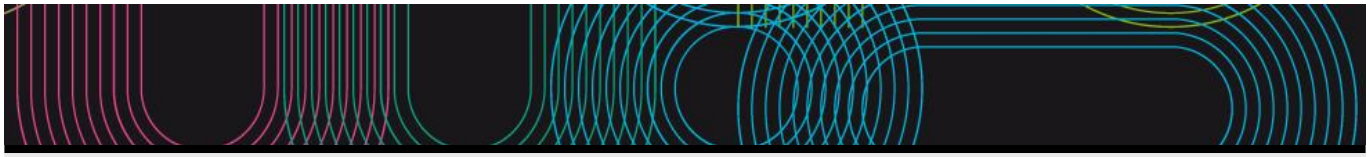

(*)Escola de Enxeñaría de Telecomunicación

(*)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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Coordinadora Xeral: María José Moure Rodríguez (teleco.master@uvigo.es)

COORDINACIÓN DO MESTRADO INTERUNIVERSITARIO EN MATEMÁTICA INDUSTRIAL

Coordinador Xeral: José Durany Castrillo (durany@dma.uvigo.es)

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	Telematics Engineering			
Coordinator	Herrería Alonso, Sergio			
Lecturers	Díaz Redondo, Rebeca Pilar Herrería Alonso, Sergio López García, Cándido Antonio Suárez González, Andrés			
E-mail	sha@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
Lecturing	26	0	26
Previous studies	0	47	47
Problem solving	24	0	24
Autonomous problem solving	0	47	47
Essay questions exam	4	0	4
Short answer tests	2	0	2

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

Methodologies

	Description
Lecturing	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	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.

Problem solving	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 problem solving	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	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 problem solving	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		
Essay questions exam	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 assessment of the learning will be practised. Continuous assessment will consist of two types of tests: short tests, every two weeks, that will take place during the group B sessions; and two partial exams, the first one in the midterm and the second one at the end of the class period. All these tests will not be repeatable and will only be accountable for the first call in the current course. The schedule of the midterm/intermediate exams will be approved in the Comisión Académica de Grado (CAG) and will be available at the beginning of each academic semester.

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

All the students that have not reached at least a grade of 5 in the continuous assessment (included the students not evaluated) can do a final exam, 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 grade.

All the students following continuous assessment or taking the final exam will be graded. The students that attend to the second partial exam will be considered following continuous assessment.

Those students who do not pass the subject at the first call have a second one consistent in the realisation of a new final exam.

In extraordinary calls the assessment will just consist in the realisation of a written exam including ALL the contents of the subject.

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

Sources of information

Basic Bibliography

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

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	Telematics Engineering			
Coordinator	Blanco Fernández, Yolanda			
Lecturers	Blanco Fernández, Yolanda Fernández Masaguer, Francisco			
E-mail	yolanda@det.uvigo.es			
Web	http://www.faitic.es			
General description	The general aim of this subject is to provide the students with the theoretical foundations and practical competitions to analyse, design, develop and debug computer applications following the Object-Oriented Programming (OOP) paradigm. Programming II is a mainly practical subject where students have to design and develo pone of several programming projects. With the goal of supporting the students during the development of these software projects, firstly a very brief introduction to the discipline of Software Engineering and its relationship with the OOP paradigm will be given, putting the focus on the stages of analysis, design, implementation and debugging. Next, we will analyse in detail the foundations of OOP, highlight the advantages of UML diagrams for the design tasks that the students will have to carry out. The main contents that will be explained in the subject are the following ones: - 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 - Relationships 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 to the 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. Parameter passing: 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
Lecturing	28	42	70
Problem solving	5	8	13
Autonomous problem solving	6	17	23
Case studies	3	9	12
Project based learning	7	18	25
Case studies	1	0	1
Problem solving	3	0	3
Laboratory practice	2	0	2
Project	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
Lecturing	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.
Problem solving	In the laboratory the professor will show pieces of Java programs with the goal of improving the students' understanding about the main OOP-related concepts. Through this methodology the competences CE50, CE51 and CE53 are developed.
Autonomous problem solving	The students will resolve the practices proposed by the professor. The best solutions and possible doubts that arise will be guided by the professor in order to identify common errors. Through this methodology the competences CE50, CE51, CE53, CG6 and CG14 are developed.
Case studies	The professor will supervise and guide the students during the design of the UML diagramas, with the goal of identifying common errors. Through this methodology the competences CE51 and CE52 are developed.
Project based learning	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
Problem solving	Revision and comments of solved exercises. Glossary of frequent errors to avoid. Recommendations of style and organization. Tips about best coding practices.
Project based learning	The professor keeps track the level of understanding of the students, supporting them in particular doubts, errors of design and possible improvements in the code.

Autonomous problem solving	Reviewing and comments for each group throughout the development phase, helping them in compilation and understanding of execution-related problems, besides the detection and solution of conceptual errors.
Case studies	Analysis, detection of errors and discussion about possible improvements for students-proposed UML designs.

Assessment

	Description	Qualification	Training and Learning Results
Project based learning	The project consists of the final design (UML diagrams), the Java code and the corresponding documentation. The code must necessarily be compiled and run on the computers of the laboratory. The project can be carried out individually or in groups of 2 people, as per the assessment mechanism chosen by each student. The professor will interview the students in order to check the authorship of their projects and to carry out different functionality tests. In case of groups, both members must attend the interview. The questions posed by the professor must be answered individually by each student in order to corroborate his/her level of understanding and involvement during the project development. Each student must identify the part of the software project he/she has implemented. Students who fail when demostrating their authorship will not pass the subject in the first call. Otherwise, the mark of each student will depend on (i) his/her particular answers during the interview, (ii) the amount of correct functionality tests, and (iii) the quality of the Java coding regarding the adoption of OOP techniques.	35	B6 B14 C50 C53
Case studies	The students will design the software project by the modeling language UML, by including different types of diagrams along with the corresponding documentation to guide the decisions taken. The UML design can be developed individually or in groups of 2 people as per the assessment mechanism chosen by each student. In case of groups, the individual grade of each student will depend on the quality of the UML diagrams delivered.	5	C51 C52
Problem solving	Each student will take individually and without material of support-- an exam on the official date approved by the Board of School. This exam will combine problems, short-answer questions, multiple choice and true/false tests, which are aimed at assessing the level of understanding of the students on the theoretical concepts explained in the subject.	50	C50 C51 C53
Laboratory practice	This test consists of a set of Java practices for beginners that will help the students to get in touch with a new programming language based on the OOP paradigm. These Java practices will be only delivered by the students who choose the Continuous Assessment mechanism. These practices will be developed in groups of 2 students and the final remark of each of them will depend on (i) his/her individual answers to the questions posed by the professor during a personal interview, and (ii) the quality and correct funcionality of the Java code delivered.	10	C50 C51 C52 C53

Other comments on the Evaluation

There exist two assessment mechanisms in this subject: continuous assessment (CA) and eventual assessment (EA). The students must choose one of them considering the following conditions:

- CA consists of the 4 tests described in the Assessment section of this document (exam, Java practices for beginners, UML design and Java implementatation of the project).
- Students who sit EA must develop the software project (whose specifications will be published at faiTIC platform) individually.
- By the submission of the UML design of the project, students make a commitment to be assessed via CA, thus renouncing the EA mechanism. In virtue of this commitment, the final mark of these students cannot be Not taken.
- Students who do not deliver the UML design in time renounce EC mechanism, thus being assessed as per the requirements of EA. Note that it will be not possible to join the CA in the next tests.
- The schedule of the midterm/intermediate exams will be approved in the Comisión Académica de Grado (CAG) and will be available at the beginning of each academic semester.
- CA tests will be carried out only on the dates defined by the professors. These CA tests cannot be repeated later.
- The grades obtained in the CA and other exams and practical projects are only valid for the current academic year.
- Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the tests or

exams, the final grade will be FAIL (0), and the incident will be reported to the corresponding academic authorities for prosecution.

Students who sit CA in the first call will be assessed as follows:

Theoretical part: Exam (50%). Individual exam without any type of supporting material. It is the third test described in the Assessment section. The grade of this exam can be retained for the second call in case the student gets 4.5 or more points (out of 5 points).

Practical part. It consists of the following tests:

- **Java practices for beginners** (10%). To be developed in groups of 2 people. It is the fourth test described in the Assessment section.
- **Project** (40%). To be developed in groups of 2 people. The project consists of two parts:
    - **UML design** (5%). It is the second test described in the Assessment section.
    - **Java implementation** (35%). It is the first test described in the Assessment section. This part consists of the Java code and the corresponding Javadoc documentation, besides the authorship interview with the professor.

The students must fulfill the following requirements to pass the subject via the CA mechanism:

- To get at least 1/3 of the maximum grade of the theoretical part.
- To get at least 1/3 of the maximum grade of the Java implementation of the project in the practical part.
- To get a final grade (theoretical part + practical part) equal or greater than 5.
- If the final grade is equal or greater than 5 but some of the part does not fulfill the aforementioned minimums, then the final grade will be 4.5 (out of 10 points).

Students who sit EA in the first call will be assessed as follows:

Theoretical part: **Exam** (50%). Individual exam without any type of supporting material. It is the third test described in the Assessment section. The grade of this exam can be saved for the second call in case the student gets 4.5 or more points (out of 5 points) in this test.

Practical part: **Project** (50%). To be developed individually. It is the first test described in the assessment section, including the UML design, the Java code and the corresponding Javadoc documentation, along with the authorship interview driven by the professor.

The students must fulfill the following requirements to pass the subject via the EA mechanism:

- To get at least 1/3 of the maximum grade of the theoretical part.
- To get at least 1/3 of the maximum grade of the practical part.
- To get a final grade (theoretical part + practical part) equal or greater than 5.
- If the final grade is equal or greater than 5 but some of the part does not fulfill the aforementioned minimums, then the final grade will be 4.5 (out of 10 points).

Students will be assessed as follows in the second call:

Theoretical part: **Exam** (50%). Individual exam without any type of supporting material. It is the third test described in the Assessment section. The grade of this exam will never be retained.

 Practical part: Project (50%). In the assessment of this part, three scenarios can be considered as per (i) the assessment mechanism chosen by the students (CA or EA) , and (ii) the grades obtained in the implementation of the project during the first call. Regardless the particular scenario, the students who sat EA in the first call must deliver the project individually in the second call.

[Scenario #1] The grade of the project is retained for the second call. Although the students can retrieve the grades obtained in the first call, they can also improve their remarks by delivering a new version of the project with additional functionalities (which will be available through faiTIC). In this case, the students must provide a document describing the

changes they made in the design of first version of the project for accomplishing the new functionalities.

o This scenario is applicable to students who sat CE, whose grade for the project was equal or greater than 1.5 (out of 4) and whose grade for the UML design was equal or greater than 0.3 (out of 0.5). In case of a new submission, the implementation of the project will be assessed with up to 3.5 points (out of 10) and the UML design with up to 0.5 points (out of 10), since the remark of the Java practices for beginners (up to 1 out of 10 points) will be recovered from the first call.

o This scenario is also valid for students who sat EA, whose grade for the project was equal or equal to 2.5 (out of 5). In case of a new submission, the project will be assessed with up to 5 points (out of 10).

[Scenario #2] The grades obtained in the UML design and Java practices for beginners are retained, and a new project must be delivered in the second call.

o This scenario is valid for students who sat CE whose grade for the project was equal or greater than 1 and lower than 1.5 (out of 4), being their remark for the UML design equal or greater than 0.3 (out of 0.5). The project will be assessed with up to 3.5 points (out of 4).

[Scenario #3] All the grades obtained in the first call are discarded. A new project must be delivered, which will be assessed with up to 5 points.

o This scenario is applicable to students who sat CA and got a grade in the UML design lower than 0.3 (out of 0.5), or a remark in the project lower than 1 (out of 4).

o This scenario is also valid for students who did not deliver project during the first call, and for pupils who did not manage to prove their authorship during the personal interview with the professor.

The students must fulfill the following requirements to pass the subject:

- To get at least 1/3 of the maximum grade of the theoretical part.
- To get at least 1/3 of the maximum grade of the practical part (3.5 in CA and 5 in EA).
- To get a final grade (theoretical part + practical part) equal or greater than 5.
- If the final grade is equal or greater than 5 but some of the part does not fulfill the aforementioned minimums, then the final grade will be 4.5 (out of 10 points).

Students will be assessed as follows in the extraordinary call:

Theoretical part: **Exam** (50%). Individual exam without any type of supporting material. It is the third test described in the Assessment section.

Practical part: **Project** (50%). To be developed individually. It is the first test described in the assessment section. The project consists of the UML design, the Java code and the corresponding Javadoc documentation, besides the authorship interview with the professor.

The students must fulfill the following requirements to pass the subject:

- To get at least 1/3 of the maximum grade of the theoretical part.
- To get at least 1/3 of the maximum grade of the practical part.
- To get a final grade (theoretical part + practical part) equal or greater than 5.
- If the final grade is equal or greater than 5 but some of the part does not fulfill the aforementioned minimums, then the final grade will be 4.5 (out of 10 points).

Sources of information
Basic Bibliography
W. Savitch, **Absolute Java**, 4ª edición, Pearson, 2010
Y. D. Liang, **Introduction to Java programming**, 8ª, Pearson, 2010
P. Deitel, H. Deitel, **Java: How to program**, 9ª, Pearson, 2011
Complementary Bibliography
B. Eckel, **Thinking in Java**, 4ª edición, Prentice-Hall, 2006
P. Niemeyer, D. Leuck, **Learning Java**, 4ª edición, O'Reilly., 2013
Oracle, **Java SE. Oracle**,
Oracle, **Java API Specifications**, 2016

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

S. Zakhour, S. Hommel, J. Royal, I. Rabinovitch, T. Risser, M. Hoeber, **The Java Tutorial. A short course on the basics**, 4ª edición, Prentice-Hall, 2006

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

Jean-Michel DOUDOUX, **Développons en Java 2.10**, 2016

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	Signal Theory and Communications			
Coordinator	Vera Isasa, María			
Lecturers	García-Tuñón Blanca, Inés Gómez Araújo, Marta Lorenzo Rodríguez, María Edita de Santalla del Río, María Verónica Vazquez Alejos, Ana Vera Isasa, María			
E-mail	mirentxu@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Fundamentals of electromagnetic guided and unguided transmission. Analysis of the operating principles of different transmission media models and their characterization in telecommunication engineering.			

Competencies	
Code	
B3	CG3: The knowledge of basic subjects and technologies that 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
Lecturing	18	27	45
Autonomous problem solving	7	28	35
Laboratory practices	10	2	12
Computer practices	8	2	10
Classroom jobs	8	16	24
Problem solving	3	12	15
Objective questions exam	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.
Lecturing	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 problem solving	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 practices	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.
Computer practices	Activities of acquisition of basic skills related with the matter. Through this methodology the competencies CG3, CE8, CE20 and CT3 are developed.
Classroom jobs	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**

Lecturing	In the tutorial schedule, teaching staff will attend the needs and queries of the students related with the study of the subject.
Laboratory practices	The teaching staff will set the time of the session and will resolve the questions about the practical implementation.
Autonomous problem solving	In the tutorial schedule, teaching staff will attend the needs and queries of the students related with the study of the subject.
Computer practices	The teaching staff will set the time of the session and will resolve the questions about the practical implementation.
Classroom jobs	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 jobs	Short checks (see other comments)	25	B4 B5	C8 C20
Problem solving	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
Objective questions exam	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 single assessment.

Continuous assessment

Continuous assessment includes the following tasks:

- Classroom work (25%): four short checks carried out during practical hours.

- Test (35%): two quizzes (25% + 10%).

- Problem solving (40%): two exams, 20% weight each one.

The time schedule of these tasks, approved by the CAG, will be available at the beginning of the semester.

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**.

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.

After the first problem solving exam the student must decide between the continuous assesment or the single assesment modes of evaluation, in which case they receive a grade, independently that they present to other tasks or not. Failure to submit to this test implies that the evaluation choice is single assessment. If the minimum grade required is not obtained in any of the three different tasks defined, the final grade will never be higher than 4.5

Single assessment

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 single assessment 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. In this case, the same weighting indicated in the continuous assessment section is maintained.

Extraordinary call (end of career)

The system described in the single assessment section will be applied.

To pass the subject at least 50% in the total qualification must be obtained in any of the assessment 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	Signal Theory and Communications			
Coordinator	Alonso Alonso, Ignacio			
Lecturers	Alonso Alonso, Ignacio Docampo Amoedo, Domingo Docio Fernández, Laura 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	Concept of signal and system. Mathematical representation

Subject 2. Sinusoids	Sinusoidal signals: Frequency, amplitude and phase. Complex exponentials and phasors. Phasor addition rule.
Subject 3. Spectrum representation	Spectrum of a sum of sinusoids. Mathematical expression and graphical plot. Fourier Series analysis of periodic signals.
Subject 4. Introduction to Sampling and Aliasing	Sampling and digital frequency. Analog frequency vs discrete frequency. Aliasing. The sampling theorem.
Subject 5. 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 6. Frequency response of FIR filters	Sinusoidal response of FIR systems. Frequency response. Properties. Graphical representation.
Subject 7. Z Transform	Definition and properties. Linear-phase filters.
Subject 8. 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 9. Continuous-Time Signals and Systems	Introduction to continuous-time systems. The unit impulse. The unit step. Time delaying. Linearity and time-invariance. Convolution
Subject 10. Continuous-Time Fourier Transform	Definition. Basic pairs. Properties
Subject 11. Sampling and Reconstruction in the Frequency Domain	The sampling theorem in the frequency domain
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.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Lecturing	23	40	63
Laboratory practices	11	22	33
Problem solving	15	30	45
Discussion Forum	0	2	2
Objective questions exam	1.5	0	1.5
Problem solving	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
Lecturing	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 practices	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.
Problem solving	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.

Discussion Forum	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
Lecturing	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 practices	The same as in the previous section.
Problem solving	The same as in the previous section.

Assessment

	Description	Qualification	Training and Learning Results		
Objective questions exam	These tests are a requirement to pass the subject. See details in the "Other comments and second call" section.	0	B3	C48 C49	D3
Problem solving	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.
- 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 as follows (for both continuous and unique assessment):
    - 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 attend a 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 attend 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.
- Assessment method:
  - **First Opportunity**: The student will have two nonexclusive ways to pass the Practice part.
    1. Two tests in the lab room during the class period (continuous evaluation)
       - 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 attend the two tests.
       - Tests dates will be announced on the web site at the beginning of the lecture period.
    1. A final exam (unique assessment). The pass mark for this test is 5 out of 10.
  - **Second Opportunity and extraordinary call**: A final exam. The pass mark for this test is 5 out of 10.
- Remarks:
  - Once the Practice pass grade is obtained, this is valid for the entire academic year.

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.
- Assessment method:
  - **First Opportunity**: The student will have two nonexclusive ways to pass the Problems part.
    1. Three tests in the classroom during the class period (continuous evaluation). 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: Subjects 1 to 4. Test2: Subjects 1 to 8. Test3: Subjects 1 to 11.
       - Tests dates will be announced on the web site at the beginning of the lecture period.
    2. A final exam (unique assessment). The pass mark for this test is 5 out of 10.
  - **Second Opportunity and extraordinary call**: A final exam. 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.
    - A student who has passed the Problems part during the First Opportunity through the continuous evaluation is allowed to attend the final exam of the First Opportunity to try to get a better mark.
    - A student who has passed the Problems part during the First Opportunity, is NOT allowed to attend the Problems Part of the final exam of the Second Opportunity.

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

Sources of information

Basic Bibliography

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

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	Electronics Technology			
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
Lecturing	13	24	37
Problem solving	14	33	47
Laboratory practices	14	30	44
Problem solving	8	0	8
Laboratory practice	5	0	5
Self-assessment	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.
Lecturing	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.
Problem solving	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 practices	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
Lecturing	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.
Problem solving	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 practices	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	
Problem solving	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
Laboratory practice	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	Techniques aimed to collect data about the participation of the student in the proposed self-assessment tests.	5		

Other comments on the Evaluation

1. First chance (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 only evaluation. Students who do not follow the continuous evaluation and do not take the only evaluation 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). The schedule of these exams will be approved in "CAG" (Degree Academic Commission) and will be made public at te beginning of the corresponding term. 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. The schedule of these tests will be approved in "CAG" (Degree Academic Commission) and will be made public at te beginning of the corresponding term. 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. First chance (only evaluation)

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 >= 1.6) 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. Second chance

It will have a theoretical part and practical one with the same format as the only evaluation.

The students who present to this chance can do it only to the theoretical part, the practical one or both. They will conserve the mark got in the first chance (continuous or only evaluation). The students who take the theoretical part will be able to carry out the blocks they want. The mark of the first chance (continuous or only evaluation) 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 first chance and the second chance.

By reasons of organisation of the groups of examination, the professors will open a period so that the students inscribe to the second chance 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 this exam.

4. Extra call (end of degree)

This call will be the same as the second chance.

5. Validity of the marks

The marks of the student in the theoretical and practical parts of the subject will be valid only for the academic course in

which they was got.

If a cheating case is detected, the final mark will be FAIL (0) and the case will be communicated to the School Management.

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	Electronics Technology			
Coordinator	Raña García, Herminio José			
Lecturers	Cao Paz, Ana María Marcos Acevedo, Jorge Quintáns Graña, Camilo Raña García, Herminio José Valdés Peña, María Dolores			
E-mail	hrana@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course is dedicated to the utilisation of integrated circuits, in particular operational amplifiers, as well as to the following fields: Electronics of Power, Electrotechnics in the aspects 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: Aspects 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
Lecturing	18	18	36
Laboratory practices	22	22	44

Problem solving	6	12	18
Essay questions exam	3	15	18
Problem solving	3	15	18
Laboratory practice	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
Lecturing	The teacher exposes the theoretical contents. This activity is individual. In these activities skills CE14 and CE16 are developped.
Laboratory practices	They include circuit mounting and testing and computer electronic circuits simulation. Some practical classes 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). This activity is collective. The students work in teams of two persons in each laboratory position. Through this methodology the competencies CE14, CE16, CG13 and CG14 are developed.
Problem solving	The teacher will solve exercises about most of the chapters. This activity is individual. Through this methodology the competencies CE14 and CE16 are developed.

Personalized attention

Methodologies	Description
Lecturing	The students may attend to the professor office in the office hours 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 practices	The students may attend to the professor office in the office hours 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.
Problem solving	The students may attend to the professor office in the office hours 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
Essay questions exam	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 July evaluation".	35	C14 C16
Problem solving	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 July evaluation".	35	C14 C16
Laboratory practice	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, making measures on them and answering questions related with these circuits and 2) simulation of circuits equal or similar to the ones studied in the practices and answering questions related with this simulation. In the laboratory practice exams the student will be allowed to use some especific technical information collected by the student during the practices (e.g. datasheets from manufacturers).	30	B13 B14 C14 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 exams 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 grades for the partial exams 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 exam 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 exams (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 exams, his/her mark on them will be zero.

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

Regarding theory:

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

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

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

The partial exams 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 development questions and one half exercises.

The duration of each block of the final theory exam (first, second and third) is one hour.

Regarding practices:

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

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

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

The practice note NP is the average grade of the two blocks, if the grade of the student in both partial exams exceeds 4 points. If the student doesn't reach 4 points in any of the two blocks, his/her practice grade is the minimum between 3.5 and the average of the two blocks.

Material for practical exams:

The student must take to the practical exams the datasheets of the semiconductors used during the practices, which the student must gather as the practices are carried out. The student can also take to the practical exams the practices printed, bound or stapled, along with annotations added by the student during the realization of the practices, according to rules that will be detailed on the web of the subject.

VERY IMPORTANT: The students who want to attend to the lab final exam of the course must enroll for it, prior to the exam, via the subject web (section"Inscripciones"). The teachers of the subject will communicate through an announcement on that website a deadline for such preinscription. This preinscription is necessary to schedule the shifts for the lab exam. Only the

students enrolled before that date will have right to do the lab exam.

Final grade:

The final grade 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 subject in May session (first call) if the final grade NF is greater than or equal to 5.

Assessment by single exam

The students who choose single test assessment do the same final exam as those other who are assessed by continuous assessment and who have reached the minimum grade in no partial exam, 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 grade NT, the practice grade NP and the final grade NF are calculated in the same way as indicated above, for students assessed by continuous assessment.

Second chance

The second chance exam consists of two parts:

- A theory exam, 3 hours long. Its grade is NT.

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

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

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

In the second chance, all the students can attend to both sections (theory and practice). The rule of highest grade which is compulsory for the total grade of all the subjects, will apply in this subject also extended to each section; i.e., the theory grade of each student to calculate the grade for the second chance will be the highest between the May theory mark (first call) and the mark in the second chance theory exam. The same for the laboratory grade.

VERY IMPORTANT: In the same way as stated for the May final proof, the students who want to attend to the second chance laboratory exam must enroll to attend to it, via the subject web. The teachers of the subject will communicate through an announcement on that website a deadline for such preinscription. This preinscription is necessary to schedule the shifts for the laboratory exam. Only the students who enroll before that date will have right to do the laboratory exam.

END OF CAREER EXAM

The end of career (E.C.) exam has the same structure as the second chance exam and its grade is calculated the same way as in the second chance exam, except that no grade of a previous opportunity is retained (neither from partial exams nor from final nor second chance exam): the grade of a student in the E.C. act depends for all students only upon the E.C. exam itself.

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

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	Electronics Technology			
Coordinator	Machado Domínguez, Fernando			
Lecturers	Gómez Yepes, Alejandro Machado Domínguez, Fernando 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
Lecturing	13	21	34
Laboratory practices	26	26	52
Problem solving	8	20	28
Laboratory practice	2	2	4
Problem solving	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.
Lecturing	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 practices	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 lecturers office. In these sessions the students will develop the skils CE15, CG13 and CG14 ("know how").

Problem solving	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
Lecturing	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.
Problem solving	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 practices	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 practices	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
Problem solving	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 (first call)

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 intermediate tests (ETT1 and ETT2) will be performed during the classes. The scheduling of the intermediate tests will be approved by the Academic Committee of the Degree (CAG) and will be available at the beginning of the semester. 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. Eventual assessment (first call)

The students who prefer a different educational policy can attend an exam on a scheduled date. This assessment consist on a theory exam and laboratory exam. 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 call assessment and extraordinary call assessment

These assessments 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.

In second call assessment, the marks obtained in the first chance assesment, continuous assessment or semester assessment, are kept for those parts in which the student has not attended (FMT or FML). The final mark will be calculated as it has described in section 2 (semester assessment).

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	Spanish Galician			
Department	Telematics Engineering			
Coordinator	López Ardao, José Carlos			
Lecturers	López Ardao, José Carlos Rodríguez Rubio, Raúl Fernando Sousa Vieira, Estrella Suárez González, Andrés			
E-mail	jardao@det.uvigo.es			
Web	http://moodle.det.uvigo.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
Lecturing	26	26	52
Problem solving	11	22	33
Autonomous practices through ICT	7	18	25
Autonomous problem solving	0	15	15
Discussion Forum	0	5	5
Computer practices	8	8	16
Essay questions exam	2	0	2
Objective questions exam	2	0	2
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Lecturing	Exposition of the ideas, concepts, technics and algorithms related to the thematic units of the course. With this methodology we will work the competences CT2, CT3, CG3, CG4, CE11, CE17, CE18 and CE19.
Problem solving	Resolution in the classroom by the professor of problems and exercises related with the contents of the master lessons. With this methodology students work the competences CG3, CG4, CE11, CE17, CE18 and CE19.
Autonomous practices through ICT	Students have to develop a network program in an autonomous and individual way. There will be several classroom sessions to explain related programming concepts (sockets, threads), to explain with all detail the program and his implementation, to solve doubts with the professor, and to test and debug the program in the laboratory where this will be tested and evaluated. With this methodology work the competences CG1, CG6, CG9, CE11, CE17 and CE19.
Autonomous problem solving	Resolution of assignments, exercises, questions and self-assessment tests in the virtual classroom in a individual, autonomous way. These activities have a global weight of 10% in the case of continuous evaluation. With this methodology we will work the competences CG4, CG6, CG9, CE11, CE17, CE18, CE19, CT2, CT3, CT4
Discussion Forum	The discussion forums will be necessarily the way to request remote attention for doubts and questions related to the contents of the subject. This discussion and collaborative help will be promoted in the virtual classroom. With this methodology we will work the competences CT3 and CT4
Computer practices	Practices and resolution of practical problems in the computers, guided by the professor. With this methodology students should acquire competences CG1, CG9, CE17 & CE19.

Personalized attention

Methodologies	Description
Lecturing	Individually personalized face-to-face attention will be dispensed. The tutorial schedule will be announced at the beginning of the course. Reservation in the virtual platform is recommended
Problem solving	Individually personalized face-to-face attention will be dispensed. The tutorial schedule will be announced at the beginning of the course. Reservation in the virtual platform is recommended
Computer practices	Individually personalized face-to-face attention will be dispensed. The tutorial schedule will be announced at the beginning of the course. Reservation in the virtual platform is recommended
Autonomous practices through ICT	Individually personalized face-to-face attention will be dispensed. The tutorial schedule will be announced at the beginning of the course. Reservation in the virtual platform is recommended. Please, in this case, contact your practice professor
Autonomous problem solving	In the case of tasks, the detailed solution will be provided in the virtual classroom. In the case of self-assesmemt tests, suitable feedback for the wrong questions will be provided to the student. In any case, individually personalized face-to-face attention will be dispensed. The tutorial schedule will be announced at the beginning of the course. Reservation in the virtual platform is recommended
Discussion Forum	In addition to individually personalized face-to-face attention, the professor will be monitor the discussions in the forums making suitable answers when necessary or explaining the answers of the students. The discussion forums are the way to request remote attention for doubts and questions related to the contents of the subject. Private attention about contents by means of messaging or e-mail is not available.

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. It has a weight of 20% but a minimum qualification of 3.5 points is required	20	B1 C11 B6 C17 B9 C19
Autonomous problem solving	During the course, with a roughly weekly periodicity, different tasks, activities, exercises, self-assessment tests must be made in the virtual classroom in an individual and autonomous way. These activities have a global weight of 10%	10	B4 C11 D2 B6 C17 D3 B9 C18 D4 C19
Essay questions exam	Final exam covering all the lessons. It has a weight of 50% but a minimum qualification of 3.5 points is required	50	B3 C11 D2 B4 C17 C18 C19

Objective questions exam	Two control tests will be done. The first one will cover lessons 1 to 4 and the second one lessons 5 to 8. Each control test has a 10% weight.	20	B3 C11 D2 B4 C17 C18 C19	

Other comments on the Evaluation

The students can choose the method of Assessment, continuous or eventual.

Continuous Assessment (CA)

It consists of:

- Two midterm control tests (**C1 and C2**) covering, respectively, the contents of the lessons 1 to 4, and 5 to 8. Each control test has a 10% weight in the Final Grade (**FG**). The schedule of the midterm/intermediate exams will be approved in the Comisión
- Académica de Grado (CAG) and will be available at the beginning of each academic semester.
- The development of a network program (**PR**). The deadline will be published together with the specifications, but it will always be between the last practical class and the day of the final exam in May. Compliance with the prescriptions and the quality of the software will determine the qualification of this program. Together with the specifications, an assessment guide will be published. This program must be done and delivered individually. The **PR** will represent 20% of the Final Grade (**FG**), and it is required to reach 3.5 points in this program to be able to pass the subject.
- The participation in the online activities in the virtual environment, that represents 10% of the Final Grade (**FG**). During the course, tasks, activities, exercises, and self-assessment tests will be proposed with a weekly periodicity in the virtual classroom. These activities must be done by all students in an autonomous and individual way. The realization of these activities allows obtaining "merit points" (**MP**) up to a maximum of 100 points (in case of all activities are evaluated with the maximum grade). The grade of this section will be equal to the amount of **MP divided by 100**. In order to facilitate the achievement of the maximum amount of points, additional optional tasks will be proposed throughout the course.
- The virtual classroom includes a **gamification** system based in other types of points and several gamification elements and mechanisms to motivate students to make the activities and participate in a meaningful way in forums of doubts and discussions. This system allows students to get **rewards** to be used in exams and assignments.
- A final exam (**FE**) covering all contents, with a weight of 50% of the Final Grade (**FG**). A minimum qualification of 3.5 points on 10 is required

FG-CA = 0.1×C1 + 0.1×C2 + PM/100 + 0.2×NP + 0.5×FE if FE and NP> = 3.5

Otherwise, **FG-CA = min(4.9, FE)**

It is considered that a student chooses CA when taking any midterm control test (C1 or C2). If any of these control tests are not made, the grade will be "0". These control tests will be not recoverable.

Eventual Assessment (EA)

It will consist on the realization of the same FE at the end of the term, and on the delivery of the same proposed network program (NP) for those who go through the CE. The delivery dates will also be the same.

Students who do not take any midterm control test, compulsorily opt for the Eventual Assessment.

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-EA = (0.4 + 0.6 × NP) × FE

Second call

In the official dates, a new final exam (FE) will be done only for students not passing in the first call. Students will also be allowed to deliver a new NP consisting of a modified version of the program of the first call, and whose specifications will be published with at least 4 weeks with respect to the deadline, that it will never be later than this second final exam.

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

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

FG-EA = Max{(0.4 + 0.6×NP-1st) × FE-1st, (0.4 + 0.6NP-2nd) × FE-2nd}

Those students who have failed in the first call by going through Continuous Assessment and wish to renounce it in order to choose the Eventual Assessment, will have to request it in writing to the coordinator before the review date of the first final exam. 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 EA, being therefore obligatory the delivery of a new PR with the specifications of this second call. In this case, any reward obtained by the CA activities in the virtual classroom is also waived.

Extraordinary call

Students presenting to this extraordinary call must approve the **FE**, to be done at the officially established dates and obtain an APT grade in the practice NP, that must be delivered before the date of this **FE**. The specifications of this practice are the same as those of the second call. It is mandatory to deliver this practice on time, although it has already been delivered in the second call.

The final grade of this call will be that of the **EF** if the **NP** is APT, and 40% of the **EF** if the **NP** is NOT APT

Other comments

All students presenting to any of the exams, **C1, C2, EF or PR** are considered to be presented to the subject. The grades for all exams, partial or final, and activities will affect only the actual academic year.

The virtual classroom platform has tools to detect possible anomalous and dishonest behaviors in self-assessment tests (tests carried out among several people, previously known answers, etc.), as well as to detect plagiarism in written works or in software programs.

Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the works/test/exams, including the activities on the virtual platform, the final grade will be FAIL (0), and the incident will be reported to the corresponding academic authorities for prosecution.

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

To take the course, in order to carry out the network program, it is very important to have a certain programming skills in an object-oriented language such as Java (or C ++). The skill level obtained after passing the Programming II course is enough.

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	Signal Theory and Communications			
Coordinator	López Valcarce, Roberto			
Lecturers	Comesaña Alfaro, Pedro Isasi de Vicente, Fernando Guillermo López Valcarce, Roberto Márquez Flórez, Óscar Willian Rodríguez Banga, Eduardo Rodríguez Vaqueiro, Yolanda			
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
Lecturing	24	24	48
Computer practices	21	31.5	52.5
Problem solving	2	8	10
Laboratory practices	6	9	15
Essay questions exam	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
Lecturing	Presentation and discussion of the fundamental theory. Through this methodology, skills CE9, CE10, CE20, CG3, CG4, CG6, CT2, CT3 are developed
Computer practices	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
Problem solving	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 practices	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 practices	Beyond the initial explanation to the group, the teachers will resolve the individual doubts of the students.
Lecturing	The personalized attention will be done at the office hours.
Computer practices	Beyond the initial explanation to the group, the teachers will resolve the individual doubts of the students.
Problem solving	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		
Essay questions exam	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 following the schedule to be approved by the Academic Committee, which will be published by the beginning of the semester. 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 repeat 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.

Plagiarism is regarded as serious misconduct. If any form of plagiarism is detected in any of the tests or exams, the final grade will be FAIL (0), and the corresponding academic authorities will be informed about the fact, in order to take the adequate measures.

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	Signal Theory and Communications			
Coordinator	Martín Rodríguez, Fernando			
Lecturers	Martín Rodríguez, Fernando Martínez Solís, Diego Pena Giménez, Antonio Rodríguez Rodríguez, José Luis			
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. Sampling & Quantization.	
S2. Sound: time and frequancy domain analysis.	-Time domain characteristics. -Windowing and DFT. -Frequancy Characteristics. -Sound: acoustic variables, generation, sources combination, sound sensations.

S3. Measuring sound.	- Measurement levels. - Sonometer. - Filter banks. - Sound acquisition. - Especifications and objective quality.
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. Still images coding.	Practical work about still image coding.
Project I 3. Video coding	Practical work about motion image coding.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Lecturing	25	50	75
Problem solving	6	12	18
Computer practices	19	19	38
Discussion Forum	0	1	1
Objective questions exam	0	2	2
Essay questions exam	4	0	4
Short answer tests	1	0	1
Practices report	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.
Lecturing	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.
Problem solving	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.
Computer practices	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.
Discussion Forum	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

Problem solving	Help with problem solving, in the classroom and/or at the office.
Computer practices	Help in the classroom and, if necessary at the office or via e-mail.
Lecturing	Querry and answer in the classroom and, if necessary, at the office.
Tests	**Description**
Practices report	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	
Objective questions exam	On the faitic website.	7.5	B3	
Essay questions exam	To evaluate theoretical knowledge and problem resolution.	65	B3 B5	C13
Short answer tests	Exam with questions and problems.	5	B3	
Practices report	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

On detecting any kind of plagiarism in any of the tests (short test, partial or final exam, lab reports) the final qualification will be FAIL (0) and the fact will be transmitted to school regents for taking the appropriate actions.
There are two kinds of assesment: continuous assesment and single assesment.

The schedule for intermediate evaluation tests will be approved by the CAG (DEGREE ACADEMIC COMMITTEE) and will be published at the beginning of four month period in which this course is delivered.

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%): 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%).
4. Short answer exam (Weight: 5%): It includes several subjects.
5. Lab project report (Weight: 15%).
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).

SINGLE EXAM 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 in the first opportunity 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.

Special Exam:

In special call exam (end of degree), we will proceed as in the case of students that have not completed the continous assesment.

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