

## Course guide

### 340609 - XACO-R2044 - Communication Networks

Last modified: 30/06/2023

**Unit in charge:** Vilanova i la Geltrú School of Engineering  
**Teaching unit:** 744 - ENTEL - Department of Network Engineering.

**Degree:** MASTER'S DEGREE IN AUTOMATIC SYSTEMS AND INDUSTRIAL ELECTRONICS (Syllabus 2012). (Optional subject).

**Academic year:** 2023    **ECTS Credits:** 5.0    **Languages:** Spanish

#### LECTURER

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**Coordinating lecturer:** Rafael Vidal Ferré

**Others:** Rafael Vidal Ferré  
Rincon Rivera, David  
León Abarca, Olga  
Piney Da Silva, Jose Ramon

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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##### Specific:

1. CEV03 - Analyze and evaluate the different protocols and wireless networks in the field of robotics and automated systems
5. CB10 - Skills that enable to continue studying in a way that should be self-directed and autonomous
6. CB7 - Students can apply their knowledge and their ability to solve problems in new or unfamiliar contexts within broader (or multidisciplinary) contexts related to their field of study
7. CB8 - Students will be able to integrate knowledge and handle complexity and formulate judgments from a incomplete or limited information, including reflecting on social and ethical responsibilities linked to the application of their knowledge and judgments
8. CB9 - Students can communicate their conclusions, knowledge and rationale underpinning these, to skilled and unskilled public in a clear and unambiguous way
9. CC08 - Acquire concepts and techniques related to quantitative and experimental methods for analysis and decision making

##### Transversal:

2. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
3. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
4. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

#### TEACHING METHODOLOGY

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On the one hand, expository classes will be used to introduce the theoretical concepts, which will go from the most basic to the most current trends, using materials prepared by teachers (slides) and other complementary resources (scientific articles, commercial information, videos, ...). On the other hand, more active methodologies will be used, such as problem-solving classes, or group work in the form of collaborative learning to prepare the presentation of a topic or to carry out the practices in the laboratory. Some collaborative activities will also be programmed to foster the team work among students, active techniques such as problem based learning and/or collaborative learning will be used for a suitable topic that requires such techniques rather than oral expositions.

## LEARNING OBJECTIVES OF THE SUBJECT

Understand the operating bases of communication networks. Know the types that exist and the elements that constitute them. Understand the operation of the most widespread network architectures and technologies (Internet and Ethernet) and those specific solutions for the industrial environment (field buses and Industrial Ethernet). Understand the implications at the network level of the Industry 4.0 paradigm (synchrony in networks, TSN, wireless networks, Industrial Internet of Things, cybersecurity). Acquire criteria and analytical tools on how to evaluate and assess the performance of a network according to the requirements of use for an industrial automation solution. Learn to make an IP addressing plan for an industrial network. Learn to configure, test and analyze the operation of an Ethernet-based IP network. Learn to implement a solution based on the Internet of Things (IoT). Know and identify the elements that make up the value chain of a solution (IoT).

## STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours small group	22,5	18.00
Hours large group	22,5	18.00

**Total learning time:** 125 h

## CONTENTS

### Topic 1: Networks of communications

#### Description:

Definition of concepts. Components of a network and basic functions it performs. Fundamental parameters to assess its operation. Types of networks. Switching. Delay (latency) in communication, definition and estimation. Architecture of a computer network. ISO OSI model. Interconnection equipment.

#### Related activities:

Solving transmission problems: latency, flow and congestion control

#### Full-or-part-time: 22h 30m

Theory classes: 2h 30m

Laboratory classes: 6h

Self study : 14h

### Topic 2: Internet

#### Description:

TCP/IP protocol stack. Bases of operation (addressing and routing). Network layer (IP and ICMP protocols, address types, CIDR). Transport layer (ports and connections, UDP vs TCP) Application layer (Web and DNS).

#### Related activities:

IP networks based on Ethernet

IP addressing plan design

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

Theory classes: 4h 30m

Practical classes: 3h 30m

Self study : 17h

### Topic 3: Data link level. LANs. Ethernet

**Description:**

Level of data link, sublayers (MAC and LLC) and functionalities (framework, media access, bit error control). Characteristics of Local Area Networks (LANs). IEEE 802 standards. Ethernet networks: MAC layer (network, address format, IP packet transport), physical layer (cabling, performance, nomenclature), switches (operating bases, basic features, VLANs, link aggregation, PoE), design (structured cabling, types of switches, hierarchies, redundancy).

**Specific objectives:**

IP networks based on Ethernet

**Related activities:**

IP networks based on Ethernet

**Full-or-part-time:** 18h 30m

Theory classes: 4h 30m

Laboratory classes: 2h

Self study : 12h

### Topic 4: Industrial networks

**Description:**

Concept, fields of application and characteristics. Requirements (capacity, latency) depending on the level of application (plant, cell, process). Network architecture. Process control. Real time. Access to the environment. Fieldbus: concept, stack of protocols, mechanisms of access to the environment (determinism) and service quality parameters.

**Related activities:**

Industrial networks sizing

**Full-or-part-time:** 18h

Theory classes: 3h

Laboratory classes: 3h

Self study : 12h

### Topic 5: Fieldbuses and Industrial Ethernet

**Description:**

Market evolution. Field buses (CAN and ProfiBus). Industrial Ethernet: typologies and benefits based on its compatibility with conventional Ethernet, operating bases and architecture of the most used solutions (ProfiNet, PowerLink, Sercos-III Ethernet / IP, EtherCAT).

**Related activities:**

Workgroup

**Full-or-part-time:** 16h 30m

Theory classes: 3h 30m

Laboratory classes: 3h

Self study : 10h

## Topic 6: Industry 4.0

### Description:

Introduction from the perspective of communication networks. Identification of key technologies (TCP / IP and Ethernet).

Challenges: achieve synchronism (TSN), facilitate connectivity through the use of wireless networks (IEEE802.15.4, Wi-Fi, Bluetooth, 2G-5G, RFID, NFC, UWB, LPWANs, use cases), implementation of the Industrial Internet of Things (elements that make up the IoT value chain, use cases), the need for cybersecurity (dangers, philosophy, tools, organizations).

### Related activities:

Workgroup

Internet of Things

**Full-or-part-time:** 24h 30m

Theory classes: 4h 30m

Laboratory classes: 5h

Self study : 15h

## GRADING SYSTEM

The final grade will be the result of the average of the activities carried out by the student throughout the course:

50% Partial exam (reevaluable)

30% Individual deliveries: exercises and laboratory questionnaires

20% Group work

## BIBLIOGRAPHY

### Basic:

- Kurose, James F.; Ross, Keith W. Redes de computadores. Un enfoque descendente basado en Internet [on line]. 7a ed. Madrid: Pearson, 2017 [Consultation: 19/02/2024]. Available on: [https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=6752](https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6752). ISBN 9788490355282.

- Castro Gil, Manuel-Alonso. Comunicaciones industriales : principios básicos [on line]. Madrid: UNED, 2007 [Consultation: 10/11/2022]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=3198983>. ISBN 9788436254600.

- Stallings, William. Comunicaciones y redes de computadores [on line]. 7a ed. Madrid [etc.]: Pearson Educación, 2004 [Consultation: 15/02/2024]. Available on: [https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB\\_BooksVis?cod\\_primaria=1000187&codigo\\_libro=1245](https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1245). ISBN 9788483227589.

## RESOURCES

### Other resources:

It will be published in atenea