAS Y SISTEMAS DE INFORMACIÓN	3016	xavier.deltoro@uclm.es	

2. Pre-Requisites

This subject is based on the skills and knowledge acquired in the subjects:

- Computer Structure
- Computer Technology
- Computer Organization

3. Justification in the curriculum, relation to other subjects and to the profession

This subject begins from the subjects *"Computer Structure"* and *"Computer Technology"* and develops the ability to design systems based on microcontrollers and microprocessors, and the subject "Embedded Systems" complements this subject.

4. Degree competences achieved in this course

Course competences

Code	Description
IC01	Ability to design and build digital systems, including computers, based on microprocessors and communication systems.
IC02	Ability to develop specific processors and embedded systems, along with the development and optimization of software in such systems.
IC05	Ability to analyse, assess, and select the most adequate hardware and software platforms for the support of embedded and real time applications.
IC07	Ability to analyse, assess, select, and set up hardware platforms for the development and execution of applications and digital systems.
INS02	Organising and planning skills.
INS04	Problem solving skills by the application of engineering techniques.
PER02	Ability to work in multidisciplinary teams.
PER04	Interpersonal relationship skills.
PER05	Acknowledgement of human diversity, equal rights, and cultural variety.
SIS01	Critical thinking.
SIS03	Autonomous learning.
SIS05	Creativity.

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Ability to recognize different types of parallel architectures.

Ability to design and build digital systems, as well as to develop and optimize software for such systems.

Ability to use and correctly program multiprocessor architectures.

Ability to analyze, evaluate and select the most appropriate hardware platform based on the specific environment in which it is to be implemented.

Ability to size and integrate systems using the most appropriate hardware and software platforms for the development and execution of computer applications and services.

6. Units / Contents

Unit 1: Microcontrollers and Microprocessors

- **Unit 1.1** Introduction
- **Unit 1.2** Cortex-M Family Processors and STM32-F411RE

Unit 2: Basics of Embedded Software

- **Unit 2.1** Basics of Software Concurrency
- **Unit 2.2** Exceptions and Interrupts
- **Unit 2.3** Task Scheduling: a freeRTOS approach

Unit 3: Peripherals

- **Unit 3.1** GPIO
- **Unit 3.2** Watchdog and Timers
- **Unit 3.3** Analog Interfacing
- **Unit 3.4** Serial Communication
- **Unit 3.5** DMA: Direct Memory Access
- **Unit 3.6** FPU: Float-Point Unit

Unit 4: Communication Protocols

- **Unit 4.1** MQTT: Message Queue Telemetry Transport

ADDITIONAL COMMENTS, REMARKS

The laboratory part is divided into labs that have an incremental character except the first one. In the labs we are going to use STM32-F411RE (Cortex-M4) and ESP-WROOM-32 (ESP32) boards.

- **Lab 1:** *Blinking LEDs (use of registers)*
- **Lab 2:** *Moore FSM*
- **Lab 3:** *Interrupts*
- **Lab 4:** *Timers*
- **Lab 5:** *PWM*
- **Lab 6:** *Serial Communications - Bluetooth and I2C*
- **Lab 7:** *MQTT - ESP32*

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures	IC01 IC02 IC05 IC07	0.6	15	N	-	Teaching of the subject matter by lecturer (MAG)
Individual tutoring sessions [ON-SITE]	Lectures	IC01 IC02 IC05 IC07	0.18	4.5	N	-	Individual or small group tutoring in lecturer¿s office, classroom or laboratory (TUT)
Study and Exam Preparation [OFF-SITE]	Self-study	IC01 IC02 IC05 IC07	1.8	45	N	-	Self-study (EST)
Other off-site activity [OFF-SITE]	Practical or hands-on activities	IC01 IC02 IC05 IC07 INS02 INS04 PER02 PER04 PER05 SIS01 SIS03 SIS05	0.9	22.5	N	-	Lab practical preparation (PLAB)
Problem solving and/or case studies [ON-SITE]	Project/Problem Based Learning (PBL)	IC01 IC02 IC05 IC07 INS02 INS04 PER02 PER04 PER05 SIS01 SIS03 SIS05	0.6	15	Y	Y	Worked example problems and cases resolution by the lecturer and the students (PRO)
Writing of reports or projects [OFF-SITE]	Self-study	IC01 IC02 IC05 IC07 INS02 INS04 PER02 PER04 PER05 SIS01 SIS03 SIS05	0.9	22.5	Y	N	Preparation of essays on topics proposed by lecturer (RES)
Laboratory practice or sessions [ON-SITE]	Practical or hands-on activities	IC01 IC02 IC05 IC07 INS02 INS04 PER02 PER04 PER05 SIS01 SIS03 SIS05	0.72	18	Y	Y	Realization of practicals in laboratory/computing room (LAB)
Final test [ON-SITE]	Assessment tests	IC01 IC02 IC05 IC07 INS02 INS04 SIS01 SIS05	0.3	7.5	Y	Y	Partial test 1 of the first half of the syllabus of the subject (EVA)
		Total:	**6**	**150**			
		Total credits of in-class work: 2.4					**Total class time hours: 60**
		Total credits of out of class work: 3.6					**Total hours of out of class work: 90**

As: Assessable training activity
Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Assessment of active participation	10.00%	10.00%	Non-compulsory activity thatcan be retaken. To be carried out in the theory/laboratory sessions for the students of the continuous assessment mode. The students of non-continuous modality will be evaluated of this activity through an alternative method. [EVA]
Final test	40.00%	40.00%	Compulsory activity that can be retaken (rescheduling) to be carried out within the planned exam dates of the final exam call (convocatoria ordinaria). [EVA] [RES]

Assessment of problem solving and/or case studies	25.00%	25.00%	Non-compulsory activity thatcan be retaken.To be carried out before end of teaching period [EVA] [PRO]
Laboratory sessions	25.00%	25.00%	Compulsory activity that can be retaken. To be carried out during lab sessions [LAB]
Total:	**100.00%**	**100.00%**	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject , an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

In compulsory activities, a minimum mark of 40% is required in order to pass that activity and have the possibility to therefore pass the entire subject. A compulsory activity cannot be divided into eliminatory parts, nor can minimum marks be established for each of its parts. In the case of the activities that may be retaken (i.e., rescheduling), an alternative activity or test will be offered in the resit/retake exam call (convocatoria extraordinaria).

The final exam will be common for all the theory/laboratory groups of the subject and will be evaluated by the lecturers of the subject in a serial way, i.e., each part of the final exam will be evaluated by the same lecturer for all the students.

A student is considered to pass the subject if she/he obtains a minimum of 50 points out of 100, taking into account the points obtained in all the evaluable activities, and also has passed all the compulsory activities.

For students who do not pass the subject in the final exam call (convocatoria ordinaria), the marks of activities already passed will be conserved for the resit/retake examcall (convocatoria extraordinaria). If an activity is not recoverable, its assessment will be preserved for the resit/retake exam call (convocatoria extraordinaria) even if it has not been passed. In the case of the passed recoverable activities, the student will have the opportunity to receive an alternative evaluation of those activities in the resit/retake exam call and, in that case, the final grade of the activity will correspond to the latter grade obtained.

The mark of the passed activities in any call, except for the final exam, will be conserved for the subsequent academic year at the request of the student, provided that mark is equal or greater than 50% and that the activities and evaluation criteria of the subject remain unchanged prior to the beginning of that academic year.

The failure of a student to attend the final exam will automatically result in her/him receiving a "Failure to attend" (no presentado). If the student has not passed any compulsory evaluation activity, the maximum final grade will be 40%.

Non-continuous evaluation:

Students may apply at the beginning of the semester for the non-continuous assessment mode. In the same way, the student may change to the non-continuous evaluation mode as long as she/he has not participated during the teaching period in evaluable activities that together account for at least 50% of the total mark of the subject. If a student has reached this 50% of the total obtainable mark or the teaching period is over, she/he will be considered in continuous assessment without the possibility of changing to non-continuous evaluation mode.

Students who take the non-continuous evaluation mode will be globally graded, in 2 annual calls per subject, an ordinary and an extraordinary one (evaluating 100% of the competences), through the assessment systems indicated in the column "Non-continuous evaluation".

In the "non-continuous evaluation" mode, it is not compulsory to keep the mark obtained by the student in the activities or tests (progress test or partial test) taken in the continuous assessment mode.

Specifications for the resit/retake exam:

Evaluation tests will be conducted for all recoverable activities.

The failure of a student to attend the final exam will automatically result in her/him receiving a "Failure to attend" (no presentado), except in the case that the student conserves the mark for the final exam from the final exam call (convocatoria ordinaria). In the latter case, the student's carrying out of any other evaluable activity in the resit/retake exam call (convocatoria extraordinaria) will result in a numerical mark.

Specifications for the second resit / retake exam:

Same characteristics as the resit/retake exam call.

9. Assignments, course calendar and important dates

Not related to the syllabus/contents

Hours **hours**

General comments about the planning: The subject is taught in 3 x 1,5 hour sessions per week.

Unit 1 (de 4): Microcontrollers and Microprocessors

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Individual tutoring sessions [PRESENCIAL][Lectures]	.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	11
Other off-site activity [AUTÓNOMA][Practical or hands-on activities]	3
Writing of reports or projects [AUTÓNOMA][Self-study]	3
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	3
Final test [PRESENCIAL][Assessment tests]	2

Teaching period: 2 weeks

Unit 2 (de 4): Basics of Embedded Software

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Individual tutoring sessions [PRESENCIAL][Lectures]	1
Study and Exam Preparation [AUTÓNOMA][Self-study]	12
Other off-site activity [AUTÓNOMA][Practical or hands-on activities]	4
Problem solving and/or case studies [PRESENCIAL][Project/Problem Based Learning (PBL)]	4.5

Writing of reports or projects [AUTÓNOMA][Self-study]	4.5
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	4.5
Final test [PRESENCIAL][Assessment tests]	3

Unit 3 (de 4): Peripherals

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	6
Individual tutoring sessions [PRESENCIAL][Lectures]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	18
Other off-site activity [AUTÓNOMA][Practical or hands-on activities]	11.5
Problem solving and/or case studies [PRESENCIAL][Project/Problem Based Learning (PBL)]	9
Writing of reports or projects [AUTÓNOMA][Self-study]	12.5
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	9
Final test [PRESENCIAL][Assessment tests]	1.5

Group 20:

Initial date: 08-03-2022 **End date:** 24-04-2022

Unit 4 (de 4): Communication Protocols

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Individual tutoring sessions [PRESENCIAL][Lectures]	1
Study and Exam Preparation [AUTÓNOMA][Self-study]	4
Other off-site activity [AUTÓNOMA][Practical or hands-on activities]	4
Problem solving and/or case studies [PRESENCIAL][Project/Problem Based Learning (PBL)]	1.5
Writing of reports or projects [AUTÓNOMA][Self-study]	2.5
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	1.5
Final test [PRESENCIAL][Assessment tests]	1

Teaching period: 2 weeks

Global activity

Activities	**hours**
Individual tutoring sessions [PRESENCIAL][Lectures]	4.5
Class Attendance (theory) [PRESENCIAL][Lectures]	15
Study and Exam Preparation [AUTÓNOMA][Self-study]	45
Other off-site activity [AUTÓNOMA][Practical or hands-on activities]	22.5
Problem solving and/or case studies [PRESENCIAL][Project/Problem Based Learning (PBL)]	15
Writing of reports or projects [AUTÓNOMA][Self-study]	22.5
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	18
Final test [PRESENCIAL][Assessment tests]	7.5
Total horas:	150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
A.K. Ganguly	Embedded Systems: Design, Programming and Applications			978-1-84265-782-9	2014	
Joseph Yiu	The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors	Elsevier		978-0-12-408082-9	2014	
Alexander G. Dean	Embedded Systems Fundamentals with ARM Cortex-M based Microcontrollers	ARM		978-1911531036	2017	
Angulo y otros	Microcontroladores PIC, Diseño Práctico de Aplicaciones	Mc Graw-Hill				
Yifeng Zhu	Embedded Systems with ARM Cortex-M3 Microcontrollers in Assembly Language and C	E-Man Press		978-0982692622	2014	
Elliot Williams	Make: AVR Programming	Maker Media, Inc.		978-1-4493-5578-4	2014	
Richard Barry	Using the FreeRTOS Real Time Kernel				2009	