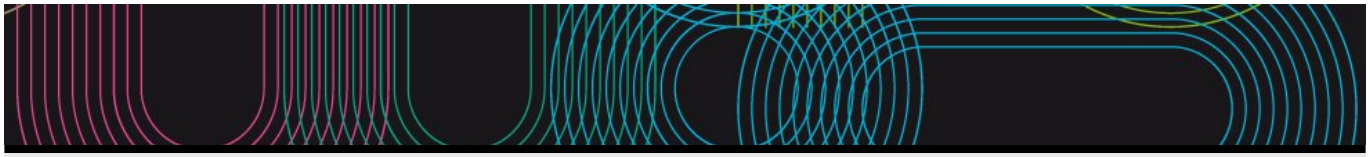

IDENTIFYING DATA				
Digital Communications				
Subject	Digital Communications			
Code	V05G300V01914			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Pérez González, Fernando			
Lecturers	Mosquera Nartallo, Carlos Pérez González, Fernando			
E-mail	fperez@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course covers the fundamentals of modulations that are used in practically all modern communication standards, including digital terrestrial television, WiFi, fourth-generation mobile communications (LTE), digital radio, visible light communications (LiFi). 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.			

Competencies	
Code	
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
B9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.
B12	CG12 The development of discussion ability about technical subjects
C71	(CE71/OP14) The ability to analyze the physical layer in modern digital communications systems.
D2	CT2 Understanding Engineering within a framework of sustainable development.
D4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Acquire the intuition and needed math skills to understand the role played by diversity in improving the provision of communication systems.	B4 B9 B12	C71	D2
Develop the capability of analyzing the physical layer of current telecommunication systems.	B4 B9 B12	C71	D2
Handle the necessary tools to understand the different aspects of the physical layer of communications system a system and put them to practice when it comes to simulating, designing or dimensioning.	B4 B9 B12	C71	D2
Strengthen the capacity to follow a technical class in English.	B9 B12	C71	D4

Contents

Topic	
Subject 1: Multicarrier modulations	1.Introduction. 2 Analog and digital OFDM modulations 3 Diagram of an OFDM transmitter. 4 Effect of the channel on the received signal. 5 Diagram of an OFDM receiver. 6 OFDM seen as a block process.
Subject 2: Equalization, coding and synchronization in multicarrier modulations.	1. Pilot carriers. 2 ZF and MMSE equalization. 3 Zero-padding methods. 4 Coded OFDM (COFDM). 5 Carrier synchronization algorithms. 6 Timing recovery algorithms. 7 Channel state information estimation.
Subject 3: Applications	1 Digital Radio/TV standards. 2 OFDM wireless communications standards. 3 OFDM wire communications standards.
Subject 4: Advanced digital communications.	1 MIMO ystems. 2 Advanced coding: turbo and LDPC codes. 3 Spread-spectrum systems. 4 Generalized multicarrier systems.

Planning

	Class hours	Hours outside the classroom	Total hours
Troubleshooting and / or exercises	6	6	12
Laboratory practises	12	24	36
Master Session	21	40	61
Short answer tests	2	10	12
Reports / memories of practice	0	14	14
Jobs and projects	1	14	15

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

Methodologies

	Description
Troubleshooting and / or exercises	Each subject will be complemented with exercises. Previous work by the students on the exercises will be required. Competences: CG4, CG9, CG12, CE71, CT2, CT4
Laboratory practises	Lab practices will consist in the demodulation of Digital Radio Mondiale (DRM) signals. This will allow students to practically implement some of the concepts seen in the lectures: OFDM, demodulations, synch recovery,... Competences: CG4, CG9, CG12, CE71, CT2, CT4
Master Session	The course is structured in four main subjects that revolve around the concept of multicarrier modulations. Each subject will be taught through lectures in the classroom. Competences: CG4, CG9, CG12, CE71, CT2, CT4

Personalized attention

Methodologies	**Description**
Master Session	The teachers will provide individualized and personalized attention to students during the course, soving 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.
Troubleshooting and / or exercises	The teachers will provide individualized and personalized attention to students during the course, soving their doubts and questions. Doubts will be answered in presential form (during the work sessions or during the office hours).
Tests	**Description**
Reports / memories of practice	The teachers will provide individualized and personalized attention to students during the course, soving their doubts and questions. Doubts will be answered in presential form (during the office hours). Office hours will be given at the beginning of the course and published in the subject's webpage.

Jobs and projects	The teachers will provide individualized and personalized attention to students during the course, soving their doubts and questions. Doubts will be answered in presential form (during the office hours). Office hours will be given at the beginning of the course and published in the subject's webpage.

Assessment

	Description	Qualification	Training and Learning Results		
Short answer tests	Final exam with short questions on the contents of the subject, that will include also some questions on the projects. Evaluated competences: CG4, CG9, CG12, CE71, CT2.	20	B4 B9 B12	C71	D2
Reports / memories of practice	Deliverables for the lab project. 50% of the final grade corresponds to tasks associated to a lab project. Along the course there will be six milestones, corresponding to each of the stages for the Matlab implementation of a simplified OFDM receiver. The weight given to each of these tasks is the following: Task 1 (Demodulation to baseband): 5% Task 2 (Mode detection and temporal allignment): 5% Task 3 (Frequency error correction): 10% Task 4 (Frame synchronization): 10% Task 5 (Channel estimation and equalization - I): 10% Task 6 (Channel estimation and equalization - II): 10% Evaluated competences: CG4, CG9, CG12, CE71, CT2, CT4.	50	B4 B9 B12	C71	D2 D4
Jobs and projects	Projects on any of the digital communication standards that employ the techniques presented in the classroom. Possible topics include: - Digital radio (DAB, DAB+, DRM) - Digital terrestrial television (DVB-T, DVB-H, DVB-T2) - LAN and MAN wireless networks. - ADSL and VDSL - Comunicaciones over PLC and multimedia over coax (MoCA) - LTE - LiFi The project must focus on those aspects of the standards that are related to the subjects covered by the lectures and should consider the following issues: - Historical aspects: previous standards solving similar problems. - Technical aspects: details about the employed modulation, bandwidth, channel coding, etc. - Applications of the standard. - Deployment degree at national and international levels. Evaluated competences: CG4, CG9, CE71, CT2.	30	B4 B9	C71	D2

Other comments on the Evaluation

In those cases in where the student decides not to carry out the continuous evaluation tasks, the final score will be solely based on the exam with short questions of the subject. This applies as well to the second call.

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. Any student that chooses the continuous evaluation track will get a final score, regardless of 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

Complementary Bibliography

Ye Li, G.L. Stuber, **Orthogonal Frequency Division Multiplexing for Wireless Communications**, Springer-Verlag,

J.R. Barry, E.A. Lee, D.G. Messerschmitt, **Digital Communication**, Kluwer,

M. Engels, Ed, **Wireless OFDM Systems. How to make them work?**, Springer-Verlag,

Antonio Artés, Fernando Pérez González, Carlos Mosquera et al., **Comunicaciones Digitales**, Pearson,

Recommendations

Subjects that it is recommended to have taken before

Principles of Digital Communications/V05G300V01613