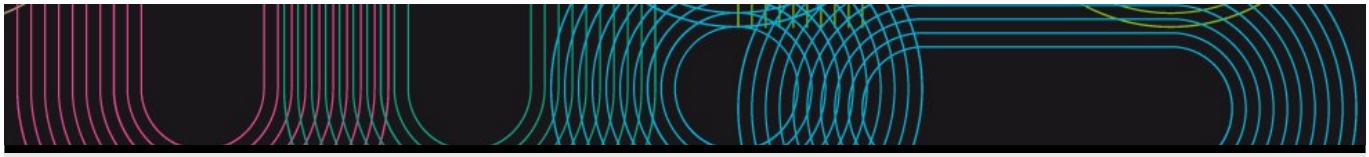

IDENTIFYING DATA

Principles of Digital Communications

Subject	Principles of Digital Communications			
Code	V05G301V01324			
Study programme	Grado en Ingeniería de Tecnologías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Comesaña Alfaro, Pedro			
Lecturers	Comesaña Alfaro, Pedro Pérez González, Fernando			
E-mail	pcomesan@gts.uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	The basic aims of the subject are the following: - Apply optimisation criteria for the realisation of diagrams of estimate and synchronisation in digital receptors of communications. - Differentiate the blocks and the functionalities of a data transmission system. - Use digital signal processing to transmit and receive analog waveforms. - Apply the basic mechanisms of reduction of the impact of noise in a communications system. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
B3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
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.
B11	CG11 To approach a new problem considering first the essential and then the secondary aspects
C26	CE26/ST6 The ability to analyze, codify, process and transmit multimedia information using analogical and digital signal processing techniques.
D2	CT2 Understanding Engineering within a framework of sustainable development.
D3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Expected results from this subject

Expected results from this subject	Training and Learning Results		
Apply criteria of optimisation for the realisation of diagrams of estimate and synchronisation in digital receptors of communications	B3	C26	
Differentiate the blocks and the functionalities of a system of transmission of complex data	B11	C26	D2
Use the processed digital of signals to transmit and receive forms of analog wave	B3 B4		D3
Apply the basic mechanisms of reduction of the impact of noise in a system of communications		C26	D2

Contents

Topic

1. Introduction to digital communications	- Historical evolution of wireless communication systems. - Basic blocks of a digital communications system. - Review of impairments in a communications channel. - Introduction to the course.
2. Discrete equivalent channel and Nyquist pulses	- Baseband equivalent channel. - Discrete equivalent channel. - Nyquist pulses. - Square root raised cosine pulses. - Application and implementation of Nyquist pulses. - Introduction to polyphase structures.
3. Symbol synchronization	- Motivation. - Phase Locked Loops (PLL). - PLLs and steepest descent. - Maximum output energy criterion. - Interpolation-based symbol synchronization. - Adaptive symbol synchronization.
4. Frame synchronization	- Review of Least Squares (LS) estimation. - Motivation for frame synchronization. - Data-aided frame synchronization. - Design of training sequences.
5. Phase and carrier recovery	- Decision-directed phase recovery. - Non-decision-directed phase recovery. - Motivation for carrier recovery. - Coarse carrier synchronization. - Fine carrier synchronization.
6. Estimation and equalization in flat channels	- Maximum likelihood detection. - Equalization through estimation. - Direct equalization. - Adaptive equalization. - The LMS algorithm.
7. Frequency selective channel equalization	- Multipath, bandwidth and frequency selectivity. - Zero-forcing equalization. - Least squares equalizer. - LMS algorithm derivation for selective channels. - Unconstrained equalizers.
8. Introduction to advanced digital communications.	- Principles of OFDM. - Introduction to MIMO systems.
Theoretical-practical contents.	The contents of chapters 2 to 7 are considered both at theoretical lectures and practical sessions.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	19	28.5	47.5
Problem solving	2	8.5	10.5
Project based learning	7	35	42
Laboratory practical	12	36	48
Problem and/or exercise solving	2	0	2

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

Methodologies

	Description
Lecturing	Presentation and discussion of the fundamental concepts associated to the different blocks that constitute a digital communications system. This methodology works competencies: B4, B11, D2, D3.
Problem solving	In A hours the doubts remaining after the publication of the solutions of the proposed problems will be discussed. Furthermore, 3 exercises will be proposed for assessment; some of them will be completed in A hours, while the remaining one(s) will be completed at home. All these 3 exercises will be used as midterm exams and they will completed individually. This methodology works competencies: B3, B4, B11, C26.

Project based learning	In C hours practical projects will be proposed; the students will develop a digital communications system that shows its good operation in the proposed application. The projects will be implemented in small groups. All the members of the group have to understand the operation of all the blocks of the complete system that will be submitted at the end of the course. This methodology works competencies: B3, B4, B11, C26, D2, D3. Software to be used: Matlab.
Laboratory practical	In B hours the students will work on the lab to create a software defined radio receptor that uses all the basic functionalities studied in the subject. They will be implemented in small groups. This methodology works competencies: B4, B11, C26. Software to be used: Matlab.

Personalized assistance

Methodologies	Description
Lecturing	The teacher will solve the doubts that each student formulates during the presentation realised in the master session, beyond the availability at office hours. Information on the latter can be found at the following links: - Fernando Pérez González (https://www.uvigo.gal/es/universidad/administracion-personal/pdi/fernando-perez-gonzalez) - Pedro Comesaña Alfaro (https://www.uvigo.gal/es/universidad/administracion-personal/pdi/pedro-comesana-alfaro)
Laboratory practical	The students will work in small groups and the teacher will solve the doubts that each group might have, both at the lectures and office hours.
Project based learning	The students will work in small groups and the teacher will solve the doubts that each group might have, both at the lectures and office hours.

Assessment

	Description	Qualification	Training and Learning Results
Problem solving	Short exercises (partial tests) related to the contents explained during the masterclasses and in the laboratory. 3 exercises (midterm exams) will be proposed for assessment; some of them will be completed in A hours, while the remaining one(s) will be completed at home. All these 3 exercises will be completed individually. The schedule of the midterm/intermediate exams will be approved in the Comisión Académica de Grado (CAG) and will be available at the beginning of each academic semester. Each exercise will have a weight of 10% in the final mark for the students assessed by continuous assessment.	30	B3 C26 B4 B11
Project based learning	Realisation of a practical project in groups, that will be assessed individually. The deadline for delivering this project will be the same for both students following continuous and global assessment, and it will be included at the midterm exam schedule approved at the CAG. The assessment of this project includes an interview; for continuous assessment students this interview will be performed in the last session of group C, whereas for global assessment students it will be perform in the date of the final exam. This is a mandatory activity for both those students who follow continuous assessment, and those who follow exam-only assessment, yielding in both cases the 40% of the final mark.	40	B3 C26 D2 B4 D3 B11
Problem and/or exercise solving	Final exam, where the student will have to solve some exercises; this exam will be the fourth test for those students who chose continuous assessment. The weight will be 60% for those students that do not follow continuous assessment, and 30% for those who do.	30	B3 C26 B4 B11

Other comments on the Evaluation

For those students that choose continuous assessment the final note will be obtained as:

If final exam mark (out of 10) < 3.5, min(4, Nmidterms + Nproject + Nexam) (1.a)
If final exam mark (out of 10) >= 3.5, Nmidterms + Nproject + Nexam (1.b)

where Nmidterms denotes the mark accumulated in the midterms exams, up to 3 points; Nproject denotes the mark

obtained in the practical project, up to 4 points; and Nexam denotes the mark of the final exam up to 3 points. The midterms exams will not be repeated.

For those students who choose global assessment, the final mark will be obtained as:

If final exam mark (out of 10) < 3.5, min(4, Nproject + Nexam) (2.a)
If final exam mark (out of 10) >= 3.5, Nproject + Nexam (2.b)

where Nproject denotes the mark obtained in a practical project specifically designed for exam-only assessment students, up to 4 points; and Nexam denotes the mark of the final exam up to 6 points.

The final exam for those students who chose global assessment might have more exercises than the exam of those students who chose continuous assessment.

The student has to inform if s/he choose to follow continuous or global assessment in a time interval defined by the teachers; this time interval will last at least for one month and will be within the period between the publication of the marks of the first midterm exam and the date of the third midterm exam. In case s/he does not inform about it and s/he does not make the third midterm exam, it will be considered that s/he chooses global assessment.

The mark in the midterm exams will be considered for the second call, but not for subsequent years. In the second call those students who chose to follow continuous assesment in the first call can choose to keep their midterm exams' mark and be qualified according to (1.a) and (1.b), or be qualified according to (2.a) and (2.b). Those students who in the first call chose to follow global assessment, will be qualified according to (2.a) and (2.b).

In the end-of-program call, the assessment will be only based on an exam.

A mark in a given call will be given (i.e., the student will be considered as "presentado") to those students who follow continuous assesment, and also to those who follow global assessmet and do the final exam of that call.

Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the tests or exams, the final grade will be FAIL (0), and the incident will be reported to the corresponding academic authorities for prosecution.

Sources of information

Basic Bibliography

A. Artés Rodríguez, F. Pérez González y otros,, **Comunicaciones Digitales**, 2007

R. W. Heath Jr., **Introduction to Wireless Digital Communication: A Signal Processing Perspective**, 2017

Complementary Bibliography

J.R. Barry, E. A. Lee y D. G. Messerschmitt, **Digital communication**, 3rd edition, 2004

Recommendations

Subjects that continue the syllabus

Digital Communications/V05G301V01414

Subjects that it is recommended to have taken before

Signal Transmission and Reception Techniques/V05G301V01208
Multimedia Signal Processing/V05G301V01321