Universitat Autònoma de Barcelona

2019/2020

Cyber-Physical Systems

Code: 104544
ECTS Credits: 6

Degree	Type	Year	Semester
2503743 Management of Smart and Sustainable Cities	OB	3	1

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Other comments on languages

Materials are in English

Teachers

Raimon Casanova

Prerequisites

For the full understanding of the contents of the course, it is convenient to have a basic ability in programming and a good knowledge of how programs execute in computers. For this, you should have completed Computer science, Internet applications' programming, and Digitalization and microcontrollers courses.

Objectives and Contextualisation

This subject is the first within the subject of Cyber-Physical Systems, in which cities are treated as proper cyber-physical systems where software is combined with the city. In this sense, the data that is collected from urban environments is transmitted and processed for decision making, which ultimately ends up in control actions that affect the same urban environments.

In this context, the Cyber-physical systems' course objective is that students acquire the following competences:

- Know how control loop closes in urban cyber-physical systems.
- Have notions of the usual requirements of cyber-physical systems, including real-time ones.
- Understand the aspects of security, reliability and robustness of the systems.
- Know the software development methodology of the cyber-physical systems.
- Understand the different computational models of the systems.

- Have practical skills with the design and manipulation of state-oriented computational models.
- Know how to estimate implementation costs from the computational models of the systems.
- Have the rudiments of programming for the implementation of control software in cyber-physical systems.

Competences

- Critically analyse work carried out and demonstrate a desire to improve.
- Design platforms of management, integration of public and government services applying technologies and systems of sensorization, acquisition, processing and communication of data.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.

Learning Outcomes

1. Analyse the behaviour of cyberphysical systems through simulation and the measurement of real data.
2. Critically analyse work carried out and demonstrate a desire to improve.
3. Describe the basic principles of cyberphysical-system behaviour.
4. Design cyberphysical systems for the management of intelligent cities.
5. Interpret the mechanisms of monitoring and control in cyberphysical systems.
6. Relate the elements that intervene in the model of an intelligent city with those of cyberphysical systems, including problems deriving from information management.
7. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
8. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.

Content

- Introduction to cyber-physical systems
- Guarantees in the cyber-physical systems
- Modeling of physical systems: continuous and hybrid systems
- Modeling of computer systems and control
- Architecture of cyber-physical systems
- Multi-agent systems

Methodology

Teaching is structured in the following face-to-face activities:

- Theory classes: Presentations of course contents, with a first part that is devoted to the dissemination of the necessary knowledge for the analysis and the design of cyber-physical systems, and to explain cases that situate in context the knowledge and the abilities that are acquired during the course. The second part will be devoted to the discussion of problems that will be dealt with in the corresponding seminars.
- Problem-solving seminars: Discussion of small case studies (for example, control of a microwave oven) that serve to consolidate theoretical knowledge regarding the analysis and design of cyber-physical systems.

- Laboratory practices: Team work at laboratory, following a walk-through guide under the supervisions of a teacher. Each session will deal with a specific aspect regarding the implementation of cyber-physical systems.

There is a very important part of team work outside the classroom and the laboratory. In this sense, each member of each team will have to assume different roles for each assignment. This also means having to work in an organized way and know how to work autonomously when appropriate.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Attendance and participation in theory classes	22	0.88	3, 5, 6
Laboratory: Course project development	12	0.48	1, 2, 4, 8, 7
Problem solution proposals and discussion	12	0.48	1, 2, 4, 8, 7
Type: Supervised			
Course project follow-up	6	0.24	2, 8, 7
Tutoring: Additional problem-solving activities	6	0.24	1, 2, 4, 8, 7
Type: Autonomous			
Course project development and report writing	12	0.48	1, 2, 4, 8, 7
Problem-solving	24	0.96	2, 4, 7
Study	26	1.04	3, 5, 6

Assessment

a) Procedure and assessment activities' plan

The assessment is continuous with specific activities (exams and assignments) throughout the course. These assessment activities generate a series of grades that determine the final grade.

The calculation of the final grade, n, follows the expression:

$$n = t \cdot 50\% + p \cdot 20\% + q \cdot 30\%$$

where t, p, and q are the grades of the theory, problem-solving, and laboratory parts, respectively.

The final grade will be, at most, a 4.5 if t, p or q <5. In other words, each part (theory, problem-solving and laboratory) must be passed separately.

The theory grade (t) is obtained from the average between the grades of the two parts. There will be two exams, one at midterm for the first part and another at the end, for the second part. A final exam lets students improve either part or both.

Problem-solving grade (*p*) is calculated from a weighted average of report grades. Missing reports count as 0. Worst grades are excluded, but the quantity of grades to be considered depend on the number of problem-solving sessions that are effectively done.

The grade of laboratory work (*q*) will be the result of a weighted average of the grades of the work that is done in the laboratory and the corresponding reports. Therefore, attendance at the laboratory sessions is mandatory.

b) Assessment activities schedule

The dates of the continuous assessment theory and problem-solving tests, assignment submission deadlines will be published on the Campus Virtual (CV) and may change to adapt to eventual incidents: it will always be reported previously through the CV since it is understood that it is the usual communication platform between lecturers and students outside the classroom.

c) Re-assessment procedures

Late submissions, subject to prior notice, will be accepted and penalized with a lower grade. Late submissions without prior notice or justification of force majeure will not be accepted. A second submission period may be opened for reports that receive a negative evaluation. Unaccepted or unsubmitted assignment reports will be scored 0 and will not have the option of a second assessment.

In accordance with the coordination of the Degree and the deanship of the School of Engineering, the following activities cannot be re-assessed:

- Problem-solving, 20% of the final grade
- Laboratory, 30% of the final grade

The final exam lets students improve the grades from partial exams, independently. There is no minimum score for either part to be re-assessed in the final examination.

d) Assessment review procedure

All assessment activities can be reviewed in tutoring hours of the teaching staff can be reviewed. For the theory and problem-solving exams, a specific place, date and time will be indicated.

Should the change of a grade be agreed upon, that grade may not be modified in a later review.

No reviews will be done after the closure of the reviews of the final exam.

e) Grading

A "non-assessable" grade will be assigned to students that have not participated in any assessment activity nor have attended any laboratory sessions. In any other case, not participating in an assessment activity, including unattendances to lab, is scored with a 0 for calculating the weighted average.

Honours will be awarded to those who obtain grades greater than or equal to 9.0 in each part, up to 5% of those enrolled in descending order of final grade. They may also be granted in other cases, provided that they do not exceed 5% and the final grade is equal to or greater than 9.0.

f) Irregularities, copies and plagiarism

Copies are evidences that the work or the examination has been done in part or in full without the author's intellectual contribution. This definition also includes attempts of copying in exams and reports, and violations of the norms that ensure intellectual authorship. Plagiarisms refer to the works and texts of other authors that are passed on as their own. They are a crime against intellectual property. To avoid plagiarism, quote the sources you use when writing the corresponding work reports or examinations.

In accordance with the UAB regulations, copies or plagiarisms or any attempt to alter the assessment result, for oneself of for others, like e.g. letting other copy, imply a final grade for the corresponding part (theory, problem solving or laboratory) of 0 and, in this case, failing the course. This does not limit the right to take action against perpetrators, both in the academic field and in the criminal.

g) Assessment of repeaters

There is no differentiated treatment for repeaters but they can take advantage of their own material from the previous year provided it is informed in the corresponding reports.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final examn	50	2	0.08	3, 4, 5, 8, 7, 6
Half-term exams (2)	50	4	0.16	3, 4, 5, 7, 6
Laboratory reports (~ 6)	30	12	0.48	1, 2, 4, 8, 7
Problem-solving reports (~ 6)	20	12	0.48	1, 2, 4, 5, 8, 7

Bibliography

(The final list is shown in the Campus Virtual.)

1. Ll. Ribas Xirgo. (2011). "Estructura bàsica d'un computador", Capítol 5 de Montse Peiron Guàrdia, Lluís Ribas i Xirgo, Fermín Sánchez Carracedo i A. Josep Velasco González: *Fonaments de computadors*. Material docent de la UOC. OpenCourseWare de la UOC. [http://openaccess.uoc.edu/webapps/o2/handle/10609/12901]
   It describes the state-based machine model, the algorithmic machines, and the digital systems' basic architectures that are used in the course from a different perspective, though.
2. Ll. Ribas Xirgo. (2014). *How to code finite state machines (FSMs) in C. A systematic approach.* TR01.102791 Embedded Systems. Universitat Autònoma de Barcelona. [https://www.researchgate.net/publication/273636602_How_to_code_finite_state_ma

   Explains a method to program state machines in C which resembles the one presented in the course.
3. Edward A. Lee and Sanjit A. Seshia. (2017) *Introduction to Embedded Systems, A Cyber-Physical Systems Approach*, Second Edition, MIT Press.
   Un buen complemento a la asignatura. Ver también:https://ptolemy.berkeley.edu/
4. M. J. Pont. (2005). *Embedded C*. Pearson Education Ltd.: Essex, England.
   It shows how embedded systems are programmed, topic also treated in the course problem-solving part and laboratory. Therefore, it's an interesting complementary material.

5. Brian Bailey, Grant Martin and Andrew Piziali. (2007). *ESL Design and Verification. A Prescription for Electronic System-Level Methodology*. Elsevier.
   It gives an overview of the embedded systems' synthesis process and situates the course material, thus it's a good complement.
6. Tim Wilmshurst. (2010). *Designing Embedded Systems with PIC Microcontrollers. Principles and Applications (Second Edition)*. Elsevier.
   Complementary information to that of the course on an embedded system for controlling a robot.
7. Oliver H. Bailey. (2005). *Embedded Systems Desktop Integration*. Wordware Publishing.
   Complementary information about the hardware-software communication aspect of embedded systems.