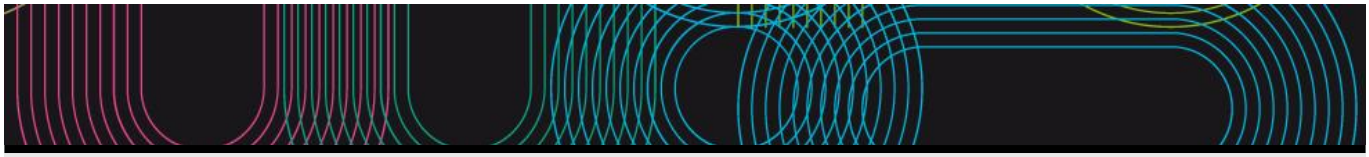

(*)Escola de Enxeñaría de Telecomunicación

Presentatiton

Telecommunications Technical Engineer

www: http://teleco.uvigo.es/index.php/es/estudios/gett

Master in Industrial Mathematicics

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Coordinador del Módulo de Telemática: Jorge García Duque (Jorge.Duque@det.uvigo.es)

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Web page

www.teleco.uvigo.es

(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación

Subjects

Year 2nd

Code	Name	Quadmester	Total Cr.
V05G300V01301	Data Communication	1st	6
V05G300V01302	Programming II	1st	6
V05G300V01303	Electromagnetic Transmission	1st	6
V05G300V01304	Digital Signal Processing	1st	6
V05G300V01305	Physics: Fundamentals of Electronics	1st	6
V05G300V01401	Electronic Technology	2nd	6
V05G300V01402	Digital Electronics	2nd	6
V05G300V01403	Computer Networks	2nd	6
V05G300V01404	Signal Transmission and Reception Techniques	2nd	6
V05G300V01405	Fundamentals of Sound and Image	2nd	6

IDENTIFYING DATA

Data Communication

Subject	Data Communication			
Code	V05G300V01301			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	López García, Cándido Antonio			
Lecturers	Díaz Redondo, Rebeca Pilar Herrería Alonso, Sergio López García, Cándido Antonio Sousa Vieira, Estrella			
E-mail	candido@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this subject the efficiency and reliability of data transmission using discrete memoryless channels will be analyzed, and the next issues will be introduced: * lossless data compression methods, * linear error control codes, * data link layer protocols, and * multiple access channels protocols and technologies.			

Competencies

Code	
B3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update 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.
C11	CE11/T6: The ability to conceive, deploy, organize and manage networks, systems, services and Telecommunication infrastructures in residential (home, city, digital communities), business and institutional environments, being responsible for launching of projects and continuous improvement like knowing their social and economical impact.
C17	CE17/T12: The knowledge and usage of concepts of communication network architecture, protocols and interfaces.
C18	CE18/T13: The ability to differentiate the concepts of access and transport networks, packet and circuit switched networks, mobile and fixed networks, as well as distributed newtwork application and systems, voice, data, video, audio, interactive and multimedia services.
C20	CE20/T15: The knowledge of national, European and international telecommunication regulations and laws.
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.

Learning outcomes

Expected results from this subject	Training and Learning Results		
Understanding the basics of the processes of digital transmission of information, the mathematical models of the channels and the concept of capacity.	B3	C17	D3
Knowledge and ability to analyze the ways of achieving reliable data transmission.	B3 B4	C17 C20	D2 D3
Understanding the methods of sharing multiple access channels, their limits and the factors that affect their performance.	B3	C11 C18	D3
Master the main technical standards, interfaces and protocols in the field of data transmission and local networks.	B3	C20	D3
Practice with interfaces and protocols in the laboratory, as well as in the development of basic transmission solutions.	B3	C20	D3

Contents

Topic

Unit 1. Fundamentals of discrete Information Theory	1.1. A basic model of data communication systems 1.1.1. Discrete sources: discrete memoryless sources 1.1.2. Discrete channels: discrete memoryless channels 1.1.3. Source coding and channel coding 1.2. Information measures 1.2.1. Entropy. Joint entropy 1.2.2. Conditional entropy 1.2.3. Mutual information 1.3. Shannon's source coding theorem 1.3.1. Uniquely decodable codes: instantaneous codes 1.3.2. Kraft's theorem. McMillan's theorem 1.3.3. Optimal codes. Code redundancy 1.3.4. Shannon's source coding theorem 1.3.5. Compact codes. Huffman's algorithm 1.4. Shannon's noisy channels coding theorem 1.4.1. Channel capacity 1.4.2. Symmetric channels 1.4.3. Shannon's noisy channels coding theorem
Unit 2. Data transmission error control	2.1. Linear codes 2.1.1. Definition and matrix description 2.1.2. Syndrome decoding 2.1.3. Error detection and correction properties 2.1.4. Hamming codes 2.1.5. Cyclic codes 2.2. ARQ protocols 2.2.1. Stop and wait 2.2.2. Go-back n 2.2.3. Selective repeat
Unit 3. Multiple access channels and local area networks	3.1. Multiple access channels 3.1.1. The multiple access channel: definition and types 3.1.2. MAC protocols: Aloha, CSMA and variants 3.1.3. Performance of MAC protocols 3.2. Local area networks 3.2.1. Wi-Fi networks 3.2.2. Ethernet networks 3.2.3. Switching ethernet 3.2.4. Virtual local networks

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	26	0	26
Previous studies / activities	0	47	47
Troubleshooting and / or exercises	24	0	24
Autonomous troubleshooting and / or exercises	0	47	47
Long answer tests and development	6	0	6

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

Methodologies

	Description
Master Session	Systematic exposition of the theoretical contents of the subject, emphasizing the aims, fundamental concepts and relationships between the different units. Through this methodology the competencies CE11, CE17, CE18, CE20, CG3 and CT2 are developed.
Previous studies / activities	Students will study the theoretical contents of the subject using the textbook and/or further material. Through this methodology the competencies CE11, CE17, CE18, CE20, CG3 and CT2 are developed.

Troubleshooting and / or exercises	Selected problems and/or exercises will be solved in detail, emphasizing the theoretical concepts involved and the methodology of resolution. Through this methodology the competencies CE11, CE17, CE18, CE20, CG4 and CT3 are developed.
Autonomous troubleshooting and / or exercises	Students will try to autonomously solve a problems and/or exercises from a proposed collection. Through this methodology the competencies CE11, CE17, CE18, CE20, CG4 and CT3 are developed.

Personalized attention

Methodologies	Description
Previous studies / activities	Individual tuitition will be dispensed to the students in the office hours announced at the beginning of the term.
Autonomous troubleshooting and / or exercises	Individual tuitition will be dispensed to the students in the office hours announced at the beginning of the term.

Assessment

	Description	Qualification	Training and Learning Results		
Long answer tests and development	Two partial examinations and a final examination. In each one of them we will evaluate all the competencies corresponding to the contents we have seen in class to date of the examination.	100	B3 B4	C11 C17 C18 C20	D2 D3

Other comments on the Evaluation

The students will choose their grading method between two possibilities: continuous assessment or single examination.

The continuous assessment comprises two midterm exams (20% each) and a final written exam (60%) if final exam grade is greater than or equal to 3.5; if not, the final grade will be equal to the points awarded to this exam. In any case, the final grade will not be less than the final exam grade. The first midterm exam will be foreseeably held on the sixth week, and the second one, on the tenth week. In both exams, the questions will be based on ALL the material covered since the first lecture and students will receive their midterm grades in the next two weeks after the examination. The final exam will be held on the date and time designated on the Centre Schedule and the questions will be based on the material covered on ALL the curse lectures.

The single examination option will require the student to pass a written exam about the contents of the subject. The final grade will be equal to the points awarded to this exam.

Every student who commits to any of the midterms or the final exam will be graded. Attending one of the midterm exams will be considered as choosing the continuous assessment mode.

Any gradings are only valid during the academic year.

Those who fail the subject in the first call at the end of the ordinary term can use the second call, which consist in taking a single written exam. The students will be graded according to the option (continuos or single) of their preference, as marked in the exam cover.

Sources of information

C. López García, M. Fernández Veiga, **Teoría de la Información y Codificación, 2/e**, 2013,
C. López García, M. Fernández Veiga, **Cuestiones de Teoría de la Información y Codificación**, 2003,
J. F. Kurose, K. W. Ross, **Computer Networking, 6/e**, 2012,

Recommendations

Subjects that continue the syllabus

Computer Networks/V05G300V01403

Subjects that it is recommended to have taken before

Mathematics: Probability and Statistics/V05G300V01204

IDENTIFYING DATA				
Programming II				
Subject	Programming II			
Code	V05G300V01302			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Fernández Masaguer, Francisco			
Lecturers	Blanco Fernández, Yolanda Fernández Masaguer, Francisco Sousa Vieira, Estrella			
E-mail	francisco.fernandez@det.uvigo.es			
Web	http://www.faitic.es			
General description	The general aim of this subject is to provide the students with the theoretical foundations and the practical competencies that allow them to analyze, design, develop and debug computer applications following the objects oriented paradigm (OOP). This is an essentially practical subject oriented to the work of the students in the development of one or several software projects. To make this task easier, the subject includes an introduction to Software Engineering. In this sense, it does not address all the phases usually recognized in software development processes, ranging from the capture and description of the requirements to the deployment of the systems, but it is mainly focused on the stages related to the analysis, design, implementation and debugging. Firstly, Software Engineering is presented as an indispensable discipline for the development of big computer applications, showing the main challenges to face and the basic concepts behind them. Next, the elements of the object oriented programming (OOP) paradigm will be analized with UML elements and diagrams, which will be used by the students in their developments. To reach this general aim the contents that will be handled in the subject can be summarized in the following items: The objects oriented paradigm - Basic concepts of object oriented programming: classes and objects - Encapsulation. Hiding principle. Concepts of decoupling and cohesion - Inheritance, abstraction, polymorphism and reuse - Relations between classes: generalization, association and dependency - Communication between objects: methods, events, messages - Persistence. Storage in files and in databases - Generation, capture and processing of exceptions Introduction to Software Engineering - Basic concepts of Software Engineering. Historical review - Introduction and concept of Cycle of Life. Standard ISO/IEC 12207 - Introduction to software development methodologies. Classification - Introduction to the processes of development of objects oriented software. Metric v3 and the Unified Process - Main phases in objects oriented development: analysis, design, implementation and testing - Introduction to the UML modeling language: structure and interaction			

Competencies
Code

B6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
B14	CG14 The ability to use software tools to search for information or bibliographical resources.
C50	(CE50/T18)The ability to develop, interpret and debug programs using basic concepts of Object Oriented Programming (OOP): classes and objects, encapsulation, relations among classes and objects, and inheritance.
C51	(CE51/T19) The ability of basic application of phases of analysis, design, implementation and debugging of OOP programs.
C52	(CE52/T20) The ability of manipulation of CASE tools (editors, debuggers).
C53	(CE53/T21) The ability of developing programs considering to the basic principles of software engineering quality taking into account the main existing sources of norms, standards and specifications.

Learning outcomes

Expected results from this subject	Training and Learning Results	
To understand the basic concepts of Object Oriented Programming (OOP).	B14	C50
To know the main UML diagrams for the documentation in the phases of analysis and design of programs according to the OOP.	B6 B14	C52 C53
To develop skills in the process of analysis, design, implementation and debugging of applications according to the OOP, taking into account the main standards and norms of quality.	B6 B14	C51 C53
To acquire maturity in techniques of development and debugging of programs to allow the autonomous learning of new skills and programming languages.	B6	C51 C52 C53

Contents

Topic	
1. Introduction to the object oriented paradigm	a. Brief introduction to the subject and its organization. b. Birth of the paradigm c. Foundations: classes and objects d. Concepts of encapsulation, inheritance (generalization), and polymorphism e. Brief Introduction to UML
2. Encapsulation	a. Classes, interfaces and packages b. Methods and member variables. Visibility. Scope of resolution c. Constructor method d. Passing parameters: pointers and references e. Pointers to objects
3. Inheritance	a. Derived classes and types of inheritance b. Abstract Classes c. Multiple Inheritance d. Object class
4. Object oriented design	a. Design foundations b. Use of UML diagrams
5. Polymorphism	a. Overloading and overwriting b. Abstract classes and interfaces c. Generic classes
6. Exception handling	a. Exceptions foundations b. Handling of Java exceptions

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	28	42	70
Troubleshooting and / or exercises	9	9	18
Autonomous troubleshooting and / or exercises	4	10	14
Case studies / analysis of situations	1	1	2
Projects	9	31	40
Case studies / analysis of situations	0	1	1
Troubleshooting and / or exercises	3	0	3
Practical tests, real task execution and / or simulated.	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

Master Session	Classes that will combine the explanation of the concepts involved in the subject and the performance of small exercises. These may be solved by the teacher or by the students, individually and/or in groups. The aim is to encourage debates in class and strengthen the adquisition of skills. Through this methodology the competencies CE50, CE51 and CE53 are developed.
Troubleshooting and / or exercises	In the laboratory, the teacher will pose small challenges to be solved collectively so that the underlying concepts and the different options of resolution can be discussed, and to provide students with the skills object of the subject. Through this methodology the competencies CE50, CE51 and CE53 are developed.
Autonomous troubleshooting and / or exercises	Students will solve independently the problems posed by the teacher in the laboratory. The solutions and the doubts that arise in addressing these problems will be put together to agree the best way of resolution. Through this methodology the competencies CE50, CE51, CE53, CG6 and CG14 are developed.
Case studies / analysis of situations	Putting in common of the designs proposed by the students to solve the project to be carried out during the second part of the course. The comparison of the different proposals will serve to select the best options and as a feedback, if appropriate, to improve the designs. Through this methodology the competencies CE51 and CE52 are developed.
Projects	The students will implement the software system proposed by the teacher during the second part of the course, combining work in the laboratory supervised by the teacher with work out of the laboratory. Through this methodology the competencies CE50, CE53, CG6 and CG14 are developed.

Personalized attention

Methodologies	Description
Troubleshooting and / or exercises	Individual attention will be coordinated following-up the work of each student, supervising the solutions proposed for each problem proposed in the laboratory sessions and monitoring of the software project to be implemented.
Projects	Individual attention will be coordinated following-up the work of each student, supervising the solutions proposed for each problem proposed in the laboratory sessions and monitoring of the software project to be implemented.
Autonomous troubleshooting and / or exercises	Individual attention will be coordinated following-up the work of each student, supervising the solutions proposed for each problem proposed in the laboratory sessions and monitoring of the software project to be implemented.
Case studies / analysis of situations	Individual attention will be coordinated following-up the work of each student, supervising the solutions proposed for each problem proposed in the laboratory sessions and monitoring of the software project to be implemented.

Assessment

	Description	Qualification	Training and Learning Results
Projects	The students, organized in pairs, will submit the proposed software project before January 6. It must include the final design (UML diagrams), the code and the generated documentation about the implementation details. It is an indispensable condition to overcome this proof of evaluation that the code can be compiled and run on the computers of the laboratory. During the last week of the course, the students will have an interview with the teacher in the laboratory hours, with the aim of proving the authorship of the project and to perform different functionality tests. Both members of the group must attend the interview. The issues raised therein must be answered individually to verify the degree of understanding and involvement of the student in the developed project. If a student does not demonstrate the authorship adequately, the evaluation of the project will be done through an individual programming practical exam in the laboratory in the date published in www.teleco.uvigo.es for this purpose. If the student does not attend this exam he/she will lose a 30% of the mark of the subject. For the students that demostrate the authorship adequately, the evaluation of the project will take into account the correct functionality, the quality of the code and the use of the techniques of object oriented programming.	30	B6 C50 B14 C53
Case studies / analysis of situations	At the end of the 9th week of the academic course the students, organized in pairs, will submit the design of a software project.	10	C51 C52

Troubleshooting and / or exercises	Written exam to be done individually in the date published in www.teleco.uvigo.es for this purpose, which will consist of the combination of the following types of questions: resolution of problems, short questions about the theoretical concepts explained in the master sessions, to justify reasonably if one or more statements are true or false, small tests about theoretical and application aspects. The number and combination of these questions will be defined for each particular exam. Support materials (notes, books, collections of problems) are not allowed.	50	C50 C51 C53
Practical tests, real task execution and / or simulated.	At the end of the 7th week of the academic course the students, organized in pairs, will submit the Java initiation practices proposed in the laboratory.	10	C50 C51 C52 C53

Other comments on the Evaluation

There are two modalities of evaluation of this subject: continuous evaluation (CE) and traditional evaluation (TE). The students will have to choose one of the two modalities taking into account the following conditions:

- The CE includes the 4 proofs described in the evaluation section.

- Whether they opt for the CE or for the TE, students must develop a project. To facilitate the choice between CE and TE, the specifications of the project will be available in Faitic the 4th week of the academic course.

- In the TE the project will be carried out individually.

- The students that choose the CE will submit at the end of the 9th week of the academic course the UML design of the project (corresponding to the 2nd proof described in the evaluation section). By means of this submission the students agree to follow the CE and reject the TE. From this moment these students may not appear as if they have not taken the subject.

- The students that do not submit the UML design of the project in the stipulated date reject the CE, so that they will be evaluated by means of the modality of TE. It is not possible to join the CE in the following intermediate proofs.

- The proofs of CE are not recoverable in any case, and they can not be repeated outside the dates stipulated by the teachers.

- Marks (of proofs of CE or practical projects or exams) are not saved from one course to another.

First call. Students who opt for the CE. They will be evaluated as follows:

 Theoretical part:

- Written exam (50%). Individual exam. It corresponds to the 3rd proof described in the evaluation section. The mark of this exam will not be never saved for others convocatories.

 Practical part:

- Practices of initiation in Java (10%). To be done in pairs. It corresponds to the 4th proof described in the evaluation section.

- Project (40%). To be done in pairs. It is divided in two parts:

1. Design (10%). It corresponds to the 2nd proof described in the evaluation section.

2. Implementation (30%). It corresponds to the 1st proof described in the evaluation section.

 The requirements to pass will be:

- A minimum of 1/3 of the total in the theoretical part.

- A minimum of 1/3 of the total in the part of implementation of the project (or 1/3 of the total of the practical exam according to the case).

- A total mark (sum of the 4 proofs) equal or higher than 5.

- If the total mark is equal or higher than 5 but the minimun in some part has not been reached, the final mark will be 4.5 points (failure).

First call. Students who opt for the TE. They will be evaluated as follows:

 Theoretical part:

- Written exam (50%). Individual exam. It corresponds to the 3rd proof described in the evaluation section. The mark of this exam will not be never saved for others convocatories.

 Practical part:

- Individual realization of a software project that will suppose the remaining 50% of the final mark. This project will consist of the design (UML diagrams), the Java code and the generated documentation about the implementation details. The evaluation will take into account correct design, correct functionality, quality of the code and use of techniques of OOP. It must be submitted before January 6.

- Realization of an interview with the teacher with the aim of proving the authorship of the project. This interview will take place in the laboratory hours during the last week of the course. If a student does not demonstrate adequately the authorship, the evaluation of the practical part will be done through a programming practical exam.

 The requirements to pass will be:

- A minimum of 1/3 of the total in the theoretical part.

- A minimum of 1/3 of the total in the part of the project (or 1/3 of the total of the practical exam according to the case).

- A total mark (sum of the 2 proofs) equal or higher than 5.

- If the total mark is equal or higher than 5 but the minimun in some part has not been reached, the final mark will be 4.5 points (failure).

Second call. The students will be evaluated as follows:

 Theoretical part:

- Written exam (50%). Individual exam. It corresponds to the 3rd proof described in the evaluation section. The mark of this exam will not be never saved for others convocatories.

 Practical part:

It will depend on whether the student has delivered or not the project in the first call. For the students that have followed the CE in the first call, it will be considered that a student has delivered the project when, as least, he/she has submitted an UML design in which he/she has obtained a mark equal or higher than 0.6 of 1.

- The students that do not deliver the project in the first call will be evaluated through an individual programming practical exam, to be done in the laboratory in the date published in www.teleco.uvigo.es for this purpose. The evaluation of this exam will suppose a 50% of the final mark.

- The practical part to be done for the students that deliver the project in the first call will depend on the mark obtained in the project in that call, as follows:

Mark >= 1.5 with CE or Mark >= 2.5 with TE. They will keep the mark, not having to attend the practical exam of the second call. However, they will be able to improve the mark of the project delivering a new version of the one of the first call together with the new functionalities to be done, that will be published in Faitic. In the same way, they will deliver a document that addresses the changes and updates in the project from the version delivered in the first call.

Mark between 1 and 1.5 with CE or Mark between 5/3 and 2.5 with TE. They may opt for doing the practical exam or the extended project of the second call. They will not keep the mark of the project of the first call, but they will keep the marks of the parts of initiation in Java and UML design if they have opted for the CE in the first call.

Mark < 1 with CE or Mark < 5/3 with TE. They may opt for doing the practical exam or the extended project of the second call. In any case, they will not keep the marks of the parts of initiation in Java and UML design if they have opted for the CE in the first call, that is, they will be evaluated on 5.

 The requirements to pass will be:

- A minimum of 1/3 of the total in the theoretical part.

- A minimum of 1/3 of the total of the project without taking into account the marks of the parts of initiation in Java and UML design if they have opted for the CE in the first call (or 1/3 of the total of the practical exam according to the case).

- A total mark (sum of all the proofs) equal or higher than 5.

- If the total mark is equal or higher than 5 but the minimun in some part has not been reached, the final mark will be 4.5

points (failure).

Sources of information

Basic references:

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Aditional references:

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[8] "How to Think Like a Computer Scientist. JavaTM Version", 4th version. Online: http://www.greenteapress.com/thinkapjava/

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[10] "Java SE. Oracle". Online: http://www.oracle.com/technetwork/java/javase/downloads/index.html

[11] "Java 2 Platform Standard Edition 5.0. API Specification". Online: http://download.oracle.com/javase/1.5.0/docs/api/

[12] "The Java Tutorials". Oracle. Online: http://download.oracle.com/javase/tutorial/

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[14] "Open-oriented Analysis and Design with Applications". G. Booch, R. Maksimchuk, M. Engel, B. Young, J. Conallen, K. Houston, 3rd edition. 2007, Addison-Wesley.

[15] "The Unified Modeling Language User Guide". G. Booch, J. Rumbaugh, I. Jacobson, 2nd edition. 2005. Addison-Wesley.

[16] "UML Distilled: A Brief Guide to the Standard Object Modeling Language". M. Fowler, 3rd edition. 2003, Addison-Wesley.

[17] "Fundamentals of object-oriented design in UML". M. Page-Jones. 2002, Addison-Wesley.

Recommendations

Subjects that it is recommended to have taken before

Programming I/V05G300V01205

IDENTIFYING DATA				
Electromagnetic Transmission				
Subject	Electromagnetic Transmission			
Code	V05G300V01303			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Vera Isasa, María			
Lecturers	Díaz Otero, Francisco Javier García-Tuñón Blanca, Inés Gómez Araújo, Marta Lorenzo Rodríguez, María Edita de Santalla del Río, María Verónica Vazquez Alejos, Ana Vera Isasa, María			
E-mail	mirentxu@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Fundamentals of electromagnetic guided and unguided transmission. Analysis of the operating principles of different transmission media models and their characterization in telecommunication engineering.			

Competencies	
Code	
B3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update 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.
B5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
C8	CE8/T3: The ability to use software tools for bibliographical resources search or information related with electronics and telecommunications.
C9	CE9/T4: The ability to analyze and specify the main parameters of a communications system.
C13	CE13/T8: The ability to understand the electromagnetic and acoustic wave mechanisms of propagation and transmission, and their corresponding receiving and transmitting devices.
C20	CE20/T15: The knowledge of national, European and international telecommunication regulations and laws.
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.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Transmissionm line specification: two-wire line, coaxial wire, coaxial models, twisted pair, optical fibre.	B3	C8 C9	
Analysing waves of tension and current and stationary wave.	B5	C9 C13	
Proposing impedance matching solutions.	B4		
Crosstalk problems evaluation.	B5	C13	
Antenna radiated field calculation and related parameters: radiation pattern, gain, beam-width, impedance, polarisation, effective area.	B5	C9 C13	
Resolving problems of propagation and reception of electromagnetic waves.	B3 B4	C20	D2 D3

Contents	
Topic	
1. Introduction	Types of transmission media, advantages and disadvantages, characterisation.

2. Transmission lines	Getting started with some of the most commonly used transmission lines: two-wire, coaxial, twisted pair. Circuit model of distributed parameters ,general equations, characteristic parameters (characteristic impedance, propagation velocity, attenuation and phase coefficients). Attenuation, dispersion and crosstalk. Transmission line in circuit (reflection coefficient, standing wave ratio, input impedance). Smith Chart.
3. Optical fiber.	Structure and types. Numerical aperture and acceptance cone. Attenuation and dispersion. Optical sources and receptors.
4. Radiowaves and antennas	Characteristics of radiowaves: far field, radiation integral. Antenna concept and fundamental parameters (radiation pattern, secondary lobe level, beamwidth, directivity, gain, polarisation, impedance). Reception: power balance in free space (Friis equation), polarization loss factor. Center feed dipoles. Antenna arrays.
Labs	- Management of software tools to search information: technical, scientific and regulation of telecommunications. - Measurement and analysis of voltage and current waves and standing waves. - UTP and coaxial. - Basic matching technics. - Radiation pattern plots. - Measurement of antenna basic parameters. - Problem resolution.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	2.5	3.5
Master Session	17	25.5	42.5
Laboratory practises	12	6	18
Practice in computer rooms	8	4	12
Presentations / exhibitions	2	16	18
Autonomous troubleshooting and / or exercises	12	24	36
Troubleshooting and / or exercises	2	8	10
Multiple choice tests	2	8	10

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

Methodologies

	Description
Introductory activities	Activities focused to take contact and get information about the students and to introduce the subject.
Master Session	Presentation by the teacher of the contents of the subject of study (theoretical basis). Through this methodology the competencies CG3, CE9,CE13,CE20 y CT2 are developed.
Laboratory practises	Application of knowledge to specific situations and acquisition of basic skills and procedures. They are developed in laboratories with specialized equipment. Through this methodology the competencies CG5 y CT3 are developed.
Practice in computer rooms	Activities of acquisition of basic skills related with the matter. Through this methodology the competencies CG3, CE8, CE20 y CT3 are developed.
Presentations / exhibitions	Student presentation of the results of a group work. Through this methodology the competencies CE20 y CT3 are developed.
Autonomous troubleshooting and / or exercises	Activity in which problems are formulated related to the subject. The student must develop the analysis and solving problems independently. The solutions are provided in ordinary class hours. Through this methodology the competencies CG4, CE9 y CE13 are developed.

Personalized attention

Methodologies	Description

Master Session	Students will have the opportunity to attend personalized tutoring in the schedule that teachers establish for this purpose at the beginning of the course and will be published in the course website. The teacher will resolve in the classroom the doubts that arise in the moment of the class and in the tutoring schedule those that arise when realising the autonomous study.
Autonomous troubleshooting and / or exercises	Students will have the opportunity to attend personalized tutoring in the schedule that teachers establish for this purpose at the beginning of the course and will be published in the course website. The teacher will resolve in the classroom the doubts that arise in the moment of the class and in the tutoring schedule those that arise when realising the autonomous study.

Assessment

	Description	Qualification	Training and Learning Results		
Laboratory practises	Performing lab practices that require instrumentation handling.	20	B5		D3
Presentations / exhibitions	Performing lab practices of software tools to search of information and a work about telecommunication regulation.	10		C8 C20	D2
Troubleshooting and / or exercises	Proof in which the student has to solve a series of problems in a time and conditions established by the teacher, applying the acquired knowledge.	40	B3 B4	C9 C13	
Multiple choice tests	Tests for evaluation of acquired skills including direct questions about a particular aspect. Students must respond directly and briefly based on their subject knowledge.	30	B3	C9 C13	

Other comments on the Evaluation

Following the guidelines of the degree two evaluation systems will be offered: continuous assessment or final exam.

Continuous assessment includes a series of tasks performed during the course (70%) and a multiple-choice test (30%) performed on date according to the official exam schedule. To pass the subject by this evaluation system, 1/3 of the maximum score of each item in the above table must be obtained (except for the multiple choice test) and 50% minimum of the global score (sum of the four blocks) must be reached.

The tasks in the course include the active participation in ordinary classroom and laboratory sessions, autonomous working, information search, development and submission of a report and two tests of problem solving (the first scheduled at the middle of the term and the second by the end). These tasks are **not recoverable**, ie if a student cannot fulfill on time the teacher has no obligation to repeat them and will **only be valid for the academic year in which they are made**.

The students must decide if they choose the ongoing evaluation after the realization of the first test of problem solving on the 8 th - 9 th week of class, in which case they receive a grade that corresponds, independently that they present to other tasks or not. If the score is high as 50% without getting 1/3 in some of the items, the official grade will be 4.5

Evaluation by final exam

In addition to the continuous assessment system described above, the student may choose to perform one final exam that will have three parts:
- Part I: practice and report (pass or fail).
- Part II: questions (40%).
- Part III: problem solving (60%).

It is necessary to pass the first part to be submitted to the other two. Obtaining a "fail" translates into a 2 official grade. If you have made the qualifying practices and the oral presentation of the report (essential) and have passed the third corresponding to, you do not need to perform the first part of the final exam.

Second chance

It consists of a final exam with the same characteristics and weights as indicated in the previous section.

Students who want to preserve the grade obtained in the first tasks of the continuous assesment (70%) can elect to perform only the multiple-choice test (30%) provided that minimum requirements had been got.

To pass the subject at least 50% in the total qualification must be obtained in any of the evaluation systems and calls.

Sources of information

F.T. Ulaby, **Fundamentals of Applied Electromagnetics**, 6ª,
S.M. Wentworth, **Applied electromagnetics. Early transmission line approach**, 1ª,
D. K. Cheng, **Fundamentos de electromagnetismo para ingeniería**,

Additional references:

B.M. Notaros, **Electromagnetics**, Pearson 2011.

N.N.Rao, **Elements of engineering electromagnetics**, Pearson, 6ª ed., 2004.

J.D. Krauss, **Electromagnetismo con aplicaciones**, McGraw-Hill 2000.

D. K. Cheng. **Field and Wave Electromagnetics,** Addison-Wesley, 2ª ed.,1989.

Recommendations

Subjects that continue the syllabus

Fundamentals of Sound and Image/V05G300V01405
Signal Transmission and Reception Techniques/V05G300V01404
Microwave Circuits/V05G300V01611
Radio Frequency Circuits/V05G300V01511
Optical Telecommunication Infrastructures/V05G300V01614
Wireless Systems and Networks/V05G300V01615
Radio Communication Systems/V05G300V01512

Subjects that are recommended to be taken simultaneously

Digital Signal Processing/V05G300V01304

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G300V01201
Physics: Fields and Waves/V05G300V01202
Mathematics: Calculus I/V05G300V01105
Mathematics: Calculus II/V05G300V01203

IDENTIFYING DATA				
Digital Signal Processing				
Subject	Digital Signal Processing			
Code	V05G300V01304			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	García Mateo, Carmen			
Lecturers	Alonso Alonso, Ignacio Docio Fernández, Laura García Mateo, Carmen Márquez Flórez, Óscar Willian Rodríguez Banga, Eduardo			
E-mail	carmen.garcia@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Digital signal processing is nowadays a feature of most everyday communications and entertainment devices. The aim of this course is to equip students with a mathematical grounding in general signal and systems analysis. In subsequent course subjects, this knowledge will be applied to specific applications of signals and systems, including audio, image, video and voice signals. Objectives cover the following areas: Managing signals and systems mathematically and visually, including learning and applying their properties. Studying the different domains for signal and systems analysis: time domain, frequency domain and Z domain. Learning how to transfer a problem in one domain to a domain in which it is easier to solve. Mastering the concept of filter frequency response and learning to interpret the system function. Understanding the relationship between the poles and zeros of the system function and the frequency response. Acquiring basic notions of filter design in the Z domain. Managing specific digital signal processing software. Applying the above knowledge to simple and practical laboratory examples.			

Competencies	
Code	
B3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update 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.
C48	(CE48/T16) The knowledge of the appropriate techniques to develop and exploit signal processing subsystems .
C49	(CE49/T17) The ability to analyze digital signal processing schemes.
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.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Managing specific software for digital signal processing	B3	C48	D3
Applying mathematical knowledge for signal filtering	B4	C49	D2
Mastering filtering operations in frequency domain.	B4	C49	D2
Learning mathematical issues for understanding the processes of sampling and windowing of analog signals.	B3	C48	D3
Analysis of simple processing systems.	B4	C49	D2

Contents
Topic

Subject 1. Introduction to Sampling and Aliasing	Sampling and digital frequency. Analog frequency vs discrete frequency. Aliasing. The sampling theorem.
Subject 2. FIR Filters	Difference equation. Filter Coefficients. Block Diagrams. Causality, linearity and time-invariance. LTI systems and convolution. FIR frequency response. Cascaded LTI systems.
Subject 3. Z Transform	Definition and properties. Linear-phase filters.
Subject 4. IIR Filters	Difference equation. Filter Coefficients. Block Diagrams. Impulse response. Relation between the position of poles and zeros of the system function and the frequency response.
Subject 5. Continuous-Time Signals and Systems	The unit impulse. The unit step. Time delaying. Linearity and time-invariance. Convolution
Subject 6. Continuous-Time Fourier Transform	Definition. Basic pairs. Properties
Subject 7. Sampling and Reconstruction in the Frequency Domain	The sampling theorem in the frequency domain
Subject 8. Windowing and Discrete Fourier Transform (DFT)	Relation of the spectrum of a continuous-time signal to the spectrum of the time-sampled signal. Windowing. DFT and FFT.
Project 1. A/D and D/A Conversion	Digitalisation of Continuous-Time Signals. Aliasing.
Project 2. Digital Filters	Digital filters in the time and frequency domains.
Project 3. Spectral Analysis	Windowing. FFT. Examples

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Master Session	23	40	63
Laboratory practises	11	22	33
Troubleshooting and / or exercises	15	30	45
Forum Index	0	2	2
Multiple choice tests	1.5	0	1.5
Troubleshooting and / or exercises	4.5	0	4.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Introductory activities	Course presentation: programme, reading materials, teaching methodology and assessment system
Master Session	Instructor presentation of the main concepts of each subject. Classes do not cover all content that is examination material. The student should take the content indicated in the guidelines for each subject into account as orientation for exams. During the 5 minutes before the lecture, a student will summarize the main concepts presented in the previous session. Students will participate by answering questions during the explanation and by doing exercises. Student will work alone afterwards on the concepts studied in class and on expanding this content using the guidelines provided for each subject. Identification of doubts that need to be resolved in personalized tutorials. Through this methodology the competencies CE48, CG3, and CT3 are developed.
Laboratory practises	Application of Matlab functions and commands for digital signal processing to solve practical exercises. Identification of doubts that need to be resolved in personalized tutorials. Through this methodology the competencies CE49, CG4 and CT2 are developed.
Troubleshooting and / or exercises	Problems and exercises formulated according to the content of the lectures and the guidelines for each subject. Students solve problems and exercises prior to the class in which one or several students explain the solution on the board. Identification of doubts that need to be resolved in personalized tutorials. Through this methodology the competencies CE49, CG4 and CT2 are developed.
Forum Index	The website for the course is included in the TEMA platform (http://faitic.uvigo.es). Subscription to this platform, including a photograph, is mandatory. The website provides all the information related to the course. It also publishes continuous assessment grades and runs forums for students to exchange ideas and discuss doubts. Through this methodology the competencies CE48, CE49, CG3, CG4 , CT2 and CT3 are developed.

Personalized attention	
Methodologies	**Description**
Master Session	Students will have the opportunity to attend personal tutorials in their lecturer's office at times established by lecturers for this purpose at the beginning of the academic year and published on the course website. These tutorials are aimed at resolving student doubts and providing guidance regarding: The content of the lectures and approaches to study. Laboratory projects and the software used. Problems and exercises proposed and solved in the classroom as well as other problems and exercises arising during the course.
Laboratory practises	Students will have the opportunity to attend personal tutorials in their lecturer's office at times established by lecturers for this purpose at the beginning of the academic year and published on the course website. These tutorials are aimed at resolving student doubts and providing guidance regarding: The content of the lectures and approaches to study. Laboratory projects and the software used. Problems and exercises proposed and solved in the classroom as well as other problems and exercises arising during the course.
Troubleshooting and / or exercises	Students will have the opportunity to attend personal tutorials in their lecturer's office at times established by lecturers for this purpose at the beginning of the academic year and published on the course website. These tutorials are aimed at resolving student doubts and providing guidance regarding: The content of the lectures and approaches to study. Laboratory projects and the software used. Problems and exercises proposed and solved in the classroom as well as other problems and exercises arising during the course.

Assessment					
	Description	Qualification	Training and Learning Results		
Multiple choice tests	These tests are a requirement to pass the subject. See details in the "Other comments and second call" section.	0	B3	C48 C49	D3
Troubleshooting and / or exercises	These tests are a requirement to pass the subject. See details in the "Other comments and second call" section.	100	B3 B4	C48 C49	D2 D3

Other comments on the Evaluation

ASSESSMENT PROCEDURE:

A. Overview

The acquired skills are assessed by a series of tests grouped into two parts, with different requirements:

1. Lab assessment.
2. Problem assessment.

To pass the course it is necessary to pass all two parts.

- For each part one or more tests are performed to obtain an independent grade on each.
- There are tests for each part both during the lecture period and final evaluation periods. In total there are three opportunities to pass each part throughout the academic year.
- A pass grade in any part is valid for the entire academic year.
- The final grade for Lab assessment is Pass or Fail.
- The final grade for the Problem assessment is a numerical mark between 0 and 10.
- The course mark is obtained roughly as follows:
    - If you have passed all two parts, the final grade is the grade of the Problem assessment.
    - If you have not passed any of the two parts, the final grade is the lowest of the two, calculated as specified later on.

It is also important to note that:

- The course can be passed with full marks from continuous assessment, with no need to sit the final exam.
- Students who have done continuous assessment and have failed any part, at the end of the term or at the end of the academic year, may need to perform only the failed parts.
- Students who sit any of the tests corresponding to continuous assessment will obtain amark that will

be listed in the academic records.

The following sections explain in detail how each part is graded.

B. Details of the assessment procedure

B1. Lab assessments

- Their goal is to determine whether the student has acquired all the knowledge and/or skills corresponding to the laboratory practice, emphasizing the use of MatLab for digital signal processing.
- Content to be assessed: content of the lab manuals and related theory content.
- Type of test: The test consists of a combination of multiple-choice questions and short questions. Students may use MatLab, lab manuals with personal notes, and text book. Students may not use a calculator for this test.
- Students are graded as pass or fail.
- There are 3 opportunities to pass:
    - Opportunity 1 (Continuous assessment)
        - There will be three mandatory tests in the lab room
        - The test consists of a series of questions at the end of each Practice assignment
        - The tests will be graded between 0 and 10. The student will pass this part if he/she gets an average greater than or equal to 5. It is compulsory to sit all three tests.
        - Exact dates will be announced on the web site at the beginning of the lecture period.
    - Opportunities 2 and 3. A test in the End-of-Term exam period, and a test in the End-of-Academic-Year exam period. Students must obtain a pass grade in this test in order to pass the course. The pass mark for this test is 5 out of 10.
- Remarks:
    - Once the pass grade is obtained, this is valid for the entire academic year.
    - While the pass grade is not obtained, it is possible to sit any of the three opportunities.

B2. Problem Assessment

- Their goal is to determine whether the student has acquired all the knowledge and/or skills corresponding to the course and knows how to apply them to solve problems.
- Content to be assessed: as specified in the guidelines for each topic in the section "Content to be assessed". MatLab knowledge is not assessed.
- Type of test: an exam of problems. Students may not use books or notes. The use of calculators may be granted on an exam basis.
- It will be graded between 0 and 10. The pass mark is 5.
- There are 3 opportunities to pass:
    - Opportunity 1 (Continuous assessment)
        - There will be three mandatory tests in the classroom. Each test will be graded between 0 and 10.
        - The mark will be obtained as : 0,25* Test1Mark+ 0,35*Test2Mark + 0,4*Test3Mark
        - Test1: from Subject 1 to Subject 3. It will take place during the sixth week of the course.
        - Test2: from Subject 1 to Subject 6. It will take place during the tenth week of the course.
        - Test3: from Subject 1 to Subject 8. It will take place during the last week of the course.
        - Exact dates will be announced on the web site at the beginning of the lecture period.
    - Opportunities 2 and 3. An exam in the End-of-Term exam period, and an exam in the End-of-Academic-Year exam period. In each exam, all content is evaluated according to the information contained in the guidelines for each subject. The pass mark for this test is 5 out of 10.
    - Remarks:
        - Once the pass mark is obtained, this is valid for the entire academic year.
        - While the pass grade is not obtained, it is possible to sit any of the three opportunities.

        - It is always possible to sit the second opportunity to try to get a better mark.

C. Other comments

- The grade obtained at the end of the term will be part of the academic record of the student. This grade will be final if the mark is above or equal to 5. Otherwise a provisional fail grade will be recorded on their academic record.
- The provisional mark will become definitive fails for students who do not sit at the end of the academic year exam period, or gets a lower mark. Otherwise the better mark will be part of the academic record and becomes final.
- The final mark is computed as:
    - If the student passes all two parts, the mark is that of the problem assessment part.
    - If the student fails any part, the mark is the minimum of:
        - The average mark of the lab assessment.
        - Mark of the problem assessment.
    - In case of more than one mark for any part, the highest one will be used.
- Tests performed as continuous assessment may not be rescheduled.
- The grades obtained in the lab assessment or problem assessment are only valid for the current academic year.
- The use of books, notes or electronic devices such as phones or computers is not permitted in any test or exam. Mobile phones must be turned off and out of reach of the student. If calculator use is permitted, the calculator must be a conventional scientific calculator. Under no circumstances may calculators be used that allow formulas to be saved or that have libraries that automatically perform operations with complex numbers, calculation of roots, etc.

Sources of information

J.H. McClellan y R.W. Schafer, R, **Signal Processing First**, Pearson Prentice Hall,

A. Quarteroni y F. Saleri, **Cálculo científico con Matlab y Octave**, Springer,

M. J. Roberts, **Señales y Sistemas**, McGraw Hill,

A.V. Oppenheim y R.W. Schafer, **Tratamiento de señales en tiempo discreto**, Prentice Hall,

It is recommended to purchase the *Signal Processing First (SPF)* book, as it constitutes the main source of content for the course.

Students will be provided with guidelines for each subject that includes the following sections:

- Theoretical content: The theory that will be evaluated in exams.
- Problems proposed: A set of problems recommended for each subject.
- SPF vocabulary: A Spanish-English vocabulary with a set of selected terms is included to facilitate reading of the book.

Students will also be provided with a document describing the Matlab content considered essential for the course.

Recommendations

Subjects that continue the syllabus

Fundamentals of Sound and Image/V05G300V01405
Signal Transmission and Reception Techniques/V05G300V01404
Fundamentals of Image Processing/V05G300V01632
Sound Processing/V05G300V01634
Audio Systems/V05G300V01532
Imaging Systems/V05G300V01633
Electronic Systems for Signal Processing/V05G300V01522
Multimedia Signal Processing/V05G300V01513
Video and Television/V05G300V01533

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G300V01201
Mathematics: Linear Algebra/V05G300V01104
Mathematics: Calculus I/V05G300V01105

IDENTIFYING DATA				
Physics: Fundamentals of Electronics				
Subject	Physics: Fundamentals of Electronics			
Code	V05G300V01305			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Domínguez Gómez, Miguel Ángel			
Lecturers	Domínguez Gómez, Miguel Ángel Pérez López, Serafín Alfonso Raña García, Herminio José Rodríguez Pardo, María Loreto			
E-mail	mdgomez@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main purpose of this course is to provide students the basis for understanding and mastery of the principles of operation of devices and electronic circuits. It begins with a brief introduction to electronics in order to provide students with a global vision. After, basic concepts about devices and electronic circuits are taught: · Diodes and circuits with diodes, including concepts such as load line, ideal diodes, rectifiers, shaping circuits, logic circuits, voltage regulators and devices physics. · Characteristics of bipolar transistors, analysis of load line, large-signal models, polarization, amplification and small-signal equivalent circuits. · Study of the FET similar to the previous highlighting the MOSFET. · Check the circuit designs studied using SPICE. Mounting and verification using laboratory electronic instrumentation. · Basic concepts about logic digital circuits. On the other hand, in the framework of the course takes place first contact of students with the electronics lab. Therefore, the main objective of the practical part of the course is that the student acquires the bases for a correct management of the most common instruments in the laboratories of electronics. The student, at the end of the course, must know handle the laboratory instruments, should distinguish and characterize the different components, and have practical skills in assembly and measurement. Students will also start with simulation of circuits, in order to introduce them to computer-aided design.			

Competencies	
Code	
B13	CG13 The ability to use software tools that support problem solving in engineering.
C4	CE4/FB4: Comprehension and command of basic concepts in linear systems and their related functions and transforms; electric circuits theory, electronic circuits, physical principles of semiconductors and logical families, electronic and photonic devices, materials technology and their application to solve Engineering problems.

Learning outcomes		
Expected results from this subject		Training and Learning Results
Understanding and control of the basic concepts of the physical principles of semiconductors.		C4
Understanding and control of the basic concepts of operation of the electronic and photonic devices.		C4
Understanding and control of simple electronic circuits based on the electronic and photonic devices and their applications.		C4
Understanding and control of the basic concepts of the logic families.		C4
Basic knowledges on CAD (Computer Aided Design) tools for the simulation of electronic circuits.	B13	
Capacity utilization of CAD tools for designing simple electronic circuits.	B13	

Contents	
Topic	
Subject 1: Introduction	Electronic systems. Design process. Integrated circuits.

Subject 2: Diodes and circuits with diodes	Characteristics of the diode. Zeners. Analysis of the load line. Ideal model of the diode. Circuits with diodes (rectifiers, clipping and voltage regulator circuits). Small signal equivalent linear circuits. Basic concepts of semiconductors. Physics of the diode. Capacity effects. LED and laser diodes. Photodiodes.
Subject 3: Principles of amplification	General aims: Voltage, current and power gains. Ideal amplifier. Amplifier Models. Limits. Introduction to amplifier frequency response.
Subject 4: Bipolar Junjction Transistors (BJT)	Operation of the npn Bipolar Junction Transistor (BJT). Load-Line Analysis of a Common-Emitter Amplifier. The pnp Bipolar Junction Transistor. Models of circuits. Analysis of circuits with BJTs. Phototransistors and optocouplers.
Subject 5: Analysis of amplifiers with Bipolar Junction Transistors	Small-Signal Equivalent Circuits. Analysis in medium frequencies: the Common-Emitter amplifier, the Emitter-Follower amplifier, the Common-Collector amplifier and the Common-Base amplifier.
Subject 6: Field Effect Transistors (FET)	NMOS Transistor. Analysis of the load line of a simplified NMOS amplifier. Polarization circuits. JFET and depletion MOSFET transistors and channel p devices.
Subject 7: Analysis of amplifiers with Field Effect Transistors	Small-Signal Equivalent Circuits. Analysis in medium frequencies: the Common-Source amplifier and the Source Follower amplifiers.
Subject 8: Digital logic circuits	Digital logic circuits. Basic concepts. Electrical specifications of the logic gates. The inverter CMOS. CMOS gates NOR and NAND.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	4	6
Master Session	13	24	37
Troubleshooting and / or exercises	14	33	47
Laboratory practises	14	30	44
Troubleshooting and / or exercises	8	0	8
Practical tests, real task execution and / or simulated.	5	0	5
Self-assessment tests	0	3	3

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

Methodologies

	Description
Introductory activities	Presentation of the subject. Presentation of the laboratory practices and the instrumentation and software to be used. Through this methodology the competencies CG13 and CE4 are developed.
Master Session	Exposition of contents. Later personal work of the student reviewing the concepts seen in the classroom and preparing the subjects using the proposed bibliography. Identification of doubts that require to be resolved in personal tutorships. Through this methodology the competency CE4 is developed.
Troubleshooting and / or exercises	Activity to formulate and resolve problems and/or exercises related with the subject. Complement of the theoretical sessions. Personal work of the student with resolution of problems and/or exercises proposed in the classroom and extracted of the bibliography. Identification of doubts that require to be resolved in personal tutorships. Through this methodology the competency CE4 is developed.
Laboratory practises	Activities of application of the theoretical knowledges. It will learn to handle the typical instrumentation of an electronic laboratory and it will implement basic electronic circuits seen in the theoric sessions. Also they will purchase skills of handle of simulation tools. Personal work of the student preparing the practices using the available documentation and reviewing the theoretical concepts related. Development and analysis of results. Identification of doubts that require to be resolved in personal tutorships. Through this methodology the competency CG13 is developed.

Personalized attention

Methodologies	Description
Master Session	Students will have opportunity to go to personal tutorships in the professor office. The doubts about the contents given by the professor will be resolved in the tutorships and students will be oriented about how to study it. Also, the doubts arisen to the students on the problems and/or exercises proposed and resolved in the classroom will be resolved as well as other problems and/or exercises that can appear along the study of the subject. The doubts arisen to the students on the development of the laboratory practises, the handle of the instrumentation, the implementation of the electronic circuits and the software of simulation will be resolved too.

Troubleshooting and / or exercises	Students will have opportunity to go to personal tutorships in the professor office. The doubts about the contents given by the professor will be resolved in the tutorships and students will be oriented about how to study it. Also, the doubts arisen to the students on the problems and/or exercises proposed and resolved in the classroom will be resolved as well as other problems and/or exercises that can appear along the study of the subject. The doubts arisen to the students on the development of the laboratory practises, the handle of the instrumentation, the implementation of the electronic circuits and the software of simulation will be resolved too.
Laboratory practises	Students will have opportunity to go to personal tutorships in the professor office. The doubts about the contents given by the professor will be resolved in the tutorships and students will be oriented about how to study it. Also, the doubts arisen to the students on the problems and/or exercises proposed and resolved in the classroom will be resolved as well as other problems and/or exercises that can appear along the study of the subject. The doubts arisen to the students on the development of the laboratory practises, the handle of the instrumentation, the implementation of the electronic circuits and the software of simulation will be resolved too.

Assessment

	Description	Qualification	Training and Learning Results	
Troubleshooting and / or exercises	Tests will be carried out in the classroom throughout the year to evaluate the competencies of the student to resolve problems and/or the exercises over a part of the contents of the subject.	60		C4
Practical tests, real task execution and / or simulated.	Tests will be carried out in the laboratory along the course about management of instrumentation, mounting of electronic circuits and simulation. The skills acquired by the student about the contents of the subject laboratory practices will be evaluated.	35	B13	C4
Self-assessment tests	Techniques aimed to collect data about the participation of the student in the proposed self-assessment tests.	5		

Other comments on the Evaluation

1. Continuous evaluation

A system of continuous evaluation will be offered to the students following the guidelines of the bachelor and the agreements of the academic commission. Students who take the first test of resolution of problems and/or exercises deem to opt for continuous evaluation. Those students who do not take the first test of resolution of problems and/or exercises deem to renounce to the continuous evaluation and they will only have the possibility to take the final exam. Students who do not follow the continuous evaluation and do not take the final exam will be considered "not presented".

1.a Self-assessment tests

The professors will evaluate the execution of the proposed self-assessment tasks, getting the student a rating from 0 to 10 (AE).

The final mark of self-assessment tests (NAE) will be:

NAE = 0.05*AE

1.b Theory

Students will carry out 3 exams (multiple choice test and/or short answer test and/or resolution of problems and/or exercises) properly programmed along the course (PT1, PT2 and PT3). PT1 will be about themes 1 and 2 (block 1), PT2 about themes 3, 4 and 5 (block 2) and PT3 about themes 6, 7 and 8 (block 3). These exams will be valued from 0 up to 10 and the final mark will be the average (NPT -> Mark of theory exams):

NPT = (NPT1 + NPT2 + NPT3)/3

It is necessary to obtain a minimum of 3 points out of 10 in each of these exams (NPT1 >= 3, NPT2 >= 3 and NPT3 >= 3) to pass the subject.

The final mark of theory (NT) will be:

NT = 0.6*NPT

The exams are not recoverable, that is to say, if a student cannot assist the day they are scheduled, the professors do not have obligation to repeat them. The mark of the missed exams will be 0.

1.c Practical

Students will carry out 2 practical tests properly programmed along the course. These tests will be valued from 0 up to 10 and the final mark of the practical (NP) will be:

NP = 0.35*[(NP1 + NP2)/2]

The practical tests are not recoverable, that is to say, if a student cannot assist the day they are scheduled, the professors do not have obligation to repeat them. The mark of the missed tests will be 0.

1.d Final mark of the subject

It must get a minimum of 4 points out of 10 in theory (NT >= 2.4) and practices (NP >= 1.4) to pass the subject. Also it is necessary to get a minimum of 3 points out of 10 in each of the 3 theory exams (NPT1 >= 3, NPT2 >= 3 and NPT3 >= 3).

The final mark (NF) will be:

If NT >= 2.4 and NP >= 1.4 and NPT1 >= 3 and NPT2 >= 3 and NPT3 >= 3 => NF = NAE + NT + NP

If NT < 2.4 or NP < 1.4 or NPT1 < 3 or NPT2 < 3 or NPT3 < 3 => NF = min {4.5; NAE + NT + NP}

2. Final exam

The students who do not follow the continuous evaluation or had a final mark lower than 5 (failed) in the continuous evaluation, will be able to present to a final exam.

The final exam will have a theoretical part and a practical one. The theoretical part will be carried out in the dates established by the School and it will consist in an exam (multiple choice test and/or short answer test and/or resolution of problems and/or exercises). This exam will have 3 parts, one for each block specified in section 1.b. Each part will be evaluated from 0 up to 10 and the final mark of theory (NT) will be the average multiplied by 0.6. It is necessary to get a minimum of 3 points in each of these parts (NPT1 >= 3, NPT2 >= 3 and NPT3 >= 3) and a minimum of 4 points out of 10 in theory (NT >= 2.4) to pass the subject.

The practical exam will be carried out in the laboratory in the dates established by the School and it will consist in a practical test which will be evaluated from 0 up to 10 and the final mark of practices (NP) will be the points of the test multiplied by 0.4. It must get a minimum of 4 points out of 10 in the practical exam (NP >= 1.4) to pass the subject.

By reasons of organisation of the groups of examination, the professors will open a period so that the students inscribe to the final exam of practices. Only those students who have inscribed in due time and form, according to the rules indicated by the professors in the corresponding announcement, will be able to take the final exam of practices.

The students who have opted for the continuous evaluation and have failed and present to the final exam, can do it only to the theoretical part or to the practical one or both. They will conserve the mark got in the continuous evaluation of the missed part if the minimums specified in the continuous evaluation process were achieved. The students who take the theoretical part will be able to carry out the blocks they want. The mark of the continous evaluation of the missed blocks (NPT1, NPT2 and NPT3) will be kept. If they do not take the practical part, the practice note (NP) of the continuous evaluation is recalculated multiplying by 0.4 instead of by 0.35.

The final mark (NF) will be:

If NT >= 2.4 and NP >= 1.6 and NPT1 >= 3 and NPT2 >= 3 and NPT3 >= 3 => NF = NT + NP

If NT < 2.4 or NP < 1.6 or NPT1< 3 or NPT2 < 3 or NPT3 < 3 => NF = min {4.5; NT + NP}

3. Recovery

The recovery call will have a theoretical part and practical one with the same format as the final exam.

The students who present to this call can do it only to the theoretical part, the practical one or both. They will conserve the mark got in the ordinary call (continuous evaluation or final exam). The students who take the theoretical part will be able to carry out the blocks they want. The mark of the ordinary call (continuous evaluation or final exam) of the missed blocks will be kept. The calculation of the final mark of the subject will be as described in section 2.

The final mark of the subject will be the best of the ordinary call and the recovery one.

By reasons of organisation of the groups of examination, the professors will open a period so that the students inscribe to the recovery practices exam. Only those students who have inscribed in due time and form , according to the rules indicated by the professors in the corresponding announcement, will be able to take this exam.

4. Validity of the qualifications

The qualifications of the student of the theoretical and practical parts of the subject will be valid only for the academic course in which they was got.

Sources of information
Hambley, A. R., **Electrónica**, 2ª ed., Prentice Hall,
Quintáns, C., **Simulación de circuitos electrónicos con OrCAD 16 Demo**, Marcombo,

Recommendations
Subjects that continue the syllabus
Digital Electronics/V05G300V01402
Electronic Technology/V05G300V01401

Subjects that it is recommended to have taken before
Physics: Analysis of Linear Circuits/V05G300V01201

IDENTIFYING DATA				
Electronic Technology				
Subject	Electronic Technology			
Code	V05G300V01401			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Raña García, Herminio José			
Lecturers	Cao Paz, Ana María Quintáns Graña, Camilo Raña García, Herminio José Río Vázquez, Alfredo del Valdés Peña, María Dolores			
E-mail	hrana@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course devotes to the utilisation of integrated circuits, in particular operational amplifiers, as well as to the following fields: Electronics of Power, Electrotechnics in his slope of electrical installations and to the conversion of photovoltaic solar energy and thermal.			

Competencies	
Code	
B13	CG13 The ability to use software tools that support problem solving in engineering.
B14	CG14 The ability to use software tools to search for information or bibliographical resources.
C14	CE14/T9: The ability to analyze and design combinatory and sequential, synchronous and asynchronous circuits and the usage of integrated circuits and microprocessors.
C16	CE16/T11: The ability to use different energy sources, especially photovoltaic and thermal ones, as well as the fundamentals of power electronics and electronics

Learning outcomes		
Expected results from this subject	Training and Learning Results	
To know how to analyse and use circuits with operational amplifiers and with other integrated circuits.	B13 B14	C14
To know the foundations of Electrotechnics.		C16
To know the foundations of the Power Electronics and the basic topologies of the power electronic converters.	B13 B14	C16
Ability to use distinct sources of energy and especially photovoltaic solar energy and thermal solar energy.	B13	C16

Contents	
Topic	
Operational amplifiers and other integrated circuits	Introduction to amplifiers: Appearances of frequency response in amplifiers. Bode diagrams. Principles of operation of an operational amplifier. Application circuits for operational amplifiers. Other integrated circuits of general application.
Power Electronics (I)	Introduction to Power Electronics. Power electronic devices .
Power Electronics (II)	DC power supplies. DC-DC converters.
Power Electronics (III)	Single-phase rectifiers. Single-phase inverters.
Electrotechnics	Electrical installations. Protections.
Photovoltaic and thermal solar energy	Photovoltaic and thermal solar installations. Photovoltaic cells. Photovoltaic panels. Photovoltaic systems of energy conversion.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	18	18	36
Laboratory practises	22	22	44

Troubleshooting and / or exercises	6	12	18
Short answer tests	3	15	18
Troubleshooting and / or exercises	3	15	18
Practical tests, real task execution and / or simulated.	4	12	16
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies

	Description
Master Session	The teachers explain the theoretical contents. Through this methodology the competencies CE14 and CE16 are developed.
Laboratory practises	They include circuit mounting and testing and computer electronic circuits simulation. Some practical clases will also include some web search made by the student, about some technical information about some specific electronic devices used in the practical classes (e.g. some kind of transistors or operational amplifiers). Through this methodology the competencies CE14, CE16, CG13 and CG14 are developed.
Troubleshooting and / or exercises	The teacher will solve exercises about most of the chapters. Through this methodology the competencies CE14 and CE16 are developed.

Personalized attention

Methodologies	Description
Master Session	The professor will attend personally doubts and queries of the students, about the study of theoretical concepts, about exercises or about practices of laboratory. The students may attend to these doubt/query sessions in the professor office in the schedule that the professors will establish at the beggining of the academic course. This schedule will be published in the page of the course. Some practical clases will include some web searchs made by the student, about some technical information about some specific electronic devices used in the practical classes (e.g. some kind of transistors or operational amplifiers).
Laboratory practises	The professor will attend personally doubts and queries of the students, about the study of theoretical concepts, about exercises or about practices of laboratory. The students may attend to these doubt/query sessions in the professor office in the schedule that the professors will establish at the beggining of the academic course. This schedule will be published in the page of the course. Some practical clases will include some web searchs made by the student, about some technical information about some specific electronic devices used in the practical classes (e.g. some kind of transistors or operational amplifiers).
Troubleshooting and / or exercises	The professor will attend personally doubts and queries of the students, about the study of theoretical concepts, about exercises or about practices of laboratory. The students may attend to these doubt/query sessions in the professor office in the schedule that the professors will establish at the beggining of the academic course. This schedule will be published in the page of the course. Some practical clases will include some web searchs made by the student, about some technical information about some specific electronic devices used in the practical classes (e.g. some kind of transistors or operational amplifiers).

Assessment

	Description	Qualification	Training and Learning Results
Short answer tests	They make part of each partial examination of theory, in which they are half of its value. The number of tests and how they work are detailed in "Other comments and second call".	35	C14 C16
Troubleshooting and / or exercises	They make part of each partial examination of theory, in which they are half of its value.The number of tests and how they work are detailed in "Other comments and second call".	35	C14 C16
Practical tests, real task execution and / or simulated.	They are made in the laboratory. They consist of the kind of tasks made or prepared during the practices of the course: the practical exams consist of: 1) mounting of circuits, taking measures on them and answering questions related with these circuits and 2) simulation circuits equal or similar to the ones studied in the practices and answering questions related with this simulation. In the examinations of practices of laboratory the student will be allowed to use some especific technical information collected by the student during the practices (eg datasheets from manufacturers).	30	B13 C14 B14 C16

Other comments on the Evaluation

NOTE: the lengths of the partial proofs specified in this section 'assesments' as "half an hour", "an hour", "two hours", probably will be shortened in a small percentage to make fit the proofs to the length of the class sessions. During the class period of teaching of the course, the exact length of these proofs will be published.

1. Continuous assesment:

The assesment of the course is made by means of a continuous assesment, that consists of partial proofs, both theoretical partial proofs as well as lab partial proofs. Nevertheless the student may choose instead a final examination as an alternative. The rules for the assesment are described in the following paragraphs.

If a student can not attend to a partial proof on the date it is programmed, the professors do not have obligation to repeat it. The qualifications of the partial proofs will be valid only for the academic course in which they take place .

To participate in the partial proofs of practices of laboratory the student must attend to all the laboratory practical classes. The students that do not fulfil this requirement can anyway attend to the partial proofs of theory and liberate themselves from its contents for the final examination of theory, according with the following explanations.

1.1. Theoretical proofs:

On the contents of theory there are during the four-month period two partial proofs that cover the 1st block and the 2nd block of the theory contents. There is no standalone '3rd partial proof'; the 3rd block of the theory is evaluated as a part of the final theory proof in the May final proof, in which participate all the students.

If the student gets a mark of 5 points (out of 10) in a partial proof, then he or she does not attend to the proof of its content in the final proof and the mark obtained is saved for the final proof (or May proof). If a student does not pass the partial proof, his/her mark is not saved for the final proof and so this marks works as a zero.

The weight of the theoretical proofs is 70% on the total of the final mark. This weight is 70%/3 for each block.

The partial proofs ('1st partial proof' and '2nd partial proof', either of theory or of laboratory practices) take place on the usual weekly scheduling of the classes. Their length is 2 hours. They include both one half (in time and in mark) of short answer questions and one half exercises.

1.2. Assesment of laboratory practices:

The practices evaluate by means of practical tests, described above (laboratory proofs). There are two laboratory partial proofs that, unlike the theory, cover the contents of all the course. The two lab partial proofs allow the student to liberate from its contents; i.e., if the student gets a mark of at least 5 points (out of 10) in a lab partial proof, this mark is saved as mark for this block for the lab final proof in May; if so, the student will not attend the proof of this part in the lab final proof in May.

If the student gets a mark greater than 5 point in both lab partial proofs, he/she will have a lab mark note greater than 5 and he/she will not attend to the lab partial proof in May. In the same way as the theory, if the student has a mark smaller than 5 points in a lab partial proof, then his/her mark is not saved for the final proof and so this mark works as a zero.

The two lab partial proofs have both the same weight.

1.3. Students presented:

The student joins continuous evaluation if and only if he/she attends to any of the partial proofs (either theoretical or laboratory ones) . From that moment, the student is considered as presented, and if he/she doesn't attend to any other partial proof, his/her mark on it will be zero.

1.4. Requirements to pass the course

The requirements a student has to fulfil to pass the course are explained in the following paragraphs. We begin the explanation back to forth in time: from the second call towards the May proof until the continuous assesment:

To pass the course the student needs a mark greater than 5 points as a whole. It must be taken in account that the weights are 7 points for the theory and 3 points for the lab. In addition, the mark in each section (i.e. both theory and lab) must be greater than 30% (3 points out of 10), in either type of evaluation (either continuous assesment or final examination without having joined the continuous assesment or second call examination).

In the second call (in which the evaluation of theory is no longer divided into blocks and the evaluation of practice is neither divided into blocks) the student must fulfill only the conditions stated in the previous paragraph. Nevertheless, in the final examination of May, in which the evaluation is made by blocks (three blocks in the contents of theory and two blocks in the contents of practices), the student needs a mark greater than 30 % (3 points out of 10) on every block.

To pass the course, the "provisional final note" of the course is considered. It is defined as:

ProvisionalFinalMark = TheoryMark x 0.7 + LabMark x 0.3

If TheoryMark and LabMark are both greater or equal that 3, then:

FinalMark = ProvisionalFinalMark

Else:

FinalMark = minimum {4.5 ; ProvisionalFinalMark}

The student passes the course if FinalMark is at least 5.

Being

TheoryBlockMark1, TheoryBlockMark2 and TheoryBlockMark3 the marks of each block of theory expressed over 10 points and

ProvisionalTheoryMark = (TheoryBlockMark1 + TheoryBlockMark2 + TheoryBlockMark3) /3, then:

If the mark of every block of theory is at least 3 points (out of 10), then:

TheoryMark = ProvisionalTheoryMark

Else: TheoryMark = minimum {ProvisionalTheoryMark ; 2.5}

In the same way:

Being LabBlockMark1 and LabBlockMark2 the marks of each lab block expressed on 10 points and

ProvisionalLabMark = (LabBlockMark1 + LabBlockMark2) /2, then:

If the mark of each one of the two blocks of practices is at least 3 (out of 10) , then:

LabMark = ProvisionalLabMark;

Else: LabMark = minimum {ProvisionalLabMark; 2.5}.

2. Evaluation by final proof

The students who do not join the continuous evaluation are evaluated in the final proof which consists of theoretical part and lab part. The theoretical part is the same for all the students that have not passed any partial proof, both the ones who failed them and the ones who didn't attend to them (the rules are explained in paragraph 1.1). For the "provisional final mark", the theory keeps the same weight as in the continuous assesment: 70%, divided into three equal parts for the three blocks, each of them divided into two halves of short answer questions and exercises.

The evaluation of lab practices for the students that did not join the continuous assesment is made by means of a lab practices proof in the period of final proofs, in the dates fixed in the calendar of final proofs. His length is two hours.

The weight of the lab mark on the "provisional final mark" is the same as for the students of continuous assesment: 30%.

To pass the course in the final proof, the student must fulfill the same conditions for "provisional final mark" and conditions of minimum theory mark and lab mark stated on the paragraph 1.4.

VERY IMPORTANT: The students who want to attend to the lab final proof of the course must enroll for it, prior to the proof, via the course web (section "Inscripciones") on May 18th, 2016. This preinscription is necessary to schedule the shifts for the lab proof. Only the students who enroll on that date will have right to do the lab proof.

3. Second call

The second call proof, like the final proof of the first call (May), consists of a theory proof and a practice proof, in the laboratory.

For the second call proof, all the paragraphs of the point 2 apply ("evaluation by final proof").

To pass the course in this call, the student must fulfill the same conditions of "provisional final mark" and conditions of minimum theory mark and lab mark explained in the point 1.4, except that there is not minimum mark by blocks, i.e. :

To pass the course, we define the "provisional final mark" of the course, which is:

ProvisionalFinalMark = TheoryMark x 0.7 + LabMark x 0.3.

If TheoryMark and LabMark are both greater or equal that 3, then:

FinalMark = ProvisionalFinalMark

Else:

FinalMark = minimum {4.5 ; ProvisionalFinalMark}

The student passes the course if FinalMark is at least 5.

All the students that have not passed the course in the first call (May) may attend to the two sections (theory and lab) of this proof. The rule of highest mark which is compulsory for the total mark of all the courses, will apply in this course also extended to each section; i.e., the theory mark of each student to calculate ProvisionalFinalMark for the second call mark will be the highest between the May theory mark and the mark in the second call theory proof. The same for the lab mark.

VERY IMPORTANT: In the same way as stated in section 2 for the May final proof, the students who want to attend to the second call lab proof must enroll to attend to it, via the course web on June 16th, 2016 . This preinscription is necessary to schedule the shifts for the lab proof. Only the students who enroll on that date will have right to do the lab proof.

Sources of information
Hambley, A. R., **Electrónica**, Prentice-Hall, 2ª ed. en español,
Hart, D. W., **Electrónica de potencia**, Prentice-Hall,
Rashid, Muhammad H., **Electrónica de potencia: circuitos, dispositivos y aplicaciones**, Pearson Education,
Reglamento Electrotécnico para Baja Tensión (REBT) e Instrucciones Técnicas Complementarias (ITC),
Schneider Electric España, S.A., **Guía de diseño de instalaciones eléctricas (PDF de uso libre disponible en www.schneiderelectric.es)**, Schneider Electric España, S.A,
Guirado, R., **Tecnología eléctrica**, McGraw-Hill,
AENOR, **Norma UNE 60617 de Símbolos gráficos para esquemas eléctricos**,
Carta, J. A. y otros, **"Centrales de energías renovables: Generación eléctrica con energías renovables"**, Pearson-UNED,
Quintáns Graña, C., **Simulación de circuitos con OrCAD 16 DEMO**, Marcombo,

Recommendations
Subjects that continue the syllabus
Analogue Electronics/V05G300V01624
Power Electronics/V05G300V01625

Subjects that it is recommended to have taken before
Physics: Analysis of Linear Circuits/V05G300V01201
Physics: Fundamentals of Electronics/V05G300V01305

Other comments

The student should have good knowledge about the course "Física: Fundamentos de Electrónica"/V05G300V01305 ("Physics: Electronics Fundamentals"/V05G300V01305), in both its theoretical contents as well as in the laboratory practic classes.

IDENTIFYING DATA				
Digital Electronics				
Subject	Digital Electronics			
Code	V05G300V01402			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Machado Domínguez, Fernando			
Lecturers	López Sánchez, Óscar Machado Domínguez, Fernando Moure Rodríguez, María José Pérez López, Serafín Alfonso Raña García, Herminio José			
E-mail	fmachado@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course is an introduction to the basic principles of digital design and the analysis and design of digital circuits and systems. First, logic circuits, basic digital devices and logic gates representation will be introduced. Then, hardware description languages (HDL) based design, description and simulation methods will be described. Combinational and sequential logic design will be explained using the top-down design paradigm. Finally, the common combinational and sequential logic circuits will be described: operation, diagrams, symbols and VHDL description and simulation.			

Competencies	
Code	
B13	CG13 The ability to use software tools that support problem solving in engineering.
B14	CG14 The ability to use software tools to search for information or bibliographical resources.
C14	CE14/T9: The ability to analyze and design combinatory and sequential, synchronous and asynchronous circuits and the usage of integrated circuits and microprocessors.
C15	CE15/T10: The knowledge and application of the fundamentals of description languages for hardware devices.

Learning outcomes		
Expected results from this subject		Training and Learning Results
Knowledge of digital design principles, components and tools.		C14 C15
Ability to analyse and design combinational systems.	B13	C14 C15
Knowledge of the combinational functional blocks and their aplications.	B14	C14
Knowledge of the basic storage elements, the sequential blocks and their aplications.	B14	C14
Ability to analyse and design synchronous sequential systems.	B13	C14 C15
Knowledge of description and simulation methods based on hardware description languages (HDL).	B13	C14 C15

Contents	
Topic	
Unit 1: Introduction to digital electronics	Introduction to Digital Electronics. Number systems and digital codes. Boolean Algebra. Truth Tables. Logic Gates. Boolean Funtions Simplification.
Unit 2: Introduction to VHDL	Introduction to hardware description languages. Basic VHDL syntax. Data types and objects. Operators. Concurrent and sequential sentences. Component instantiation.
Unit 3: Basic combinational systems	Functional blocks. Technologies and output types of the digital circuits. Decoders. Encoders. Multiplexers. Demultiplexers. Application examples. VHDL description.
Unit 4: Programmable gate arrays	Introduction to the programmable circuits. PLA and PAL. Application examples.
Unit 5: Arithmetic combinational systems	Comparators. Parity detection and generation. Arithmetic circuits. Application examples. VHDL description.

Unit 6: Sequential logic systems principles	Definition and classification. Latches and flip-flops. Application examples. VHDL description.
Unit 7: Synchronous sequential systems	General theory. Counters. Multibit registers. Shift registers. Application examples. VHDL description.
Unit 8: Synchronous sequential logic design	Synchronous sequential systems design. Application examples. VHDL description.
Unit 9: Programmable logical devices	Introduction to the PLDs. Application examples.
Unit 10: Memory units	Classification. Active and pasive random access memories. Random access memories. Sequential acces memories. Associative memories.

PRACTICE 1. INTRODUCTION TO XILINX ISE	General ISE flow diagram. Schematic description. Practical examples.
PRACTICE 2. INTRODUCTION TO VHDL DESIGN	Description and synthesis of combinational systems using VHDL. Practical examples.
PRACTICE 3. DIGITAL SYSTEMS TEST: FUNCTIONAL SIMULATION	Obtaining symbols from schematic. Component instantiation. Stimulus definition. Test-bench Functional simulation. Practical examples.
PRACTICE 4. DIGITAL SYSTEMS COMPILATION AND IMPLEMENTATION. TEMPORAL SIMULATION	PLD architecture (Xilinx CoolRunner 2 family). Compilation and implementation. Temporal simulation. Practical examples.
PRACTICE 5. TESTING DIGITAL SYSTEMS TEST IN THE DEVELOPMENT BOARD	PLD development board CoolRunner 2 starter kit from Xilinx. Configuration file. PLD Technology and configuration methods. PLD programming. Digital systems test in the development board. Implementation examples.
PRACTICE 6. COMBINATIONAL CIRCUITS	Design and implementation of combinational circuits using VHDL: truth table, logic function and behavioural descriptions.
PRACTICE 7. ARITHMETIC CIRCUITS	Design and implementation of arithmetic circuits usign VHDL: truth table, logic function and behavioural descriptions.
PRACTICE 8. ARITHMETIC SYSTEMS	Design and implementation of arithmetic systems usign VHDL. Arithmetic and logic unit (ALU).
PRACTICE 9. SEQUENTIAL CIRCUITS I	Design and implementation of sequential circuits usign VHDL (flip-flops, registers and counters).
PRACTICE 10. SEQUENTIAL CIRCUITS II	Design and implementation of sequential circuits usign VHDL (counters, shift registers). Design and implementation of synchronous sequential logic systems usign VHDL (state machines).
PRACTICE 11. COMPONENT ASSEMBLY AND CONNECTION. DIGITAL INSTRUMENTATION.	Logic analyser. Connection of external push-buttons, switches, LEDs, 7-segments displays. Test of sequential circuits using the logic analyser.
PRACTICE 12. SEQUENTIAL SYSTEMS I	Design and implementation of a sequential system based on functional blocks usign VHDL. Dynamic controller of a 4-digit, 7-segment display.
PRACTICE 13. SEQUENTIAL SYSTEMS II	Design and implementation of a complex sequential system. Reading system of a row and column based button keypad .

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	1	2
Master Session	13	21	34
Laboratory practises	26	26	52
Troubleshooting and / or exercises	8	20	28
Practical tests, real task execution and / or simulated.	2	2	4
Troubleshooting and / or exercises	6	24	30

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

Methodologies

	Description
Introductory activities	Subject presentation. Presentation of laboratory sessions, instrumentation and software resources to be used.
Master Session	The lecturer will explain in the classroom the main contents of the subject. The students have to manage the proposed bibliography to carry out a self-study process in a way that leads to acquire the knowledge and the skills related to the subject. The lecturer will answer the students questions in the classroom or in the office. In these sessions the students will develop the skils CE14 and CE15 ("know").
Laboratory practises	Activities designed to apply the main concepts and definitions of the subject. The students will be asked to acquire the basic skills to manage the laboratory instrumentation, software tools and components in order to construct and test electronic circuits. The students have to develop and demonstrate autonomous learning and collaborative skills. Possible questions can be answered in the laboratory sessions or in the lecturer s office. In these sessions the students will develop the skils CE15, CG13 and CG14 ("know how").

Troubleshooting and / or exercises	Activities designed to apply the main concepts of the subject to solve problems and exercices. The lecturer will explain a set of problems and the students have to solve diferent take-home sets of problems. The answers to selected problems will be provided later on. The lecturer will answer the students questions in the classroom or at the office. In these sessions the students will develop the skils CE14 and CG15 ("know how").

Personalized attention

Methodologies	Description
Master Session	The lecturer will answer the students questions and also give instructions to guide the studying and learning process. The students can go to the lecturers office. The timetable will be available on the subject website at the beginning of the term.
Troubleshooting and / or exercises	The lecturer will answer the students questions and also give instructions to guide the studying and learning process. The students can go to the lecturers office. The timetable will be available on the subject website at the beginning of the term.
Laboratory practises	The lecturer will answer the students questions and also give instructions to guide the studying and learning process. The students can go to the lecturers office. The timetable will be available on the subject website at the beginning of the term.

Assessment

	Description	Qualification	Training and Learning Results	
Laboratory practises	The lecturers will check the level of compliance of the students with the goals related to the laboratory skills. Marks for each session will be assessed in a 10 points scale. Final mark of laboratory, FML, will be assessed in a 10 points scale.	20	B13 B14	C15
Troubleshooting and / or exercises	The lecturers will check the students' skills to solve exercices and troubleshooting. Marks for each test will be assessed in a 10 points scale. Final mark of theory, FMT, will be assessed in a 10 points scale.	80		C14 C15

Other comments on the Evaluation

1. Continuous assessment

According to the guidelines of the degree and the agreements of the academic commission, a continuous assessment learning scheme will be offered to the students.

When the students perform a troubleshooting test or attend at least two laboratory sessions, ***they will be assessed by continuous assessment***.

The subject comprises two different parts: theory and laboratory. Once a task has been assessed, the students can not do/repeat the task at a later date. The marks are valid only for the current academic course.

1.a Theory

Three exercises and troubleshooting tests (ETT) are scheduled. The first and second test (ETT1 and ETT2) will be respectively performed after unit 4 and 7 (~ in weeks 6 and 12), in the usual weekly scheduling of the theoretical classes. The third test (ETT3) will be performed during the examination period in the date specified in the academic calendar. Marks for each test will be assessed in a 10 points scale. The minimum mark required to pass this part is of 4 (ETTi>=4). The weighted points from all assessed tests are added together to calculate the final mark of theory (FMT):

$$FMT = 0.3 \cdot ETT1 + 0.3 \cdot ETT2 + 0.4 \cdot ETT3$$

The students cannot do the tests at a later date. The student who miss a test will be assessed with a mark of 0 for that test.

If the minimun mark in the first or second test is not achieved (ETT1 or ETT2 less than 4), the students can repeat these parts in the same date of the third test.

1.b Laboratory

Thirteen laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in pairs. The first five sessions are guided practices. In these sessions, the instrumentation and software resources will be presented and the students will configure a programmable logic device following the design flow. These five sessions are

mandatory but will not be assessed. The following seasons will be assessed by continuous assessment. Each session will be only evaluated according to the developed work at the schedule date. The marks for these laboratory sessions (LSM) will be assessed in a 10 points scale. The lecturers will consider the work of the students carried out before the laboratory session to prepare the proposed tasks, the work in the laboratory to deal with them as well as the student□s behavior. A mark of 0 will be obtained for missing sessions. In order to pass the laboratory part the students can not miss more than two laboratory sessions. Only sessions 6 to 13 will be assessed. The weighted points from all assessed sesions are added together to calculate the final mark of laboratory (FML):

FML = (LSM6 + LSM7 + LSM8 + LSM9 + LSM10 + LSM11 + LSM12 + LSM13) / 8

1.c Final mark of the subject

The weighted points from all assessed parts are added together to calculate the final mark (FM). The following weightings will be applied: 80% theory (FMT) and 20% laboratory (FML). In order to pass the subject, students will be require to pass the laboratory and theory parts and to obtain at least a mark of 5 in each part (FMT>=5 and FML>=5). In this case the final mark (FM) will be:

FM = (0.8·FMT + 0.2·FML)

However, when the students do not pass both parts (FMT or FML less than 5) or do not reach the minimum mark of 4 required to pass each exersices and troubleshooting test or miss more than 2 laboratory sessions, the final mark will be:

FM = (0.8·FMT + 0.2·FML)·4.9/9

A final mark higher than five points (FM >= 5) should be achieved in order to pass the subject.

2. Final Exam

The students who prefer a different educational policy can attend an exam on a scheduled date. This exam consist on a theory part and laboratory part. In order to attend the laboratory exam, the students have to contact to the lecturer according to an established procedure. The procedure will be published in advance.

The theory exam will consist on three exercises and troubleshooting tests (ETT). Marks for each test will be assessed in a 10 points scale. The minimum mark required to pass this part is of 4 (ETTi>=4). The weighted points from all assessed tests are added together to calculate the final mark of theory (FMT):

FMT = 0.3·ETT1 + 0.3·ETT2 + 0.4·ETT3

The final mark of theory will be assessed in a 10 points scale.

The laboratory exam will consist on the resolution of a practical exercise in the laboratory. This practical exercise will be similar to those made in the laboratory sessions. The final mark of laboratory (FML) will be assessed in a 10 points scale.

In order to pass the subject, students will be required to pass the laboratory and theory exams. The minimum mark required to pass each part is of 5 (FMT>=5 and FML>=5). In this case the final mark (FM) will be:

FM = (0.8·FMT + 0.2·FML)

However, when the students do not pass both parts (FMT or FML less than 5) or do not reach the minimum mark of 4 required to pass each exersices and troubleshooting test or miss more than 2 laboratory sessions, the final mark will be:

FM = (0.8·FMT + 0.2·FML)·4.9/9

A final mark higher than five points (FM >= 5) should be achieved in order to pass the subject.

3. Second opportunity to pass the subject

This exam consist on a theory exam and a laboratory exam. Dates will be specified in the academic calendar. In order to attend the laboratory exam, the students have to contact to the lecturer according to an established procedure. The

procedure will be published in advance.

The marks obtained in the previous continuous assessment or final exam are kept for those parts in which the student has not attended.

The theory exam will consist on an exercises and troubleshooting test. The final mark of theory (FMT) will be assessed in a 10 points scale.

The laboratory exam will consist on the resolution of a practical exercise in the laboratory. This practical exercise will be similar to those made in the laboratory sessions. The final mark of laboratory (FML) will be assessed in a 10 points scale.

The minimum mark required to pass each part is of 5. In order to pass the subject, students will be required to pass the laboratory and theory exams (FMT>=5 and FML>=5). In this case the final mark (FM) will be:

$$FM = (0.8 \cdot FMT + 0.2 \cdot FML)$$

However, when the students do not pass both parts (FMT or FML less than 5) the final mark will be:

$$FM = (0.8 \cdot FMT + 0.2 \cdot FML) \cdot 4.9/9$$

A final mark higher than five points (FM >= 5) should be achieved in order to pass the subject.

Sources of information

Wakerly J. F., **Diseño Digital. Principios y prácticas**, 3ª,
S. Pérez, L. J. Álvarez, M.J. Moure, F. Machado, **Electrónica Digital**, Curso 2012-2013,
Wakerly J. F., **Digital Design. Principles and Practices**, 4ª,
E. Mandado, **Sistemas Electrónicos Digitales**, 9ª,
Thomas L. Floyd, **Fundamentos de Sistemas Digitales**, 9ª,
L.J. Álvarez, E. Mandado, M.D. Valdés, **Dispositivos Lógicos Programables y sus aplicaciones**, 1ª,
S. Pérez, E, Soto, S. Fernández, **Diseño de sistemas digitales con VHDL**,
L.J. Álvarez, **Diseño Digital con Lógica Programable**, 1ª,

Recommendations

Subjects that it is recommended to have taken before

Informatics: Computer Architecture/V05G300V01103
Mathematics: Linear Algebra/V05G300V01104
Physics: Fundamentals of Electronics/V05G300V01305

IDENTIFYING DATA				
Computer Networks				
Subject	Computer Networks			
Code	V05G300V01403			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Rodríguez Pérez, Miguel			
Lecturers	López Ardao, José Carlos López Bravo, Cristina Rodríguez Pérez, Miguel Rodríguez Rubio, Raúl Fernando Sousa Vieira, Estrella Suárez González, Andrés			
E-mail	Miguel.Rodriguez@det.uvigo.es			
Web	http://www.socialwire.es			
General description	Operating principles, architecture, technology and norms of computer networks, especially of Internet. Design-oriented course, complemented by practical skills			

Competencies	
Code	
B1	CG1: The ability to write, develop and sign projects in the field of Telecommunication Engineering, according to the knowledge acquired as considered in section 5 of this Law, the conception and development or operation of networks, services and applications of Telecommunication and Electronics.
B3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update 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.
B6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
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.
C11	CE11/T6: The ability to conceive, deploy, organize and manage networks, systems, services and Telecommunication infrastructures in residential (home, city, digital communities), business and institutional environments, being responsible for launching of projects and continuous improvement like knowing their social and economical impact.
C17	CE17/T12: The knowledge and usage of concepts of communication network architecture, protocols and interfaces.
C18	CE18/T13: The ability to differentiate the concepts of access and transport networks, packet and circuit switched networks, mobile and fixed networks, as well as distributed newtwork application and systems, voice, data, video, audio, interactive and multimedia services.
C19	CE19/T14: The knowledge of methods of networking and routing, as well as the fundamentals of planning and network evaluation based on traffic parameters.
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.
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		
Comprise the general organization and the basic aspects of operation of communication networks, and particularly of computer networks	B3	C17	D2
Identify and know employ the concepts of switching, access and transport networks and wired and wireless networks	B3	C18	
Comprise the principles and the organization of distributed applications and services, either data or media oriented	B3	C17	

Comprise and know how to analyze the operation of the Internet: the architecture, the service model, the data transport, the routing methods and inter-networking, error control and congestion control	B3 B6	C11 C17 C19	D2 D3
Dominate the technical standards and the fundamental protocols of the Internet	B3 B4 B6	C17 C18 C19	
Practical capacity to design, handle and configure computer networks, from the point of view of data switching and transport	B1 B9	C11	D4

Contents	
Topic	
1. Introduction	a) Network Infrastructure: Nodes, links and netwoks b) Circuit and Packet Switching c) Communications Architecture: Layers, encapsulating, models
2. Packet Networks. Internet	a) Performance: Throughput, delays, losses b) The Internet ecosystem
3. Links and subnetworks	a) Concept of link and subnetwork b) Interconnection of networks at level 2: Bridges
4. Ethernet and WiFi	a) Ethernet Switching. b) VLANs and trunking c) Spanning Tree d) WiFi networks
5. Internet and IP	a) Interconnection of subnetworks. Routers b) IP Addressing c) IP datagram format d) Fragmentation e) The ICMP protocol
6. IP Forwarding	a) IP Forwarding mechanism b) Connected and Next-Hop Routes c) The DHCP protocol
7. Name and address translation	a) ARP b) DNS c) NAT
8. Routing	a) Graph theory. Shortest distance paths b) Link state: Dijkstra's algorithm c) Distance vector: Bellman-Ford d) Broadcast routing
9. Internet routing	a) Routing hierarchy b) Intradomain routing: RIP, OSPF c) Interdomain routing: BGP
10. Midterm Exam	Lectures 1 to 7
11. Transport protocols	a) Service model b) TCP & UDP c) Transport connections: establishment, retransmissions, flow control
12. Congestion control	a) Network model b) Dynamics, fairness and stability c) TCP Reno, Vegas, FAST
13. Web. Content distribution networks	a) HTTP protocol b) Proxy web. Caching. Persistence c) Content distribution networks: architecture and operations
14. Network security	a) Vulnerabilities. Protection c) Secure network and transport layers c) Denial of service. Spoofing d) Fundamentals of cryptography e) Digital signatures

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	26	39	65
Troubleshooting and / or exercises	10	15	25
Autonomous practices through ICT	6	15	21
Integrated methodologies	0	10	10
Practice in computer rooms	10	15	25
Long answer tests and development	2	0	2
Long answer tests and development	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
Master Session	Exposition of ideas, concepts, techniques and algorithms that shape every lecture. With this methodology students should acquire competencies CT2, CT3, CG3, CG4, CE11, CE17, CE18 & CE19.
Troubleshooting and / or exercises	Resolution by part of the students of problems and exercises of some of the lessons, and resolution by the teacher in the classroom. With this methodology students should acquire competencies CG3, CG4, CE11, CE17, CE18 & CE19.
Autonomous practices through ICT	The students must develop a network program. There will be several sessions for tutoring with the professor and development, test and debugging of the programs in the laboratories where these will be tested and evaluated. With this methodology students should acquire competencies CG1, CG6, CT4, CG9, CE11, CE17 & CE19.
Integrated methodologies	Participation in on-line activities to be proposed along the course, and in activities of making questions and answer of these. With this methodology students should acquire competencies CE17, CE18 & CE19.
Practice in computer rooms	Practices in the computers of the computer classroom, guided by the professor. With this methodology students should acquire competencies CG1, CG9, CE17 & CE19.

Personalized attention	
Methodologies	**Description**
Master Session	Individual tuition will be dispensed to the students in the office hours announced at the beginning of the term. It is not mandatory to book the appointment.

Assessment				
	Description	Qualification	Training and Learning Results	
Autonomous practices through ICT	The students must develop a network program. There will be several sessions for tutoring with the professor and development, test and debugging of the programs in the laboratories where these will be tested and evaluated	20	B1 B6 B9	C17 C19
Integrated methodologies	Participation in on-line activities to be proposed along the course, and in activities of making questions and answer of these	10		C17 C18 C19
Long answer tests and development	Final exam	50	B3 B4	C11 C17 C18 C19
Long answer tests and development	Midterm exam	20	B3 B4	C11 C17 C18 C19

Other comments on the Evaluation

The students can choose the method of evaluation, continuous or single.

The Continuous Evaluation (CE) consist of three previous tests plus a final exam:

- A midterm exam (ME) in the 10th week, which will cover the contents of lectures 1 to 7, and represents 20% of the final grade (FG)
- The development of a network program (NP). The deadline will be the day of the final exam. The compliance of prescriptions and the quality of the software will determine the qualification of this test. Depending on the number of students, teachers may allow this program to be done by couples of students but in that case both members of the couple must belong to the same group of laboratory and both of them must follow continuous assessment. The NP represents 20% of the final (NF)
- Participation in online activities (AO) that will be proposed along the course and in the activities of raising questions and answer them. The OA represents 10% of the final grade (NG)
- A final exam (FE) covering all the contents, which has a weight of 50% of the final grade (FG)

FG-CE = 0.2·ME + 0.1·OA + 0.2·NP + 0.5·FE

The Single Evaluation (SE) will consist of the same Final Exam at the end of the semester and the same Network Program (NP) proposed for CE. In this case, the program must be made mandatory and delivered individually.

The grade of NP in this case is simply APT (with a numeric value 1), if it meets the minimum requirements or NOT APT (with a numeric value 0) in the other case or if the NP is not delivered, in which case the grade will be 40% of the FE. That is,

FG-SE = (0.4 + 0.6·NP) · FE

It is considered that a student choose CE when presenting to the midterm exam. The students not doing this exam must opt for SE.

There will be a second evaluation with a new FE and it will also be allowed to deliver a new NP consisting of a modified version of the program of the first evaluation, and whose specifications will be published with at least 4 weeks with respect to the deadline of the Final Exam. Any students, regardless of having opted for CE or SE, will be able to do this FE and present a new NP. *Those students that passed the subject in the first evaluation that want to attend the second one will have to present a signed letter asking the subject coordinator to assign them a "Not Presented" mark in the minutes of the first evaluation. The last day to present this letter is the day of the revision of the first evaluation exam.*

For students who chose CE, these FE and NP represent an opportunity to improve the grade in these with respect to the fist evaluation, and so the calculation of the final grade considers the best grade obtained.

For students who chose to SE, the FE and the NP are considered joint and inseparable, that is,

FG-SE = Max{(0.4 + 0.6·NP-1st) x FE-1st, (0.4 + 0.6·NP-2nd) · FE-2nd}

All students that assists to any of the written tests will be considered for evaluation in this subject.

The grades of all written tests, partial or final, programs and activities will only take effect in the academic year in which they are proposed and will be communicated to the students to later than 20 working days from the date of the examination.

Sources of information

J.F. Kurose, K.W. Ross, **Computer networking: a top-down approach featuring the Internet**, 6,
L. Peterson, B. Davie, **Computer networks: a systems approach**, 5,
C. López, M. Rodríguez, S. Herrería, M. Fernández, **Cuestiones de redes de datos: principios y protocolos**, 1,

Recommendations

Subjects that continue the syllabus

Data Networks: Technology and Architecture/V05G300V01542
Network and Switching Theory/V05G300V01642

Subjects that are recommended to be taken simultaneously

Data Communication/V05G300V01301

Other comments

Though advisable, it is not necessary prior exposure to computer programming.

IDENTIFYING DATA

Signal Transmission and Reception Techniques

Subject	Signal Transmission and Reception Techniques			
Code	V05G300V01404			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Comesaña Alfaro, Pedro			
Lecturers	Comesaña Alfaro, Pedro Isasi de Vicente, Fernando Guillermo López Valcarce, Roberto Márquez Flórez, Óscar Willian Rodríguez Banga, Eduardo Rodríguez Rodríguez, José Luis			
E-mail	pcomesan@gts.tsc.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The course "Techniques for Signal Transmission and Reception" is an introduction to the different existent methods for the exchange of information in digital format at the physical layer level. Its main focus is on pulse amplitude modulation (PAM) as illustrative example. The main components of a digital transmitter and receiver are described, as well as the different effects caused by the communication channel and the different performance parameters of a digital system.			

Competencies

Code	
B3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update 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.
B6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
C7	CE7/T2: The ability to use communication and software applications (ofimatics, databases, advanced calculus, project management, visualization, etc.) to support the development and operation of Electronics and Telecommunication networks, services and applications.
C9	CE9/T4: The ability to analyze and specify the main parameters of a communications system.
C10	CE10/T5: The ability to evaluate the advantages and disadvantages of different technological alternatives in the implementation and deployment of communication systems from the point of view of signals, perturbations, noise and digital and analogical modulation systems.
C20	CE20/T15: The knowledge of national, European and international telecommunication regulations and laws.
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.

Learning outcomes

Expected results from this subject	Training and Learning Results		
Differentiate the blocks and the functionalities of a complete transmission data system.	B3	C7 C9 C10	
Identify the minimum requirements for a reliable data communication.	B3 B4	C9 C10	
Distinguish the fundamental parameters of a complete communications system oriented to data transmission.	B3 B4	C9 C10	
Describe, develop and analyse the different blocks of a data transmission system.	B3 B6	C9 C10 C20	D3

Develop and implement basic circuits for modulation and demodulation of signals.	B4 B6	C9 C10 C20	D2
Use applications of communication and computer (text processing, databases, advanced calculus, management of projects, visualisation, etc.) to support the design of data transmission systems.	B4		D2 D3
Recognise the different quality assessment measures of a digital signal.		C9 C10	
Statistically analyse the noise and understand its effects.	B3	C9 C10	

Contents

Topic	
1. Introduction to digital communication systems	-Basic elements and general description of a communication system. -Analog and digital communications -Description of a digital transmitter -Description of a digital receiver
2. Signals, systems and stochastic processes in communications	-Review of basic concepts: signals, systems, transforms. -Autocorrelation function of a stochastic process. -Power spectral density. Transmitted power, transmission bandwidth. -Noise characterization
3. Frequency conversion and analog processing	-Amplitude modulation (AM): with large carrier, with suppressed carrier -I/Q Modulation and demodulation. - Transceiver requirements and specifications -Receiver architectures: direct conversion, intermediate frequency. Analog and digital stages.
4. Pulse amplitude modulation (PAM)	- Baseband PAM - Bandlimited channels and intersymbol interferences (ISI) - Nyquist criterion, raised cosine pulses, eye diagram - Bandpass PAM
5. Modulation and detection in Gaussian channels	-Introduction to the Signal Space -Derivation of the Matched Filter -Maximum A Posteriori (MAP) and Maximum Likelihood (ML) detectors -Probability of error
6. The communication channel	-Transmission media -Signal to noise ratio -Multipath and frequency selectivity -Fading -Doppler effect

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	24	24	48
Practice in computer rooms	21	31.5	52.5
Troubleshooting and / or exercises	2	8	10
Laboratory practises	6	9	15
Long answer tests and development	2	16	18
Short answer tests	1	5.5	6.5

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

Methodologies

	Description
Master Session	Presentation and discussion of the fundamental theory. Through this methodology the competencies CE9, CE10, CE20, CG3, CG4, CG6, CT2, CT3 are developed
Practice in computer rooms	The concepts presented in class will be further illustrated and developed by means of Matlab-based simulation and signal processing tools. Through this methodology the competencies CE7, CE9, CE10, CG3, CG4, CT2 are developed
Troubleshooting and / or exercises	Students will be given different take-home sets of problems. The answers to selected problems will be provided later on. Through this methodology the competencies CE9, CE10, CG4 are developed

Laboratory practises	Experimental study of different components and effects in analog transmitter/receiver frontends. Through this methodology the competencies CE9, CE10, CG3, CG6, CT2 are developed

Personalized attention

Methodologies	Description
Laboratory practises	Student aid will be provided during office hours as well as on-line (email, chat). On-line discussion forums will be set up for each chapter, through the usual e-learning platform.
Master Session	Student aid will be provided during office hours as well as on-line (email, chat). On-line discussion forums will be set up for each chapter, through the usual e-learning platform.
Practice in computer rooms	Student aid will be provided during office hours as well as on-line (email, chat). On-line discussion forums will be set up for each chapter, through the usual e-learning platform.
Troubleshooting and / or exercises	Student aid will be provided during office hours as well as on-line (email, chat). On-line discussion forums will be set up for each chapter, through the usual e-learning platform.

Assessment

	Description	Qualification	Training and Learning Results		
Long answer tests and development	Final examination. It will cover all of the material covered during the course and will take place during the exam period as established by the Center.	60	B3 B4 B6	C9 C10 C20	D2
Short answer tests	Three short tests will be given during the semester.	40	B3 B4 B6	C7 C9 C10 C20	

Other comments on the Evaluation

For those students that choose continuous assesment. Four tests: 10% the first, 15% the second, 15% the third, and 60% the fourth.

The three first will realise roughly in the weeks 5, 9, and 14. The results will give to know in a reasonable time from his realisation. These tests are not recoverable, that is to say, if a student can not realise them in the moment in that they take place, the instructors do not have the obligation of repeating them. Each test will evaluate the exposed concepts in the subject from its start until the previous week to its realisation, included. The fourth test will be a version reduced of the examination that will realise those who do not choose continuous assesment.

For those students that do not choose continuous assessment. Final examination: 100%

Students will be graded as long as they make any test (either the short tests, or the final examination). Students will be considered to choose continuous assesment as long as they make any short answer test. Students choosing final assesment will only make the final exam.

Students who chose continuous assesment and did not pass the subject, will receive the "fail" mark, independently of doing the final exam or not.that

The achieved mark will be kept for the retest, but not for subsequent years.

During the retest those students who chose continuous assessment will be allowed to choose if they wish to keep the mark achieved in the short tests, or if they want to be 100% assessed by the final exam.

Sources of information

C.R. Johnson Jr., W.A. Sethares, **Telecommunication Breakdown**, 1,

A. Artés, F. Pérez González et al., **Comunicaciones Digitales**, 1,

Leon W. Couch, **Digital & Analog Communication Systems**, 7,

Bernard Sklar, **Digital Communications: Fundamentals and Applications**, 2,

J. G. Proakis, M. Salehi, **Fundamentals of Communication Systems**, 1,

B. Razavi, **RF Microelectronics**, 1,

R. Sobot, **Wireless communication electronics : introduction to RF circuits and design techniques**, 1,

Recommendations

Subjects that continue the syllabus

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G300V01201
Mathematics: Probability and Statistics/V05G300V01204
Digital Signal Processing/V05G300V01304

Other comments

It is assumed that the student has basic knowledge of analog and digital signal processing, as well as of probability and statistics.

IDENTIFYING DATA				
Fundamentals of Sound and Image				
Subject	Fundamentals of Sound and Image			
Code	V05G300V01405			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Martín Rodríguez, Fernando			
Lecturers	Docio Fernández, Laura Márquez Flórez, Óscar Willian Martín Rodríguez, Fernando Pena Giménez, Antonio			
E-mail	fmartin@uvigo.es			
Web	http://faitic.uvigo.es			
General description	"Fundamentos de Sonido e Imagen" presents the basic concepts of sound and image, as well as the processes operating over the audiovisual signals.			

Competencies	
Code	
B3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations
B5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
C13	CE13/T8: The ability to understand the electromagnetic and acoustic wave mechanisms of propagation and transmission, and their corresponding receiving and transmitting devices.
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.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Analysing the basic properties of the sound.		C13	D3
Explaining different sound production systems: human sound production, musical instruments, machines and other vibrant systems.		C13	D3
Interpreting results of acoustic measures and selecting tools for the appropriate analysis.	B5		D3
Describing the human perception of sound based on the physiological interface and the psychology of the perception.		C13	D3
Reviewing diffrent processes and systems associated to the sound production	B3 B5		D3
Applying the basic rules of the colorimetry.	B3		D3
Analysing lens systems.	B3 B5		D3
Choosing the most suitable capture and presentation image sytems.	B3 B5		D3
Choosing the most adapted formats for image and video.	B3 B5		D3
Relating the influence of the coding parameters with the results of compression and quality.	B3 B5		D3

Contents	
Topic	
S1. Acoustic waves	Introduction. Acoustic wave equation. Harmonic plane waves. Spherical waves. Power and Intensity. Diffraction
S2. Sound propagation and transmission	Acoustic field. Propagation.Transmission between different media.
S3. Sound radiation and production	Impedances. Transductors. Mechanical vibration. Radiation of simple sources. Directivity.
S4. Sound perception	Human audition. Auditory losses. Equal loudness contours.

I1. Colorimetry	Fiixed image signals and video signals. Visual human system. Light and colour. Visual effects.
I2. Capture and representation of images	Cameras and lens. Monitors. 3D Visualisation.
I3. Image and video coding	Fixed image: format of colour YUV; standards of compression. Image in movement: H.261 standard; MPEG formats.
Projects S1 and S2. Sound analysis.	Time, frequency and spectrograms.
Projects S3 and S4. Sound measurements	Sound pressure level. Sonometer. Octave-filter banks
Project I1. Colorimetry	Basic functions
Project I2. Fixed images coding	Functions for JPEG coding
Project I 3. Video coding	Time-predictive coding

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Master Session	25	50	75
Troubleshooting and / or exercises	6	12	18
Practice in computer rooms	19	19	38
Forum Index	0	1	1
Multiple choice tests	0	2	2
Long answer tests and development	4	0	4
Short answer tests	1	0	1
Reports / memories of practice	0	10	10

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

Methodologies

	Description
Introductory activities	Course presentation: programme, reading materials, teaching methodology and assessment system. Developed capabilities: CG3, CG5, CE13, CT3.
Master Session	Instructor presentation of the main concepts of each subject. Classes do not cover all content that is examination material. The student should take the contents of the documents provided for each subject. Student will work alone afterwards on the concepts studied in class and on expanding this content using the documents provided for each subject. Identification of doubts that need to be resolved in personalized tutorials. Developed capabilities: CG3, CG5, CE13, CT3.
Troubleshooting and / or exercises	Problems and exercises formulated according to the content of the lectures and the documents for each subject. Students solve problems and exercises prior to the class. Identification of doubts that need to be resolved in personalized tutorials. Developed capabilities: CG3, CG5, CE13, CT3.
Practice in computer rooms	Handling of analysis tools and algorithms. Identifying which one must to be used to solve each specific problem. Identification of doubts that need to be resolved in personalized tutorials. Developed capabilities: CG3, CG5, CE13, CT3.
Forum Index	The website for the course is included in the TEMA platform (http://faitic.uvigo.es). Subscription to this platform, including a photograph, is mandatory. The website provides all the information related to the course. It also publishes continuous assessment grades and runs forums for students to exchange ideas and discuss doubts. Developed capabilities: CG3, CG5, CE13, CT3.

Personalized attention

Methodologies	Description

Troubleshooting and / or exercises	Students will have the opportunity to attend personal tutorials in their lecturer□s office. These tutorials can be individual or in reduced groups (typically with a maximum of 2-3 students). Previous appointment with the corresponding professor will be requested and fixed by email, preferably in the schedules and place established by lecturers at the beginning of the academic year and published on the course website.
Practice in computer rooms	Students will have the opportunity to attend personal tutorials in their lecturer□s office. These tutorials can be individual or in reduced groups (typically with a maximum of 2-3 students). Previous appointment with the corresponding professor will be requested and fixed by email, preferably in the schedules and place established by lecturers at the beginning of the academic year and published on the course website.
Master Session	Students will have the opportunity to attend personal tutorials in their lecturer□s office. These tutorials can be individual or in reduced groups (typically with a maximum of 2-3 students). Previous appointment with the corresponding professor will be requested and fixed by email, preferably in the schedules and place established by lecturers at the beginning of the academic year and published on the course website.
Tests	**Description**
Reports / memories of practice	Students will have the opportunity to attend personal tutorials in their lecturer□s office. These tutorials can be individual or in reduced groups (typically with a maximum of 2-3 students). Previous appointment with the corresponding professor will be requested and fixed by email, preferably in the schedules and place established by lecturers at the beginning of the academic year and published on the course website.

Assessment

	Description	Qualification	Training and Learning Results	
Multiple choice tests	On the faitic website.	7.5	B3	
Long answer tests and development	To evaluate theorical knowledges and problems resolution.	65	B3 B5	C13
Short answer tests	Exam with questions and problems.	5	B3	
Reports / memories of practice	Report about the perfomed work during several weeks in the computer classroom.	22.5	B5	

Other comments on the Evaluation

CONTINUOUS ASSESSMENT

The continuous assessment consists of several activities. If the student can not do them in the fixed date, this activity will not be evaluated. The grades of these activities will be valid only for the present academic course.
If the student sits for "Exam 1", she/he will be evaluated by continuous assessment. Furthermore, once the student has taken this exam, she/he will be considered to have attended this examination call. Qualification will be computed using the following criteria with no consideration if she/he takes the final exam or not.

Types and assessment of activities:

1. Exam 1 (Weight: 15%): weeks 7-8. It includes the subjects explained until this week.
2. Tests (Weight: 7.5%): developed along the course on the faitic website.
3. Exam of practices (Weight: 7.5%): week 6-7.
4. Short answer exam (Weight: 5%): week 13. It includes several subjects.
5. Lab project report (Weight: 15%): weeks 13 and 14.
6. Exam 2 (Weight: 50%): on the date of the final exam. It includes all the subjects, except those evaluated in the Exam 1 and the contents of lab projects.

In order to ensure that students acquire a balanced minimum on the subject competences, they will pass the course if they meet these two conditions:

1) get a final mark equal to or greater than 5 (on a ten-points scale)

2) and a score equal to or greater than 3.5 (on a ten-points scale) in each one of these two sets:

* assessment of sound-related scores

* assessment of image-related scores

Results for all assessment items will be announced as soon as possible.

NON CONTINUOUS ASSESSMENT

Students will be evaluated by means of an only exam, in the official date, if they don't do the "Exam 1". The grades for this final exam are between 0 and 10 points. It includes all the subjects of the course, including the laboratory works.

In order to ensure that students acquire a balanced minimum on the subject competences, they will pass the course if they meet these two conditions:

1) get a final mark equal to or greater than 5 (on a ten-points scale)

2) and a score equal to or greater than 3.5 (on a ten-points scale) in each one of these two sets:

* assessment of sound-related scores

* assessment of image-related scores

Student can do the activities of Continuous Assessment, except the Exam 2.

Second opportunity exam:

⇒ Students evaluated by Continuous Assessment can opt between two possibilities the same day of the exam:

1. Do again the Exam 2 and be evaluated according what is stipulated for the system of "Continuous Assessment".
2. Be evaluated with a single final exam in the official date assigned by the Centre. The grades for this final exam are between 0 and 10 points. It includes all the subjects of the course, including the laboratory works. "Non Continuous Assessment" rules apply.

⇒ Studentss not evaluated by Continuous Assessment:
The grades for this final exam are between 0 and 10 points. It includes all the subjects of the course, including the laboratory works. "Non Continuous Assessment" rules apply. No other activities are assessed.

Sources of information
Finn Jacobsen et al., **FUNDAMENTALS OF ACOUSTICS AND NOISE CONTROL**,
Lawrence Kinsler, Austin Frey, Alán Coppens, James Sanders, **FUNDAMENTALS OF ACOUSTICS**,
R. J. Clarke, **Digital Compression of Still Images and Video**,
T. Perales Benito, **Radio y Televisión Digitales: Tecnología de los Sistemas DAB, DVB, IBUC y ATSC**,
Ulrich Reimers, **DVB : the family of international standards for digital video broadcasting**,

In addition to the previous bibliography, students will be provided with:

* Documents for each subject: main material for an appropriate preparation of the course.
* Documents with the project's contents for each practise session.
* Copy of the graphic material used in the master sessions.
* Problems proposed: A set of problems recommended for each subject.

Recommendations
Subjects that continue the syllabus
Room Acoustics/V05G300V01635
Fundamentals of Acoustics Engineering/V05G300V01531
Fundamentals of Image Processing/V05G300V01632
Sound Processing/V05G300V01634
Audio Systems/V05G300V01532
Imaging Systems/V05G300V01633
Audiovisual Technology/V05G300V01631
Video and Television/V05G300V01533

Subjects that are recommended to be taken simultaneously

Signal Transmission and Reception Techniques/V05G300V01404

Subjects that it is recommended to have taken before

Physics: Fields and Waves/V05G300V01202
Physics: Fundamentals of Mechanics and Thermodynamics/V05G300V01102
Digital Signal Processing/V05G300V01304
Electromagnetic Transmission/V05G300V01303