

## Course guide

### 205094 - 205094 - Industrial Iot and Cyber-Physical Systems

**Last modified:** 19/04/2023

**Unit in charge:** Terrassa School of Industrial, Aerospace and Audiovisual Engineering  
**Teaching unit:** 710 - EEL - Department of Electronic Engineering.

**Degree:** MASTER'S DEGREE IN AUTOMATIC SYSTEMS AND INDUSTRIAL ELECTRONICS (Syllabus 2012). (Optional subject).  
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2013). (Optional subject).  
MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).  
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Optional subject).

**Academic year:** 2023    **ECTS Credits:** 3.0    **Languages:** English

#### LECTURER

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**Coordinating lecturer:** José Luís ROMERAL MARTÍNEZ

**Others:** Miguel DELGADO PRIETO

#### TEACHING METHODOLOGY

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The teaching methodology is based on a learning-by-doing approach under an active-learning framework. Thus, the learning is supported by:

- Lecture sessions
- Laboratory sessions
- Independent learning

In the lecture sessions, the lecturer will promote discussion over a practical problem to be solved in order to introduce the theoretical basis, concepts and methodologies related with the subject. The lecture sessions will be supported by presentations and simulations in software platforms. That is, following an action-based approach in which the teacher and the student continually reflect on the practice.

In the laboratory work sessions, the teacher will guide the students in the application of the theoretical concepts for the resolution of experimental assemblies, basing at all times the critical reasoning. Activities will be proposed that the students solve in the classroom and outside the classroom, in order to favor the contact and use of the basic tools necessary for the realization of an cyber-physical system. The laboratory sessions will follow a project-based-learning, in which groups of students will solve industrial problems to produce experimental results taking advantage of the required digital tools. Thus, promoting a collaborative work were the students will carry out the proposed activities, based on a common objective, in which they must collaborate actively to finalize it.

Finally, the students, autonomously, must work on the material provided by the teachers and the results of the lecture and laboratory sessions in order to assimilate and fix the concepts. Teachers will provide a study and activity monitoring plan (ATENEA).

#### LEARNING OBJECTIVES OF THE SUBJECT

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This course will provide an overview of industrial internet of things and cyber-physical systems to deploy digital twins of industrial processes in the cloud. Sensor devices are applied to real machinery and processes, which are connected to the industrial IoT network. Thus, data is collected and send to a cloud-hosted system so that the data can be processed on a digital model of the industrial process, i.e., a digital twin. By this way the twin replicate on a digital dimension some characteristics of the industrial assets, offering real-time analytics and insights on how it is functioning and awaring about potential issues. In this regard, industrial plant management and control are typical cyber-physical applications, as well as enabling augmented reality procedures over of complex industrial processes for predictive maintenance purposes. From a very technical approach and by means of practical examples, this subject reviews the different engineering technologies related to the development of an Industrial IoT and Cyber-Physical System in practice. Including configuration of network-based communications and embedded hardware programming (Edge box, Node-Red, and other programming platforms); design and management of data-bases (InfluxDB and other data structures); and development of cloud-based analytical procedures and interfacing (machine learning, Grafana and other softwares and analytical approaches).

## STUDY LOAD

Type	Hours	Percentage
Self study	48,0	64.00
Hours small group	27,0	36.00

**Total learning time:** 75 h

## CONTENTS

### Mòdul 1: Network-based communications for Industry 4.0

#### Description:

At the core of Industry 4.0 are smart sensors and devices. This technology gathers virtually infinite volumes of information about its own environment and then uses embedded intelligence to complete programmed functions before sharing the information with other systems and devices via network-based communications. This module includes: 1. Overview of network types 2. IIoT connectivity standards and industrial common protocols 3. Communication requirements assessment 4. Software based communication connector suites 5. Outlook for future communication standards in the Industry 4.0

#### Related activities:

Laboratory report 1 – Communications  
Cyber-physical system project

#### Full-or-part-time: 25h

Theory classes: 3h  
Laboratory classes: 6h  
Self study : 16h

### Mòdul 2: Edge, Fog and Cloud computing architectures

#### Description:

For many industrial companies one challenge of Industry 3.0 was the lack of data. With the deployment of smart devices and the corresponding communication networks, the problem in Industry 4.0 quickly become not the absence of data but the excess of it. This module includes: 1. Edge, fog and cloud architectures. 2. Main IT devices for each architecture: strenghts and weaknesses 3. Data bases and information flow

#### Related activities:

Laboratory report 2 – Computigng architecture  
Cyber-physical system project

#### Full-or-part-time: 25h

Theory classes: 3h  
Laboratory classes: 6h  
Self study : 16h

### Mòdul 3: Cyber-Physical Systems and Interfacing

**Description:**

The greater versatility and increasingly smaller sizes of sensing devices, communication networking and architectures, results in a new computing paradigm called cyber-physical system, which represent the convergence point between the operational technology and the information technology. Thus, this module includes:

1. Basis for a technological deployment of a cyber-physical system
2. Analytical procedures for a digital twin over industrial assets
3. Remote visualization of industrial processes condition and operation

**Related activities:**

Laboratory report 3 – Analytics and interfacing  
Cyber-physical system project

**Full-or-part-time:** 25h

Theory classes: 3h

Laboratory classes: 6h

Self study : 16h

### GRADING SYSTEM

60% - Laboratory reports. After each laboratory session the students will handle a short laboratory report.

40% - Final project presentation. At the end of the course, the students will present the complete project.

Final mark =  $0.2 * LR1 + 0.2 * LR2 + 0.2 * LR3 + 0.4 * P$

### BIBLIOGRAPHY

**Complementary:**

- Velásquez, Nancy; Estevez, Elsa; Pesado, Patricia. "Cloud Computing, Big Data and the Industry 4.0 Reference Architectures, Journal of Computer Science & Technology". Journal of Computer Science & Technology December 2018, [on line]. Vol. 18, núm. 3, desembre 2018 [Consultation: 11/01/2021]. Available on: <https://journal.info.unlp.edu.ar/JCST/article/view/1151/914>.- Zzulka, F.; Marcon, P.; Bradac, Z.; Arm, J.; Benesl, T.; Vesely, I. "Communication Systems for Industry 4.0 and the IIoT". IFAC-PapersOnLine [on line]. 2018, vol. 51, issue 6, p. 150-155 [Consultation: 03/05/2022]. Available on: <https://www.sciencedirect-com.recursos.biblioteca.upc.edu/science/article/pii/S2405896318308899?via%3Dihub>.- Monostori, L.; Kádár, B.; Bauernhansl, T.; Kondoh, S.; Kumara, S.; Reinhart, G.; Sauer, O.; Schuh, G.; Sihn, W.; Ueda, K. "Cyber-physical systems in manufacturing". CIRP Annals [on line]. 2016, vol. 65, issue 2, p. 621-641 [Consultation: 23/01/2023]. Available on: <https://doi.org/10.1016/j.cirp.2016.06.005>.- Tulloch, Mitch. Introducing Windows Azure for IT professionals [on line]. Redmond: Microsoft Press, 2013 [Consultation: 23/01/2023]. Available on: <https://www.microsoftpressstore.com/store/introducing-windows-azure-for-it-professionals-9780735682887>. ISBN 9780735682887. - Da Costa, M. B.; Dos Santos, L. M. A. L.; Schaefer, J. L. "et al. Industry 4.0 technologies basic network identification". Scientometrics [on line]. 2019, núm. 121, p. 977-994 [Consultation: 03/05/2022]. Available on: <https://doi-org.recursos.biblioteca.upc.edu/10.1007/s11192-019-03216-7>.

### RESOURCES

**Other resources:**

<https://www.se.com/es/es/> /> <https://azure.microsoft.com/es-es>