Course guide
205120 - 205120 - Fundamentals of Industrial Wireless Communication

Last modified: 02/04/2024

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: 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: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Bertran Alberti, Eduardo

Others:

TEACHING METHODOLOGY

Regarding telecommunication topics, the starting level is the initial one, assuming that the students have taken the mathematics and physics subjects, and that they also have a knowledge on basic electronics.

In the theoretical sessions (large group), the formal explanation of the teacher is combined with informal participation of the students that favor the understanding and settlement of the basic concepts of the
subject. The expository rhythm will be controlled in order to assure it is acceptable for the students, distinguishing, in different points along the syllabus, among the different taxonomies comprised between teaching and "just showing", according to the learning objectives and the allowable time.

In the application / laboratory sessions, students can work individually or in couples, solving exercisesor carrying up simulations related to the theory.

Through the available material (transparencies and lecture notes, exercises, manuals, catalogs, technical regulations, etc.) accessible via the Internet or from the ATENEA digital campus, the students have
sufficient tools and resources to work (either in groups or individually), which will allow an improved achievement of the lectures, as well to consolidate concepts and to resolve doubts.

LEARNING OBJECTIVES OF THE SUBJECT

The trend in professional engineering (Industry 4.0) is to combine production technologies with other ones, including computer science and telecommunication. Besides, in the aeronautical world, both on-board electronics (avionics) and radio-aids are also extremely dependent on telecommunication systems. This entails a need for a more multidisciplinary training: a future engineer may have to face the acceptance procedure, or to sign product designs (remote controls, remote alarms, toys, radio-identification (RFID), sensor networks, ...), or systems (distributed: water, gas, electricity, industrial processes, airport facilities - ILS, VOR, radars, ...) which include telecommunications. So, the future engineer should know, at least at a general level, how to specify a product or system, and, later, what are the critical aspects to accept it. In this line, and starting from the assumption of a very initial level of the students in the subject, the objectives of the course are to provide a first basis to specify radio-communication equipment, make its subsequent acceptance, or to buy professional equipment in order to:

- (MUEI, MUESAEI) to incorporate / to plan / to homologate a radio-communication equipment that will form part of a more complex industrial equipment or system.
- (MUEA) To exercise the professional competence of formally receiving (to "sign") airport equipment and facilities. Choose / evaluate radio-communication equipment for remote control of UAVs (taking into account the background already acquired from previous subjects in order to avoid redundancies).

After completing the course, the student must be able to:
- To interpret and to evaluate products in catalogs, commercialized equipment and chip-sets, to evaluate benefits, and make elementary calculations when necessary.
- To understand the main radio-communication topologies.
- To know the main limiting factors and risks of a radio-communication system.

STUDY LOAD

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

Total learning time: 75 h

CONTENTS

Module 1: Introduction

Description:
• Industrial measurement and control systems. SCADA. Avionics and aircraft guidance and control. Applications in equipment, processes and systems.
• General scheme of a telecommunications system. Analog and digital communications. Synchronous and asynchronous.
• Voice and data communications, remote alarms and remote actions. Safety and reliability. Regulations (SIL). RAMS Engineering

Full-or-part-time: 4h
Theory classes: 2h
Self study : 2h

Module 2: Communication Channels

Description:
content english• Guided and unguided media.
â□□ The radio-electric spectrum. Terminology. Frequency bands and applications. EMC and EMI. Homologation and certification. Regulatory bodies and procedures. Costs

Related activities:
- Theoretical lectures with examples.

Full-or-part-time: 6h
Theory classes: 2h
Self study : 4h

Module 3: Networks

Description:
• Modes of operation. Topologies. Directionality. Circuit and packet switching.
• ISO and OSI. Layers. Examples: message structure. Wired and radio signal protections. Secretization. Data rate, cost and security. QoS. Interfaces with wired networks.
• Allowable delays in remote controls of distribution and transportation systems (latency). Case of digital tele-control in closed loop. Delays and stability of control systems.

Related activities:
- Theoretical lectures with examples.
- Practice: Setting up a connection between a factory and the office. Selection of commercial equipment.
- Practice (to choose between):
• Calculation of the allowable latency in the primary remote control of an electric power generation system.
• Comparison between the OSI regulation and the CCSDS regulation for satellites or the ARINC regulation for aircraft.

Full-or-part-time: 6h
Theory classes: 2h
Self study : 4h

Module 4: Fundamental aspects

Description:
• Introduction to spectral analysis. Fourier. Periodic and non-periodic signals. Spectra and spectral densities. Filtering. Bandwidths. Calculations in dB. Types of units. Application areas.
• Baseband transmission. Buses.
• Modulations. Objectives. Linear and non-linear. Analog and digital. Bits, bauds and symbols. Spectra, constellations and efficiencies. Advantages and disadvantages. Noise. Minimum detectable signal. Measuring equipment.
• Source coding. Digitization. Adaptation to the canal. Multipath and Doppler. Interferences. Errors detection and correction. Multiple access. Protocols.
• Structures and subsystems of emitters and receivers. Conventional ones and "software radio" (SDR) based. Advantages and problems.
• Safety for people or for critical equipment. Authentication. Redundancy / diversity. Coexistence. Special modulations.

Related activities:
Theoretical lectures with examples.
Practice. WinIQSIM program.

Full-or-part-time: 40h
Theory classes: 16h
Self study : 24h

Module 5: Final work

Description:
To choose between:
• Comparison between physical layers of two different IEEE 802.11 (WiFi) standards.
• Identification of frequency bands (CNAF) for particular applications, and commercial selection of the corresponding antennas.
Related

Related activities:
Final work

Full-or-part-time: 19h
Theory classes: 5h
Self study : 14h

GRADING SYSTEM

What is pursuit is a knowledge at the level of understanding, analysis and evaluation, more at qualitative than at quantitative level. Hence, the evaluation of the subject will be based on the reports
of the practices and works delivered along the course. The final work will weigh 33% of the whole grade and the average of the practices will weigh 67%