UNIVERSIDAD DE CASTILLA - LA MANCHA
GUÍA DOCENTE

Course: MICROPROCESSOR-BASED SYSTEM DESIGN	**Code:** 42335
Type: CORE COURSE	**ECTS credits:** 6
Degree: 347 - DEGREE PROGRAMME IN COMPUTER SCIENCE ENGINEERING (CR)	**Academic year:** 2020-21
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: Technical documentation in English	**English Friendly:** Y
Web site: Virtual space of the subject in 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/categories/profesorado-y-tutorias

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

Ability to recognize different types of parallel architectures.

Ability to use and correctly program multiprocessor architectures.

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

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

6. Units / Contents

Unit 1: Microcontrollers and Microprocessors
    Unit 1.1 Introduction
    Unit 1.2 ATMega328P Microcontroller (Arduino)
    Unit 1.3 Cortex-M Family Processors

Unit 2: Basics of Embedded Software

    Unit 2.1 Basics of Software Concurrency

    Unit 2.2 Exceptions and Interrupts

    Unit 2.3 C in Assembly Language

Unit 3: Peripherals

    Unit 3.1 GPIO

    Unit 3.2 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: RTOS

    Unit 4.1 Introduction to FreeRTOS

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 Arduino Uno (ATMega328P), STM32-F411RE (Cortex-M4) and ESP-WROOM-32 (ESP32) boards.

- **Lab 1:** *Arduino + Oscilloscope*
- **Lab 2:** *Hello STM32CubeMX + IDE!*
- **Lab 3:** *Traffic Light and FSM*
- **Lab 4:** *Adding Interrupts*
- **Lab 5:** *Adding Car Detection Feature (Timers)*
- **Lab 6:** *Adding Barrier for Cars (PWM)*
- **Lab 7:** *Adding Serial Communication - Bluetooth and I2C (UART & I2C)*
- **Lab 8:** *ESP32, MicroPython and API REST*

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	0.72	18	N	-	Teaching of the subject matter by lecturer (MAG)
Individual tutoring sessions [ON-SITE]		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	2.1	52.5	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	0.6	15	N	-	Lab practical preparation (PLAB)
Problem solving and/or case studies [ON-SITE]	Problem solving and exercises	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	0.6	15	Y	Y	Realization of practicals in laboratory/computing room (LAB)
Other on-site activities [ON-SITE]	Assessment tests	IC01 IC02 IC05 IC07 INS02 INS04 SIS01 SIS05	0.15	3.75	Y	Y	Partial test 1 of the first half of the syllabus of the subject (EVA)
Other on-site activities [ON-SITE]	Assessment tests	IC01 IC02 IC05 IC07 INS02 INS04 SIS01 SIS05	0.15	3.75	Y	Y	Partial test 2 of the second 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 assessment mode will be evaluated of this activity through an alternative method.
Test	25.00%	25.00%	Partial Test 1. Compulsory and activity than can be retaken (rescheduling). To be carried out at the end of the first half of the teaching period
Test	25.00%	25.00%	Partial Test 2. Compulsory activity that can be retaken. To be carried out within the planned dates of the final exam call. The

			Partial Test 1 retake will be performed at this date.
Theoretical papers assessment	15.00%	15.00%	Non-compulsory activity thatcan be retaken.To be carried out before end of teaching period
Laboratory sessions	25.00%	25.00%	Compulsory activity that can be retaken. To be carried out during lab sessions
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. The evaluation of the activities will be global and therefore must be quantified by means of a single mark. If the activity consists of several sections, each section may be evaluated separately provided students are informed in writing of this evaluation criterion at the beginning of the academic year. 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 partial tests 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 exam call (convocatoria extraordinaria). 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 qualification of the passed activities in any call, except for the partial tests, will be conserved for the next academic year at the request of the student, provided that it is equal or superior to 5 and the training activities and the evaluation criteria of the subject are not modified in the next academic year.

The failure of a student to attend the partial 1 and partial 2 tests 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 who are unable to attend training activities on a regular basis may apply at the beginning of the semester for the non-continuous assessment mode. Similarly, if a student who is undergoing continuous assessment incurs any circumstance that prevents her/him from regularly attending the classroom-based training activities, she/he may renounce the accumulated mark in continuous assessment and apply for the non-continuous assessment mode. In this case, a notification by the student must be given before the date scheduled for the tests in the ordinary call, in accordance with a deadline that will be informed at the beginning of the semester.

Students who take the non-continuous assessment 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 assessment".

In the "non-continuous assessment" 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.
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]	4.5
Individual tutoring sessions [PRESENCIAL][]	.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	12
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
Other on-site activities [PRESENCIAL][Assessment tests]	1.75

Teaching period: 2 weeks

Group 20:	
Initial date: 01-02-2021	**End date:** 14-02-2021

Unit 2 (de 4): Basics of Embedded Software	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4.5
Individual tutoring sessions [PRESENCIAL][]	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][Problem solving and exercises]	4.5
Writing of reports or projects [AUTÓNOMA][Self-study]	4.5
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	4.5

Activities			Hours
Other on-site activities [PRESENCIAL][Assessment tests]			2

Group 20:	
Initial date: 15-02-2021	**End date:** 07-03-2021

Unit 3 (de 4): Peripherals

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	6
Individual tutoring sessions [PRESENCIAL][]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	22.5
Other off-site activity [AUTÓNOMA][Practical or hands-on activities]	6
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	9
Writing of reports or projects [AUTÓNOMA][Self-study]	12.5
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	6
Other on-site activities [PRESENCIAL][Assessment tests]	3

Group 20:	
Initial date: 08-03-2021	**End date:** 18-04-2021

Unit 4 (de 4): RTOS

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Individual tutoring sessions [PRESENCIAL][]	1
Study and Exam Preparation [AUTÓNOMA][Self-study]	6
Other off-site activity [AUTÓNOMA][Practical or hands-on activities]	2
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	1.5
Writing of reports or projects [AUTÓNOMA][Self-study]	2.5
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	1.5
Other on-site activities [PRESENCIAL][Assessment tests]	.75

Teaching period: 2 weeks

Group 20:	
Initial date: 20-04-2021	**End date:** 09-05-2021

Global activity

Activities	hours
Class Attendance (theory) [PRESENCIAL][Lectures]	18
Individual tutoring sessions [PRESENCIAL][]	4.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	52.5
Other off-site activity [AUTÓNOMA][Practical or hands-on activities]	15
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	15
Writing of reports or projects [AUTÓNOMA][Self-study]	22.5
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	15
Other on-site activities [PRESENCIAL][Assessment tests]	3.75
Other on-site activities [PRESENCIAL][Assessment tests]	3.75
Total horas:	150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	City	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	