



## (\*)Escola de Enxeñaría de Telecomunicación

## (\*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación

### Subjects

#### Year 2nd

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

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

<b>Competencies</b>	
Code	
A3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations
A4	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.
A20	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.
A26	CE17/T12: The knowledge and usage of concepts of communication network architecture, protocols and interfaces.
A27	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 network application and systems, voice, data, video, audio, interactive and multimedia services.
A29	CE20/T15: The knowledge of national, European and international telecommunication regulations and laws.

<b>Learning aims</b>	
Expected results from this subject	Training and Learning Results
Knowledge of the foundations of discrete Information Theory	A3
Understanding of the basic properties of lossless data compression methods and linear error control codes	A4
Knowledge of logical link protocols and physical level interfaces	A26 A29
Understanding the principles and fundamental technologies of local area networks, as well as their interconnection possibilities among them and with other types of networks	A20 A27

<b>Contents</b>
Topic

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

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

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

Methodologies	
	Description
Master Session	Systematic exposition of the theoretical contents of the subject, emphasizing the aims, fundamental concepts and relationships between the different units.
Previous studies / activities	Students will study the theoretical contents of the subject using the textbook and/or further material.
Troubleshooting and / or exercises	Selected problems and/or exercises will be solved in detail, emphasizing the theoretical concepts involved and the methodology of resolution.
Autonomous troubleshooting and / or exercises	Students will try to autonomously solve a problems and/or exercises from a proposed collection.

## Personalized attention

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

Assessment		
	Description	Qualification
Long answer tests and development	Two partial examinations and a final examination. In each one of them we will evaluate all the competencies corresponding to the contents we have seen in class to date of the examination.	100

#### Other comments on the Evaluation

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

The continuous assessment comprises two midterm exams (20% each) and a final written exam (60%).

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

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

Any gradings are only valid during the academic year.

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

#### Sources of information

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

C. López García, M. Fernández Veiga, **Cuestiones de Teoría de la Información y Codificación**, 2003,

J. F. Kurose, K. W. Ross, **Computer Networking, 6/e**, 2012,

#### Recommendations

##### Subjects that continue the syllabus

Computer Networks/V05G300V01403

##### Subjects that it is recommended to have taken before

Mathematics: Probability and Statistics/V05G300V01204

<b>IDENTIFYING DATA</b>				
<b>Programming II</b>				
Subject	Programming II			
Code	V05G300V01302			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Fernández Masaguer, Francisco			
Lecturers	Blanco Fernández, Yolanda Fernández Masaguer, Francisco Manso Vázquez, Mario Servia Rodríguez, Sandra			
E-mail	francisco.fernandez@det.uvigo.es			
Web	http://www.faitic.es			
General description	<p>The general aim of this subject is to provide the students with the theoretical foundations and the practical competitions that allow them analyze, design, develop and debug computer applications following the paradigm of oriented objects programming (OOP). This is an essentially practical subject oriented to the work of the students in the development of software projects. To make this task easier, the subject includes an introduction to the Engineering of the Software. In this sense, the focus is not put on all the well-known phases of the processes of development software (ranging from capture and description of requirements to the deployment of the systems), but just on main stages related to analysis, design, implementation and debugging. Firstly, the engineering of the software is presented as an indispensable discipline for the development of big computer applications, showing the main challenges to face and the basic concepts behind them. Next, the elements of the OOP will be detailed by resorting to UML elements and diagrams, which will be used by the students in their developments. To reach this general aim the contents that will be handled in the subject are the following ones:</p> <p>OOP paradigm: basic concepts, classes and objects.  Encapsulation. Concepts of decoupling and cohesion  Inheritance, abstraction, polymorphism and reuse  Relations between classes: Generalization, association and dependency  Communication between objects: methods, events, messages  Persistence. Storage in files and in databases  Generation, capture and processing of exceptions  Introduction to the Engineering of the Software  Concepts of the Engineering of the Software. Historical review or Introduction and concept of Cycle of Life.</p>			

<b>Competencies</b>	
Code	
A6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
A9	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.
A59	(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.
A60	(CE51/T19) The ability of basic application of phases of analysis, design, implementation and debugging of OOP programs.
A61	(CE52/T20) The ability of manipulation of CASE tools (editors, debuggers).
A62	(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.
B5	The ability to use software tools to search for information or bibliographical resources

<b>Learning aims</b>	
Expected results from this subject	Training and Learning Results
To understand the fundamental concepts of the Object Oriented Programming model (OOP) and carry them to practise using the most representative object oriented programming language (Java).	A9 A59
To introduce in the use of the UML language, the ISO standard language for software modeling, for the making of structure, behaviour and interaction diagrams, and fundamental for the documentation in the phases of analysis and design of OO programs.	A6 A61 A62
	B5

To develop skills in the process of analysis, design, implementation and debugging of OOP applications taking into account the main standards and quality norms.	A60
To acquire maturity in development and debugging programming techniques to allow the autonomous learning of new capacities and programming languages.	A62
To acquire familiarity with the use of a modern software development tool (Eclipse) to facilitate the design, development and debugging of programs.	A60
	A61

## Contents

Topic	
1. Introduction to OO paradigm	a. Brief introduction to the subject and organization. b. Birth of the paradigm c. Bases: 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 variable member. Visibility. Resolution of field. c. Method constructor d. Step of parameters: pointers and references e. Pointers to objects
3. Inheritance	a. Derived classes and types of inheritance b. Abstract Classes c. Multiple Inheritance d. Object class
4. Object-Oriented design	a. Design Basics b. Use of UML diagrams
5. Polymorphism	a. Overloading and overwriting b. Abstract classes and interfaces c. Generic classes
6. Exception Handling	a. Exception Basics b. Handling Java exceptions

## Planning

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

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

## Methodologies

	Description
Master Session	Classes that will combine explanation of theoretical concepts and realisation of small exercises. These will be able to be resolved by the professor or by the own students individually and/or in group. The goal is to boost the debate in the class and reinforce the acquisition of skills. This methodology is oriented to the acquisition by the student of competences CE50, CE51 and CE53.
Troubleshooting and / or exercises	In the computer rooms, the professor will pose challenges to be resolved by the students, thus discussing collectively the possible options to face a solution. This methodology is oriented to competences CE50, CE51 and CE53.
Autonomous troubleshooting and / or exercises	Students individually will resolve the problems posed by the professor in the computer room. Solutions and doubts that arise in addressing these problems will be put together to agree the best way to fix each concern. This methodology is oriented to competences CE50, CE51, CE53 and A9.
Case studies / analysis of situations	Put in common of the designs posed to solve the project that have to carry out during the second part of the course. The comparison of the different proposals will serve to select the best options and be used, if it is timely, to improve the designs realised. This methodology is oriented to competences CE51 and CE52.

Projects	The students will develop a software project defined by the professor. The development of this project will require face-to-face work in the computer room (supported by the professor) and individual work. This methodology is oriented to competences CE50, CE53, A6 and A9.
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### Personalized attention

Methodologies	Description
Troubleshooting and / or exercises	The personalized attention will consist of following-up the work of each student, tracking the solutions proposed for each problem posed in the sessions in the computer room and the exhibition of their UML designs for the proposed software project.
Projects	The personalized attention will consist of following-up the work of each student, tracking the solutions proposed for each problem posed in the sessions in the computer room and the exhibition of their UML designs for the proposed software project.
Autonomous troubleshooting and / or exercises	The personalized attention will consist of following-up the work of each student, tracking the solutions proposed for each problem posed in the sessions in the computer room and the exhibition of their UML designs for the proposed software project.
Case studies / analysis of situations	The personalized attention will consist of following-up the work of each student, tracking the solutions proposed for each problem posed in the sessions in the computer room and the exhibition of their UML designs for the proposed software project.

### Assessment

	Description	Qualification
Projects	The students, organized into groups of 2 people, will submit a software project during the week from 2 to 6 of December of the course. This submission must include the UML diagrams of the final design, the code and the documentation about the implementation details. The software must run correctly on the computers of the educational laboratories. In the assessment, the professor will consider both the correct execution of the program and the designed adopted in the development. With this test CE53, CE50, A6 (CG6), A9( CG9) and B5 competences will be assessed.	30
Case studies / analysis of situations	The students, organized into groups of 2 people, will submit and present in the computer room the design defined for the project software, including UML class diagrams. This design will be submitted during the week from 4 to 7 of November of the course. With this test CE51, CE52 and A9 competences will be assessed.	10
Troubleshooting and / or exercises	Each student will take a final exam in the official date published in <a href="http://www.teleco.uvigo.es">www.teleco.uvigo.es</a> , which will consist of the following types of questions: resolution of problems, short-answer questions about the theoretical concepts explained in master sessions, true/false assessments, multiple-choice tests. Note that support materials are not allowed. The number and the combination of the aforementioned questions will be defined for each particular exam. With this test, CE50, CE51 and CE53 competences will be assessed.	50
Practical tests, real task execution and / or simulated.	The students, organized into groups of 2 people, will submit the Java initiation practices proposed in the computer room. This submission will take place during the week from 21 to 25 of October of the course. With this test, CE50, CE52 and CE53 competences will be assessed.	10

### Other comments on the Evaluation

There are two modalities in the evaluation of this subject: continuous evaluation (EC) and traditional evaluation (ET). The students will have to choose one of the two modalities taking into account the following restrictions:

- The EC includes the 4 proofs described in the separated evaluation.
- So much by EC as by ET, the students will have to realise a project of laboratory. To facilitate the election of EC or ET the students will have in Fatic platform of the project to realise from the day 20 September.
- In ET the project will realise of individual form.
- The students that opt by the EC will have to deliver in the first week of November, the UML design of the project posed in the laboratory (corresponding to the 3ª proof of evaluation). By means of said delivers the students engage to be followed the EC and renounce to the ET. From this moment, these students will not be able to appear as "No presented".
- The students that do not deliver the UML design of the project in the week of the 4 to 7 November, renounce to the EC, so that they will be evaluated by means of the mechanism of ET. It does not exist the possibility to add to EC in the following intermediate proofs.
- The proofs of EC will not be in no case recoverable, not being able to repeat out of the dates stipulated by the educational.

- They will not save qualifications (of proofs of EC neither of practical projects or final examinations) of a course to another.
- The EC only will apply in the first announcement, in the rest of announcements governs only the ET.

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**First announcement. Students that opt by EC.** They will be evaluated as follows:

- Theoretical part:
  - Examination written (50%). Individual examination. It corresponds with the proof 3 described in the separated "Evaluation". It will not allow material of support.
- Practical part:
  - Practices of initiation in Java (10%). In groups of 2 students. It corresponds with the proof 4 described in the separated "Evaluation".
  - Project (40%). In groups of 2 students. Divided in two parts:
    - Design (10%). It corresponds with the proof 2 described in the separated "Evaluation".
    - Implementation (30%). It corresponds with the proof 3 described in the separated "Evaluation". This project will have to be delivered individually the first week of December of the educational period. For his evaluation will realise , like previous requirement, a proof or interview of authorship:
      - If the student does not surpass it, the evaluation of the implementation realised by an examination practise.
      - If the student surpasses the proof of authorship, his note of evaluation (that it will be the same for both members of the group) will take into account: correct design, correct functionality, quality of the code and use of technicians of OOP.
- The requirements to approve will be:
  - A minimum of 1/3 on the total in the theoretical part.
  - A minimum of 1/3 on the total in the part of implementation of the project (or 1/3 on the total of the practical examination in his case).
  - A total note (sum of the 4 proofs) equal or upper to 5.

For the proof of authorship of the practical part (that it can suppose individual questions of diverse nature) will be compulsory that the code delivered can be compiled and executed in the teams of the educational laboratories.

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**First announcement. Students that opt by ET.** They will be evaluated as follows:

- Theoretical part:
  - An examination written (whose description coincides with the proof 3 of EC). The result of this examination will suppose 50% of the final qualification. It will not allow material of support.
- Practical part:
  - The realisation of a software project that will suppose the other 50% of the final qualification. Of individual realisation. This project will consist of design (UML diagrams), the Java code and the documentation generated explanatory of the implementation. The note of evaluation will take into account: correct design, correct functionality, quality of the code and use of technicians of OOP model. This project will have to be delivered individually the first week of December.
  - The realisation of an interview with the tutor oriented to determine the authorship of the project. Said interview will take place in the laboratory the last academic week of the course. If the student does not surpass the proof of authorship will have to go to an examination practise.
- The requirements to approve will be:
  - A minimum of 1/3 on the total in the theoretical part.
  - A minimum of 1/3 on the total in the project or practical examination according to the case.
  - A total note (sum of the 2 proofs) equal or upper to 5.

For the proof of authorship of the practical part (that it can suppose individual questions of diverse nature) will be



compulsory that the code delivered can be compiled and executed in the teams of the educational laboratories.

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**Second announcement / Announcement of end of course / extraordinary Announcement.** In this announcement that does not govern the EC. The evaluation will be as follows:

- Theoretical part:
  - An examination written (whose description coincides with the proof 3 of EC). The result of this examination will suppose 50% of the final qualification. It will not allow material of support.
- Practical part:
  - The students that do not deliver the project in the first announcement, will evaluate with an examination of individual programming in the laboratory that will take place in the date fixed by the Board of School for this. The evaluation of this proof will suppose 50% of the final qualification.
  - The part practises to realise for the students that deliver the project in the first announcement, will depend on the note of the project obtained in the first announcement, as the following:
    - *It notices  $\geq 1.5$ .* It will keep them the note, not having to present to the practical examination of the second announcement. They will be able to, however, improve the punctuation of the project delivering a new version of the one of the first announcement together with the new functions to realise that they published in his moment in the Fatic platform. Likewise, they will have to deliver a document that collect the changes and updates realised to the project on the version that deliver in the first announcement.
    - *Note between 1.5 and 1.* They will be able to opt between going to the examination practise or realise the project of the second announcement. No it keeps them the note of the project of the first announcement, but if the one of initiation and the one of UML design.
    - *It notices  $< 1$ .* They will be able to opt between going directly to the examination practise or realise the project expanded. In any case loses the note of practices of the part of initiation and UML design. That is to say, it evaluated them on 5, independently of if they opt by the project or the practical examination.
- The requirements to approve will be:
  - A minimum of 1/3 on the total in the theoretical part.
  - A minimum of 1/3 on the total in the project or examination according to the case.
  - A total note (sum of the 2 proofs) equal or upper to 5.

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## Sources of information

Basic references:

[2] *Introduction to Java programming*. Y. Daniel Liang, 8ª edición. 2010, Pearson.

Other references:

[1] *Programación orientada a objetos con Java: una introducción práctica usando BlueJ*. D. J. Barnes, M. Kölling. 3ª edición. 2007, Pearson.

[3] *Data Structures & Algorithms in Java*. Michale T. Goodrich, Roberto Tamassia, 5ª edición. 2010, Willey.

[4] *Java Tools*. Andreas Eberhart, Stefan Fischer. 2002, Wiley

[5] *Java In A Nutshell*. David Flanagan, 5ª edición. 2005, O'Reilly.

[6] *Thinking in Java*. Bruce Eckel, 4ª edición. 2006, Prentice Hall

[7] *Learning Java*. Patrick Niemeyer, 3ª edición. O'Reilly Media

[8] *How to Think Like a Computer Scientist. Java™ Version*. 4ª version. Online:  
<http://www.greenteapress.com/thinkajava/>

[9] *Java notes*. Fred Swartz. Online: <http://www.lepoint.net/notes-java/index.html>

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

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

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

[14] *Open-oriented Analysis and Design with Applications*. Grady Booch, Robert Maksimchuk, Michael Engel, Bobbi Young, Jim Conallen, Kelli Houston, 3ª edición. 2007, Addison Wesley.

[17] *Fundamentals of Object-oriented design in UML*. Meilir Page-Jones. 2002, Addison Wesley.

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## Recommendations

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### Subjects that it is recommended to have taken before

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Programming I/V05G300V01205

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<b>IDENTIFYING DATA</b>				
<b>Electromagnetic Transmission</b>				
Subject	Electromagnetic Transmission			
Code	V05G300V01303			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Vera Isasa, María			
Lecturers	Aguado Agelet, Fernando Antonio Arias Acuña, Alberto Marcos Díaz Otero, Francisco Javier García-Tuñón Blanca, Inés Gómez Araújo, Marta Lorenzo Rodríguez, María Edita de Rubiños López, José Óscar Santalla del Río, María Verónica Vazquez Alejos, Ana Vera Isasa, María			
E-mail	mirentxu@uvigo.es			
Web	http://fatic.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	
A3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations
A4	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.
A5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
A17	CE8/T3: The ability to use software tools for bibliographical resources search or information related with electronics and telecommunications.
A18	CE9/T4: The ability to analyze and specify the main parameters of a communications system.
A22	CE13/T8: The ability to understand the electromagnetic and acoustic wave mechanisms of propagation and transmission, and their corresponding receiving and transmitting devices.
A29	CE20/T15: The knowledge of national, European and international telecommunication regulations and laws.

### Learning aims

Expected results from this subject	Training and Learning Results
To understand the mechanisms of propagation and transmission of electromagnetic waves.	A3 A22
To identify and define the main parameters that characterize transmission media of electromagnetic waves.	A3 A17 A18
To solve problems that require the handling of basic concepts related to guided and radio transmission.	A4 A22
To estimate transmission losses in different media.	A3 A5
To measure antenna basic parameters.	A5 A18 A29
To search updated information about specifications and regulations.	A3 A17 A29

### Contents

Topic	
1. Introduction	Types of transmission media, advantages and disadvantages, characterisation.
2. Transmission lines	Getting started with some of the most commonly used transmission lines: coaxial, twisted pair. Circuit model of distributed parameters ,general equations, characteristic parameters (characteristic impedance, propagation velocity, attenuation and phase coefficients). Attenuation, dispersion and crosstalk. Transmission line in circuit (reflection coefficient, standing wave ratio, input impedance). Smith Chart.
3. Waveguides and optical fiber.	Rectangular waveguide: TE and TM modes, cutoff frequency, guided wavelength, wave impedance. Optical fiber: structure, types, numerical aperture, acceptance cone , attenuation and dispersion.
4. Radiowaves and antennas	Characteristics of radiowaves: far field, radiation integral. Antenna concept and fundamental parameters (radiation pattern, secondary lobe level, beamwidth, directivity, gain, polarisation, impedance). Reception: power balance in free space (Friis equation), polarization loss factor. Center feed dipoles. Radiosystems evaluation.
Labs	<ul style="list-style-type: none"> <li>- Management of software tools to search information: technical, scientific and regulation of telecommunications.</li> <li>- UTP and coaxial.</li> <li>- Basic matching technics.</li> <li>- Radiation pattern plots.</li> <li>- Measurement of basic parameters in transmission lines, waveguides and antennas.</li> <li>- Problem resolution.</li> </ul>

## Planning

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

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

## Methodologies

	Description
Introductory activities	Activities focused to take contact and get information about the students and to introduce the subject.
Master Session	Presentation by the teacher of the contents of the subject of study (theoretical basis). Learning aims T4, T8 and CG3.
Laboratory practises	Application of knowledge to specific situations and acquisition of basic skills and procedures related with CG5 aim. They are developed in laboratories with specialized equipment.
Practice in computer rooms	Activities of acquisition of basic skills related with the matter. Learning aims T3 and T15 are specifically worked with this methodology.
Presentations / exhibitions	Student presentation of the results of a group work about T15 aim.
Autonomous troubleshooting and / or exercises	Activity in which problems are formulated related to the subject. The student must develop the analysis and solving problems independently. The solutions are provided in ordinary class hours. Learning aim CG4.

## Personalized attention

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

### Assessment

	Description	Qualification
Laboratory practises	Performing lab practices that require instrumentation handling in which CG5 learning aim is assessed.	20
Presentations / exhibitions	Performing lab practices of software tools to search of information and a work about telecommunication regulation. Learning aims T3 and T15 are jointly assessed.	10
Troubleshooting and / or exercises	Proof in which the student has to solve a series of problems in a time and conditions established by the teacher, applying the acquired knowledge. Assessment of T4, T8, CG3 and CG4 learning aims.	40
Multiple choice tests	Tests for evaluation of acquired skills including direct questions about a particular aspect. Students must respond directly and briefly based on their subject knowledge. Learning aims T4, T8 and CG3.	30

### Other comments on the Evaluation

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

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

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

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

### Evaluation by final exam

In addition to the continuous assessment system described above, the student may choose to perform one final exam that will have three parts:

- Part I: practice and report (pass or fail).
- Part II: multiple-choice test (40%).
- Part III: problem solving (60%).

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

### July exam

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

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

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

### Sources of information

F.T. Ulaby, **Fundamentals of Applied Electromagnetics**, 6<sup>a</sup>,

S.M. Wentworth, **Applied electromagnetics. Early transmission line approach**, 1ª,

D. K. Cheng, **Fundamentos de electromagnetismo para ingeniería**,

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**Additional references:**

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

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

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

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

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**Recommendations**

**Subjects that continue the syllabus**

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Fundamentals of Sound and Image/V05G300V01405

Signal Transmission and Reception Techniques/V05G300V01404

Microwave Circuits/V05G300V01611

Radio Frequency Circuits/V05G300V01511

Spectrum Management/V05G300V01612

Optical Telecommunication Infrastructures/V05G300V01614

Wireless Systems and Networks/V05G300V01615

Radio Communication Systems/V05G300V01512

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**Subjects that are recommended to be taken simultaneously**

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Digital Signal Processing/V05G300V01304

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**Subjects that it is recommended to have taken before**

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Physics: Analysis of Linear Circuits/V05G300V01201

Physics: Fields and Waves/V05G300V01202

Mathematics: Calculus I/V05G300V01105

Mathematics: Calculus II/V05G300V01203

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<b>IDENTIFYING DATA</b>				
<b>Digital Signal Processing</b>				
Subject	Digital Signal Processing			
Code	V05G300V01304			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	García Mateo, Carmen			
Lecturers	Abreu Sernández, María Victoria Alonso Alonso, Ignacio García Mateo, Carmen Márquez Flórez, Óscar Willian			
E-mail	carmen.garcia@uvigo.es			
Web	http://fatic.uvigo.es			
General description	<p>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.</p> <p>Objectives cover the following areas:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Managing signals and systems mathematically and visually, including learning and applying their properties.</li> <li><input type="checkbox"/> Studying the different domains for signal and systems analysis: time domain, frequency domain and Z domain.</li> <li><input type="checkbox"/> Learning how to transfer a problem in one domain to a domain in which it is easier to solve.</li> <li><input type="checkbox"/> Mastering the concept of filter frequency response and learning to interpret the system function.</li> <li><input type="checkbox"/> Understanding the relationship between the poles and zeros of the system function and the frequency response.</li> <li><input type="checkbox"/> Acquiring basic notions of filter design in the Z domain.</li> <li><input type="checkbox"/> Managing specific digital signal processing software.</li> <li><input type="checkbox"/> Applying the above knowledge to simple and practical laboratory examples.</li> </ul>			

### Competencies

Code	
A3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations
A4	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.
A57	(CE48/T16) The knowledge of the appropriate techniques to develop and exploit signal processing subsystems .
A58	(CE49/T17) The ability to analyze digital signal processing schemes.

### Learning aims

Expected results from this subject	Training and Learning Results
Managing specific software for digital signal processing	A57
Applying mathematical knowledgements for signal filtering	A58
Mastering filtering operations in frequency domain.	A3 A58
Learning mathematical issues for understanding the processes of sampling and windowing signals.	A4 A57
Analysis of simple processing systems.	A58

### Contents

Topic	
Subject 1. Introduction to Sampling and Aliasing	Sampling and digital frequency. Analog frequency vs discrete frequency. Aliasing. The sampling theorem.

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

## Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Master Session	22	44	66
Laboratory practises	11	18	29
Troubleshooting and / or exercises	15	30	45
Forum Index	0	2	2
Multiple choice tests	1.5	0	1.5
Short answer tests	1	0	1
Troubleshooting and / or exercises	4.5	0	4.5

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

## Methodologies

	Description
Introductory activities	Course presentation: programme, reading materials, teaching methodology and assessment system
Master Session	Instructor presentation of the main concepts of each subject. Classes do not cover all content that is examination material. The student should take the content indicated in the guidelines for each subject into account as orientation for exams. During the 5 minutes before the lecture, a student will summarize the main concepts presented in the previous session. Students will participate by answering questions during the explanation and by doing exercises. Student will work alone afterwards on the concepts studied in class and on expanding this content using the guidelines provided for each subject. Identification of doubts that need to be resolved in personalized tutorials.
Laboratory practises	Application of Matlab functions and commands for digital signal processing to solve practical exercises. Identification of doubts that need to be resolved in personalized tutorials.
Troubleshooting and / or exercises	Problems and exercises formulated according to the content of the lectures and the guidelines for each subject. Students solve problems and exercises prior to the class in which one or several students explain the solution on the board. Identification of doubts that need to be resolved in personalized tutorials.
Forum Index	The website for the course is included in the TEMA platform ( <a href="http://fatic.uvigo.es">http://fatic.uvigo.es</a> ). 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.

## Personalized attention

Methodologies	Description
Master Session	Students will have the opportunity to attend personal tutorials in their lecturer's office at times established by lecturers for this purpose at the beginning of the academic year and published on the course website. These tutorials are aimed at resolving student doubts and providing guidance regarding: <ul style="list-style-type: none"> <li>□ The content of the lectures and approaches to study.</li> <li>□ Laboratory projects and the software used.</li> <li>□ Problems and exercises proposed and solved in the classroom as well as other problems and exercises arising during the course.</li> </ul>



Laboratory practises	Students will have the opportunity to attend personal tutorials in their lecturer's office at times established by lecturers for this purpose at the beginning of the academic year and published on the course website. These tutorials are aimed at resolving student doubts and providing guidance regarding: <ul style="list-style-type: none"> <li>□ The content of the lectures and approaches to study.</li> <li>□ Laboratory projects and the software used.</li> <li>□ Problems and exercises proposed and solved in the classroom as well as other problems and exercises arising during the course.</li> </ul>
Troubleshooting and / or exercises	Students will have the opportunity to attend personal tutorials in their lecturer's office at times established by lecturers for this purpose at the beginning of the academic year and published on the course website. These tutorials are aimed at resolving student doubts and providing guidance regarding: <ul style="list-style-type: none"> <li>□ The content of the lectures and approaches to study.</li> <li>□ Laboratory projects and the software used.</li> <li>□ Problems and exercises proposed and solved in the classroom as well as other problems and exercises arising during the course.</li> </ul>

Assessment		
	Description	Qualification
Multiple choice tests	These tests are a requirement to pass the subject. See details in the "Other comments and second call" section.	0
	In these tests the skill A57 will be evaluated.	
Short answer tests	These tests are a requirement to pass the subject. See details in the "Other comments and second call" section.	0
	In these tests the skill A53 will be evaluated.	
Troubleshooting and / or exercises	These tests are a requirement to pass the subject. See details in the "Other comments and second call" section.	100
	In these tests the skills A3, A4 and A58 will be evaluated.	

## Other comments on the Evaluation

### ASSESSMENT PROCEDURE:

#### A. Overview

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

1. Lab assessment.
2. Basic knowledge test.
3. Problem assessment.

#### To pass the course it is necessary to pass all three parts.

- For each part one or more tests are performed to obtain an independent grade on each.
- There are tests for each part both during the lecture period and final evaluation periods. In total there are three opportunities to pass each part throughout the academic year.
- A pass grade in any part is valid for the entire academic year.
- The final grade for Basic knowledge test and Lab assessment is Pass or Fail.
- The final grade for the Problem assessment is a numerical mark between 0 and 10.
- The course mark is obtained roughly as follows:
  - If you have passed all three parts, the final grade is the grade of the Problem assessment.
  - If you have not passed any of the three parts, the final grade is the lowest of the three, calculated as specified later on.
  - It is also important to note that:
    - The course can be passed with full marks from continuous assessment, with no need to sit the final exam.
    - Students who have done continuous assessment and have failed any part, at the end of the term or at the end of the academic year, may need to perform only the failed parts.
    - Students who sit any of the tests corresponding to continuous assessment will obtain 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.
- Students are graded as pass or fail.
- There are 3 opportunities to pass:
  - Opportunity 1 (Continuous assessment)
    - There will be three mandatory tests in the lab room
    - The test consists of series of questions at the end of each Practice assignment
    - The tests will be graded between 0 and 10. The student will pass this part if he/she gets an average greater than or equal to 5. It is compulsory to sit all three tests.
    - Exact dates will be announced on the web site at the beginning of the lecture period.
  - Opportunities 2 and 3. A test in the End-of-Term exam period, and a test in the End-of-Academic-Year exam period. Students must obtain a pass grade in this test in order to pass the course. The pass mark for this test is 5 out of 10.
- Remarks:
  - Once the pass grade is obtained, this is valid for the entire academic year.
  - While the pass grade is not obtained, it is possible to sit any of the three opportunities.

### **B2. Basic knowledge test**

- The goal of this test is to determine whether the student has acquired the minimum knowledge and skills needed to pass the course.
- Content to be assessed: as specified in the guidelines for each topic in the section "Basic Skills". Knowledge of MatLab is excluded from this test. The test consists of a combination of multiple-choice questions and short theoretical and practical questions. Students may not use books, notes or a calculator for this test.
- Students are graded as pass or fail. Students must obtain a pass grade in this test in order to pass the course. The pass mark for this test is 7 out of 10.
- There are 3 opportunities to pass this test: in an hour of classroom time in the second-last week of the course, in the End-of-Term exam period and in the End-of-Academic-Year exam period. Exact dates will be announced on the web site at the beginning of the lecture period.
- Remarks:
  - Once the pass grade is obtained, this is valid for the entire academic year.
  - While the pass grade is not obtained, it is possible to sit any of the three opportunities.

### **B3. Problem Assessment**

- Their goal is to determine whether the student has acquired all the knowledge and/or skills corresponding to course and knows how to apply them to solve problems.
- Content to be assessed: as specified in the guidelines for each topic in the section "Content to be assessed". MatLab knowledge is not assessed.
- Type of test: an exam of problems. Students may not use books or notes. The use of calculators may be granted on an exam basis.
- It will be graded between 0 and 10. The pass mark is 5.
- There are 3 opportunities to pass:
  - Opportunity 1 (Continuous assessment)

- There will be three mandatory tests in the classroom. Each test will be graded between 0 and 10.
- The mark will be obtained as :  $0,25 * \text{Test1Mark} + 0,35 * \text{Test2Mark} + 0,4 * \text{Test3Mark}$
- Test1: from Subject 1 to Subject 3. It will take place during the sixth week of the course.
- Test2: from Subject 1 to Subject 6. It will take place during the tenth week of the course.
- Test3: from Subject 1 to Subject 8. It will take place during the last week of the course.
- Exact dates will be announced on the web site at the beginning of the lecture period.
- Opportunities 2 and 3. An exam in the End-of-Term exam period, and an exam in the End-of-Academic-Year exam period. In each exam, all content is evaluated according to the information contained in the guidelines for each subject. The pass mark for this test is 5 out of 10.
- Remarks:
  - Once the pass mark is obtained, this is valid for the entire academic year.
  - While the pass grade is not obtained, it is possible to sit any of the three opportunities.
  - It is always possible to sit the second opportunity to try to get a better mark.

### C. Other comments

- The grade obtained at the end of the term will be part of the academic record of the student. This grade will be final if the mark is above or equal to 5. Otherwise a provisional fail grade will be recorded on their academic record.
- The provisional mark will become definitive fails for students who do not sit at the end of the academic year exam period, or gets a lower mark. Otherwise the better mark will be part of the academic record and becomes final.
- The final mark is computed as:
  - If the student passes all three parts, the mark is that of the problem assessment part.
  - If the student fails any part, the mark is the minimum of:
    - The average mark of the lab assessment.
    - $(5/7) * \text{Mark of the Basic knowledge test}$ .
    - Mark of the problem assessment.
    - In case of more than one mark for any part, the highest one will be used.
- Tests performed as continuous assessment may not be rescheduled.
- The grades obtained in the basic knowledge test, the lab assessment, and 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.

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#### Sources of information

J.H. McClellan y R.W. Schafer, R, **Signal Processing First**, Pearson Prentice Hall,  
 A. Quarteroni y F. Saleri, **Cálculo científico con Matlab y Octave**, Springer,  
 M. J. Roberts, **Señales y Sistemas**, McGraw Hill,  
 A.V. Oppenheim y R.W. Schafer, **Tratamiento de señales en tiempo discreto**, Prentice Hall,

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

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

- Theoretical content: The theory that will be evaluated in exams.
- Basic knowledge: Content considered essential for the course and tested by the basic knowledge test described in the section on assessment.
- Problems proposed: A set of problems recommended for each subject.
- SPF vocabulary: A Spanish-English vocabulary with a set of selected terms is included to facilitate reading of the book.

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

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**Recommendations**

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**Subjects that continue the syllabus**

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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

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**Subjects that it is recommended to have taken before**

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Physics: Analysis of Linear Circuits/V05G300V01201  
Mathematics: Linear Algebra/V05G300V01104  
Mathematics: Calculus I/V05G300V01105  
Mathematics: Calculus II/V05G300V01203

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<b>IDENTIFYING DATA</b>				
<b>Physics: Fundamentals of Electronics</b>				
Subject	Physics: Fundamentals of Electronics			
Code	V05G300V01305			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Domínguez Gómez, Miguel Ángel			
Lecturers	Domínguez Gómez, Miguel Ángel Pérez López, Serafín Alfonso Raña García, Herminio José Rodríguez Pardo, María Loreto			
E-mail	mdgomez@uvigo.es			
Web	http://fatic.uvigo.es			
General description	<p>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:</p> <ul style="list-style-type: none"> <li>· Diodes and circuits with diodes, including concepts such as load line, ideal diodes, rectifiers, shaping circuits, logic circuits, voltage regulators and devices physics.</li> <li>· Characteristics of bipolar transistors, analysis of load line, large-signal models, polarization, amplification and small-signal equivalent circuits.</li> <li>· Study of the FET similar to the previous highlighting the MOSFET.</li> <li>· Check the circuit designs studied using SPICE. Mounting and verification using laboratory electronic instrumentation.</li> <li>· Basic concepts about logic digital circuits.</li> </ul> <p>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.</p>			

<b>Competencies</b>	
Code	
A13	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.
B4	The ability to use software tools that support problem solving in engineering

<b>Learning aims</b>	
Expected results from this subject	Training and Learning Results
Understanding and control of the basic concepts of the physical principles of semiconductors.	A13
Understanding and control of the basic concepts of operation of the electronic and photonic devices.	A13
Understanding and control of simple electronic circuits based on the electronic and photonic devices and their applications.	A13
Understanding and control of the basic concepts of the logic families.	A13
Basic knowledges on CAD (Computer Aided Design) tools for the simulation of electronic circuits.	B4
Capacity utilization of CAD tools for designing simple electronic circuits.	B4

<b>Contents</b>	
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 Junction Transistors (BJT)	Operation of the npn Bipolar Junction Transistor (BJT). Load-Line Analysis of a Common-Emitter Amplifier. The pnp Bipolar Junction Transistor. Models of circuits. Analysis of circuits with BJTs. Phototransistors and optocouplers.
Subject 5: Analysis of amplifiers with Bipolar Junction Transistors	Small-Signal Equivalent Circuits. Analysis in medium frequencies: the Common-Emitter amplifier, the Emitter-Follower amplifier, the Common-Collector amplifier and the Common-Base amplifier.
Subject 6: Field Effect Transistors (FET)	NMOS Transistor. Analysis of the load line of a simplified NMOS amplifier. Polarization circuits. JFET and depletion MOSFET transistors and channel p devices.
Subject 7: Analysis of amplifiers with Field Effect Transistors	Small-Signal Equivalent Circuits. Analysis in medium frequencies: the Common-Source amplifier and the Source Follower amplifiers.
Subject 8: Digital logic circuits	Digital logic circuits. Basic concepts. Electrical specifications of the logic gates. The inverter CMOS. CMOS gates NOR and NAND.

## Planning

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

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

## Methodologies

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

## Personalized attention

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

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

Assessment		
	Description	Qualification
Troubleshooting and / or exercises	Tests will be carried out in the classroom throughout the year to evaluate the competencies of the student to resolve problems and/or the exercises over a part of the contents of the subject. The skill A13 will be evaluated in these tests.	60
Practical tests, real task execution and / or simulated.	Tests will be carried out in the laboratory along the course about management of instrumentation, mounting of electronic circuits and simulation. The skills acquired by the student about the contents of the subject laboratory practices will be evaluated. The skills A13 and B4 will be evaluated in these tests.	35
Self-assessment tests	Techniques aimed to collect data about the participation of the student in the proposed self-assessment tests.	5

### Other comments on the Evaluation

#### 1. Continuous evaluation

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

##### 1.a Self-assessment tests

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

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

$$NAE = 0.05 \cdot AE$$

##### 1.b Theory

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

$$NPT = (NPT1 + NPT2 + NPT3)/3$$

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

The final mark of theory (NT) will be:

$$NT = 0.6 \cdot NPT$$

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

### 1.c Practical

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

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

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

### 1.d Final mark of the subject

It must get a minimum of 4 points out of 10 in theory ( $NT \geq 2.4$ ) and practices ( $NP \geq 1.4$ ) 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 ( $NPT1 \geq 3$ ,  $NPT2 \geq 3$  and  $NPT3 \geq 3$ ).

The final mark (NF) will be:

$$\text{If } NT \geq 2.4 \text{ and } NP \geq 1.4 \text{ and } NPT1 \geq 3 \text{ and } NPT2 \geq 3 \text{ and } NPT3 \geq 3 \Rightarrow NF = NAE + NT + NP$$

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

### 2. Final exam

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

The final exam will have a theoretical part and a practical one. The theoretical part will be carried out in the dates established by the School and it will consist in an exam (multiple choice test and/or short answer test and/or resolution of problems and/or exercises). This exam will have 3 parts, one for each block specified in section 1.b. Each part will be evaluated from 0 up to 10 and the final mark of theory (NT) will be the average multiplied by 0.6. It is necessary to get a minimum of 3 points in each of these parts ( $NPT1 \geq 3$ ,  $NPT2 \geq 3$  and  $NPT3 \geq 3$ ) and a minimum of 4 points out of 10 in theory ( $NT \geq 2.4$ ) 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 ( $NP \geq 1.4$ ) to pass the subject.

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

The students who have opted for the continuous evaluation and have failed and present to the final exam, can do it only to the theoretical part or to the practical one or both. They will conserve the mark got in the continuous evaluation of the missed part if the minimums specified in the continuous evaluation process were achieved. The students who take the theoretical part will be able to carry out the blocks they want. The mark of the continuous 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:

$$\text{If } NT \geq 2.4 \text{ and } NP \geq 1.6 \text{ and } NPT1 \geq 3 \text{ and } NPT2 \geq 3 \text{ and } NPT3 \geq 3 \Rightarrow NF = NT + NP$$

$$\text{If } NT < 2.4 \text{ or } NP < 1.6 \text{ or } NPT1 < 3 \text{ or } NPT2 < 3 \text{ or } NPT3 < 3 \Rightarrow NF = \min \{4.5; NT + NP\}$$

### 3. Recovery (July)

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

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

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

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



#### 4. Validity of the qualifications

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

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#### **Sources of information**

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

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

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#### **Recommendations**

##### **Subjects that continue the syllabus**

Digital Electronics/V05G300V01402

Electronic Technology/V05G300V01401

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##### **Subjects that it is recommended to have taken before**

Physics: Analysis of Linear Circuits/V05G300V01201

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

### Competencies

Code	
A23	CE14/T9: The ability to analyze and design combinatory and sequential, synchronous and asynchronous circuits and the usage of integrated circuits and microprocessors.
A25	CE16/T11: The ability to use different energy sources, especially photovoltaic and thermal ones, as well as the fundamentals of power electronics and electronics
B4	The ability to use software tools that support problem solving in engineering
B5	The ability to use software tools to search for information or bibliographical resources

### Learning aims

Expected results from this subject	Training and Learning Results
CE14/T9 Capacity of analysis and design of combinational and sequential circuits , both synchronous and asynchronous, and utilisation of microprocessors and integrated circuits.	A23
CE16/T11 Capacity to use several sources of energy and especially the solar photovoltaic and thermal, as well as the fundamentals of electrotechnics and power electronics.	A25
B4 CG13 Capacity to handle software tools that support the resolution of problems in engineering.	B4
CG14 Capacity to use computer tools of research of bibliographic resources or information.	B5

### Contents

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

### Planning

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

Troubleshooting and / or exercises	6	12	18
Short answer tests	3	15	18
Troubleshooting and / or exercises	3	15	18
Practical tests, real task execution and / or simulated.	4	12	16

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

### Methodologies

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

### Personalized attention

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

### Assessment

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

### Other comments on the Evaluation

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

1. Continuous assesment:

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

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

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

#### 1.1. Theoretical proofs:

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

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

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

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

#### 1.2. Assesment of laboratory practices:

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

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

The two lab partial proofs have both the same weight.

#### 1.3. Students presented:

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

#### 1.4. Requirements to pass the course

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

To pass the course the student needs a mark greater than 5 points as a whole. It must be taken in account that the weights are 7 points for the theory and 3 points for the lab. In addition, the mark in each section (i.e. both theory and lab) must be greater than 30% (3 points out of 10), in either type of evaluation (either continuous assesment or final examination whithout having joined the continuous assesment or july examination).

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

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

$$\text{ProvisionalFinalMark} = \text{TheoryMark} \times 0.7 + \text{LabMark} \times 0.3$$

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

$\text{FinalMark} = \text{ProvisionalFinalMark}$

Else:

$\text{FinalMark} = \text{minimum} \{4.5 ; \text{ProvisionalFinalMark}\}$

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

Being

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

$\text{ProvisionalTheoryMark} = (\text{TheoryBlockMark1} + \text{TheoryBlockMark2} + \text{TheoryBlockMark3}) / 3$ , then:

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

$\text{TheoryMark} = \text{ProvisionalTheoryMark}$

Else:  $\text{TheoryMark} = \text{minimum} \{\text{ProvisionalTheoryMark} ; 2.5\}$

In the same way:

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

$\text{ProvisionalLabMark} = (\text{LabBlockMark1} + \text{LabBlockMark2}) / 2$ , then:

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

$\text{LabMark} = \text{ProvisionalLabMark}$ ;

Else:  $\text{LabMark} = \text{minimum} \{\text{ProvisionalLabMark} ; 2.5\}$ .

## 2. Evaluation by final proof

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

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

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

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

**VERY IMPORTANT:** The students who want to attend to the final proof of the course must enroll for it, prior to the proof, by communicating with the professors of the course, either in person or by e-mail on May 13th, 2015. This preinscription is necessary to schedule the shifts for the lab proof, but does not force the student to attend; a student may enroll and finally do not attend to the proof. Only the students who enroll on that date will have right to do the lab proof.

## 3. Second call (July)

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

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

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

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

$\text{ProvisionalFinalMark} = \text{TheoryMark} \times 0.7 + \text{LabMark} \times 0.3$ .

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

$\text{FinalMark} = \text{ProvisionalFinalMark}$

Else:

FinalMark = minimum {4.5 ; ProvisionalFinalMark}

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

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

VERY IMPORTANT: In the same way as stated in section 2 for the May final proof, the students who want to attend to the July proof must enroll to attend to it, by communicating with the professors of the course, either in person or by e-mail on June 17th, 2015. This preinscription is necessary to schedule the shifts for the lab proof, but does not force the student to attend; a student may enroll and finally do not attend to the proof. Only the students who enroll on that date will have right to do the lab proof.

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#### Sources of information

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

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

Rashid, Muhammad H., **Electrónica de potencia: circuitos, dispositivos y aplicaciones**, Pearson Education,

**Reglamento Electrotécnico para Baja Tensión (REBT) e Instrucciones Técnicas Complementarias (ITC)**,

Schneider Electric España, S.A., **Guía de diseño de instalaciones eléctricas (PDF de uso libre disponible en**

**[www.schneiderelectric.es](http://www.schneiderelectric.es))**, Schneider Electric España, S.A,

Guirado, R., **Tecnología eléctrica**, McGraw-Hill,

AENOR, **Norma UNE 60617 de Símbolos gráficos para esquemas eléctricos**,

Carta, J. A. y otros, **"Centrales de energías renovables: Generación eléctrica con energías renovables"**, Pearson-UNED,

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

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#### Recommendations

##### Subjects that continue the syllabus

Analogue Electronics/V05G300V01624

Power Electronics/V05G300V01625

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##### Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G300V01201

Physics: Fundamentals of Electronics/V05G300V01305

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#### 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 practice classes.

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<b>IDENTIFYING DATA</b>				
<b>Digital Electronics</b>				
Subject	Digital Electronics			
Code	V05G300V01402			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Machado Domínguez, Fernando			
Lecturers	Álvarez Ruíz de Ojeda, Luís Jacobo López Sánchez, Óscar Machado Domínguez, Fernando Moure Rodríguez, María José Pérez López, Serafín Alfonso Raña García, Herminio José			
E-mail	fmachado@uvigo.es			
Web	http://fatic.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	
A23	CE14/T9: The ability to analyze and design combinatory and sequential, synchronous and asynchronous circuits and the usage of integrated circuits and microprocessors.
A24	CE15/T10: The knowledge and application of the fundamentals of description languages for hardware devices.
B4	The ability to use software tools that support problem solving in engineering
B5	The ability to use software tools to search for information or bibliographical resources

### Learning aims

Expected results from this subject	Training and Learning Results
Knowledge of digital design principles, components and tools.	A23
Ability to analyse and design combinational systems.	A23
Knowledge of the combinational functional blocks and their applications.	A23
Knowledge of the basic storage elements, the sequential blocks and their applications.	A23
Ability to analyse and design synchronous sequential systems.	A23
Knowledge of description and simulation methods based on hardware description languages (HDL).	A24
Ability to use software tools to describe and simulate digital systems.	B4
Ability to use software tools to search digital circuit data sheets and information resources.	B5

### Contents

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

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

## Planning

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

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

## Methodologies

	Description
Introductory activities	Subject presentation. Presentation of laboratory sessions, instrumentation and software resources to be used.
Master Session	The lecturer will explain in the classroom the main contents of the subject. The students have to manage the proposed bibliography to carry out a self-study process in a way that leads to acquire the knowledge and the skills related to the subject. The lecturer will answer the students' questions in the classroom or in the office. In these sessions the students will develop the skills A23 and A24 ("know").
Laboratory practises	Activities designed to apply the main concepts and definitions of the subject. The students will be asked to acquire the basic skills to manage the laboratory instrumentation, software tools and components in order to construct and test electronic circuits. The students have to develop and demonstrate autonomous learning and collaborative skills. Possible questions can be answered in the laboratory sessions or in the lecturer's office. In these sessions the students will develop the skills A24, B4 and B5 ("know how").



Troubleshooting and / or exercises  
Activities designed to apply the main concepts of the subject to solve problems and exercises. The lecturer will explain a set of problems and the students have to solve different 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 skills A23 and A24 ("know how").

## Personalized attention

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

## Assessment

	Description	Qualification
Laboratory practises	The lecturers will check the level of compliance of the students with the goals related to the laboratory skills. Marks for each session will be assessed in a 10 points scale. Final mark of laboratory, FML, will be assessed in a 10 points scale.  The skills A24, B4 and B5 will be evaluated in these laboratory practices.	35
Troubleshooting and / or exercises	The lecturers will check the students' skills to solve exercises 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.  The skills A23 and A24 will be evaluated in these tests.	65

## Other comments on the Evaluation

### 1. Continuous assessment

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

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

The subject comprises two different parts: theory (60%) and laboratory (35%). Once a task has been assessed, the students can not do/repeat the task at a later date. The marks are valid only for the current academic course.

#### 1.a Theory

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

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

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

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

#### 1.b Laboratory

Thirteen laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in pairs.

The first five sessions are guided practices. In these sessions, the instrumentation and software resources will be presented and the students will configure a programmable logic device following the design flow. These five sessions are mandatory but will not be assessed. The following sessions will be assessed by continuous assessment. The marks for these laboratory sessions (LSM) will be assessed in a 10 points scale.

In order to pass the laboratory part the students can not miss more than two laboratory sessions. Only sessions 6 to 13 will be assessed. The weighted points from all assessed sessions are added together to calculate the final mark of laboratory (FML):

$$FML = (LSM6 + LSM7 + LSM8 + LSM9 + LSM10 + LSM11 + 2 \cdot LSM12 + 2 \cdot LSM13) / 10$$

### 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: 65% theory (FMT) and 35% laboratory (FML). In order to pass the subject, students will be required to pass the laboratory and theory parts and to obtain at least a mark of 5 in each part ( $FMT \geq 5$  and  $FML \geq 5$ ). In this case the final mark (FM) will be:

$$FM = (0.65 \cdot FMT + 0.35 \cdot FML)$$

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

$$FM = (0.65 \cdot FMT + 0.35 \cdot FML) \cdot 4.9/8.8$$

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

## 2. Final Exam

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

The theory exam will be assessed in a 10 points scale. The minimum mark required to pass this part is of 5 ( $FMT \geq 5$ ).

The laboratory exam will be assessed in a 10 points scale. The minimum mark required to pass this part is of 5 ( $FML \geq 5$ ).

In order to pass the subject, students will be required to pass the laboratory and theory exams ( $FMT \geq 5$  and  $FML \geq 5$ ). In this case the final mark (FM) will be:

$$FM = (0.65 \cdot FMT + 0.35 \cdot FML)$$

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

$$FM = (0.65 \cdot FMT + 0.35 \cdot FML) \cdot 4.9/8.8$$

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

## 3. Second opportunity to pass the subject

The assessment policy in this call will follow the scheme described in the previous section. Dates will be specified in the academic calendar. This exam consists of a theory exam and a laboratory exam. In order to attend the laboratory exam, the students have to contact the lecturer according to an established procedure. The procedure will be published in advance.

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

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

S. Pérez, L. J. Álvarez, M.J. Moure, F. Machado, **Electrónica Digital**, Curso 2012-2013,

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

E. Mandado, **Sistemas Electrónicos Digitales**, 9ª,

Thomas L. Floyd, **Fundamentos de Sistemas Digitales**, 9ª,

L.J. Álvarez, E. Mandado, M.D. Valdés, **Dispositivos Lógicos Programables y sus aplicaciones**, 1ª,

S. Pérez, E. Soto, S. Fernández, **Diseño de sistemas digitales con VHDL**,

L.J. Álvarez, **Diseño Digital con Lógica Programable**, 1ª,

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## Recommendations

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### Subjects that it is recommended to have taken before

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Informatics: Computer Architecture/V05G300V01103

Mathematics: Linear Algebra/V05G300V01104

Physics: Fundamentals of Electronics/V05G300V01305

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

### Competencies

Code	
A1	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.
A3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations
A4	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.
A6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
A9	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.
A20	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.
A26	CE17/T12: The knowledge and usage of concepts of communication network architecture, protocols and interfaces.
A27	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 network application and systems, voice, data, video, audio, interactive and multimedia services.
A28	CE19/T14: The knowledge of methods of networking and routing, as well as the fundamentals of planning and network evaluation based on traffic parameters.

### Learning aims

Expected results from this subject	Training and Learning Results
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.	A1
CG3 The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations	A3
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.	A4
CG6: The aptitude to manage mandatory specifications, procedures and laws.	A6
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	A9

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. A20

CE17/T12 The knowledge and usage of concepts of communication network architecture, protocols and interfaces A26

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 network application and systems, voice, data, video, audio, interactive and multimedia services A27

CE19/T14 The knowledge of methods of networking and routing, as well as the fundamentals of planning and network evaluation based on traffic parameters A28

## Contents

### Topic

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

## Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	26	39	65
Troubleshooting and / or exercises	10	15	25
Autonomous practices through ICT	6	15	21
Integrated methodologies	0	10	10

Practice in computer rooms	10	15	25
Long answer tests and development	2	0	2
Long answer tests and development	2	0	2

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

Methodologies	
	Description
Master Session	Exposition of ideas, concepts, techniques and algorithms that shape every lecture.
Troubleshooting and / or exercises	Resolution by part of the students of problems and exercises of some of the lessons, and resolution by the teacher in the classroom
Autonomous practices through ICT	The students must develop a network program. There will be several sessions for tutoring with the professor and development, test and debugging of the programs in the laboratories where these will be tested and evaluated
Integrated methodologies	Participation in on-line activities to be proposed along the course, and in activities of making questions and answer of these
Practice in computer rooms	Practices in the computers of the computer classroom, guided by the professor

### Personalized attention

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

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

### Other comments on the Evaluation

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

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

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

$$FG-CE = 0.2xME + 0.1xOA + 0.2xNP + 0.5xFE$$

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

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

$$FG-SE = (0.4 + 0.6xNP) \times FE$$

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

In July there will be a new FE and also it will be allowed the delivery of a new NP consisting of a modified version of the May program, and whose specifications will be published with at least 4 weeks with respect to the deadline of the Final Exam. Any student, regardless opting for CE or SE, will be able to do this FE and present a new NP

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

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

$$\text{FG-SE} = \text{Max}[(0.4 + 0.6 \times \text{NP-May}) \times \text{FE-May}, (0.4 + 0.6 \times \text{NP-July}) \times \text{FE-July}]$$

The grades of all written tests, partial or final, programs and activities will only take effect in the academic year in which they are proposed.

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#### Sources of information

J.F. Kurose, K.W. Ross, **Computer networking: a top-down approach featuring the Internet**, 6,

L. Peterson, B. Davie, **Computer networks: a systems approach**, 5,

C. López, M. Rodríguez, S. Herrería, M. Fernández, **Cuestiones de redes de datos: principios y protocolos**, 1,

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#### Recommendations

##### Subjects that continue the syllabus

Data Networks: Technology and Architecture/V05G300V01542

Network and Switching Theory/V05G300V01642

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##### Subjects that are recommended to be taken simultaneously

Data Communication/V05G300V01301

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#### Other comments

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

<b>IDENTIFYING DATA</b>				
<b>Signal Transmission and Reception Techniques</b>				
Subject	Signal Transmission and Reception Techniques			
Code	V05G300V01404			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	López Valcarce, Roberto			
Lecturers	Comesaña Alfaro, Pedro Fernández Barciela, Mónica González Prelcic, Nuria Isasi de Vicente, Fernando Guillermo López Valcarce, Roberto Márquez Flórez, Óscar Willian Rodríguez Banga, Eduardo Romero González, Daniel			
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.			

<b>Competencies</b>	
Code	
A3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations
A4	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.
A6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
A16	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.
A18	CE9/T4: The ability to analyze and specify the main parameters of a communications system.
A19	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.
A29	CE20/T15: The knowledge of national, European and international telecommunication regulations and laws.

<b>Learning aims</b>	
Expected results from this subject	Training and Learning Results
Ability to use communication and office computer applications (databases, advanced computation, project management, visualisation tools, etc.) to support the development and exploitation of networks, services, and telecommunication and electronics applications.	A16
Ability to analyse and specify the fundamental parameters of a communications system.	A18
Ability to evaluate the advantages and drawbacks of different technological alternatives for the deployment or implementation of analog and digital communication systems, from the signal space point of view, and taking into account the perturbations and the noise.	A19
Knowledge of basic technologies that enable the student to learn new methods and techniques, with the flexibility required to adapt to new situations.	A3
Ability to solve problems with initiative, decision making, and creativity.	A4
Familiarity with telecommunication regulations and standards at the national, European and world levels.	A29
(*)	A6



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

## Planning

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

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

## Methodologies

	Description
Master Session	Presentation and discussion of the fundamental theory
Practice in computer rooms	The concepts presented in class will be further illustrated and developed by means of Matlab-based simulation and signal processing tools
Troubleshooting and / or exercises	Students will be given different take-home sets of problems. The answers to selected problems will be provided later on.
Laboratory practises	Experimental study of different components and effects in analog transmitter/receiver frontends

## Personalized attention

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

## Assessment

Description	Qualification
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Long answer tests and development	Final examination. It will cover all of the material covered during the course and will take place during the exam period as established by the Center. In this exercise, skills A3, A4, A6, A18, A19 and A29 will be assessed.	60
Short answer tests	Three short tests will be given during the semester. These exercises will assess skills A3, A4, A16, A18 and A19.	40

### Other comments on the Evaluation

The final grade will consist of: - grade of comprehensive test (up to 4 points)- lab reports (up to 4 points)- final project (up to 2 points)

Grades from lab reports will be kept for the second call, in which the student will be able to resubmit his/her final project, as well as take a new comprehensive test.

### Sources of information

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

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

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

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

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

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

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

### Recommendations

#### Subjects that continue the syllabus

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.

<b>IDENTIFYING DATA</b>				
<b>Fundamentals of Sound and Image</b>				
Subject	Fundamentals of Sound and Image			
Code	V05G300V01405			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Pena Giménez, Antonio			
Lecturers	Abreu Sernández, María Victoria Docio Fernández, Laura Márquez Flórez, Óscar Willian Martín Rodríguez, Fernando Pena Giménez, Antonio Rodríguez Banga, Eduardo			
E-mail	apena@gts.uvigo.es			
Web	http://fatic.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	
A3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations
A5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
A22	CE13/T8: The ability to understand the electromagnetic and acoustic wave mechanisms of propagation and transmission, and their corresponding receiving and transmitting devices.

### Learning aims

Expected results from this subject	Training and Learning Results
Analysing the basic properties of the sound.	A3 A22
Explaining different sound production systems: human sound production, musical instruments, machines and other vibrant systems.	A22
Interpreting results of acoustic measures and selecting tools for the appropriate analysis.	A5
Describing the human perception of sound based on the physiological interface and the psychology of the perception.	A3 A22
Reviewing different processes and systems associated to the sound production	A3 A5
Applying the basic rules of the colorimetry.	A3
Analysing lens systems.	A3
Choosing the most suitable capture and presentation image systems.	A3 A5
Choosing the most adapted formats for image and video.	A3 A5
Relating the influence of the coding parameters with the results of compression and quality.	A3 A5

### Contents

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

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

## Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Master Session	26	50	76
Troubleshooting and / or exercises	6	12	18
Practice in computer rooms	17	20	37
Forum Index	0	1	1
Multiple choice tests	0	2	2
Practical tests, real task execution and / or simulated.	1	0	1
Long answer tests and development	4	0	4
Short answer tests	1	0	1
Reports / memories of practice	0	9	9

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

## Methodologies

	Description
Introductory activities	Course presentation: programme, reading materials, teaching methodology and assessment system
Master Session	<p>Instructor presentation of the main concepts of each subject. Classes do not cover all content that is examination material. The student should take the contents of the documents provided for each subject.</p> <p>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.</p> <p>Competencies A3, A5 and A22 are developed.</p>
Troubleshooting and / or exercises	<p>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.</p> <p>Competency A22 is developed.</p>
Practice in computer rooms	<p>Handling of analysis tools and algorithms. Identifying which one must be used to solve each specific problem.</p> <p>Identification of doubts that need to be resolved in personalized tutorials.</p> <p>Competencies A3, A5 are developed.</p>
Forum Index	<p>The website for the course is included in the TEMA platform (<a href="http://fatic.uvigo.es">http://fatic.uvigo.es</a>). 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.</p> <p>Competency A3 is developed.</p>

## Personalized attention

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

<b>Assessment</b>		
	Description	Qualification
Multiple choice tests	On the faitic website.  In these tests the skill A3 will be evaluated.	7.5
Practical tests, real task execution and / or simulated.	Exam related to the work performed during several weeks of laboratory.  In these tests the skill A5 will be evaluated.	7.5
Long answer tests and development	To evaluate theoretical knowledges and problems resolution.  In these tests the skills A3, A5 and A22 will be evaluated.	65
Short answer tests	Exam with questions and problems.	5
Reports / memories of practice	Report about the performed work during several weeks in the computer classroom.  In these tests the skill A5 will be evaluated.	15

#### **Other comments on the Evaluation**

#### **CONTINUOUS ASSESSMENT**

The continuous assessment consists of several activities. If the student can not do them in the fixed date, this activity will not be evaluated. The grades of these activities will be valid only for the present academic course. If the student does the "Examen 1", she/he will be evaluated by continuous assessment.

Types and assessment of activities:

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

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

meet these two conditions:

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

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

\* assessment of sound-related scores

\* assessment of image-related scores

### **NON CONTINUOUS ASSESSMENT**

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

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

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

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

\* assessment of sound-related scores

\* assessment of image-related scores

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

### **June/July exam:**

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

1. Do again the Exam 2 and be evaluated according to the stipulated for the system of "Continuous Assessment".
2. Be evaluated with an only 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.

⇒ **Students 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.

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### **Sources of information**

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

Lawrence Kinsler, Austin Frey, Alán Coppers, James Sanders, **FUNDAMENTALS OF ACOUSTICS**,

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

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

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

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

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

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### **Recommendations**

#### **Subjects that continue the syllabus**

Room Acoustics/V05G300V01635

Fundamentals of Acoustics Engineering/V05G300V01531

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Fundamentals of Image Processing/V05G300V01632  
Sound Processing/V05G300V01634  
Audio Systems/V05G300V01532  
Imaging Systems/V05G300V01633  
Audiovisual Technology/V05G300V01631  
Video and Television/V05G300V01533

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**Subjects that are recommended to be taken simultaneously**

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Signal Transmission and Reception Techniques/V05G300V01404

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**Subjects that it is recommended to have taken before**

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

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