



POLITÉCNICA

INTERNATIONAL
CAMPUS OF
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COORDINATION PROCESS OF
LEARNING ACTIVITIES
PR/CL/001



E.T.S. de Ingenieros de
Telecomunicacion

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000810 - Mobile communications

DEGREE PROGRAMME

09AQ - Master Universitario en Ingeniería de Telecomunicacion

ACADEMIC YEAR & SEMESTER

2017/18 - Semester 2

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1. Description

1.1. Subject details

Name of the subject	93000810 - Mobile communications
No of credits	6 ECTS
Type	Optional
Academic year of the programme	Second year
Semester of tuition	Semester 4
Tuition period	February-June
Tuition languages	English
Degree programme	09AQ - Master Universitario en Ingeniería de Telecomunicacion
Centre	Escuela Tecnica Superior de Ingenieros de Telecomunicacion
Academic year	2017-18

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Luis Mendo Tomas (Subject coordinator)	C-425	luis.mendo@upm.es	Th - 17:00 - 18:00 F - 11:00 - 13:00
Jose Manuel Riera Salis	C-430	jm.riera@upm.es	Tu - 17:00 - 18:00 W - 10:00 - 12:00

* 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

- Tecnologías de acceso radio

3.2. Other recommended learning outcomes

- Basic knowledge on signals and systems: undergraduate course Signals and Systems or equivalent
- Comunicaciones Móviles (undergraduate course) or equivalent. This Master's degree course is based on concepts taught in an undergraduate mobile communication course, which the student must already know: fundamentals and description of current systems
- Basic knowledge on probability theory: undergraduate course Señales Aleatorias or equivalent

4. Skills and learning outcomes *

4.1. Skills to be learned

CE2 - Capacidad para desarrollar sistemas de radiocomunicaciones: diseño de antenas, equipos y subsistemas, modelado de canales, cálculo de enlaces y planificación.

CE6 - Capacidad para modelar, diseñar, implantar, gestionar, operar, administrar y mantener redes, servicios y contenidos.

CG1 - 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.

CG5 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CT4 - Capacidad para trabajar de forma efectiva como individuo, organizando y planificando su propio trabajo, de forma independiente o como miembro de un equipo.

4.2. Learning outcomes

RA292 - To know the main techniques and methods used in radio planning of mobile communication systems

RA294 - To know the fundamentals of link-level and system-level simulators for mobile communication systems

RA293 - To know the general features of evolved-4G and future 5G systems

RA290 - To know how the radio interface of 2G, 3G and 4G mobile communication systems works

* 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 covers radio planning and simulation aspects of mobile communication systems. It is based on previous knowledge acquired in an undergraduate Mobile Communications course, namely fundamentals and description of current systems.

Second-, Third- and Fourth-generation networks are considered separately, as radio planning and simulation methods are different for each of those technologies.

5.2. Syllabus

1. Introduction
 - 1.1. Radio network planning. Simulation
 - 1.2. Approximate and detailed planning
2. GSM/GPRS radio network planning
 - 2.1. Overview of the radio interface
 - 2.2. Link budget
 - 2.3. Capacity
3. Simulation models for mobile communication systems
 - 3.1. Monte Carlo methods
 - 3.2. Multipath channel models
 - 3.3. Shadow fading models
4. UMTS radio network planning
 - 4.1. Overview of the radio interface
 - 4.2. Link-to-system level interface
 - 4.3. Capacity: analytical models
 - 4.4. Link budget
 - 4.5. System-level modelling of power control
 - 4.6. Link-level simulation. Power control
 - 4.7. System-level simulation
 - 4.8. Optimization of parameters
5. Radio planning of HSPA systems
 - 5.1. Overview of the radio interface
 - 5.2. HSDPA planning aspects
 - 5.3. HSUPA planning aspects
6. LTE/LTE-A radio network planning
 - 6.1. Overview of the radio interface
 - 6.2. Link budget

- 6.3. Capacity
- 6.4. Link-to-system level interface in OFDM
- 6.5. Link-level simulation
- 6.6. Link adaptation
- 6.7. System-level simulation
- 6.8. User scheduler
- 6.9. Frequency reuse techniques. Interference coordination
- 6.10. Optimization of parameters
- 7. Outlook of future 5G systems
 - 7.1. General features. Frequency bands
 - 7.2. Propagation in millimeter-wave bands
 - 7.3. Multiple access and modulation

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	Chapters 1 and 2 Duration: 04:00 Lecture			
2	Chapter 3 Duration: 04:00 Lecture			
3	Chapter 3 Duration: 04:00 Lecture			
4	Chapter 4 Duration: 04:00 Lecture			
5	Chapter 4 Duration: 04:00 Lecture			
6	Chapter 4 Duration: 04:00 Lecture			
7	Chapter 4 Duration: 04:00 Lecture			
8	Chapters 5 and 6 Duration: 04:00 Lecture			
9	Chapter 6 Duration: 04:00 Lecture			
10	Chapter 6 Duration: 04:00 Lecture			
11	Chapter 7 Duration: 04:00 Lecture			
12	Chapter 7 Duration: 02:00 Lecture			
13				Final essay. Hand-in and discussion with the professor Individual work Continuous assessment and final examination Duration: 02:00

14				Final essay. Presentation Individual presentation Continuous assessment and final examination Duration: 04:00
15				
16				
17				Exam Written test Continuous assessment and final examination Duration: 02:00

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 theoretical planning of the subject plan and might go 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
13	Final essay. Hand-in and discussion with the professor	Individual work	Face-to-face	02:00	30%	4 / 10	CG5 CE2 CT4 CG1 CE6
14	Final essay. Presentation	Individual presentation	Face-to-face	04:00	10%	4 / 10	CE2 CT4 CG1 CG5 CE6
17	Exam	Written test	Face-to-face	02:00	60%	4 / 10	CG5 CE2 CT4 CG1 CE6

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
13	Final essay. Hand-in and discussion with the professor	Individual work	Face-to-face	02:00	30%	4 / 10	CG5 CE2 CT4 CG1 CE6
14	Final essay. Presentation	Individual presentation	Face-to-face	04:00	10%	4 / 10	CE2 CT4 CG1 CG5 CE6
17	Exam	Written test	Face-to-face	02:00	60%	4 / 10	CG5 CE2 CT4 CG1 CE6

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Final essay. Hand-in and discussion with the professor	Individual work	Face-to-face	00:30	30%	4 / 10	CG5 CE2 CT4 CG1 CE6
Final essay. Presentation	Individual presentation	Face-to-face	00:30	10%	4 / 10	CG5 CE2 CT4 CG1 CE6
Exam	Written test	Face-to-face	02:00	60%	4 / 10	CG5 CE2 CT4 CG1 CE6

7.2. Assessment criteria

Students will be qualified through continuous evaluation by default. According to the Normativa de Evaluación del Aprendizaje de la Universidad Politécnica de Madrid, students willing to renounce to continuous evaluation must so indicate in written form, by a printed letter addressed to the course coordinator and presented at the school's office. This written communication must take place before 10 weeks after the beginning of the semester.

Evaluation will assess if students have acquired all the competences of the subject. Thus, evaluation through final assessment will be carried out considering all the evaluation techniques used in continuous evaluation (EX, ET, TG, etc.), and will be celebrated in the exam period approved by Junta de Escuela for the current academic semester and year. Evaluation activities that assess learning outcomes that cannot be evaluated through a single exam can be carried out along the semester.

Extraordinary examination will be carried out exclusively by the final assessment method.

Students will be graded through **continuous evaluation** by default. The final mark will be computed as follows:

- **30% final essay**
- **10% presentation of final essay**
- **60% exam**

The **minimum mark** in each of these three parts is **4** (out of 10).

For assessment via **final examination** or **extraordinary examination**, the final mark is computed using the same percentage weights as above. The minimum marks in each part are also the same.

The mark obtained in the final essay or in the presentation is maintained, if the student so wishes, up to the present year's extraordinary examination or the following year's examinations.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Chris Johnson. "Radio Access Networks for UMTS". John Wiley and sons, 2008.	Bibliography	
Jaana Laiho, Achim Wacker, Tomás Novosad. "Radio Network Planning and Optimization for UMTS". John Wiley and sons, second edition, 2006.	Bibliography	
D. Tse, P. Viswanath. "Fundamentals of Wireless Communication". Cambridge University Press, 2005.	Bibliography	
Erik Dahlman, Stefan Parkvall, Johan Sköld. "4G. LTE/LTE-Advanced for Mobile Broadband". Academic Press, second edition, 2014.	Bibliography	
Chris Johnson, "LTE in Bullets", second edition. 2012	Bibliography	
Stefania Sesia, Issam Toukik, Matthew Barker. "LTE. The UMTS Long Term Evolution. From Theory to Practice". John Wiley and sons, 2009.	Bibliography	
Artículos publicados en revistas especializadas, que serán proporcionados por el profesor	Bibliography	