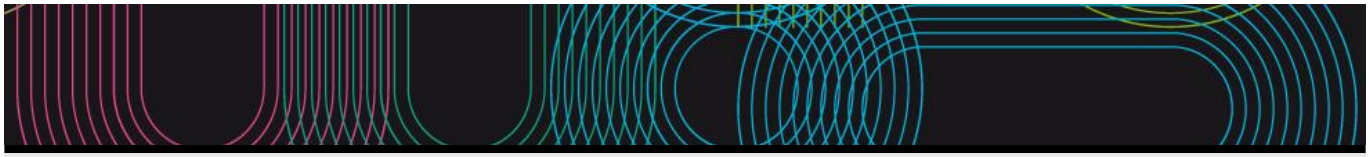

(*)Escola de Enxeñaría de Telecomunicación

(*)Páxina web

(*)

www.teleco.uvigo.es

(*)Presentación

(*)

A Escola Enxeñaría de Telecomunicación oferta para o curso académico 2017-18 un grao e dous másteres totalmente adaptados ao Espacio Europeo de Educación Superior, verificados pola ANECA axustándose á Orde Ministerial CIN/352/2009. A continuación indícanse os enlaces de acceso aos dípticos informativos dos tres títulos.

Grao en Enxeñaría de Tecnoloxías de Telecomunicación

http://teleco.uvigo.es/images/stories/documentos/gett/diptico-uvigo-eet-grao-gal.pdf

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

Máster en Enxeñaría de Telecomunicación

http://teleco.uvigo.es/images/stories/documentos/met/diptico-uvigo-eet-master-gal.pdf

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

Máster Interuniversitario en Matemática Industrial

http://teleco.uvigo.es/images/stories/documentos/promocion/M2i_Presentacion.pdf

www: http://m2i.es

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(*)

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Degree in Telecommunications Technologies Engineering

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	Degree in Telecommunications Technologies Engineering			
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 Suárez González, Andrés			
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 enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
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	28	0	28
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	3	0	3
Short answer tests	1	0	1

*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	Students will receive personalized attention (in the professor's office, during the office hours) to resolve doubts that can arise in the autonomous study of the subject.
Autonomous troubleshooting and / or exercises	Students will receive personalized attention (in the professor's office, during the office hours) to resolve doubts that can arise in the autonomous resolution of exercices.

Assessment

	Description	Qualification	Training and Learning Results		
Long answer tests and development	Two partial examinations. 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.	70	B3 B4	C11 C17 C18 C20	D2 D3
Short answer tests	They will be realised with periodicity roughly twice-weekly during the sessions of type B classes.	30	B3	C17 C18	D3

Other comments on the Evaluation

A continuous evaluation of the learning will be practiced. This evaluation consist of two types of tests: short tests, every two weeks, to evaluate the steady student learning, that will take place during the group B sessions; and two partial examinations, the first one in the midterm and the second one at the end of the class period. These tests will not be repeatable and will only be accountable in the current course.

The assessment of the continuous work will be obtained as the weighted average of all the mentioned tests: 30% due to all the short tests (equally weighted) and 35% of each one of the partial examinations, whenever the average score of partial examinations was not less than 3,5. In other case, the grade of the continuous evaluation will be the average score obtained in the partial examinations.

All the students that have not reached at least a score of 5 in the continuous evaluation (included the students not evaluated) can do a final examination, that will include ALL the contents of the subject and that will take place in the exam period scheduled by the Centre. In this case, the final grade of the subject will be the exam score.

All the students that are bound to continuous evaluation or take the final examination will be graded. The students that attend to the second partial exam will be considered bound to continous evaluation.

Those who do not surpass the subject at the earliest opportunity have a second one consistent in the realisation of a new final examination.

In case of plagiarism in any one of the tests (short tests, partial examinations or final examination), the final grade will be FAIL (0) and the fact will be reported to the direction of the Centre for the timely effects.

Sources of information

Basic Bibliography

C. López García, M. Fernández Veiga, **Teoría de la Información y Codificación, 2/e**, 2013,

Complementary Bibliography

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: Linear algebra/V05G300V01104
Mathematics: Calculus 1/V05G300V01105
Mathematics: Probability and Statistics/V05G300V01204

IDENTIFYING DATA				
Programming II				
Subject	Programming II			
Code	V05G300V01302			
Study programme	Degree in Telecommunications Technologies Engineering			
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			
E-mail	francisco.fernandez@det.uvigo.es			
Web	http://www.faitic.es			
General description	The general aim of this subject is to provide to the student the theoretical foundations and the practical competitions that allow him analyse, design, develop and debug computer applications following the paradigm oriented to objects. This is an essentially practical subject and in this sense is oriented to the work of the students in the realisation of one or several projects. To facilitate the development of the projects, in the subject will realise firstly a very brief introduction to the discipline of Software Engineering , linking it with the paradigm of the object oriented programming (OOP) and restricting it only to the stages of analysis, design, implementation and debugging. Then we will analyse in detail the elements of OOP, using elements and UML diagrams that they will be used by the students in his developments. To reach this general aim the contents that will be handled in the subject can be summarized in the following items: - Basic concepts of Software Engineering. - 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: generalisation, association and dependency. - Communication between objects: methods, events, messages. - Persistence. Storage in files and in databases. - Generation, capture and processing of exceptions. - Introduction tothe UML modeling language.			

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	Revision and comments of solved exercises. Glossary of frequent errors to avoid. Recommendations of style and organization.
Projects	Beside commenting with the group, diferent alternatives, recommendations and strategies for the good realization of the project, we examine with group members the level of understanding of the project, particular doubts that can arise, errors of design and code and options of improvement.
Autonomous troubleshooting and / or exercises	Review and comments with each group of the diverse practise proposed during his development phase. Help for compilation and execution errors. Detection and solution of conceptual errors.
Case studies / analysis of situations	Review and general critic of the UML design UML of each group during his development.

Assessment

	Description	Qualification	Training and Learning Results
Projects	Students, organised in groups of two, will deliver the proposed software project at most the first school day after Christmas. This will consist of his final design (UML diagrams), the code and the documentation generated explanatory of the implementation. That the code delivered can be compiled and executed in the laboratory computers will be necessary condition to surpass this proof of evaluation. During the last week of the course, students will have an interview with the professor in the schedule of the laboratory, devoted to show the authorship of the project and realise diverse proofs of functionality. Both members of the group must attend the interview. The issues raised therein will have to be answered individually to be able to ascertain the degree of understanding and implication of the student in the project developed, owing each student identify the parts of the project that has implemented. The adecuate answers wil be used to establish, together with a group of tests of functionality and the analysis of the quality of the code, the individual cualification of each student. In case that a student do not accredit properly the authorship, the project will be considered not valid, and the students will be considered suspense in the corresponding announcement. For the students that accredit properly the authorship, the evaluation of the project will take into account so much the adecuate answers in the authorship interview, like the correct functionality, like the quality of the code and the use of the technics of object oriented programming. The determination of the correct functionality will be realised by means of a group of around 50 tests on the software delivered.	33	B6 C50 B14 C53
Case studies / analysis of situations	At the end of the 9ª week of the academic course the students, organised in groups of two, will deliver the UML design of a project software. In lective hours the members of each group wil do with the professor a brief authorship interview of this design, which together with the delivered design, wil be used to establish the individual note of each student.	7	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. In lective hours the members of each group wil realise with the professor a brief authorship interview of the initiation practices, which together with a group of tests of correct operation on the software delivered, wil be used the establish the individual note of each student.	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 announcement. Students that 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 only will be saved for the second announcement if it is equal or higher than 4.5 over 5.

 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 (7%). It corresponds to the 2nd proof described in the evaluation section.
2. Implementation (33%). 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 announcement. Students that 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 only will be saved for the second announcement if it is equal or higher than 4.5 over 5.

 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 the first school day after Christmas holidays.

- 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 the student does not accredit properly the authorship did not surpass the announcement, and will have to do the corresponding project to the second announcement.

 The requirements to approve 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 announcement. 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 0.4 of 0.7.

- The students that do not deliver the project in the first announcement or that have not surpassed the authorship interview, will have to do necessarily the extended project of the second announcement. In any case lose the notes of the parts of initiation in Java and UML design if they opted for the CE in the first announcement, that is to say, will be evaluated on 5.

- 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. 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 by CE or Mark between 5/3 < 2.5 with TE*. Must do necessarily the extended project of the second announcement. 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 by TE*. Must do necessarily the extended project of the second announcement. 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.

 Requirements to pass. 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 Bibliography

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Complementary Bibliography

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G. Booch, J. Rumbaugh, I. Jacobson, **The Unified Modeling Language User Guide**, 2, Addison-Wesley., 2005

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A. Eberhart, S. Fischer, **Java Tools**, Wiley, 2002

M. Page-Jones, **Fundamentals of object-oriented design in UML**, Addison-Wesley, 2002

M. Fowler, **UML Distilled: A Brief Guide to the Standard Object Modeling Language**, 3ª edicion, Addison-Wesley., 2003

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Recommendations

Subjects that it is recommended to have taken before

Programming I/V05G300V01205

IDENTIFYING DATA				
Electromagnetic Transmission				
Subject	Electromagnetic Transmission			
Code	V05G300V01303			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Vera Isasa, María			
Lecturers	García-Tuñón Blanca, Inés Gómez Araújo, Marta 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 enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
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	
Introduction	Types of transmission media, advantages and disadvantages, characterisation.

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.
Waveguides	Transmission modes, cutoff frequency, guided wavelength, wave impedance. Rectangular waveguide.
Optical fiber.	Structure and types. Numerical aperture and acceptance cone. Attenuation and dispersion. Optical sources and receptors.
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. 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. - Optical fiber transmission fundamentals. - Basic impedance matching technics. - Radiation pattern plots. - Measurement of antenna basic parameters. - Problem resolution.

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Master Session	18	27	45
Autonomous troubleshooting and / or exercises	7	28	35
Laboratory practises	10	2	12
Practice in computer rooms	8	2	10
Classroom work	8	16	24
Troubleshooting and / or exercises	3	12	15
Multiple choice tests	1	7	8
*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 and CT2 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 and CE13 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 and 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 and CT3 are developed.
Classroom work	Activities of acquisition and handle of technics and tools related with the matter. Through this methodology the competencies CG3 and CG4 are developed.

Personalized attention	
Methodologies	**Description**

Master Session	In the tutorial schedule, teaching staff will attend the needs and queries of the students related with the study of the subject.
Laboratory practises	The teaching staff will set the time of the session and will resolve the questions about the practical implementation.
Autonomous troubleshooting and / or exercises	In the tutorial schedule, teaching staff will attend the needs and queries of the students related with the study of the subject.
Practice in computer rooms	The teaching staff will set the time of the session and will resolve the questions about the practical implementation.
Classroom work	The teaching staff will set the time of the session and will resolve the questions about the practical implementation.

Assessment

	Description	Qualification	Training and Learning Results	
Classroom work	Short checks (see other comments)	25	B4 B5	C8 C20
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.	35	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

Continuous assessment includes the following tasks performed approximately in the week indicated:

- Classroom work: four short checks carried out in practical hours (weeks 4, 9, 12 and 14) weighing 5%, 5%, 5% and 10%, respectively.
- Test: two quizzes. The first half of the quarter, with a weight of 25%, and the second at the end, weighing 10%.
- Problem solving: two exams. The first half of the quarter, with a weight of 20% and the second at the end, with a weight of 20%.

To pass the subject by this evaluation system, 1/3 of the maximum score of each item in the above table must be obtained and 50% minimum of the global score (sum of the three blocks) must be reached.

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, in which case they receive a grade that corresponds, independently that they present to other tasks or not. Failure to submit to this test implies that the evaluation choice is by final exam. 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: test on measurement practices (10%) and information search exercise (5%).
- Part II: questions (35%).
- Part III: problem solving (50%).

Second chance

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

Students who have opted for the continuous assessment system may keep the grade (classroom work, test or problem) in which they have exceeded the required minimum.

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
Basic Bibliography
F.T. Ulaby, **Fundamentals of Applied Electromagnetics**, 7ª,
S.M. Wentworth, **Applied electromagnetics. Early transmission line approach**, 1ª,
D. K. Cheng, **Fundamentos de electromagnetismo para ingeniería**,
Complementary Bibliography
B.M. Notaros, **Electromagnetics**, Pearson, 2011
N.N.Rao, **Elements of engineering electromagnetics**, 6ª, Pearson, 2004
J.D. Krauss, **Electromagnetismo con aplicaciones**, McGraw-Hill, 2000
D. K. Cheng, **Field and Wave Electromagnetics**, 2ª, Addison-Wesley, 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 1/V05G300V01105
Mathematics: Calculus 2/V05G300V01203

IDENTIFYING DATA				
Digital Signal Processing				
Subject	Digital Signal Processing			
Code	V05G300V01304			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Alonso Alonso, Ignacio			
Lecturers	Alonso Alonso, Ignacio Docio Fernández, Laura García Mateo, Carmen Márquez Flórez, Óscar Willian			
E-mail	ignacio.alonso@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 enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
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	Introduction to discrete-time systems. 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	Introduction to continuous-time 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. 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 a numerical mark between 0 and 10. A student needs a grade equal or greater than 5 to pass the Lab. If the Lab grade is greater than 7, the Lab grade will increase the Course mark (see details below).
- 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 and the Lab grade is not greater than 7:
        - Course mark=Problem assessment grade.
    - If you have passed all two parts and the Lab grade is greater than 7:
        - Course mark=minimum [10 , Problem assessment grade + [(Lab grade-7)/3]]
    - If you have not passed any of the two parts:
        - minimum [Problem assessment grade, Lab grade]
    - In case the student has more than one mark for any part, the highest one will be used.

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 Problem assessment will obtain a mark 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.
- The final grade for Lab assessment is a numerical mark between 0 and 10. A student needs a grade equal or greater than 5 to pass the Lab. If the Lab grade is greater than 7, the Lab grade will increase the Course mark.
- 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.
- 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

Basic Bibliography

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

Complementary Bibliography

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,

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 1/V05G300V01105
Mathematics: Calculus 2/V05G300V01203
Mathematics: Probability and Statistics/V05G300V01204

IDENTIFYING DATA				
Physics: Fundamentals of Electronics				
Subject	Physics: Fundamentals of Electronics			
Code	V05G300V01305			
Study programme	Degree in Telecommunications Technologies Engineering			
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	The students will be able to attend to personalised tutorials in the professor´s office in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts about the contents given in the Master Sessions and will be oriented about how to deal with them.

Troubleshooting and / or exercises	The students will be able to attend to personalised tutorials in the professor's office in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts about the problems and/or exercises proposed and resolved in the classroom as well as other problems and/or exercises that can appear along the study of the subject.
Laboratory practises	The students will be able to attend to personalised tutorials in the professor's office in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts about the development of the laboratory practices, the handle of the instrumentation, the setting of the electronic circuits and the software of simulation.

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

Basic Bibliography

Hambley, A. R., **Electrónica**, 2ª ed., Prentice Hall, 2001

Quintáns, C., **Simulación de circuitos electrónicos con OrCAD 16 Demo**, Marcombo, 2008

Complementary Bibliography

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	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Raña García, Herminio José			
Lecturers	Baneira Collazo, Fernando Marcos Acevedo, Jorge Pérez Estévez, Diego Quintáns Graña, Camilo Raña García, Herminio José Rodríguez Pardo, María Loreto 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 students may attend to the professor office in the tutorship time published in the course webpage. Doubts about the contents of the master classes will be resolved in this tutorship time as well as doubts about how to prepare their study.
Laboratory practises	The students may attend to the professor office in the tutorship time published in the course webpage. Doubts arisen to the students about the practices of laboratory, about how to use the instrumentation or about the implementation of the electronic circuits and the simulation software will be resolved in this sessions.
Troubleshooting and / or exercises	The students may attend to the professor office in the tutorship time published in the course webpage. Doubts arisen to the students on the problems and/or exercises proposed and resolved in the classroom will be resolved in this tutorship time as well as other problems and/or exercises that can appear along the study of the subject.

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

A process of continuous assessment based on midterms is established, but the student may choose alternatively a single assessment in a final exam.

Partial proofs are not recoverable, i.e., if a student can not attend the day they are scheduled, teachers do not have obligation to repeat them. The scores for the partial proofs are valid only for the academic year in which they are made.

Note 1: During exams mobile phones must be turned off and kept away. It is not allowed to use them as calculators. The

student must have a calculator.

Note 2: It is not allowed to enter the classroom after an examination begins.

Continuous assessment:

For continuous assessment, the contents of theory are divided into three blocks and the contents of laboratory are divided into two blocks.

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.

As specified below, 4 points (out of 10) is considered as minimum grade in each block, as well as minimum theory mark, laboratory mark or mark of each block (mark of a partial examination or mark of that block in the final examination, in theory or practice, as well).

Regarding theory:

There are two partial proofs, for the first two blocks. The student must repeat each partial proof in the final exam if the mark on any of them is less than 4. The examination of the third block is done by all students in the final proof.

If a student gets a mark of at least 4 points in a partial exam, he/she may try to improve the mark of that block in the final examination, but the mark in that block will be the one obtained in the final exam, even though it is less than the mark obtained in the partial proof.

The theory mark NT is the average mark of the three blocks, if the three student's marks exceed 4 point. If in any of the three blocks, the student does not reach 4 points, his/her theory mark is the minimum between 3.5 and the average of the three blocks.

The partial proofs take place on the usual weekly scheduling of the classes and last 1 hour and 50 minutes each.

They include both one half (in time and in mark) of short answer questions and one half exercises.

Each block of the final theory exam (first, second and third) lasts an hour.

Regarding practices:

Laboratory practices are assessed through practical tests described above (laboratory proofs).

The practices of the two blocks are examined in two partial laboratory proofs. The student must repeat a lab proof in the final exam if his/her mark in it is less than 4.

To participate in the partial proofs of practices of laboratory the student must attend to all the laboratory practical classes. Nevertheless, the students that do not fulfil this requirement can attend to the partial proofs of theory and liberate themselves from its contents for the final examination of theory.
If a student gets a mark of at least 4 points in a partial (lab) exam, he/she may try to improve the mark of that block in the final examination, but the mark in that block will be the one obtained in the final exam, even though it is less than the mark obtained in the partial proof.

The practice note NP is the average mark of the two blocks, if the mark of the student in both partial proofs exceed 4 points. If the student doesn't reach 4 points in one of the two blocks, his/her practice note is the minimum between 3.5 and the average of the two blocks.

The only documentation that can, and should, take the student to the practical tests for use during the lab proofs are manufacturer datasheets about the semiconductors used during practices. The student has to gather them to perform the practices.

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"). The teachers of the course will communicate through an announcement on that website a deadline for such preinscription. 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.

Final mark:

The final mark NF is NT x 0.7 + NP x 0.3, if NT and NP are both at least 4 points. Otherwise NF is the minimum between 4.5 and NT x 0.7 + NP x 0.3 . NT and NP are calculated as indicated above. The student passes the course in May session if the final mark NF is greater than or equal to 5.

Evaluation by single exam

Students who choose single test evaluation do the same final exam as those other who are assessed by continuous assessment and who have reached the minimum mark in no partial proof. i.e., they have to make all the final examination, both the three blocks of theory and the two blocks of lab practices.

The theory mark NT, the practice mark NP and the final mark NF are calculated in the same way as indicated above, for students assessed by continuous assessment.

Second call

The second call exam consists of two parts:

- A theory proof, 3 hours long. Its mark is NT.

- A laboratory proof, 1 hour 50 minutes long. Its mark is NP.

Unlike the final exam (first call), this proofs are not divided into blocks.

The mark in this second call exam, NR, is NT x 0,7 + NP x 0,3, where NT is the theory proof mark and NP is the laboratory proof mark, provided that NT and NP are both greater or equal to 4 points. Otherwise, the mark in this second call is the minimum between 4.5 and NT x 0,7 + NP x 0,3.

In the second call, all the students may attend to both sections (theory and practice). 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 the mark for the second call 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 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. The teachers of the course will communicate through an announcement on that website a deadline for such preinscription. 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

Basic Bibliography

Hambley, A. R., **Electrónica**, Prentice-Hall, 2ª ed. en español,

Hart, D. W., **Electrónica de potencia**, Prentice-Hall,

Quintáns Graña, C., **Simulación de circuitos con OrCAD 16 DEMO**, Marcombo,

Complementary Bibliography

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,

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	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Machado Domínguez, Fernando			
Lecturers	Álvarez Ruiz de Ojeda, Luís Jacobo Machado Domínguez, Fernando Moure Rodríguez, María José Pérez López, Serafín Alfonso			
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 10: Memory units	Classification. Active and pasive random access memories. Random access memories. Sequential acces memories. Associative memories.
Unit 9: Programmable logical devices	Introduction to the PLDs. Application examples.

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 lecturer will check the level of compliance of the students with the goals related to the laboratory skills. Final mark of laboratory, FML, will be assessed in a 10 points scale. For the evaluation of the laboratory sessions, the lecturer will assess the group work (the same mark for each member) and the individual answers to personalized questions for each session (individual mark).	20	B13 C15 B14
Troubleshooting and / or exercises	The lecturer 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 final test (FETT) 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. In order to pass this part, students will be require to obtain at least a mark of 4 in the final test (FETT>=4). In this case the final mark of theory (FMT) will be:

$$FMT = \max\{FETT ; (0.2 \cdot ETT1 + 0.2 \cdot ETT2 + 0.6 \cdot FETT)\}.$$

However, when the students do not pass the final test (FETT less than 4), the final mark of theory will be:

$$FMT = \min\{4 ; \max\{FETT ; (0.2 \cdot ETT1 + 0.2 \cdot ETT2 + 0.6 \cdot FETT)\}\}.$$

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.

1.b Laboratory

Thirteen laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in pairs whenever possible. 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 lecturer 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. Only sessions 6 to 13 will be assessed. 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. In this case, the weighted points from all assessed sessions are added together to calculate the final mark of laboratory (FML):

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

For the students who miss more than two laboratory sessions, the with a final mark of laboratory will be:

FML = min{4 ; (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 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), the final mark will be:

FM = min{4, (0.8·FMT + 0.2·FML)}.

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 at least two weeks before the exam. This way, the organization of the laboratory exam will be simpler.

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

FMT = FETT.

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), the final mark will be:

FM = min{4 ; (0.8·FMT + 0.2·FML)}.

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 at least two weeks before the final exam.

The marks obtained in the previous continuous assessment or final exam (FMT or FML) are kept for those parts in which the student has not attended. The final mark will be calculated as it has described in section 2 (final exam).

Sources of information

Basic Bibliography

L. J. Álvarez, F. Machado, M.J. Moure, S. Pérez, **Electrónica Digital**, Curso 2017-2018,

Wakerly J. F., **Digital Design. Principles and Practices**, 4ª,

E. Mandado, **Sistemas Electrónicos Digitales**, 10ª,

Complementary Bibliography

Thomas L. Floyd, **Fundamentos de Sistemas Digitales**, 11ª,

Wakerly J. F., **Diseño Digital. Principios y prácticas**, 3ª,

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

Physics: Fundamentals of Electronics/V05G300V01305

IDENTIFYING DATA				
Computer Networks				
Subject	Computer Networks			
Code	V05G300V01403			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Galician			
Department				
Coordinator	López Ardao, José Carlos			
Lecturers	López Ardao, José Carlos Rodríguez Pérez, Miguel Rodríguez Rubio, Raúl Fernando Sousa Vieira, Estrella			
E-mail	jardao@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 enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
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. Transport protocols	a) Service model b) TCP & UDP c) Transport connections: establishment, retransmissions, flow control
11. Congestion control	a) Network model b) Dynamics, fairness and stability c) TCP Reno, Vegas, FAST
12. 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	21	27
Integrated methodologies	0	10	10
Practice in computer rooms	10	9	19
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 individually. There will be several presential sessions for tutoring with the professor and for developing, testing and debugging the program in the laboratory where this will be tested and evaluated. With this methodology students should acquire competencies CG1, CG6, CG9, CE11, CE17 & CE19.
Integrated methodologies	Participation in on-line activities (autoevaluation tests and tasks previous to the laboratory sessions) to be proposed along the course . With this methodology students should acquire competencies CG4, CG6, CG9, CE17, CE18, CE19, CT2, CT3, CT4
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 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		
Autonomous practices through ICT	The students must develop a network program individually. There will be several presential sessions for tutoring with the professor and for developing, testing and debugging the program in the laboratory where this will be tested and evaluated.	20	B1 B6 B9	C11 C17 C19	
Integrated methodologies	Participation in on-line activities (autoevaluation tests and tasks previous to the laboratory sessions) to be proposed along the course.	10	B4 B6 B9	C17 C18 C19	D2 D3 D4
Long answer tests and development	Final exam covering all the contents	50	B3 B4	C11 C17 C18 C19	D2
Long answer tests and development	Two partial exams of short duration (one hour) in the 7th week (between February 26 and March 2) and 13th week (between April 9 and 13), covering units 1 to 4, and 5 to 8, respectively. Each partial exam has a weight of 10% on the final grade	20	B3 B4	C11 C17 C18 C19	D2

Other comments on the Evaluation

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

Continuous Evaluation (CE) consist of 4 previous tests plus a final exam:

- Two partial exams, PE1 and PE2, of short duration (one hour) in the 7th week (between February 26 and March 2) and 13th week (between April 9 and 13), covering units 1 to 4, and 5 to 8, respectively. Each partial exam has a weight of 10% on the final grade.
- The development of a network program (NP). The last day of practical classes must be delivered by the deadline. Compliance with the requirements and quality of software will determine the qualification of this test. **This program must be made and delivered compulsorily on an individual basis**. The PR will represent 20% of the Final Grade (FG), being necessary to reach 3.5 points out of 10 in this test to be able to surpass the subject.
- Participation in online activities (**OA**), which represent 10% of the Final Grade (FG). Throughout the course will be proposed 8 activities to be delivered in the virtual classroom of the subject. These activities will consist of small tasks to be done before or after the practical classes, and self-assessment tests will also be done. In each activity the student will get a certain amount of accumulated points of play throughout the course. In the tests can be obtained between 0 and 10 game points, depending on the number of hits achieved. In the tasks will always have a minimum of points of play by the simple delivery of the task in time and form, and optionally an additional amount can be assigned to perform the task in a satisfactory or correct way. In addition to these 8 activities, teachers will be able to allocate additional points to students for having participated prominently in the class or for actively participating in virtual classroom forums to try to resolve peer doubts. In any case, the maximum mark in this section (10% of the total of the subject) will be obtained by every student who correctly delivers and answers the 8 activities. Students who obtain a score equivalent to twice the average or the median, the lowest of them, will also receive the maximum score. The rest of the students will receive a grade proportional to the minimum between: the score equivalent to the delivery of the 8 tasks, twice the median and twice the average.

- A final exam (**FE**) written on all the contents of the subject, which has a weight of 50% on the Final Grade (FG) and where it is necessary to reach 3.5 points out of 10 to be able to surpass the subject.

FG-CE = 0.1×PE1 + 0.1×PE2 + 0.1×OA + 0.2×NP + 0.5×FE if FE and NP> = 3.5
In case of not reaching in the FE the minimum grade of 3.5, the final grade will be that obtained in FE ==> FG-CE = FE
In case of not reaching in the NP the minimum grade of 3.5 (but in the FE), the final grade will that obtained in the NP ==> FG-CE = NP
It is considered that a student choose CE when presenting to any partial exam, PE1 or PE2, choice that is maintained until end of course. Failure to submit a continuous assessment test involves a qualification of "0" on that test.
Students who do not take part in any partial exam are obliged to take the Single Evaluation (SE).**Single Evaluation (SE)**
It will consist in the realization of the same FE at the end of the term, and in the delivery of the proposed network program (NP) for those who go through the CE. The delivery dates will also be the same.
The grade of NP in this case is simply APT (with a numeric value 1), if the qualification of this program is equal or greater than 5.0, or NOT APT (with a numeric value 0) if the quelification is less than 5.0 or if the NP is not delivered, in which case the final grade will be 40% of the FE. That is,FG-SE = (0.4 + 0.6 × NP) × FESecond Evaluation (june/july)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 first 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) × FE-1st, (0.4 + 0.6NP-2nd) × FE-2nd}
Those students who had chosen CE but they want to change to SE for this second call, they must communicate it to the coordinator of the subject before the review of the examination of the first call. In this case, the conditions to approve the subject are exactly the same as those of the rest of the students that are presented by SE, being therefore obligatory the delivery of a new PR with the specifications of this second call.
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.
In case of detection of plagiarism in any of the works/test/exams, the final qualification will be Suspense (0) and this case will be communicated to the academic authorities.
In case of any contradiction that may occur between the different versions of the guide, due to some error in the translation, the version that will prevail is the Galician language version.

Sources of information

Basic Bibliography

J.F. Kurose, K.W. Ross, **Computer networking: a top-down approach featuring the Internet**, 7,
L. Peterson, B. Davie, **Computer networks: a systems approach**, 5,

Complementary Bibliography

A. Leon-Garcia, I. Widjaja, **Communication networks: fundamental concepts and key architectures**, 2,
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
Multimedia Networks/V05G300V01643
Network Security/V05G300V01543
Internet Services/V05G300V01501
Network and Switching Theory/V05G300V01642

Subjects that are recommended to be taken simultaneously

Data Communication/V05G300V01301

Subjects that it is recommended to have taken before

Mathematics: Calculus 1/V05G300V01105
Mathematics: Probability and Statistics/V05G300V01204
Programming II/V05G300V01302

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	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	López Valcarce, Roberto			
Lecturers	Comesaña Alfaro, Pedro Isasi de Vicente, Fernando Guillermo López Valcarce, Roberto Márquez Flórez, Óscar Willian Pedrouzo Ulloa, Alberto Rodríguez Banga, Eduardo			
E-mail	valcarce@gts.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 enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
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 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, skills 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, skills CE7, CE9, CE10, CG3, CG4, CT2 are developed
Troubleshooting and / or exercises	A simple problem will be solved after each batch of slides. This problem will help to understand the concepts introduced in that batch of slides. Through this methodology, skills CE9, CE10, CG4 are developed

Laboratory practises	Experimental study with real communication signals by means of Software-Defined Radio tools. This year a new practice, dealing with the modulation and demodulation of digital communications signals, will be introduced. Through this methodology, skills CE9, CE10, CG3, CG6, CT2 are developed

Personalized attention

Methodologies	Description
Laboratory practises	Beyond the initial explanation to the group, the teachers will resolve the individual doubts of the students.
Master Session	The personalized attention will be done at the office hours.
Practice in computer rooms	Beyond the initial explanation to the group, the teachers will resolve the individual doubts of the students.
Troubleshooting and / or exercises	The personalized attention will be done at the office hours. Special group sessions will be organized for solving the proposed problems; in those sessions the students will try to resolve the problems, so questions on the subject will be arised, and will be solved by the teachers.

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 the continuous assesment track. Four tests: 10% the first, 15% the second, 15% the third, and 60% the fourth.

The first three tests will take place approximately in weeks 5, 9, and 14. Results will be given within a reasonable time afterwards. These tests are not recoverable, that is to say, if a student does not show up when they take place, the instructors do not have the obligation to repeate them. In each test, the material covered from the start of the course until the previous week (inclusive) will be evaluated. The fourth test will be a shorter version of the exam that students who do not choose the continuous assesment track will have to take.

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

Students will be graded as long as they take any test (either the short-answer tests, or the final exam). Students will be assumed to choose the continuous assesment track as soon as they take any two of the short-answer tests. Students taking at most one of the short answer tests and the final exam will be assumed to choose the final assesment track.

Students choosing the continuous assesment track and not passing the subject will receive the "fail" mark, whether they took the final exam or not.

The mark achieved in the first three short-answer tests will be kept for the second call, but not for subsequent years.

Regarding the second call, students in the continuous assessment track will be allowed to choose if they wish to keep the mark achieved in the short-answer tests, or if they want to be assessed only by the final exam.

Sources of information

Basic Bibliography

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

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

Complementary Bibliography

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

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

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

Recommendations

Subjects that continue the syllabus

Principles of Digital Communications/V05G300V01613

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	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Martín Rodríguez, Fernando			
Lecturers	Isasi de Vicente, Fernando Guillermo 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 enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt 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. The student should take the contents of the guiding documents provided for each section. 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	Help with problem solving, in the classroom and/or at the office.
Practice in computer rooms	Help in the classroom and, if necessary at the office or via e-mail.
Master Session	Querry and answer in the classroom and, if necessary, at the office.
Tests	**Description**

Reports / memories of practice	Querry and answer about report writing. Report correction consists in a brief remark being sent to students (via faitic).

Assessment				
	Description	Qualification	Training and Learning Results	
Multiple choice tests	On the faitic website.	7.5	B3	
Long answer tests and development	To evaluate theoretical knowledge and problem resolution.	65	B3 B5	C13
Short answer tests	Exam with questions and problems.	5	B3	
Reports / memories of practice	Report about the work perfomed during several weeks in the computer classroom. This is the only methodology where team work is assessed (teams of two). The qualification is the same for both students.	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

If this second condition is not fullfilled, although global mean is equal or greater than 5, qualification will be stated in the records as "fail" (4).

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

If this second condition is not fullfilled, although global mean is equal or greater than 5, qualification will be stated in the records as "fail" (4).

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

Basic Bibliography

Finn Jacobsen et al., **FUNDAMENTALS OF ACOUSTICS AND NOISE CONTROL**, Technical University

R. J. Clarke, **Digital Compression of Still Images and Video**, Academic Press.

Complementary Bibliography

Lawrence Kinsler, Austin Frey, Alán Coppens, James Sanders, **FUNDAMENTALS OF ACOUSTICS**, John Wiley & son

T. Perales Benito, **Radio y Televisión Digitales: Tecnología de los Sistemas DAB, DVB, IBUC y ATSC**, Creaciones Copyright

Ulrich Reimers, **DVB : the family of international standards for digital video broadcasting**, Springer

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