# UNIVERSIDAD DE CASTILLA - LA MANCHA
## GUÍA DOCENTE

## 1. General information

**Course:** CYBER-PHYSICAL SYSTEMS

**Type:** CORE COURSE

**Degree:** 2362 - MÁSTER UNIVERSITARIO EN INGENIERÍA INFORMÁTICA (CR) - (2020)

**Center:** 108 - SCHOOL OF COMPUTER SCIENCE OF C. REAL

**Year:** 1

**Main language:** Spanish

**Use of additional languages:**

**Web site:** Virtual space of the course at https://campusvirtual.uclm.es

**Code:** 311047

**ECTS credits:** 6

**Academic year:** 2023-24

**Group(s):** 20

**Duration:** First semester

**Second language:** English

**English Friendly:** Y

**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: MARIA JOSE SANTOFIMIA ROMERO - Group(s): 20

| Building/Office | Department | Phone number | Email | Office hours |
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### Lecturer: XAVIER DEL TORO GARCIA - Group(s): 20

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| Fermín Caballero/3.12 | TECNOLOGÍAS Y SISTEMAS DE INFORMACIÓN | 3016 | xavier.deltoro@uclm.es | |

## 2. Pre-Requisites

It is recommended that the student (at least) be familiar with the concepts of the following areas:

- Computer Networks
- Distributed Systems
- Embedded Systems
- Microprocessor-Based Systems Design

The syllabus to be developed in this course assumes that the student knows the basic concepts of the above topics and he/she has acquired these skills: (a) either by taking the subjects directly related to these subjects in the corresponding Degree: Computer Engineering, Technical Engineering in Computer Systems or Technical Engineering in Computer Management; (b) or for the development of his/her professional activity.

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

In the last years, we have seen a revolution in the way people and computer systems interact. Applications are being migrated to user-transparent platforms instead of running them on a particular PC or even on a particular server. Users can access to applications (and services) through mobile devices (such as samrtphones and tablets) that are permanently connected, offering the behaviour of a ubiquitous computing system.

In this context appears the idea of the "Internet of Things" that significantly changes the way devices relate to each other and to people.

It must be mentioned that, in the short and medium term, the development of technologies and systems that make possible the commercial implementation of these applications will be reflected in a significant demand of this kind of professionals and will open up clear business opportunities in a market segment that will be exploited.

This course is presented as a training complement at an academic and professional level that aims to provide a critical vision of the current technology for all systems related to IoT, cyber-physical systems (CPS) and their future projection. Specifically, in this course the student will acquire knowledge of the existing technology and its application in industry and home.

## 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. |
| PER03 | Ability to work in an international context. |

| | | |
|---|---|---|
| SIS01 | Critical thinking. | |
| SIS03 | Autonomous learning. | |
| UCLM01 | Command of a second language at a B1 level within the Common European Framework of Reference for Languages | |
| UCLM02 | Ability to use Information and Communication Technologies. | |
| UCLM03 | Accurate speaking and writing skills. | |

## 5. Objectives or Learning Outcomes

**Course learning outcomes**

Description

Understand the concept and the scope of embedded and ubiquitous systems

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

Know how to effectively apply communications support to a hardware infrastructure

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

## 6. Units / Contents

**Unit 1: Introduction to Cyber-Physical Systems**

**Unit 2: Physical Systems, Modelling and Examples**

**Unit 3: Sensors and Data Acquisition**

**Unit 4: Actuators and Environmental Control/Monitoring**

**Unit 5: Communications and Distributed Processing**

### ADDITIONAL COMMENTS, REMARKS

This subject follows the project/problem-based learning methodology, thus hands-on activities includes such technologies studied in the syllabus

## 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] | Combination of methods | CE04 CE11 | 0.96 | 24 | N | - | Teaching of the subject matter by lecturer (MAG) |
| Laboratory practice or sessions [ON-SITE] | Practical or hands-on activities | CE04 CE11 INS02 INS04 INS05 PER01 PER03 SIS01 SIS03 UCLM01 UCLM02 UCLM03 | 0.96 | 24 | Y | Y | Realization of practicals in laboratory/computing room (LAB) |
| Group tutoring sessions [ON-SITE] | Group tutoring sessions | CE04 CE11 INS02 INS04 PER01 SIS01 | 0.18 | 4.5 | N | - | Individual or small group tutoring in lecturer's office, classroom or laboratory (TUT) |
| Writing of reports or projects [OFF-SITE] | Project/Problem Based Learning (PBL) | CE04 CE11 INS02 INS04 INS05 PER01 PER03 SIS01 SIS03 UCLM01 UCLM02 UCLM03 | 2.4 | 60 | Y | Y | Preparation of reports or case studies (EVA) |
| Study and Exam Preparation [OFF-SITE] | Self-study | CE04 CE11 INS02 INS04 INS05 PER01 SIS01 SIS03 UCLM02 UCLM03 | 0.32 | 8 | N | - | Self-Study (EST) |
| Final test [ON-SITE] | Assessment tests | CE04 CE11 INS02 INS04 INS05 SIS01 UCLM03 | 0.06 | 1.5 | Y | Y | Test of the syllabus of the subject (EVA) |
| Project or Topic Presentations [ON-SITE] | Debates | CE04 CE11 INS02 INS04 INS05 SIS01 UCLM03 | 0.08 | 2 | Y | N | Lab practical preparation (PLAB) |
| Workshops or seminars [ON-SITE] | Lectures | CE04 CE11 INS02 INS04 INS05 PER03 SIS01 UCLM01 UCLM02 UCLM03 | 0.16 | 4 | N | - | |
| Writing of reports or projects [OFF-SITE] | project-based learning | CE04 CE11 INS02 INS04 INS05 PER01 SIS01 SIS03 UCLM02 UCLM03 | 0.88 | 22 | Y | Y | |
| | | **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 |
|---|---|---|---|
| Oral presentations assessment | 10.00% | 10.00% | Non-Compulsory activity that can be retaken (EVA). |
| Practicum and practical activities reports assessment | 20.00% | 20.00% | Non-compulsory activity that can be retaken. To be carried out during the theory/lab sessions. (LAB) |
| Assessment of problem solving and/or case studies | 25.00% | 25.00% | Theoretical and/or practical work, reports and/or problem solving and cases. (EVA). Compulsory activity that can be retaken. |

| | | | |
|---|---|---|---|
| Final test | 30.00% | 30.00% | Theoretical and/or practical work, reports and/or resolution of problems and cases. (EVA). Compulsory activity that can be retaken. |
| Self Evaluation and Co-evaluation | 15.00% | 15.00% | Self-evaluation test. Compulsory activity that can be retaken. (EST) |
| **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** |
| **Unit 1 (de 5): Introduction to Cyber-Physical Systems** | |
| **Activities** | **Hours** |
| Class Attendance (theory) [PRESENCIAL][Combination of methods] | 4 |
| Study and Exam Preparation [AUTÓNOMA][Self-study] | 1 |
| Workshops or seminars [PRESENCIAL][Lectures] | 4 |
| **Teaching period:** 1 semana | |
| **Unit 2 (de 5): Physical Systems, Modelling and Examples** | |
| **Activities** | **Hours** |
| Class Attendance (theory) [PRESENCIAL][Combination of methods] | 6 |
| Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities] | 6 |
| Group tutoring sessions [PRESENCIAL][Group tutoring sessions] | 1.5 |
| Writing of reports or projects [AUTÓNOMA][Project/Problem Based Learning (PBL)] | 35 |
| Study and Exam Preparation [AUTÓNOMA][Self-study] | 4 |
| Final test [PRESENCIAL][Assessment tests] | .5 |
| Project or Topic Presentations [PRESENCIAL][Debates] | 1 |
| Workshops or seminars [PRESENCIAL][Lectures] | 6 |
| **Teaching period:** 3 semanas | |
| **Unit 3 (de 5): Sensors and Data Acquisition** | |

| Activities | Hours |
|---|---|
| Class Attendance (theory) [PRESENCIAL][Combination of methods] | 2 |
| Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities] | 4 |
| Group tutoring sessions [PRESENCIAL][Group tutoring sessions] | 1.5 |
| Writing of reports or projects [AUTÓNOMA][Project/Problem Based Learning (PBL)] | 10 |
| Study and Exam Preparation [AUTÓNOMA][Self-study] | 1 |
| Final test [PRESENCIAL][Assessment tests] | .5 |
| Project or Topic Presentations [PRESENCIAL][Debates] | 1 |
| Workshops or seminars [PRESENCIAL][Lectures] | 4 |

**Teaching period:** 1 semana

### Unit 4 (de 5): Actuators and Environmental Control/Monitoring

| Activities | Hours |
|---|---|
| Class Attendance (theory) [PRESENCIAL][Combination of methods] | 4 |
| Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities] | 4 |
| Group tutoring sessions [PRESENCIAL][Group tutoring sessions] | 1 |
| Writing of reports or projects [AUTÓNOMA][Project/Problem Based Learning (PBL)] | 10 |
| Study and Exam Preparation [AUTÓNOMA][Self-study] | 1 |
| Final test [PRESENCIAL][Assessment tests] | .25 |
| Workshops or seminars [PRESENCIAL][Lectures] | 4 |

**Teaching period:** 2 semanas

### Unit 5 (de 5): Communications and Distributed Processing

| Activities | Hours |
|---|---|
| Class Attendance (theory) [PRESENCIAL][Combination of methods] | 8 |
| Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities] | 10 |
| Group tutoring sessions [PRESENCIAL][Group tutoring sessions] | .5 |
| Writing of reports or projects [AUTÓNOMA][Project/Problem Based Learning (PBL)] | 5 |
| Study and Exam Preparation [AUTÓNOMA][Self-study] | 1 |
| Final test [PRESENCIAL][Assessment tests] | .25 |
| Workshops or seminars [PRESENCIAL][Lectures] | 4 |
| Workshops or seminars [PRESENCIAL][Lectures] | 4 |

**Teaching period:** 4 semanas

### Global activity

| Activities | hours |
|---|---|
| Workshops or seminars [PRESENCIAL][Lectures] | 22 |
| Group tutoring sessions [PRESENCIAL][Group tutoring sessions] | 4.5 |
| Writing of reports or projects [AUTÓNOMA][Project/Problem Based Learning (PBL)] | 60 |
| Study and Exam Preparation [AUTÓNOMA][Self-study] | 8 |
| Final test [PRESENCIAL][Assessment tests] | 1.5 |
| Project or Topic Presentations [PRESENCIAL][Debates] | 2 |
| Class Attendance (theory) [PRESENCIAL][Combination of methods] | 24 |
| Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities] | 24 |

**Total horas:** 146

### 10. Bibliography and Sources

| Author(s) | Title/Link | Publishing house | Citv | ISBN | Year | Description |
|---|---|---|---|---|---|---|
| Kevin Roebuck | Service-oriented Architecture (SOA): High-impact Strategies - What You Need to Know: Definitions, Adoptions,Impact, Benefits, Maturity, Vendors | Emereo Pty Limited | | 9781743044926 | 2011 | |
| | http://books.google.es/books/about/Service_oriented_Architecture_SOA_High_i.html?id=mdKUZwEACAAJ&redir_esc=y | | | | | |
| Poslad, Stefan | Ubiquitous computing : smart devices, environments and interactions | Wiley | | 9780470035603 | 2009 | |
| Dogan Ibrahim | Microcontroller based Applied Digital Control | John Wiley & Sons | | 978-0-470-86335-0 | 2006 | |
| Raj Rajkumar, Dionisio de Niz, Mark Klein | Cyber-Physical Systems | O'Reilly | | 9780133416169 | 2016 | |
| Ogata, Katsuhiko | Ingeniería de control moderna | Pearson-Prentice Hall | | 978-84-8322-660-5 | 2010 | |