UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: CYBER-PHYSICAL SYSTEMS
Code: 311047
Type: CORE COURSE
ECTS credits: 6
Degree: 2361 - MÁSTER UNIVERSITARIO EN INGENIERÍA INFORMÁTICA (AB) (2020)
Academic year: 2022-23
Center: 604 - SCHOOL OF COMPUTER SCIENCE AND ENGINEERING (AB)
Group(s): 10 11
Year: 1
Duration: First semester
Main language: Spanish
Second language: English
Use of additional languages:
English Friendly: Y
Web site:
Bilingual: N

Lecturer: **RAFAEL CASADO GONZALEZ** - Group(s): **10 11**

Building/Office	Department	Phone number	Email	Office hours
ESII/1.D.2	SISTEMAS INFORMÁTICOS	926 053 580	rafael.casado@uclm.es	

2. Pre-Requisites

There are no prerequisites for this subject within the Master's degree curriculum. However, it is recommended that the student feel familiar with the concepts of the following areas:

- Embedded Systems
- Distributed systems
- Computer networks

The syllabus to be developed in this subject assumes that the student feels comfortable with the terminology and subject matter listed above. It is assumed that said student has acquired said skills: (a) either by having taken the subjects directly related to said subjects in the study plans corresponding to the Degree in Computer Engineering; (b) or by the development of their professional activity.

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

In recent years we are witnessing a revolution in the way in which computer systems interact not only with people, but with the real world in general. Advances such as the miniaturization of components, wireless communication technologies, or the manufacture of increasingly sophisticated and affordable sensors / actuators, have made it possible for applications to escape from the desktop. Today, the use of embedded systems and devices (smartphones, tablets, etc.) is widespread to control and interact with all kinds of physical systems in our environment.

A market is developing around this way of conceiving modern computer systems that, according to all projections, will see its importance and weight increase in the ICT industry. Therefore, a growing demand for professionals with specific training is expected, who are capable of managing and applying new technologies in the company, opening the doors to new business opportunities.

In this context, the CPS (Cyber-Physical Systems) subject is presented as a training complement at an academic and professional level that aims to provide the skills demanded by the industry in the field of ubiquitous embedded systems, currently called cyber-physical systems.

4. Degree competences achieved in this course

Course competences

Code	Description
CE04	Ability to model, design, architecture define, implement, manage, operate, administrate and maintain applications, networks, systems services and computer content.
CE11	Ability to design and develop systems, applications and computer services on embedded and ubiquitous systems.
INS02	Organising and planning skills.
INS04	Problem solving skills by the application of engineering techniques.
INS05	Argumentative skills to logically justify and explain decisions and opinions.
PER01	Team work abilities.
SIS01	Critical thinking.
SIS03	Autonomous learning.
UCLM02	Ability to use Information and Communication Technologies.
UCLM03	Accurate speaking and writing skills.

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Learn different technological solutions for the design of applications based on embedded and ubiquitous systems

Know how to determine the embedded and ubiquitous system requirements in terms of hardware support, communications and system software

Understand the concept and the scope of embedded and ubiquitous systems

6. Units / Contents

Unit 1: Introduction to cyber-physical systems
Unit 2: Physical systems, modeling, and examples
Unit 3: Sensors and data acquisition
Unit 4: Actuators and control of the environment
Unit 5: Distributed communications and processing

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	CE11 SIS01	0.6	15	N	-	Explanation by the teacher of the theoretical concepts of the subject. The theoretical presentations will consist of video-lessons that can be followed in a blended way. In the case of not having video-lessons, the explanations will be transmitted by video-streaming and stored for later consultation by the student. Students will have on the teaching platform all the support slides used by the teacher.
Problem solving and/or case studies [ON-SITE]	project-based learning	CE11 INS04 PER01 SIS01 SIS03	0.72	18	Y	N	Presentation of a practical case related to the exposed topic and resolution by the students under the supervision of the teacher.
Computer room practice [ON-SITE]	Work with simulators	CE11 INS02 INS04 PER01 SIS01 SIS03 UCLM02	0.6	15	Y	N	Implementation and evaluation of embedded systems presented in the theoretical classes.
Group tutoring sessions [ON-SITE]	Group tutoring sessions	CE11 SIS01	0.24	6	N	-	Consult the teacher about the problems that have arisen during the development of the rest of the activities.
Study and Exam Preparation [OFF-SITE]	Self-study	CE11 INS02 SIS01 SIS03 UCLM02	1.8	45	N	-	Review work at home of knowledge acquired in class.
Writing of reports or projects [OFF-SITE]	Cooperative / Collaborative Learning	INS02 INS05 PER01 SIS01 SIS03 UCLM03	1.2	30	Y	N	On a weekly basis, students will reinforce what they have learned in face-to-face teaching by solving and delivering certain problems related to the content taught.
Study and Exam Preparation [OFF-SITE]	Self-study	CE11 INS02 INS04 INS05 PER01 SIS01 SIS03 UCLM02 UCLM03	0.6	15	N	-	Preparation of laboratory practices.
Progress test [ON-SITE]	Assessment tests	CE11 INS04 INS05 PER01 SIS01 SIS03 UCLM03	0.24	6	Y	N	Theoretical concepts will be assessed through progress tests.
		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 problem solving and/or case studies	40.00%	40.00%	Resolution and delivery of various works and problems raised throughout the course. Master's Memory Keys: ESC
Practicum and practical activities reports assessment	30.00%	30.00%	A global project will be carried out throughout the course, of which a descriptive report will be delivered and evaluated. Master's Memory Code: INF Keys Master's Report: LAB
Assessment of activities done in the computer labs	20.00%	20.00%	Supervision of the activities carried out by the student in the computer laboratory.
Oral presentations assessment	10.00%	10.00%	The global project will also be presented by oral presentation. Master's Report Code: PRES
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 the development of the subject we will use software applications that allow students to download them at home (either because they are free or because the corporate license maintained by the University admits it). We will also use the collaborative tele-teaching tools provided by the UCLM in problem solving, oral presentations, tutorials and evaluation tests. Consequently, the students' evaluations do not differ according to their face-to-face or blended modality.

If a student has carried out 50% of assessable activities in continuous mode, she will not be able to change to non-continuous mode.

Non-continuous evaluation:

In non-continuous evaluation, the evaluation system consists of the same tests in the same format. The student can keep the grade obtained previously or attend certain activities again. In case of doing so, the resulting grade will be the last one obtained.

Specifications for the resit/retake exam:

The evaluation system consists of the same tests in the same format. The student can keep the grade obtained previously or attend certain activities again. In case of doing so, the resulting grade will be the last one obtained.

Specifications for the second resit / retake exam:

The evaluation system consists of the same tests in the same format. In this case, the student cannot keep any marks previously obtained.

9. Assignments, course calendar and important dates

Not related to the syllabus/contents	
Hours	**hours**
Group tutoring sessions [PRESENCIAL][Group tutoring sessions]	6
Progress test [PRESENCIAL][Assessment tests]	6
Unit 1 (de 5): Introduction to cyber-physical systems	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Study and Exam Preparation [AUTÓNOMA][Self-study]	8
Writing of reports or projects [AUTÓNOMA][Cooperative / Collaborative Learning]	6
Unit 2 (de 5): Physical systems, modeling, and examples	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Problem solving and/or case studies [PRESENCIAL][project-based learning]	4
Computer room practice [PRESENCIAL][Work with simulators]	4
Study and Exam Preparation [AUTÓNOMA][Self-study]	8
Writing of reports or projects [AUTÓNOMA][Cooperative / Collaborative Learning]	6
Study and Exam Preparation [AUTÓNOMA][Self-study]	4
Unit 3 (de 5): Sensors and data acquisition	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Problem solving and/or case studies [PRESENCIAL][project-based learning]	4
Computer room practice [PRESENCIAL][Work with simulators]	4
Study and Exam Preparation [AUTÓNOMA][Self-study]	8
Writing of reports or projects [AUTÓNOMA][Cooperative / Collaborative Learning]	6
Study and Exam Preparation [AUTÓNOMA][Self-study]	4
Unit 4 (de 5): Actuators and control of the environment	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Problem solving and/or case studies [PRESENCIAL][project-based learning]	4
Computer room practice [PRESENCIAL][Work with simulators]	4
Study and Exam Preparation [AUTÓNOMA][Self-study]	8
Writing of reports or projects [AUTÓNOMA][Cooperative / Collaborative Learning]	6
Study and Exam Preparation [AUTÓNOMA][Self-study]	4
Unit 5 (de 5): Distributed communications and processing	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Problem solving and/or case studies [PRESENCIAL][project-based learning]	4
Computer room practice [PRESENCIAL][Work with simulators]	4
Study and Exam Preparation [AUTÓNOMA][Self-study]	8
Writing of reports or projects [AUTÓNOMA][Cooperative / Collaborative Learning]	6
Study and Exam Preparation [AUTÓNOMA][Self-study]	4
Global activity	
Activities	**hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	20
Problem solving and/or case studies [PRESENCIAL][project-based learning]	16
Group tutoring sessions [PRESENCIAL][Group tutoring sessions]	6
Study and Exam Preparation [AUTÓNOMA][Self-study]	40
Writing of reports or projects [AUTÓNOMA][Cooperative / Collaborative Learning]	30
Study and Exam Preparation [AUTÓNOMA][Self-study]	16
Progress test [PRESENCIAL][Assessment tests]	6
Computer room practice [PRESENCIAL][Work with simulators]	16
Total horas:	150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Rafael Casado	Sistemas Ciberfísicos https://campusvirtual.uclm.es/	UCLM				Diapositivas y vídeos de la asignatura
Taha, Walid M. ; Taha, Abd-Elhamid M. ; Thunberg, Johan	Cyber-Physical Systems: A Model-Based Approach https://library.oapen.org/bitstream/20.500.12657/41754/1/2021_Book_Cyber-PhysicalSystemsAModel-Ba.pdf	Springer Nature		978-3-030-36071-9	2021	eBook
Dogan Ibrahim	Microcontroller based Applied Digital Control	John Wiley & Sons		978-0-470-86335-0	2006	sección 1.7 (sensores en sistemas de control); sección 2 (modelado de sistemas)
Edward A. Lee and Sanjit A. Seshia	Introduction to Embedded Systems, A Cyber-Physical Systems Approach http://LeeSeshia.org	UC Berkeley		978-0-557-70857-4	2011	
Alur, Rajeev (1966-)	Principles of cyber-physical systems	MIT Press,		978-0-262-02911-7	2015	
Karl Johan Astrom and Richard M, Murray	Feedback Systems: An introduction for scientists and enginners www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page	Princeton University Press		978-0-691-13576-2	2012	
Ogata, Katsuhiko	Ingeniería de control moderna	Pearson-Prentice Hall		978-84-8322-660-5	2010	
M. Sam Fadali	Digital Control Engineering	Academic Press (Elsevier)		978-0-12-374498-2	2009	