ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

593000400 - Wireless Communications

DEGREE PROGRAMME

59AF - Master Univ. Ing. Sistemas Y Servicios Para La Sociedad De La Informacion

ACADEMIC YEAR & SEMESTER

2019/20 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	593000400 - Wireless Communications
No of credits	5 ECTS
Type	Compulsory
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	59AF - Master Univ. Ing. Sistemas Y Servicios Para La Sociedad De La Informacion
Centre	59 - Escuela Tecnica Superior de Ingenieria y Sistemas de Telecomunicacion
Academic year	2019-20

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Pedro Garcia Del Pino (Subject coordinator)	D8210	pedro.gdelpino@upm.es	Sin horario.
Jose Maria Rodriguez Martin	D8417	josemaria.rodriguez.martin@upm.es	Sin horario.

Antonio Perez Yuste	D8304	antonio.perez@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

3.1. Recommended (passed) subjects

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

3.2. Other recommended learning outcomes

- Digital communications: modulation, noise, coding, equalization

- Radio communication systems, especially mobile communications

- Basic knowledge about antennas and radiowave propagation

4. Skills and learning outcomes *

4.1. Skills to be learned

CB.06 - To have knowledge that provides the basis or the opportunity of being original to develop and/or to apply ideas, usually in a research context.

CB.07 - To be capable of applying the students' acquired knowledge, as well as their problem solving abilities, to new or not well-known environments in broader (or multidisciplinary) contexts that are in the framework of their expertise area.

CB.10 - To have the learning abilities to continue studying in a mostly self-guided or autonomous manner.

CE.07 - To be capable of proposing, organizing and executing research works in the framework of the Information Society engineering.

CEI.1 - To be capable of analyzing, interpreting and applying standards related to the ICT.

CESI.02 - To be capable of analyzing and synthesizing electronic circuits for communication systems.

CESI.1 - To be capable of characterizing, designing and deploying wireless communications systems and services.

CGEN.4 - To be capable of planning, calculating and designing systems and services for the Information Society.

4.2. Learning outcomes

RA2 - Evaluate communication standards typically used in the deployment of wireless systems

RA1 - Design radiating systems to deploy radio communication systems

RA6 - Characterize microstrip antennas

RA3 - Measure the main characteristics of wireless communications antennas

RA4 - Manage simulation and planning tools for the design of mobile communications

RA8 - Analyze and characterize mobile communication channels

RA5 - Design wireless communication systems

RA7 - Use propagation models to calculate radio coverage of a transmitter

* 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

The course gives the student the basic knowledge and skills to understand, characterize and analyze wireless communication systems. Some radiating systems typically employed in wireless communications are presented, analyzed and measured in the laboratory. There is a detail description of the propagation mechanisms affecting the radio channel, especially multipath fading, as well as radio access technologies currently used in wireless systems: multicarrier transmission, multi-antenna techniques and different radio-related procedures. The physical layer of two wireless communications standards, IEEE 802.11 for wireless LAN and Long Term Evolution for mobile communications, are studied in depth.

5.2. Syllabus

1. Introduction to wireless communication systems
   1.1. The wireless spectrum
   1.2. Structure of a wireless communication system
   1.3. Digital modulations
   1.4. The cellular concept
   1.5. Wireless communication standards
2. Radiating systems and propagation in wireless communications
   2.1. Fundamentals of antennas
   2.2. Linear, printed and active antennas
   2.3. Antennas for wireless and mobile systems
   2.4. Fundamentals of radiowave propagation applied to wireless communications
3. Radio access technologies
   3.1. The wireless channel environment
   3.2. Multipath fading
   3.3. Multicarrier transmission
   3.4. Multi-antenna techniques
   3.5. Radio-related procedures
4. Wireless Local Area Networks. IEEE 802.11
   4.1. Network architecture
   4.2. IEEE 802.11 family of standards
5. Long Term Evolution (LTE)
   5.1. General overview of 4G communications
   5.2. LTE channel models
   5.3. Physical layer
   5.4. Scheduling, link adaptation, multi-antenna techniques

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Other face-to-face activities	Assessment activities
1	**Unit 1. Introduction to wireless communication systems** Duration: 03:00			
2	**Unit 1. Introduction to wireless communication systems** Duration: 02:00 **Unit 2. Radiating systems** Duration: 01:00			
3	**Unit 2. Radiating systems** Duration: 01:00	**Measurement of antenna parameters** Duration: 02:00		
4	**Unit 2. Radiating systems** Duration: 02:00	**Antennas simulation** Duration: 01:00		**Antenna measurements. Exercises and laboratory report** Continuous assessment Duration: 03:00
5	**Unit 2. Fundamentals of radiowave propagation** Duration: 02:00	**Antennas simulation** Duration: 01:00		
6	**Unit 3. Radio-access technologies** Duration: 03:00			
7	**Unit 3. Radio-access technologies** Duration: 01:00	**Simulation of multipath fading channel** Duration: 02:00		
8	**Unit 3. Radio-access technologies** Duration: 03:00			**Multipath fading. Report on the activity** Continuous assessment Duration: 02:00
9	**Unit 3. Radio-access technologies** Duration: 01:30	**Simulation of multi-antenna techniques** Duration: 01:30		**Multi-Antenna Techniques. Report on the activity** Continuous assessment Duration: 02:00
10	**Unit 4. Wireless Local Area Networks (WLAN)** Duration: 03:00			

11	**Unit 4. Wireless Local Area Networks (WLAN)** Duration: 01:00	**Visualization of the physical layer of IEEE 802.11 in WinIQSIM 2** Duration: 02:00		**WiFI physical layer. Report on the activity** Continuous assessment Duration: 02:00
12	**Unit 5. LTE** Duration: 03:00			
13	**Unit 5. LTE** Duration: 01:00	**Visualization of the LTE physical layer in WinIQSIM2** Duration: 01:00 **LTE-Visualization Tool** Duration: 01:00		**LTE physical layer in WinIQSIM2. Report on the activity** Continuous assessment Duration: 01:00
14		**LTE propagation through a multipath fading channel** Duration: 01:00 **LTE Vienna Simulator** Duration: 02:00		**Vienna simulator. Report on the activity** Continuous assessment Duration: 02:00
15				
16				
17				**Written exam about the activities carried out during the course** Continuous assessment Duration: 03:00 **Final exam** Final examination Duration: 03:00

The independent study hours are training activities during which students should spend time on individual study or individual assignments.

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 subject schedule is based on a previous theorical planning of the subject plan and might go to through experience some unexpected changes along throughout the academic year.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
4	Antenna measurements. Exercises and laboratory report		Face-to-face	03:00	18%	5 / 10	CGEN.4 CESI.1 CESI.02
8	Multipath fading. Report on the activity		Face-to-face	02:00	8%	5 / 10	CEI.1 CGEN.4 CESI.1
9	Multi-Antenna Techniques. Report on the activity		Face-to-face	02:00	8%	5 / 10	CEI.1 CGEN.4 CESI.1
11	WiFI physical layer. Report on the activity		Face-to-face	02:00	8%	5 / 10	CEI.1 CGEN.4 CESI.1
13	LTE physical layer in WinIQSIM2. Report on the activity		Face-to-face	01:00	8%	5 / 10	CGEN.4 CEI.1 CESI.1
14	Vienna simulator. Report on the activity		Face-to-face	02:00	10%	5 / 10	CEI.1 CGEN.4 CESI.1
17	Written exam about the activities carried out during the course		Face-to-face	03:00	40%	5 / 10	CE.07 CEI.1 CB.07 CB.10 CB.06 CGEN.4 CESI.1

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final exam		Face-to-face	03:00	100%	5 / 10	CESI.02 CB.07 CB.10 CB.06 CGEN.4 CE.07 CEI.1 CESI.1

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

All students should perform the proposed activities and deliver the corresponding reports.

The weight of the activities on the final grade is 60%. There is a written exam about the activities carried out during the course, with a weight of 40%.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
E. Dahlman, S. Parkvall, J. Sköld and P. Beming. 4G: LTE/LTE-Advanced for Mobile Broadband	Bibliography	
C.A. Balanis. Antenna Theory: Analysis and Design	Bibliography	
K. Daniel Wong. Fundamentals of Wireless Communication Engineering Technologies	Bibliography	
K. Du, M. Swamy. Wireless Communication Systems	Bibliography	
M. Sauter. From GSM to LTE-Advanced: An Introduction to Mobile Networks and Mobile Broadband	Bibliography	
Rappaport. Wireless Communications. Principles and Practice	Bibliography	