

# ANX-PR/CL/001-01

## LEARNING GUIDE

### SUBJECT

**593000612 - Wireless Communications In Its**

### DEGREE PROGRAMME

**59AJ - Master Universitario En Comunicaciones Inalámbricas**

### ACADEMIC YEAR & SEMESTER

**2024/25 - Semester 2**

## Index

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### Learning guide

1. Description.....	1
2. Faculty.....	1
3. Prior knowledge recommended to take the subject.....	2
4. Skills and learning outcomes .....	2
5. Brief description of the subject and syllabus.....	3
6. Schedule.....	6
7. Activities and assessment criteria.....	8
8. Teaching resources.....	10

## 1. Description

### 1.1. Subject details

<b>Name of the subject</b>	593000612 - Wireless Communications In Its
<b>No of credits</b>	4.5 ECTS
<b>Type</b>	Optional
<b>Academic year of the programme</b>	First year
<b>Semester of tuition</b>	Semester 2
<b>Tuition period</b>	February-June
<b>Tuition languages</b>	English
<b>Degree programme</b>	59AJ - Master Universitario en Comunicaciones Inalámbricas
<b>Centre</b>	59 - Escuela Técnica Superior De Ingeniería Y Sistemas De Telecomunicación
<b>Academic year</b>	2024-25

## 2. Faculty

### 2.1. Faculty members with subject teaching role

<b>Name and surname</b>	<b>Office/Room</b>	<b>Email</b>	<b>Tutoring hours *</b>
Cesar Briso Rodriguez (Subject coordinator)		cesar.briso@upm.es	- -
Juan Anton Moreno Garcia-Loygorri		juan.moreno.garcia-loygorri@upm.es	Sin horario.

\* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

### 3. Prior knowledge recommended to take the subject

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#### 3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

#### 3.2. Other recommended learning outcomes

- Wireless communications
- Wireless technology

### 4. Skills and learning outcomes \*

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#### 4.1. Skills to be learned

CEM08 - Adquirir las destrezas que permitan analizar e interpretar la arquitectura y servicios de los sistemas de comunicaciones inalámbricos de corta distancia e implementar sus protocolos. / Acquire the skills to analyze and interpret the architecture and services of short distance wireless communication systems and implement its protocols.

CGI04 - Leer y comprender publicaciones dentro de su ámbito de estudio/investigación, así como su catalogación y valor científico. / Read and understand publications within their field of study / research, as well as their cataloging and scientific value.

UPM1 - Uso de la lengua inglesa / Use of the English language

## 4.2. Learning outcomes

RA46 - Identificar y distinguir entre los interfaces y protocolos de una red de comunicaciones inalámbricas en sistemas ITS/ Identify and distinguish between the interfaces and protocols of wireless communication networks in ITS systems

RA43 - Enumerar y describir los componentes necesarios en un sistema de comunicaciones en sistemas ITS/ List and describe the necessary components in ITS communication systems

RA44 - Diseñar la arquitectura de comunicaciones de un sistema ITS a partir de unos requisitos dados/ Design the communications architecture of an ITS communication system based on given requirements

RA45 - Identificar el impacto social y económico de las comunicaciones inalámbricas en sistemas ITS/ Identify the social and economic impact of wireless communications in ITS systems

\* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

## 5. Brief description of the subject and syllabus

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### 5.1. Brief description of the subject

This course is aimed to gain a comprehensive understanding on the use of Wireless Communications in Intelligent Transportation Systems (ITS). The more representative technologies and results will be provided.

Introducing transportation systems makes no sense because we are using them all the time, but ITS are applications that provide added-value to the transportation system using wireless communications technologies. For example, a system that makes trains safer or more punctual, or a GNSS-based device that allows a more efficient management of a fleet of vehicles are two examples of ITS. But there are many more.

More precisely, in this course we will give context on ITS explaining details about the transportation systems where the ITS work and also specific concepts about the environment and the specific conditions to deal with ITS. In particular, we will discuss the following topics:

- Sensors and networks onboard cars, both autonomous or not.
- All the wayside and onboard systems integrated on all trains types, i.e. high-speed trains, metro trains, tramways,

freight, etc., as well as some other that do not run on rails, like magnetic levitation vehicles or, more recently, Hyperloop.

- What is needed to have a fully-unmanned train

- Aircrafts, like UAVs, helicopters, etc.

In this course students will learn a practical approach of wireless communications and electronics to a specific and growing field: transportation systems. Therefore, the previous knowledge on this field will be mapped to certain transportation requirements and scenarios in order to improve related problems. Moreover, vehicular scenarios are among the most challenging for wireless communications and also are also the most benefited from the adoption of wireless technologies.

## 5.2. Syllabus

### 1. INTRODUCTION

- 1.1. Concepts and scenarios: road , railway , air.

- 1.2. Electronics in ITS

- 1.2.1. Onboard electronics

- 1.2.2. Technologies: LIDAR, RADAR, video, sensors.

### 2. AUTOMOTIVE IN ITS

- 2.1. Smart roads

- 2.2. CAN buses, sensors, ITS automotive industry.

- 2.3. Integration and testing

### 3. RAILWAYS

3.1. General description of railway environment.

3.2. Metropolitan railways

3.2.1. Train communications Network, (TCN)

3.2.2. Automatic Train control .CBTC

3.2.3. Passengers information and operational systems

3.3. High Speed Trains

3.3.1. Signaling. ERTMS

3.3.2. Communications: GSM-R

### 4. UNMANNED AERIAL VEHICLES

4.1. General concepts

4.2. Communications links

4.3. Global Navigation Systems

4.4. Homologation and certification

### 5. FUTURE ITS

5.1. Communications: 5G, Satellite

5.2. Future Railway Mobile Communications System

5.3. New Technologies for transport.

## 6. Schedule

### 6.1. Subject schedule\*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	<b>INTRODUCCION</b> Duration: 03:00  <b>AUTOMOTIVE IN ITS</b> Duration: 03:00			
2	<b>AUTOMOTIVE IN ITS</b> Duration: 03:00	<b>LAB AUTOMOTIVE</b> Duration: 02:00		<b>PRACTICAL WORK EVALUATION</b>  Progressive assessment and Global Examination Presential Duration: 01:00
3	<b>RAILWAYS METRO</b> Duration: 03:00	<b>RAILWAYS METRO</b> Duration: 02:00		<b>PRACTICAL WORK EVALUATION</b>  Progressive assessment and Global Examination Presential Duration: 01:00
4	<b>RAILWAYS METRO</b> Duration: 03:00  <b>RAILWAYS AVE</b> Duration: 02:00			<b>EXAM PART 1</b>  Progressive assessment and Global Examination Presential Duration: 01:00
5	<b>RAYLWAYS AVE</b> Duration: 04:00  <b>UAVS</b> Duration: 02:00			
6	<b>UAVs</b> Duration: 04:00	<b>UAVs</b> Duration: 01:00		<b>PRACTICAL WORK EVALUATION</b>  Progressive assessment and Global Examination Presential Duration: 01:00
7	<b>FUTURE ITS</b> Duration: 04:00			<b>ITS PROJECT</b>  Progressive assessment and Global Examination Presential Duration: 02:00

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Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

## 7. Activities and assessment criteria

### 7.1. Assessment activities

#### 7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	PRACTICAL WORK EVALUATION		Face-to-face	01:00	10%	4 / 10	CEM08
3	PRACTICAL WORK EVALUATION		Face-to-face	01:00	10%	4 / 10	
4	EXAM PART 1		Face-to-face	01:00	50%	4 / 10	CEM08 CGI04 UPM1
6	PRACTICAL WORK EVALUATION		Face-to-face	01:00	10%	4 / 10	
7	ITS PROJECT		Face-to-face	02:00	20%	5 / 10	CEM08 CGI04 UPM1

#### 7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	PRACTICAL WORK EVALUATION		Face-to-face	01:00	10%	4 / 10	CEM08
3	PRACTICAL WORK EVALUATION		Face-to-face	01:00	10%	4 / 10	
4	EXAM PART 1		Face-to-face	01:00	50%	4 / 10	CEM08 CGI04 UPM1
6	PRACTICAL WORK EVALUATION		Face-to-face	01:00	10%	4 / 10	
7	ITS PROJECT		Face-to-face	02:00	20%	5 / 10	CEM08 CGI04 UPM1

#### 7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
FINAL EXAMINATION		Face-to-face	02:00	70%	5 / 10	

PRACTICAL EXAMINATION		Face-to-face	01:00	30%	5 / 10	
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## 7.2. Assessment criteria

### Continuous assessment

Continuous evaluation is done by:

- 1) A written exam to evaluate the first part of the subject that will be carried out during the course. This exam represents 50% of the final grade. To average, the student must achieve a minimum grade of 4 points out of 10.
- 2) Carrying out laboratory practices. This exam accounts for 30% of the final grade. To average, the student must achieve a minimum grade of 4 points out of 10.
- 3) A final work of a project for ITS. which represents 20% of the note. To average it is necessary to obtain 5.0p

To pass the subject, a final grade greater than or equal to 5 out of 10 must be obtained.

If the minimum grade is not reached in one of the parts, the final grade will be 4.0p.

### Evaluation by final test

It will be carried out in the same way as the continuous evaluation.

To pass the subject, a final grade greater than or equal to 5 out of 10 must be obtained.

### Extraordinary exam

There will be an extended theoretical exam and an oral exam on the practices carried out.

## 8. Teaching resources

### 8.1. Teaching resources for the subject

Name	Type	Notes
Wireless Communications (Wiley ? IEEE)	Bibliography	Libro general para todo el master
Juan Moreno García-Loygorri, ?Telecommunication Systems for Modern Railways?, Springer, 202	Bibliography	Libro para la parte de ferrocarril
<a href="https://www.seguridadaerea.gob.es/es/particulares/piloto-de-drones">https://www.seguridadaerea.gob.es/es/particulares/piloto-de-drones</a>	Web resource	Pagina para UAVs
MATLAB	Web resource	programa para practicas
XIRIO online	Web resource	Progama para practicas