## IDENTIFYING DATA

### Digital Communications

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| Subject | Digital Communications |
| Code | V05G300V01914 |
| Study programme | (*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación |

| Descriptors | ECTS Credits | Choose | Year | Quadmester |
|---|---|---|---|---|
| | 6 | Optional | 4th | 1st |

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| Teaching language | English |
| Department | |
| Coordinator | Pérez González, Fernando |
| Lecturers | Mosquera Nartallo, Carlos<br>Pérez González, Fernando |
| E-mail | fperez@gts.uvigo.es |
| Web | http://faitic.uvigo.es |
| General description | This course presents the modulations that are used in practically all modern communication standards. Teaching and exams are in English. |

## 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.<br>2 Analog and digital OFDM modulations<br>3 Diagram of an OFDM transmitter.<br>4 Effect of the channel on the received signal.<br>5 Diagram of an OFDM receiver.<br>6 OFDM seen as a block process. |
|---|---|
| Subject 2: Equalization, coding and synchronization in multicarrier modulations. | 1. Pilot carriers.<br>2 ZF and MMSE equalization.<br>3 Zero-padding methods.<br>4 Coded OFDM (COFDM).<br>5 Carrier synchronization algorithms.<br>6 Timing recovery algorithms.<br>7 Channel state information estimation. |
| Subject 3: Applications | 1 Digital Radio/TV standards.<br>2 OFDM wireless communications standards.<br>3 OFDM wire communications standards. |
| Subject 4: Advanced digital communications. | 1 MIMO ystems.<br>2 Advanced coding: turbo and LDPC codes.<br>3 Spread-spectrum systems.<br>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.<br><br>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,...<br><br>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.<br><br>Competences: CG4, CG9, CG12, CE71, CT2, CT4 |

## Personalized attention

| Methodologies | Description |
|---|---|
| Master Session | Students will have the opportunity to meet in person with the instructor at some office hours that will be announced at the beginning of the course. The schedule will published in the course webpage. |
| Troubleshooting and / or exercises | Students will have the opportunity to meet in person with the instructor at some office hours that will be announced at the beginning of the course. The schedule will published in the course webpage. |

| Tests | Description |
|---|---|
| Reports / memories of practice | Students will have the opportunity to meet in person with the instructor at some office hours that will be announced at the beginning of the course. The schedule will published in the course webpage. |
| Jobs and projects | Students will have the opportunity to meet in person with the instructor at some office hours that will be announced at the beginning of the course. The schedule will published in the course 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. | 20 | B4 B12 | C71 | D2 |
| Reports / memories of practice | Deliverables for the lab project.<br><br>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:<br><br>Task 1 (Demodulation to baseband): 5%<br>Task 2 (Mode detection and temporal allignment): 5%<br>Task 3 (Frequency error correction): 10%<br>Task 4 (Frame synchronization): 10%<br>Task 5 (Channel estimation and equalization - I): 10%<br>Task 6 (Channel estimation and equalization - II): 10% | 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.<br><br>Possible topics include:<br><br>- Digital radio (DAB, DAB+, DRM)<br>- Digital terrestrial television (DVB-T, DVB-H, DVB-T2)<br>- LAN and MAN wireless networks.<br>- ADSL and VDSL<br>- Comunicaciones over PLC and multimedia over coax (MoCA)<br>- LTE<br>- LiFi<br><br>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:<br><br>- Historical aspects: previous standards solving similar problems.<br>- Technical aspects: details about the employed modulation, bandwidth, channel coding, etc.<br>- Applications of the standard.<br>- Deployment degree at national and international levels. | 30 | B4 | 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.

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

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