Universida_de_Vigo

IDENTIFYING DATA
Data Communication

Subject	Data Communication
Code	V05M145V01204
Study programme	Máster Universitario en Ingeniería de Telecomunicación

Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd

Teaching language	English
Department	
Coordinator	Mosquera Nartallo, Carlos
Lecturers	Gómez Cuba, Felipe Mosquera Nartallo, Carlos
E-mail	mosquera@gts.uvigo.es
Web	http://moovi.uvigo.gal
General description	This course presents advanced topics in digital communications with emphasis on modulations, coding and detection. The covered techniques are part of the state of the art in digital communications, and comprise novel aspects as MIMO systems and advanced waveforms. Contents, teaching and exams are in English. Students may participate in classes and answer to exams preferably in English, but Spanish and Galician are also accepted.

Training and Learning Results

Code	
B1	CG1 Ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
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.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C1	CE1 Ability to apply methods of information theory, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing systems and audiovisual communications.
C2	CE2 Ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.
C3	CE3 Ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Handle the mathematical tools needed to model, simulate and evaluate moderns communication systems.	B1 B4 C1 C2 C3
Solve problems whose solution does not derive from the application of a standardized procedure.	B1 B4 B8 C1 C2 C3

Understand the principles underlying modern communication standards.	B1 B4 B8 C1 C2 C3
Design transmitters, receivers and measurement equipment for modern communication systems.	B1 B4 B8 C1 C2 C3

Contents

Topic	
1. MIMO communications	1.1 Equivalent discrete channel, multipath and modulation with MIMO and OFDM. MIMO channel and signal models. Statistical characterization. Random fading vs. explicit multipath. 1.2 Constant MIMO channel capacity, with and without CSIT. Ergodic capacity and outage capacity of random MIMO channel. 1.3 Spatial multiplexing. Principles of design of detectors in various dimensions. 1.4 SIMO detectors and MISO beamforming with CSIT. Array gain. Effect of fading on BER and outage. Diversity vs. multiplexing trade-off. 1.5 Principles of transmission with limited CSIT. Time-frequency diversity. ST codes. Limited feedback beamforming.
2. Advanced modulations	2.1 Filtered OFDM 2.2 FBMC 2.3 Beyond multicarrier modulations

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	14	29.4	43.4
Lecturing	14	57.6	71.6
Objective questions exam	2	0	2
Problem and/or exercise solving	0	4	4
Problem and/or exercise solving	0	4	4

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

Methodologies

	Description
Laboratory practical	Lab practices will cover different aspects of multiple-input multiple-output (MIMO) communications. This will allow students to practically implement and considerably expand some of the concepts seen in the lectures. Matlab will be used for simulation purposes. Competences: CG1, CG4, CE1, CE2, CE3
Lecturing	The course is structured in several advanced topics in digital communications with emphasis on multiple-input multiple-output (MIMO) communications. Competences: CG1, CG4, CG8, CE1, CE2, CE3

Personalized assistance

Methodologies	Description
Lecturing	The instructors will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered in presential form (during the master session, or during the office hours). Office hours will be given at the beginning of the course and published in the subject's webpage: for contact information, see https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo.

Tests	Description
Problem and/or exercise solving	The instructors will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered in presential form (during the work review sessions or during the office hours).

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Problem and/or exercise solving	

Assessment

	Description	Qualification	Training and Learning Results	
Objective questions exam	Final exam with short questions and exercises.	40	B1 B4 B8	C1 C2 C3
Problem and/or exercise solving	Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis. If the solution is not turned in within the allocated deadline, the corresponding assignment will not be graded.	30	B1 B4 B8	C1 C2 C3
Problem and/or exercise solving	Every week a homework challenge will be proposed to be solved with the aid of software tools. If the solution is not turned in within the allocated deadline, the corresponding assignment will not be graded.	30	B1 B4 B8	C1 C2 C3

Other comments on the Evaluation

A minimum score of 35% with respect to the maximum possible score in the final exam is required to pass the course.

In those cases in which the student decides not to carry out the continuous evaluation tasks, the final score will be solely based on the exam with questions of the subject. This also applies to the extra call.

In case the student does not achieve the minimum score in the final written exam, his/her global score will be obtained using the formula: $\min(0.6*REP+0.4*TEST,4.9)$, where REP is the score achieved in the reports and TEST is the score achieved in the final exam.

In case of collective reports, the respective contribution of each student must be clearly stated, and the final score will be personalized as a function of such contribution. An interview with the lecturer may be required in order to assess the individual contributions.

Once the student turns in any of the deliverables, he/she will be considered to be following the continuous evaluation track, unless informed 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 whether he/she takes the final exam.

Continuous evaluation tasks cannot be redone after their corresponding deadlines, and are only valid for the current year.

Sources of information
Basic Bibliography
Jerry Hampton, **Introduction to MIMO Communications**, First, Cambridge University Press, 2013

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

Robert W. Heath Jr. and Angel Lozano, **Foundations of MIMO Communication**, First, Cambridge University Press, 2018

A. Artés, F. Pérez-González, J. Cid, R. López, C. Mosquera, F. Pérez-Cruz, **Principios de comunicaciones digitales**, Versión electrónica, Prentice-Hall, 2012

Complementary Bibliography

Recommendations

Subjects that it is recommended to have taken before
Signal Processing in Communications/V05M145V01102