INTERNATIONAL
CAMPUS OF
EXCELLENCE

POLITÉCNICA

E.T.S. de Ingenieria y Sistemas
de Telecomunicacion

# ANX-PR/CL/001-01

# LEARNING GUIDE

## SUBJECT

**593000612 - Wireless Communications In Its**

## DEGREE PROGRAMME

59AI - Master Universitario En Comunicaciones Inalámbricas

## ACADEMIC YEAR & SEMESTER

2022/23 - Semester 2

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## Learning guide

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# 1. Description

## 1.1. Subject details

| | |
|---|---|
| **Name of the subject** | 593000612 - Wireless Communications In Its |
| **No of credits** | 4.5 ECTS |
| **Type** | Optional |
| **Academic year ot the programme** | First year |
| **Semester of tuition** | Semester 2 |
| **Tuition period** | February-June |
| **Tuition languages** | English |
| **Degree programme** | 59AI - Master Universitario en Comunicaciones Inalámbricas |
| **Centre** | 59 - Escuela Tecnica Superior De Ingenieria Y Sistemas De Telecomunicacion |
| **Academic year** | 2022-23 |

# 2. Faculty

## 2.1. Faculty members with subject teaching role

| Name and surname | Office/Room | Email | Tutoring hours * |
|---|---|---|---|
| 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.

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# 3. Prior knowledge recommended to take the subject

## 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 *

## 4.1. Skills to be learned

CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio

CB8 - Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios

CEM11 - Comprender la utilidad de los sistemas inalÃ¡mbricos y sus ventajas en el desarrollo de sistemas de transporte inteligente.

CGI02 - Comprender el procedimiento, valor y límites del método científico, siendo capaz de identificar, localizar y obtener datos requeridos en un trabajo de investigación, de diseñar y guiar investigaciones analíticas, de modelado y experimentales, así como de evaluar datos de una manera crítica y extraer conclusiones.

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CGI03 - Valorar la importancia de las fuentes documentales, manejarlas y buscar la información para el desarrollo de cualquier trabajo de investigación.

CGI04 - Leer y comprender publicaciones dentro de su ámbito de estudio/investigación, así como su catalogación y valor científico.

UPM1 - Uso de la lengua inglesa

UPM4 - Organización y planificación /

## 4.2. Learning outcomes

RA4 - RA7 - To design and develop mobile applications which can collect data from the nearby environment and publish them in the cloud

RA50 - RA04 - Present and rigorously defend a work in written and oral form in English.

RA1 - CEM09 - .- Design and manufacture printed circuit boards for real wireless communication devices and carry out the proper assembly of the subsystems which are part of it.

RA2 - RA5 - To know what sensor types are present in a modern mobile terminal, together with their applicability in IoT environments

* 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

## 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.

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## 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. Tecnologies: 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 infoamation and operational systems

    3.3. High Speed Trains

        3.3.1. Signaling. ERTMS

        3.3.2. Communications: GSM-R

4. UNMMANED AERIAL VEHICLES

    4.1. General concepts

    4.2. Communications links

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4.3. Global Naviation 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.

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# 6. Schedule

## 6.1. Subject schedule*

| Week | Face-to-face classroom activities | Face-to-face laboratory activities | Distant / On-line | Assessment activities |
|---|---|---|---|---|
| 1 | **INTRODUCCION**<br>Duration: 03:00<br><br>**AUTOMOTIVE IN ITS**<br>Duration: 03:00 | | | |
| 2 | **AUTOMOTIVE IN ITS**<br>Duration: 03:00 | **LAB AUTOMOTIVE**<br>Duration: 02:00 | | **EVALUACION REALIZACION PRACTICA**<br><br>Continuous assessment and final examination<br>Presential<br>Duration: 01:00 |
| 3 | **RAILWAYS METRO**<br>Duration: 03:00 | **RAILWAYS METRO**<br>Duration: 02:00 | | **EVALUACION REALIZACION PRACTICA**<br><br>Continuous assessment and final examination<br>Presential<br>Duration: 01:00 |
| 4 | **RAILWAYS METRO**<br>Duration: 03:00<br><br>**RAILWAYS AVE**<br>Duration: 02:00 | | | **Examen parte 1.**<br><br>Continuous assessment and final examination<br>Presential<br>Duration: 01:00 |
| 5 | **RAYLWAYS AVE**<br>Duration: 04:00<br><br>**UAVS**<br>Duration: 02:00 | | | |
| 6 | **UAVs**<br>Duration: 04:00 | **UAVs**<br>Duration: 01:00 | | **EVALUACION REALIZACION PRACTICA**<br><br>Continuous assessment and final examination<br>Presential<br>Duration: 01:00 |
| 7 | **FUTURE ITS**<br>Duration: 04:00 | | | **PROYECTO DE ITS**<br><br>Continuous assessment and final examination<br>Presential<br>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.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

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# 7. Activities and assessment criteria

## 7.1. Assessment activities

### 7.1.1. Continuous assessment

| Week | Description | Modality | Type | Duration | Weight | Minimum grade | Evaluated skills |
|------|-------------|----------|------|----------|--------|---------------|------------------|
| 2 | EVALUACION REALIZACION PRACTICA | | Face-to-face | 01:00 | 10% | 4 / 10 | CGI02<br>CGI03<br>CB8<br>CGI04<br>CB7<br>CEM11 |
| 3 | EVALUACION REALIZACION PRACTICA | | Face-to-face | 01:00 | 10% | 4 / 10 | CGI02<br>CGI03<br>CB8<br>CGI04<br>CB7<br>CEM11 |
| 4 | Examen parte 1. | | Face-to-face | 01:00 | 50% | 4 / 10 | CB8<br>UPM1<br>UPM5<br>CGI04<br>CB6<br>CB7<br>CGI02<br>CGI03<br>UPM4<br>CEM11 |
| 6 | EVALUACION REALIZACION PRACTICA | | Face-to-face | 01:00 | 10% | 4 / 10 | CGI02<br>CGI03<br>CB8<br>CGI04<br>CB7<br>CEM11 |
| 7 | PROYECTO DE ITS | | Face-to-face | 02:00 | 20% | 5 / 10 | |

### 7.1.2. Final examination

| Week | Description | Modality | Type | Duration | Weight | Minimum grade | Evaluated skills |
|------|-------------|----------|------|----------|--------|---------------|------------------|

| 2 | EVALUACION REALIZACION PRACTICA | | Face-to-face | 01:00 | 10% | 4 / 10 | CGI02 CGI03 CB8 CGI04 CB7 CEM11 |
|---|---|---|---|---|---|---|---|
| 3 | EVALUACION REALIZACION PRACTICA | | Face-to-face | 01:00 | 10% | 4 / 10 | CGI02 CGI03 CB8 CGI04 CB7 CEM11 |
| 4 | Examen parte 1. | | Face-to-face | 01:00 | 50% | 4 / 10 | CB8 UPM1 UPM5 CGI04 CB6 CB7 CGI02 CGI03 UPM4 CEM11 |
| 6 | EVALUACION REALIZACION PRACTICA | | Face-to-face | 01:00 | 10% | 4 / 10 | CGI02 CGI03 CB8 CGI04 CB7 CEM11 |
| 7 | PROYECTO DE ITS | | Face-to-face | 02:00 | 20% | 5 / 10 | |

## 7.1.3. Referred (re-sit) examination

| Description | Modality | Type | Duration | Weight | Minimum grade | Evaluated skills |
|---|---|---|---|---|---|---|
| Examen Teoria final | | Face-to-face | 02:00 | 70% | 5 / 10 | CGI03 CB8 UPM1 UPM5 CGI04 CGI02 CB6 CB7 UPM4 CEM11 |
| Eamen de practicas | | Face-to-face | 01:00 | 30% | 5 / 10 | CGI02 CGI03 CB8 UPM1 UPM5 CGI04 CB6 CB7 |

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| | | | | | | | UPM4 |
|---|---|---|---|---|---|---|---|
| | | | | | | | CEM11 |

## 7.2. Assessment criteria

**Evaluación continua**

La evaluación continua se realizará mediante:

1) Un examen escrito para evaluar la primera parte de la asignatura que se realizará durante el curso. Este examen supone un 50% de la nota final. Para promediar, el alumno deberá alcanzar una nota mínima de 4 puntos sobre 10.

2) La realización de las prácticas de laboratorio. Este examen supone el 30% de la nota final. Para promediar, el alumno deberá alcanzar una nota mínima de 4 puntos sobre 10.

3) Un trabajo final de un proyecto para ITS. que supone el 20% de la nota. Para promediar es necesario obtener 5.0p

Para aprobar la asignatura se debe obtener una nota final mayor o igual que 5 sobre 10.

Si en aluna de las partes no se llega a la nota minima, la nota final será 4.0p.

**Evaluación por prueba final**

Se realizará realiza igual que la evaluación continua.

Para aprobar la asignatura se debe obtener una nota final mayor o igual que 5 sobre 10.

**Convocatoria extraordinaria**

Se realizará un examen teórico ampliado y un examen oral sobre las prácticas realizadas.

# 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 |
| https://www.seguridadaerea.gob.es/es/particulares/piloto-de-drones | Web resource | Pagina para UAVs |
| MATLAB | Web resource | programa para practicas |
| XIRIO online | Web resource | Progama para practicas |