



IDENTIFYING DATA

Communication Advanced Systems

Subject	Communication Advanced Systems			
Code	V05M145V01302			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	English			
Department				
Coordinator	Mosquera Nartallo, Carlos			
Lecturers	Gómez Cuba, Felipe Mosquera Nartallo, Carlos			
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General description	This course covers the application of advanced mathematical tools to address some challenges in new and emerging satellite and terrestrial communication systems, with special emphasis on lower layers and multiuser systems.			

Training and Learning Results

Code	
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
C22	CE22/PS2 Ability to understand the impact of the requirements of the telecommunications systems design services, with special emphasis in the lower layers, while maintaining a global vision of the solutions employed in modern commercial systems of communications.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Understand the impact of telecommunication services requirements on system design, with special emphasis on lower layers.	B4 C22
Acquire a global view of the solutions developed for modern commercial communication systems.	B4 C22

Contents

Topic	
1. Convex optimization	1.1 Basic concepts of convex sets 1.2 Introduction to convex functions 1.3 Quasiconvex functions 1.4 Convex optimization problems 1.5 Duality 1.6 Introduction to non-convex problems 1.7 Practical examples in communications

2. Multi-user fundamentals

- 2.1 Fundamentals of information theory for multi-user systems, regions of capacity.
- 2.2 Multiple access channel: rate region, orthogonal and non-orthogonal allocations. Multi-user detection.
- 2.3 Broadcast channel: rate region, orthogonal assignments, linear precoding and Dirty Paper Coding techniques.
- 2.4 Network modeling: Interfering Channel and Relay Channel. Interference management and performance.
- 2.5 Networks and multiple access: planned systems and contention systems. Limitations of IoT systems. Hybrid retransmission.
- 2.6 Spectrum and interference management. Spectral sensing, cognitive radio, and virtualization.
- 2.7 Applications in current standards

Planning

	Class hours	Hours outside the classroom	Total hours
Seminars	6	15	21
Lecturing	24	53	77
Problem solving	0	12	12
Problem solving	0	13	13
Problem and/or exercise solving	0	2	2

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Seminars	Different communication systems will be presented with special emphasis on those challenges which are at the core of modern solutions and require advanced mathematical tools. Skills CG4 and CE22 are developed here.
Lecturing	Advanced mathematical tools will be introduced as background material to address practical solutions in modern communication systems. Skills CG4 and CE22 are developed here.
Problem solving	1. Convex optimization. Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis, Matlab-based software tools or both. Skills CG4 and CE22 are developed here.
Problem solving	2. Multi-user fundamentals. Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis, Matlab-based software tools or both. Skills CG4 and CE22 are developed here.

Personalized assistance

Methodologies Description

Lecturing	Student support will be provided during office hours and by e-mail. For contact information, see https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo .
Seminars	Student support will be provided during office hours and by e-mail. For contact information, see https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo
Problem solving	Student support will be provided during office hours and by e-mail. For contact information, see https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo
Problem solving	Student support will be provided during office hours and by e-mail. For contact information, see https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo

Assessment

	Description	Qualification	Training and Learning Results
Problem solving	1. Convex optimization. Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis, software tools or both. If the solution is not turned in within the allocated deadline, the corresponding assignment will not be graded.	30	B4 C22
Problem solving	2. Multi-user fundamentals. Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis, software tools or both. If the solution is not turned in within the allocated deadline, the corresponding assignment will not be graded.	30	B4 C22

Other comments on the Evaluation

The students need to obtain 50 out of 100 points to pass the course. In addition, a minimum grade of 30% is required in the final exam; if this grade is not achieved, his/her global score will be obtained using the formula: $\min(0.6 \cdot \text{REP} + 0.4 \cdot \text{TEST}, 4.9)$, where REP is the score achieved in the reports and TEST is the score achieved in the final exam. This applies also to the extra call.

The grades obtained from the weekly assignments are only valid for the current academic year, and cannot be redone after the corresponding deadline. A student can decide to opt out the evaluation of the weekly assignments; in such a case, his/her final score will be fully based on the final exam. This applies also to the extra call. Once the student turns in any of the deliverables, he/she will be considered to be following the continuous evaluation track if he/she does not say otherwise within one month from the beginning of the course.

Any student that chooses the continuous evaluation track will get a final score, regardless of her/his taking the final exam.

All the homeworks and exam will be given in English.

Sources of information

Basic Bibliography

Stephen Boyd, Lieven Vandenberghe, **Convex Optimization**, Cambridge University Press, 2004

Carlos Mosquera, **Class notes**, 2020

David Tse, Pramod Viswanath, **Fundamentals of Wireless Communication**, Cambridge University Press, 2005

Complementary Bibliography

Dimitri P. Bertsekas, **Convex Optimization Theory**, Athena Scientific, 2009

David G. Luenberger, Yinyu Ye, **Linear and Nonlinear Programming**, Fourth, Springer, 2016

Thomas Cover and Joy Thomas, **Elements of Information Theory**, Second, Wiley, 2006

Recommendations

Subjects that it is recommended to have taken before

Data Communication/V05M145V01204

Signal Processing in Communications/V05M145V01102

Other comments

Attendance to physical classes is mandatory. If a minimum 80% attendance is not fulfilled, the grade will be entirely based on the final exam.