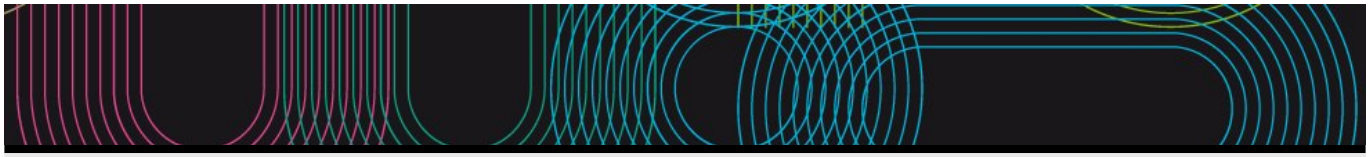

IDENTIFYING DATA				
Digital Communications				
Subject	Digital Communications			
Code	V05G306V01414			
Study programme	Grado en Ingeniería de Tecnologías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Pérez González, Fernando			
Lecturers	Mosquera Nartallo, Carlos Pérez González, Fernando			
E-mail	fperez@gts.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This course covers the fundamentals of modulations that are used in practically all modern communication standards, including digital terrestrial television, WiFi, 4G and 5G mobile communications, 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.			

Training and Learning Results	
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.

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
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
Develop the capability of analyzing the physical layer of current telecommunication systems.	B4 B9 B12	C71	D2
Strengthen the capacity to follow a technical class in English.	B4 B9 B12		D4

Contents

Topic	
Subject 1: Multicarrier modulations (theoretical-practical contents).	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 (theoretical-practical contents).	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: Advanced digital communications (theoretical-practical contents).	1 Convolucional coding. 2 Trellis coding. 3 Advanced channel coding: turbo and LDPC codes.
Subject 4: Applications (practical contents).	1 Digital Radio/TV standards. 2 OFDM wireless communications standards. 3 OFDM cable communications standards. 4 OFDM in visible light communications.

Planning			
	Class hours	Hours outside the classroom	Total hours
Laboratory practical	14	57.6	71.6
Mentored work	7	0	7
Lecturing	19	21.6	40.6
Problem and/or exercise solving	2	0	2
Report of practices, practicum and external practices	0	11.5	11.5
Report of practices, practicum and external practices	0	2.9	2.9
Essay	0	14.4	14.4
*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 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,...
Mentored work	Guided work with design considerations for a practical system based on OFDM.
Lecturing	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.

Personalized assistance	
Methodologies	**Description**
Lecturing	The teachers will provide individualized and personalized attention to students during the course, soving their doubts and questions. Doubts will be answered 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. Contact: https://www.uvigo.gal/es/universidad/administracion-personal/pdi/fernando-perez-gonzalez https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo
Laboratory practical	The teachers will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered during the office hours. Office hours will be given at the beginning of the course and published in the subject's webpage. Contact: https://www.uvigo.gal/es/universidad/administracion-personal/pdi/fernando-perez-gonzalez https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo
Mentored work	The teachers will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered during the office hours. Office hours will be given at the beginning of the course and published in the subject's webpage. Contact: https://www.uvigo.gal/es/universidad/administracion-personal/pdi/fernando-perez-gonzalez https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo
Tests	**Description**

Report of practices, practicum and external practices	The teachers will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered during the office hours. Office hours will be given at the beginning of the course and published in the subject's webpage. Contact: https://www.uvigo.gal/es/universidad/administracion-personal/pdi/fernando-perez-gonzalez https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo
Essay	The teachers will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered during the office hours. Office hours will be given at the beginning of the course and published in the subject's webpage. Contact: https://www.uvigo.gal/es/universidad/administracion-personal/pdi/fernando-perez-gonzalez https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo
Report of practices, practicum and external practices	

Assessment

	Description	Qualification	Training and Learning Results		
Problem and/or exercise solving	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
Report of practices, practicum and external practices	Deliverables for the lab project. Tasks corresponding to a lab project. Deliverables correspond 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%	40	B4 B9 B12	C71	D2 D4
Report of practices, practicum and external practices	Deliverables for the lab project. Implementation in Matlab of a task corresponding to a simplified OFDM receiver. Task 6 (Channel estimation and equalization - II): 10%	10	B4 B9 B12	C71	D2 D4
Essay	Short report related to one of the digital communications standards/systems that employ the techniques seen in the lectures. The report will consist of the answers to a list of questions that will be handed at the beginning of the course, related to practical design aspects of a digital communications system using OFDM. Evaluated competences: CG4, CG9, CE71, CT2.	30	B4 B9	C71	D2

Other comments on the Evaluation

In those cases where the student decides not to take part in the continuous assessment tests, the grade for the short-answer exam covering the course content will account for 100% of the final grade.

The student follows the continuous assessment from the moment they submit their first assignment for the course. In any case, they may opt out of continuous assessment within one month. A student who chooses continuous assessment is considered to have taken the course, regardless of whether they sit for the final exam.

For group reports, each student's contribution must be explicitly stated, and assessment will be individualized based on that contribution. The professor may conduct interviews to determine individual contributions.

Continuous assessment tasks cannot be retaken and are only valid for the current academic year.

The grades from continuous assessment tests are retained for the extraordinary exam. For the end of program evaluation, assessment will consist solely of a written exam.

In cases of plagiarism or widespread use of AI tools in any of the assignments/tests, the final grade for the course will be a fail (0), and the professors will report the matter to the school's administration to take appropriate actions. Furthermore, professors will inform the school's administration of any unethical conduct by students, with the possibility of the administration taking necessary measures.

Sources of information

Basic Bibliography

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,

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,

Recommendations