



POLITÉCNICA

INTERNATIONAL
CAMPUS OF
EXCELLENCE

COORDINATION PROCESS OF
LEARNING ACTIVITIES
PR/CL/001



E.T.S. de Ingenieros de
Telecomunicacion

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000811 - Satellite communications

DEGREE PROGRAMME

09AQ - Master Universitario En Ingenieria De Telecomunicacion

ACADEMIC YEAR & SEMESTER

2018/19 - Semester 1

Index

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.....	9
8. Teaching resources.....	11
9. Other information.....	12

1. Description

1.1. Subject details

Name of the subject	93000811 - Satellite communications
No of credits	6 ECTS
Type	Optional
Academic year of the programme	Second year
Semester of tuition	Semester 3
Tuition period	September-January
Tuition languages	English
Degree programme	09AQ - Master universitario en ingenieria de telecomunicacion
Centre	09 - Escuela Tecnica Superior de Ingenieros de Telecomunicacion
Academic year	2018-19

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Ramon Martinez Rodriguez-Osorio (Subject coordinator)	C-411	ramon.martinez@upm.es	Sin horario. Ask for tutorships via e-mail.
Miguel Alejandro Salas Natera	C-411	miguel.salas@upm.es	Sin horario. Ask for tutorships via e-mail.

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

2.2. Research assistants

Name and surname	Email	Faculty member in charge
Ortiz Gomez, Flor De Guadalupe	fdg.ortiz@upm.es	Martinez Rodriguez-Osorio, Ramon

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

- Sistemas de comunicaciones

3.2. Other recommended learning outcomes

- Communication networks and systems
- Radiocommunication
- Communication electronics

4. Skills and learning outcomes *

4.1. Skills to be learned

CE1 - Capacidad para aplicar métodos de la teoría de la información, la modulación adaptativa y codificación de canal, así como técnicas avanzadas de procesamiento digital de señal a los sistemas de comunicaciones y audiovisuales.

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

CE4 - Capacidad para diseñar y dimensionar redes de transporte, difusión y distribución de señales multimedia.

CG4 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades.

CT2 - Capacidad para dinamizar y liderar equipos de trabajo multidisciplinares.

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

RA285 - Trade different alternatives of a satellite communication system considering orbits, performance, feasibility and cost

RA284 - Sizing of satellite communication systems

RA283 - Know satellite communication systems, including payload, platform, ground segment and communication services

RA288 - Get familiar with existing satellite communication systems and services, and global satellite navigation systems

RA289 - Elaborate technical reports and presentations to propose a feasible solution based on satellite communications

RA286 - Understand the impact of the satellite non-linear channel on the communication system performance

* 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 scope of this course is to provide a complete vision of satellite communication systems, from orbital used by artificial satellites to the optimization of satellite links. Beginning with the SatCom architecture, concepts related with orbits and constellations, satellite subsystems, communication payloads will be covered. Then, design and sizing of satellite communication links will be analyzed. Students will use all the concepts to carry out the design of a satellite communication system or the implementation of a specified service. Students will deal with advanced communication concepts, interference coordination and satellite link optimization. Course will cover GEO systems, as well as Medium and Low Earth satellites and constellations.

Different practical exercises and labs will be carried out along the course to consolidate the theoretical concepts, which will be related to existing systems.

In case it is feasible, a visit to a satellite control center or similar facility will be organized.

At the end of the course, students will have a clear understanding of the aspects that influence the design of a satellite communication system and will know to evaluate the fundamental trade-offs between satellite subsystems, communication payloads, ground segment, orbits and advanced transmissions concepts.

5.2. Syllabus

1. Introduction to satellite communication systems
2. Orbits and constellations used by artificial satellites
3. Architecture of satellite communication systems
 - 3.1. Platform and subsystems
 - 3.2. Communication payload. Transponder and antennas
4. Ground segment: control and user stations
 - 4.1. Ground station architecture and station types
 - 4.2. Antennas and radiofrequency elements
5. Communication techniques used in satellite communications
 - 5.1. DVB-S2 and DVB-S2x transmission systems
 - 5.2. Timing and carrier recovery techniques
 - 5.3. Techniques to improve capacity. Carrier-in-Carrier, etc.
 - 5.4. Techniques to improve availability
6. Design and optimization of satellite links
 - 6.1. Propagation
 - 6.2. Design and sizing of satellite links
 - 6.3. Interferences and coordination
 - 6.4. Optimization of satellite links
7. Satellite communication networking
8. Commercial satellite communication systems
 - 8.1. GEO systems. HTS and VHTS
 - 8.2. MEO systems and constellations
 - 8.3. LEO systems and constellations

9. Satellite navigation systems

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	<p>Course presentation. Introduction to SatCom systems Duration: 02:00 Lecture</p> <p>Orbits. Kepler laws. Ephemeris. Coordinate systems. Duration: 02:00 Lecture</p>			
2	<p>Orbits. Pointing and satellite coverage. Perturbations and launch systems. Duration: 02:00 Lecture</p> <p>Orbits and constellations used by artificial satellites Duration: 01:30 Lecture</p> <p>Presentation of work in group topics Duration: 00:30 Additional activities</p>			
3	<p>Architecture of satellite communication systems Duration: 02:00 Lecture</p> <p>Architecture of satellite communication systems Duration: 01:00 Lecture</p> <p>Architecture of satellite communication systems Duration: 01:00 Problem-solving class</p>			
4	<p>Ground segment Duration: 02:00 Lecture</p> <p>Ground segment Duration: 01:00 Lecture</p> <p>Ground segment Duration: 01:00 Problem-solving class</p>		<p>Work in group organization Duration: 00:30 Cooperative activities</p>	

5	<p>Communication techniques used in satellite communications Duration: 02:00 Lecture</p>	<p>Lab: Mission analysis applied to a SatCom system Duration: 03:00 Laboratory assignments</p>		
6	<p>Communication techniques used in satellite communications Duration: 01:30 Lecture</p> <p>Communication techniques used in satellite communications Duration: 01:30 Problem-solving class</p>			<p>Lab manuals and/or proposed exercises Individual work Continuous assessment Duration: 00:30</p>
7	<p>Design and optimization of satellite links Duration: 02:00 Lecture</p> <p>Design and optimization of satellite links Duration: 02:00 Lecture</p>		<p>Work in groups. Progress presentation (1/2) Duration: 00:30 Cooperative activities</p>	
8	<p>Design and optimization of satellite links Duration: 02:00 Problem-solving class</p>		<p>Sizing of a satellite communication system Duration: 02:00 Cooperative activities</p>	
9	<p>Satellite communication networking Duration: 02:00 Lecture</p> <p>Satellite communication networking Duration: 02:00 Lecture</p>			
10	<p>Commercial systems. GEO. HTS and VHVS Duration: 02:00 Lecture</p>		<p>Work in groups Duration: 02:00 Cooperative activities</p> <p>Work in groups. Progress presentation (2/2) Duration: 00:30 Cooperative activities</p>	
11	<p>Commercial systems. MEO, LEO and Big LEO Duration: 02:00 Lecture</p>		<p>Work in groups Duration: 02:00 Cooperative activities</p> <p>Work in groups Duration: 02:00 Cooperative activities</p>	
12			<p>Visit to SatCom facility (if feasible) Duration: 04:00 Additional activities</p> <p>Work in groups Duration: 02:00 Cooperative activities</p>	<p>Lab manuals and/or proposed exercises Individual work Continuous assessment Duration: 00:30</p> <p>Lab manuals and/or proposed exercises Individual work Final examination Duration: 00:30</p>

13	Satellite Navigation Systems Duration: 02:00 Lecture		Work in groups. Preparation of oral presentation Duration: 02:00 Additional activities	
14				Work in Group Group work Continuous assessment Duration: 02:00 Work in Group Group work Final examination Duration: 02:00
15				
16				
17				Exam. Theory and Case study exercise Written test Continuous assessment Duration: 03:00 Exam. Theory and Case study exercise Written test 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 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
6	Lab manuals and/or proposed exercises	Individual work	No Presential	00:30	10%	3 / 10	CT4 CE2
12	Lab manuals and/or proposed exercises	Individual work	No Presential	00:30	10%	3 / 10	CT4 CE2
14	Work in Group	Group work	Face-to-face	02:00	50%	3 / 10	CG4 CT2 CT4
17	Exam. Theory and Case study exercise	Written test	Face-to-face	03:00	30%	3 / 10	CE1 CE2 CE4

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
12	Lab manuals and/or proposed exercises	Individual work	No Presential	00:30	20%	3 / 10	CT4 CE2
14	Work in Group	Group work	Face-to-face	02:00	50%	3 / 10	CG4 CT2 CT4
17	Exam. Theory and Case study exercise	Written test	Face-to-face	03:00	30%	3 / 10	CE1 CE2 CE4

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Exam	Written test	Face-to-face	03:00	50%	3 / 10	CE1 CE2 CE4

Work in Group/Individual homeworks	Group work	Face-to-face	00:00	50%	0 / 10	CG4 CT2 CT4
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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 complete the Moodle task entitled "Renounce to continuous evaluation" before week number 6 (deadline will be announced in Moodle).

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, TI, and TG). EX 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 as TI and TG will be carried out along the semester.

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

ORDINARY EXAMINATION

Evaluation in the ordinary period (both continuous and by final examination) will consist on the following items:

1. Individual homework. Submission of homeworks along the course and completion of the laboratory manual. Laboratory manual can be substituted by individual exercises with mandatory submission in case the laboratory session cannot be carried out. (20%)
2. Work in group. Intermediate reviews will be performed along the course with potential presentation in class (in English). Each group will carry out a final presentation in class. Organization, oral presentation, technical documentation and results will be evaluated. (50%)
3. Exam. Theory and case study exercise. (30%)

Work in group will consist in the analysis and/or design of a particular satellite communication system to provide a specific communication service (e.g. broadband access in Europe, application of big LEO constellations for low latency Internet service, in-flight connectivity) or a particular process (e.g. evaluation of ACM strategies in DVB-S2

systems, impact of intermodulation in channel quality). Progress meetings will be held along the course or when required by students. Work in group will include the realization of simulations, submission of technical report and public presentation.

EXTRAORDINARY EXAMINATION

Final qualification in the extraordinary examination will be composed of:

1. Exam. Theory and case study exercise. (50%)
2. Work in Group/Individual homeworks (50%). Qualification of the work in group in the ordinary evaluation will be kept in the academic year. Work in group can be substituted by an individual homework depending on the number of students involved in the extraordinary examination.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Satellite Communications Systems: Systems, Techniques and Technology, 5th Edition, Gerard Maral, Michel Bousquet, Zhili Sun, Wiley, 2009.	Bibliography	SatCom book
Comunicaciones por Satélite, Miguel Calvo, Ramón Martínez, Antonio García, ETSIT-UPM, 2005.	Bibliography	SatCom manual
Moodle site of the course	Web resource	Moodle site
Satellite Communications, 4th. Ed., Dennis Roddy, McGraw Hill, 2006.	Bibliography	SatCom book

ITU Handbook on Satellite Communications, 3rd. Ed., Wiley, 2002.	Bibliography	ITU SatCom manual
ITU recommendations for propagation calculations	Web resource	
System Toolkit	Equipment	Mission analysis software available at www.agi.com (evaluation version)
Journal papers	Others	International Journal of Satellite Communications and Networking, Via Satellite, etc.
Satellite Communications Payload and System, T. M. Braun, Wiley, 2012.	Bibliography	SatCom payload book

9. Other information

9.1. Other information about the subject

Realization of the mission analysis laboratory sessions is conditioned to the availability of System Toolkit (STK) software licenses. Thus, lab sessions might change the date, might be modified or could be substituted by individual exercises or homeworks with the same working hours.

The visit to the Satellite Control Center depends on the availability of the center and its personnel. Exact dates will be announced when confirmed.