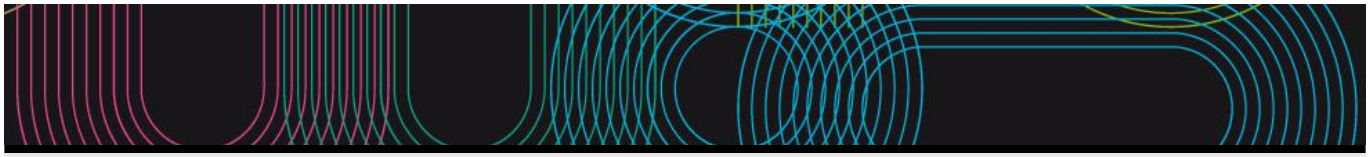

(*)Escola de Enxeñaría de Telecomunicación

(*)Páxina web

(*)

www.teleco.uvigo.es

(*)Presentación

The School of Telecommunication Engineering (EET) is a higher education school of the University of Vigo that offers Bachelor's degrees, Master's degrees and Doctoral programs in the fields of Telecommunications Engineering.

Bachelor's Degree in Telecommunication Technologies Engineering (EUR-ACE®).

The mail goal of the Bachelor's Degree in Telecommunication Technologies Engineering is to form professionals at the forefront of technological knowledge and professional competences in telecommunication engineering. This Bachelor has been recognized with the best quality seals, like the EUR-ACE's. **It has a bilingual option: up to 80% of the degree credits can be taken in English**.

http://teleco.uvigo.es/images/stories/documentos/gett/degree_telecom.pdf

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

Master in Telecommunication Engineering

The Master in Telecommunication Engineering is a Master's degree that qualifies to exercise the profession of Telecommunication Engineer, in virtue of the established in the Order CIN/355/2009 of 9 of February.

http://teleco.uvigo.es/images/stories/documentos/met/master_telecom_rev.pdf

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

Interuniversity Masters

The current academic offer includes interuniversity master's degrees that are closely related to the business sector:

Master in Cybersecurity: www: https://www.munics.es/

Master in Industrial Mathematics: www: http://m2i.es

International Master in Computer Vision: www: https://www.imcv.eu/

(*)Equipo directivo

MANAGEMENT TEAM

Director: Íñigo Cuíñas Gómez (teleco.direccion@uvigo.es)

Subdirección de Relaciones Internacionales: Enrique Costa Montenegro (teleco.subdir.internacional@uvigo.es)

Subdirección de Extensión: Francisco Javier Díaz Otero (teleco.subdir.extension@uvigo.es)

Subdirección de Organización Académica: Manuel Fernández Veiga (teleco.subdir.academica@uvigo.es)

Subdirección de Calidad: Loreto Rodríguez Pardo (teleco.subdir.calidade@uvigo.es)

Secretaría y Subdirección de Infraestruturas: Miguel Ángel Domínguez Gómez (teleco.subdir.infraestructuras@uvigo.es)

BACHELOR□S DEGREE IN TELECOMMUNICATION TECHNOLOGIES ENGINEERING

General coordinator: Rebeca Díaz Redondo (teleco.grao@uvigo.es)

http://teleco.uvigo.es/images/stories/documentos/comisions/membros_comisions_grao.pdf

MASTER IN TELECOMMUNICATION ENGINEERING

General coordinator: Manuel Fernández Iglésias (teleco.master@uvigo.es)

http://teleco.uvigo.es/images/stories/documentos/comisions/membros_comisions_master.pdf

MASTER IN CYBERSECURITY

General coordinator: Ana Fernández Vilas (camc@uvigo.es)

http://teleco.uvigo.es/images/stories/documentos/comisions/membros_comisions_master_ciberseguridade.pdf

MASTER IN INDUSTRIAL MATHEMATICS

General coordinator: Elena Vázquez Cendón (USC)

UVigo coordinator: José Durany Castrillo (durany@dma.uvigo.es)

http://www.m2i.es/?seccion=coordinacion

INTERNATIONAL MASTER IN COMPUTER VISION

General coordinator: Xose Manuel Pardo López (USC)

UVigo coordinator: José Luis Alba Castro (jalba@gts.uvigo.es)

https://www.imcv.eu/legal-notice/

Degree in Telecommunications Technologies Engineering - In extinction

Subjects			
Year 3rd			
Code	Name	Quadmester	Total Cr.
V05G300V01501	Servizos de internet	1st	6
V05G300V01502	Circuítos electrónicos programables	1st	6
V05G300V01511	Circuítos de radiofrecuencia	1st	6
V05G300V01512	Sistemas de comunicacións por radio	1st	6
V05G300V01513	Tratamento de sinais multimedia	1st	6

V05G300V01521	Sistemas de adquisición de datos	2nd	6
V05G300V01522	Sistemas electrónicos de procesado de sinal	1st	6
V05G300V01523	Enxeñaría de equipos electrónicos	1st	6
V05G300V01531	Fundamentos de enxeñaría acústica	1st	6
V05G300V01532	Sistemas de audio	2nd	6
V05G300V01533	Vídeo e televisión	1st	6
V05G300V01541	Sistemas operativos	1st	6
V05G300V01542	Arquitectura e tecnoloxía de redes	1st	6
V05G300V01543	Seguridade	1st	6
V05G300V01611	Circuítos de microondas	2nd	6
V05G300V01613	Principios de comunicacións dixitais	2nd	6
V05G300V01614	Infraestruturas ópticas de telecomunicación	2nd	6
V05G300V01615	Redes e sistemas sen fíos	2nd	6
V05G300V01616	Xestión do espectro radioeléctrico	2nd	6
V05G300V01621	Instrumentación electrónica e sensores	2nd	6
V05G300V01622	Deseño microelectrónico	2nd	6
V05G300V01623	Sistemas electrónicos para comunicacións dixitais	2nd	6
V05G300V01624	Electrónica analóxica	1st	6
V05G300V01625	Electrónica de potencia	2nd	6
V05G300V01631	Tecnoloxía audiovisual	2nd	6
V05G300V01632	Fundamentos de procesado de imaxe	2nd	6
V05G300V01633	Sistemas de imaxe	2nd	6
V05G300V01634	Procesado de son	1st	6
V05G300V01635	Acústica arquitectónica	2nd	6
V05G300V01641	Programación concorrente e distribuída	2nd	6
V05G300V01642	Teoría de redes e conmutación	2nd	6
V05G300V01643	Redes multimedia	2nd	6
V05G300V01644	Sistemas de información	2nd	6
V05G300V01645	Arquitecturas e servizos telemáticos	2nd	6

Year 4th

Code	Name	Quadmester	Total Cr.
V05G300V01801	Xestión e dirección tecnolóxica	2nd	6
V05G300V01802	Laboratorio de proxectos	2nd	12
V05G300V01911	Teledetección	1st	6

V05G300V01912	Sistemas de navegación e comunicacións por satélite	1st	6
V05G300V01913	Procesado dixital en tempo real	1st	6
V05G300V01914	Comunicacións dixitais	1st	6
V05G300V01915	Fundamentos de bioenxeñaría	1st	6
V05G300V01921	Deseño de aplicacións con microcontroladores	1st	6
V05G300V01922	Dispositivos optoelectrónicos	1st	6
V05G300V01923	Deseño e síntese de sistemas dixitais	1st	6
V05G300V01924	Sensores electrónicos avanzados	1st	6
V05G300V01925	Comunicacións industriais	1st	6
V05G300V01931	Procesado e análise de imaxe	1st	6
V05G300V01932	Tecnoloxía multimedia e computer graphics	1st	6
V05G300V01933	Acústica avanzada	1st	6
V05G300V01934	Técnicas de medida de ruído e lexislación	1st	6
V05G300V01935	Produción audiovisual	1st	6
V05G300V01941	Servizos multimedia	1st	6
V05G300V01942	Redes sen fíos e móbiles	1st	6
V05G300V01943	Programación de sistemas intelixentes	1st	6
V05G300V01944	Deseño de sistemas integrados	1st	6
V05G300V01945	Novos servizos telemáticos	1st	6
V05G300V01951	Mobilidade I	1st	6
V05G300V01952	Mobilidade II	1st	6
V05G300V01953	Mobilidade III	1st	6
V05G300V01954	Mobilidade IV	1st	6
V05G300V01955	Mobilidade V	1st	6
V05G300V01981	Prácticas externas: Prácticas en empresas I	1st	6
V05G300V01982	Prácticas externas: Prácticas en empresas II	1st	6
V05G300V01991	Traballo de Fin de Grao	2nd	12

IDENTIFYING DATA				
Internet Services				
Subject	Internet Services			
Code	V05G300V01501			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Gil Solla, Alberto Burguillo Rial, Juan Carlos			
Lecturers	Álvarez Sabucedo, Luis Modesto Burguillo Rial, Juan Carlos Gil Solla, Alberto Mikic Fonte, Fernando Ariel			
E-mail	jrial@uvigo.es alberto.gil@uvigo.es			
Web	http://http://faitic.uvigo.es			
General description	This subject will provide to the student a global vision of the group of current services of Internet like DNS, email, the WWW, the Web Services, the sharing of resources among peers (P2P), the Semantic Web and the Cloud Computing. Besides, the student will be introduced in the most frequent technologies to develop such services and web applications.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG9	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.
CE11	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.
CE18	CE18/T13: The ability to differentiate the concepts of access and transport networks, packet and circuit switched networks, mobile and fixed networks, as well as distributed newtwork application and systems, voice, data, video, audio, interactive and multimedia services.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	Competences		
To know the basic services of Internet, as well as comprise the basic principles of his operation.	CG3 CG6	CE11 CE18	CT2 CT3 CT4
To dominate the main technical standards in the field of development of telematic services.	CG6	CE11 CE18	
To understand the importance of organising the structured information for his suitable utilisation.	CG3 CG4	CE11 CE18	CT2
To Know the basic concepts of semantic management of the information.		CE11	CT2
To understand the principles and the general organisation of a web service.	CG9	CE11 CE18	

To improve the skill in the design and development of basic telematic services.	CG4 CG9	CT2 CT3 CT4

Contents	
Topic	
Internet basic services	- DNS - Electronic mail - World Wide Web: architecture, languages, protocols.
Information structure	- XML introduction - NameSpaces, - Document Object Model (DOM) - JSON - XML Schema
Server-side development technologies	- CGI, FastCGI, DSO modules - PHP - Servlets - JSP - XPath, XSLT
Client-side development technologies	- JavaScript - jQuery - Ajax, SSE - Angular - MEAN stack - WebSockets
Web Services	- Simple Object Access Protocol (SOAP) - Universal Description, Discovery and Integration (UDDI) - Web Services Description Language (WSDL)
Additional services	- Sharing resources among peers (P2P) - Semantic Web - Cloud Computing

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	2	4
Lecturing	24	24	48
Practices through ICT	26	38	64
Discussion Forum	0	4	4
Self-assessment	0	2	2
Objective questions exam	1	10	11
Essay questions exam	1	10	11
Problem and/or exercise solving	2	4	6
*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	In the first classes we will describe the activities to be performed along the subject, along the theory and along the practices.
Lecturing	Along the theory classes we will describe the main contents of the subject by means of slides. Theory classes will promote the competences: CT2, CT3 y CT4. Besides, the exam for this part evaluates the competencies: CG3, CG4, CG6, CE11, CE18.
Practices through ICT	The subject also will require the development and delivery of 3 practices that the students will perform individually. The applications to develop in these practices will be done by means of the languages common used in the Internet: Javascript, PHP, Java, etc. These practices evaluate the competences: CG3, CG4, CG6, CG9, CE11, CE18 and promote the competences CT2, CT3 y CT4.
Discussion Forum	During the course we will discuss several topics, related with the concepts seen in theory, in the forums of the subject. This forum will promote the competences: CG3, CG6, CT2, CT3 and CT4.

Personalized assistance

Methodologies	Description
Discussion Forum	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.
Practices through ICT	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.

Tests	Description
Objective questions exam	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.
Essay questions exam	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.
Problem and/or exercise solving	n the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.

Assessment

	Description	Qualification	Evaluated Competencess		
Self-assessment	They will do two test of self-evaluation along the subject on the theoretical concepts that the students have learnt up to such point.	0	CG3 CG4 CG6	CE11 CE18	
Objective questions exam	There will be a theoretical exam at the end of the course about the contents seen in it. This part will be made up of short and/or multiple choice questions.	25	CG3 CG4 CG6 CG9	CE11 CE18	CT2 CT3 CT4
Essay questions exam	There will be a theoretical exam at the end of the course about the contents seen in it. This part will be made up of development questions where the student will describe one or several concepts, relating them to each other, and illustrating them with examples.	25	CG3 CG4 CG6	CE11 CE18	CT2 CT3
Problem and/or exercise solving	The code of the practices will be evaluated by the teachers to check that it works according to the requirements and specifications. In addition, the student must pass a practical test (related to the proposed practices) to verify that he adequately masters his code.	50	CG3 CG4 CG6	CE11 CE18	CT2 CT3

Other comments on the Evaluation

The subject is composed of a theoretical part and a practical part. Each one of them is valued with 5 points, having to obtain at least 2,5 points in each part to pass the subject.

Following the guidelines of the career two systems of evaluation will be offered to the students following this subject: continuous assessment (EC) and exam-only assessment (EU).

EC:

- The student follows the continuous assessment from the moment he delivers a practice.

- The theoretical part is composed of a final exam (with a value of 5 points). This final exam will be the same for all the students, independently that they have opted or not by the EC. Additionally, the students following the EC can receive until 1 extra point from the activities realized in class and/or through the forums of the subject. Half of that extra grade will be added to the theory grade in any case. The other half, only if the theoretical part is passed. Finally, the theory part grade will be adjusted to 5 if the result is higher.

The final exam consists of two parts, ET1 and ET2, both of them optional. Both score over 5, and the grade of the final exam (GRADE) is computed as follows: if ET1 is passed, GRADE = 2,5 + ET2/2; if not, GRADE = ET2. In any case, it is possible an adjustment later described.

- The practical part is composed of three practices.

- The practice 1 is valued with 0,5 points, will be delivered along the month of October, on pending date. The student will have to correct the errors found, moment in which he will obtain the indicated grade.

- The practice 2 is valued with 2 points and can be delivered until a week before the exam. After delivery, the student will have to correct the errors identified by the professors until the practice work properly, with dead-line until a week before the exam. Once obtained the approval of the professors, the student will receive the indicated grade.

The correction of the errors identified by teachers in practices 1 and 2, depending on number and importance, could lead to a penalty in the final grade of the subject.

- The third practice is valued 2,5 points and can be delivered from the approval of the practice 2, to the end of classes. The practice will be evaluated as delivered, without possibility of correction of the errors observed.

- Practical exam: The day of the exam, a practical test will be done for practices 2 and 3, consisting in a modification of the original functions, to check that the student master the delivered code. This practical test will have a result of 1 (modifications work) or 0,25 (don't work) for each practice independently.

The grade of the practical part will be the addition of the grades of the practice 1 and the other practices multiplied by the result of their corresponding test.

EU:

The students that have not opted by the EC will have to attend the theoretical exam and deliver the practices 1 and 2 before finishing the classes (with the modifications specified). The students will have to correct the errors identified by the professors until obtaining approval (with the aforementioned penalty). Then, they can deliver practice 3, always before the end of the classes. Besides, they will have to pass the practical test.

Passing the subject: Both in EC and in EU, to pass the subject the student will have to obtain at least 2,5 points in each part. In the case of not obtaining the minimum grade in any of the parts, the grade obtained adding both parts will be reduced to 4 points in the case to be above such grade.

In the case that the resultant grade is less than 2,5 points, the student will have to deliver the practices of the second chance and pass the practical test.

Second call:

The student will have to fulfill the same theoretical exam as the first call, deliver the specified practices (published in March), and perform the described practical test.

In case some part was passed in the first call, the grade is preserved and it is not necessary to repeat the described activities of such part.

End-of-program call:

It will have the same characteristics than the second call. The practices could suffer modifications or incorporate additional functionalities that will be communicated along July.

Initially, none of the grades obtained in both parts in the first and second calls are preserved for this call. Once the practices of this call have been published, the teaching staff will decide and report in a timely manner on whether or not the grades obtained in the previous calls are kept.

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

Sources of information

Basic Bibliography

H.M Deitel et al., **Internet and World Wide Web How to Program: International Edition**, 5, 2012

Priscilla Walmsley, **Definitive XML Schema, 2/E**, 2, 2012

Michael Papazoglou, **Web Services and SOA: Principles and Technology, 2/E**, 2, 2012

Steve Graham et al., **Building Web Services with Java: Making Sense of XML, SOAP, WSDL, and UDDI**, 2, 2004

J Murach, M. Urban, **java Servlets and JSP**, 3, Murach, 2014

Ethan Brown, **Web Development with Node and Express: Leveraging the JavaScript Stack**, 978-1491949306, 1, O'Reilly, 2014

Andrew Lombardi, **WebSocket: Lightweight Client-Server Communications**, 978-1449369279, 1, O'Reilly, 2015

Complementary Bibliography

Robert W. Sebesta, **Programming the World Wide Web**, 8, 2014

Andrew S. Tanenbaum, **Computer Networks**, 5, 2012

Kevin Howard Goldberg, **XML: Visual QuickStart Guide, 2/E**, 2, 2008

Thomas Erl, **Service-Oriented Architecture: A Field Guide to Integrating XML and Web Services**, 1, 2004

W. Stallings, **Data and Computer Communications**, 9, 2013

S. Holzner, **Ajax**, 1, McGraw Hill, 2009

Recommendations

Subjects that continue the syllabus

Architectures and Services/V05G300V01645

New computerised services/V05G300V01945

Subjects that it is recommended to have taken before

Programming II/V05G301V01110

Contingency plan

Description

In the case that the teaching is exclusively remote, the classes of the subject will be developed in a similar way, but using the platforms provided by the University.

Virtual classes will be taught weekly through the Remote Campus, both in the theoretical sessions (groups A) and in the practical sessions (groups B). In this second case, the students will develop and test the software using their personal computers.

The means enabled for the resolution of the doubts raised by the students will include online consultation forums and tutorials in the teacher's virtual office.

The remote assessment of the subject will be governed by the conditions described in the teaching guide for the regular teaching, including the same number of tests, identical weighting and minimum grades. The theoretical and practical exams will be carried out virtually, using the platforms provided by the University.

IDENTIFYING DATA

Programmable Electronic Circuits

Subject	Programmable Electronic Circuits			
Code	V05G300V01502			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Poza González, Francisco			
Lecturers	Álvarez Ruiz de Ojeda, Luís Jacobo Costas Pérez, Lucía Poza González, Francisco Valdés Peña, María Dolores			
E-mail	fpoza@uvigo.es			
Web	http://www.faitic.uvigo.es/			
General description	Part of the documentation of the subject is in English. The objectives of this course are that students learn the general aspects of the architecture of microprocessors, microcontrollers and configurable devices, as well as the adequate design methods and tools, while they acquire the necessary skills to design systems based on these devices.			

Competencies

Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG13	CG13 The ability to use software tools that support problem solving in engineering.
CE7	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.
CE8	CE8/T3: The ability to use software tools for bibliographical resources search or information related with electronics and telecommunications.
CE14	CE14/T9: The ability to analyze and design combinatory and sequential, synchronous and asynchronous circuits and the usage of integrated circuits and microprocessors.
CE15	CE15/T10: The knowledge and application of the fundamentals of description languages for hardware devices.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes

Learning outcomes	Competences		
To understand the basic architecture of microprocessors, microcontrollers and configurable devices (FPGAs).	CG3	CE14 CE15	
To know the methods and techniques of design of integrated hardware/software systems (System on Chip □ SoC).	CG3	CE14 CE15	
To know the hardware and software tools for the design of systems based in programmable devices.	CG13	CE14 CE15	
To acquire the skills to use the design tools for the design of digital systems.		CE14 CE15	
Ability to design simple integrated systems (System on Chip □ SoC) applied to the telecommunications fields.	CG3 CG4 CG13	CE7 CE8 CE14 CE15	CT2 CT3

Contents

Topic

LESSON 0 THEORY (2 h.). REVIEW OF DIGITAL CIRCUITS.	0.1.- Digital circuits. 0.1.1.- Combinational circuits. 0.1.2.- Aritmetic circuits. 0.1.3.- Sequential circuits. 0.2.- VHDL. 0.2.1.- VHDL syntax. 0.2.2.- VHDL sentences.
LESSON 1 THEORY (5 h.). DESIGN OF COMPLEX SYSTEMS.	1.1.- Introduction. 1.2.- Previous analysis of the most suitable solution. 1.3.- Application specific peripherals. Design methods. 1.3.1.- Practical examples.
LESSON 2 THEORY (1 h.). INTRODUCTION TO CORRECT DESIGN METHODS.	2.1.- Introduction. 2.2.- Design of digital systems with FPGAs. 2.2.1.- Hierarchical design. 2.2.2.- Technology-independent design. 2.2.3.- Timing design.
LESSON 3 THEORY (2 h.). SYNCHRONOUS DIGITAL SYSTEM DESIGN.	3.1.- Introduction. 3.2.- Synchronous design. 3.3.- Synchronous sequential systems. FPGA design recommendations. 3.4.- Synchronisation of input variables.
LESSON 4 THEORY (2 h.). XILINX PICOBLAZE MICROPROCESSOR (I).	4.1.- Introduction. 4.2.- Versions of the Xilinx Picoblaze microprocessor. 4.3.- Internal architecture of the Picoblaze microprocessor. 4.4.- Instruction set of the Picoblaze microprocessor.
LESSON 5 THEORY (1 h.). SOFTWARE DEVELOPMENT FOR XILINX PICOBLAZE MICROPROCESSOR.	5.1.- Introduction. 5.2.- Syntax of an assembler program for the Picoblaze microprocessor. 5.3.- Program development with pBlazeIDE environment for Picoblaze .
LESSON 6 THEORY (4 h.). XILINX PICOBLAZE MICROPROCESSOR (II).	6.1.- Introduction. 6.2.- External architecture. 6.2.1.- Input / Output instructions. 6.2.2.- Connection of input peripherals. 6.2.3.- Connection of output peripherals. 6.2.4.- Picoblaze reset. 6.2.5.- External interrupts. 6.3.- Design of peripherals for the Picoblaze microprocessor.
LESSON 7 THEORY (1 h.). INTRODUCTION TO FPGAs.	7.1.- Introduction. 7.2.- Definition of FPGA. FPGA classification. 7.3.- FPGA architectures. 7.3.1.- Logical resources. 7.3.2.- Interconnection resources. 7.3.3.- Examples of commercial FPGAs. 7.4.- FPGA technologies. 7.5.- General characteristic of the FPGAs. 7.6.- Advantages of the FPGAs. 7.7.- FPGA design flow. 7.7.1.- Design implementation with FPGAs. 7.8.- FPGA CAD tools. 7.9.- FPGA applications.
LESSON 8 THEORY (1 h.). XILINX ARTIX 7 FPGA FAMILY. ARCHITECTURE.	8.1.- Introduction. 8.2.- Xilinx Artix 7 family architecture. 8.2.1.- Logical resources. CLBs. Slices. RAM-based shift registers. 8.2.2.- Internal memories. Distributed memory. Embedded memory. 8.2.3.- Clock circuits. 8.2.4.- DSP circuits. 8.2.5.- Input / Output technologies.
LESSON 9 THEORY (2 h.). INTRODUCTION TO MICROCONTROLLERS.	9.1.- Introduction. Definition of microcontroller. 9.2.- Internal architecture. Harvard. Von Neumann. 9.3.- External architecture. 9.4.- Integrated peripherals. 9.5.- Examples of commercial microcontrollers. 9.6.- Microcontroller applications. 9.7.- Tools for programming and verification.

LESSON 10 THEORY (1 h.). INTRODUCTION TO SYSTEMS ON CHIP (SOC).	10.1.- Introduction to digital design methods. 10.1.1.- Software method. 10.1.2.- Hardware method. 10.2.- Systems On Chip (SOC). 10.3.- Systems On a Programmable Chip (PSOC). Microprocessors embedded in FPGAs. 10.3.1.- Hardware Microprocessors. 10.3.2.- Software Microprocessors. 10.4.- Embedded microprocessor applications.
LESSON 11 THEORY (4 h.). HARDWARE / SOFTWARE CODESIGN.	11.1.- Introduction. 11.2.- Hardware / software codesign. 11.3.- Examples of hardware / software codesign.
LESSON 1 LABORATORY (2 h.). INTRODUCTION TO DESIGN WITH FPGAs	1.1.- Introduction to the digital systems design tool with FPGAs. 1.2.- Digital system description. 1.3.- Simulation. 1.4.- Synthesis and implementation. 1.5.- FPGA based development board. 1.6.- FPGA programming. 1.7.- Exercises.
LESSON 2 LABORATORY (8 h.). PROJECTS. DESIGN OF PERIPHERALS FOR THE PICOBLAZE MICROPROCESSOR.	2.1.- Design and implementation of a medium-complexity peripheral for the Picoblaze 3 microprocessor, according to the instructions supplied by the teacher through FaiTIC website.
LESSON 3 LABORATORY (2 h.). XILINX PICOBLAZE MICROPROCESSOR SOFTWARE TOOLS.	3.1.- Introduction. 3.2.- Program assembler and simulator in Mediatronix. Picoblaze IDE. 3.3.- Exercises.
LESSON 4 LABORATORY (6 h.). DESIGN OF DIGITAL SYSTEMS BASED ON THE PICOBLAZE MICROPROCESSOR.	4.1.- Introduction to the design of embedded systems. 4.2.- Design flow for embedded systems in FPGAs. 4.3.- Microprocessor program design. 4.4.- Description of the necessary hardware circuits. 4.5.- Program and hardware simulation. 4.6.- Test of the complete digital system. 4.7.- Design of a basic example with use of interrupts, based on the Picoblaze microprocessor.
LESSON 5 LABORATORY (8 h.). PROJECTS. DESIGN OF AN EMBEDDED SYSTEM BASED ON THE PICOBLAZE MICROPROCESSOR.	5.1.- Design and implementation of a medium-complexity application example based on the Picoblaze 3 microprocessor, according to the instructions supplied by the teacher through FaiTIC website.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	2	4
Lecturing	12	16	28
Problem solving	12	19	31
Laboratory practical	10	12	22
Mentored work	16	32	48
Objective questions exam	1	3	4
Problem and/or exercise solving	3	10	13

*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	Introduction to key topics both theoretical and practical. Through this methodology the outcome CG3 is developed.
Lecturing	Conventional lectures. Through this methodology the outcome CG3 is developed.
Problem solving	In these sessions, exercises will be solved by both the teacher and the students. Through this methodology the outcomes CG3, CG4, CE8/T3, CE14/T9 and CE15/T10 are developed.
Laboratory practical	In these sessions, both guided practices and exercises of circuits and programs will be set out. Through this methodology the outcomes CG3, CG4, CG13, CE7/TE2, CE8/T3, CE14/T9, CE15/T10, CT2 and CT3 are developed.

Mentored work	The students will have to develop two laboratory projects which consist of designing circuits and programs. These projects are related to laboratory lessons 2 and 5. Through this methodology the outcomes CG3, CG4, CG13, CE7/TE2, CE8/T3, CE14/T9, CE15/T10, CT2 and CT3 are developed.

Personalized assistance

Methodologies	Description
Introductory activities	Questions will be answered preferably via email, videoconference and forums on FaiTIC. If there are face-to-face classes, students' questions will also be answered during them. Moreover, students will have the opportunity to schedule an appointment to receive tuition in the place designated by the teachers, if that is possible.
Lecturing	Questions will be answered preferably via email, videoconference and forums on FaiTIC. If there are face-to-face classes, students' questions will also be answered during them. Moreover, students will have the opportunity to schedule an appointment to receive tuition in the place designated by the teachers, if that is possible.
Problem solving	Questions will be answered preferably via email, videoconference and forums on FaiTIC. If there are face-to-face classes, students' questions will also be answered during them. Moreover, students will have the opportunity to schedule an appointment to receive tuition in the place designated by the teachers, if that is possible.
Laboratory practical	Questions will be answered preferably via email, videoconference and forums on FaiTIC. If there are face-to-face classes, students' questions will also be answered during them. Moreover, students will have the opportunity to schedule an appointment to receive tuition in the place designated by the teachers, if that is possible.
Mentored work	Questions will be answered preferably via email, videoconference and forums on FaiTIC. If there are face-to-face classes, students' questions will also be answered during them. Moreover, students will have the opportunity to schedule an appointment to receive tuition in the place designated by the teachers, if that is possible.

Assessment

	Description	Qualification	Evaluated Competencess		
Laboratory practical	The assessment will be based on the operation of the circuits and programs developed in the practical sessions corresponding to the laboratory lessons 1, 3 and 4, according to the published criteria. It will be necessary to show the teacher the operation of each of the circuits and programs.	20	CG3 CG4 CG13	CE7 CE8 CE14 CE15	CT2 CT3
Mentored work	Autonomous Project. The students will have to develop two autonomous projects. The first project will consist of the design of a complex peripheral. The peripheral must be composed by a control unit and an ALU and must be designed following the method analysed in the theoretical lesson 1. The content corresponds with laboratory lesson 2. The second project will consist of the design of a medium-complexity embedded digital system. The embedded system must be composed by a microprocessor and its peripherals, as well as the auxiliary circuits needed to work correctly. It will also be necessary to develop a program for the microprocessor in assembler language. The content corresponds with laboratory lesson 5. In both projects the assessment will be based on the correct operation of the circuits and programs developed during the laboratory sessions assigned to the abovementioned lessons, as well as the correct application of the theoretical concepts to the work done, according to the published criteria. It will be necessary to show every circuit and program to the teacher.	30	CG3 CG4 CG13	CE7 CE8 CE14 CE15	CT2 CT3
Objective questions exam	Two multiple-choice tests with questions on theoretical topics will be scheduled throughout the term.	20	CG3 CG4	CE14 CE15	
Problem and/or exercise solving	Three tests which include problem solving and/or exercises on theoretical topics will be scheduled throughout the term.	30	CG3 CG4	CE14 CE15	

Other comments on the Evaluation

The final mark will be expressed in numerical form ranging from 0 to 10.

The students will be offered two assessment systems: continuous assessment and exam-only assessment.

It is considered that the students who deliver the first assessable practice have chosen continuous assessment.

By default, if a student does not deliver the first assessable practice, it is assumed that it is in a exam-only assessment.

The students that opt for the exam-only assessment will not be assessed in any of the tasks of continuous assessment.

All the tasks must be delivered in the date specified by the professor, otherwise they will not be assessed.

In case of detection of plagiarism in any of the tasks (theoretical exam, laboratory practices or autonomous projects) the final qualificationwill be fail (0) and the fact will be communicated to the Head of the faculty for further actions.

The subject is composed of a theoretical part and a laboratory part. Each of them represents 50 % of the total mark of the subject.

CONTINUOUS ASSESSMENT (first call)

Laboratory class attendance is compulsory if the student has chosen continuous assessment.

The students who have chosen continuous assessment can only miss 1 laboratory session without justification, as a maximum.

The students that do not attend a session with justification, will receive a 0 mark in that session, but they will still be considered to be in continuous assessment.

Nevertheless, if a student misses more than 3 sessions, even with justification, they will have to realise an individual additional task to be allowed to remain in continuous assessment.

If the number of students in any laboratory group is sufficiently small, the students will carry out the practices and projects individually. Otherwise, students will perform these tasks in groups of 2. In the latter case, the two students will receive the same mark.

Theoretical class attendance is considered crucial to achieve success in continuous assessment, as the experience shows that it has a strong influence on the rate of success in the continuous assessment.

All the tasks have to be delivered on the date specified by the professor, otherwise they will not be assessed.

None of the tasks can be done on a different date that the one set up by the professor.

If any of the previous conditions is not met, the student that was in continuous assessment will lose the right to it and will automatically fail.

The total mark will be the sum of the marks obtained in the different tasks of the subject.

To pass the subject, it is necessary that:

· The global mark of the theory (TM) is greater or equal than 4 over 10.

· The global mark of the laboratory (LM) is greater or equal than 5 over 10.

· The global mark of the subject (FM) is greater or equal than 5 over 10.

The theory mark is calculated as follows:

TM = 0.20 * TE1 + 0.20 * TE2 + 0.20 * EX1 + 0.20 * EX2 + 0.20 * EX3

being:

TE1 and TE2: Mark of test exams.

EX1, EX2 and EX3: Mark of problems and/or exercises.

The laboratory mark is calculated as follows:

LM = 0.10 * LP1 + 0.10 * LP3 + 0.20 * LP4 + 0.30 * LAP1 + 0.30 * LAP2

being:

LP1, LP3 and LP4 = Mark of laboratory practices.

LAP1 = Laboratory Autonomous Project that consists of the design of a complex peripheral.

LAP2 = Laboratory Autonomous Project that consists of the design of a medium-complexity embedded system.

In case a student passes all the minimum marks, the final mark (FM) will be:

FM = 0.50 * TM + 0.50 * LM

In case a student does not reach any of the minimum marks (global theory mark < 4 or global laboratory mark < 5), the final mark (FM) will be:

FM = minimum [4.5; (0.50 * TM + 0.50 * LM)]

being:

TM = Global theory mark.

LM = Global laboratory mark.

The students that pass the course by means of continuous assessment will not be allowed to repeat any tasks (theory, laboratory) in the exam-only assessment in order to improve the mark.

If the students who are following continuous assessment deliver all the tasks, the mark of the part of the subject (theory, laboratory) in which they have obtained the minimum demanded will be preserved, only until the second call of the same academic course.

EXAM-ONLY ASSESSMENT(first or second call) AND END-OF-PROGRAM CALL

The students that opt for the exam-only assessment (whether it is the first or the second call) or for the end-of-program call will have to do a theoretical exam and a laboratory exam individually.

To be allowed to do the laboratory exam, it is necessary to request it previously on the dates that will be communicated to the students through the FaiTIC website.

The total mark will be the sum of the marks obtained in the different tasks of the subject.

To pass the subject, it is necessary that:

· The mark of the theoretical exam is greater or equal to 4 over 10.

· The mark of the laboratory exam is greater or equal to 5 over 10.

· The global mark of the subject is greater or equal to 5 over 10.

In case a student passes all the different tasks, the final mark (FM) will be the weighted sum of the marks of each exam:

FM = 0.50 * TE + 0.50 * LE

In case a student does not pass one of the exams (theoretical exam < 4 or laboratory exam < 5), the final mark (FM) will be:

FM = minimum [4.5; (0.50 * TE + 0.50 * LE)]

being:

TE = Theoretical Exam.

LE = Laboratory Exam.

Theoretical exam

The theoretical exam will include test questions and practical problems on the topics of all the theoretical lessons. The students will have to answer all the exam questions correctly to obtain the maximum mark.

This exam will be held on the date and place that the faculty will determine.

Laboratory exam

The exam will consist of the design of circuits in VHDL and programs in assembler for the microprocessor used in the subject. These circuits and programs may be part of a complex peripheral or an embedded system and they will have a similar complexity to the ones designed in the laboratory practices and the autonomous laboratory projects during the

continuous assessment.

The students will have to perform the simulations and tests described in the exam in the assigned time.

The teacher may request that the students show them the operation of each of the circuits and programs.

All the sections have to work perfectly to obtain the maximum mark.

The addition of additional functionality to the minimum required will be taken into account.

It is compulsory to deliver the files indicated in the exam.

If this condition is not fulfilled, the corresponding sections will not be assessed.

The correct operation and the correct application of the theoretical concepts to the circuits and programs realised during the exam will be assessed, according to the same assessment criteria for the laboratory practices and the autonomous projects during the continuous assessment.

Sources of information

Basic Bibliography

POZA GONZÁLEZ, F., ÁLVAREZ RUIZ DE OJEDA, L.J., **Diseño de sistemas empotrados de 8 bits en FPGAs con Xilinx ISE y Picoblaze**, Vision libros, 2012

Chu, Pong P., **FPGA prototyping by VHDL examples**, John Wiley & Sons, Inc., 2008

Complementary Bibliography

ÁLVAREZ RUIZ DE OJEDA, L.J., **Diseño Digital con FPGAs**, Vision libros, 2013

ÁLVAREZ RUIZ DE OJEDA, L.J.,, **Diseño Digital con Lógica Programable**, Editorial Tórculo, 2004

ÁLVAREZ RUIZ DE OJEDA, L. Jacobo, MANDADO PÉREZ, E., VALDÉS PEÑA, M.D., **Dispositivos Lógicos Programables y sus aplicaciones**, Editorial Thomson-Paraninfo, 2002

PÉREZ LÓPEZ, S.A., SOTO CAMPOS, E., FERNÁNDEZ GÓMEZ, S., **Diseño de sistemas digitales con VHDL**, Thomson-Paraninfo, 2002

Ken Chapman, **PicoBlaze 8-bit Embedded Microcontroller User Guide for Spartan-3, Spartan-6, Virtex-5, and Virtex-6 FPGAs (UG129)**, Xilinx, 2010

Ken Chapman, **KCPSM3, 8-bit Microcontroller for Spartan-3, Virtex-2 and Virtex-2 Pro (KCPSM3_Manual)**, Xilinx, 2003

Recommendations

Subjects that continue the syllabus

Design and synthesis of digital systems/V05G300V01923

Subjects that are recommended to be taken simultaneously

Electronic Systems for Signal Processing/V05G301V01312

Subjects that it is recommended to have taken before

Programming I/V05G301V01105
Digital electronics/V05G301V01203
Physics: Fundamentals of electronics/V05G301V01201

Other comments

The students will have previously followed the subject Digital Electronics. It gives the necessary knowledge to understand the topics of this course. It is not necessary to have passed it.

Besides, it is recommended that the students have previously followed the subject Physical: Foundations of Electronics and Programming I. They give the necessary knowledge to understand some topics of this course.

Contingency plan

Description

In case of having to teach partly or entirely online because of health and safety recommendations, the same teaching methodologies and assessment methods will be maintained.

IDENTIFYING DATA				
Radio Frequency Circuits				
Subject	Radio Frequency Circuits			
Code	V05G300V01511			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Isasi de Vicente, Fernando Guillermo			
Lecturers	Isasi de Vicente, Fernando Guillermo			
E-mail	fisasi@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Main radio system circuits are studied. In this matter main characteristics and structure are treated. The evaluation of this circuits is studied too. International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG4	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CE24	CE24/ST4 The ability to select circuits, subsystems and systems of radiofrequency, microwaves, broadcasting, radio link and radio determination.
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	Competences		
Learn the effect that each parameter of the specifications of a circuit has in the complete system.	CG6		
Learn to analyse the priorities of the parameters in different circumstances.	CG4 CG6	CE24 CE25	CT2 CT4

Contents	
Topic	
Main radiocommunication systems characteristics.	Non linear effects
Use of radiofrequency laboratory equipment.	Use and understanding of laboratory equipment: Spectrum analyzer Network analyzer Signal source
Filtros	Theorical and practical principles of radiofrequency filters.
Study of amplifiers.	Main characteristics Noise in amplifiers
Oscillators	Non linear treatment Oscillators measurement Voltage controlled oscillators (VCO) Phase noise
Frequency synthesizers	Based in PLL. Direct digital synthesis.
Mixers	Basic approach Main mixers structures

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	2.5	3.5
Lecturing	17	42.5	59.5
Practices through ICT	2	3	5
Laboratory practical	16.5	33	49.5
Essay	1	1	2
Problem and/or exercise solving	4	24	28
Laboratory practice	0.5	2	2.5
*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	Student will be guided to study of previous required knowledge using various sources in order to adequate subject study. Student is encouraged to make use of tutorship hours in order to solve more difficult topics. It is a group activity.
Lecturing	Lecture at classroom using blackboard and computer about subject theory. Through this methodology the competencies CG4, CG6, CG8, CE24 y CE25 are developed. It is a group activity. International students will be allowed to ask the professor for: a) Information sources and bibliographic references for the study of subject in english. b) have the tutor sessions in english c) tests in english.
Practices through ICT	Learning of some EDA (computer design applications) for design and test of radiocommunication systems. Through this methodology the competencies CG4, CG6, CG9, CE24 y CE25 are developed. It is a group activity.
Laboratory practical	Radiocommunication systems measurements. Use of radiocommunication circuit measurement equipment. Basic knowledge about radiofrequency circuits manufacturing. Team project using official standards and specifications. Through this methodology the competencies CG4, CG6, CG9, CE24, CE25, CT2 y CT4. are developed. It is a group activity.

Personalized assistance	
Methodologies	**Description**
Laboratory practical	In laboratory practises the professor is pays attention to students' work to solve any question. Moreover, students can make use of tutor sessions at professor's office. Office hours will be scheduled by the professor when a student sends an email asking for it. They will be at the professor's virtual office.
Practices through ICT	In laboratory practises the professor is pays attention to students' work to solve any question. Moreover, students can make use of tutor sessions at professor's office. Office hours will be scheduled by the professor when a student sends an email asking for it. They will be at the professor's virtual office.
Tests	**Description**
Essay	In addition of master classes, students can make use of tutor sessions at professor's office. Office hours will be scheduled by the professor when a student sends an email asking for it. They will be at the professor's virtual office.
Laboratory practice	In doing tests, student's ability must be shown without help.

Assessment			
	Description	Qualification	Evaluated Competencess
Lecturing	Class of blackboard in classroom with occasional support of computer,	0	
Practices through ICT	Tests in order to evaluate the correct comprension and ability in use of informatic tools.	5	CG4 CE24 CG6 CE25
Laboratory practical	Questions of the professor and evaluation on the fly of the work of laboratory.	10	CG4 CE24 CG6 CE25
Essay	Project to work into a team. A presentation of the results will be done to professor in wich some questions could be asked. The team's member who presents results is chosen by random between all team's members. In case of online tuition, then the evaluation the examination would be oral.	20	CG4 CE24 CG6 CE25

Problem and/or exercise solving	Written tests of numerical problems.Three contiunuous assesment (5%, 15%, y 15%) plus one test at the end of course (15%) for students following continuous assesmnt. In case of online tuition, then the evaluation will be carried out as follows: they will be carried out online including the possibility of a videoconference in which the professor has the possibility of seeing the student and his/her near environment. The test could be as well oral by videoconference.	50	CG4 CG6	CE24 CE25	
Laboratory practice	Evaluation of practic work. Results of the necessary calculations for the development of the practices.	15	CG4 CG6	CE24 CE25	CT2 CT4

Other comments on the Evaluation

Continuous assesement:

To pass the subject by continuous assesment it is mandatory to get a 3 points out of 10 in average out of all problems tests. If this condition is not accomplished final mark will be 4 if total average is equal or higher than this mark or the total average in other cases. The schedule of the different tests of continuous assesment will be approved by an Academic Commission of Degree (CAG) and will be available at the beginning of the semester. A student chooses continous assesment when two or more tests are done. Intermediate tests have not a second opportunity.

When a student doesn't follow continuous assesmnt or haven't done three or more continuous assesmnt tests, will do a test at the end of course which will have a value of 50% of the global qualification if student has done lab practises and C group's proyect. If student has not done such practises and proyect, has to contact professor for a practical assesment (50%) and a problems test (50%).

To pass the subject it is neccesary to get a minimum average mark of 3 out of 10 in problems tests. If this condition is not accomplished final mark will be 4 if total average is equal or higher than this mark or the total average in other cases.

If a student follows continuous assesment, the final mark can not be "not assesed".

B groups practices:

If continuous assesment is chosen laboratory practices are mandatory and the maximum number of absences is 20%. The student can do missing practices agreeing with professor about date and hour to do practices if it is possible.

C groups practices:

A practical project is proposed to a group of students. This project is de design, construction and test of a practical circuit. This work is evaluated by oral exposition carrid by one or more students from the team. These students will be chosen by random way.

Final examinations:

Both in final and july examinations if a student has not done B or C practices, the value of them is the same as in continuous assesment (B: 30% and C: 20%). If some of them are missing student can be examined about them in practical way or by written questions in problem examination. This is a professor's choice.

These practical examinations can be done also by students which want to improve previous marks**.**

Plan of contingency:

In case of online tuition, then the evaluation will be carried out as follows:

The tests would be by videoconference or by an online multiple choice test during a short time. About the laboratory test, if the number of students allows it, it would be an oral test by videoconference. For the C groups evaluation, it would be like B groups but the test would be simultaneous for all participants in the group.

Sources of information

Basic Bibliography

Apuntes de la asignatura, **F. Isasi**, 1,

Complementary Bibliography

Electrónica de comunicaciones, **M. Sierra y otros**, 1,

Solid state radio engineering, **Kraus, Bostian y Raab**, 1,

James W. Nilsson, Susan A. Riedel, **Circuitos eléctricos**, 7,

Recommendations

Subjects that continue the syllabus

Microwave Circuits/V05G301V01322
Wireless Systems and Networks/V05G301V01326

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G301V01108
Mathematics: Calculus 1/V05G301V01101
Mathematics: Calculus 2/V05G301V01106
Signal Transmission and Reception Techniques/V05G301V01208
Electronic technology/V05G301V01206
Analogue Electronics/V05G301V01311

Other comments

Studens should be skillful in network analisys and know the small signal equivalent circuits.
Electronics subjects around the transistor must be reviewed.

Contingency plan

Description

=== EXCEPTIONAL MEASURES SCHEDULED ===
In front of the uncertain and unpredictable evolution of the sanitary alert caused by the *COVID-19, the University of Vigo establishes an extraordinary planning that will activate in the moment in that the administrations and the own institution determine it attending to criteria of security, health and responsibility, and guaranteeing the teaching in a no face-to-face stage or partially face-to-face. These already scheduled measures guarantee, in the moment that was prescriptive, the development of the teaching of a more agile and effective way when being known in advance (or with a wide *antelación) by the students and the *profesorado through the tool normalised and institutionalised of the educational guides.

=== ADAPTATION OF THE METHODOLOGIES ===
* educational Methodologies that keep
The theoretical classes keep the same and with the same schedule but of on-line form.
* Educational methodologies that modify
The practices of laboratory, in case of not being able to be face-to-face, will modify in order to not affect learning outcomes, fullfilling the neccesary competences.

* Mechanism no face-to-face of attention to the students (*tutorías)
The *tutorías do not modify for being in remote in all the cases.

* Additional bibliography to facilitate the car-learning
In case to use some distinct application of the one of the face-to-face teaching, the professor will provide to the students the manuals and the necessary information for his efficient use.

=== ADAPTATION OF THE EVALUATION ===
Plan of contingency:

In the case in that the teaching was exclusively no face-to-face, then the evaluation will make as follows:

it will examine of the theory by videoconference or by an examination type on-line test with a time limited. With regard to the laboratory will examine to the student, if the number of the same allows it, of oral form by videoconference. With regard to the projects of groups C will be of equal way but of simultaneous form for all the group that has done the project.
The weights of the different examinations keep have done of face-to-face or remote form.

IDENTIFYING DATA				
Radio Communication Systems				
Subject	Radio Communication Systems			
Code	V05G300V01512			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Rubiños López, José Óscar			
Lecturers	Arias Acuña, Alberto Marcos Rubiños López, José Óscar			
E-mail	oscar@com.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course is devoted to the study of the fundamentals of radio communications systems, including the antennas, the link budget as well as those factors that limit the correct recepction such as noise and interference.			

Competencies	
Code	
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.
CG4	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.
CE21	CE21/ST1 The ability to construct, exploit and manage telecommunication networks, services, process and applications, considered as systems of receiving, transporting, representation, processing, storage, management and presentation of multimedia information from the point of view of transmission systems.
CE22	CE22/ST2 The ability of applying the basic techniques of telecommunication networks, services and applications for mobile and fixed environments, personal, local or long distance, with different bandwidth, including telephony, radio broadcasting, TV and data, from the point of view of transmission systems.
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.
CT2	CT2 Understanding Engineering within a framework of sustainable development.

Learning outcomes	Competences		
Learning outcomes			
Ability to apply the techniques underlying radio communications systems in fixed and mobile communication services in local or long-distance links at different bandwidths.	CG4	CE22	CT2
Ability to understand the concept of systems limited by noise, as well as the types of noise and interferences.	CG2		CT2
Ability to understand the mechanisms of propagation and how to model the propagation channel.	CG2	CE25	
Ability to understand the foundations of antennas. Ability to know and characterize the different types of antennas.	CG2	CE25	
Ability to understand and specify the foundations of terrestrial and satellite broadcast services.	CG2	CE21	
Ability to understand the foundations of the radio links.	CG2	CE21	
Ability to understand the concept of coverage and to apply it to the radio link and broadcasting services.	CG2	CE22 CE25	CT2
Ability to analyse the coverage in order to specify the quality of service.	CG4	CE21	CT2

Contents	
Topic	
1. RADIATION FUNDAMENTALS	1.1 Electromagnetic Fundamentals 1.2 Antenna parameters in transmission 1.3 Antenna parameters in reception 1.4 Types of antennas

2. LINK BUDGET	2.1 Friis transmission equation 2.2 Propagation losses. 2.3 Band frequencies.
3. NOISE	3.1 Thermal noise. 3.2 Noise in antennas. 3.3 Noise factor and noise-equivalent temperature of a receiver.
4. INTERFERENCE	4.1 Concept and types of interference 4.2 Characterization of interference
5. AVAILABILITY	5.1 Concepts of availability, fading and diversity 5.2 Noise-limited Systems 5.3 Interference-limited Systems
6. RADIOWAVE PROPAGATION	6.1 Propagation at very low frequencies 6.2 Surface wave propagation 6.3 Ionospheric propagation 6.4 Tropospheric Propagation

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	11	11	22
Problem solving	7	7	14
Laboratory practical	7	14	21
Introductory activities	1	1	2
Case studies	10	50	60
Report of practices, practicum and external practices	0	15	15
Problem and/or exercise solving	4	8	12
Essay questions exam	2	2	4

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

Methodologies

	Description
Lecturing	Presentation, by the professor, of the contents of the course (theoretical basis, guidelines for solving exercises/problems or developing a radio communication project). The competencies CG2, CE21, CE22, CE25, CT2 are worked with this methodology. In group.
Problem solving	Resolution, by the student, of problems and/or exercises related with the course. The student not only has to get the suitable or correct solutions by the application of the theory previously explained but also has to interpret correctly the results. The competencies CG4, CE21, CE22, CE25, CT2 are worked with this methodology. Individual.
Laboratory practical	Application of knowledge to specific situations and acquisition of basic skills and procedures in the related field. They are developed in laboratories with specialized equipment. The competencies CG4, CE21, CE22, CE25 are worked with this methodology. In group.
Introductory activities	Review of necessary contents in that class that had previously been explained in previous classes and / or subjects. The competences CG2, CG4, CE21, CE22, CE25, CT2 are worked with this methodology. Group activity
Case studies	Study and analysis of problems based on real events in order to know them, think about them, interpret them, generate hypothesis, constrast data ... and train in the use of different procedures of solution. The competencies CG4, CE21, CE22, CE25, CT2 are worked with this methodology. Individual.

Personalized assistance

Methodologies	Description
Lecturing	In this methodology, all the questions that each student can ask will be answered.
Problem solving	Each student will be attended in an individual way.
Case studies	Each student will be attended in an individual way.
Laboratory practical	Each student will be attended in an individual way.

Assessment

Description	Qualification	Evaluated Competencess

Case studies	Technique that consists of monitoring the student, who will be assessed from his autonomously solving of the proposed tasks (case studies / analysis of situations). The professor will provide help students if necessary.	3	CG2 CG4	CE25	CT2
Report of practices, practicum and external practices	Evaluation of: - the preparation and development of the lab practices, - the reports and memories on lab practices. The professor will provide help students if necessary.	7	CG4	CE21 CE22 CE25	CT2
Problem and/or exercise solving	Two examinations in which the student has to solve (in an autonomous way) a number of exercises by applying the acquired knowledge in the time and conditions established by the professor. The student can take them during the course or together with the final examination, depending on the evaluation system chosen.	40	CG2 CG4	CE22	
Essay questions exam	Final examination: evaluation of the skills acquired by the student. He/she has to develop, relate, organise and present the knowledge acquired in the course in an autonomous way.	50	CG2 CG4	CE22 CE25	

Other comments on the Evaluation

The student can choose between two evaluation systems: continuous assessment or only final examination. Previously to the final examination (or at the entrance of the session), the student will decide the evaluation system. Before permorming each task or delivery, the procedure and dates for the review of the qualifications will be published within a reasonable period of time.

1. The CONTINUOUS ASSESSMENT assessment includes a series of tasks performed during the course. They are not recoverable, i.e., if a student can not fulfilled them in the time established, the professor is not bound to repeat them. The obtained qualification will be valid only for the current academic course.

The continuous assessment consists of:

a) two examinations;

b) delivery (in the last weeks of the course) of memories of the lab and autonomous-ICT practices;

c) autonomous tasks (case studies / analysis of situations);

d) the final examination.

2. FINAL EXAMINATION at the end of the semester. It is mandatory for all students.

3. FIRST CALL

E1=score obtained in the mandatory part of the final examination (up to 10 points).

PM=score obtained in the lab practices (attendance, quality of the reports...) (up to 10 points).

PEC=score obtained in both exams (continous assessment) (up to 10 points).

S=score obtained in the autonomous tasks (case studies / analysis of situations) (up to 10 points).

Continuous assessment:

If PEC < 4 points, Qualification = PEC

If PEC >= 4 points, Qualification = 0.5 * E1 + 0.4 * PEC + 0.07 * PM + 0.03 * S

Exam-only assessment: Qualification = E1

4. SECOND CALL. Previously to the exam (or at the entrance of the session) the students choose between continous or exam-only assessment. The qualification formulas are the same (as those of the first call)

5. END-OF-PROGRAM CALL. Exam-only assessment.

6. STUDENTS PRESENTED AT THE COURSE. A student is considered "presented" if he/she receives the final exam or both exercises of the continuous assessment.

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

Sources of information

Basic Bibliography

Marcos Arias Acuña, Oscar Rubiños López, **Radiocomunicación**, 1ª, Andavira Editora, 2011

José María Hernando Rábanos, **Transmisión por Radio**, 7ª, Editorial Universitaria Ramón Areces, 2013

Complementary Bibliography

John Griffits, **Radio Wave Propagation and Antennas. An Introduction**, 1st, Prentice Hall, 1985

Robert E. Collin, **Antennas and Radiowave Propagation**, 1st, Mc Graw Hill, 1985

Constantine A. Balanis, **Antenna Theory. Analysis and design**, 4th, Wiley, 2016

Thomas A.Milligan, **Modern Antenna Design**, 2nd, Wiley, 2005

Angel Cardama, L. Jofre, J.M. Rius, S. Balnch, M. Ferrando, **Antenas**, 2ª, Ediciones UPC, 2002

ITU-R, **Recommendations**,

Recommendations

Subjects that continue the syllabus

Wireless Systems and Networks/V05G300V01615

Subjects that are recommended to be taken simultaneously

Radio Frequency Circuits/V05G300V01511

Contingency plan

Description

In case of health alert that prevents physical attendance at classrooms and laboratories,
(i) face-to-face learning (A- and B-groups) will be replaced by emergency remote teaching,
(ii) the laboratory practices that require the use of specific material and cannot be virtualised will not take into account in the assessment,
(iii) the assessment shall be carried out virtually via the UVigo Remote platform under conditions which shall be described at the appropriate time

(*) but which shall try to be as close as possible to what would be the case in the absence of a health alert.

IDENTIFYING DATA				
Multimedia Signal Processing				
Subject	Multimedia Signal Processing			
Code	V05G300V01513			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Cardenal López, Antonio José			
Lecturers	Cardenal López, Antonio José			
E-mail	cardenal@gts.uvigo.es			
Web	http://http://faitic.uvigo.es/			
General description	Multimedia signal processing is now a fundamental part of any modern information, communication, learning, and entertainment system. Once the main Digital Signal Processing concepts and bases have been introduced in the second year, this course prepares students for the analysis and processing of deterministic and random signals, before encoding and transmission of multimedia information. In related courses both on this and next academic year, the knowledge acquired shall be applied to voice, audio, image and video signals and systems,. The main goals of the course are: - Analyze digital signal processing schemes. - Design digital filters according to prescribed specifications. - Analyze and specify the basic parameters of communication subsystems from the point of view of signal processing. - Apply statistical filtering in coding, processing and transmission of multimedia information. To help in reaching these goals, the course is divided into four major topics: DFT and Fast Fourier Transform, Fundamentals of statistical signal processing, digital filter characterization and multirate signal processing. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CE26	CE26/ST6 The ability to analyze, codify, process and transmit multimedia information using analogical and digital signal processing techniques.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes			
Learning outcomes	Competences		
Analyze digital signal processing diagrams.	CG3	CE26	
Design digital filters from specifications.	CG4	CE26	CT2
Analyze and specify the fundamental parameters of the communication subsystems from the point of view of digital signal processing.	CG4	CE26	
Statistical analysis and filtering applied to the coding, processing and transmission of multimedia information.	CG3 CG4	CE26	CT3

Contents	
Topic	
Practice 1 Fourier Analyses through DFT.	Linear Filtering using DFT. Effects of the temporal and frequency sampling. Windowing and spectral resolution

Topic 1 Fourier Transform of discrete signals: DFT.	Formulation and properties of the DFT. Efficient computation of the DFT (FFT). Linear Filtering Methods using DFT. Effects of the time and frequency sampling. Windowing and spectral resolution.
Topic 2 Introduction to Statistical signal processing.	Random signals. Correlation and spectra for stationary signals. Random signals and linear systems. Optimal Linear Filters. Wiener filter. Introduction to adaptive filtering: LMS algorithm. Spectral Estimation.
Practice 2 Adaptive Filtering.	Wiener Filter. LMS.
Topic 3 Filter Design and implementation.	Z transform: a review. Implementation of FIR and IIR filters from difference equations. Block Diagramas. Structures for digital filters. FIR and IIR Design.
Practice 3 Digital Filters Design and implementation.	FIR filters Design. IIR filters Design.Implementation of digital filters.
Topic 4 Multirate signal processing.	Decimation and Interpolation. Spectral interpretation of interpolation and decimatio. FIR Filter Structures Based on Polyphase Decomposition. Filter Banks.
Practice 4 Multirate signal processing.	Decimation and Interpolation. Polyphase Filter Banks.

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	12	24	36
Mentored work	7	35	42
Lecturing	21	42	63
Essay questions exam	2	7	9

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

Methodologies

	Description
Laboratory practical	Application of MatLaB commands and functions to digital signal processing practical exercises. Through this methodology the competencies CG4, CE26, CT2 and CT3. are developed. (Individual)
Mentored work	Group work on a project centered in a practical application of signal processing. Through this methodology the competencies CG3, CG4, CE26, CT2 and CT3 are developed. (Group)
Lecturing	Presentation of main topics in class. Multimedia material will be made available in faitic before classes take place. Personal study. Support from the instructors through tutorial help. Through this methodology the competencies CG3, CE26, CT2 and CT3. are developed. (Individual)

Personalized assistance

Methodologies	Description
Lecturing	Lectures take place within a continuous interaction framework in which students may answer questions formulated by the teacher. They could also solve their particular doubts during the sessions.
Laboratory practical	In practical sessions students are required to carry on their own the assigned task. The instuctorr will be available during the session to solve any problems/questions students may have.
Mentored work	Tutored works are carried out in small working groups. The follow up of the work in progress takes place in regular meetings between the groups and the instructor, in which students may formulate any questions related to the work to be done.

Assessment

	Description	Qualification	Evaluated Competencess		
Laboratory practical	Individual drills related with the laboratory content. Will be taken in laboratory time, and will last 30 minutes.	40	CG3 CG4		CT3
Mentored work	Projects to be carried out in groups. Different gradings according to levels of participation that will be assessed through cross- evaluation surveys among students.	20		CE26	CT2
Lecturing	Written exam encompassing all the material exposed in the classroom and laboratory . Students will receive support to clarify any questions about the written exam.	40	CG3 CG4		

Other comments on the Evaluation

Evaluation

Students shall be offered two evaluation systems: continuous assessment or evaluation at the end of the semester.

- Continuous assessment .
- Exam-only assessment.
- Recovery in the month of June-July.

CONTINUOUS ASSESSMENT

The continuous assessment of the course will consist in:

- Four 30-minutes drills related to the laboratory work, that will account for 40% of the final grade.
- One project to be carried out in a group that will account for 20% of the final grade.
- A written exam encompassing all the material exposed in the classroom and laboratory. Will take place on the dates scheduled by the School. The exam shall help in gauging the level of understanding of the four-course topics. The exam will feature exercises and questions to be answered in two hours. Students may bring to the exam books, laboratory and classroom notes, and any other materials downloaded from faitic. The exam will account for 40% of the final grade.

The final qualification of the student will be computed as a weighted sum (40%, 20%, and 40%, respectively) of the qualifications of the laboratory, group project, and final exam. However, in order to pass the course, the grade of the final exam must not lie below 25 out of 100 points. If that grade is lower than 25, the final qualification will be the minimum among the aforementioned weighted sum and 4.5.

The contents and weights of each continuous assessment exercises are the following:

- Laboratory drill 1 (10 %):

Fourier Analysis through DFT: will take place in the fourth week of the course.

- Laboratory drill 2 (10 %)

Adaptive filtering: will take place in the sixth week of the course.

- Laboratory drill 3 (10 %):

Design and implementation of FIR and IIR filters: will take place in the tenth week of the course.

- Laboratory drill 4 (10 %):

Multirate Filter Banks: will take place in the thirteenth week of the course.

- Project: (20%) practical application of concepts mastered in the course. Oral presentations shall take place in the fourteenth week of the course.

The planning of the different intermediate evaluation tests will be approved in an Academic Committee of Degree (CAG) and will be available at the beginning of the semester.
EXAM-ONLY ASSESSMENT

Should a student decide not to be graded through continuous assessment , she will have a written examination opportunity that will take place the same day of the final exam for all the students. Before taking the exam though, the student shall sign a form in which he states his decision to dispense with continuous assessment .
This written exam will last three hours and will be composed of 5 exercises encompassing all the material mastered in the classroom, laboratory, and tutorial sessions, under the same conditions specified for the students that take the final exam at the end of the continuous assessment process.

Grading Periods

First opportunity to pass the course (December-January)

If the student passes the course in this period, her grade will be final and will be recorded in her academic file.

If the student does not pass the course, a provisional fail shall be posted in his academic file.

Second opportunity to pass the course (June-July)

In June-July only the written exams shall be offered. If a student wants to dispense with continuous assessment in this period, the student will be able to take the final exam reserved for those cases. Before taking the exam though, a form shall be signed, in which the student formulates the decision to dispense with continuous assessment .

The provisional fail will become definitive should the student not take any of the written exams in this second period.

END-OF-PROGRAM CALL

The student will have a written examination. This written exam will last three hours and will be composed of 5 exercises encompassing all the material mastered in the classroom.

Sources of information

Basic Bibliography

John G. Proakis, Dimitris G. Manolakis., **Tratamiento Digital de Señales**, Prentice Hall,

Complementary Bibliography

Sanjit K. Mitra., **Digital Signal Processing: A Computer Based Approach.**, Ed. McGraw-Hill,

Alan V. Oppenheim, Ronald W. Schafer, **Discrete-Time Signal Processing**, Prentice Hall,

Recommendations

Subjects that it is recommended to have taken before

Digital Signal Processing/V05G301V01205

Contingency plan

Description

In case of online tuition, then the planning and evaluation will be maintained as described in the guide.
Lecturing and laboratory sessions will be taught remotely.
For the laboratory sessions, students must have a computer with the Matlab program installed.
The evaluation tests will be carried out using the tools provided by the University.

IDENTIFYING DATA				
Data Acquisition Systems				
Subject	Data Acquisition Systems			
Code	V05G300V01521			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Poza González, Francisco			
Lecturers	Eguizábal Gándara, Luis Eduardo Machado Domínguez, Fernando Poza González, Francisco			
E-mail	fpoza@uvigo.es			
Web	http://www.faitic.uvigo.es			
General description	This subject is about acquisition data, including instrumention amplifiers, analog switches, active filters, S&H and converters.			

Competencies
Code
CE43 (CE43/SE5): The ability to design analogical and digital electronics circuits of analogical to digital conversion and vice versa, of radiofrequency, of feeding and electrical energy conversion for computing and telecommunication engineering.
CE45 (CE45/SE7): The ability to design interface, data capturing and storage devices, and terminals for services and telecommunication systems.

Learning outcomes	
Learning outcomes	Competences
Knowledge of instrumentation amplifiers, and control about its use.	CE43 CE45
Knowledge of the different types of electronic analogue switches and the control of applications.	CE43 CE45
Knowledge of Sample&Hold circuits and their applications in data acquisition.	CE43 CE45
Knowledge of the operation of different DAC and ADC converters, and the control of their applications.	CE43 CE45
Knowledge about data storage and the control of their applications.	CE43 CE45
Knowledge of the design of data acquisition using the previous elements.	CE43 CE45

Contents	
Topic	
Unit 1. Introduction to data acquisition systems (DAS)	1.1. Introduction 1.2. Components of DAS 1.3. Control systems
Unit 2. Auxiliary circuits	2.1. Level shifter circuits 2.2. Voltage reference 2.3. Voltage-to-current converters
Unit 3. Analog switches and multiplexers	3.1. Analog switches 3.2. Analog multiplexers
Unit 4. Amplification in data acquisition	4.1. Instrumentation amplifiers 4.2. Programmable gain amplifiers 4.3. Isolation amplifiers
Unit 5. Active filters	5.1. Introduction 5.2. First and second order transfer functions 5.3. Transfer functions aproximation 5.4. Active filters synthesis

Unit 6. Sample and hold circuits	6.1. Introduction 6.2. Base circuit 6.3. Practical architectures 6.4. Real parameters 6.5. Commercial devices
Unit 7. Digital-to-analog and analog-to-digital converters	7.1 Digital-to-analog converters (DAC) 7.1.1. Introduction 7.1.2. Transfer function 7.1.3. Parameters and errors 7.1.4. Classification 7.1.5. DAC architectures 7.2. Analog-to-digital converters (ADC) 7.2.1. Introduction 7.2.2. Transfer function 7.2.3. Parameters and errors 7.2.4. Classification 7.2.5. ADC architectures
Practice 0. Introduction	Introduction to laboratory concepts and tools.
Practice 1. Auxiliary circuits	Experimental test and analysis of auxiliary circuits used in signal conditioning stages.
Practice 2. Instrumentation amplifier	Experimental test and analysis of instrumentation amplifiers.
Practice 3. Isolation amplifier	Experimental test and analysis of linear optical isolation amplifiers built from discrete components.
Practice 4. Active filters	Experimental test and analysis of active filter topologies.
Practice 5. Digital-to-analog conversion	Experimental test and analysis of a digital-to-analog converter (DAC) built from discrete components.
Practice 6. Analog-to-digital conversion	Experimental test and analysis of an analog-to-digital converter (ADC) based on an ADC integrated circuit.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	14	37.5	51.5
Problem solving	4	22.5	26.5
Laboratory practical	14	28	42
Mentored work	7	20	27
Problem and/or exercise solving	3	0	3

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

Methodologies

	Description
Lecturing	The lecturer will show some theoretical contents related to the subject. Competencies CE43 and CE45 will be addressed in these sessions.
Problem solving	The lecturer will solve some exercises related to the subject. Competencies CE43 and CE45 will be addressed in these sessions.
Laboratory practical	Simulations and real assembled circuits will be tested. Competencies CE43 and CE45 will be addressed in these sessions.
Mentored work	The lecturer will lead the students in a data acquisition system design. Competencies CE43 and CE45 will be addressed in these sessions.

Personalized assistance

Methodologies	Description
Lecturing	The teacher will resolve the doubts of the students in his office at the schedule established and published on the school website.
Problem solving	The teacher will resolve the doubts of the students in his office at the schedule established and published on the school website.
Mentored work	The teacher will resolve the doubts of the students in his office at the schedule established and published on the school website.
Laboratory practical	The teacher will resolve the doubts of the students in his office at the schedule established and published on the school website.

Assessment

	Description	Qualification	Evaluated Competences
Laboratory practical	The lecturer will check the level of compliance of the students with the goals related to the laboratory skills. The final mark of laboratory, FML, will be assessed in a 10 points scale. For the evaluation of the laboratory sessions, the lecturer will assess the group work (the same mark for each member), the individual preliminary tasks and the answers to personalized questions for each session.	30	CE43 CE45
Mentored work	The lecturer will consider the results and the quality of the analysis performed in the developed work. The tutored work mark, TWM, will be assessed in a 10 points scale. For the evaluation of the work, the lecturer will assess the group work (the same mark for each member) and the individual answers to personalized questions (individual mark).	20	CE43 CE45
Problem and/or exercise solving	The lecturer will check the level of compliance of the students with the goals related to the theory skills. To achieve this three exercises and troubleshooting tests are scheduled. The final mark of theory, FMT, will be assessed in a 10 points scale.	50	CE43 CE45

Other comments on the Evaluation

1. Continuous assessment in first call

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

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

The subject comprises three different parts: theory (50 %), laboratory (30%) and tutored work (20%). 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 are scheduled. The exercises and troubleshooting tests (ETT1, ETT2 and ETT3) will be respectively performed after unit 4, 5 and 7, in the usual weekly scheduling of the theoretical classes. The first test (ETT1) of the themes 1 to 4, the second test (ETT2) of the theme 5 and third test (ETT3) of the themes 6 and 7.These tests are approximately 60 minutes long.

Marks for each test will be assessed in a 10 points scale. The minimum mark required to pass this part is of 4 (ETTi>=4). The final mark of theory (FMT) is calculated as the arithmetic mean of the individual marks:

FMT = (ETT1 + ETT2 + ETT3)/3

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 tests is not achieved (ETTi less than 4), the students can repeat this part in the same date of the final exam.

1.b Laboratory

Seven laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in pairs. The first session is mandatory but will not be assessed. The following seasons (practice 1 to 6) will be assessed by continuous assessment. The lecturer will consider the proposed individual tasks, the work in the laboratory as well as the student□s behavior. Each session will be only evaluated according to the developed work at the schedule date.

Marks for each laboratory session (LSM) will be assessed in a 10 points scale. A mark of 0 will be obtained for missing sessions. The final mark of laboratory (FML) is calculated as the arithmetic mean of the individual laboratory session marks:

FML = (LSM1 + LSM2 + LSM3 + LSM4 + LSM5 + LSM6)/6

1.c Tutored work

In the first session lecturer will present the objectives and the schedule of the project. They also assign a specific project to each group. The students will work in pairs whenever possible.

In order to assess the work, the lecturer will consider the results, their analysis and presentation, and the quality of the written report. The tutored work mark (TWM) will be assessed in a 10 points scale.

1.d 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: 50% theory (FMT), 30% laboratory (FML) and 20% tutored work (TWM). In order to pass the subject, students will be required to pass the theory (ETT1>=4, ETT2>=4 , ETT3>=4 and FMT>=5), the laboratory (FML >= 5) and the tutored work (TWM >= 5). In this case the final mark (FM) will be:

FM = 0.5·FMT + 0.3·FML + 0.2 TWM.

However, when the students do not pass the theory (ETT1 < 4, ETT2 < 4 , ETT3 < 4 or FMT < 5), the laboratory (FML < 5) or the tutored work (TWM < 5), the final mark will be:

FM = min{4 ; (0.5·FMT + 0.3·FML + 0.2 TWM)}.

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

2. Exam-only assessment (first call)

The students who prefer a different educational policy can attend an exam on a scheduled date and deliver a tutored work the same date. Dates will be specified in the academic calendar. This exam will comprise two parts: theory and laboratory exam.

The theory exam will consist on three exercises and troubleshooting tests (ETT1, ETT2 and ETT3): the first test of the themes 1 to 4, the second test of the theme 5 and third test of the themes 6 and 7. These tests are approximately 60 minutes long. Marks for each test will be assessed in a 10 points scale. The minimum mark required to pass this part is of 4 (ETTi>=4). The final mark of theory (FMT) is calculated as the arithmetic mean of the individual marks:

FMT = (ETT1 + ETT2 + ETT3)/3

The laboratory exam will consist on the resolution of a practical exercise in the laboratory. This practical exercise will be similar to those made in the laboratory sessions. The final mark of laboratory (FML) will be assessed in a 10 points scale. In order to attend the laboratory exam, the students have to contact to the lecturer at least two weeks before the exam. This way, the organization of the laboratory exam will be simpler.

In order to pass the subject, students will be required to pass the theory (ETT1>=4, ETT2>=4 , ETT3>=4 and FMT>=5), the laboratory (FML >= 5) and the tutored work (TWM >= 5). In this case the final mark (FM) will be:

FM = 0.5·FMT + 0.3·FML + 0.2·TWM).

However, when the students do not pass the theory (ETT1 < 4, ETT2 < 4 , ETT3 < 4 or FMT < 5), the laboratory (FML < 5) and the tutored work (TWM < 5), the final mark will be:

FM = min{4 ; (0.5·FMT + 0.3·FML + 0.2·TWM)}.

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

3. Second call and end-of-program call

This exam will have the same format as the exam-only assessment (first chance). Dates will be specified in the academic calendar. In order to attend the laboratory exam, the students have to contact to the lecturer at least two weeks before the exam. This way, the organization of the laboratory exam will be simpler. The same day of this exam the students will deliver the tutored work, assigned previously.

The marks obtained in the previous assessments are kept for those parts in which the student has not attended. The final mark will be calculated as it has described in section 1.d for students in continuous assessment in first call and in section 2 for students in exam-only assessment (first call).

Sources of information
Basic Bibliography
Paul Horowitz y Winfield Hill, **The Art of Electronics**, Cambridge Univ. Press.,
Sergio Franco, **Design with Operational Amplifiers and Analog Integrated Circuits**, WCB/McGraw-Hill,
Franco Maloberti, **Data Converters**, ISBN 978-0-387-32485-2,
Complementary Bibliography
Analog Devices Library, **hhtp;//www.analog.com/library/analogDialogue/archives/43-09/EDCh%206%20Converter.pdf**, Capitulos 6.1,6.2,6.3,

Recommendations

Subjects that continue the syllabus

Analogue Electronics/V05G301V01311

Subjects that are recommended to be taken simultaneously

Analogue Electronics/V05G301V01311

Subjects that it is recommended to have taken before

Digital electronics/V05G301V01203
Electronic technology/V05G301V01206

Other comments

I recommend the students to search the web for information about this subject. Electronic devices factories show interesting information. Many universities around the world hung interesting notes in the Internet. And many of them for free.

Contingency plan

Description

In case of online tuition, then the planning and the evaluation will be carried out as follows:

* Theory: the theory classes will be performed through electronic means and the contents will be available online.

* Practices: depending on the contents developed in each laboratory practice and the availability of material, the session will be performed in a virtual way, in the students home (using provided basic equipment) or by simulation (using free software or University licensed software). The details of each practices session will be available online in FAITIC. In this scenario, the practices will be individually developed and evaluated.

* Project: depending on the proposed project and the availability of material, the work will be performed in a virtual way, in the students home (using provided basic equipment) or by simulation (using free software or University licensed software). The details of each project session will be available online in FAITIC. In this scenario, the project will be individually developed and evaluated.

* Assessment: the assessment will supported by FAITIC and Campus Remoto.

IDENTIFYING DATA

Electronic Systems for Signal Processing

Subject	Electronic Systems for Signal Processing			
Code	V05G300V01522			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Valdés Peña, María Dolores			
Lecturers	Valdés Peña, María Dolores			
E-mail	mvaldes@uvigo.es			
Web	http://www.faitic.uvigo.es			
General description	This subject introduces the basic concepts of digital signal processing systems from the point of view of its hardware implementation. Emphasis is put on FPGAs-based solutions, using professional software design tools and hardware supports. The nature of the course is mainly practical. It enhances the development of collaborative projects whose ultimate goal is the design of electronic signal processing systems.			

Competencies

Code	
CG4	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG9	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.
CG13	CG13 The ability to use software tools that support problem solving in engineering.
CE39	(CE39/SE1): The ability to construct, exploit and manage the receiving, transporting, representation, processing, storage, manage and presentation multimedia information from the electronic systems point of view.
CE45	(CE45/SE7): The ability to design interface, data capturing and storage devices, and terminals for services and telecommunication systems.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes

Learning outcomes	Competences		
Understand the fundamental design principles of the signal processing hardware systems.	CG6 CG13	CE39 CE45	
Ability to decide different design strategies depending on the application.	CG4	CE39 CE45	CT2
Ability to choice the most suitable hardware architecture for each application.	CG4 CG6	CE39 CE45	
Ability to design basic circuits for audio and image processing.	CG4 CG6 CG9 CG13	CE39 CE45	CT4
Acquire skills in the use of design, simulation and implementation tools of signal processing systems.	CG13	CE39 CE45	
Acquire skills to verify the proper operation of complex hardware systems.	CG6 CG13	CE39 CE45	
Acquire skills to combine different software tools and hardware platforms.	CG13	CE39 CE45	
Ability to document hardware design projects.	CG4 CG9		CT4

Contents

Topic

Theory: Theme 1. Introduction	- Basic architecture of electronic signal processing systems: signal conditioning, sampling, conversion, and reconstruction.
Theory: Theme 2. Types of signal processing	-Different hardware and software solutions: DSP and FPGAs. -Processing forms: Serial/Parallel, Hardware/Software. -Hardware cost of regular signal processing circuits. Logical resources used. Processing rate.
Theory: Theme 3. Arithmetic in DSP	-Data types. -Data modification: quantification and overflow. -Arithmetic operations and associated circuits. -Associated concepts: critical path, pipeline and latency.
Theory: Theme 4. Siignal conditioning and sampling	- Example of a real system for signal conditioning and sampling using a FPGA-based development board.
Theory: Theme 5. Design and Implementation of Digital Filters	- Implementation of digital filters in FPGA. - Analysis of full parallel and semi-parallel solutions: hardware costs, operation rates.
Theory: Theme 6. Design of audio processing systems	- Examples of audio processing systems. - Analysis of required hardware resources. - Implementation and performance analysis.
Theory: Theme 7. Design of image processing systems	- Examples of basic image processing systems. - Analysis of hardware resources required. - Implementation and performance analysis.
Labs: Design of basic signal processing systems.	- Design, implementation and verification of basic signal processing systems described using VHDL: digital filters, communication applications, image processing, audio processing. - Using the ISE design tool from Xilinx and MATLAB from MathWorks.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Lecturing	14	14	28
Laboratory practical	14	14	28
Project based learning	9	54	63
Problem and/or exercise solving	2	6	8
Project	2	6	8
Laboratory practice	0	14	14

*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	The teacher will present the theoretical ad practical key topics of the subject, as well as the projects to be developed along the course. CG6, CE39 and CE45 competencies will be worked on. It is an individual activity.
Lecturing	The theoretical content of the course and the introductory activities of both the theoretical and practical contents will be presented. CG6, CE39 and CE45 competencies will be worked on. It is an individual activity.
Laboratory practical	The students will implement basic signal processing systems using FPGAs platforms. CG6, CG9, CE39, CE45 and CG13 competencies will be worked on. It is a group activity.

Project based learning	Working groups of two or more students will be established. Each group will develop one project along the course. This projects will address the design of a signal processing system of medium complexity. Additionally, small groups (Groups Type C) will be available allowing monitoring the project to be developed in the course. Activities to be developed in groups C: Activity 1. Description, analysis and discussion of the system designed in the project. Activity 2. Demonstration of the behavior of the designed system. Analysis and discussion of results. CG6, CG9, CE39, C345, CG13, CT2, CG4 and CT4 competencies will be worked on. It is a group activity.

Personalized assistance

Methodologies	Description
Lecturing	The teacher will personally attend student□s doubts and queries related to theoretical contents. Students will have the opportunity to attend to individual or group tutorials, which will be held at the teacher's office following the schedule to be established at the beginning of the course, and to be published at the School of Telecommunications Engineering website.
Laboratory practical	The teacher will personally attend student□s doubts and queries related to laboratory practices and projects. Students will have the opportunity to attend to individual or group tutorials, which will be held at the teacher's office following the schedule to be established at the beginning of the course, and to be published at the School of Telecommunications Engineering website.
Project based learning	The teacher will personally attend student□s doubts and queries related to laboratory practices and projects. Students will have the opportunity to attend to individual or group tutorials, which will be held at the teacher's office following the schedule to be established at the beginning of the course, and to be published at the School of Telecommunications Engineering website. In adition, the projects asigned will be monitoring during the small groups (Groups Type C) activities.

Assessment

	Description	Qualification	Evaluated Competencess		
Problem and/or exercise solving	There will be a short-answer test on the theoretical issues of the course. More information is provided in the "Other Comments" section below. This test will assess competencies CE39 and CE45.	20		CE39 CE45	
Project	The students will develop a project focused on the design of a signal processing system of medium complexity. More information is provided in the "Other Comments" section that follows. This project will assess competencies CG4, CG6, CG9, CG13, CE39, CE45, CT2 and CT4.	45	CG4 CG6 CG9 CG13	CE39 CE45	CT2 CT4
Laboratory practice	Laboratory practices will be evaluated based on the continuously work carried out during the laboratory hours (Type B hours) and on a final report of practices. These practices will assess competencies CG4, CG6, CG13, CE39, CE45 y CT4.	35	CG4 CG6 CG13	CE39 CE45	CT4

Other comments on the Evaluation

According to the guidelines for the degree programme, two evaluation systems will be offered to students: continuous assessment and eventual assessment.

1.- Continuous assessment

The continuous assessment consists of one theoretical test, a set of laboratory practices and one theoretical-practical work (project).

1.1 Theoretical examination (NExam):

The theoretical examination will include all the theoretical contents of the course and will take place at the end of the term.

The weight of this examination will be 2 points out of 10.

1.2 Laboratory practices (NPra):

The laboratory practices will be performed in groups of two or more students. The evaluation of the labs will take in to account both, the work in the laboratory as well as a final report. The weight of this assessment is 3,5 point out of 10.

The work in the laboratory will be individually evaluated and represent the 60% of the score. The remaining 40% correspond to the final report and will be the same for all the members of a working group.

1.3 Theoretical-practical work (NPro):

The theoretical-practical work will be conducted in type B and C hours, in groups of two or more students. As a result of the work a writing report and the implemented system must be delivered and the results will be oral discussed. The weight of this assessment is 4,5 points out of 10 (4 points correspond to the design and documentation tasks and 0,5 points to the discussion one).

To carry out the theoretical-practical work individual and cooperative tasks will be assigned to the students. The weight of the individual work will be the 60% of the maximum score of the project and the weight of the cooperative work will be the 40%. The 40% of the score corresponding the cooperative work will be the same for all the members of a working group.

1.4 Final grade (Final_grade):

The final grade for the continuous assessment correspond to:

Final_grade = (0,2*NExam + 0,35*NPrac + 0,45*NPro) if Nexam, NPrac and NPro are greater or equal to 4 and Final_grade is greater or equal to 5;

Final_grade = min[(0,2*NExam + 0,35*NPrac + 0,45*NPro), 4] in any other case.

The students who fail any of the partial assessments will have the possibility to repeat it/them in the second call. In this case the students would be evaluated only of the part they have not pass (theoretical exam, laboratory practices and/or project). The grade obtained in this evaluation will replace the previous one.

It is understood that the student chooses continuous assessment if he/she conducts the two first laboratory practices. In no case the final grade of a student who opts for continuous assessment may be "Not Submitted".

2.- Eventual assessment and extraordinary call

Students who opt for the eventual assessment or for the extraordinary call must pass two exams, a theoretical one covering all the contents of the subject and a practical exam.

2.1 Theoretical examination (NExam_U):

The theoretical examination would include short answer questions, problems, and/or system design exercises.

2.2 Practical examination (NPra_U):

The practical examination will consist in the final test of a previously designed and simulated system. One week before the date established for the exam the student must submit a writing report of the designed system as well as the simulation results. During the practical exam the student will validate the system designed in the hardware.

Both the theoretical and the practical exam will weigh 50% of the final grade.

2.3 Final grade (Final_grade_U):

The final grade of the eventual assessment and the extraordinary call will correspond to:

Final_grade_U = (0,5*NExam_U + 0,5*NPrac_U) if Nexam_U and NPrac_U are greater or equal to 4 and Final_grade_U is greater or equal to 5;

Final_grade_U = min[(0,5*NExam_U + 0,5*NPrac_U), 4] in any other case.

As in the case of continuous assessment, the students who opt for the eventual assessment will have two opportunities, first call and second call. Those students do not pass the course in the first call will be only evaluated of the part they have not passed (theory and/or practice) in the second call.

3.- Other comments

- The students can use the Spanish, English or Galician to answer the exam and for the reports, works or presentations.
- The grades obtained from the continuous assessment, the eventual assessment or the extraordinary call 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 classroom test or exam. Mobile phones must be turned off and be out of reach of the student.
- In case of plagiarism is detected in any of the reports/tasks/exams done/taken, the final score for the subject will be fail (0) and the teachers will inform the School authorities so that they take the actions that they consider appropriate.
- In case of plagiarism or abandonment of a member of a work group is detected, his/her score will be fail (0) and will not compute for the score of the rest of the group.

Sources of information

Basic Bibliography

U. Meyer-Baese, **Digital signal processing with Field Programmable Gate Arrays**, 3th ed., Springer-Verlag, 2007

James H. McClellan, Ronald W. Schafer, Mark A. Yoder, **Signal processing first**, 1st ed., Pearson Education International, 2003

XUP, University of Strathclyde and Steepest Ascent, **DSP for FPGA Primer**, 2011

Complementary Bibliography

John G. Proakis, Dimitris G. Manolakis, **Digital signal processing**, 4th ed., Pearson Education International, 2007

John G. Proakis, **Tratamiento digital de señales : principios, algoritmos y aplicaciones**, 4ª ed., Prentice Hall, 2007

Recommendations

Subjects that are recommended to be taken simultaneously

Programmable Electronic Circuits/V05G301V01302

Contingency plan

IDENTIFYING DATA				
Engineering of Electronic Equipment				
Subject	Engineering of Electronic Equipment			
Code	V05G300V01523			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Marcos Acevedo, Jorge			
Lecturers	López Sánchez, Óscar Marcos Acevedo, Jorge			
E-mail	acevedo@uvigo.es			
Web	http://faitic.uvigo.es/			
General description	This course shows students the basics concepts about RAMS (Reliability, Availability, Maintainability and Safety) of electronic components and electronic systems, as well as techniques to follow for a study of this type or design a system that meets specifications RAMS. the basics concepts about the sources of electromagnetic interference and their minimization are also discussed.			

Competencies	
Code	
CG1	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.
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.
CG9	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.
CE41	(CE41/SE3):The ability to make the specification, implementation, documenting and tuning of electronic systems and equipment (both instrumentation and control oriented), considering the corresponding technical aspects and the regulations.
CE47	(CE47/SE9): The ability to analyze and solve interference and electromagnetic compatibility problems .
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes		
Learning outcomes		Competences
Knowledge of the applicable standards in the design of electronic systems	CG2	CE41
Ability for the specification of components and electronic systems		CE41 CE47
Knowledge and application of techniques to meet EMC standards		CE47
Knowledge of techniques and tools for the design and manufacture of an electronic system based on dependability specifications	CG2 CG6 CG8	
Ability to design, implement and manage a dependability system	CG1	
Ability to manage the knowledge of the organization	CG9	CT4

Contents	
Topic	
Item 1: Introduction	Definitions. Reliability Basics. RAMS Technologies. Statistical functions. Reliability Management.
Item 2: Reliability of electronic components	Definitions. Parameters (Failure rate, MTBF, MTTF). Reliability prediction of electronic components. Regulations.

Item 3: Reliability of electronic systems	Serie systems. Redundant systems. Reliability allocation. Redundancy optimitation. Srtandards.
Item 4: Maintainability and Availability	Definitions and types of maintenance. Parameters (Repair rate, MTTR). Stocks management. Availability of series and parallel systems. Regulations.
Item 5: Safety	Definitions. Electronic systems for safety applications. Safety level or safety category determination for safety electronic systems. Standards.
Item 6: Reliability tools	Failure mode effects analysis and criticalities (FMECA). Fault Tree (FTA). Markov Models. Standards.
Item 7: Essays	Types and test plans. Accelerated tests. Standards.
Item 8: Electromagnetic Interferences	Definitions. Fundamentals of electromagnetic interferences. Sources of interference. Minimization elements. Standards.
Item 9: Dependability management I	R + D + i. Lifecycle. Continuous improvement: management and assurance. Support tools.
Item 10: Dependability management II	HR and strategic management. Teamwork and improvement systems. Support tools.

Planning

	Class hours	Hours outside the classroom	Total hours
Problem solving	6	12	18
Laboratory practical	8	0	8
Mentored work	0	60	60
Case studies	7	0	7
Lecturing	21	32	53
Presentation	0	4	4

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

Methodologies

	Description
Problem solving	Teaching activities with problems develop, case studies and exercises related to the subject. Also it be used to show existing doubts and also for feedback to teachers. Individual activity. Competencies CG1, CG2, CG6, CE47 and CE41 are used
Laboratory practical	The students learn how to perform reliability calculations by using specific software for this application. Individual activity. Competencies CG2, CE41 and CT4 are used
Mentored work	Sspecific workbs that are related to the content of the subject and in partnership with a company or outside entity. Whenever possible, the student will develop two jobs one of them in collaboration with AENOR and another in collaboration with a company's environment. Group activity. Competencies CG6, CG8, CG9, CE41, CE47 and CT4 are used
Case studies	The groups are conducted with a small number of students and are used for the development of group work and learning methodologies teamwork. Group activity. Competencies CG1, CG2, CE41 and CT4 are used.
Lecturing	It will develop in the schedules fixed by the direction of the engineering school. It consist of a presentation by the teacher, of the contents of the subject. Also proceed to solving examples and / or problems that illustrate the problems to be solved adequately. The student may submit all doubts and questions deemed appropriate, during the session. We will promote the more active participation of the student possible. Group activity. Competencies CG1, CG2, CG6, CG8, CG9, CE41, and CE47 are used.

Personalized assistance

Methodologies	Description
Lecturing	The teacher will personally attend doubts and queries of students, on the study of theoretical, laboratory or projects. Students will have opportunity to attend individual tutorials or in groups in the teacher's office on schedule to be established for this purpose at the beginning of the course and to be published on the page of the subject.
Laboratory practical	The teacher will personally attend doubts and queries of students, on the study of theoretical, laboratory or projects. Students will have opportunity to attend individual tutorials or in groups in the teacher's office on schedule to be established for this purpose at the beginning of the course and to be published on the page of the subject.

Mentored work	The teacher will personally attend doubts and queries of students, on the study of theoretical, laboratory or projects. Students will have opportunity to attend individual tutorials or in groups in the teacher's office on schedule to be established for this purpose at the beginning of the course and to be published on the page of the subject.
Case studies	The teacher will personally attend doubts and queries of students, on the study of theoretical, laboratory or projects. Students will have opportunity to attend individual tutorials or in groups in the teacher's office on schedule to be established for this purpose at the beginning of the course and to be published on the page of the subject.

Assessment

	Description	Qualification	Evaluated Competencess		
Problem solving	Deliverables, problems and exercises will be assess.	30	CG1 CG2 CG6	CE41 CE47	
Laboratory practical	The deliverables of the proposed laboratory practices will be evaluated.	10	CG2	CE41	CT4
Mentored work	They will evaluate the contents (methodology of development, conclusions obtained, exhibition of results, capacity of work in team, capacity of work in multidisciplinary team) in the work in collaboration with the company. Also will take into account the opinion of the tutor in the company. The other work in collaboration with UNE will value the quality of the work realised and the capacity of work in team. For works in team the indivual note will be the same for all members of the team	40	CG6 CG8 CG9	CE41 CE47	CT4
Presentation	The results of the work carried out will be evaluated, as well as the student's ability to answer the questions asked.	20	CG9		CT4

Other comments on the Evaluation

The schedule of the midterm/intermediate exams will be approved in the Comisión Académica de Grado (CAG) and will be available at the beginning of each academic semester.
Following the own guidelines of the degree and the agreements of the academic commission, offers to the students the option of continuous evaluation or only evaluation in the date established by the school.
Students who choose the continuous assessment should inform the instructor during the first two weeks of class.
Continuous assessment involves:
a) The students should do the problems and exercises and it will be delivered to the teacher. Maximun rating 4 ponits (40% of the final grade). The students must obtain a minimum of 2 points. These tasks are not recoverable later.

b) The students should do in group two jobs. One of them in collaboration with UNE and students of the Faculty of Philology and Translation, and another in collaboration, with a company´s environment, to whose installations will go the students when it was necessary. Maximum rating 6 points (60% of the final grade). The students must obtain a minimum of 3 points.

Students do not exceed any of the two minimum requirements, the rating will be the lower of the average grade of the two scores and 4.5 points.

Students working in groups will have the same grade.

The eventual assessment by the first call or second call or extraordinary call, involves:

a) That the students perform and deliver on exam day, the exercises and problems posed in the subject, which is referred to in paragraph a) above. Maximum rating 4 points (40% of the final mark). The students must obtain a minimum of 2 points.

b)That the students to take an exam with questions and problems 2h corresponding to both the theoretical and laboratory. Maximum rating 6 points (60% of the final grade). The students must obtain a minimum of 3 points.

Students in the eventual assessment do not exceed any of the two minimum requirements, the rating will be the lower of the average grade of the two scores and 4.5 points.

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

Sources of information

Basic Bibliography

T.I. Bajenescu, M.I. Bâzu, **Reliability of Electronic Components**, Springer-Verlag, 1999

P. Kales, **Reliability**, Prentice-Hall, 1998
David J. Smith, **Reliability, Maintainability and Risk**, 8ª, Butterworth Heinemann, 2011
Kececioglu, Dimitri, **Reliability Engineering Handbook**, DEStech, 2002
Antonio Creus Solé, **Fiabilidad y seguridad: Su aplicación en procesos industriales**, Marcombo, 2005
J. Balcells, F. Daura, R. Esparza e R. Pallás, **Interferencias Electromagnéticas en Sistemas Electrónicos**, Marcombo, 1991
Milton Ohring, **Reliability and Failure of Electronic Materials and Devices**, 2ª, Elsevier, 2015

Complementary Bibliography

ISO, **UNE-EN ISO 9000:2005: Sistemas de gestión de la calidad. Fundamentos y vocabulario.**, AENOR, 2005
ISO, **UNE-ISO 55000:2015: Gestión de activos. Aspectos generales, principios y terminología.**, AENOR, 2015
I. Fernández, A. Camacho, C. Gasco, A.M. Macías, M.A. Martín, G. Reyes, J. Rivas, **Seguridad Funcional en Instalaciones de Proceso: Sistemas Instrumentados de Seguridad y Análisis SIL**, ISA, 2012
Cherry Bhargava, **AI Techniques for Reliability Prediction for Electronic Components**, 1ª, IGI Global, 2020

Recommendations

Subjects that are recommended to be taken simultaneously

Data Acquisition Systems/V05G301V01314

Subjects that it is recommended to have taken before

Digital electronics/V05G301V01203
Physics: Fundamentals of electronics/V05G301V01201
Electronic technology/V05G301V01206

Contingency plan

Description

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained
All methodologies are maintained except for the practices of the laboratory. The other methodologies carried out in remote.

* Teaching methodologies modified
The practices of the laboratory will see modified of the following form: Of the 7 planned practices, 5 could be made of remote form since they base in the utilization of a PC and specific software. Of the two programs of specific software used, one of them could them happen to the students so that they install it and use in his own computers and for the another, if it is not possible we would look for an alternative so that the students can use it also in the remote. The other two practices would do in the remote. The professor shows by means of a video the operation of the place of work and of his equipment takes the measures and the students treat said information and elaborate the corresponding memory.

* Non-attendance mechanisms for student attention (tutoring)
The attention of the students would make in remote by videoconference, email, and telephone.

* Modifications (if applicable) of the contents
There are no changes

* Additional bibliography to facilitate self-learning
There are no changes. It will follow using the included bibliography in point 8, in addition to the additional documentation that is in FAITIC, although it is likely that includes some additional articles.

* Other modifications
There are not more modifications

=== ADAPTATION OF THE TESTS ===
The continuous evaluation will follow the same criteria of previous courses since it bases on the realization of tasks and works, so much individual as in a group. In addition to the realization of the practices of the laboratory. In the case of online tuition, then the presentation of the works will be in a remote.

If some student opts by the only evaluation, so much in first as in the second opportunity, the evaluation neither changes, excepting that the examination will be made also in the remote.

IDENTIFYING DATA				
Fundamentals of Acoustics Engineering				
Subject	Fundamentals of Acoustics Engineering			
Code	V05G300V01531			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Torío Gómez, Pablo			
Lecturers	Torío Gómez, Pablo			
E-mail	ptorio@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Concepts covered by the subject: vibratory systems related to the acoustic wave equation, radiation and propagation, mechanisms of acoustic-mechanical-electrical transduction, behaviour and design of speakers and microphones.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG9	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.
CG11	CG11 To approach a new problem considering first the essential and then the secondary aspects
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.
CE37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes		
Learning outcomes	Competences	
* Understand the basic mechanisms of vibration of distinct elements and interpret his relation with the production of sound. * Know the bases of the linear acoustics and understand the concepts of pressure, speed of particle, intensity, power and impedance. * Understand the phenomena of propagation of the sound and to analyse the influence of the medium. * Understand the phenomenon of the radiation of acoustic waves. * Understand the basic mechanisms of the *transducción mechanical-acoustic.	CG3 CG11	CE34 CE37
* Analyse electro-mechanical-acoustic systems by the use of analogies which are based on circuit theory. * Design acoustic systems by using speakers, acoustic boxes and horns. * Analyse different types of microphones from the point of view of their technical specifications and their possible applications.	CG3 CG5 CG11	CE34 CE37

* Interpret technical specifications within working teams. * Apply norms of measuring. * Elaborate trial procedures. * Develop trial procedures. * Process data obtained from trials * Program processing algorithms. * Value technical results. * Write trial reports.	CG6 CG9 CG11	CE34 CE37
* Cooperate and collaborate in working groups to carry out technical projects. * Adapt to new surroundings. * Accept the role allocation in a group. * Contribute to the resolution of conflicts.		CT3 CT4

Contents

Topic	
1. Sound power measurement tests.	Acoustic variables. Sound field. Propagation. Uses of intensity and power. Sound intensity probes. Power measurement standards using acoustic pressure or intensity.
2. Models of radiation sources.	Directivity. Acoustic impedance. Monopole. Dipole. Monopole on infinite baffle. Baffled circular piston. Directivity measurement standards.
3. Vibrating systems.	Damped and forced oscillatory motion. Vibration of strings, bars, membranes and plates. The sound in tubes. Sound sources. Acoustic filters.
4. Specifications and measurement of electroacoustic systems.	Introduction to loudspeakers: baffles and crossovers. Acoustic measurement tests: measurement of speakers. Measurement of noise and nonlinear distortion.
5.Analogies and transduction.	Electro-mechano-acoustic systems. Equivalent circuits. Transduction
6. Speakers, horns and cabinets.	Equivalent model of an infinite baffle loudspeaker. Equivalent model of a cabinet with speaker. Horns.
7. Cabinet design.	Techniques and design criteria of acoustic boxes
8. Microphones.	A microphone equivalent model. Tank circuits.
9. Submarine acoustics and ultrasounds	Submarine acoustics. Ultrasounds

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	19	38	57
Autonomous problem solving	0	44	44
Practices through ICT	13	0	13
Laboratory practical	6	6	12
Problem solving	0	20	20
Problem and/or exercise solving	2	0	2
Objective questions exam	1	0	1
Problem and/or exercise solving	1	0	1

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

Methodologies

	Description
Lecturing	Oral speech, promoting the critical discussion of the concepts. Theoretical bases of algorithms and procedures used to solve problems are presented. CG3, CG5, CG11, CE34, CE37.
Autonomous problem solving	Individual resolution of exercises as a practical application of the theoretical bases and procedures described in the master sessions. Given a specific situation, the student has to obtain the suitable solution, in a reasoned way, by properly choosing the appropriate formulas and coming to a valid solution. CG3, CG5, CG11, CE34, CE37.
Practices through ICT	Handle and adjustment of tools of analysis and algorithms, in group, identifying which is appropriate for a given situation. CG3, CG5, CG6, CG9, CG11, CE34, CE37, CT3, CT4.
Laboratory practical	Cooperative and collaborative work with measuring equipment in reduced groups, and registering of acoustic magnitudes, in laboratoy environments. CG3, CG5, CG6, CG9, CG11, CE34, CE37, CT3, CT4.
Problem solving	Given a certain situation, students individually should obtain the reasoned suitable solution, properly choosing the applicable formulas and arriving to a valid solution. CG3, CG5, CG6, CG11, CE34, CE37.

Personalized assistance

Methodologies	Description
Lecturing	Doubts may be solved in the tutorial classes. These will take place in the following way: - Individually or in small groups (typically with a maximum of 2-3 people). - Unless the contrary is specified, previous appointment with the professor will be required. The appointment will be requested and acknoledged by email. Place and time will preferrably be as officially scheduled.
Practices through ICT	Doubts may be solved in the tutorial classes. These will take place in the following way: - Individually or in small groups (typically with a maximum of 2-3 people). - Unless the contrary is specified, previous appointment with the professor will be required. The appointment will be requested and acknoledged by email. Place and time will preferrably be as officially scheduled.
Problem solving	Doubts may be solved in the tutorial classes. These will take place in the following way: - Individually or in small groups (typically with a maximum of 2-3 people). - Unless the contrary is specified, previous appointment with the professor will be required. The appointment will be requested and acknoledged by email. Place and time will preferrably be as officially scheduled.
Autonomous problem solving	Doubts may be solved in the tutorial classes. These will take place in the following way: - Individually or in small groups (typically with a maximum of 2-3 people). - Unless the contrary is specified, previous appointment with the professor will be required. The appointment will be requested and acknoledged by email. Place and time will preferrably be as officially scheduled.
Laboratory practical	Doubts may be solved in the tutorial classes. These will take place in the following way: - Individually or in small groups (typically with a maximum of 2-3 people). - Unless the contrary is specified, previous appointment with the professor will be required. The appointment will be requested and acknoledged by email. Place and time will preferrably be as officially scheduled.

Assessment

	Description	Qualification	Evaluated Competencess		
Practices through ICT	Assessment of the reports describing the results obtained in the computer classroom.	4	CG3 CG5 CG6 CG9 CG11	CE34 CE37	CT3 CT4
Laboratory practical	Exam on the preliminary preparation of the laboratory practices	6	CG3 CG5 CG6 CG9 CG11	CE34 CE37	CT3 CT4
Problem and/or exercise solving	Written exam, with brief questions and problems.	50	CG3 CG5 CG11	CE34 CE37	
Objective questions exam	Exam on the work done in the computer classroom.	16	CG3 CG5 CG6 CG11	CE34 CE37	
Problem and/or exercise solving	Exam on the interpretation exercises of the laboratory practices.	24	CG3 CG5 CG6 CG11	CE34 CE37	

Other comments on the Evaluation

Following the guidelines of the studies, two assessment systems will be offered to the students inscribed on this subject:

Continuous assessment (the preferred method, academic activities are linked to this system) and exam-only assessment (not recommended).

*** Students who choose continuous assessment:**

Students will follow the continuous assessment system if they sign a document that will be delivered and collected when the collaborative work begins.

Weighing:

* Short answer tests of magister sessions. At the official date. Individual assesment.

* Practices in computer rooms. The assessment will be done twofold: Reports describing the results obtained in the computer classroom, assessed in flexible groups of two, and short answer tests, with individual assesment.

* Laboratory practices. The assessment will be done twofold: Practice preparation, with exam at the same session, assessed in small groups, and practice interpretation, at the last session, with individual assesment. Attendance to these laboratory practices is considered as compulsory.

When group assessment, all group components will obtain the same mark, provided that their contribution in the compulsory attendance sessions is reasonably similar, according to professor's judgement.

To ensure that all competencies are acquired, it will be necessary to jointly fulfill these two conditions to pass:

1) To obtain a grade equal to or greater than 4 (on a scale of 0 to 10), in the set of activities of each type.

2) To obtain an overall mark, calculated as the sum of the scores of activities weighted correspondingly, equal to or greater than 5 (on a scale of 0 to 10)

In the event that only condition 2) is fulfilled, and not condition 1), the global mark in the subject will be 4.

Missed quizzes and/or lab classes will not be rescheduled.

*** Students who choose for exam-only assessment:**

The possibility of a final examination will be provided to students who do not opt for the continuous assessment. This final exam will cover all the activities of the subject.

Weighing:

* Magister sessions. Individual assesment. (weight: 50%)

* Practises in computer rooms. Individual assesment. (weight: 20%)

* Laboratory practises. Individual assesment. (weight: 30%)

To ensure that all competencies are acquired, it will be necessary to jointly fulfill these two conditions:

1) To obtain a grade equal to or greater than 4 (on a scale of 0 to 10), in each of the sections in which the test is divided.

2) To obtain an overall grade in the examination equal to or greater than 5 (on a scale of 0 to 10).

SECOND CALL

Two different situations:

=> Students that are evaluated using continuous assessment:

Two options to choose (just before the exam begins):

* To perform again the written part of the exams on the official date assigned by the Center and be evaluated as stated in the above section Students who choose continuous assessment.

* To be evaluated with the same final exam as stated in the above section Students who choose for exam-only assessment.

=> Students who choose for exam-only assessment:

A final examination will be provided to students who do not opt for the continuous assessment. This final exam will be assessed as stated in the above section Students who choose for exam-only assessment.

END OF PROGRAM CALL

End of program calls will be assessed as stated in the above section Students who choose for exam-only assessment.

In the event of copycatting at any proof or work, the final assessment will be FAIL (0) and the event will be communicated to the Centre headmaster in order to conduct appropriate measures.

Sources of information
Basic Bibliography
Basilio Pueo Ortega, Miguel Romá Romero, **Electroacústica : altavoces y micrófonos**,
W. Marshall Leach, Jr., **Introduction to electroacoustics and audio amplifier design**,
Finn Jacobsen et al., **FUNDAMENTALS OF ACOUSTICS AND NOISE CONTROL**,
Complementary Bibliography
Lawrence E. Kinsler, **Fundamentals of acoustics**,
Vance Dickason, **Loudspeaker Design Cookbook**,

Recommendations

Subjects that continue the syllabus

Room Acoustics/V05G300V01635
Audiovisual Technology/V05G300V01631

Subjects that are recommended to be taken simultaneously

Audio Systems/V05G300V01532

Contingency plan

Description

=== ADAPTATION OF THE METHODOLOGIES ===
In the event that teaching cannot be in person, on-site sessions will be substituted by remote sessions and by the resolution of exercises.

=== ADAPTATION OF THE TESTS ===
In the event that assessing cannot be in person, it will be carried out remotely, either by oral exams or by written exams. If required, assessing will be complemented by homeworking or home resolution of exercises.

IDENTIFYING DATA				
Audio Systems				
Subject	Audio Systems			
Code	V05G300V01532			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Pena Giménez, Antonio			
Lecturers	Pena Giménez, Antonio			
E-mail	apena@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Interactive systems are discussed, from human perception to user experience and user interfaces, considering audiovisual quality. Interactive sound mixing is revised in comparison to traditional linear sound mixing. A project using a game engine is developed.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG9	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.
CG12	CG12 The development of discussion ability about technical subjects
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.
CE37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	
Learning outcomes	Competences

Results of learning (SI1.2): -> Describe sound and image human perception using Physiology and Psychology of Perception. Understand the concept 'quality' in a given audio/image application -> Understand which aspects influence audiovisual quality. -> Understand the basics of spatial audition and vision. -> Know and understand the operation of dynamic range processors and its application in a chain of audio systems. -> Apply equalization techniques and other processes. -> Schedule and carry out a mixture of sounds from the technical point of view, either a linear mix or an event-driven mix in interactive environments. -> Know and understand which properties an user interface must hold, specially related to sound and image. -> Design and develop a virtual environment using a game engine.	CG3 CG5 CG6 CG12	CE34	CT3
Results of learning Organize a working group to carry out a project, including the following: -> technical ability to collect information, interpret technical specifications, discuss several options and select a combination of audio systems. -> Write progress reports, minutes of meetings and a final technical report . -> Technical meetings, discussion of partial results and oral presentation of the final work in front of a demanding audience. -> Adaptation to new environments , internal management roles in the group and dispute resolution. -> Internalize the importance of the human relationship with the client , preserving a fluent contact.	CG9 CG12	CE37	CT3 CT4

Contents

Topic	
Virtual environment in a graphic engine.	Graphic engine management. C# programming.
Dynamic range and processes.	Dynamic range. Compressors and expansors. Filtering. Effects.
Mixture of sounds.	Lineal mixture of sounds. Event-controlled sound mixture for interactive systems.
Audiovisual quality.	Quality of sound and image systems. Audiovisual quality
Perception.	Sound and image human perception systems. Hearing and vision in three-dimensional environments.
User interface and User eXperience (UX).	User interface (UI). User eXperience (UX).

Planning

	Class hours	Hours outside the classroom	Total hours
Practices through ICT	14	10.5	24.5
Studies excursion	0	7	7
Project based learning	7	52.5	59.5
Flipped Learning	0	10	10
Lecturing	19	24	43
Problem and/or exercise solving	2	0	2
Objective questions exam	0	4	4

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

Methodologies

	Description

Practices through ICT	Handle and adjustment of tools of analysis and algorithms, identifying which is appropriate for a given situation. Through this methodology, competencies CT3, CG3 and CE34 are developed.
Studies excursion	Visits to places where the concepts discussed are applied (radio studio, recording studio, etc.). Due to availability and funding. Through this methodology, competency CE34 is developed.
Project based learning	Collaborative work in reduced groups. A complex design with a regular monitoring agenda. Role assignments, working in common, planning, technical reports and oral presentation. Through this methodology, competencies CT3, CT4, CG3, CG12, CG5, CG6, CG9, CE34, CE35 and CE37 are developed.
Flipped Learning	Written and/or audiovisual material is provided to study and prepare an online test. This activity is prior to the master class or practice in computer rooms where doubts will be resolved and challenges will arise. Through this methodology, competencies CG3 and CE35 are developed.
Lecturing	Oral speech, promoting the critical discussion of the concepts. Theoretical bases of algorithms and procedures used to solve problems are presented. Through this methodology, competencies CT3, CG3, CG12, CE34, CE35 and CE37 are developed.

Personalized assistance

Methodologies	Description
Lecturing	Tutoring to solve issues related to master sessions or lab practice is implemented: -> Individually or -> in reduced groups (no more than 2-3 students). E-mail confirmation to match the date of the appointment is needed.
Practices through ICT	Tutoring to solve issues related to master sessions or lab practice is implemented: -> Individually or -> in reduced groups (no more than 2-3 students). E-mail confirmation to match the date of the appointment is needed.
Project based learning	During group projects an individualized tracking of the student is developed. Cross-avaliation within the group and autoavaliation may be used.

Assessment

	Description	Qualification	Evaluated Competencess		
Practices through ICT	Work assessment in the computer room.	10	CG3	CE34	CT3
Project based learning	Assessment of a collaborative work, developed along the semester, including a written report and oral presentation.	45	CG3 CG5 CG6 CG9 CG12	CE37	CT3 CT4
Problem and/or exercise solving	Written test with short questions and problems to solve.	35	CG3 CG12	CE34	
Objective questions exam	Automatic corrected online test.	10	CG3		

Other comments on the Evaluation

Following the guidelines of the studies, two evaluation systems will be offered to the students inscribed on this subject: continuous assessment (the preferred method, academic activities are linked to this system) and exam-only assessment (not recommended).

*** "Students who choose continuous assessment" conditions:**

A student follows the continuous assessment system if she/he assigns a document that will be delivered and collected during weeks 1-3, so the collaborative work can begin.

If a student has participated in continuous assessment and does not pass the course he/she will receive a grade of fail, regardless of he/she takes the written exam or not.

BONUS SYSTEM (used or not depending on the number of students)

* Group: a weekly score of the groups is publicly published. * Individual: a monthly score of the students is privately published.

Up to a maximum of 1.5 points may be added to the final group mark.In no case, this bonus is negative.Details will be given at the beginning of the course.

CONDITIONS TO PASS THE SUBJECT

Once bonus points are added, in order to ensure that students acquire a balanced minimum on the subject competences, they will pass the course if they meet these three conditions:

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

2) a score equal to or greater than 4 (on the same scale) in the written exam mark,

3) and a score equal to or greater than 5 (on the same scale) both in the collaborative group mark and in the work assessment in the computer room.

If some of these conditions are not fulfilled, then the final grade (on a ten-points scale) will be the minimum between the final mark and the value "4".
Time planning of intermediate evaluation exams will be approved by the Comisión Académica de Grado (CAG) and will be available at the beginning of the semester.
*** "Students who choose for exam-only assessment" conditions:**
The possibility of a final examination will be provided to students who do not opt for the continuous assessment.
In order to ensure that students acquire a balanced minimum on the subject competences, they will pass the course if they meet both 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 4 (on the same scale) in each of the sections of the exam. These sections, respectively, correspond with:
* contents included in all activities* project developed in group, including group internals, management, writing of technical reports and oral presentations.
If some of these conditions are not fulfilled, then the final grade (on a ten-points scale) will be the minimum between the final mark and the value "4".

--- SECOND CALL

Two different situations:
=> Students that are evaluated using continuous assessment:
Two options to choose (just before the exam begins):
* repeat the written exam included in the continuous assessment planning an be evaluated under the "Students who choose continuous assessment" conditions, described above.
* be evaluated with the same final exam of students who choose for exam-only assessment, under the "Students who choose for exam-only assessment" evaluation conditions, described above. No other activities are considered.
=> Students who choose for exam-only assessment:
A final examination will be provided to students who do not opt for the continuous assessment, and are evaluated under the "Students who choose for exam-only assessment" conditions, described above. No other activities are considered.

Sources of information

Basic Bibliography

Bruce and Jenny Bartlett, **Practical recording techniques**, Ed. 7, Focal press, 2016

Dieter Schmalstieg and Tobias Hollerer, **Augmented Reality: Principles and Practice (Usability)**, Ed. 1, Addison-Wesley Professional, 2016

Complementary Bibliography

Francis Rumsey and Tim McCormick, **Sound and recording**, Ed. 7, Focal press, 2014

Unity Technologies,

George Mather, **Foundations of Sensation and Perception**, Ed. 3, Psychology Press, 2016

Recommendations

Subjects that continue the syllabus

Multimedia technology and computer graphics/V05G300V01932

Subjects that are recommended to be taken simultaneously

Design of audiovisual installations/V05G301V01334

Subjects that it is recommended to have taken before

Programming II/V05G301V01110
Fundamentals of Sound and Image/V05G301V01209

Contingency plan

Description

* If circumstances force online teaching in A, B and C groups
Sessions will take place in a syncronous way using the Campus Remoto platform of Universidade de Vigo.

* If circumstances force online evaluation
The written exam will take place in a synchronous way, either by delivering a scanned copy of the student□s answers or

using an oral exam. The rest of the assessment tasks will be managed online too.
The Campus Remoto platform of Universidade de Vigo will be used.

IDENTIFYING DATA				
Video and Television				
Subject	Video and Television			
Code	V05G300V01533			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Martín Rodríguez, Fernando			
Lecturers	Martín Rodríguez, Fernando			
E-mail	fmartin@uvigo.es			
Web	http://faitic.uvigo.es			
General description	(*)(*) This subject develops nowadays available video technology: video saving on magnetic and/or optic media, digital television over different transmission media (terrestrial, satellite, cable and IP) and television networks. We assume knowledge of basic image and video formats that were studied in the prerequisite FSI (Fundamentos de Son e Imaxe, compulsory in the second year). English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.
CE35	CE35/SI2 The ability to analyze, specify, carry out and maintain systems, equipments, heads and installations of TV, audio and video for mobile and fixed environments.

Learning outcomes		
Learning outcomes		Competences
Chossing appropriate saving formats for each need. Choosing appropriate equipment to work with such formats (C1).	CG5	CE34 CE35
Designing and implementing interactive TV projects (C2).	CG6	CE34 CE35
Making the necessary calculations for design and implementation of TV networks of all different kinds (C3).	CG5	CE34 CE35
Writing intra-building video distribution projects and monitoring their installation process. Testing and correcting problems in existing systems (C4).	CG6	CE34 CE35

Contents	
Topic	
Still image & video formar revision.	JPEG (review). H.261 & MPEG (review). Intra-Frame video formats. File formats, multimedia containers (AVI). Magnetic tape formats. Optical formats.
Televisión Digital.	DVB Standard: Digital Video Broadcasting. DVB transmission media: DVB-T, DVB-S, DVB-C. IPTV (Television over IP). Digital Interactive TV (MHP standard). Fundamentals of 3D TV (Coding and Transmission).

Redes de TV.	TV Broadcasting. Satellite TV. Terrestrial networks: emitters, re-emitters, gap-fillers. Cable networks: HFC, FTTB, FTTH. Intra-building networks (residential buildings, hotels, other...).
Practical content 1.	Practical work on coding/formats.
Practical content 2.	Practical work on TV nets.
Lab content 3.	Desing of an intra-building TV network for a real example.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	21	42	63
Practices through ICT	12	9	21
Mentored work	7	49.5	56.5
Objective questions exam	0	1.5	1.5
Report of practices, practicum and external practices	0	6	6
Essay questions exam	2	0	2

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

Methodologies

	Description
Lecturing	Professor makes presentation of contents, encouraging critical discussion. Algorithm and procedures teoretical basis are exposed. Related competencies: CG5, CG6, CE34, CE35.
Practices through ICT	Small projects are suggested. Students must obtain well founded solutuions, choosing appropriate methods and coming to a valid solution. Related competencies: CG5, CG6, CE34, CE35.
Mentored work	Lab projects are checked in individual or small group interviews. Professor suggests a qualification (the one the presented work derserves). Possible improvement actions are discussed. Related competencies: CG5, CG6, CE34, CE35.

Personalized assistance

Methodologies	Description
Lecturing	Query and answer in the classroom and, if necessary, at the office.
Practices through ICT	Query and answer in the classroom and, if necessary, at the office (previous appointment). Help via e-mail.
Mentored work	Query and answer at the office (with previous appointment). Help via e-mail.

Assessment

	Description	Qualification	Evaluated Competencess	
Mentored work	This consists of small projects proposed in the lab clases (B group). Such works start at B group but are monitored in C group. In such meetings, work state will be analyzed included a qualification (achieved up to the moment). Improvements will be suggested and they could be implemented in B group or via non presential work.	0	CG5 CG6	CE34 CE35
Objective questions exam	Multiple choice tests, performed online via faitic platform. On finishing each theme, professor will announce the dates to take the online test. Each test will deserve a maximum of 0.5 points of the final qualification.	15	CG5 CG6	CE34 CE35
Report of practices, practicum and external practices	They are the final version of tutored jobs. Reports are submitted at course ending. Altough we show here the complete qualification, this 25% is due to the work performed in this section and also in the section above. Team work (in pairs). Both students achieve the same qualification.	25	CG5 CG6	CE34 CE35
Essay questions exam	Final written exam in time and place according to school official scheduling.	60	CG5 CG6	CE34 CE35

Other comments on the Evaluation

Student can decide wether he wants to be evaluated via final exam (single assesment) or with continuous assesment (the procedure described above). Students must indicate their decision writing it on the final exam. If he chooses the final exam option (final exam is 100% of the qualification), he will be required to answer extra questions or to solve extra exercises (having extra time available).

In the second call, students will be ask the same question (choosing between continuous evaluation and final exam) but with

the following considerations:

- The qualification from test and lab reports is the same of the first call.

- That qualification is only valid within the present academic year.

End of Program Call: in this exam call, we will proceed as in the case of students that have not fulfilled the continuous assesment process.

In case of detecting any kind of plagiarism in any of the tests (short tests, partial and final exams, lab. reports), the qualification will be FAIL (0) and this fact will be communicated to the school regents for taking the appropriate actions.

Sources of information

Basic Bibliography

Ulrich Reimers, **DVB: the family of international standards for digital video broadcasting**, Springer, 2005

José Luis Fernández Carnero, Antonio Suárez Perdigón, **Televisión y radio analógica y digital : sistemas para la recepción y distribución de las comunicaciones y los servicios en edificios y viviendas**, Televés, 2004

Complementary Bibliography

Tomás Perales Benito, **Radio y Televisión Digitales: Tecnología de los Sistemas DAB, DVB, IBUC y ATSC**, Creaciones Copyright, 2005

Mark Massel, **Digital Television: Dvb-T Cofdm And Atsc 8-Vsb**, Digitaltvbooks.com, 2008

Walter Fischer, **Digital Television: A Practical Guide for Engineers (Signals and Communication Technology)**, 1, Springer, 2013

Recommendations

Subjects that are recommended to be taken simultaneously

Audiovisual Technology/V05G300V01631

Contingency plan

Description

In the event that teaching cannot be in person, the activities would be carried out remotely:

GROUP A:
- Group A classes using the virtual campus.

GROUP B & C:
- Group B and C activities would focus on student work and tutoring meetings through the virtual campus.

ASSESSMENT:
- Online tests are already performed remotely (using faitic).
- The submission of group B and C works is already done remotely (using faitic as a document delivery place).
- The final evaluation test is DESIRABLE to be done in person but it can be done online combining faitic and virtual campus.

IDENTIFYING DATA				
Operating Systems				
Subject	Operating Systems			
Code	V05G300V01541			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Pazos Arias, José Juan			
Lecturers	Pazos Arias, José Juan Ramos Cabrer, Manuel			
E-mail	jose@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The aim of this subject is that the student was able to learn the foundations of the current operating systems and to comprise its importance inside the architecture of a computer.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG9	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.
CE33	CE33/TEL7 The ability to program network and distributed applications and services.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	Competences		
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	CG3		CT3
Knowledge of the main concepts and the principles of design of the operating systems.	CG3		CT3
Ability to identify the components of an operating system, recognise its functions and the interrelationships between them.	CG3		CT3
Knowledge of the lastest advances and tendencies related with operating systems	CG3		CT3
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.	CG4		CT2
Acquisition of basic skills for the configuration and the utilisation of operating system services.	CG9	CE33	CT4
Manage and know the operative associated to the administration of current operating systems.	CG3		CT3

Contents	
Topic	
Introduction and general perspective of the Operating systems	• Concept of operating system. • Structure of an operating system. • Types of operating systems. • Emulation and virtualization.
Processor management.	• Concept of process and thread. • Strategies of allocation of capacity of computation.

Memory management.	• Strategies of contiguous allocation. • Concepts of fragmentation, protection, compactation, relocation and sharing of memory. • Strategies of non-conriguous allocation: paging, segmentation and hybrid methods. • Virtual memory.
Permanent storage of the information.	• Functions of a file system. Concepts of file and directory. • Interface with the file system. • File sharing. • File Protection. • File system implementation. • Free space management. • Methods for allocation of space to files.
Input/Output (I/O) management.	• I/O Controllers. • I/O Interfaces. • Secondary and tertiary storage. • Disk scheduling. • Management of disk. • Replication and consistency of the information. RAID and RAIN technologies.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	20	46	66
Practices through ICT	13	26	39
Workshops	5	30	35
Problem and/or exercise solving	1	0	1
Laboratory practice	1	0	1
Essay	2	6	8

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

Methodologies

	Description
Lecturing	Presentation of the ideas, concepts, technics and algorithms of each lesson. This activity develops the CG3, CG4, CT2 and CT3 competencies.
Practices through ICT	The students will resolve under the supervision of the professors practical problems that pose in each session of laboratory. This activity develops the CG4, CT2 and CE33 competencies.
Workshops	Each group of students will tackle the design and implementation of a software project with half complexity. This task will be realised in successive steps, that will be discussed and validated in each one of the face-to-face sessions. The aim of this methodology of work is to provide a suitable feedback to improve the proposed solutions. This activity develops the CG4, CG9, CT2 and CT4 competencies.

Personalized assistance

Methodologies	Description
Practices through ICT	The professor will be present during the realisation of the practices, answering all the doubts that can arise to the students.
Workshops	The professor will be present during the realisation of the workshops, answering all the doubts that can arise to the students.
Lecturing	During the development of the master sessions, the students will be able to interrupt and formulate all the questions or doubts that can arise them.

Assessment

	Description	Qualification	Evaluated Competencess		
Problem and/or exercise solving	Proof of theoretical contents exposed in the master classes.	60	CG3 CG4		CT2 CT3
Laboratory practice	Validation of the work realised in the sessions of laboratory.	20	CG4	CE33	CT2

Essay	In the last face-to-face session of workshop, students will deliver and will expose to their mates the design and the proposed solution for their project. This solution will be exposed to debate for students and professors. The professor will do questions to each member of the group, what will allow his individual evaluation.	20	CG4 CG9	CT2 CT4

Other comments on the Evaluation

The subject can be surpassed by means of Continuous Evaluation according to the following criteria, having opened the possibility to opt by the No Continuous Evaluation anytime until the beginning of the final examination to celebrate the day fixed to such effect in the official calendar of the EET. All those students that opt by the continuous evaluation will consider presented if they evaluate of the part of the work in Workshops.

Continuous evaluation:

The final note will result of the sum of the corresponding notes to the three following components:

1. Three proofs of type short answer quesrtions to evaluate the contents given in the masterclasses. Each proof will take place in one of the master classes , except the last that will realise in one of the sessions of the Workshop.

Punctuation: Up to 2 points each proof. (T=t1+t2+t3)

2. One Practical Proof that will realise at the last session of laboratory.

Punctuation: Up to 2 points. (L)

3. Presentation of the Project proposed like work in the sessions of the Workshop.

Punctuation: Up to 2 points. (P)

To pass the subject by Continuous Evaluation will have to give the three following conditions: (i) obtain an equal or upper qualification to 2 points in the group of the tests.; (ii) Upper qualification to 0,75 points in the practical proof; and (iii) to attend all the face-to-face sessions and obtain more than 0 points in the presentation of the project. In the case to fulfil the three previous conditions, the final mark of the continuous evaluation will be the sum of the three components (Mark=T+L+P). If the student does not fulfil any of the three conditions, the mark of the continuous evaluation will be the minimum of the marks obtained in each one of the three components.

No Continuous Evaluation:

By means of an examination on 10 points scheduled in the official calendar of the EET.

Second Opportunity and Extraordinary Evaluation:

It will be governed by the indicated for the No Continuous evaluation.

Sources of information

Basic Bibliography

Abraham Silberschatz, Greg Gagne y Peter B. Galvin, **Operating System Concepts**, 10, Wiley, 2018

Robert Love, **Linux Kernel Development**, 3, Addison-Wesley Professional, 2010

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Jesús Carretero, Felix García, Pedro de Miguel y Fernando Pérez, **Sistemas Operativos: Una Visión Aplicada**, 2, McGraw Hill, 2007

Ralf Steinmetz y Klara Nahrstedt, **Multimedia Systems**, 1, Springer, 2004

Frederic Magoules , Jie Pan, Kiat-An Tan y Abhinit Kumar, **Introduction to Grid Computing**, 1, CRC Press, 2009

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Andrew S. Tanenbaum, **Modern Operating Systems**, 4, Prentice Hall, 2014

Daniel P. Bovet y Marco Cesati, **Understanding the Linux Kernel**, 3, O'Reilly Media, 2005

Wolfgang Mauerer, **Professional Linux Kernel Architecture (Wrox Programmer to Programmer)**, 1, Wrox, 2008

Recommendations

Subjects that continue the syllabus

Distributed and Concurrent Programming/V05G300V01641
Information Systems/V05G300V01644

Subjects that are recommended to be taken simultaneously

Network Security/V05G300V01543

Subjects that it is recommended to have taken before

Informatics: Computer Architecture/V05G301V01109
Programming I/V05G301V01105
Programming II/V05G301V01110

Contingency plan

Description

In the case that it is decided that the teaching is exclusively non-face-to-face, the classes of this subject will be developed in a similar way, but using the telematic platforms provided by the University.

Synchronous virtual classes will be taught weekly through the Campus Remoto tool, both in the theoretical sessions and in the practical sessions. In this second case, students will develop and test the software using their personal computers.

The means enabled for the resolution of the doubts raised by the students will include online consultation forums and tutorials in the teacher's virtual office.

The non-face-to-face assessment of the subject will be governed by the conditions described in the teaching guide for the face-to-face teaching modality, including the same number of tests, identical weighting and minimum grades. The theoretical and practical exams will be carried out virtually, using the platforms provided by the University.

IDENTIFYING DATA				
Data Networks: Technology and Architecture				
Subject	Data Networks: Technology and Architecture			
Code	V05G300V01542			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Rodríguez Pérez, Miguel			
Lecturers	Rodríguez Pérez, Miguel Rodríguez Rubio, Raúl Fernando			
E-mail	miguel@det.uvigo.gal			
Web	http://faitic.uvigo.es			
General description	The objective of this subject is to teach our students the technical basics that govern the modern computer networks, regarding topics like new switching paradigms, new access technologies or data transport with quality of service. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG1	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.
CG4	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CE30	CE30/TEL4 The ability to describe, program, assess and optimize communication protocols and interfaces at different network architecture layers .
CE32	CE32/TEL6 The ability to design networks and service architectures.
CT2	CT2 Understanding Engineering within a framework of sustainable development.

Learning outcomes	Competences		
Capacity to apply concepts and recent technologies of transmission, switching and data transport for the design, the operation and the exploitation of heterogeneous networks	CG1 CG4	CE32	
Identify and know how to use specific solutions of switching, data transport and management for the deployment of special purpose networks.	CG4 CG6	CE30	CT2
Know and apply the techniques and the mechanisms of engineering of data traffic in packet networks, both in close and open environments.	CG4	CE30	
Practical capacity for the design, usage and configuration of advances computer networks, from the point of view of switching, quality of service, data transport and telematic services deployment.		CE30 CE32	CT2

Contents	
Topic	
LAN Virtualization Technologies	The VLAN Concept Trunks Routing Considerations
Network virtualization	Tunnels Overlay networks Remote access (VPNs)

Advanced switching mechanisms	Label switching (MPLS) MPLS applications VPNs with provider support
IP mobility	Network mobility concepts IPv4 Mobility IPv6 Mobility
Access network technologies	xDSL Cable (HFC, DOCSIS) Optical access networks
Optical switching and transmission	Circuit switching, burst switching and packet swithching

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	21	24	45
Laboratory practical	8	12	20
Mentored work	7	42	49
Presentation	2	4	6
Report of practices, practicum and external practices	0	10	10
Essay questions exam	4	16	20
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	The master lectures follow the usual scheme for this way of teaching; although, in some sessions, we will be able to dedicate 5 or 10 minutes of the class to make a simple examination (some brief questions) that will form part of the continuous evaluation. These short tests intend to motivate our students for a daily work.We work on competencies CG6, CE32 and CE32 in these master sessions.
Laboratory practical	In the labs the students will face several practical sessions -supervised by the professors- where they will settle the concepts learned in the theoretical classes. In such practicals they will use real network equipment (routers and switches) and/or virtualization software that will allow their instruction and training on their own. The practicals that the teachers will pose will be designed to be done within the respective face-to-face sessions at the School; although the student will be able to reproduce them at home using free software that will allow to virtualize the network hardware used in the laboratory. Also, the professors will be able to propose optional exercises that the student will be able to do as homework; and review individually in tutorial time. The students should acquire competencies CE30 and CE32 in the lab.
Mentored work	A project with a fairly large magnitude will be posed to be developed as a teamwork during all the semester. This practical work might require in its earliest stage to be set in context doing an additional theoretical study/research. Both works will be supervised by the professors with periodic meetings every 10/15 days (roughly). The tutored works are related with competencies CG1, CG4, CE30 and CE32.
Presentation	Every group must deliver the right documents where the suggested challenge (project teamwork) have to be explained in a detailed way. Also, the students must prepare a public presentation of the team solution to be defended in front of the rest of the class.The students practice competencie CG4 in the presentations.

Personalized assistance	
Methodologies	**Description**
Lecturing	During tuitition time, the professors will be able to help the students either individually in the understanding of the theoretical concepts explained in the master sessions and/or in the demonstrative lab activities, or to correct whichever optional homework done out of the class or collectively with the supervision of the teamwork that will share among a group of peers.
Laboratory practical	During tuitition time, the professors will be able to help the students either individually in the understanding of the theoretical concepts explained in the master sessions and/or in the demonstrative lab activities, or to correct whichever optional homework done out of the class or collectively with the supervision of the teamwork that will share among a group of peers.
Mentored work	During tuitition time, the professors will be able to help the students either individually in the understanding of the theoretical concepts explained in the master sessions and/or in the demonstrative lab activities, or to correct whichever optional homework done out of the class or collectively with the supervision of the teamwork that will share among a group of peers.

Assessment

	Description	Qualification	Evaluated Competencess	
Laboratory practical	They will be marked as "passed" or "not passed". To pass them, the student must attend all the sessions of this type. If any unexpected event makes one student to miss one session, it can be recovered by doing an extra practical to be assigned by the teacher.	0		
Mentored work	The practical teamwork (project) that the student will face will determine one of the mid-term marks, T, of our continuous evaluation. The quantitative value (between 0-10) will be determined by the correctness of the solution presented by the group, the associated presentation and docs, the individual implication of the student in the developed work and the answers given to a individual interview with each member of the group.	50	CG1 CG4 CG6	CE32
Essay questions exam	There will be two written exams: a mid-term exam in the middle of the semester (Ep), and a final one (Ef). Both tests are theory examinations and will be evaluated individually between 0 and 10. Students must score at least 3 out of 10 to pass the subject.	50		CE30 CE32

Other comments on the Evaluation

Please note that even though utmost care has been placed to ensure the accuracy of this translation, it is possible that some mistakes have been inadvertently made. So, in case of discrepancy between this text and the canonical version available in the Galician language, the latter shall hold.

The assessment of the subject can either be based on a *continuous assessment* or *exam-only* assessment. Students will choose the *continuous assessment* if they take the mid-term written exam (Ep) around the middle of the semester. The percentages shown in the previous section only reflect the maximum weights that any activity (partial mark) can obtain when following the continuous evaluation strategy, and serve only as illustration. The precise assessment follows:

For *continuous assessment*, the final grade is the geometric mean between the tutored work grade (T) and the corresponding from the written tests (Y). Mark Y is calculated as the arithmetic mean between the final exam (Ef) and partial exam (Ep) marks. In order to pass the subject, students must obtain at least 3 out of 10 in value Ef and attend all sessions of laboratory practices (unless justified reasons). If this is not accomplished, the final grade is the minimum between Ef and 3.

Y = ½×(Ef+Ep)

FINAL MARK=(T×Y)^½

Students that do not opt for the continuous assessment, must take a final examination that will be made up of three parts: a theory examination, like the final one in the continuous assessment (Ef), an aptitude test about the laboratory, and a practical project that must be developed individually (T). The final mark, in this case, will be the geometric mean between the theoretical exam and the project work, provided that the student passes the aptitude test in the lab. If the Ef mark is less than 3 or the aptitude test is not passed, the final mark is calculated as the minimum between Ef and 3.

Finally, the end-of-program call and the second call evaluation (June/July) will have the same characteristics than the exam-only assessment just described, but students will be allowed to inherit the partial mark of any activity (T or Ef) if that has been passed during the same academic year, independently of the assessment modality that the student had followed.

Sources of information

Basic Bibliography

Peterson & Davis, **Computer Networks**, 5ª, Morgan Kauffman, 2011

Ina Minei & Julian Lucek, **MPLS-Enabled Applications**, 3ª, Wiley, 2011

Christian Huitema, **IPv6**, 2ª, Prentice Hall, 1997

Sanjeev Mervana, Chriis Le, **Design and implementation of DSL-based access solutions**, Cisco-press, 2001

Gerd Keiser, **FTTx Concepts and applications**, John Wiley & sons, 2006

Complementary Bibliography

Kurose & Ross, **Computer Networks**, 7ª, Prentice Hall, 2016

Charlie Scott, Paul Wolfe & Mike Erwin, **Virtual Private Networks**, 2ª, O'Reilly, 1998

Roderick W. Smith, **Broadband Internet connections: a user guide to DSL and cable**, Addison Wesley, 2007

Walter Goralski, **Tecnologías ADSL y xDSL**, McGraw-Hill, 2000

Biswanath Mukherjee, **Optical WDM networks**, Springer, 2006

G. Papadimitriou, C. Papazoglou & A. Pomportsis, **Optical Switching**, Wiley, 2008

James Farmer, Brian Lane, Kevin Bourg, Weyl Wang, **FTTx Networks: Technology implementation and operation**, 1ª, Morgan Kaufmann Publishers, 2016

Recommendations

Subjects that are recommended to be taken simultaneously

Network Security/V05G300V01543
Network and Switching Theory/V05G300V01642

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

It is not expected that it will be necessary to make any changes in the teaching planning of the subject. All planned tasks can be carried out remotely with the equipment that students typically have.

IDENTIFYING DATA				
Network Security				
Subject	Network Security			
Code	V05G300V01543			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Fernández Masaguer, Francisco			
Lecturers	Fernández Masaguer, Francisco Rodríguez Rubio, Raúl Fernando			
E-mail	francisco.fernandez@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this course are studied , in an unified way, the main problems and threats to security in networks and telematic services, and distinct techniques to protect them are presented. First the subject is considered from a general point of view, so that the concepts, services and security techniques studied, can be applied to any type of network, telematic service or information system to secure. This block is formed by chapters 1 to 4. This carries to treat with detail the three central subjects of security: the algorithmic part (encipherment, digital signature and integrity), the authentication problem and the procedures of key management. The aim is to give the student the knowledge and practice to entitle him/her to ease his understanding of the particular techniques that each application can require and to apply them to other scenarios that he(she) have to face. Afterwards the subject is considered in a more particular way, reviewing the problems, techniques and standards of security in some of the communication environments of greater prevalence in actuality. Thus a chapter is devoted to the security to the IP level, central protocol in the Internet architecture, and another chapter to the security in the Web, given the current importance of this way of telematic intercommunitation. Here the student will familiarize with the theoretical and practical aspects of the SSL protocol, central for the security of Web transactions. Given also the every time greater utilisation of wireless communications and his particular security problems, one chapter is devoted to the subject. The course is closed with an introduccion to other two subjects of increasing transcendence: botnets, malicious networks and software, and the forensic analysis of information systems.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CE28	CE28/TEL2 The ability to apply the techniques that are basis of computer networks, services and applications, such as management, signaling and switching, routing and securing systems (cryptographic protocols, tunneling, firewalls, charging mechanisms, authentication and content protection) traffic engineering (graph theory, queuing theory and teletraffic) rating, reliability and quality of service in both fixed, mobile, personal, local or long distance environments with different bandwidths, including telephony and data.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes			
Learning outcomes	Competences		
Understand the foundations of the cryptographic science	CG3		
To acquire the necessary knowledges to ensure the security of a computer or telematic system.	CG3		
To acquire skills on the process of analysis of the attacks that can suffer a network and the main mechanisms of defence against them.	CG4	CE28	CT3
Know the main architectures of applicable security to the computer and telematic systems.	CG4	CE28	CT3

Know the main ideas of the norms and standard more important in matter of security in computer systems and communication networks.	CG6	CE28	CT2

Contents	
Topic	
1 Mathematics foundations of security.	- Notions of Complexity Theory. - Notions of Number Theory.
2. Cypher, digital signature and hash algorithms	- Types of criptosistems and algorithms. - Integrity and hash algorithms. - Symetric key cryptosistems. Mac functions. Encrytion. Shannon principles. Stream and block cyphers. DES and AES algorithms Cypher modes of operation. - Public key cryptosystems. RSA, DSA and elliptic curves.
3. Certification and Public Key Infrastructures.	- Security problems of asimetric cryptography. Certification and certificate formats. - Trust models. Flat trust model and PGP. Third partiy trust model and certification authorities. - Certificate Infrastructures. Certification path and revocación of certificates.
4. Authentication and key agreement protocols.	- Authentication methods. - Threats to an authentication protocol. Countermeasures. - Requirements of a key agreement protocol. Diffie-Hellman protocol. - Authentication in simmetric cryptosistems. Cases of study: GSM and Kerberos. - Authentication in asimetric cryptosistems. Cases of study: X509 and SSL. - Passwords based protocols: SRP. - Single Sign On (SSO)
5. Security at the network layer	- Threats in the network layer. - IP Security Architecture. - IPsec Protocol. IPsec tunnels. IPsec and NAT. - Key manegement protocols: IKE, ISAKMP and OAKLEY.
6. Security in the Web and electronic commerce.	- Problems of security in the Web. - Protocols: SSL and TLS. - Certification in the Web.
7. Wireless security and AAA protocols.	- Threats to security in wireless environments. - Wireless Application Protocol (WAP). WTLS. Protocols WEP, WPA, WPA2 (802.11i). - AAA Protocols: RADIUS.
8. Systems Security.	- Firewalls and systems against intrusions. - Malicious software and networks. Botnets. - Forensic analysis of systems.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	21	38	59
Autonomous problem solving	0	10	10
Mentored work	6	28	34
Laboratory practical	11	22	33
Laboratory practice	1	0	1
Essay	1	0	1
Essay questions exam	1	5	6
Essay questions exam	1	5	6
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Exhibition by means of powerpoint presentations and blackboard of the theoric contents of the course. They will develop the theoretical subjects of the matter that do not remain covered by the others methodologies employed. With this methodology, student will adquire part of CG3 y CE28 competences.
Autonomous problem solving	The student will solve in an autonomous form the exercises, cuestions or problems of the bulletin not solved in the face-to-face hours. The doubts arisen will be agreed and will be exposed to the tutor in normal tutor time. This methodology is aimed to CG4 and CE28 competences.

Mentored work	Work in group. Several theoretical and practical works to develop will be explained to the students, between which each group will have to choose one. In the C class type, will expose to each group the aims of the work, hardware and software tools to use, form to tackle it and will realise a follow-up to each group. This methodology, is aimed to adquire part of CG4,CG6, CE28, CT2 and CT3 competences.
Laboratory practical	Work in group. The group will developed some practices in the laboratory, focused to mature and carry to practice the theoretical concepts , as to improve his ability for the engineering of secure networks and services. This methodology, is aimed to CG6, CE28, CT2 and CT3 competences.

Personalized assistance

Methodologies	Description
Laboratory practical	Individualized monitoring of each group work. Comments of diverse options, recommendations and strategies for the good development of the project. Reviews with each group the level of understanding and advance of the project, particular doubts that can arise, design and Java coding errors. Help for the understanding of the JCA/JCE and JSSE packages. Individualized help for instalation of the keystore management tool and of the basic Java code of the practice.
Mentored work	Individualized monitoring of each student in the group. General comments to the group of recommendations and strategies for the good development of the project. Reviews with each group of the level of understandings and advance of the project, particular doubts that can arise, design or approach errors and options of improvement.
Autonomous problem solving	Reviews and comments of the diverse exercises proposed. The student will have in Faitic with the solucion to some of the proposed exercises.

Assessment

	Description	Qualification	Evaluated Competencess		
Laboratory practice	Proof of group in which the teacher will value laboratory practises, reviewing his operation with the members of the group. This proof will be made in the first academic week of January. All the members of the group have to be presents at the moment of the presentation. The teacher will do an authorship interview of which the level of participation of each student will be deduced and of which, together with the correct operation, the individual mark of each student will de determined.	25	CG6	CE28	CT3
Essay	Assessment of the tutee project or work realised by the group (type C). The group will do a demonstration to the teacher of the project or work realised and results obtained. This proof will be made in the first academic week of January. All the members of the group have to be presents in the moment of the presentation. The teacher will do an authorship interview of which the level of participation of each student in the proyect will be deduced and of which, together with the correct operation, the individual mark of each student will de determined.	25	CG4 CG6	CE28	CT2 CT3
Essay questions exam	Final exam of the course. This exam will consist of a group of exercises/questions on the contents given in the course.	25	CG3 CG4	CE28	
Essay questions exam	Partial exam of the course, neccesary for students that follow continuos evaluation. This exam will consist of a group of exercises/questions on the contents given until aproximately the middle of the theoretic course.	25	CG3 CG4	CE28	

Other comments on the Evaluation

- **CHOICE OF CONTINUOUS EVALUATION.**

  By default it will be considered that the student opts by continuous assessment (CA). If a student wishes to opt by no continuous, he/she will must communicate it to the teacher before the week 4 of the academic course. The communication must be made by email.

- **FIRST CALL.**

  Continuous assessment (CA). This will be formed by:

  1. Laboratory work B, representing 25% of the mark. This work must be delivered via Faitic before day 11 January.
  2. Project C, representing 25% of the mark. This project must be delivered via Faitic before the day 11 January.
  3. Partial exam of the contents given until about the quarter's middle, representing 25% of the mark. This exam will do average with the final exam if the student minimun mark is 3.5 points of 10. If the student mark is lower than this minimun he/she must do another exam of this part in the final exam. The date of this exam will be approved at the Comision Academica de Grado (CAG) and published at the beginning of the quarter.
  4. Final exam, in the agreed date in Board of School. Two cases are posible:

     - Students with mark greather than minimum in the partial exam. This exam will consist of the subjects given from about the quarter's middle to the end. It will represent 25% of the total mark. To be able to surpass the course the student must obtain in this exam a minimum mark of 3,5 points of 10.
     - Students with mark lower than minimum in the partial exam. This exam will consist of all the subjects given in the course.It will represent 25% of the total mark. To be able to surpass the course the student must obtain in this exam a minimum mark of 3,5 points of 10.

  Eventual assessment. The students that do not choose CA will do a final exam by 80% of the mark, together with B laboratory practise, that will provide the other 20%.

  The final exam will be the same for all the students, independently of if they opt by continuous or no continuous assessment.

- **SECOND CALL (JULY)**

  Students that do not choose CA in the first call will do a final exam by 80% of the final mark, together with the laboratory that will complete the other 20%. It is saved the mark of the laboratory of the first call.
  The students that have opted in the first call by CA, can follow in July by CA or change to not CA. The students that change to not CA, MUST communicate it explicitly to the teacher by electronic mail before day June 1.

  - In the first case, that is for the students than continue by CA in July, the mark of the partial exam and final exam (when the minimun mark is surpasses), is saved from the January announcement. All students that have not surpassed the minimum mark in the theoric exam of the first call MUST do the final exam in July.
  - In the second case, not CA students in July, will do a final exam by 80% of the note, and laboratory practices by 20%. The laboratory mark will be maintained in this case, properly scaled/porcentuated.

  The students that change from non CA to CA, will maintain the laboratory mark.

- **ADDITIONAL NOTES.**

  - *Minimal cualification for theory evaluation (long answer tests and development)*. Independently of if continuous or not continuous assesment, and independently of the call, it will be necessary to get a minimun of 3.5 over 10 for CA and 4 over 10 for non CA, in the theoretical exam (long answer tests and development), for the approval of the course.
  - It will be considered to the student as "no presented" if he/she has not followed continous evaluation and has not presented to the final exam. Equally, if he/she follows CA (continuous evaluation) and has not attended anyone of the A, B and C parts, he/she will be considered as "no presented".

- The qualifications obtained in the laboratory B and project C will be valid only during the academic course in that they were realised.
- In the case that the total mark is equal or higher than 5, but the minimun in some part has not been reached, the final mark will be 4.5 points (failure).

- **EXTRAORDINARY CALL (END OF GRADE).**

  - Will be formed by:

    - Theoretical exam (50%). Personal exam about all theoric themes of the course, representing 50% of the total mark. The student will need a minimal mark of 3,33 of 10 for the approval of the course.
    - Laboratory work B, representing 25% of the mark.
    - Project C, representing 25% of the mark.

Sources of information

Basic Bibliography

F. Fernandez Masaguer, **Apuntes de Seguridad en Redes y Sistemas de Informacion**, 1ª ed., Revision 2020

William Stallings, **Cryptography and Network Security. Principles and practice.**, 7ª ed., Pearson, 2017

Complementary Bibliography

R.Perlman, C. Kaufman, M.Speciner, **Network Security: Private communications on a public world**, 2ª ed., Prentice Hall, 2002

Joseph Migga Kizza, **Guide to Computer Network Security**, 2ª ed.,

Douglas R. Stinson, **Cryptography. Theory and Practice.**, 3ª ed.,

M. Laurent Maknavicius, **Wireless and Mobile Network Security**, 1ª, Wiley, 2009

Enisa, **Botnets: Detection; Measurement, Disinfection & Defence**, Enisa, 2011

Recommendations

Subjects that are recommended to be taken simultaneously

Architectures and Services/V05G301V01310
Internet Services/V05G301V01301

Contingency plan

IDENTIFYING DATA				
Microwave Circuits				
Subject	Microwave Circuits			
Code	V05G300V01611			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Fernández Barciela, Mónica			
Lecturers	Fernández Barciela, Mónica Rodríguez Rodríguez, José Luis			
E-mail	monica.barciela@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject provides the student with the basic tools to analyze components and analog subsystems (active and passive) that operate in the band of the microwaves, as well as to evaluate his specifications and performance. The microwave subsystems are part, among others, of the modern communications systems transceivers (cellular telephony, wireless networks, satellite communications, and so on), thus the importance for the student to get some knowledge and background about these components. On the other hand, this subject complements the knowledge the student has, due to previous subjects, in electronics for communications, since when working in the microwave range, we need to use different tools for an accurate circuit analysis and design. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CG9	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.
CE23	CE23/ST3 The ability to analyze the components and their specifications for guided and non-guided communications systems
CE24	CE24/ST4 The ability to select circuits, subsystems and systems of radiofrequency, microwaves, broadcasting, radio link and radio determination.
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes			
Learning outcomes	Competences		
To learn how to analyze microwave active and passive circuits and components, and to evaluate their specifications and performance. The student will learn how to use S-parameters, electronic instrumentation for measurements in the microwave range and circuit simulators for that purpose.	CG3 CG5	CE23	
To learn how to solve exercises, how to perform measurements, how to elaborate and present reports, how to work in a technical team and to transfer knowledge in the field. To learn how to handle technical documentation and scientific bibliography, both in English.	CG4 CG5 CG9	CE24 CE25	CT3 CT4

To learn how to select, analyze and apply semiconductor active devices in circuits for microwave communications subsystems.	CG5	CE23 CE24 CE25	
To learn how to analyze and select microwave circuits for optical transmitters and receivers.	CG5	CE23 CE25	
To learn how to evaluate and select microwave subsystems. To propose solutions for applications at the different frequency bands for guided (coaxial cable, waveguide) and wireless transmissions.	CG3 CG5	CE24 CE25	CT2

Contents	
Topic	
1.Introduction to microwave circuits.	A. Microwaves and their advantages for communications. B. Microwave Subsystems. Solutions for applications in the different frequency bands for wave guided and wireless transmissions. C. Integrated technologies for high frequencies. MICs.
2. Basic concepts.	A. Transmission Lines Theory. Travelling waves, characteristic impedance and reflection coefficient. B. Smith Chart. C. Coaxial cable and planar transmission lines.
3. S-parameters.	A. Definition and properties. B. Signal Flow Charts. C. Power and Gain. D. Stability.
4. Impedance Matching.	Basic matching networks (discreet and distributed) for narrowband applications.
5. Microwave passive components.	Filters, couplers, phase shifters and resonators.
6. Microwave active devices for integrated circuits.	A. Semiconductors for microwave active devices. Heterostructures. B. High Frequency Diodes c. Bipolar and FET Transistor technologies for high frequencies.
7. Circuits for microwave transceivers.	A. Linear microwave amplifiers. B. Circuits for optical receivers and transmitters.
8. Analysis of microwave active and passive components, and circuits with a commercial simulator.	
9. Measurements on microwave devices and circuits.	Microwave measurement systems for linear device characterization. Calibration.

Planning			
	Class hours	Hours outside the classroom	Total hours
Laboratory practical	7	14	21
Practices through ICT	12	36	48
Introductory activities	0	7	7
Lecturing	19	38	57
Problem and/or exercise solving	4	13	17
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Laboratory practical	The work will be performed individually or in pairs of students. With the aid of different microwave measurement instruments/components, there will be analyzed passive and active microwave devices / circuits mostly in microstrip technology. It will be defined and evaluated different figures of merit and other tools that will be used in the experimental characterization of these components. An introduction to Vector Network Analyzers with be provided to the student, besides description of their use and calibration procedure . Students will find in Faitic support documentation. These practises are designed to aid in adquiring competencies CG3, CG4, CG5, CG9, CE23, CE24, CE25, CT2, CT3 y CT4.

Practices through ICT	The work will be performed individually or in small teams of 2 students. With the aid of a commercial microwave circuits simulator, there will be analyzed different passive components (matching networks, filters, couplers, etc.) and active semiconductor devices (diodes and transistors), and simple amplifier circuits, in agreement with Chapter 8. There will be defined and evaluated diverse figures of merit and other tools that will be in used in the analysis of these components. Also, exercise resolution will be described, to complete the one described in the lectures. Students will find in Faitic support documentation and files. Besides, they will have available a procedure to obtain a simulator licence for their PCs, through an agreement between UVIGO and the simulator provider. These practises are designed to help in adquiring competencies: CG3, CG5, CE23, CE24 y CE25.
Introductory activities	The student will have available documents about concepts from previous subjects that the student need to recall.
Lecturing	It will be given in a classroom with the aid of a slate board and a video projector. Most of the concepts in the subject Topics will be described in detail and explained. Application of these concepts will be supplied through exercises resolution, during lectures, and in the practices (ICT and laboratory). Students will find in Faitic support documentation. These sessions are designed to help in adquiring competencies CG3, CG5, CG4, CE23, CE24 y CE25.

Personalized assistance

Methodologies	Description
Lecturing	During master sessions, the professor will answer the questions addressed by the students regarding the content of the subject or the assessment tests. Besides, in office hours, the professor will also be available to the students, providing answers to their questions in a more personalized way.
Laboratory practical	During laboratory practises, the professor will guide the work of each student, and answer those questions he/she may ask regarding the work and the assessment test/s.
Practices through ICT	During practises, the professor will guide the work of each student, and answer those questions he/she may ask regarding the work and the assessment test/s.

Assessment

	Description	Qualification	Evaluated Competencess
Laboratory practical	In the case of Continuous Assessment: During or outside the designated time for experimental practices, the student will perform one or several short examinations, individually (or in small groups), involving short questions/exercises and/or circuit implementations. This evaluation may involve a team presentation of the work performed. Besides, in the short exam 3, the work performed in theses practices may be also evaluated, through questions/exercises. In the case of Exam-only Assessment, the work performed in these practices may also be evaluated, though questions/exercises and/or some experimental implementation/test.	10	CG3 CE23 CT2 CG4 CE24 CT3 CG5 CE25 CT4 CG9
Practices through ICT	In the case of Continuous Assessment: During or outside practice hours, the student will have one/several examinations in which will answer/solve individually some proposed questions/exercises with the aid of the simulator. Besides, in the short exam 3, the work performed in the practices may be similarly evaluated. In the case of Exam-only Assessment, the work performed in the practices may be evaluated in the Exam through questions/exercises with the aid of the simulator.	10	CG3 CE23 CG5 CE24 CE25
Problem and/or exercise solving	Continuous Assessment: There will be 3 short examinations, each one will contain exercises resolution. Moreover, they may contain a set of short questions related to the master sessions or, in the case of Short Examination 3, the practices, both experimental or CAD-based. In the case of Exam-only Assessment, problem/exercise solving will be an important part of the Exam.	80	CG3 CE23 CG4 CE24 CG5 CE25

Other comments on the Evaluation

It is convenient that all students participate in the practices, both experimental and computer aided ones, to acquire all the required skills of this subject.

A) If the student selects Continuous Assessment (CA):

The schedule of the different assessments events will be approved by the Grade Academic Commission (CAG) and it will be available at the Term beginning. These assessments tests will not have available second chance ones.

1. In order that his/her work is evaluated, his/her presence in all scheduled experimental and computer aided practices will be mandatory. Besides, he/she must perform all the assessment events scheduled related to these practices. The maximum grade the student might obtain in the evaluation of these practices is 20 % of the Total Available Course Grade (TACG).

2. The rest of the student work will be evaluated by means of 3 Short Examinations that will mainly contain exercises resolution, but may also include short questions. These 3 short examinations, as a whole, add up to 80% of the TACG.

The First and Second Short Examinations may last around 1 hour; the First corresponds to 15% of the TACG and the Second to the 25% of the TACG.

It is assumed that students performing the Second and/or Third Short Examination do choose Continuous Evaluation. In this case, the final grade cannot be "Not Presented".

The Third Short Examination will take place simultaneously with the Final Examination, performed by those students who do not follow CA. This short examination is the most important one, it involves all or almost all of the subject Topics and corresponds to a 40 % of the TACG.

B) In the case of the students who choose E*xam-only Assessment*, the Final (extended) Examination corresponds to 100% of the TACG. In this examination it will be evaluated exercises resolution, with or without the aid of the simulator, answers to short questions related to the course theoretical and experimental parts (Lab) and computer/simulator aided practices. It may also include some type of experimental test/implementation. In this Exam, the weight of each subject Topic and part (theory/practices) in the available grade may differ to that applied in Continuous Assessment.

The Second Call:

In it the students who have previously failed must perform a similar Final Examination than in option B, with similar characteristics as the ones described previously.

In particular, those students who followed CA in the first call may opt now between option B and option A.

If they choose option A, all their grades in the first call, with respect to the First and Second short Examinations, and the practices (both experimental and computer aided) will be preserved; hence, it will add up as a whole to 60% of the TACG. Moreover, these students must solve an exam similar to the Third one in option A (corresponding to 40 % of the TACG). Before this Examination takes place, the student will send a written communication to the course coordinator about his/her decision with respect to the desired type of evaluation (A or B).

In the End-of-Program Call, evaluations will be similar to the Second Call.

In case of plagiarism detection in any of the student works/tests,the grade obtained by the student in this course will be a failing grade (0) and the course professor will communicate this issue to the school Board of Directors so they may take those measures deemed appropriate.

Sources of information

Basic Bibliography

D.M. Pozar, **Microwave Engineering**, 3,

J.M. Miranda y otros, **Ingeniería de Microondas**, 1,

Guillermo González, **Microwave Transistor Amplifiers: Analysis and Design**, 1,

Enrique Sánchez, **Introducción a los dispositivos y circuitos semiconductores de microondas**, 1,

Complementary Bibliography

R.E. Collin, **Foundations for Microwave Engineering**, 2,

P.A. Rizzi, **Microwave Engineering, Passive Circuits**, 1,

S. Y. Liao, **Microwave Devices and Circuits**, 3,

Recommendations

Subjects that are recommended to be taken simultaneously

Radio Frequency Circuits/V05G300V01511

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G301V01108
Physics: Fundamentals of electronics/V05G301V01201
Electronic technology/V05G301V01206
Electromagnetic Transmission/V05G301V01207

Contingency plan

Description

Teaching Group A: It will be done through online classes (synchronous or asynchronous).

Teaching Groups B: It will be done through online classes (synchronous or asynchronous). During these classes, students will be provided with a description / explanation of each practice and answers to their questions, so that, together with the documentation and support files, and the simulator license, they will be able to perform the practices fully at home.

Teaching Groups C: Students will be provided with demonstration videos of the experimental practices and supporting documentation.

Evaluation:

In Continuous Evaluation: All planned exams (theory part) will be made online.
The evaluation of the practices (both CAD based and experimental) may be through online exams (using the simulator) or or through deliverable work, such as problems solving / questions or reports.

In the Single Assessment thought a Final Exam, this will be fully online.

IDENTIFYING DATA

Principles of Digital Communications

Subject	Principles of Digital Communications			
Code	V05G300V01613			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Comesaña Alfaro, Pedro			
Lecturers	Comesaña Alfaro, Pedro Pérez González, Fernando			
E-mail	pcomesan@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The basic aims of the subject are the following: - Apply optimisation criteria for the realisation of diagrams of estimate and synchronisation in digital receptors of communications. - Differentiate the blocks and the functionalities of a data transmission system. - Use digital signal processing to transmit and receive analog waveforms. - Apply the basic mechanisms of reduction of the impact of noise in a communications system. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies

Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG11	CG11 To approach a new problem considering first the essential and then the secondary aspects
CE26	CE26/ST6 The ability to analyze, codify, process and transmit multimedia information using analogical and digital signal processing techniques.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes

Learning outcomes	Competences		
Apply criteria of optimisation for the realisation of diagrams of estimate and synchronisation in digital receptors of communications	CG3	CE26	
Differentiate the blocks and the functionalities of a system of transmission of complex data	CG11	CE26	CT2
Use the processed digital of signals to transmit and receive forms of analog wave	CG3 CG4		CT3
Apply the basic mechanisms of reduction of the impact of noise in a system of communications		CE26	CT2

Contents

Topic	
1. Introduction to digital communications	- Historical evolution of wireless communication systems. - Basic blocks of a digital communications system. - Review of impairments in a communications channel. - Introduction to the course.

2. Discrete equivalent channel and Nyquist pulses	- Baseband equivalent channel. - Discrete equivalent channel. - Nyquist pulses. - Square root raised cosine pulses. - Application and implementation of Nyquist pulses. - Introduction to polyphase structures.
3. Symbol synchronization	- Motivation. - Phase Locked Loops (PLL). - PLLs and steepest descent. - Maximum output energy criterion. - Interpolation-based symbol synchronization. - Adaptive symbol synchronization.
4. Frame synchronization	- Review of Least Squares (LS) estimation. - Motivation for frame synchronization. - Data-aided frame synchronization. - Design of training sequences.
5. Phase and carrier recovery	- Decision-directed phase recovery. - Non-decision-directed phase recovery. - Motivation for carrier recovery. - Coarse carrier synchronization. - Fine carrier synchronization.
6. Estimation and equalization in flat channels	- Maximum likelihood detection. - Equalization through estimation. - Direct equalization. - Adaptive equalization. - The LMS algorithm.
7. Frequency selective channel equalization	- Multipath, bandwidth and frequency selectivity. - Zero-forcing equalization. - Least squares equalizer. - LMS algorithm derivation for selective channels. - Unconstrained equalizers.
8. Introduction to advanced digital communications.	- Principles of OFDM. - Introduction to MIMO systems.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	19	28.5	47.5
Problem solving	2	8.5	10.5
Project based learning	7	35	42
Laboratory practical	12	36	48
Essay questions exam	2	0	2
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Presentation and discussion of the fundamental concepts associated to the different blocks that constitute a digital communications system. This methodology works competencies: CG4, CG11, CT2, CT3.
Problem solving	In A hours the doubts remaining after the publication of the solutions of the proposed problems will be discussed. Furthermore, 3 exercises will be proposed for assessment; some of them will be completed in A hours, while the remaining one(s) will be completed at home. All these 3 exercises will be completed individually. This methodology works competencies: CG3, CG4, CG11, CE26.
Project based learning	In C hours practical projects will be proposed; the students will develop a digital communications system that shows its good operation in the proposed application. The projects will be implemented in small groups. All the members of the group have to understand the operation of all the blocks of the complete system that will be submitted at the end of the course. This methodology works competencies: CG3, CG4, CG11, CE26, CT2, CT3.

Laboratory practical	In B hours the students will work on the lab to create a software defined radio receptor that uses all the basic functionalities studied in the subject. They will be implemented in small groups. This methodology works competencies: CG4, CG11, CE26.

Personalized assistance

Methodologies	Description
Lecturing	The teacher will solve the doubts that each student formulates during the presentation realised in the master session.
Laboratory practical	The students will work in small groups and the teacher will solve the doubts that each group might have.
Project based learning	The students will work in small groups and the teacher will solve the doubts that each group might have.

Assessment

	Description	Qualification	Evaluated Competencess		
Problem solving	Short exercises (partial tests) related to the contents explained during the masterclasses and in the laboratory. 3 exercises will be proposed for assessment; some of them will be completed in A hours, while the remaining one(s) will be completed at home. All these 3 exercises will be completed individually. The dates of those tests will be approved by the Comisión Académica del Grado (CAG) and will be available at the beginning of the semester. Each exercise will have a weight of 10% in the final mark for the students assessed by continuous evaluation.	30	CG3 CG4 CG11	CE26	
Project based learning	Realisation of a practical project in groups, that will be evaluated individually in C hours during the last week of the course. This is a mandatory activity for both those students who choose to follow the continuous evaluation, and those who do not, yielding in both cases the 40% of the final mark.	40	CG3 CG4 CG11	CE26	CT2 CT3
Essay questions exam	Final exam, where the studen will have to solve some exercises; this exam will be the fourth test for those students who chose continuous evaluation. The weight will be 60% for those students that do not follow continuous evaluation, and 30% for those who do.	30	CG3 CG4 CG11	CE26	

Other comments on the Evaluation

For those students that choose continuous evaluation the final note will be obtained as:

Npartials + Nproject + Nexam

where Npartials denotes the mark accumulated in the partial tests, up to 3 points; Nproject denotes the mark obtained in the practical project, up to 4 points; and Nexam denotes the mark of the final exam up to 3 points. In order to pass the sbuject, the student has to obtain a minimum mark of 3.5 points (out of 10) in the final exam; if that minimum threshold is not achieved, the final mark of the student will be the minimum of that obtained in the exam and Npartials + Nproject + Nexam (with the weights mentioned above.) The partial tests will not be repeated.
For those students who did not choose continuous evaluation, the final mark will be obtained as:
Nproject + Nexam

where Nproject denotes the mark obtained in a practical project specifically designed for non-continuous evaluation students, up to 4 points; and Nexam denotes the mark of the final exam up to 6 points. In order to pass the sbuject, the student has to obtain a minimum mark of 3.5 points (out of 10) in the final exam; if that minimum threshold is not achieved, the final mark of the student will be the minimum of that obtained in the exam and Nproject + Nexam (with the weights mentioned above.)

The final exam for those students who choose single (non-continuous) evaluation might have more exercises than the exam of those students who chose continuous evaluation.
The student has to choose, after the realisation of the second partial test, if he/she chooses continuous evaluation or single one, informing about it to the teacher within the established period of time. Those students who chose continuous evaluation

and did not pass the subject will be assigned the qualification "Failed" independently that they present to the final exam or not.
The mark in the partial exams will be considered for the recovery exam, but not for subsequent courses. In recovery exam the students that choose continuous evalution can decide if they want to keep the mark obtained in the partial tests and the homework/s, or if they want to be evaluated just by considering the final exam (with 60% weight) and the project (40%).
In the end-of-program call, the assessment will be only based on an exam.
In the case that plagiarism is detected in any of the reports/exams done/taken, the final score for the subject will be 'fail' (0) and the teachers will inform the School authorities of the affaire so that they take the appropriate measures. Besides, the teachers will inform the School authorities of any conduct against ethics by the students, the possibility existing that the School authorities take the appropriate measures.

Sources of information

Basic Bibliography

A. Artés Rodríguez, F. Pérez González y otros,, **Comunicaciones Digitales**, 2007

R. W. Heath Jr., **Introduction to Wireless Digital Communication: A Signal Processing Perspective**, 2017

Complementary Bibliography

J.R. Barry, E. A. Lee y D. G. Messerschmitt, **Digital communication**, 3rd edition, 2004

Recommendations

Subjects that continue the syllabus

Digital Communications/V05G300V01914

Subjects that it is recommended to have taken before

Multimedia Signal Processing/V05G300V01513

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained
All of them

* Teaching methodologies modified
None

* Non-attendance mechanisms for student attention (tutoring)
Videoconference

* Modifications (if applicable) of the contents
N/A

* Additional bibliography to facilitate self-learning
N/A

* Additional Information
Both in the mixed modality and in the non-face-to-face modality, the evaluation scheme considered in the corresponding section of this guide will be maintained; the only difference is that the corresponding tests will be done in a non-face-to-face way. Likewise, the planification of the theory and group C lectures will be independent of the modality; in case of mixed or non-face-to-face modalities, IT tools will be used. In the mixed modality and in the non-face-to-face modality those lab sessions requiring specific hardware will be replaced by computer simulations; IT tools will be used.

In order to enable as much as possible the self-organization of the work by the students, and preventing possible problems of conciliation and/or connectivity, the material used in each session of the course will be provided to the students well in advance.

IDENTIFYING DATA				
Optical Telecommunication Infrastructures				
Subject	Optical Telecommunication Infrastructures			
Code	V05G300V01614			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Curty Alonso, Marcos			
Lecturers	Curty Alonso, Marcos Fraile Peláez, Francisco Javier			
E-mail	mcurty@com.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Firstly, we explain the physical foundations of the optical fibre technology. This includes concepts of electromagnetism in dielectric dispersive materials that may be nonlinear, the theory of the optical reception and noise, and the theory of the optical sources and optical modulators. Then, we describe the different transmission systems that use fibre, and we present optical networks. Special emphasis is made on the analysis and design of these optical systems.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CE21	CE21/ST1 The ability to construct, exploit and manage telecommunication networks, services, process and applications, considered as systems of receiving, transporting, representation, processing, storage, management and presentation of multimedia information from the point of view of transmission systems.
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes	Competences		
1. To understand the origin and reasons for the use of optical transmission systems.	CG3		
2. To learn the physical foundations of the optical transmission systems and optical information processes. In particular, those concepts that deviate most from the classical technics such as, for instance, the optical generation and photonic detection.	CG3 CG5		CT3
3. To know the basic theory of optical devices and optical subsystems like, for example, LEDs and lasers, photodetectors, modulators, fibre amplifiers and optical filters.	CG3 CG5		CT3
4. To be able to specify the type of optical fibres and other necessary optoelectronical components that are needed for a certain optical link. Also, to understand their physical and technological limitations.		CE25	CT3
5. To be able to develop models for optical links and to evaluate the impact that the different transmission subsystems and transmission formats have on their performance.		CE25	CT3
6. To know the foundations, topologies and switching technologies of optical networks, as well as those of the current proposals of FTTH		CE21	

Contents	
Topic	
1. Introduction to optical communications	1.1. Reasons for the optical transmission 1.2. Digital transmission in multimode fibres

2. Electromagnetism in dielectrics	2.1. Maxwell equations in dielectrics 2.1. Wave equations in dielectrics 2.3. Refraction index and losses 2.4. Dispersion
3. Monochromatic propagation in flat guides	3.1. Solution to the wave equation in flat guides 3.2. Guided modes: TE and TM 3.3. Modal power 3.4. Normalised parameters
4. Monochromatic propagation in step index fibres	4.1. Solution to the wave equation in step index fibres 4.2. Guided modes 4.3. Modal power 4.4. Weakly guiding fibres 4.5. Losses; transmission windows
5. Propagation of pulses in single-mode fibres	5.1. Pulse distortion in optical fibres 5.2. Propagation of gaussian pulses in single-mode fibres 5.3. Propagation of analog signals in single-mode fibres 5.4. Dispersion minimisation in single-mode fibres
6. Detection of the luminous radiation	6.1. Light detection in semiconductors 6.2. p-i-n photodiodes and APDs 6.3. Photonic noise 6.4. Quantum efficiency and equivalent noise power
7. Sources and optical amplifiers	7.1. Photonic emission: basic concepts 7.2. Light emitting diodes (LEDs) 7.3. Semiconductor lasers (LDs) 7.4. External modulation of the laser 7.5. Doped fibre and semiconductor optical amplifiers
8. Digital optical links	8.1. Basic concepts of digital transmission in fibre optics 8.2. Digital receiver: a simplified model. The quantum limit 8.3. Optical amplifiers 8.4. Nonlinear effects 8.5. Penalties
9. Coherent systems	9.1. Homodyne and heterodyne receivers 9.2. Coherent modulations 9.3. I-Q Systems
10. Introduction to WDM and to optical networks	10.1. Introduction 10.2. WDM systems 10.3. Optical networks 10.4. Basic topologies of optical networks 10.5. FTTH
Laboratory exercise 1. Measuring the numerical aperture of a multimode fibre	Here we will measure the numerical aperture of a multimode fibre
Laboratory exercise 2. Acousto-optic modulator (AOM)	Here we will built a free-space optical link that uses an AOM together with an He-Ne laser.
Laboratory exercise 3. Optical amplifier	Here we will characterise an erbium doped fibre amplifier (EDFA)
Laboratory exercise 4. Electro-optic modulator	Characterisation of an electro-optic modulator
Laboratory exercise 5. Digital link based on graded index fibres	Here we will characterise a LED and a FP laser. Also, we will analyse the effects that losses and noise have on a digital link based on graded index fibres
Laboratory exercise 6. WDM systems	Here we will characterise the performance of WDM systems working at 1310/1550nm

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Lecturing	18	27	45
Problem solving	0	12	12
Laboratory practical	12	9	21
Project based learning	6	39	45
Presentation	1	3	4
Problem and/or exercise solving	2	8	10
Essay questions exam	2	10	12

*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: program, bibliography, educational methodology and assessmentsystem.
Lecturing	The professor introduces the main contents of each chapter to the students. Note, however, that these lectures do not cover all the contents of each subject. For that reason, the students have to review the supplementary notes provided in class. It is also expected that the students review the concepts introduced in the classroom and expand on their contents using the guide of each chapter, together with the recommended bibliography, as a reference. Through this methodology the competencies CG3, CG5, CE21 and CE25 are developed.
Problem solving	The students can solve problems and/or exercises given by the professor. These exercises are related to the contents presented in the class. It is an individual activity. Through this methodology the competencies CG3, CG5 and CE21 are developed.
Laboratory practical	The lectures include some exercises in the lab involving different optical devices and optical communication systems. The students have to read the lab notes provided by the professor before the lab starts. At the beginning of each exercise the professor might request that the students summarise the main concepts related to the exercise. Any doubt can be solved using the office hours of the professor. The realisation of the laboratory exercises is a group activity. Through this methodology the competencies CG3, CG5 and CE25 are developed.
Project based learning	The students will have to complete several small projects proposed by the professor. These projects require the correct planning, design and realisation of a series of activities and are performed in groups of students. Each project has to be turned over on a given deadline. It is a group activity. Through this methodology the competencies CG3, CG5, CE21, CE25 and CT3 are developed.
Presentation	The students will give a small presentation of the completed projects in front of the professor and possibly other students. It is a group activity. Through this methodology the competency CG5 is developed.

Personalized assistance

Methodologies	Description
Lecturing	The students can use the office hours of the professor to solve doubts related to the subject. The timetable of these office hours will be available at the beginning of the semester and is published on the website of the course.
Problem solving	The students can use the office hours of the professor to solve doubts related to the subject. The timetable of these office hours will be available at the beginning of the semester and is published on the website of the course.
Laboratory practical	The students can use the office hours of the professor to solve doubts related to the subject. The timetable of these office hours will be available at the beginning of the semester and is published on the website of the course.
Project based learning	The students can use the office hours of the professor to solve doubts related to the subject. The timetable of these office hours will be available at the beginning of the semester and is published on the website of the course.
Tests	**Description**
Essay questions exam	The professor who teaches the group A will help the students to solve any doubt related to the exams and tests.

Assessment

	Description	Qualification	Evaluated Competencess		
Problem solving	The students can solve a series of problems and/or exercises proposed by the professor.	0			
Project based learning	The students will have to deliver a report for each of the realised projects. Also, the students shall give a presentation of the results obtained within a certain timeframe and follow the conditions established by the professor.	25	CG3 CG5	CE21 CE25	CT3
Problem and/or exercise solving	Before the lab starts, the students will perform a test (7% of the final mark) about the contents of the the lab notes. Likewise, when finalising the lab, the students will perform a test (23% of the final mark) about the lab exercises.	30	CG5	CE21 CE25	
Essay questions exam	At the end of the semester, the students will perform a final test that covers all the contents of the course.	45	CG3 CG5	CE21 CE25	

Other comments on the Evaluation

We will offer to the students two possible assessment systems: continuous assessment or exam-only assessment at the end of the semester.

It will be considered that the students decide continuous assessment unless they specifically request the profesor to follow a exam-only assessment. Such request should be done in the third week of the semester.

Continuous assessment:

The continuous assessment comprises a series of tasks that the student has to realise along the semester (55%), together with a long answer test (45%) that he/she performs at the end of the semester. These tasks include the completion of two short answer tests about the lab (30%), and the realisation of several projects (25%). The projects will be conducted in groups of students and the mark for each student for this task will be the mark of the group. The schedule of the midterm/intermediate exams will be approved in the Comisión Académica de Grado (CAG) and will be available at the beginning of each academic semester. All these tasks may not be retaken at another point in time. That is to say, if a student cannot fulfill them within the time stipulated by the professor, there is no possibility to fulfil them afterwards. Also, they are only valid for the present academic year.

Those students who decide to opt for a continuous assessment will have to fulfill these conditions in order to pass the course: (a) perform at least 5 out of the 6 lab exercises; (b) obtain, at least, 10 points out of 25 in the projects; (c) obtain, at least, 18 points out of 45 in the long answer test; and (d) obtain a minimum of 50 points in total (i.e., taking all the activities into account). The final mark of those students who do not fulfill these minimum requirements will be calculated as follows. It will be the minimum between: (i) the total number of points obtained by the student in all the activities of the course, and (ii) 40 points. That is to say, the maximum mark obtainable for these students is 40 points.

The choice of a continuous assessment necessarily implies that the student is counted as present at the final evaluation, independently of whether or not the student has performed the long answer test.

Exam-only assessment:

In addition to the system of continuous assessment described above, the student can opt for a exam-only assessment. This exam-only assessment covers all the contents of the subject. The professor may demand the student to deliver some additional tasks, which will be notified by the fourth week of the course. These tasks have to be delivered on the day of the exam. To pass the course the student will have to obtain, at least, 50 points out of 100 in the exam together with the additional tasks.

Second Call:

Those students who opted for a continuous assessment and fulfill the requirements of (a) and (b) above, will be able, if they so wish, to keep the mark obtained in the tasks performed during the continuous assessment (55%). In such a case, they will only take a long answer test (45%). To pass the course, these students will have to obtain, at least, 18 points out of 45 in the long answer test, and obtain a minimum of 50 points in total.

Alternatively, these students can also opt for a exam-only assessment, which covers all the contents of the course. In this case, the students will have to inform the professor one month prior to the final exam. Otherwise, it will be understood that the student opts for continuous assessment.

The rest of students (i.e., those that opted for a system of continuous assessment and do not fulfil the requirements of (a) and (b) above, and those students that opted for a exam-only assessment) will be evaluated by a exam-only assessment, which covers all the contents of the course.

In the case of choosing a exam-only assessment, the professor may demand the student to deliver some additional tasks, which will be notified by one month before the exam. These tasks have to be delivered at the day of the exam. To pass the course the student will have to obtain, at least, 50 points out of 100 in the final exam together with the additional tasks.

End-of-program call:

It follows the same rules as the evaluation in the second call.

Ethical code:

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

Sources of information

Basic Bibliography

J. Capmany, F. J. Fraile Peláez y J. Martí, **Fundamentos de Comunicaciones Ópticas**, 2ª Edición, Síntesis, 2001

J. Capmany, F. J. Fraile Peláez y J. Martí, **Dispositivos de Comunicaciones Ópticas**, 1ª Edición, Síntesis, 1999

Complementary Bibliography

G. P. Agrawal, **Fiber-Optic Communication Systems**, 4ª Edición, Wiley-Interscience, 2010

G. Keiser, **Optical Fiber Communications**, 5ª Edición, McGraw-Hill, 2014

Recommendations

Contingency plan

Description

In the case of online teaching, the planning will be as follows:

- Teaching of Group A: The contents will be exactly the same as those corresponding to face-to-face teaching.

- Teaching of Group B: The hardware exercises in the lab will be replaced by detailed theoretical online explanations about them.

- Assessment: The assessment will be online. We will replace the two short answer tests about the lab with a single oral test (15%), and the long answer test will now have a weight of 60%. The realisation of projects will still have a weight of 25%, which means that the tasks that the student realises along the semester will now weight 40% (which includes the projects and the single oral test).

IDENTIFYING DATA				
Wireless Systems and Networks				
Subject	Wireless Systems and Networks			
Code	V05G300V01615			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Pérez Fontán, Fernando			
Lecturers	Pérez Fontán, Fernando			
E-mail	fpfontan@uvigo.es			
Web	http://http://faitic.uvigo.es/			
General description	(*)(*) A general overview of current wireless communications systems will be provided including standards and dimensioning issues.			

Competencies	
Code	
CB2	Students can apply their knowledge to their jobs in a professional way and they have competences that are typically demonstrated through devising and sustaining arguments and solving problems within their field of study.
CB3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical topics.
CB4	Students can communicate information, ideas, problems and solutions to both general and specialized public.
CG1	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.
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.
CG9	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.
CG13	CG13 The ability to use software tools that support problem solving in engineering.
CE1	CE1/FB1: The ability to solve mathematical problems in Engineering. The aptitude to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, differential and partial differential equations; numerical methods, numerical algorithms, statistics and optimization
CE3	CE3/FB3: Comprehension and command of basic concepts about the general laws of mechanics, thermodynamics, electromagnetic fields and waves and electromagnetism and their application to solve Engineering problems.
CE4	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.
CE5	CE5/FB5: The necessary knowledge of business concepts, of law and institutional frameworks. business organization and management .
CE6	CE6/T1: The ability to learn independently new knowledge and appropriate techniques for the conception, development and exploitation of telecommunication systems and services
CE7	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.
CE8	CE8/T3: The ability to use software tools for bibliographical resources search or information related with electronics and telecommunications.

CE10	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.
CE11	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.
CE12	CE12/T7: The knowledge and use of basics in telecommunication networks, systems and service programming.
CE13	CE13/T8: The ability to understand the electromagnetic and acoustic wave mechanisms of propagation and transmission, and their corresponding receiving and transmitting devices.
CE16	CE16/T11: The ability to use different energy sources, especially photovoltaic and thermal ones, as well as the fundamentals of power electronics and electronics
CE21	CE21/ST1 The ability to construct, exploit and manage telecommunication networks, services, process and applications, considered as systems of receiving, transporting, representation, processing, storage, management and presentation of multimedia information from the point of view of transmission systems.
CE22	CE22/ST2 The ability of applying the basic techniques of telecommunication networks, services and applications for mobile and fixed environments, personal, local or long distance, with different bandwidth, including telephony, radio broadcasting, TV and data, from the point of view of transmission systems.
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.
CE28	CE28/TEL2 The ability to apply the techniques that are basis of computer networks, services and applications, such as management, signaling and switching, routing and securing systems (cryptographic protocols, tunneling, firewalls, charging mechanisms, authentication and content protection) traffic engineering (graph theory, queuing theory and teletraffic) rating, reliability and quality of service in both fixed, mobile, personal, local or long distance environments with different bandwidths, including telephony and data.
CT1	CT1 Development of sufficient autonomy to carry out works within the area of Telecommunications in interdisciplinary contexts.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes

Learning outcomes	Competences			
Cellular and wireless network specifications.		CG7	CE1 CE3 CE6 CE7 CE10 CE22	
To apply previously acquired knowledge on wave propagation for the planning of radio networks.		CG1 CG5 CG8 CG9 CG13	CE6 CE10 CE16 CE21	
To specify the various elements (antennas, transmitters and receivers) which make up a global system.	CB2 CB3 CB4	CG1 CG2 CG7 CG8	CE5 CE8 CE12 CE25	CT1 CT2
Provide access solutions to communications systems.	CB2	CG4 CG8	CE3 CE4 CE12 CE13 CE22 CE28	CT1
Develop roll-out models which minimize the social and environmental impact of the radio communication networks, understanding the ethic and moral responsibilities involved in such work.	CB2 CB4	CG1 CG2 CG3 CG4 CG5	CE11 CE22	CT1 CT2 CT3 CT4

Contents

Topic

Theory 1. Introduction to radiocommunications	Basic concepts Current situation
Theory 2. Cellular systems	Fundamental concepts The radio propagation channel Multiple access techniques Interference Network sizing up Countermeasures Medium access control. Security and access control. Network management. Mobility management. Quality of service.
Theory 3. Review of cellular and wirelss lan standards and other proposals	Cell network generations. Evolution for the technological solutions in each generation.
Tutored work 1. Introduction to multipath effects	Reproducing multipath fading Doppler effect Narrow and wideband channel
Lab. 1. Introduction tho the radio channel	Statistical representation.
Lab 2. Channel effects on 3G	DS-SS
Lab 3. Introduction to 4G standard LTE	OFDMA

Planning

	Class hours	Hours outside the classroom	Total hours
Mentored work	7	14	21
Problem solving	6	18	24
Practices through ICT	14	28	42
Introductory activities	1	0	1
Lecturing	12	0	12
Objective questions exam	1	0	1
Report of practices, practicum and external practices	0	8	8
Problem and/or exercise solving	1	0	1
Essay	0	14	14

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

Methodologies

	Description
Mentored work	GROUP AND INDIVIDUAL. Simulation work to be carried out in Matlab language will be proposed to C class gropus where they will go deeper into specific issues discussed in less detail in the theoretical classes. Through this methodology the competencies CG2, CG4, CG7, CT2 and CE21
Problem solving	INDIVIDUAL.The theoretical treatment of the various topics studied in theoretical classes will be complemented by performing numerical calculations relative to radio network dimensioning. Through this methodology the competencies CG2 and CE22
Practices through ICT	GROUP AND INDIVIDUAL. In laboratory sessions (type B) various Matlab simulations will be proposed to the students in order to study specific topics which are more suitably aproached this way. Through this methodology the competencies CE21, CE22 and CE25
Introductory activities	In the course of the explanations provided in the lectures as well as during lab work or supervised work mention will be made to concepts already presented in earlier lectures from previous years
Lecturing	INDIVIDUAL. In classroom lectures the more theoretical issues will be presented. Through this methodology the competencies CE21, CE22, CE25 and CT2

Personalized assistance

Methodologies	Description
Lecturing	The student will be able to consult individually during tutoring hours all his/her doubts arising during the study of the theoretical contents as well as in the resolution of numerical exercises, laboratory work and supervised projects
Mentored work	The student will be able to consult individually during tutoring hours all his/her doubts arising during the study of the theoretical contents as well as in the resolution of numerical exercises, laboratory work and supervised projects
Problem solving	The student will be able to consult individually during tutoring hours all his/her doubts arising during the study of the theoretical contents as well as in the resolution of numerical exercises, laboratory work and supervised projects
Practices through ICT	The student will be able to consult individually during tutoring hours all his/her doubts arising during the study of the theoretical contents as well as in the resolution of numerical exercises, laboratory work and supervised projects

Introductory activities	In the same way as with the above points, personalized attention will be provided to the students in all aspects related to introductory activities.

Assessment

	Description	Qualification	Evaluated Competencess	
Objective questions exam	Adequate knowledge of the theoretical materials of the lecture will be assessed by means of short response questions during the final exam. A minimum mark of 3 over 10 points is set for this part. Continued class attendance will be evaluated.	25	CE21 CE22 CE25	CT2
Report of practices, practicum and external practices	For each lab assignment, the students in pairs, will present an individual written report. The evaluation will be carried out by means of (1) group reports and (2) an specific part in the final exam to be taken individually. The weights of parts one and two will be 2/3 and 1/3, respectively. A minimum mark of 3 over 10 points is set for this part. Continued class attendance will be evaluated.	25	CE21 CE22 CE25	CT2
Problem and/or exercise solving	In the final exam, there will be a part containing various short numerical problems. A minimum mark of 3 over 10 points is set for this part.Continued class attendance will be evaluated.	25	CG2 CE21 CE22 CE25	
Essay	The evaluation of supervised group work (C classes) will be carried out through (1) a group report and (2) a specific test to be taken individually. The weights of parts one and two will be 2/3 and 1/3, respectively. A minimum mark of 3 over 10 points is set for this part.Continued class attendance will be evaluated.	25	CG4 CG7 CE21 CE22 CE25	

Other comments on the Evaluation

GENERAL.FIRST CALL

If possible all skills pertaining to this subject will be evaluated in all the various tests and exercises proposed: short answer tests, lab reports, problem solving and projects.

For those who choose to take the Final Exam (alternatively to Continuous Assessment), this will have a weight of 100% of the final grades and will cover all issues dealt with in the theoretical lectures, the problem solving lectures, tutored group work and laboratory. In this case, it will not be compulsory to present all lab and supervised project works. The exam will contain a fourth part to asses the concepts presented in the supervised work classes.

As a minimum grade is set for each part making up the final evaluation, if this threshold is not exceed in any of the four parts, the final mark will be limited, as a maximum, to this threshold.

The schedule for the various intermediate tests will be decided at a (Academic Commission) CAG meeting and published at the beginning of the semester.

The grades for the lab. work and group work will only be valid during the current school year.

Those students who choose the Continuous Assessment option shall inform the professor of this during the first few weeks of the school term. The Continuous Assessment option entails the completion of all activities proposed: lab works and group work, and taking all tests comprising the Continuous Assessment route. Those students not fulfilling the above will be assessed with the final exam only.

A student will be attributed the "no presentado" grade if he or she has not followed the full Continuous Assessment route and has not taken the final exam. In case of choosing the Continuous Assessment option, the student will be graded "no presentado" in he or she has not taken the final exam.

SECOND AND END-OF-PROGRAM CALLS

Evaluation will be different for those following the Continuous Evaluation path and those following the Exam-only path. For the Continuous Assessment case, the student will only need to take those part of the finals exam he or she failed. Exam-only students will have to take the full final exam.

Evaluation in the case of end-of-program call will be done on the basis of a final exam.

ETHICS CODE

Should a case of plagiarism be detected in any of the various activities and tests , the final mark will be FAILED (0) and the school direction team will be advised on the fact.

Sources of information

Basic Bibliography

José María Hernando Rábanos, **Comunicaciones Móviles. 2ª ed.**, Ed. Centro de Estudios Ramón Areces, S.A., 2014

F.Pérez-Fontán and P.Mariño Espiñeira, **Modeling of the wireless propagation channel. A simulation approach with Matlab**, Wiley, 2008

Oriol Sallent Roig, Jordi Pérez Romero, **Fundamentos de diseño y gestión de sistemas de comunicaciones móviles celulares**, UPC, 2014

Complementary Bibliography

Fernando Pérez Fontán, Sigfredo Pagel Lindow, **Introducción a las. Comunicaciones Móviles**, Servicio de Publicaciones. Universidad de Vigo, 1997

José María Hernando Rábanos, **Comunicaciones Móviles de Tercera Generación**, Telefónica Móviles, 2000

Simon R. Saunders, **Antennas and Propagation for Wireless Communications Systems**, Wiley, 2007

José María Hernando Rábanos, Fernando Pérez Fontán, **Introduction to Mobile Communications Engineering**, Artech House, 1999

Ramón Agustí Comés, **LTE: nuevas tendencias en comunicaciones móviles**, Fundación Vodafone, 2010

Recommendations

Subjects that it is recommended to have taken before

Radio Frequency Circuits/V05G301V01319
Radio Communication Systems/V05G301V01320

Contingency plan

Description

In case the teaching will be done exclusively by telematic means, the planing of this lecture will be as follows:
*The teaching of A, B and C groups will be carriead out by telematic means through the classrooms in Campus Remoto.
*All group A, B and C sessions will provide the same contents as indicated in this guide.

In case the teaching will be done exclusively by telematic means, student assessment will de carried according to the following criteria:
*The various parts of the final exam will take place in a synchronous way through the classrooms in Campus Remoto.
*Any other parts will assessed by grading the various reports provided by the students.

IDENTIFYING DATA				
Radio Spectrum Management				
Subject	Radio Spectrum Management			
Code	V05G300V01616			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	García Sánchez, Manuel			
Lecturers	García Sánchez, Manuel Torío Gómez, Pablo			
E-mail	manuel.garciasanchez@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Radio spectrum management pursues the most efficient use of the radio spectrum (a natural, limited and scarce resource), by applying effective processes that facilitate the implementation of communication systems and guarantee minimum interference between them. Engineering, planning and management tools, as well as measurement equipment and techniques to survey the use of the radio spectrum are needed to acomplish these objectives. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.
CG9	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.
CE21	CE21/ST1 The ability to construct, exploit and manage telecommunication networks, services, process and applications, considered as systems of receiving, transporting, representation, processing, storage, management and presentation of multimedia information from the point of view of transmission systems.
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes			
Learning outcomes	Competences		
Understand the concepts of frequency allocation, allotment and assignment.	CG6	CE21	
Apply concepts of base station certification.	CG6 CG7 CG8	CE21	
Propose solutions for fulfilment the broadcast limits.	CG5 CG6 CG7 CG8	CE25	
Interference analysis	CG5 CG6 CG8 CG9	CE21 CE25	CT4
Field measurements	CG5 CG9	CE21 CE25	CT4

Contents	
Topic	
Introduction	Introduction to the matter. General concepts.
Spectrum management	National and international regulatory bodies International management and coordination National management The Telecommunications Law National telecommunication Plans CNAF
Spectrum engineering	Specifications of telecommunication equipment. Radio wave propagation. Coverage. Interferences. Re-use distance. Techniques to share the spectrum.
Modulations	Definitions The radio channel Objective of the modulation Types Analog Modulations: AM, FM Digital Modulations Wideband Modulations MIMO
Frequency planning	Trellis method List method Other methods Examples
Technical surveillance	The spectrum analyzer The wideband sounder Measurement procedures for radioelectric base station certification

Planning			
	Class hours	Hours outside the classroom	Total hours
Laboratory practical	15	30	45
Practices through ICT	6	9	15
Lecturing	19	19	38
Objective questions exam	2	50	52
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Laboratory practical	Activities of application of the acquired knowledge to particular situations. Acquisition of basic skills related with the matter. Specific measurement equipment as Spectrum Analysers , Field level sounders, etc, will be used. Through this methodology the competencies CG5, CG6, CG8, CG9, CE21, CE25 and CT4 are developed. Group activity.
Practices through ICT	The student, alone or in a small group with other students, elaborates a report on a given subject. This includes the search of the information, reading, writting, etc Through this methodology the competencies CG9 and CT4 are developed. Group activity.
Lecturing	Field activities. Activities of application of the acquired knowledge to particular situations. Acquisition of basic skills related with the matter. Specific measurement equipment as Spectrum Analysers , Field level sounders, etc, will be used. Through this methodology the competencies CG5, CG6, CG7, CG8, CG9, CE25 and CT4 are developed. Group activity.

Personalized assistance	
Methodologies	**Description**
Lecturing	The students will be able to resolve doubts and questions during the activity, in the scheduled tutoring hours or by means of email.

Laboratory practical	The students will be able to resolve doubts and questions during the activity, in the scheduled tutoring hours or by means of email.
Practices through ICT	The students will be able to resolve doubts and questions during the activity, in the scheduled tutoring hours or by means of email.

Tests	**Description**
Objective questions exam	The students will be able to resolve doubts and questions during the activity, in the scheduled tutoring hours or by means of email.

Assessment

	Description	Qualification	Evaluated Competencess		
Laboratory practical	These practices are made in groups. In some cases the qualification of each student will be the one of the group and in others by means of an individual exam about the practice.	42		CE21 CE25	
Practices through ICT	Calculation of the coverage area of an AM radio station. This practice is made in groups but will be evaluated individually by means of the assistance, the performance during the realisation and by means of the memory of the practice delivered by the group.	8	CG6 CG9	CE21 CE25	CT4
Objective questions exam	Individual exam with questions and problems from the contents of the lectures.	50	CG5 CG6 CG7 CG8	CE21 CE25	

Other comments on the Evaluation

1) First call. We offer students two ways of assessment: continuous assessment and exam-only assessment. Students will have to opt by one of them. The delivery of a report or participation in anyone of the exams of continuous evaluation means that you opt by this type of assessment and your qualification could not be "not presented". The attendance to the practices is compulsory if you opt by continuous assessment.

1.a) Continuous assessment. Assessment will be made according to the results of the report of the computer practice, the tests of the lab practices and the two partial exams about the lecture contents. One of these partial exams will be conducted at the middle of the lecture period and the other after the end of the lectures. These tasks are not recoverable and only are valid for the current course.

1.b) Exam-only assessment. Students that do not opt by continuous assessment will have an exam about the lectures contents (50%) and another one about the practices (50%) in the official exam date fixed by the School.

2) Second call. Students that opted previously by continuous assessment will have the chance to repeat just the exam about the lecture contents (50%) or take a full exam of the subject (100%), including lectures (50%) and practices (50%). They will have to tell to the coordinator of the subject about the option that choose before the official date of the exam. The rest of the students will take a full exam of the subject (100%), including lectures (50%) and practices (50%).

3) End-of-program call. Full exam of the subject (100%), including lectures (50%) and practices (50%).

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

Sources of information

Basic Bibliography

International Telecomunication Union, **National Spectrum management Manual**, 2005,

Complementary Bibliography

International Telecomunication Union, **ITU-R recommendations**,
International Telecomunication Union, **Radiocomunication Rules**, 2012,
Gretel-COIT, **La evolución de la gestión del espectro radioeléctrico**, 2007,
SETSI, **Cuadro Nacional de Atribución de Frecuencias**, 2013,

Recommendations

Subjects that it is recommended to have taken before

Contingency plan

IDENTIFYING DATA				
Electronic Instrumentation and Sensors				
Subject	Electronic Instrumentation and Sensors			
Code	V05G300V01621			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Mariño Espiñeira, Perfecto			
Lecturers	Mariño Espiñeira, Perfecto Pastoriza Santos, Vicente			
E-mail	pmarino@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main purpose of the subject is to provide the theoretical and practical skills for the design and characterization of electronic instrumentation systems, and the range of sensors which provide analogical and digital signal in the input stage of said instrumentation systems. Course outline: + Analysis of sensor parameters. + Basic concepts about the physical principles of the sensors. + The most important application of sensors in electronic instrumentation. + Electronic instrumentation architectures, from the simplest point to point systems to the most complex distributed systems. International standards for electronic instrumentation are presented. + Design of programmable instrumentation: GPIB, VXI and PXI buses. + Classification of architectures for electronic instrumentation. Introduction of wired and wireless field buses. The main goal of the laboratory sessions (practical work) is to enable the students to acquire sufficient understanding and knowledge to: +Analyse the parameters and main features of the sensors integrated in the electronic instrumentation systems. + Know the applications of each group of sensors. + Manage specific software tools to design (virtual) instruments that allow store, display and analyse recorded data. + Use specific software tools to work with buses of instrumentation programmable. The documentation of the course will be in Spanish. It will be taught in Galician and Spanish. It will be assessed in Spanish.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CE42	(CE42/SE4): The ability to apply electronics as support technology in other fields and activities and not only in information and communication technologies.
CE46	(CE46/SE8): The ability to specify and use electronic instrumentation and measurement systems.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes			
Learning outcomes	Competences		
Knowledge of the distinct types of sensors and his applications.	CG3	CE42 CE46	CT2 CT3
Capacity for the development of electronic circuits of conditioning of signal.	CG4 CG5	CE42 CE46	CT2 CT3

Knowledge and utilisation of computer tools for treatment of data and representation of the information.	CG4 CG5	CE42 CE46	
Knowledge of the basic principles of the programmable instrumentation and his utilisation.	CG3	CE42 CE46	CT2 CT3

Contents	
Topic	
Unit 1: Introduction to sensors.	Energy conversions. Concepts of sensor, transducer and actuator. Dynamic and static features. Other features. Selection of sensors.
Unit 2: Temperature resistive sensors. Strain gauges.	Temperature resistive sensors: General features. Types. Conditioning . Application examples. Strain gauges: Basic principles. General features. Types of using. Conditioning . Application examples.
Unit 3: Photoresistive and Optoelectronic. Other resistive sensors.	Photoresistive and Optoelectronic: Basic principles. General features. Encoders. Conditioning. Application examples. Other resistive sensors: Gas sensors. Magnetoresistors. Potentiometers. Basic principles. General features. Conditioning . Application examples.
Unit 4: Capacitive sensors. Inductive and magnetic sensors.	Capacitive sensors: Introduction. Measurements principles. Features. Conditioning. Proximity sensors. Application examples. Inductive and magnetic sensors: Introduction. Basic principles. Variable transformer types. Features. Conditioning. Hall effect sensors. Application examples.
Unit 5: Thermocouples. Other sensors.	Thermocouples: Basic principles. General features. Calibration scales. Conditioning. Application examples. Other sensors: Pyroelectric. Ultrasounds. Magnetostrictive.
Unit 6: Programmable instrumentation.	Programmable instrumentation. Switched instrumentation. Hybrid systems on instrumentation. GPIB bus: General features. Configurations and equipment. Standards IEEE 488.1/488.2. Transference procedures. Standard HS488. GPIB command groups. Basic functions. Integrated circuits. Controllers on cards. SCPI Standard. Design environments for ATE systems.
Unit 7: Standard multiprocessor buses.	Systems on cards. Applications of standard buses. Classification. Types of connectors and cards. Multiprocessor systems. Common memory multiprocessor systems. Multiplexing. Bus arbiters. Arbiter techniques. Asynchronous bus concept. Addressing. Data transfer. Interrupts. Electrical design of high speed buses. ECL and TTL signals. Backplane features.
Unit 8: The VME bus.	Introduction . Functional modules. Subbuses and signals. Data transfer. Types of arbitration. System controller. The interrupt chain. Commercial products.
Unit 9: Standards on programmable instrumentation.	Introduction to VXI and PXI buses. Subbuses and signals. Configurations. Types of devices. Products and systems of development. PCI Express and the switched instrumentation. Ethernet and its LXI version for instrumentation. The AXIEe for high features.
Practice 1: Introduction to the LabVIEW Application Development Environment	Introduction to LabVIEW environment by means of basic examples of programming.
Practice 2: Temperature sensors. NTC thermistor.	Signal conditioning and virtual instrument development for measurement
Practice 3: Optoelectronic sensors. PIN photodiode.	Spectral response analysis.
Practice 4: Capacitive sensors. Accelerometer.	Signal analysis and post-processing, and virtual instrument developing for tilt measurement.
Practice 5: Programmable Instrumentation I.	Frequency response test of two RC circuits via the programmable control of the laboratory instrumentation. The programmable control will realise through a USB connection from the PC to each instrument.

Practice 6: Programmable Instrumentation II.	To develop an application that verify the frequency response of a RC circuit by means of the programmable control of some of the instruments situated in a VXI chassis. The programmable control of each instrument from the PC will realise through a LAN connection and using a GPIB - Ethernet gateway .

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	1	3
Lecturing	16	16	32
Laboratory practical	14	28	42
Mentored work	7	29	36
Objective questions exam	3	34	37

*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. Individual task. In these sessions, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be worked.
Lecturing	The lecturer will explain in the classroom the main contents of the subject. The students, individually, 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 at the office. In these sessions, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be worked.
Laboratory practical	Small-group activities designed to apply the main concepts and definitions of the subject. The student 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 student has to develop and demonstrate autonomous learning and collaborative skills. He/she is supposed to be able to manage bibliography and recently acquired knowledge. Possible questions can be answered in the laboratory sessions or at the lecturers office. In these practises, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be worked.
Mentored work	The students have to manage basic concepts to search and select information in order to get a deeper understanding in some specific fields related to the subject. This is a group activity. The lecturer will propose in the classroom the topic of this group task and monitor the students work in personalized attention sessions. In these sessions, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be worked.

Personalized assistance

Methodologies	Description
Lecturing	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will answer the students questions and also give instructions to guide the studying and learning process.
Laboratory practical	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will help students understand the work to be developed in the laboratory (components, circuits, instrumentation and tools).
Mentored work	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will help students to deal with the monitored work.

Assessment

Description	Qualification	Evaluated Competencess

Laboratory practical	The lecturers will check the level of compliance of the students with the goals related to the laboratory skills. They will consider the work of the students carried out before the practical session to prepare the proposed tasks, the attendance, and the quality of the work done. Marks for each session (LSM: Laboratory Session Mark) will be assigned in a 10 points scale. Final mark of laboratory, FML, will be assessed in a 10 points scale. For the evaluation of these sessions, the lecturer will assess the group work (the same mark for each member), the individual preliminary tasks and the answers to personalised questions for each session. In these practices, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be assessed.	35	CG3 CG4 CG5 CE42 CE46 CT2 CT3
Mentored work	The lecturers will consider the quality of results obtained, their presentation and analysis, and the quality of the final report. The tutored work mark, TWM, will be graded in a 10 points scale. For the evaluation of the project, the lecturer will assess the group work (the same mark for each member). In these works, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be evaluated.	15	CG3 CG4 CG5 CE42 CE46 CT2 CT3
Objective questions exam	The lecturers will check the level of compliance of the students with the goals related to the theory skills. 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. In these tests, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be evaluated.	50	CG3 CG4 CG5 CE42 CE46 CT2 CT3

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 short answer test or attend at least two laboratory sessions, **they will be assessed by continuous assessment.**

The subject comprises three different parts: theory (50 %), laboratory practical (35%) and tutored work (15%). The marks are valid only for the current academic course. The final grade for the students which have selected this option, may not be "no standing".

1.a Theory

Two partial testing (PT) are scheduled. The first exam will be performed after unit 5, in the usual weekly scheduling of the theoretical classes. The second exam will be performed during the examination period in the date specified in the academic calendar.The students cannot do the exams at a later date.

Each theory exam will be comprised short answer tests and long answer development. Marks for each theory exam (TEM) will be assessed in a 10 points scale. The classroom attendance (CA) during the academic course will be graded in a 1 point scale.

The final mark of each partial testing will be calculated by the expression:

PTi = min({ 10; (1+0.1·CA)·TEMi }) i=1,2.

The final mark of theory (FMT), will be the arithmetic mean of the two parts:

FMT = (PT1 + PT2)/2

The minimum mark required to pass the theory is of 5 for each test (PTi>=5). If the minimum mark in the first test is not achieved (PT1 less than 5), the students can repeat this part in the same date of the second exam.

1.b Laboratory

Seven laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in small groups. This part also will be assessed by continuous assessment. Marks for each laboratory session (LSM) will be assessed in a 10 points scale.

The final mark of laboratory (FML) is calculated as the arithmetic mean of the individual laboratory session marks.

In order to pass the laboratory part the students can not miss more than one practical sessions and the minimum mark required is of 5 (FML>=5). These absences must be excused with a valid documented reason (medical, bereavement or other), otherwise FML=0.

1.c Tutored work

In the first session of C hours, lecturers will present the objectives and the schedule of the work. They also assign a specific work to each group. After that, the most important part of the workload will be developed outside the classroom hours. The lecturers will monitor the group work and the individual student work in the following sessions of C hours. The students will be duly informed by the lecturer about the deadline for the report submission.

The minimum mark required to pass this part is of 5, TWM (Tutored Work Mark) >=5, and the students are only allowed to miss one tutored work session. This absence must be excused with a valid documented reason (medical, bereavement or other), otherwise TWM=0.

2. Single assessment

The students who prefer a different educational policy can attend an exam on a scheduled date. This exam will comprise three parts (similar to the activities completed by the continuously assessed students): theory exam, practical exam and tutored work. Dates will be specified in the academic calendar. In order to attend the practical exam and to assign the tutored work, the students have to contact to the lecturer according to an established procedure. The procedure will be published in advance.

The theory exam will be comprised two exams (PT) each one with short answer tests and long answer development. Marks for each test will be assessed in a 10 points scale. The final mark of theory (FMT) is calculated as the arithmetic mean of the individual marks:

FMT = (PT1 + PT2)/2

The practical exam will include the implementation of electronic circuits developed in the laboratory sessions as well as some short answer questions related to these sessions. The practical exam will be assessed in a 10 points scale and this mark will be the final mark of laboratory (FML).

The student will also do a tutored work and prepare a written report to be handed in just before the exam.

3. Final mark of the subject

In order to pass the subject, students will be required to pass the three parts:

- theory: FMT>=5 with PT1>=5 and PT2>=5
- and laboratory: FML>=5
- and tutored work: TWM>=5

In this case the final mark (FM) will be:

FM = 0.5·FMT + 0.3·FML + 0.15·TWM

However, when the students do not pass all parts, the final mark will be:

FM = min({ 4.5; 0.5·FMT + 0.3·FML + 0.15·TWM })

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

4. Second opportunity and extraordinary call

The assessment policy in these calls will follow the scheme described in the single assessment: a theory exam, a practical exam and a tutored work. Dates will be specified in the academic calendar. In order to attend the practical exam and to assign the tutored work, the students have to contact to the lecturer according to an established procedure. The procedure will be published in advance.

The marks obtained during the current academic year in the first opportunity are kept in the second one for those parts in which the student has not attended. Moreover, in the second opportunity, the students can not take an exam or a tutored work task if they have got a pass previously in the first opportunity.

The final mark will be calculated as it has described in section 3.

Sources of information

Basic Bibliography

Black, J. (editor), **The system engineering handbook: a guide to building VME bus and VXI bus Systems**, Academic Press, 1992

Mariño, P., **Las comunicaciones en la empresa: normas, redes y servicios**, 2ª ed., RAMA, 2002
Norton, H., **Sensores y analizadores**, Gustavo Gili D.L., 1984
Pérez García, M.A., **Instrumentación Electrónica**, 1ª ed., Ediciones Paraninfo, S.A., 2014
Pérez García, M.A., Álvarez Antón, J.C., Campo Rodríguez, J.C., Ferrero Martín, F.J., y Grillo Orteg, **Instrumentación Electrónica**, 2ª ed., Thomson, 2004

Complementary Bibliography

del Río Fernández, J., Shariat-Panahi, S., Sarriá Gandul, S., y Lázaro, A.M., **LabVIEW: Programación para Sistemas de Instrumentación**, 1ª ed., Editorial Garceta, 2011

Recommendations

Subjects that are recommended to be taken simultaneously

Programmable Electronic Circuits/V05G301V01302
Analogue Electronics/V05G301V01311
Data Acquisition Systems/V05G301V01314

Contingency plan

Description

In case of exclusively online teaching, then the planning will be as follows:
*The teaching in groups A, B and C will be taught through classrooms on the Remote Campus.
*In A sessions, the same content described in the guide will be developed. The tasks in B sessions will try to adapt, as far as possible, to be able to be carried out with simulators; and in C sessions, the students will carry out a work assigned by the teacher.

In case of exclusively online teaching, the evaluation will be as follows:
*The objective tests will be carried out synchronously in classrooms of the Remote Campus.

IDENTIFYING DATA				
Microelectronics Design				
Subject	Microelectronics Design			
Code	V05G300V01622			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Cao Paz, Ana María			
Lecturers	Cao Paz, Ana María Rodríguez Pardo, María Loreto			
E-mail	amcaopaz@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main purposes of this course are for the students: 1) To get acquainted with integrated circuits (ICs) and micro-electro-mechanical systems (MEMs) fabrication technologies. 2) To get acquainted with CMOS fabrication processes for ICs and MEMs. 3) To analyze the physical structure of passive components and active devices in CMOS technology. 4) To get acquainted with the basic aspects of MEMs design. 5) To work with CAD tools for the design.of CMOS ICs English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CB3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical topics.
CG1	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG9	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.
CG13	CG13 The ability to use software tools that support problem solving in engineering.
CE8	CE8/T3: The ability to use software tools for bibliographical resources search or information related with electronics and telecommunications.
CE16	CE16/T11: The ability to use different energy sources, especially photovoltaic and thermal ones, as well as the fundamentals of power electronics and electronics
CE17	CE17/T12: The knowledge and usage of concepts of communication network architecture, protocols and interfaces.
CE42	(CE42/SE4): The ability to apply electronics as support technology in other fields and activities and not only in information and communication technologies.
CE43	(CE43/SE5): The ability to design analogical and digital electronics circuits of analogical to digital conversion and vice versa, of radiofrequency, of feeding and electrical energy conversion for computing and telecommunication engineering.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	Competences		
To know and understand integrated circuits (ICs) and micro-electro-mechanical systems (MEMs) fabrication processes.		CE42	
To know and understand CMOS fabrication processes for ICs and MEMs, as well as the corresponding design methodologies and the steps in the development of an IC.	CG1 CG6	CE16 CE17 CE43	
To know and be capable of analizing the physical structure of resistors, capacitors, and transistors in CMOS technology.	CG6 CG9	CE43	CT4

To know and understand the basic aspects of MEMs design and their basic structures	CB3	CE8 CE42	
To be capable of working with CAD tools for the design of CMOS ICs	CG6 CG9 CG13		CT4

Contents	
Topic	
Chapter 1: Introduction (1h)	Course introduction. Purposes and planning of the course. Basic concepts in the design of integrated circuits (ICs) and micro-electro-mechanical systems (MEMs).
Chapter 2: Fabrication steps for ICs and MEMs (2h)	Introduction to ICs and MEMs fabrication. Planar technology. Micromachining and micromolding technologies. CMOS IC fabrication steps. Structure of MOS transistors. Fabrication example: CMOS inverter. Layout. MEMs fabrication steps: bulk micromachining, surface micromachining, and LIGA.
Chapter 3. ICs and MEMs fabrication processes (3h)	Silicon wafers. Epitaxial layers. Dielectric layers. Oxidation. Deposition. Semiconductor layers. Dopant diffusion. Ion implantation. Photolithography. Etching. Metalization.
Chapter 4. Modeling of MOS transistors (3h).	MOS transistors: analytical model. Higher-order effects. Fundamentals of Spice modeling and simulatin. Spice models of MOS transistors.
Chapter 5. Physical structure of basic elements (2h)	Specification of the physical structure of a MOS transistor. Specification of the physical structure of a resistor. Specification of the physical structure of a capacitor. Types of physical specifications. Influence of physical design in the behavior of a device. Design rules. Design methodologies and tools.
Chapter 6. Resistor layout strategies (1h)	Lateral diffusion. Effective geometric dimensions. Influence of the terminals. Long resistors. Unit resistors. Stacked resistors. Neighborhood effects. Dummies. Interdigited and common centroid structures.
Chapter 7. Capacitor layout strategies (1h)	Oxide thickness gradient, lateral diffusion, and neighborhood effects. Area and perimeter unit capacitances.
Chapter 8. Transistor layout strategies (2h)	Transistor with high aspect ratio. Stacked transistors. Interdigited structures.
Chapter 9. Physical design case studies (3h)	Basic current mirror. Self-biased differential amplifier.
Lab assignment 1. Introduction to IC design tools (2h)	Introduction to physical design tools. Basic layout elements and individual nMOS and pMOS transistors. Design Rule Check (DRC). Predesigned elements and transistors.
Lab assignment 2. CMOS inverter (4h)	Schematic design of a CMOS inverter. Corrections for symmetrical response. Simulation with capacitive loads. Layout design and DRC. Layout Versus Schematic (LVS). Post-layout simulation (without and with capacitive load). Comparison with schematic simulation.
Lab assignment 3. MOS transsitor layout strategies (2h)	Layout of pMOS and nMOS transistors. Snake, stacked, and interdigited structures. Dummy structures.
Lab assignment 4. Physical design of analog functional blocks: current mirror and differential pair (3h)	Layouts of a basic curent mirror and a self-biased pMOS differential amplifier.
Lab assignment 5. Passive components layout strategies (2h)	Layouts of resistors and capacitors. Linear, snake, stacked and interdigited structures. Dummy structures.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	18	45	63
Practices through ICT	13	19.5	32.5
Project based learning	6	27	33
Presentation	1	2.5	3.5
Problem and/or exercise solving	1	3.5	4.5
Problem and/or exercise solving	2	7	9
Laboratory practice	1	3.5	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

Lecturing	The professor will present the relevant concepts of the course. Before each lecture, students must carry out a preparatory analysis of the topics to be addressed, aiming at their active participation. Practical examples and case studies will be developed and analyzed. Attendance will be recorded. Competencies CE42 and CE43 will be addressed in these sessions
Practices through ICT	Students will work in groups of two people, using IC CAD tools. All relevant steps in the physical design of an IC will be practically studied. Attendance will be recorded, and performance of each group in each lab assignment will be evaluated. Competencies CE43 and CG13 will be addressed in these sessions
Project based learning	Students will work in small teams (C-type groups) in the physical design and characterization of a circuit consisting of active devices and passive components, under the close guidance of professors. Attendance will be recorded. The activities to be developed by each team are: - Analysis of possible solutions and design alternatives. - Critical analysis of the design process developed. - Demonstration of the circuits designed in the project. - Preparation of a report where results are presented, analyzed, and discussed. Competencies CE43, CG6, CG9, CG13, and CT4 will be addressed in these sessions.
Presentation	Each group of students will publicly present their project to professors and the other students in the group. Anyone in the audience will be allowed to ask questions about the project. Competencies CE43, CG6, CG9, and CT4 will be addressed in these sessions.

Personalized assistance

Methodologies	Description
Lecturing	Professors will personally assist students with doubts and questions they may have about either theoretical contents. Office hours will be scheduled for both individual and group sessions.
Practices through ICT	Professors will personally assist students with doubts and questions they may have about lab assignments. Office hours will be scheduled for both individual and group sessions.
Project based learning	Professors will personally assist students with doubts and questions they may have about the development of the projects. Office hours will be scheduled for both individual and group sessions.
Presentation	Professors will personally assist students with doubts and questions they may have about the preparation of the public presentations. Office hours will be scheduled for both individual and group sessions.

Assessment

	Description	Qualification	Evaluated Competencess
Project based learning	Each group of students will deliver the design carried out in the project in the format of the integrated circuit design tool. To pass the course, the design must meet technological standards and it shall comply the required specifications. In addition, each group must submit a detailed project report, with explicit information about the contribution of each of them to the whole, as well as the methodology followed for the distribution and coordination of tasks. Based on this division of tasks, it can be assigned an individual mark to each of the group members. The evaluation of the projects will be based on a list of items provided previously. Reports must be submitted on the date indicated in the planning of the course and it will be at least two days prior to the public presentation. To pass the course, students must achieve at least a mark of 5 or higher in a scale of 0-10 in the project (design and reporting). Competencies CE43, CG6, CG9, CG13, and CT4 will be assessed in these projects.	20	CG6 CE43 CT4 CG9 CG13

Presentation	Each student must provide an individual 5-minute public presentation of the part of the project he/she carried out (including planning / coordination tasks, if applicable). Presentations will be scheduled in the last (1-hour) classroom session of the corresponding group. At the end of each presentation, the student must give suitable replies to questions from the audience, which will consist of professors and the other students in the group, who must attend the whole session. Evaluation will be based on the content, formal issues, and deliverance of the presentation, as well as on the way the student replies to que questions from the audience. Students asking relevant questions will get additional score for them. The mark obtained in the public presentation consists of two parts, a common part for tasks carried out jointly and an individual part of the exposition of each student of his or her work as well as the appropriate interventions at the end of the exposure of other groups. To pass the course, the student must achieve in his/her presentation (plus additional score if applicable) a mark of 5 or higher in a 0-10 scale. Competencies CE43, CG6, CG9, and CT4 will be assessed in these presentations.	10	CG6 CG9	CE43	CT4
Problem and/or exercise solving	As part of the continuous assessment, two written individual tests are conducted. The first evaluation 1-hour written test will be held during one of the classroom sessions, covering course contents lectured so far. This test is the last chance for students to decide whether or not they opt for continuous evaluation. All students completing the test implicitly choose to follow continuous evaluation. The remaining students have to explicitly declare their choice. The lack of declaration from a student means he/she will not follow continuous evaluation. The test will consist of short answer questions, accounting for 20% of the global mark. The second written test will be held at the end of classroom sessions, covering the remaining classroom contents and accounting for 5% of the global mark. This test will be held in conjunction with the test of design problems or exercises more fully described below. The test will last for about an hour, including written test and design problems (or exercises) test. Both tests (covering the same course contents and with the same duration and evaluation criteria) will be held in the date of the final exam. They are compulsory for students not in continuous evaluation. Students in continuous evaluation can also voluntarily complete it. In that case, the score they will receive in this part of the course evaluation will be the one achieved in this second test. To pass the course, students must achieve in each of the tests a mark or 4 or higher in a 0-10 scale. Competencies CE42 and CE43 will be assessed in these tests	25		CE42 CE43	
Problem and/or exercise solving	An exam of troubleshooting and / or exercises will be carried out as part of the continuous assessment, accounting for 15% of the global mark. This exam will be held in conjuction with the second written test described in the previous section and it will last for about an hour as a whole. Students in continuous evaluation can also voluntarily complete it again in the date of the final exam. In that case, the score they will receive in this part of the course evaluation will be the one achieved in this second test. For students not in continuous evaluation it is compulsory to carry out this exam (with the same structure, duration and evaluation criteria) on the date of the final exam. To pass the course, students must achieve in this exam a mark or 4 or higher in a 0-10 scale. Competencies CE42 and CE43 will be assessed in this test.	15		CE42 CE43	
Laboratory practice	All students, in continuous evaluation or not, must submit the files of the Lab practices. Deadline for submissions will be communicated sufficiently in advance. These submissions account for 10% of the global mark. All students, in continuous evaluation or not, must submit a complete report based in Lab Assignments 1 and 2 with the achieved results and conclusions according to the indications of the teaching staff. The report is due the indicated date in the planning. The corresponding report account for 10% of the global mark. A continuous evaluation 1-hour lab test using an IC CAD tool will be held in the last scheduled lab session. Another similar test will be held in the date of the final exam. It is compulsory for students not in continuous evaluation. Students in continuous evaluation can also voluntarily complete it. In that case, the score they will receive in this part of the course evaluation will be the one achieved in this second test. Lab tests account for 10% of the global mark. To pass the course, students must achieve a mark or 4 or higher in a 0-10 scale in each part: lab files submissions, Lab Report and the lab test. Competencies CE43 and CG13 will be assessed in this part.	30	CG13	CE43	

Other comments on the Evaluation

The planning of the different tests of intermediate evaluation will be approved by the "Comisión Académica de Grado" (CAG) and it will be available at the beginning of the semester.

In order to pass the course, students must achieve a global mark of 5 or higher in a 0-10 scale. The global mark will be obtained as the weighted summation of the scores obtained in the different parts of the course. A minimum score is required in each of these parts. For students not achieving the minimum score in any of the parts, the global mark will be the lower value between 4 and the weighted summation of scores.

Students not in continuous evaluation will be evaluated as follows:

- Final written and lab tests will account for the same percentage of the global mark as in the case of students in continuous evaluation.
- They must develop a project and deliver the corresponding report and public presentation (in the same sessions and with the same criteria as students in continuous evaluation). Reports are due two days before public presentation.
- They must complete all the lab practice files submissions and deliver the Lab written report with the achieved results and conclusions.

Minimum scores in the different parts for students not in continuous evaluation are the same as for students in continuous evaluation.

Second call and extraordinary call.

Requirements to pass the course in these calls will be the same as in the first call, in terms of the minimum scores. Students must complete the two written tests and the lab test. No new projects and presentations will be allowed except for students not having achieved the minimum required scores on them. Project reports are due seven days before the date of the test. Students who achieved the minimum scores in written and lab tests but not in project reports or presentations, will not need to complete the tests again, but only deliver project reports and presentations. However, they can voluntarily (in written) give up tests scores (at least seven days before the date of the second call) and complete all the tests again.

In the case of the extraordinary call, the students must complete all the tests, submit the practice files, the lab report and the memory of the project 7 days before the date of the test as well as present the project.

Sources of information

Basic Bibliography

José Antonio Rubio Solà, **Diseño de circuitos y sistemas integrados**,
Stephen A. Campbell, **Fabrication Engineering at the Micro-and Nanoscale**, 4ª,
J. Franca, Y. Tsividis (eds.), **Design of analog VLSI circuits for telecommunications and signal processing**,

Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

Analogue Electronics/V05G300V01624

Subjects that it is recommended to have taken before

Digital electronics/V05G301V01203
Physics: Fundamentals of electronics/V05G301V01201
Electronic technology/V05G301V01206

Other comments

All conclusions achieved both in the written tests and in the projects must be adequately justified. Non-trivial concepts cannot be assumed but they have to be explained. The methodologies used by the student will be taken into account in the computation of his/her marks. No auxiliary resources, including but not limited to documentation, can be used in the written tests.

In case of detection of plagiarism in any of the evaluation tests or assignment submissions, the final grade will be SUSPENSE (0) and the fact will be reported to the corresponding academic authorities for prosecution.

Contingency plan

Description

Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes

an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

In the event that face-to-face teaching is not possible, neither the contents nor the learning outcomes will be affected. In this situation, the following adaptations will be made:

Theory sessions and Laboratory sessions:

In the event that they cannot be attended in-class, remote classrooms or any other means enabled by the university will be used for their delivery.

Tutorials:

When face-to-face office hours are not possible, remote attendance will be available: e-mail or any other means enabled by the university.

Assessment:

The assessment criteria will be maintained and the tests will be carried out by physical presence, except if a Rectoral Resolution indicates telematic format. In that case, assessments will be carried out by telematic means according to the university instructions.

IDENTIFYING DATA				
Electronic Systems for Digital Communications				
Subject	Electronic Systems for Digital Communications			
Code	V05G300V01623			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Machado Domínguez, Fernando			
Lecturers	Machado Domínguez, Fernando Mariño Espiñeira, Perfecto			
E-mail	fmachado@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The overall objective of this course is to provide the theoretical and practical skills for the analysis and design of electronic systems for digital communications. To achieve this, several wire and wireless communication standards will be reviewed and the basic architectures of digital communication systems, the design of the electronic circuits that compose these systems and their functionality will be studied.			

Competencies	
Code	
CB1	Students have demonstrated knowledge acquisition and understanding in the field of study. This knowledge begins based on general secondary education, and it is typically at a level that, although advanced textbooks would support it, includes some aspects at the forefront of their field of study.
CG11	CG11 To approach a new problem considering first the essential and then the secondary aspects
CG13	CG13 The ability to use software tools that support problem solving in engineering.
CE40	(CE40/SE2): The ability to select electronic circuits and devices specialized in transmission, forwarding or routing, and terminals for fixed and mobile environments.

Learning outcomes	Competences		
Knowledge of transmission-reception principles and general considerations on the transmission-reception (transceivers) and routing circuits.			CE40
Knowledge of the basic digital communication systems architecture and the functional design of these systems.		CG11	CE40
Ability to design different basic subcircuits that compose the transmision-reception circuits of a digital communication system.		CG11 CG13	CE40
Ability to evaluate the possibilities of diferent interconnection standards for the design of communications systems.			CE40
Knowledge of the terminals used in digital communications systems.	CB1		CE40

Contents	
Topic	
Unit 1. Introduction	Introduction and review of the basic concepts of transmission-reception and general considerations on the transmission-reception circuits. Basic architecture of digital communications systems. Different hardware and software implementations: ASIC, DSP and FPGA.
Unit 2. Wired communication systems	Introduction to serial communication systems. Transmission media, signals and bit encoding. Transceiver circuits. Medium access methods.
Unit 3. Asynchronous serial communication systems	Asynchronous serial communication protocols. Standards and practical implementations.
Unit 4. Synchronous serial communication systems	Synchronous serial communication protocols. Standards and practical implementations.
Unit 5. High-speed synchronous serial communication systems	High-speed synchronous serial communication protocols. Differential technologies. Standards and practical implementations.
Unit 6. Wireless communication systems	Wireless communication protocols. Wiireless networks characteristics and configurations.

Unit 7. Short range wireless communication systems	Wireless communication protocols of short range and low consumption. WPAN Networks. Characteristics and analysis of the wireless sensors networks. Standards and practical implementations.
Unit 8. Radio frequency identification systems. Near-field communications	RFID technology. Near-field communications. Standards and practical implementations.
Laboratory	
Block 1. Wired asynchronous serial communication circuits	Design, implementation and test of an asynchronous serial communication circuit. Transceivers.
Block 2. Wired synchronous serial communication circuits	Design, implementation and test of a synchronous serial communication circuit. Clock recovery.
Block 3. Wireless communication circuits	Design, implementation and test of a wireless communication circuit. Using and configuring communication modules.
Block 4. Project: Design and implementation of a digital communications system	Design, implementation and test of a digital communication system. Applying theoretical and practical concepts.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	12	12	24
Problem solving	4	4	8
Laboratory practical	8	20	28
Project based learning	15	60	75
Objective questions exam	1.5	6	7.5
Problem and/or exercise solving	1.5	6	7.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies

	Description
Lecturing	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 CE40 and CG11 ("know").
Problem solving	Activities designed to apply the main concepts of the subject to solve problems and exercices. The lecturer will explain a set of problems and the students have to solve diferent take-home sets of problems. The lecturer will answer the students questions in the classroom or in the office. In these sessions the students will develop the skill CE40 ("know").
Laboratory practical	Activities designed to apply the main concepts and definitions of the subject. The student 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 student has 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 CE40 and CG13 ("know how").
Project based learning	Students have to develop a group project, as long as it is possible to form groups, that goes on over a period of time and addresses a specific problem. They have to design, schedule and carry out a set of tasks to achieve a solution. Each group will present the proposed solution and a project report. In these sessions the students will develop the skills CE40, CG11 and CG13 ("know how").

Personalized assistance

Methodologies	Description
Lecturing	The lecturer will answer the students questions and also give instructions to guide the studying and learning process. The students can go to the lecturer's office. The timetable will be available on the subject website at the beginning of the term. Tutoring sessions also may be carried out online: either asynchronously (e-mail, FAITIC forums, etc.) or by videoconference, in this case by appointment.
Problem solving	The lecturer will answer the students questions and also give instructions to guide the studying and learning process. The students can go to the lecturer's office. The timetable will be available on the subject website at the beginning of the term. Tutoring sessions also may be carried out online: either asynchronously (e-mail, FAITIC forums, etc.) or by videoconference, in this case by appointment.
Laboratory practical	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. Tutoring sessions also may be carried out online: either asynchronously (e-mail, FAITIC forums, etc.) or by videoconference, in this case by appointment.

Project based learning	The lecturer will answer the students questions and also give instructions to guide the studying and learning process. The students can go to the lecturers office. The timetable will be available on the subject website at the beginning of the term. Tutoring sessions also may be carried out online: either asynchronously (e-mail, FAITIC forums, etc.) or by videoconference, in this case by appointment.

Assessment

	Description	Qualification	Evaluated Competencess	
Laboratory practical	The lecturer will check the level of compliance of the students with the goals related to the laboratory skills. The final mark of laboratory, FML, will be assessed in a 10 points scale. For the evaluation of the laboratory sessions, the lecturer will assess the group work (the same mark for each member), as long as it was possible to form groups, the individual preliminary tasks and the answers to personalized questions for each session.	20	CG13	CE40
Project based learning	The lecturer will consider the results and the quality of the analysis performed in the developed project. The group project mark (GPM) will be assessed in a 10 points scale. For the evaluation of the project, the lecturer will assess the group work (the same mark for each member), as long as it was possible to form groups, and the individual oral presentation of the developed project.	50	CG11 CG13	CE40
Objective questions exam	The lecturer will check the level of compliance of the students with the goals related to the theory skills. The final mark of theory, FMT, will be assessed in a 10 points scale.	15		CE40
Problem and/or exercise solving	The lecturer will check the level of compliance of the students with the goals related to the theory skills. The final mark of theory, FMT, will be assessed in a 10 points scale.	15		CE40

Other comments on the Evaluation

1. Continuous assessment (first call)

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

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

The subject comprises three different parts: theory (30 %), laboratory (20%) and group project (50%). 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

Two short answer tests (SAT) are scheduled. The first intermediate test (SAT1) will be performed during the classes. The scheduling of the intermediate test will be approved by the Academic Committee of the Degree (CAG) and will be available at the beginning of the semester. The second test (SAT2) 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 (SATi>=4). The final mark of theory (FMT) is calculated as the arithmetic mean of the individual marks:

FMT = (SAT1 + SAT2)/2.

The students cannot do the tests at a later date.

If the minimun mark in the first test is not achieved (SAT1 less than 4), the students can repeat this part in the same date of the second test.

1.b Laboratory

Four laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in groups. This part also will be assessed by continuous assessment. The lecturer will consider the work of the students carried out before the laboratory session to prepare the proposed tasks, the work in the laboratory to deal with them as well as the students behavior.

Marks for each laboratory session (LSM) will be assessed in a 10 points scale. In order to pass the laboratory part the students can not miss more than one laboratory sessions. The final mark of laboratory (FML) is calculated as the arithmetic mean of the individual laboratory session marks:

FML = (LSM1 + LSM2 + LSM3 + LSM4)/4.

1.c Group project

In the first session lecturers will present the objectives and the schedule of the project. They will also assign a specific project to each group, as long as it was possible to form groups. After that, the most important part of the workload and the project supervision will be developed in the remaining sessions: six hours of B laboratory sessions and six hours of C laboratory sessions. In order to assess the project, the lecturer will consider the results, their analysis and presentation, and the quality of the written report. The group project mark (GPM) will be assessed in a 10 points scale. The students are only allowed to miss one project session. The minimum mark required to pass this part is of 4 (GPM>=4).

1.d 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: 30% theory (FMT), 20% laboratory (FML) and 50% group project (GPM). In order to pass the subject, students will be required to pass the theory, laboratory and group project parts. In this case the final mark (FM) will be:

FM = (0.3·FMT + 0.2·FML + 0.5 GPM).

However, when the students do not pass both parts (FMT or GPM less than 4) or do not reach the minimum mark of 4 required to pass each short answer test or miss more than 1 laboratory sessions or miss more than 1 project sessions, the final mark will be:

FM = (0.3·FMT + 0.2·FML + 0.5 GPM)·3.5/7.

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

2. Exam-only assessment (first call)

The students who prefer a different educational policy can attend an exam on a scheduled date. This assessment will comprise three parts (similar to the activities completed by the continuously assessed students): theory exam, laboratory exam and project. In order to attend the exam-only assessment, the students have to contact to the lecturer two weeks in advance. For the project assignation, the students have to contact to the lecturer in advance.

The theory exam will be assessed in a 10 points scale. The minimum mark required to pass this part is of 4 (FMT>=4).

The laboratory exam will be assessed in a 10 points scale. The minimum mark required to pass this part is of 4 (FML>=4).

The project will be assessed in a 10 points scale. The student will prepare a written report to be handed in just before the exam. The final project must be presented within one week of delivery of reports. The minimum mark required to pass this part is of 4 (GPM>=4).

In order to pass the subject, students will be required to pass each part (FMT>=4, FML>=4 and GPM>=4). In this case the final mark (FM) will be:

FM = (0.3·FMT + 0.2·FML + 0.5 GPM).

However, when the students do not reach the minimum mark of 4 required (FMT or FML or GPM less than 4), the final mark will be:

FM = (0.3·FMT + 0.2·FML + 0.5 GPM)·3.5/7.

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

3. Second call assesment and end-of-program assesment

The assessment policy in these calls will follow the scheme described in the previous section. Dates will be specified in the academic calendar. These assesments consist on a theory exam, a laboratory exam and a project. In order to attend the second call and end-of-program assessment, the students have to contact to the lecturer two weeks in advance. For the project assignation, the students have to contact to the lecturer in advance.

In second call and end-of-program assestment, the marks obtainedin the first call assesment, continuous assessment or exam-only assessment, are kept for those parts in which the student has not attended. The final mark will be calculated as it has described in section 2.

Sources of information

Basic Bibliography

F. Machado, V. Pastoriza, F. Poza, **Sistemas Electrónicos para Comunicaciones Digitales**, Curso 2016/2017,

P. Mariño, **Las comunicaciones en la empresa. Normas, redes y servicios**, 2ª Ed.,

S. Mackay, E. Wright, D. Reynders, J. Park., **Practical industrial data networks : design, installation and troubleshooting**, 1ª Ed.,

Complementary Bibliography

R. Faludi, **Building wireless sensor networks**, 2011,

H. Lehpamer, **RFID design principles**, 2012,

B. Sklar, **Digital communications. Fundamentals and applications**, 2ª Ed.,

Recommendations

Subjects that it is recommended to have taken before

Digital electronics/V05G301V01203
Programmable Electronic Circuits/V05G301V01302

Contingency plan

Description

In case of online tuition, then the planning and the evaluation will be carried out as follows:

* Theory: the theory classes will be performed through electronic means and the contents will be available online.

* Practices: depending on the contents developed in each laboratory practice and the availability of material, the session will be performed in a virtual way, in the students home (using provided basic equipment) or by simulation (using free software or University licensed software). The details of each practices session will be available online in FAITIC. In this scenario, the practices will be individually developed and evaluated.

* Project: depending on the proposed project and the availability of material, the work will be performed in a virtual way, in the students home (using provided basic equipment) or by simulation (using free software or University licensed software). The details of each project session will be available online in FAITIC. In this scenario, the project will be individually developed and evaluated.

* Assessment: the assessment will supported by FAITIC and Campus Remoto.

IDENTIFYING DATA				
Analogue Electronics				
Subject	Analogue Electronics			
Code	V05G300V01624			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Raña García, Herminio José			
Lecturers	Quintáns Graña, Camilo Raña García, Herminio José			
E-mail	hrana@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject studies the feedback concept, and its applications to amplifiers. The opamps and their applications are also studied. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies
Code
CE42 (CE42/SE4): The ability to apply electronics as support technology in other fields and activities and not only in information and communication technologies.
CE43 (CE43/SE5): The ability to design analogical and digital electronics circuits of analogical to digital conversion and vice versa, of radiofrequency, of feeding and electrical energy conversion for computing and telecommunication engineering.
CE44 (CE44/SE6): The ability to understand and use feedback theory and electronic control systems.

Learning outcomes	
Learning outcomes	Competences
Knowledge of the techniques for feed-back amplifiers and oscillators.	CE43 CE44
Knowledge of the internal structures of the operational amplifiers and their structures.	CE43 CE44
Knowledge of the design of circuits based on operational amplifiers.	CE43 CE44
Knowledge of the design of power-supplies.	CE42 CE43 CE44

Contents	
Topic	
Feedback amplifiers I	Feedback concept. Sample and mix networks. Feedback topologies. Feedback law.
Feedback amplifiers II	Negative and positive feedback. Parameters for the study of feedback. Benefits and draws of feedback. Effect on the uniform of gain. Effect on the harmonic distortion. Effect on the input and output impedances.
Feedback amplifiers III	Methods for the analysis: Simple or using matrix. Topology identifying. Amplifier without feedback, but with the load effect of the feedback network. The gain of the feedback amplifier. The input and the output impedances of the feedback amplifier.

Feedback amplifiers IV	Effect of the feedback on the frequency response. Bandwidth and stability. The effect of poles on the amplifier (one pole, two poles and three poles). Gain and phase margins. Nyquist criteria. Root places. Compensation methods.
Sine waveform oscillators	Barkhausen criteria. Design of a sinusoidal oscillator. RC oscillator. LC oscillator. Oscillator based on quartz crystals.
Operational amplifiers I	Internal structure of an operational amplifier. Current mirrors. Active loads. Voltage references. Technologies for the operational amplifiers: bipolars, bifet, cmos.
Operational amplifiers II	Analysis of the operational amplifier in the non inverting mode, using feedback. Voltage follower. Converters I-V and V-I. Integrator. Derivator. Applications.
Operational amplifiers III	Half-wave inverter rectifier . Full-wave inverter rectifier. Relaxation oscillator. Generator of triangle waves. Sinusoid oscillators based on the operational amplifier.
Power amplifiers	Output stages in class A, B and A-B. Full amplifier in class B. Full amplifier in class A-B. Introduction to the class-D amplifiers.
Regulated power supplies	Linear regulated power supplies. Protection to over current. Low drop-out (LDO).
Lab work 1	The effect of the feedback on a two-stage amplifier .
Lab work 2	Linear applications. Voltage-to-current converter. Integrator.
Lab work 3	Half-wave inverter rectifier. Full-wave inverter rectifier. Peack detector. Slope detector.
Lab work 4	Operational-based relaxation oscillator. Operational-based sinusoidal oscillator.
Lab work 5	Power amplifiers. Class B. Class A-B.
Lab work 6	Design of an active load. Design of a voltaje regulated supply.

Planning

	Class hours	Hours outside the classroom	Total hours
Mentored work	7	20	27
Laboratory practical	12	38	50
Lecturing	15	27.5	42.5
Problem solving	4	22.5	26.5
Objective questions exam	1	0	1
Problem and/or exercise solving	2	0	2
Laboratory practice	1	0	1

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

Methodologies

	Description

Mentored work	The lecturer will lead the students in order to design an amplifier. This activity is collective. The students work in teams of two persons. Competencies CE42, CE43 and CE44 will be addressed in these sessions.
Laboratory practical	Simulations and real assembled circuits will be tested. This activity is collective. The students work in teams of two persons in each laboratory position. Competencies CE42, CE43 and CE44 will be addressed in these sessions.
Lecturing	The lecturer will show some theoretical contents related to the subject. This activity is individual. Competencies CE42, CE43 and CE44 will be addressed in these sessions.
Problem solving	The lecturer will solve some exercises related to the subject. This activity is individual. Competencies CE42, CE43 and CE44 will be addressed in these sessions.

Personalized assistance

Methodologies	Description
Problem solving	The teacher will resolve the doubts of the students at the schedule established and published on the school website.
Mentored work	The teacher will resolve the doubts of the students at the schedule established and published on the school website.
Laboratory practical	The teacher will resolve the doubts of the students at the schedule established and published on the school website.
Lecturing	The teacher will resolve the doubts of the students at the schedule established and published on the school website.

Assessment

	Description	Qualification	Evaluated Competences
Mentored work	The students have to write a document about the assigned work. A single document for the group of two persons that work together in this job. The grade for both students in this job is the same. Competencies CE42, CE43 and CE44 will be assessed in these works.	10	CE42 CE43 CE44
Objective questions exam	Multiple choice test. Competencies CE42, CE43 and CE44 will be assessed in these tests.	30	CE42 CE43 CE44
Problem and/or exercise solving	Exercise test. Competencies CE42, CE43 and CE44 will be assessed in this test.	30	CE42 CE43 CE44
Laboratory practice	Laboratory-work exam based on simulations and real circuits. Competencies CE42, CE43 and CE44 will be assessed in this test.	30	CE42 CE43 CE44

Other comments on the Evaluation

CONTINUOUS EVALUATION OPTION:

The subject is evaluated in a continue way, by means of two partial exams. These exams cover the theoretical aspects. In addition, there is an exam for the lab-work and a tutored work.

This first partial exam includes themes from one to five. The second partial exam includes themes from six to ten. The weight of both partials is 60% from the total mark.

The two partials take place in the classroom, within the class time. These partials are approximately 90 minutes long. The first 30 minutes will be dedicated to a multiple-choice test. The other 60 minutes will be dedicated to exercises.

Inside each partial exam, the 60 minutes exam and the 30 minutes exam have the same weight.

In order to pass a partial exam (the first or the second), the student is required to obtain at least a mark of 5 over 10.

The student that passes only one partial will only have to try the other one at the final exam, which is the same for the students who do that exam as a recovery exam for the continuous assessment and for the students who do that exam as their unique assessment.

The lab-work is evaluated using a unique exam, in the laboratory. The weight is 30%.

The weight of the tutored work in the continuous assessment is 10% of the total mark.

When a student attends the first partial, he or she accepts to follow the continuous assessment. Students that do not attend to the first partial will be assessed by means of a unique assessment.

The mark that a student obtains in the lab-work is maintained until the second call, except if the student does not want. In this case, the student will have to do partials and lab exams in the second call.

In order to pass the subject, once partial exams have been passed, the student has to obtain a global mark (GM) of at least 5 points out of ten. The global mark is calculated acording to the following expression if the student has more than 5 points in each partial exam:

GM = 0.6 * TM + 0.3*LM + 0.1*RM

where

TM (Theory Mark) = Mean value of the partial marks; LM = lab mark; RM = report mark

If the mark of the student in any of the two partial theory exams is less than 5, then the value of GM is the minimum between 4.5 and 0.6*TM+0.3*LM+0.1*RM.

The lab exam will take place in the lab, the day of the last lab session.

UNIQUE ASSESSMENT OPTION:

The students that do not follow the continuous assessment will be assessed by means of a unique assessment. The unique assessment will consist of an exam with three parts: the first part covers the themes 1 to 5, the second part covers the themes 6 to 10 and the third part is a lab-work in the laboratory.

In order to pass the subject, the student has to obtain a mark of at least 5 points over ten for the first and second parts. In this case, the global mark (GM) is calculated according to the following formula:

GM = 0.6 * TM + 0.4*LM

where:

TM = Average mark of the first and second part of the exam; LM = lab mark

If the student does not obtain a mark of at least 5 in the first part or in the second part, the global mark would be the minimum between 4 and 0.6*TM + 0.4*LM.

IMPORTANT. MANDATORY ENROLLMENT.

If a student did not enter the continuous assessment mode but is interested in participate in the unique assessmente, he or she must enroll in this assessment by talking to the professors at least two weeks before the day of the exam. Contact can be by e-mail. This helps in the organization of the lab work exam.

SECOND CALL AND EXTRAORDINARY CALL

The second call and the extraordinary call have the same exam structure and the same rules (calculation of the mark and mandatory enrollment) as for the unique assessment.

Sources of information
Basic Bibliography
Sergio Franco, **Design with operational amplifiers and analog integrated circuits**, third edition, McGraw-Hill,
Hambley, Allan R., **Electrónica**, 2ª ed., Pearson-Prentice Hall, 2001
Complementary Bibliography
Paul Horowitz y Winfield Hill, **The Art of Electronics**, Cambridge Univ. Press,

Horenstein, Mark N., **Microelectrónica**, 2ª ed., Prentice Hall, 1997
Malik, Norbert, **Circuitos electrónicos**, Prentice Hall, 1996
Rashid, Muhammad, **Circuitos microelectrónicos**, Thomson, 2002
Sedra, Adel, **Circuitos microelectrónicos**, 5ª ed., McGraw-Hill, 2006

Recommendations

Contingency plan

Description

The following extraordinary measures will be applied:

A groups

The contents and their distribution in the different parts will be kept
independently of the format of teaching, either classroom teaching or online teaching.

B and C groups

The laboratory practices will be made by using an electronic circuits simulator with free access version available.

Assessment

The contents and the distribution of marks of the assessment will be the same
independently of the format of teaching, either classroom teaching or online teaching.

IDENTIFYING DATA				
Power Electronics				
Subject	Power Electronics			
Code	V05G300V01625			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	López Sánchez, Óscar			
Lecturers	Doval Gandoy, Jesús López Sánchez, Óscar			
E-mail	olopez@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main goal of this subject is to provide students with the knowledge about the basics of power electronics. Contents include power semiconductor and magnetic devices, ac-dc converters, dc-dc converters, dc-ac converters and basic concepts about the control of these power converters. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CB1	Students have demonstrated knowledge acquisition and understanding in the field of study. This knowledge begins based on general secondary education, and it is typically at a level that, although advanced textbooks would support it, includes some aspects at the forefront of their field of study.
CE43	(CE43/SE5): The ability to design analogical and digital electronics circuits of analogical to digital conversion and vice versa, of radiofrequency, of feeding and electrical energy conversion for computing and telecommunication engineering.
CE44	(CE44/SE6): The ability to understand and use feedback theory and electronic control systems.

Learning outcomes		Competences
Knowledge about power electronics semiconductor devices.		CE43
Knowledge about the operation of the basic topologies of electronic converters used in conversion of electrical energy.	CB1	CE43
The ability to understand and analyse power electroncis circuits.		CE43 CE44
The ability to analyse and design the control loop of power electronics converters.		CE43 CE44
The ability to design basic circuits used in power electronic converters.		CE43 CE44

Contents	
Topic	
Chapter 1: Introduction to power electronics	Introduction, overview of power electronics, applications.
Chapter 2: Power electronic devices	Diode, MOSFET, IGBT. Switching, drivers, thermal analysis, association of devices, electrical protection.
Chapter 3: Magnetics in power electronics	Basics, inductors, transformers, magnetic materials.
Chapter 4: AC to DC power conversion	Three phase rectifiers. Non-controlled rectifiers, controlled rectifiers. Resistive load, inductive load, capacitive filter.
Chapter 5: DC to AC power conversion	Basics of DC to AC power conversion. Single phase and three phase inverters. Square wave inverters, PWM inverters. Modulation techniques.
Chapter 5: DC to DC power conversion	Basic DC to DC converter topologies. Converters without isolation and with isolation. Control in DC to DC power converters.
Laboratory exercise 1. Power electronic semiconductor devices.	MOSFET transistor, switching characteristics. Current and voltage characteristics.
Laboratory exercise 2. AC to DC power conversion	Non-controlled three phase rectifier, controlled three phase rectifier. Input/ output current and voltage.

Laboratory exercise 3. DC to AC power conversion	DC to AC converter. Input/ output current and voltage.
Laboratory exercise 4. DC to DC power conversion	Non-isolated and isolated DC to DC converter. Input/ output current and voltage.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	21	42	63
Laboratory practical	12	24	36
Autonomous problem solving	7	28	35
Problem and/or exercise solving	2	14	16
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Presentation by the professor of the contents of the subject, guidelines for the work to be developed by the student. Work will be focused on Competencies CE43 and CE44.
Laboratory practical	Practical application of the theoretical concepts. Work will be focused on Competencies CE43 and CE44.
Autonomous problem solving	Proposal of problems and/or exercises related with the subject contents. Students have to obtain the correct solutions. The professor will support and will help students to solve the problems. Work will be focused on Competencies CE43 and CE44.

Personalized assistance	
Methodologies	**Description**
Lecturing	The students can attend tutorials in the professor office on dates and hours published in the web of the subject.
Laboratory practical	The students can attend tutorials in the professor office on dates and hours published in the web of the subject.
Autonomous problem solving	The students can attend tutorials in the professor office on dates and hours published in the web of the subject.

Assessment			
	Description	Qualification	Evaluated Competences
Laboratory practical	The laboratory practices are evaluated in a continuous way (session to session) taking into account their previous preparation and the execution in the laboratory.	10	CE43 CE44
Autonomous problem solving	The execution of several tasks and the corresponding reports are requested.	10	CE43 CE44
Problem and/or exercise solving	Exams consist of exercises and problems related to the theoretical and practical contents of the subject.	80	CE43 CE44

Other comments on the Evaluation

For the first and the second call, it will be possible to choose between continuous evaluation and single evaluation. Students that select single evaluation should notify this to the teachers during the very first two weeks of classes of the subject.

The end-of-program call will be by single evaluation.

The dates and classrooms of the written tests will be those approved and published by the Academic Commission of the Degree of the school.

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

1. Continuous evaluation

It consists of the realization of several weekly tasks, the preparation and execution of the laboratory practices, and the realization of two tests of partial evaluation.

1.1 Weekly tasks

Along the course, the execution of several individual tasks and the corresponding written report will be requested. These tasks will be no retakeable. By the correct realization of these tasks, it will be possible to obtain up to 10% of the final qualification of the subject.

1.2 Laboratory practices

There will be four sessions of laboratory practices in groups of two students, which will be both graded individually. The laboratory practices will be no retakeable. By the correct preparation and execution of the practices, it will be possible to obtain up to 10% of the final qualification of the subject.

1.3 Tests of partial evaluation

There will be two individual written tests of partial evaluation, in which will be possible to obtain up to 40% of the final qualification of the subject in each one of them. It will be possible to retake these tests in the second call.

1. **First partial test:** it will evaluate the contents taught to date of the test.
2. **Second partial test:** it will evaluate the remaining contents of the subject that were not included in the first test.

2. Single evaluation

It will be an individual written test consisting of theoretical questions, problems and exercises that will evaluate all the contents, theoretical and practical, of the subject.

Sources of information

Basic Bibliography

Mohan, Ned, **Electrónica de Potencia. Convertidores, Aplicaciones y Diseño**, 3, Mc Graw Hill, 2009
Barrado, Andrés, **Problemas de electrónica de potencia**, Pearson Prentice Hall, 2007
Rashid, Muhammad H., **Electrónica de potencia: circuitos, dispositivos y aplicaciones**, Pearson Education, 2004
Hart, Daniel W., **Electrónica de potencia**, Prentice-Hall, 2001

Complementary Bibliography

Recommendations

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G301V01108
Mathematics: Linear algebra/V05G301V01102
Mathematics: Calculus 1/V05G301V01101
Mathematics: Calculus 2/V05G301V01106
Physics: Fundamentals of electronics/V05G301V01201
Electronic technology/V05G301V01206
Analogue Electronics/V05G301V01311

Other comments

This version in English of the guide is a translation of the original one in Galician. In the case that, by mistake, there exists differences between them the original one in Galician is what prevails.

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Lecturing. The same content will be taught, adapting the format of the exhibitions to online teaching, using the remote campus.

* Laboratory practices. They will be replaced by simulation exercises using a specific power electronics simulator. The exercises will become individual. The remote campus will be used to solve the doubts of the students.
* Autonomous problem solving. In-person sessions will be replaced by online sessions through the remote campus.

===PERSONALIZED ASSISTANCE===
The students can attend tutorials in the professor office of the remote campus.

=== ADAPTATION OF THE TESTS ===
* The written tests will be substituted by reports.

IDENTIFYING DATA				
Audiovisual Technology				
Subject	Audiovisual Technology			
Code	V05G300V01631			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Torres Guijarro, María Soledad			
Lecturers	Martín Rodríguez, Fernando Torres Guijarro, María Soledad			
E-mail	soledadtorres@uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this subject the student will learn to design audiovisual systems,with respect to sound take and sound reinforcement, image take and visual coating, synchronisation, wiring, connections and supply. Indoor and outdoor applications of audiovisual networks, as well as distinct multimedia platforms, will be analysed. English Friendly curse: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG1	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG9	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.
CG12	CG12 The development of discussion ability about technical subjects
CE36	CE36/SI3 The capacity to implement projects at places and installations for the production and recording of audio and video signals.
CE38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes		
Learning outcomes		Competences
Understand which elements have an influence on audiovisual quality.		CE36 CE38
Design a system of sound take and sound reinforcement given a certain enclosure, comparing different subsystems and elements.	CG1 CG6	CE36
Create atmospheres addressing acoustic and visual appearances	CG12	CE36
Design the wiring and connections of an audiovisual network for his control and supply	CG1 CG6	CE36 CE38
Analyse different indoor and outdoor applications of Audiovisual Networks.		CE36 CE38
Apply and analyse distinct multimedia systems: videoconference, streaming, audiovisual databases, synchronisation, metadata processing, exchange of multimedia contents.	CG6 CG12	CE38

Organize a working group to carry out a project, including the following: * technical ability to collect information, interpret technical specifications of equipment, discuss different options and select a combination of certain equipment. * use of theoretical calculations and simulation software tools to support the design of sound systems and visual coating. * conduction of meetings, discussion of partial results and oral presentation of a definitive work in front of a demanding audience. * writing of progress reports, minutes of meetings and a final technical report. * adaptation to new environments, management of internal roles in the group and conflict resolution.	CG6 CG9 CG12	CT4

Contents	
Topic	
Sound reinforcement	Sizing and distribution in the processes of take and presentation of sound
Visual overlay	Design of systems of visual take and presentation indoor and outdoor. Sizing and distribution of the visual coverage, in the processes of take and presentation
Connections and supply	Design of the wiring and connecting of an audiovisual network and his supply. Audiovisual networks, indoor and outdoor applications.
Synchronisation and control	Synchronisation of audio and video signals in an audiovisual network. Control systems. Audiovisual quality: sound/image interaction. Ambient creation addressing visual and acoustic issues
Multimedia systems	Videoconference, streaming, audiovisual databases, synchronisation, metadata procesing, exchange of multimedia contents

Planning	Class hours	Hours outside the classroom	Total hours
Practices through ICT	12	0	12
Project based learning	7	57	64
Lecturing	21	42	63
Problem and/or exercise solving	2	0	2
Report of practices, practicum and external practices	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
Practices through ICT	Use and adjustment of analysis tools and algorithms, identifying which one should be used in each situation. With this methodology they work the CE36 competence, individually or in couples.
Project based learning	Collaborative work in reduced groups on a complex design that applies several topics covered in the subject. The work is periodically followed-up and it fosters working in group, role sharing, information sharing, planning and public defending of results. With this methodology they work the CG1, CG6, CG9, CG12, CE36, CE38 and CT4 competences.
Lecturing	Presentation by the teacher of the contents of the subject, fostering the critical discussion of the concepts. The theoretical grounds of algorithms and procedures used to resolve problems are given. With this methodology they work the CG1, CG6, CG12, CE36 and CE38 competences.

Personalized assistance	
Methodologies	**Description**
Lecturing	Doubts can be solved in the rests of the classes and in the teacher tutorial sesions. These tutorial sessions will be done individually or in short groups (with a maximum of 2-3 students). The tutorial sessions are typically agreed with the professor. The meetng requests can be done personally or by email. The tutorial sessions are preferably done in the schedules and place officially reserved for them.
Practices through ICT	In the classes of practices is a good moment to consult doubts with the professor. The professor moves between the tables and some students take advantage of the proximity of the professor to consult doubts of the own class or punctual doubts of other classes.
Project based learning	The projects have its own classes of C group in which the students of each team consult their doubts about the project and the professor is with them helping to define the project and giving them support for the development of their particular project. They are classes with a very pleasant interaction.

Assessment						
	Description	Qualification	Evaluated Competencess			
Project based learning	Assessment of a project, developed through the four-month period, including the preparation and public presentation of a report. The corresponding individual mark to the works done in group is obtained as a ponderated sum of: 1) the common mark of the group (60%); 2) the individual mark (40%), obtained from one or various of the following methods of evaluation: cross-evaluation by the other members of the group, oral questions during the presentations of the works, written questions about the content of the work.	40	CG1 CG6 CG9 CG12	CE36 CE38	CT4	
Problem and/or exercise solving	Assessment of a written exam, with brief questions and problems.	50	CG1 CG6 CG12	CE36 CE38		
Report of practices, practicum and external practices	Assessment of a written inform that describes the work of several weeks in the computer classroom.	10		CE36		

Other comments on the Evaluation

TEACHING LANGUAGE:English

ASSESSMENT LANGUAGE: The student can choose to do the written test in English or Spanish.

Following the guidelines of the degree, two systems of evaluation are offered: continuous assessment (recommended) and exam-only assessment. Exam-only assessment will be only allowed in situations in which it is imposible to follow the recommended system.

In case of detection of plagiarism in any of the tests (short tests, reports of the laboratory practices, reports of the directed works or final exam), the final grade will be of FAIL (0) and the fact will be communicated to the Centre Management for the opportune effects.

FIRST CALL

A) CONTINUOUS ASSESSMENT:

The continuous assessment will be based on the evaluation of practical task, projects and a test. Once a student has signed a document of agreement with the process of continuous assessment, it will be understood that the student has submitted to the call, and the final degree will be obtained by the application of the criteria described bellow, regardless of whether or not the final exam is taken.

The subject is assessed in a 0 to 10 points scale and is considered "passed" if each activity is graded equal or greater than 4, and the final grade obtained is equal or greater than 5. The final grade with be obtained from the weighted sum of the grade obtained in the following tasks with the given weights. If in any of the activities the grade does not reach 4 but the average exceeds 5, the final grade will be 4.

Types and weights of the activities:

1. Tutored works: 30 % of the final grade. Two reports will be delivered: the first during Halfway through the term and the second at the end. The individualized part of the assessment will be done through cross-evaluation, oral questions during presentations, and written exam questions.
2. Reports of practical tasks (Weight: 40 %).
3. Short answer tests: A short answer test is included in the process of continuous assesment, at the end of the tern, with a weight of 40% on the final grade.

B) EXAM-ONLY ASSESSMENT

A final examination is available for those students that for some reason could not follow the continuous evaluation assessment process. In this case the final examination will consist in a short answer test, and some additional questions related with the practical tasks and projects.The subject is assessed in a 0 to 10 points scale and it is considered "passed" if the final grade obtained is equal or greater than 5.

SECOND CALL:

There is a scheduled date for a second call examination, for those students that either dropped out during the semester or failed. Prior the examination, a student can choose to follow the continuous assessment or the exam-only assessment. In the

former selection, the grades obtained in the projects and practical tasks will be taken into account and the student will only answer to the short answer test. If the later, (exam-only assessment), the student will also have to answer a full examination as described before.

END-OF-PROGRAM CALL:

The exam will consist of a short answer test. This final exam will be rated between 0 and 10 points. It includes all the topics of the course. To pass, at least five points are needed. No other activity is valued.

Sources of information

Basic Bibliography

John Eargle, **JBL Sound system design reference manual**, 3, JBL, 1999

Complementary Bibliography

John Eargle, Chris Foreman, **Audio Engineering for Sound Reinforcement**, Hal Leonard, 2002
Gary Davis and Ralph Jones, **Sound Reinforcement Handbook**, Hal Leonard, 1989
Philip Giddings, **Audio Systems Design and Installation**, Focal Press, 1990
Hilary Wyatt y Tim Amyes, **Postproducción de Audio para TV y Cine**, Escuela de Cine y Video de Andoain, 2005
Rüdiger Ganslandt, Harald Hofmann, **Handbook of Lighting Design**,
José Luis Sánchez Bote, **Sistemas de refuerzo sonoro**, Universidad Politécnica de Madrid, 2013
José María Mellado, **Fotografía de alta calidad: las técnicas y métodos definitivos.**, CS6. Anaya multimedia, 2013
Ben Simonds, **Blender master class : a hands-on guide to modeling, sculpting, materials, and rendering**, No Starch Press, 2013

Recommendations

Subjects that are recommended to be taken simultaneously

Room Acoustics/V05G300V01635
Imaging Systems/V05G300V01633

Subjects that it is recommended to have taken before

Audio Systems/V05G300V01532
Video and Television/V05G300V01533

Contingency plan

Description

=== ADAPTATION OF THE METHODOLOGIES ===
In the event that face-to-face activities are suspended at the University of Vigo, its continuation will be carried out as follows:
* Group A teaching: Master sessions will be done through the remote campus, recording the sessions so that they can be followed non-synchronously.
* Group B teaching: Group B practices will be adapted, as far as possible, so that students can do them individually at home.
* Group C teaching: Group C projects will be adapted, as far as possible, so that students can carry them out at home.
* Assessment: The assessment will be carried out on the scheduled dates, using the Remote Campus for supervision and resolution of doubts, and Fatic for delivery of questions and collection of test solutions.

IDENTIFYING DATA				
Fundamentals of Image Processing				
Subject	Fundamentals of Image Processing			
Code	V05G300V01632			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Martín Herrero, Julio			
Lecturers	Martín Herrero, Julio			
E-mail	julio@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Introduces to the student the basics of digital image processing. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG10	CG10 The ability for critical reading of scientific papers and docs.
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.
CE38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes	Competences		
Understand the nature and organisation of digital images	CG3 CG10	CE34 CE38	
Learn to process digital images	CG3 CG4 CG10	CE34 CE38	CT2 CT3
Learn how to program a computer to process a digital image	CG3 CG4 CG10	CE34 CE38	CT2 CT3
Understand how the fundamental technics of image processing work	CG3 CG10	CE34 CE38	
Apply fundamental processing technics to solve specific problems with images or groups of images	CG3 CG4	CE34 CE38	

Contents	
Topic	
GUI programming	.
Basic preprocessing.	.
Image restoration.	.
Global and local operators.	.
Linear and nonlinear filters.	.
Segmentation	.
Mathematical morphology.	.

Planning			
	Class hours	Hours outside the classroom	Total hours
Practices through ICT	19.6	78.4	98
Lecturing	21	21	42
Systematic observation	0.01	0	0.01
Laboratory practice	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
Practices through ICT	Handling and tuning analytic tools and algorithms, identifying which ones to use in different scenarios. All learning aims are addressed.
Lecturing	Master talks by the teacher on central topics, promoting critical discussion of concepts. All learning aims are addressed.

Personalized assistance	
Methodologies	**Description**
Practices through ICT	Implementation of image processing methods within an image processing and visualization framework with graphic user interface, programming in C and C++.

Assessment					
	Description	Qualification	Evaluated Competencess		
Practices through ICT	Personalised monitoring of the student's work, with feedback. All teaching aims specified in the corresponding section of this guide are evaluated.	100	CG3 CG4 CG10	CE34 CE38	CT2 CT3
Systematic observation	Personalised monitoring of the student's work, with feedback. All teaching aims specified in the corresponding section of this guide are evaluated.	100	CG3 CG4 CG10	CE34 CE38	CT2 CT3
Laboratory practice	Final exam.	100	CG3 CG4 CG10	CE34 CE38	CT2 CT3

Other comments on the Evaluation

The assistance to class under continuous evaluation is compulsory, unless exceptional circumstances concur. Continuous evaluation is used for assessment, based on the work of the student. There is a final exam in the official date marked by the Board of School in May, for those students that have not passed the continuous evaluation. This final exam will be marked between 0 and 10 points. It covers all the subjects seen during the semester. To approve, the student has to obtain, at least, five points. Students wishing to improve their continuous evaluation marks can also attend the final exam: in this case the mark of this exam will be the final mark. The students that have passed the continuous evaluation and are satisfied with their mark do not need to attend the final exam. Along the semester the students will receive feedback on their progress, and the final mark of continuous evaluation will be communicated to the students well before the final exam. The delivery of the personal work the last week of class will imply the official participation in continuous evaluation.

The extraordinary evaluation of July will be an extraordinary final exam, for those students that have not passed neither the continuous evaluation neither the final exam in May. The final mark will be the mark of the extraordinary final exam in both cases. This extraordinary final exam will be marked between 0 and 10 points, and covers all the subjects. To approve, the student has to obtain, at least, five points.

Note that there are two final exams, but both correspond to a single and the same call ("convocatoria").

Sources of information

Basic Bibliography

Rafael C. Gonzalez, Richard E. Woods, **Digital Image Processing**, 3ª, Prentice Hall,

Complementary Bibliography

Robert Laganière, **OpenCV Computer Vision Application Programming Cookbook**, Packt Publishing, 2014

Jasmin Blanchette, Mark Summerfield, **C++ GUI Programming with Qt 4**, Prentice Hall, 2008

Recommendations

Subjects that continue the syllabus

Image processing and analysis/V05G300V01931

Subjects that are recommended to be taken simultaneously

Imaging Systems/V05G300V01633

Other comments

Simultaneously taking the subject Imaging Systems is emphatically recommended. You also should have passed the subject Programming, or have some notions of, at least, C programming.

Contingency plan

Description

See Annex.

IDENTIFYING DATA				
Imaging Systems				
Subject	Imaging Systems			
Code	V05G300V01633			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish English			
Department				
Coordinator	Martín Herrero, Julio			
Lecturers	Martín Herrero, Julio			
E-mail	julio@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The study of several families of systems of generation of images, including artificial vision, remote sensing and medical image. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG10	CG10 The ability for critical reading of scientific papers and docs.
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.
CE66	(CE66/OP9) The ability for selection of circuits, subsystems and systems of remote sensing.

Learning outcomes	Competences	
Know most common imaging (capture) systems for medical diagnosis, essay and remote sensing.	CG3 CG10	CE34 CE66
Understand the principles of operation of such systems.	CG3 CG10	CE34 CE66
Knowledge about the capabilities and limitations of such systems.	CG3 CG10	CE34 CE66
Knowledge about the most common applications of such systems.	CG3 CG10	CE34 CE66

Contents	
Topic	
Computer vision systems	Illumination systems (LED, laser, fluorescent), monochrome cameras, Bayer and 3 CCD color cameras, matrix and line cameras, framegrabbers, multicamera systems (mono/stereo)
Medical image and non destructive testing (NDT) systems	Generation and processing of echography, X-ray, computerized axial tomography, nuclear magnetic resonance, and positron emission scanner.
Satellital, airborne and proxy remote sensing	Acquisition, processing and applications of panchromatic images, monoband, multispectral, and hyperspectral, active and passive in UV / VIS / SWIR / NIR / FIR / Thermal / GHz, Radar and Lidar.

Planning			
	Class hours	Hours outside the classroom	Total hours
Practices through ICT	17.6	35.2	52.8
Mentored work	0	35.2	35.2
Lecturing	21	21	42
Essay questions exam	2	8	10
Systematic observation	0.01	0	0.01
Presentation	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
Practices through ICT	Handling and tuning analytic tools and algorithms, identifying which ones to use in different scenarios. We will work mainly in C/C++. Competencies: CG3, CG10, CE34, CE66.
Mentored work	Personal work on the fundamentals, functioning and state of the art of a given imaging system. All competences are addressed.
Lecturing	Master talks by the teacher on central topics, promoting critical discussion of concepts. All learning aims are addressed.

Personalized assistance	
Methodologies	**Description**
Practices through ICT	Doubts can be solved in the teacher's office hours, individually or in small groups. Except otherwise noted, upon previous appointment with the teacher via email, preferably in the schedules and location officially reserved.

Assessment				
	Description	Qualification	Evaluated Competencess	
Essay questions exam	All teaching aims specified in the corresponding section of this guide are evaluated.	100	CG3 CG10	CE34 CE66
Systematic observation	Personalized follow-up of the work of the student in the laboratory, with feedback. All competences are evaluated.	50	CG3 CG10	CE34 CE66
Presentation	Presentation to the classroom of the personal work.	50	CG3 CG10	CE34 CE66

Other comments on the Evaluation

The assistance to class under continuous evaluation is compulsory, unless exceptional circumstances concur. Continuous evaluation is used for assessment, based on the work of the student. There is a final exam in the official date marked by the Board of School in May, for those students that have not passed the continuous evaluation. This final exam will be marked between 0 and 10 points. It covers all the subjects seen during the semester. To approve, the student has to obtain, at least, five points. Students wishing to improve their continuous evaluation marks can also attend the final exam: in this case the mark of this exam will be the final mark. The students that have passed the continuous evaluation and are satisfied with their mark do not need to attend the final exam. Along the semester the students will receive feedback on their progress, and the final mark of continuous evaluation will be communicated to the students well before the final exam. The delivery of the personal work the last week of class will imply the official participation in continuous evaluation. The extraordinary evaluation of July will be an extraordinary final exam, for those students that have not passed neither the continuous evaluation neither the final exam in May. The final mark will be the mark of the extraordinary final exam in both cases. This extraordinary final exam will be marked between 0 and 10 points, and covers all the subjects. To approve, the student has to obtain, at least, five points. Note that there are two final exams, but both correspond to a single and the same call ("convocatoria").

Sources of information

Basic Bibliography

Erik Reinhard et al., **Color Imaging: Fundamentals and Applications**, 1ª, A K Peters, 2008

John Robert Schott, **Remote Sensing: The Image Chain Approach**, 1ª, Oxford University Press, 2007

Michael Vollmer and Klaus-Peter Möllmann, **Infrared Thermal Imaging: Fundamentals, Research and Applications**, 1ª, Wiley-VCH, 2010

Arnulf Oppelt, **Imaging Systems for Medical Diagnostics**, 2ª, Wiley-VCH, 2005

Complementary Bibliography

Oleg S. Pianykh, **Digital Imaging and Communications in Medicine (DICOM)**, 2ª, Springer, 2012

Recommendations

Subjects that are recommended to be taken simultaneously

Fundamentals of Image Processing/V05G300V01632

Other comments

Simultaneously taking the subject Fundamentals of Image Processing is highly recommended.

Abundant digital bibliographic material will be provided to the students through the subject's web, covering all the subject matter in the program.

Contingency plan

Description

See Annex.

IDENTIFYING DATA				
Sound Processing				
Subject	Sound Processing			
Code	V05G300V01634			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Rodríguez Banga, Eduardo			
Lecturers	Rodríguez Banga, Eduardo			
E-mail	erbanga@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course describes the main techniques of the sound processing, with special emphasis on real applications. Students are shown the basic principles of these techniques and how the same principles may give rise to different algorithms or systems depending on the type of signal to process (speech or audio, for instance). This course also makes an introduction to Speech Technologies and their applications.			

Competencies	
Code	
CG4	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.
CE38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.
CT2	CT2 Understanding Engineering within a framework of sustainable development.

Learning outcomes	Competences		
Understand some basic techniques for speech and audio processing.	CG4	CE34 CE38	
Development of basic speech and audio coders.	CG4	CE34 CE38	
Analyse speech and audio specifications and standards.	CG4 CG6	CE34 CE38	CT2
Understand some basic techniques used in Speech Technologies.	CG4	CE34 CE38	
Ability to adapt learned techniques to other applications.	CG4		CT2

Contents	
Topic	
Voice production and perception	Voice generation. Physiology. General characteristics of a speech signal. Perception. Auditive physiology.
Analysis of speech and audio signals	Short term analysis. Time and spectral parameters. Linear Prediction Techniques. Psychoacoustic models.
Speech coding	Waveform coding. Parametric coding. Hybrid coding. Standards. Applications.
Audio Coding	Main characteristics of an audio signal. Time-frequency analysis : filterbanks and transforms. Coding. Standards. Applications.
Speech Technologies	Recognition, Synthesis and related applications.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	21	42	63
Practices through ICT	12	9	21

Mentored work	7	57	64
Problem and/or exercise solving	2	0	2

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

Methodologies

	Description
Lecturing	The teacher makes a presentation of some relevant contents of the subject. Some concepts may be illustrated by means of computer simulation. Students are encouraged to make questions and discuss some proposed problems and exercises. The main objective of these sessions is to provide the students with the theoretical background so that they can develop all the subject competences. Therefore, every subject competence is developed in these sessions.
Practices through ICT	Students will carry out computer simulations using Matlab, which will help them to better understand the concepts introduced in the theory sessions and to discover new ones. All the subject competences are developed in these sessions.
Mentored work	The students will be grouped into teams which will develop one or several tasks proposed by the teacher. The number of students in a team will be established taking into account the number of students enrolled and the complexity of the proposed tasks. Each team work will be supervised by the teacher who, in addition to evaluate the team work, may establish procedures for self and cross evaluation. Tutored works are thought to develop CG4 and CG6 competences, as well as CE34, CE38 and CT2.

Personalized assistance

Methodologies	Description
Practices through ICT	The teacher will establish mechanisms to determine the degree of understanding of the main concepts by the students.
Mentored work	At the regular team meetings the teacher will track the work of each student. In addition , the teacher will establish additional mechanisms such as, for instance, cross-evaluation of the student work by his/her team mates.

Assessment

	Description	Qualification	Evaluated Competencess		
Mentored work	The evaluation of a team work will be done through the collection of evidences and/or tests during its developement, at personal and group levels, a final report and a presentation and/or test about the work. A final report will be delivered to the teacher around the 13th week of the teaching period. The precise date will be established at the beginning of this period. In order to pass this course a minimum score will be required in the tutored work as explained in the section Other comments on the evaluation.	50	CG4 CG6	CE34 CE38	CT2
Problem and/or exercise solving	Final exam with several questions referred to the contents of the subject. In order to pass this course a minimum score will be required in the final exam as explained in the section Other comments on the evaluation.	50	CG4 CG6	CE34 CE38	CT2

Other comments on the Evaluation

The previously proposed evaluation method will apply to students who follow the recommended continuous evaluation (C.E.) procedure. In order to not handicap his potential teammates, the student will have a brief period to decide whether or not follows the C.E. procedure (as an orientation, the first two weeks of the semester). Selecting C.E implies that the student will be graded in the first call. Students attending only the final exam may obtain the maximum grade in the subject. However, these students will have to answer some additional questions related to the proposed team works to demonstrate that they have acquired the same skills that students following C.E.

In exceptional cases, such as long-term justified reasons that unable to follow the C.E. procedure or to take essential assessment tests within the foreseen period, the teacher will decide whether or not it is appropriate to allow the student to change from C.E. to final-exam assessment or to consider him/her 'no show'.

The second call will consist of a final exam, but students who followed C.E. may choose to keep the grade obtained in the team works, as described below, instead of answering the additional questions related to these works. In extraordinary calls the evaluation procedure will be equal to the case of opting out C.E.

Students will pass the course if they get a final mark equal to or greater than 5 (on a ten-points scale) and a score equal to

or greater than 4 (on the same scale) in both the tutored work and the final exam. The individual mark of the tutored work will be obtained as the sum of the mark of two individual tests (30% of the grade of the tutored work) and the mark obtained jointly by the group (70%), although the latter will be weighted according to the results of the cross-evaluations and the teacher's opinion about the student's personal contribution to the group work. Normally the weighting factor will be 1, although factors less than 1 will be applied to students that hinder the normal progress of the group or show poor participation or understanding in the tasks of the supervised work. Likewise, the teacher will be able to reward those students who stand out significantly for their contribution to the teamwork with a weighting factor of up to 1.2, especially in case of unexpected difficulties. In case of justified absence to any of the individual tests corresponding to the tutored work, the student may recover it by answering some additional questions in the first final exam (or the second one in case of justified absence to the first final exam).

The score obtained jointly by the group (70% of the tutored work mark) will be obtained from the evaluation of the reports corresponding to the tasks assigned and from a joint final presentation. Non-attendance to this presentation, except for a justified reason, will result in a zero as weighting factor. In case of justified absence, the student must contact his/her teacher as soon as possible to ask for an interview in which he/she will have to demonstrate his/her knowledge of the work carried out by the group.

Just in case a student has no grade on the tutored work, or chooses to leave it out at the second call, the score obtained in the group of questions related to the tutored work will be considered the grade on the tutored work and the score on the remaining questions will be the final-exam grade. The final grade will be calculated as the weighted average of the grades of the tutored work (weight 0.5) and the final exam (weight 0.5). These weights could be modified as described in the contingency plan. If a mark of 4 is not reached in both parts (tutored work and final exam) separately, the final grade will be 4 at most.

Students attending the second-call exam, with independence of the assesment track followed, will be able to choose, before starting the exam, to maintain the grade obtained in the first call in any of the two aforementioned parts if equal or higher than 4. Nevertheless they must be aware of the weight of the two parts in the final grade.

The solution to any possible inconsistency, discrepancy or difference of interpretation that may arise from this guide, as well as any error or any other not considered case, will be discussed between the teacher and the directly concerned students and, in case of no agreement, the matter will be referred to the competent higher bodies.

Sources of information

Basic Bibliography

Andreas Spanias, Ted Painter and Venkatraman Attii, **Audio Signal Processing and Coding**, 978-0-471-79147-8, Wiley, 2007

Wai C. Chu, **Speech Coding Algorithms: Foundation and Evolution of Standardized Coders**, 978-0-471-66887-9, Wiley, 2004

Douglas O'Shaughnessy, **Speech Communications. Human and Machine**, 978-0780334496, Second edition, Wiley-IEEE Press, 1999

Boss, M. and Goldberg, R. E., **Introduction to digital audio coding and standards**, 978-1-4615-0327-9, Kluwer Academic Publishers, 2003

Ian Vince McLoughlin, **Speech and Audio Processing: A MATLAB Based Approach**, 978-1-107-08546-6, Cambridge University Press, 2016

Complementary Bibliography

Dutoit, T. and Marqués F., **Applied signal processing : a matlab-based proof of concept**, 978-0-387-74535-0, Springer, 2009

Paul Taylor, **Text-to-Speech Synthesis**, 978-0521899277, Cambridge University Press, 2009

Recommendations

Subjects that it is recommended to have taken before

Fundamentals of Sound and Image/V05G301V01209
Digital Signal Processing/V05G301V01205

Other comments

It is assumed that the student has some basic skills in Matlab.

Contingency plan

Description

In case of online teaching (A, B and C groups), it will take place in a synchronous mode.

All the assessment tests provided for in the teaching guide are face-to-face, either oral or written. If not possible, they will be held online.

Based on the experience accumulated during the confinement period in the previous academic year, the following paragraphs complete the initial contingency plan. However, given the unpredictability of the events, further adjustments could be applied to this initial plan.

The teacher will decide, depending on the circumstances and the number of students in the course, whether these tests will be taken orally and whether the group presentation of the tutored work will be done individually, representing in this case the 25% of the grade of the tutored work. If this change takes place, the grade obtained jointly by the group will represent 45% of the supervised work grade, although this part of the grade will still be affected by the weighting factor described in this teaching guide.

Depending on the circumstances, it is also not ruled out to modify the weighting of the tutored work and the final exam (for instance 60% and 40% respectively, instead of the initial 50% each) and/or reorder the evaluated contents. Obviously, the type of online tests/exams, especially if they are oral, may also affect the type of questions and exercises involved, as well as the possible use of support material.

As for the duration of the final exam when it is an oral test, as a guideline, it is planned that for students following continuous assessment the duration will be about 30 minutes, while for those who take the whole final exam the duration will be about 60-90 minutes.

Regarding the exam date, if oral, it will be kept as close as possible to the official examination date for students taking the whole exam, as it is expected that the number of these students will be small. In any case, these students will be contacted to confirm the date and approximate time. For students following C.E., shifts will be established for the oral exam, with the possibility of even starting before the beginning of the official examination period.

IDENTIFYING DATA				
Room Acoustics				
Subject	Room Acoustics			
Code	V05G300V01635			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Sobreira Seoane, Manuel Ángel			
Lecturers	Sobreira Seoane, Manuel Ángel			
E-mail	msobre@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Architectural acoustics, develops the fundamental theoretical principles of the architectural acoustics, in the fields of room acoustics and acoustic isolation. The aims of the subject are: provide a sufficient theoretical background that allow the understanding of the behaviour of the sound filed in rooms; define the parameters that allow to evaluate the acoustic quality of rooms; develop the techniques of design that allow to optimise the acoustic behaviour of rooms; detail the parameters that allow to evaluate the acoustic isolation in buildings and introduce the problematic of the calculation of the acoustic insulation in the buildings and building elements. International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CE36	CE36/SI3 The capacity to implement projects at places and installations for the production and recording of audio and video signals.
CE37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.

Learning outcomes	Competences	
Knowledge on the theoretical fundamentals of room acoustics.	CG2	CE36
Ability to analyse the acoustic behaviour of rooms and identify acoustic problems.	CG5	CE37
Capacity to design solutions to acoustic problems in rooms.		
Capacity to write expert technical reports on room acoustics measurement test and analysis.		
Ability to check and assess the acoustic quality of rooms.		
Capacity to design different kind of rooms matched to the specific acoustic requirements (recording studios, control rooms, conference rooms and classrooms).		

Contents	
Topic	
Introduction	Basic concepts in acoustics. Acoustic power, sound pressure, sound intensity. Levels and decibels.
Statistital theory in acoustics.	Average sound pressure in rooms. Reverberation time: Sabine and Eyring equations.
Absorbents and Acoustic Diffusers.	Porous absorbing materials. Membrane and Helmhotz resonators. Acoustic diffusers.
Wave theory in rooms.	Three dimensional wave equation.Resonant frequencies and resonant modes in rooms. Modal density. Frequency response of rooms. The influence of dimension relations and frequency response.
Geometrical theory.	Method of the virtual image. Reflections in flat surfaces. The acoustic behaviour of curved surfaces

Acoustic design of rooms.	Descriptors of room acoustics. Echoes in rooms. Focalization effects in rooms. Acoustic behaviour of audience: seat dip. Geometrical design of rooms. Design of conference rooms and classrooms. Recording studios: LEDE and Non-Environment design techniques.
Acoustic insulation.	Introduction to the acoustic insulation. Acoustic isolation of single panels. Insulation of double walls. Introduction to the flanking transmission evaluation in buildings. Noise control in buildings.

Planning			
	Class hours	Hours outside the classroom	Total hours
Mentored work	7	28	35
Practices through ICT	12	9	21
Previous studies	0	15	15
Lecturing	19	38	57
Problem and/or exercise solving	2	10	12
Problem and/or exercise solving	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
Mentored work	The students will have to develop and write a report on three small projects: 1. Design and building Helmholtz and membrane resonators. 2. Design and acoustic measurements on scale models. 3. Software to calculate acoustic reflectors and diffusers Through this methodology the general competencies CG2, CG5 and the specific competency CE36 and CE37 are developed.
Practices through ICT	During practical sessions, the student will learn the use use of software to measure and analyse the impulse response of rooms. Through this methodology the general competencies CG5 and the specific competency CE36 and CE37 are developed.
Previous studies	The students must study and prepare with the sources of information given before the lectures and the practical sessions. Through this methodology the general competencies CG2, CG5 and the specific competency CE36 and CE37 are developed.
Lecturing	Lectures will be given, developing the main theoretical concepts of the subject. Through this methodology the general competencies CG2, CG5 and the specific competency CE36 and CE37 are developed.

Personalized assistance	
Methodologies	**Description**
Lecturing	Lectures are develop within a continuous interaction framework, where students can answer questions delivered by the teacher. They could also solve their particular doubts during the sessions.
Mentored work	Tutored works are developed in small working groups. The works are followed during meetings between the groups and the teacher. In those meetings the students can interact and ask their questions to the teacher.
Practices through ICT	In practical sessions, each student must solve his/her own tasks. The teacher will be available during the session to solve any problem/question or doubt the student may have.

Assessment			
	Description	Qualification	Evaluated Competencess
Mentored work	Tutored practical project, with the delivery of a final report. The learning aims containing the developent of the ability to develop projects are assesed through this practical tutored works.	35	CE36 CE37
Practices through ICT	Practical tasks, solved in a computer lab with specific acoustic software.	15	CG2 CG5
Problem and/or exercise solving	Written examination, solving calculation problems. Evaluation of the learning aims, mainly in those aspects related to "know how to carry calculations out" in the field of room acoustics. To be done at the end of the semester in the dates agreed and published by the Degree Academic Comitee (Comisión Académica de Grado-CAG).	25	CG5

Problem and/or exercise solving	Short answers related to the theoretical content of the subject. Evaluation of the knowledge of regulations in the matter of room acoustics. To be done at the mid of the semester in the dates agreed and published by the Degree Academic Comitee (Comisión Académica de Grado-CAG).	25	CG2

Other comments on the Evaluation

Following the guidelines of the degree, two systems of evaluation are offered: continuous assessment (recommended) and a final examination. Evaluation with only a final examination will be only allowed in situations in which it is imposible to follow the system recommended.

CONTINUOUS ASSESSMENT:

The continuous assessment will be based in the evaluation of practical task, projects and two tests. Once a student has signed a document of agreement with the process of continuous assessment, the final degree will be obtained by a weighted average of the grades obteined in the methodologies/tests described.

Some considerations on the continous assessment process:

- Tutored works are developed in groups. The final grade will be weighted taking into account the results of a cross assesment survey. To consider as "satiscactory" the contribution of each student to the group a minimum grade of 2 over 5 points is stablished.
- The studenst have to show good skills in all the learning outcomes, therefore, four points over a ten points scale must be obtained in all the learning outcomes evaluated during the continuous evaluation process.
- The final grade will be obtained through a weighted average, with the weights included in the qualification column of the methodologies/tests section, once the minimum grade is obtained in each activity. If the 4 over 10 condition in all the activities is not fullfilled, the final grade resulting form the continuous assesment process will be 4 over 10 points.

Final examination: The final examination, both in first or second chance (may/june or july), will include two parts:

- A written examination covering a short anwer tests and a troubleshouting part.
- Practical activities: practical questions and delivering the reports of practical works the teacher may ask.
- The final examination will be develpoped on the official dates published by the accademic staff.

Those students who have passed the subject following the continuous assessment proccess, will have the chance to attend the final examination in order to get a higher grade (either in the written part or the practical activities or both).
Those students who did not succeed in some of the parts of the evaluation proccess, will have the chance to do only the part of the final examination required to fullfill the requirement.
If the subject is passed in first chance, there is no chance to attend the second opportunity to improve the final grade.

The subject is assessed in a 0 to 10 points scale and it is considered "passed" if the final grade obtained is equal or greater than 5.

NON CONTINUOUS ASSESSMENT:

If a student does not sign the agreement to follow the continous assesment proccess, he/she will be evaluated through the final examination, with the same structure as commented before. The student have to show he/she has got the same skills as the students who have followed the continuous assessment proccess. The final grade will be obtained by averaging the grades of each part (written examination+ practical questions and reports) provided at least of 4 over 10 points have been obtained en each part. The final grade should be greater than 5 over 10 points.

EXTRAORDINARY CALL:

The same criteria as the established in case of non continuous assessment will be followed for the extraordinary call.

Sources of information

Basic Bibliography

Higini Arau, **ABC de la acústica arquitectónica**,
Heinrich Kuttruff, **Room Acoustics**, 5,
Manuel A. Sobreira, **Acústica Arquitectónica (Apuntes de la Asignatura)**,

Complementary Bibliography

Phillip R. Newell, **Recording Studio Design**, 3,
Lothar Cremer, **Principles and applications of room acoustics**,

Recommendations

Subjects that continue the syllabus

Advanced acoustics/V05G300V01933
Legislation and noise measurement techniques/V05G300V01934

Subjects that it is recommended to have taken before

Fundamentals of Acoustics Engineering/V05G300V01531

Contingency plan

IDENTIFYING DATA				
Distributed and Concurrent Programming				
Subject	Distributed and Concurrent Programming			
Code	V05G300V01641			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	García Duque, Jorge			
Lecturers	García Duque, Jorge			
E-mail	jgd@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main goal of this subject is to provide the foundations of the synchronisation and communication among processes in centralised and distributed systems.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG9	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.
CE33	CE33/TEL7 The ability to program network and distributed applications and services.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes		
Learning outcomes	Competences	
The ability to program network and distributed applications and services.	CG4 CG9	CE33
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	CG3	CT2 CT3 CT4
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.	CG4 CG9	CE33

Contents	
Topic	
Introduction to Concurrent Programming	Concepts of concurrence, parallelism and multitasking. Interleaving of atomic instructions. Precedence graphs.
The critical section problem	The definition of the problem. Busy waiting. Starvation Deadlock. Dekker´s algorithm. Peterson´s algorithm

Concurrent Programming Constructs	Semaphores. The problem of the producer-consumer. The problem of the philosophers. Monitors. Variables of Condition. The problem of the readers-writers.
Deadlock	Introduction and definition of deadlock. Necessary conditions. Deadlock prevention. Deadlock avoidance. Detection and Recovery
Communication among processes	Message Passing. Remote Procedure Call (RPC).
Distributed Programming	Introduction to Distributed Systems. Distributed mutual exclusion Ricart-Agrawala Algorithm. Token ring Algorithms. Consensus: Crash Failures. Byzantine Failures.

Planning

	Class hours	Hours outside the classroom	Total hours
Workshops	5	30	35
Practices through ICT	13	26	39
Lecturing	20	46	66
Objective questions exam	1	0	1
Laboratory practice	1	0	1
Essay	2	6	8

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

Methodologies

	Description
Workshops	Each group of students will tackle the design and implementation of a project software of half complexity. Said task will make in different successive steps, that will be discussed and validated in each one of the face-to-face sessions. This methodology of work has like aim provide a suitable *realimentación for, if it is timely, improve the solutions posed. This methodology is oriented to purchase the competitions *CG4, *CG9 and *CT4
Practices through ICT	The students will resolve under the supervision of the *profesorado the practical problems that pose in each session of laboratory. This methodology is oriented to purchase the competitions *CE33/*TEL7 and *CT3
Lecturing	Exhibition of the ideas, concepts, technical and algorithms of each lesson of the *temario. This methodology is oriented to purchase the competitions *CG3 and *CT2

Personalized assistance

Methodologies	Description
Lecturing	By means of tutoring
Workshops	Part of the sessions devote to resolve individual questions with each student by means of individual questions so much by part of the professor as of the student
Practices through ICT	Of complete way for the students that do the practices of individual way, and by means of the resolution of individual questions with each student by means of questions *individualizadas so much by part of the professor as of the student

Assessment

	Description	Qualification	Evaluated Competencess		
Objective questions exam	Proof of theoretical contents exposed in the master classes.	50	CG3 CG4	CE33	CT2

Laboratory practice	Evaluation of the work carried out in each one of the sessions of laboratory For the individual evaluation of each student, personalised questions will be asked in each one of the sessions.	20	CG3 CG4	CE33	CT2 CT3
Essay	In the last face-to-face session of workshop, students will deliver and will expose to their mates the design and the proposed solution for their project. This solution will be exposed to debate for students and professors For the individual evaluation of each student will realise personalised questions in each one of the sessions.	30	CG9	CE33	CT3 CT4

Other comments on the Evaluation

The subject can surpass by means of Continuous Evaluation according to the criteria that indicate more advance, having opened the possibility to opt by the No Continuous Evaluation anytime until the beginning of the final examination to celebrate the day fixed to such effect in the official calendar of the *EET.

All those students that opt by the continuous evaluation will consider presented evaluate of the part of the work in Workshops.

Continuous assesment:

The final note will result of the sum of the corresponding notes to the three following components:

1. Four proofs of type Test to evaluate the contents given in the masterclasses. Each proof will take place in one of the sessions *magistrales, except the last that will carry out in one of the sessions of the Workshop.

Score: Until 1,25 points each proof.

2. Six Practical Proofs that will carry out when finalising each one of the sessions of laboratory and that will consist in the **validation of the results obtained during the said session.

Score: Until 1/3 points. Each proof.

3. Presentation of the Project proposed like work in the sessions of the Workshop.

Score: Until 3 points.

To approve the subject by Continuous Evaluation will have to give the three following conditions:

(*i) Obtain an equal or upper qualification to 2 points in the group of the tests.;
(*ii) Upper qualification to 0 points in, at least, four of the six practical proofs; and
(*iii) Assist to all the face-to-face sessions of workshop and obtain more than 0 points in the presentation of the project.

In case of not fulfilling any of said condition, the final note of the student will be limited to a maximum of 4 points.

Eventual Assesment:

By means of an examination on 10 points fixed in the official calendar of the *EET.

Second and Extraordinary call:

It will govern by the indicated for the eventual assesment.

Sources of information

Basic Bibliography

M. Ben-Ari, **Principles of Concurrent And Distributed Programming**, Second Edition,

Complementary Bibliography

George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, **Distributed Systems Concepts and Design**, Fifth Edition,

William Stallings, **Operating Systems: Internals and Design Principles, 6/E**, Eight Edition,

Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, **Operating system concepts**, Ninth Edition,

Lea, Douglas, **Programación concurrente en Java : principios y patrones de diseño**, Second Edition,

Recommendations

Subjects that are recommended to be taken simultaneously

Architectures and Services/V05G300V01645
Information Systems/V05G300V01644

Subjects that it is recommended to have taken before

Operating Systems/V05G300V01541

Contingency plan

Description

Teaching of groups A in the case in that it have to make on-line:
it will make through remote campus and by means of forums of debate in *faitic

Teaching of groups *B in the case in that it have to make on-line:
it will make through remote campus and by means of forums of debate in *faitic

Teaching of groups C in the case in that it have to make on-line:
it will make through remote campus and by means of forums of debate in *faitic

Evaluation in the case in that it have to make on-line.
It will make through remote campus and/or by means of the available tools in *faitic

IDENTIFYING DATA				
Network and Switching Theory				
Subject	Network and Switching Theory			
Code	V05G300V01642			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Suárez González, Andrés			
Lecturers	López García, Cándido Antonio Suárez González, Andrés			
E-mail	asuarez@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The objective pursued with this course is that students acquire mastery of the basic methods of analysis for predicting the performance of networks, services and telecommunication systems, in terms of the amount of traffic they carry, the physical structure of the system and the way it is interconnected, the capacity of its constituent network elements and the algorithms used in them.			

Competencies	
Code	
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CE28	CE28/TEL2 The ability to apply the techniques that are basis of computer networks, services and applications, such as management, signaling and switching, routing and securing systems (cryptographic protocols, tunneling, firewalls, charging mechanisms, authentication and content protection) traffic engineering (graph theory, queuing theory and teletraffic) rating, reliability and quality of service in both fixed, mobile, personal, local or long distance environments with different bandwidths, including telephony and data.
CE31	CE31/TEL5 The ability to follow the technological progress of transmission, switching and processing to improve computer networks and services.

Learning outcomes		Competences
Ability to apply mathematical methods of queueing theory to the analysis and design of telecommunication networks and systems.	CG5	CE28 CE31
Ability to understand the basic compromises in designing telecommunication networks and systems in function of the parameters of traffic.	CG5	CE28 CE31
Ability to use methods of discrete mathematics to resolve problems of routing and interconnection of networks, reliability, quality of service and distribution of contents in wired and wireless networks, fixed and mobile networks, access and transport networks.	CG5	CE28 CE31
Mastery of the necessary basic concepts to resolve problems of resource optimization in networks.	CG5	CE28 CE31

Contents	
Topic	
Queuing Theory	One-server systems. Finite queue systems. Systems with congestion: models of Erlang and Engset. Reversibility. Networks of queues with product solution. Applications: design of link capacity; design of buffer size; congestion in cellular networks; analysis of systems with priorities; provision of ARQ; provision of multiaccess networks.

Graph theory	Graph traversal and connectivity. Minimum cut, maximum flow. Tree coverage and expansion. Minimum cost trees. Graph coloring. Results and uses. Regular and irregular random graphs: small world networks, scale-free networks. Applications: Network topology design, the web graph, message broadcasting in wired networks and ad hoc networks.
Network Optimization	Utility Maximization. NUM decomposition problems. Applications.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	21	42	63
Practices through ICT	4	6	10
Problem solving	8	12	20
Project based learning	7	35	42
Essay questions exam	2	6	8
Problem and/or exercise solving	0	7	7

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

Methodologies

	Description
Lecturing	It will present a systematic theoretical approach to the subject, highlighting the objectives, key concepts and relationships between different topics. Students should assimilate knowledge to enable them in the CG5, CE28/TEL2 and CE31/TEL5 competencies.
Practices through ICT	Guided practice where it is intended to study problems by both by applying analytical techniques and by using software tools, providing a training in the use of the latter. So students should acquire practical training in the CE28/TEL2 competency.
Problem solving	Resolution in detail of a series of selected problems and/or exercises, focused on both the theoretical concepts involved and the methodology to be employed. Students should assimilate knowledge to enable them in the CE28/TEL2 competency.
Project based learning	Group work focused on studying and solving a real problem using the techniques studied in theory and the software tool seen in practice. So students should gain practical experience that will enable them on the CE31/TEL5 competency.

Personalized assistance

Methodologies	Description
Lecturing	The student may consult individually in the tutoring hours all doubts that arise in the study of the theoretical content.
Practices through ICT	The student may consult individually both in the practice time and in the tutoring hours all doubts that arise in the use of the software tools of the practices.
Project based learning	The student may consult individually in the tutoring hours all doubts that arise both in applying the theoretical concepts and in the use of the software tools used in the projects.

Assessment

	Description	Qualification		Evaluated Competencess
Project based learning	Group work, presentation and defense of the resolution of a typical real-world problem by applying both theoretical knowledge as using, where appropriate, the software tools used in practical classes.	20		CE28 CE31
Essay questions exam	Final test developed over all of the themes.	60	CG5	CE28 CE31
Problem and/or exercise solving	The student will have to resolve individually two bulletins of problems, corresponding to the first two lessons.	20		CE28

Other comments on the Evaluation

It is left to the discretion of the students two alternative evaluation methods in the subject: continuous assessment and eventual assessment.

Selection of continuous assessment involves conduct of a no-scoring short test (15 minutes) of basic knowledge. It will take place during the first two weeks of class. In addition to this short test, the continuous assessment will consist of the group development of one project, the individual resolution of two groups of problems on the two first lessons, and the completion of a written exam about the full subject at the end of the quarter. The individual qualification in the project will depend as much on the joint qualification of the report of the project as on personal interviews (arranged from the delivery on) to the members of the group. The qualification of the project and of the exercises is effective only in the course they are proposed, including the second call at the end of the academic year. In any case, the score on the continuous assessment evaluation (once the requirement at the beginning of this paragraph is met) is given by: either score = 0.2 x project + 0.8 x maximum (exam, 0.2 x exercises + 0.6 x exam) if the exam score is higher than 2.5 or the exam score if not.

The eventual assessment (only choice on extraordinary call) will consist of a written examination on the contents of the subject. The final grade will be the score obtained in this exam. This exam will include (eventual assessment) one or several questions about the computer tools presented in the laboratory, evaluating a minimum on the CE28/TEL2 competency.

All students who have attended the final exam will be subjected to a final qualification. Continuous evaluation is selected for when delivering the project. Those who fail the course at the first opportunity at the quarter end have a second at the end of the academic year, similar to the first call.

Sources of information

Basic Bibliography

Pazos Arias, J.J., Suárez González, A., Díaz Redondo, R.P., **Teoría de colas y simulación de eventos discretos**, 2003,

M.J. Newman, **Networks**, 2012,

Complementary Bibliography

Villy B. Iversen, **TELETRAFFIC ENGINEERING and NETWORK PLANNING**, 2011,

Boyd, S., Vandenberghe, L., **Convex Optimization**, 2009,

Recommendations

Contingency plan

Description

In the case that the teaching or the evaluation had to proceed on-line, it will use the tools provided by the University, like faiTIC and Campus Remoto.

IDENTIFYING DATA				
Multimedia Networks				
Subject	Multimedia Networks			
Code	V05G300V01643			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Herrería Alonso, Sergio			
Lecturers	Herrería Alonso, Sergio López García, Cándido Antonio			
E-mail	sha@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject presents the main specific technological solutions for distributing multimedia contents over telecommunication networks.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CE30	CE30/TEL4 The ability to describe, program, assess and optimize communication protocols and interfaces at different network architecture layers .
CE33	CE33/TEL7 The ability to program network and distributed applications and services.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes	Competences		
The comprehension of basic concepts in digital encoding of audio and video.	CG3		
The knowledge of the main standards in the field of digital encoding of audio and video.	CG6		
The knowledge and comprehension of the main problems raised in the transmission of multimedia contents.	CG3	CE30	CT3
The knowledge of the main protocols used for the transmission of multimedia contents.		CE30	
The knowledge and comprehension of the main techniques used to provide quality of service in Internet.	CG3	CE30	CT3
The ability to analyze and develop VoIP networks.		CE30 CE33	

Contents	
Topic	
Digital Audio and Video Encoding	a) Digital audio (PCM). Audio compression b) Digital video. Intraframe and interframe compression
Multimedia Applications	a) Classes. Quality of service requirements b) Impact of delay and packet losses c) Content distribution. Multicast. CDN d) IP telephony: architecture, codecs, softphones, softswitches...
Multimedia Protocols	a) Transport protocols: TCP/UDP, RTP, HTTP b) Adaptive streaming. MPEG-DASH c) Session protocols: SIP, H.323, RTSP
Quality of Service in the Internet	a) Monitoring and policing techniques b) Scheduling and resource allocation c) Differentiated Services (DiffServ) d) Integrated Services (IntServ). RSVP

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	20	40	60
Practices through ICT	12	18	30
Mentored work	5	25	30
Problem and/or exercise solving	1	5	6
Project	2	4	6
Problem and/or exercise solving	2	16	18

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

Methodologies

	Description
Lecturing	Exhibition of the ideas, concepts and techniques of each topic of the course. In these sessions, students must acquire competences CG3, CG6 and CE30.
Practices through ICT	Practical learning of basic tools for the distribution of multimedia contents on computer networks. Group activity. In these sessions, students must acquire competences CE30, CE33 and CT3.
Mentored work	Configuration, with the teacher's guidance, of a basic IP PBX. Group activity. This work should help students to acquire competences CE33 and CT3.

Personalized assistance

Methodologies	Description
Lecturing	Personalized assistance will be provided in person and/or remotely by email, Faitic forums or Campus Remoto during the office hours that will be announced at the beginning of the course.
Practices through ICT	Personalized assistance will be provided in person and/or remotely by email, Faitic forums or Campus Remoto during the office hours that will be announced at the beginning of the course.
Mentored work	Personalized assistance will be provided in person and/or remotely by email, Faitic forums or Campus Remoto during the office hours that will be announced at the beginning of the course.

Assessment

	Description	Qualification	Evaluated Competencess	
Problem and/or exercise solving	Midterm exam covering some of the contents of the subject. Questions and problems of conceptual, logical, analytical or applied character. One hour long written exercise.	20	CG3 CG6	CE30
Project	Evaluation of the features and performance of the IP PBX configured by the student during the course.	20		CE33
Problem and/or exercise solving	Final exam covering all the contents of the subject. Questions and problems of conceptual, logical, analytical or applied character. Two hour long written exercise.	60	CG3 CG6	CE30

Other comments on the Evaluation

Two different methods of evaluation will be offered to the students: continuous assessment and exam-only assessment.

Students opting for continuous assessment must take two intermediate tasks: a midterm exam (20% of the final grade) and a project involving the configuration of a basic IP PBX (20% of the final grade), together with a final exam at the end of the course (60% of the final grade). If the score of the final exam is less than 3.5/10, then the final grade of the subject will be the score obtained in this final exam. The score of the project will take into account both the features and performance of the IP PBX configured (70%) and the answers to a practical exam that will be solved individually (30%). Both intermediate tasks are not recoverable and will be only valid for the current course.

Students can also opt for being evaluated by means of just a final exam at the end of the course. In this case, the final grade of the subject will be the score obtained in this exam.

It will be considered that students opt for the continuous assessment if they take the midterm exam or the project proposed. Students taking the final exam will be considered presented to the subject. The final exam will contain some additional questions for those students that have opted by the exam-only assessment.

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

Those students that have not passed the subject in first call will have to take a new written exam in second call. Those students that opted for continuous assessment in first call will be able to choose in second call between exam-only

assessment or to keep continuous assessment. In the latter case, they will keep the scores obtained in the intermediate tasks (midterm exam and project) and will only have to take the final exam as the last task. Students must indicate their preferred assessment method at the final exam.

In the end-of-program call the assessment will just consist in the realization of a written exam about ALL the contents of the subject.

The schedule of the midterm/intermediate exams will be approved in the Comisión Académica de Grado (CAG) and will be available at the beginning of each academic semester.

Sources of information

Basic Bibliography

J. F. Kurose, K. W. Ross, **Computer networking: a top-down approach**, 7ª ed., Pearson, 2016

Z. Li, M. Drew, J. Liu, **Fundamentals of Multimedia**, 2ª ed., Springer, 2014

Kun I. Park, **QoS in packet networks**, 1ª ed., Springer, 2005

R. Bryant, L. Madsen, J. Van Meggelen, **Asterisk: the definitive guide**, 5ª ed., O'Reilly Media, 2019

Complementary Bibliography

H. W. Barz, G. A. Bassett, **Multimedia networks: protocols, design, and applications**, 1ª ed., Wiley, 2016

M. Barreiros, P. Lundqvist, **QoS-enabled networks: tools and foundations**, 2ª ed., Wiley, 2016

Flavio Goncalves, **Complete Asterisk Training**, 1ª ed., 2019

Bruce Hartpence, **Packet Guide to Voice over IP**, 1ª ed., O'Reilly Media, 2013

Alan B. Johnston, **SIP: Understanding the Session Initiation Protocol**, 4ª ed., Artech House Publishers, 2015

Recommendations

Subjects that continue the syllabus

Multimedia services/V05G300V01941

Subjects that it is recommended to have taken before

Fundamentals of Sound and Image/V05G301V01209
Computer Networks/V05G301V01210

Contingency plan

Description

In case of online tuition, the planning proposed will be maintained with just some small adjustments. Lecturing will continue through Campus Remoto in the schedule established whereas the practices with ICT support will be properly adapted so that they can be made by the students in their personal computers instead of in the laboratory.

Regarding the assessment, the same intermediate tasks (midterm exam, project and final exam) with the same weighting will be carried out. Only the evaluation of the project will be modified. In this scenario, the project will be individually evaluated by means of a series of optional assignments proposed along the course and of a questionnaire at the end of the course. The students will be able to sum up to 1,5 points to the score obtained in the questionnaire (on 10 points) if they satisfactorily complete all the optional assignments proposed. Anyway, the maximum score in the project will be 10 points.

IDENTIFYING DATA				
Information Systems				
Subject	Information Systems			
Code	V05G300V01644			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	García Duque, Jorge			
Lecturers	García Duque, Jorge			
E-mail	jgd@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The aim of this subject is to introduce to the student in the main technologies to process and store the information, like central element of the telematic services			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG9	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.
CE27	CE27/TEL1The ability to construct, operate and manage telecommunication networks, services, processes and applications considered as systems to receive, transport, represent, process, store, manage and present multimedia information from the computer services point of view.
CE29	CE29/TEL3 The ability to build, operate and manage computer services using planning, sizing and analytical tools
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes			
Learning outcomes		Competences	
Know the main mechanisms of organisation of the information for their storage and process.		CE27	
Know the main mechanisms of research, recovery and presentation of the information.		CE27	
Comprise the concept of metainformatión and its main applications in the new telematic services.		CE27	
Capacity to design and implement a database using current models.		CE29	
Comprise the importance of information management like a basic support element for telematic services.	CG3	CE29	CT3
Skill to select the mechanisms of information management more suitable for a problem.	CG4 CG6	CE27	CT2
Capacity to build telematic services based in stored information.	CG4 CG6 CG9	CE29	CT2 CT4

Contents	
Topic	
Introduction and general perspective of the Systems of Information.	- Concepts of system of information and database. - Types of systems of information. - Concept of Managing System of Databases. - Models of databases. - The process of design of a database.

Design of Relational Databases: Conceptual Model.	- Aims of the conceptual design. - Conceptual models of databases. - The E-A model.
Design of Relational Databases: Logical Model.	- Concept of the logical design. - Logical models of databases. - The relational model. - Relational algebra. - Normalisation of databases.
Database Management Systems.	- Physical storage of the data. - Organisation of data in files. - Indexes and associations. - Management of the integrity of the data. - Consistency. - Concepts related with the security. - Optimisation of queries.
Other information systems.	- No relational databases. - Semistructured information Processing. - No-structured information Processing. - Semantic information processing.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	20	46	66
Practices through ICT	13	26	39
Workshops	5	30	35
Problem and/or exercise solving	1	0	1
Laboratory practice	1	0	1
Essay	2	6	8

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

Methodologies

	Description
Lecturing	Presentation of the ideas, concepts, technics and algorithms of each lesson. This activity develops CG3, CG4, CG6, CT2 and CT3 competencies.
Practices through ICT	The students will resolve practical problems under supervision of teachers. This activity develops CG4, CT2, CE29 and CE27 competencies.
Workshops	Each group of students will tackle the design and implementation of a software project with half complexity. This task will be realised in successive steps, that will be discussed and validated in the face-to-face sessions. The aim of this methodology is to provide a suitable feedback to improve the proposed solutions. This activity develops CG4, CG9, CT2, CT4 and CE27 competencies.

Personalized assistance

Methodologies	Description
Workshops	The professor will be present during the realisation of the workshops, answering all the doubts that can arise to the students.
Practices through ICT	The professor will be present during the realisation of the practices, answering all the doubts that can arise to the students.
Lecturing	In the development of the master sessions, the students will be able to interrupt and formulate all the questions or doubts that can arise them.

Assessment

	Description	Qualification	Evaluated Competencess		
Problem and/or exercise solving	Proof of theoretical contents exposed in the master classes.	60	CG3 CG4 CG6		CT2 CT3
Laboratory practice	Evaluation of the work carried out in the sessions of laboratory.	20	CG4	CE27 CE29	CT2

Essay	In the last face-to-face session of workshop, students will deliver and will expose to their mates the design and the proposed solution for their project. This solution will be exposed to debate for students and professors. The professor will do questions for each member of the group, what will allow his individual evaluation.	20	CG4 CG9	CE27	CT2 CT4

Other comments on the Evaluation

The subject can be surpassed by means of Continuous Evaluation according to the following criteria, having opened the possibility to opt by the No Continuous Evaluation anytime until the beginning of the final examination to celebrate the day fixed to such effect in the official calendar of the EET. All those students that opt by the continuous evaluation will consider presented if they evaluate of the part of the work in Workshops.

Continuous evaluation:

The final mark will result of the sum of the corresponding notes to the three following components:

1. Three proofs of type short answer questions to evaluate the contents given in the masterclasses. Each proof will take place in one of the master classes , except the last that will carry out in one of the sessions of the Workshop.

Score: Up to 2 points each proof. (T=t1+t2+t3)

2. One Practical Proofs that will carry out at the last session of laboratory.

Score: Up to 2 points. (L)

3. Presentation of the Project proposed like work in the sessions of the Workshop.

Score: Up to 2 points. (P)

To pass the subject by Continuous Evaluation will have to give the three following conditions: (i) obtain an equal or upper qualification to 2 points in the group of the tests.; (ii) Upper qualification to 0.75 points in the practical proof; and (iii) to attend all the face-to-face sessions and obtain more than 0 points in the presentation of the project. In the case to fulfil the three previous conditions, the final mark of the continuous evaluation will be the sum of the three components (Mark=T+L+P). If the student does not fulfil any of the three conditions, the mark of the continuous evaluation will be the minimum of the marks obtained in each one of the three components (Mark=min(T,L,P))

No Continuous Evaluation:

By means of an examination on 10 points scheduled in the official calendar of the EET.

Second and Extraordinary call:

It will be governed by the indicated for the No Continuous evaluation.

Sources of information

Basic Bibliography

Abraham Silberschatz, Henry Korth y S. Sudarshan, **Database System Concepts**, 6, McGraw-Hill, 2010

Anthony Molinaro, **SQL Cookbook**, 1, O'Reilly Media, 2005

Complementary Bibliography

Ramez Elmasri y Shamkant Navathe, **Fundamentals of Database Systems**, 6, Addison Wesley, 2010

Hector Garcia-Molina, Jeffrey D. Ullman y Jennifer Widom, **Database Systems: The Complete Book**, 2, Prentice Hall, 2008

Jeffrey D. Ullman y Jennifer Widom, **A First Course in Database Systems**, 3, Prentice Hall, 2007

Chris J. Date, **An Introduction to Database Systems**, 8, Addison Wesley, 2003

Chris J. Date, **Database Design and Relational Theory: Normal Forms and All That Jazz**, 1, O'Reilly Media, 2012

Clare Churcher, **Beginning Database Design: From Novice to Professional**, 1, Apress, 2007

Rick A Morelan, **Beginning SQL Joes 2 Pros: The SQL Hands-On Guide for Beginners**, 1, BookSurge Publishing., 2009

Recommendations

Subjects that are recommended to be taken simultaneously

Architectures and Services/V05G300V01645
Distributed and Concurrent Programming/V05G300V01641

Subjects that it is recommended to have taken before

Internet Services/V05G300V01501
Operating Systems/V05G300V01541

Contingency plan

Description

Teaching of groups To in the case in that it have to make on-line:
it will make through remote campus and by means of forums of debate in *faitic

Teaching of groups *B in the case in that it have to make on-line:
it will make through remote campus and by means of forums of debate in *faitic

Teaching of groups C in the case in that it have to make on-line:
it will make through remote campus and by means of forums of debate in *faitic

Evaluation in the case in that it have to make on-line.
It will make through remote campus and/or by means of the available tools in *faitic

IDENTIFYING DATA				
Architectures and Services				
Subject	Architectures and Services			
Code	V05G300V01645			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Mikic Fonte, Fernando Ariel			
Lecturers	Caeiro Rodríguez, Manuel Mikic Fonte, Fernando Ariel			
E-mail	mikic@gist.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course focuses on the architectonic solutions for the design of distributed systems. More specifically, the course is oriented to scenarios based on services (service-oriented architectures) and the deployment of SOA and RESTful solutions by means of Web Services Technologies. Taking the Web Services as our techonological layout, the course focuses on the description, discovery and invocation of services in SOA and ReSTful. Finally, the course introduces models for services composition in SOA and RESTful (again using Web Services as deployment technology). This subject will be taught in Spanish and Galician.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CE29	CE29/TEL3 The ability to build, operate and manage computer services using planning, sizing and analytical tools
CE32	CE32/TEL6 The ability to design networks and service architectures.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes			
Learning outcomes	Competences		
To know the main architectures for telematic services of medium & high complexity.	CG3 CG6	CE29 CE32	CT2 CT3
To Understand the concept of middleware as a supporting element for services, and to know the main models used today.	CG3	CE29 CE32	
To understand the importance and utility of web services for the development of telematic services.	CG6	CE29 CE32	
To know the main technologies to build complex services by combining other services.	CG6	CE29 CE32	
To master the basic concepts and technologies associated with the management of services and their security.	CG3	CE29 CE32	
To Acquire skills to build complex telematic services.	CG4		CT2 CT3

Contents
Topic

Introduction	□ Distributed Systems. □ Client-server Model: RPC. □ Message Middlewares. □ Web Services and SaaS. □ SOA : Roles, operations, layers.
Web Services	□ Simple SOA with REST. □ API Styles for Web Services. □ RPC, messages and resources APIs. □ Stack of Web Services technologies.
Technological Basis	□ Review of XML. □ SOAP Protocol & Messages. □ WSDL: Description of Services. □ Services Discovery.
Designing Services	□ Design of Web Services. □ Web Service LifeCycle. □ Implementation Axis2.
RESTful Web Services	□ Introduction to REST: Principles and objectives. □ Description of services with WADL. □ Introduction to Node.js. □ Implementation of Web API. □ Introduction to NoSQL data bases.
Services Development	□ Microservices basics. □ Microservices development. □ Containers of services: Docker. □ Containers orchestration: Kubernetes.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	16	48	64
Practices through ICT	12	12	24
Problem solving	3	6	9
Project based learning	6	40	46
Presentation	1	2	3
Laboratory practice	2	0	2
Objective questions exam	2	0	2

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

Methodologies

	Description
Lecturing	Classes that will combine the exhibition of the concepts and small exercises. These will be resolved by the teacher or by the students individually and/or in groups. The aim is to boost the debate and reinforce the acquisition of skills. COMPETENCES: CG3, CE29, CE32
Practices through ICT	Practice sessions will be devoted to the development of small prototypes that allow to materialise the fundamental concepts of the course. COMPETENCES: CG4, CG6
Problem solving	The professor will pose small challenges that will be resolved collectively so that the students can discuss abouth the underlying concepts and the different options. COMPETENCES: CG3, CG4.
Project based learning	The students, in groups, will develop a software system with specific requirements. The follow-up of the project will be carried out during the C sessions. COMPETENCES: CE29, CE32, CT2, CT3
Presentation	Each workgroup will justify in a presentation the adopted solution for the course project and its performance. COMPETENCES: CG4, CT2, CT3

Personalized assistance

Methodologies	Description
Project based learning	The students, organized in groups, develop a project that addresses the design and implementation of a distributed service-oriented architecture. Personalized attention related to these projects will take place in the sessions type C in the course. In each session of personalized attention, groups would discuss with the teacher the following questions concerning the progress of the project: What work has been addressed since the previous meeting? What problems have been found? What problems have not been solved? and What is the planning of future work?

Assessment					
	Description	Qualification	Evaluated Competencess		
Project based learning	Each workgroup will deliver a preliminary design of the project and later the final implementation of the course project. The delivery will consist of the design, implementation and documentation. After delivering the project, a practical test will be performed on the project implemented by each of the groups. This test may be individual or in group, including modifications of the delivered project.	30	CG4 CG6	CE32	CT2 CT3
Presentation	Each workgroup will justify in a presentation the solution adopted in the project. They also will give to the teachers an explanation about the project. Questions will be asked to each member of the group individually to verify the involvement of each student in the project.	5	CG4		CT2 CT3
Laboratory practice	There will be a group practice that demonstrates competence in the use of certain subject technologies in a practical environment. After the delivery of the practice, there will be a test of it. This test may be individual or in group, including modifications of the delivered practice.	15	CG6	CE29	
Objective questions exam	An individual exam will take place in the date indicated in the official calendar of exams. The exam may include the following types of questions: problem solving, short questions to be solved by applying the theoretical concepts explained in class, reasoned justification if one or more statements are true or false, small tests on theoretical and application aspects. Books, class notes and other material will not be allowed during the exam. The number and combination of these questions will be set for each particular exam.	50	CG3	CE29 CE32	

Other comments on the Evaluation

In first call students can follow up a continuous assessment or an exam-only assessment model. Once a student selects "continuous assessment" (joining a group of the practical part) his/her grade will never be "not taken".

Final grade will be the sum of two partial results: (i) exam of the theoretical part (50%) and (ii) practical assignments (50%).

- The exam of the theoretical part will take place when and where the official calendar specifies. No additional material is allowed.
- Practical assignments:
    1. Continuous assessment: Laboratory practice (15%) + presentation (5%) + project: design and final implementation (30%). Grade will be individual.
    2. Exam-only assessment: Delivery of laboratory practice and project.

In second call and end-of-program call scheme is exactly the same as the exam-only assessment (with the possible modifications of practice and/or project that will be specified at the convenient time).

The schedule of the intermediate exams/assignments will be approved in the Comisión Académica de Grado (CAG) and will be available at the beginning of each academic semester.

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

Sources of information

Basic Bibliography

Michael Papazoglou, **Web Services; SOA: Principles and Technology**, 1, Pearson Education, 2012

Deepal Jayasinghe, Arkham Azeez, **Apache Axis2 Web Services**, 2, Packt Publishing, 2011

Valentin Bojinov, **RESTful Web API Design with Node.js**, 1, Packt Publishing, 2015

Bruno Joseph Dmello, **What You Need To Know About Node.js**, 1, Packt Publishing, 2016

Complementary Bibliography

Steve Graham, Doug Davis, Simeon Simeonov, Glen Daniels, Peter Brittenham, Yuichi Nakamura, Paul Fre, **Building Web Services with Java: Making Sense of XML, SOAP, WSDL, and UDDI**, 1, Sams, 2004

Thomas Erl, **Service-Oriented Architecture: A Field Guide to Integrating XML and Web Services**, 1, Prentice Hall, 2004

Eric Newcomer, **Understanding Web Services: XML, WSDL, SOAP, and UDDI**, 1, Addison-Wesley Professional, 2002

Mark D. Hansen, **SOA Using Java Web Services**, 1, Prentice Hall, 2007

George F. Coulouris, **Distributed Systems: Concepts and Design**, 5, Addison Wesley, 2011

Harvey M. Deitel, Paul J. Deitel, B. DuWaldt, L. K. Trees, **Web Services: A Technical Introduction**, 1, Prentice Hall, 2002

Robert Daigneau, **Service Design Patterns: Fundamental Design Solutions for SOAP/WSDL and RESTful Web Services**, 1, Addison-Wesley Professional, 2011
Nicolai M. Josuttis, **SOA in Practice: The Art of Distributed System Design (Theory in Practice)**, 1, O'Reilly Half, 2007
Binildas To. Christudas, **Service Oriented Architecture with Java: Using SOA and Web Services to build powerful Java applications**, 1, Packt Publishing, 2008
Michael Rosen, **Applied SOA: Service-Oriented Architecture and Design Strategies**, 1, Wiley, 2008
Thomas Erl, **SOA Principles of Service Design**, 1, Prentice Hall, 2007
Thomas Erl, **Service-Oriented Architecture (SOA): Concepts, Technology, and Design**, 1, Prentice Hall, 2005
Basarat Syed, **Beginning Node.js**, 1, Apress Ed., 2014

Recommendations

Subjects that it is recommended to have taken before

Internet Services/V05G300V01501

Contingency plan

Description

Those methodologies used and tests to be carried out in person will respectively be used and carried out online through the Remote Campus and the Faitic platform (without prejudice to other measures that can be adopted to guarantee the accessibility of the students).

IDENTIFYING DATA				
Technology Management				
Subject	Technology Management			
Code	V05G300V01801			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	Spanish English			
Department				
Coordinator	González Castaño, Francisco Javier			
Lecturers	Docio Fernández, Laura González Castaño, Francisco Javier López Bravo, Cristina			
E-mail	javier@det.uvigo.es			
Web	http://http://faitic.uvigo.es			
General description	This course provides skills in design, management and leadership of technological projects. This includes detection of needs, technological surveys, team creativity techniques, project management, property definition and protection, and business models. The course is taught in Spanish and English.			

Competencies	
Code	
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.
CE54	(CE54/PY1) The ability to elaborate the proposal of technical projects according to the specified requirements in a public competitive bidding.
CE55	(CE55/PY2) The ability for technical direction of telecommunication project.
CE56	(CE56/PY3) The ability to manage telecommunication project human resources and economic.
CE57	(CE57/PY4) The ability to elaborate technical reports and for the follow up of a telecommunication project.

Learning outcomes		Competences
- To analyze the technical and economic feasibility of a project. Project budgets.	CG7 CG8	CE55 CE56
- Learn how to find statistical information and indicators - Learn how to perform technological surveys and consulting		CE57
- Learn how to apply the main certification regulations	CG8	
- Project reporting		CE54 CE55 CE56 CE57
- Project planning and management	CG8	CE54 CE55 CE56
- Sociological and human aspects of projects.		CE55 CE56
- Telecommunciations, safety and environmental regulations	CG7	CE54
- To develop models for the creation of entreprises, products and services - To propose business models in telecommunications	CG8	CE55 CE56

Contents
Topic

Project design and management	- Definition of technical goals - Translating goals into tasks - Planning the project - Project resources - Human team. R&D profiles - Budget - Tracking project evolution
Identifying and interpreting needs	- Gathering requisites - Translating needs into technical objectives - Technological perspective. Hype cycles - Sources and methods for technical surveys
Creativity techniques	- Research, development and innovation - Team methods to boost creativity - Is my idea original? Formulating and evaluating it
Collaborative Tools	- Purpose - Tools - Tool-assisted collaborative techniques
Legal aspects	- Types of property: Intellectual and industrial - Technological actives vs. legal property. Models, patents. Licenses - Spanish case/international case. Europe and the US. Internationalization hints - CIN/352/2009 regulation
Business models. Entrepeneurship.	- Product proposal - Risk analysis - Customer survey - From the idea to the business plan - First steps towards the creation of an enterprise
(*)-	(*)-

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	38	62
Project based learning	4	20	24
Practices through ICT	28	36	64

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

Methodologies

	Description
Lecturing	Oral presentation of the main concepts of the course by the professors, supported by multimedia. Lectures by experts. Through this methodology the competencies CG7, CG8, CE54, CE55, CE56 and CE57 are developed.
Project based learning	Group project to be presented during class hours A of the last week. Through this methodology the competencies CE54, CE55, CE56 and CE57 are developed.
Practices through ICT	Practice on aspects of specification of requisites, creativity and business plans (in groups) and project planning using computer tools (individual). Through this methodology competencies CE54, CE55, CE56 and CE57 are developed.

Personalized assistance

Methodologies	Description
Lecturing	The professors will be available during tutoring hours to clarify any doubts on master session contents. Tutoring hours will be published at the beginning of the course.
Project based learning	All techniques in the course will be applied to the creation and planning of a project. The project will be performed in groups. At the beginning of the course, the professors will notify a working field for the course (ex. medical applications, intelligent furniture). Projects will focus on product proposals in that specific working field. Nevertheless, the professors will track individual performance, and at the final defence there may be individual questions. Personalized individual attention on these aspects will take place during official tutoring times or via e-mail at any time.

Assessment

	Description	Qualification	Evaluated Competencess

Lecturing	Exam	40	CG7 CG8	CE54 CE55 CE56 CE57
Project based learning	Individual defense (commitee)	40		CE55 CE56 CE57
Practices through ICT	Evaluation of partial results+exam	20		CE55 CE56 CE57

Other comments on the Evaluation

FIRST OPPORTUNITY with CONTINUOUS EVALUATION:

· Individual exam (Maximum 4 points). Official calendar.

· Intermediate practical test (Maximum 1.5 points).

· Final project (Maximum 3.5 points).

· Participation in class (Maximum 1 points).

To pass the course, the final student score (as the sum of the previous activities) must be 5 points or more. Maximum score is 10 points. To pass the course it is necessary to get at least 1/4 in the individual exam.

The project will be performed in groups of 5-6 people. Individual scores will be assigned according to student interaction in B hours and the part corresponding to each student in the public project defence.

SECOND OPPORTUNITY with SINGLE EVALUATION:

It will consist in an exam with theoretical and practical parts in the official date. The practical part will cover the same content as the continuous evaluation along the course.

Sources of information

Basic Bibliography

Carl Chatfield,Timothy Johnson, **Microsoft Project 2013 Step by Step**, 1, Microsoft Press, 2013

Complementary Bibliography

Michael Michalko, **Thinkertoys: A Handbook of Creative Thinking Techniques**, 2, Ten Speed Press, 2006

Alexander Osterwalder, Yves Pigneur, **Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers**, 1, John Wiley and Sons, 2010

Edward de Bono, **Six Thinking Hats**, 2, Back Bay Books, 1999

Recommendations

Contingency plan

Description

EXCEPTIONAL MEASURES

Due to the uncertain evolution of the COVID-19 alert, University of Vigo has established an exceptional planning that will be activated when the administration or the university itself consider it necessary, while guaranteeing remote or partially remote tutoring and advice.

METODOLOGY ADAPTATION

Recorded lectures for A groups will be published at Faitic.

For B groups, communication channels will be established via Campus Remoto, Faitic or other tools.

Tutoring will take place via electronic means (e-mail, Campus Remoto, Faitic fora, etc.) under appointment.

ASSESSMENT ADAPTATION

In case of remote teaching, assessment will be modified as follows:

· Individual exam (Maximum 2 points). Official calendar.

· Interview about partial project results (Maximum 2 points).

· Final project (Maximum 6 points).

IDENTIFYING DATA				
Projects Lab				
Subject	Projects Lab			
Code	V05G300V01802			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	12	Mandatory	4th	2nd
Teaching language	#EnglishFriendly Spanish Galician English			
Department				
Coordinator	Caeiro Rodríguez, Manuel			
Lecturers	Anido Rifón, Luis Eulogio Caeiro Rodríguez, Manuel Cao Paz, Ana María Díaz Otero, Francisco Javier Eguizábal Gándara, Luis Eduardo Fernández Masaguer, Francisco García Sánchez, Manuel Gómez Cuba, Felipe Gómez Yepes, Alejandro González Valdés, Borja Liz Domínguez, Martín López Nores, Martín Lorenzo Rodríguez, María Edita de Machado Domínguez, Fernando Raña García, Herminio José Rodríguez Rodríguez, José Luis Santos Gago, Juan Manuel Torres Guijarro, María Soledad			
E-mail	mcaeiro@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Interdisiciplinary projects must be addressed by a team of students who must represent at least two of the four technologies of the Telecommunication Technologies Engineering Degree. The teams are supervised by two faculty members from different Departments to enrich and facilitate the cross-fertilization between different areas of work. The work developed by the different teams will be defended at the end of the course as part of the evaluation process. The teaching language is Spanish, Galician or English. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG1	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.
CG4	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.
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.
CG9	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.
CG11	CG11 To approach a new problem considering first the essential and then the secondary aspects
CG12	CG12 The development of discussion ability about technical subjects

CE54	(CE54/PY1) The ability to elaborate the proposal of technical projects according to the specified requirements in a public competitive bidding.
CE55	(CE55/PY2) The ability for technical direction of telecommunication project.
CE56	(CE56/PY3) The ability to manage telecommunication project human resources and economic.
CE57	(CE57/PY4) The ability to elaborate technical reports and for the follow up of a telecommunication project.
CT1	CT1 Development of sufficient autonomy to carry out works within the area of Telecommunications in interdisciplinary contexts.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes

Learning outcomes	Competences		
Learn to work in group in a medium term project	CG1 CG4 CG6 CG8 CG9 CG11 CG12	CE54 CE56 CE57	CT4
Plan the development of a team project	CG9 CG11	CE55 CE56 CE57	CT4
Integrate the required skills in a multidisciplinary team	CG4 CG9 CG12	CE56	CT1 CT4
Keep a dynamic attitude and foster an on-going improvement effort	CG1 CG4 CG7 CG9		CT1 CT2

Contents

Topic	
Team work	The contents for each team will be specific of the project developed. In any case, they will be multidisciplinary contents. As an example, in the school web page is available the list of projects developed in previous years. See at http://teleco.uvigo.es/index.php/es/estudios/gett/planificacion-academica/lpro
Technical edition	Executive report Stages in report development
Project development	Introduction to project development methodologies such as, Design Thinking, Lean and Agile, where key principles are introduced: focus on the final user, rapid prototyping, to provide value to the client from the beginning, communication, etc.
Public presentations	Key elements in a presentation. Hints to perform an effective presentation. How to prepare a good presentation: - Strategy - Structure - Examples - Issues to take into account

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	0	2
Mentored work	4	4	8
Project based learning	14	244	258
Presentation	8	24	32

*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	Some practical hints on skills such as oral and written presentation, and team working. This activity is individual. Competences CT1, CT2 and CT4 are developed here.

Mentored work	Partial review of the different projects evolution, with short presentations and discussions. This is a group activity. Competences CG9, CG11 and CG12 are developed here.
Project based learning	This is the core of the course: the team of students must address a project, either proposed by them or by two faculty members. During the duration of the course the team members must work in close cooperation to achieve the objectives of the project; the supervision is such that a weekly one hour meeting willl take place with one or both advisors. It is recommended the creation of a web site, such as a wiki, blog or similar, for each team to document and show the works developed during the term. All members of the team must be able to defend its project at the end of the course in both oral and two public poster sessions. This is a group activity. Competences CG1, CG4, CG6, CG7, CG8, CG9, CG11, CG12, CE54, CE55, CE56 and CE57 are developed here.
Presentation	Every team must defend its project in a final oral presentation and in two poster sessions, known as LPRO DAYS. The oral presentation can be made by one or more members of the team, and must include evidences to show proof of the work developed and achieved results. At the end of the presentation all members must be available for Q&A. The poster sessions require the presence of all members of the team. A summary of the work must be submitted to the evaluation committee three days in advance. This is a group activity. Competences CG9 and CG12 are developed here.

Personalized assistance

Methodologies	Description
Introductory activities	Subject teachers will be available during tutoring hours to solve any doubts and issues about theses activities. Teachers will establish timetables for this purpose at the beginning of the term.
Project based learning	Each team will have the support of their tutors for the development of the project and to solve any doubts and issues about it in tutoring hours. Teachers will establish timetables for this purpose at the beginning of the term.
Mentored work	Subject teachers will be available to solve any doubts and issues about the development of these tasks during tutoring hours. Teachers will establish timetables for this purpose at the beginning of the term.

Assessment

	Description	Qualification	Evaluated Competencess
Project based learning	A portion of the final grade will be based on: 1. Advisors recommendations. For an adequate tracking of the project development, advisors will request different pieces of evidence, both oral and/or written, including partial and/or final reports. Each pair of advisors must submit a justified recommendation to the committee as to the team work methodology and the performance of the team members in the accomplishment of the project goals. Although the grade is expected to be similar for the entire group as a general principle, exceptions might apply. Competences CG1, CG4, CG6, CG7, CG8, CG11, CG12, CE54, CE55, CE56, CE57 will be evaluated here. 2. Group mates. Although the grade is expected to be similar for the entire group as a general principle, exceptions might apply. A peer review among the team members will be also requested as additional evidence for competences CG9, CT1, CT4.	65	CG1 CE54 CT1 CG4 CE55 CT4 CG6 CE56 CG7 CE57 CG8 CG9 CG11 CG12
Presentation	A portion of the final grade will be based on the committee evaluation during the LPRO DAYS. The attendance to these days will be mandatory for all students. They must submit an executive summary of the project at least three days in advance to help assess their work. This part of the assessment will be made taking into account the summary of the project, the presentation, the poster and the work performed during the LPRO DAYS. The members of the evaluation committee will be the instructors of the Type-A ECTS, as long as they are not involved in the supervision of any project. Otherwise, additional assistance for the evaluation of those conflicting projects will be requested from other instructors from the course. Although the grade is expected to be similar for the entire group as a general principle, exceptions might apply. Thus, especially underperforming students not contributing to the team effort can get a different grade. Similarly, students contributing well above the average of the group can get a higher grade.	35	CG1 CT2 CG7 CG9 CG12

Other comments on the Evaluation

The first call evaluation is carried out in accordance to the previously mentioned Presentation and Project based learning methodologies. It is mandatory the attendance to the 80% of the face to face sessions during the term, both in type-A and Type-C academic activities. Final presentations are allowed in Galician, Spanish or English. In any case, those students that decide to take the course in English should participate always in the English activities.

Those students/teams not getting the minimum grade to pass the course in the first call will have some additional weeks till the allocated date in the second call and extraordinary call to present the project again. In this second call, the individual learner will need to show a comprehensive domain of the project developed by his/her team, together with sufficient additional contributions of his/her own.

Sources of information

Basic Bibliography

Eric Ries, **El método Lean Startup: Cómo crear empresas de éxito utilizando la Innovación Continua**, 1, Deusto, 2011

Ken Beck y colegas, **Manifiesto por el Desarrollo Ágil de Software**, 1, 2001

Complementary Bibliography

Jim Highsmith e Ken schwaber, **Lean Software Development. An Agile Toolkit**, 1, Addison Wesley, 2003

Recommendations

Subjects that are recommended to be taken simultaneously

Technology Management/V05G300V01801

Other comments

This subject involves a high workload for the students outside of the classrooms related to the development of the projects: 244 hours. This effort is not just required individually, but also for the team as a joint group. In addition, it is important to have time availability to maintain meetings and perform group activities. Therefore, it is highly recommended to take this subject just with the subjects included in the second semester of the fourth year (DTEC and TFG) or equivalent. It is recommended to inform about subjects of other courses taken simultaneously with LPRO.

The work teams of this subject are multidisciplinary taking into account the 4 specializations of the degree. As a generic rule, if possible, teams cannot involve more than 3 students of the same specialization and students of 3 different specializations will be involved.

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF METHODOLOGIES ===
* Teaching methodologies that are maintained
In the event that teaching must be carried out online, all methodologies are maintained in both groups A and groups C. In this case, lectures and meetings are held through the remote campus.

In the case of groups A, presentations will be provided through Faitic.

In the case of groups C, the tutoring teachers can establish the means of communication with the students through the Remote Campus and Faitic.

* Non-attendance mechanism for student attention (tutorials)
In the event that teaching must be carried out online, the tutoring sessions may be carried out by electronic means (email, videoconference at the Remote Campus, FAITIC forums, ...) under the modality of prior agreement.

=== ADAPTATION OF THE TESTS ===
In the event that teaching must be carried out online, the evaluation scheme will be maintained, although the activities to be carried out in the LPRO DAYS will be done through the Remote Campus and the presentation of posters will be replaced by short videos demonstrating the operation of the prototypes.

IDENTIFYING DATA				
Remote sensing				
Subject	Remote sensing			
Code	V05G300V01911			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Cuiñas Gómez, Íñigo			
Lecturers	Cuiñas Gómez, Íñigo Díaz Otero, Francisco Javier Torío Gómez, Pablo			
E-mail	inhigo@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Remote Sensing is the subject devoted to all systems that allow the collection of data related to objects or surface characteristics without physical contact. We begin presenting the principles of Remote Sensing, in visible, infrared and in microwaves spectrum. Special care will be put on active and passive sensors, with a deep explanation of RADAR and optic-electronic systems. Then, the subject involves technological elements and signal processing, with a focus on the applications on Earth surface and other space bodies. The academic language is English.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.
CG9	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.
CE65	(CE65/OP8)Applying conceptual, theoretical and practical tools of telecommunications in the development and applications of radar and remote sensing systems.
CE66	(CE66/OP9) The ability for selection of circuits, subsystems and systems of remote sensing.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes			
Learning outcomes	Competences		
Identify and analyse problems that can be solved with Remote Sensing techniques	CG3 CG4 CG9	CE65	CT4
Propose solutions based on RADAR, microwaves, infrared, LIDAR or visible spectrum observation	CG3 CG4 CG9	CE66	CT3 CT4
Specify sensors and Remote Sensing systems more adequate for each application	CG3 CG7	CE65 CE66	CT2
Interpret and analyse images taken from satellites	CG3 CG4 CG7	CE65	CT2

Contents
Topic

Introduction to Remote Sensing	The aim of this topic is to provide a panoramic of the meaning and application of remote sensing of earth, sea and air. Special attention is given to different points of view: from our usual perception of the Earth to its appearance when it is observed from a satellite or another airlifted platform. Besides, the subject shows the historical evolution of Remote Sensing and its implication in the human life, standing out the hits of the space exploration and the different programs that have been designed along the space race. The contents given in group A have an autonomous activity associated, called "The Earth from the air/space", proposed when the subject begins.
Fundamental concepts	The three fundamental concepts of Remote Sensing are the core of this topic: the spectral signature, the classification and the compositions of color. All these are explained after an introduction to the multispectral sensors.
Sensors	Explanation of the concept of sensor, introduction to the different types of sensors, the concept of resolution and calibration. Then, there is at least a session of two hours devoted to the passive sensors (optical-electronic, thermal and radiometers of microwaves) and another session to the active sensors (RADAR and LIDAR). This explanation includes the foundations and operation, its characteristics, advantages and inconvenients, and typical applications. The contents given in group A have several associated practices of laboratory (group B), those called "Sensors calibration", "Passive Sensors: infrared", and "RADAR Fundamentals".
Processing, interpretation and formation of images	This section is a summary of the different techniques of signal processing applied to interpreting and classifying images taken from satellites. It uses an example image to which all different processing techniques are applied and explained. The subject also takes care of the formation of images of big regions of the surface of the Earth from pictures of areas more reduced, by means of the use of mosaics. It shows the process of constructing the mosaic from both satellite and airborne images. All the contents are given in laboratory (group B), for four sessions of 2 hour each. Besides, the works developed in group C will support the contents of this chapter.
Geographic Information Systems (GIS)	It tries to introduce the foundations and applications of the GIS, orienting all the exhibition to the support in the decisions process related with geographic locations. The second part of the session devotes to deepen in the knowledge of applications of GIS by means of the study of practical cases.
Terrestrial exploration	This section devotes to some examples of applications of Remote Sensing in diverse fields: studies of the ground, agriculture, mining, geology. The own actuality at teaching time can determine the applications in which more upsetting is done. The contents given in group A could have associated some of the works developed by students in groups C, depending on the focus of each group challenge.
Meteorology and Oceanography	In this section, the applications that more satellites have used along the history of Remote Sensing are introduced: the meteorology and the oceanography. In Meteorology, we introduce which types of sensors are employed, and we analyse the different parameters of interest, the characteristics regarding resolution and the results of climatic studies along the planet. Regarding Oceanography, the subject focuses on the observed parameters, the sensors, and it also presents images that show the results of the observations both directly and after the application of distinct processed. The contents given in group A could have associated some of the works developed by students in groups C, depending on the focus of each group challenge.

Space exploration	The aim of the subject is to show a panoramic of the space exploration. Beginning with the sensors employed along the years of history of the humanity in the space, the subject shows the main knowledges that we have obtained from the distinct bodies of the solar system and it explains how they arrived to this knowledge (missions, peculiarities of the ships and sensors employed, etc.).

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	17.2	25.8	43
Laboratory practical	4	8	12
Practices through ICT	10	15	25
Mentored work	5	45	50
Presentation	2	4	6
ICT suppoted practices (Repeated, Dont Use)	0	2	2
Introductory activities	1	1.2	2.2
Systematic observation	0	2	2
Essay	0	5	5
Essay questions exam	2.8	0	2.8
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	The course topics are presented and developed by the lecturer: foundations, theoretical bases, applications, etc. Group A sessions. 1 session/week. 2 hours/session Through this methodology the competencies CE65, CE66, CT2, and CG3 are developed.
Laboratory practical	Experimental work on sensor calibration and infrared termography. Group B sessions. 2 sessions/semester. 2 hours/session. Through this methodology the competencies CE65, CE66, CT4, and CG4 are developed.
Practices through ICT	Computer-based work on radar fundamentals and satellite imagery processing and interpretation. Group B sessions. 5 sessions/semester. 2 hours/session Through this methodology the competencies CG4, CG7, CG9, CT4, and CT3 are developed.
Mentored work	The students will be assigned a simulation project. They will developed the project working in groups of 5-7 students. Project class sessions will be devoted to discussion and follow-up of the project. Group C sessions. 6 sessions/semester. 1 hour/session. Additional tutorial sessions will be scheduled if required. Through this methodology the competencies CG4, CG7, CG9, CT4, and CT3 are developed.
Presentation	The students will present, in an open session, the results of their project. Previously, the students must send, by e-mail to the lecturer assigned to group C, the code developed and a report summarizing the results. Group C sessions. 1 session/semester. 1 hour/session. Through this methodology the competency CG9 is developed.
ICT suppoted practices (Repeated, Dont Use)	Activities to be autonomously developed, with software provided by means of FaiTIC platform: "Earth from air/space", to learn about points of view. This methodology works on competences CE65 and CE66

Introductory activities	Activities focused on taking contact and gathering information on the students, as well as to present the topic. For this activity, one face-to-face hour is reserved in group A, during which the professor presents the topic, explain the practices of laboratory and computer, and what expects of the works in group C. This methodology works on competences CE65, CE66, and CG4

Personalized assistance	
Methodologies	**Description**
Introductory activities	Time that each professor has reserved to attend and resolve doubts of the students
Lecturing	Time that the lecturer of group A has reserved to attend and resolve doubts of the students
Laboratory practical	Time that the lecturer of groups B can use to help the students understand the lab practices and to resolve doubts.
Practices through ICT	Time that the lecturer of groups B can use to help the students understand the lab practices and to resolve doubts.
Mentored work	Time that the lecturer of groups C can use to provide support to the tutored groups, additional to the scheduled meetings.
Presentation	Time that the lecturer of groups C can use to help the students in preparing their results presentations.
ICT suppoted practices (Repeated, Dont Use)	Time that the lecturer of group A will use to attend the students that need some support in doing their autonomous work.
Tests	**Description**
Essay questions exam	The lecture of group A will support the students to solve any doubt related to the tests

Assessment					
	Description	Qualification	Evaluated Competencess		
Lecturing	Essay questions exams: there will be four proofs, at dates informed to the students at the beginning of the academic year, of 10 minutes length, that allows the student to pass part of the matters. In these short proofs the skils CE65, CE66, CG3 and CG7 will be evaluated.	40	CG3 CG7	CE65 CE66	
Laboratory practical	Systematic observation: During laboratory practices, the results and the demonstration of having understood the procedure to arrive to them will be evaluated: 1. "Sensors calibration": 5% 2. "Infrared thermography": 10% In these practices the skils CE66, CT3, CG4 and CG9 will be evaluated.	15	CG4 CG9	CE66	CT3
Practices through ICT	Systematic observation: During the computer practices , the results and the demonstration of having understood the procedure to arrive to them will be evaluated: 1. "Foundations of RADAR": 7% 2. "Image Processing": 13% In these practices the skils CE65, CT2 and CG4 will be evaluated.	20	CG4	CE65	CT2
Mentored work	The works developed in C groups will be evaluated in two parts: the own dynamics of the works and the presentations. The work itself will receive 15% of the final mark of the subject. Each of the members of the work would receive the same mark, as each of them is co-responsible of the development. In these works the skils CE66, CG7 and CG9 will be evaluated.	15	CG7 CG9	CE66	

Presentation	Presentations of the works developed by the groups C. After the presentation, the lecturers will ask questions, individually, to the members of the group. The mark of this part will be given individually, depending on the demonstrated knowledge of each member of the group, and will represent 7% of the total subject mark. In the presentation of the works the skils CG9 and CT4 will be evaluated.	7	CG9	CT4
ICT suppoted practices (Repeated, Dont Use)	Students will give the lecturer their autonomous work results: "The Earth from the air/space": 3% In these practices the skils CE65 and CG4 will be evaluated.	3	CG4	CE65
Essay questions exam	These exams are used to assess the lecture contents, and they are included in that issue	0	CG3 CG7	CE65 CE66

Other comments on the Evaluation

The subject language is English. **Tests, reports and exams should be written in English.**

Evaluation and grading.

The students can chose any of the following assessment systems:

1.-**Continuous evaluation.** This consist of the following activities

1.1. Four quizzes. They account for 40%of the final grade.

1.2. Performance at lab classes. It accounts for a 35% of the final grade.

1.3. Simulation project results andreport. 15% of the grade.

1.4. Project presentation. 7% of thegrade.

1.5. Homework. 3% of the final grade.

Missed quizzes and/or lab classes will not be rescheduled.

Students attending to two of the four quizzes will be considered in the continuous assessment system. A student in continuos assessment is considered to be presented to the exam, independently of having taken all assessment events.

Students that want to improve their grade may attend the exam-only assessment test. Their final grade will be the average between the final exam and the continuous assessment grade.

2.- **Exam-only assessment.** It consists of a 10 questions exam. The exam can be taken up to two times per course, in first and second calls. Time and place are published in the School web page. All material given in the lectures, lab classes and project presentations is subject to questioning.

The second call (end of course) will use the same method of assessment as single evaluation.

Ethical code

Final exams and quizzes must be worked out on everyone□s own. Any infraction will beconsidered a serious breach of ethics and reported to the academic authorities.

Lecturers may decide to fail a student if he has committed a serious ethical breach.

Sources of information

Basic Bibliography

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Recommendations

Subjects that are recommended to be taken simultaneously

Navigation systems and satellite communications/V05G300V01912

Subjects that it is recommended to have taken before

Microwave Circuits/V05G300V01611
Radio Frequency Circuits/V05G300V01511
Optical Telecommunication Infrastructures/V05G300V01614
Principles of Digital Communications/V05G300V01613
Wireless Systems and Networks/V05G300V01615
Radio Communication Systems/V05G300V01512
Multimedia Signal Processing/V05G300V01513

Other comments

The subject is going to be taught in English.
All the documents will be in English.

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===

*CLASSROOM SESSIONS, GROUP A.
Audiovisual material will be provided for prior individual work in understanding the contents of the weekly sessions, and virtual sessions will be scheduled (at the same official timetable or when the School indicates) to explain those contents and resolve any doubts that may arise.

*LABORATORY SESSIONS, GROUP B.
Laboratory sessions that have not been done in face-to-face format will be adapted to the remote mode:
A) Laboratory practices with equipment.
The practice of sensor calibration would not be carried out, or would be replaced by audiovisual material that shows the different situations.
The practice of infrared thermography would be carried out by establishing shifts for the use of the thermal imager, which would be provided individually to the students if the establishment of a home delivery system was possible and feasible.
Each student will send a report on the results obtained in each of the proposed experiments.
B) Practices in the computer room.
RADAR fundamentals: the activity will be carried out individually and each student will save the screenshot of the final score, which will be sent to the teacher in charge of the practices.
Processing and interpretation of satellite images. The MultiSpec software is free, and so that, each student will be able to obtain it on the page of the School of Electrical and Computer Engineering, Purdue University as the professor in charge will indicate, and will be able to carry out the practices from their own home computer. As a result, it will send a report with the questions that the lecturer in charge indicates.

*TEAMWORK, GROUPS C

The teams would continue to carry out the assigned tasks, meeting virtually with the teacher weekly or biweekly to monitor the activity. The presentations of the works would be made in a virtual classroom of the Remote Campus.

*ASSESSMENT
The assessment, both continuous and final, would follow the outline described in the regular guide, although the assessment events must be done remotely if this is required by the regulations in force during the corresponding evaluation period.

IDENTIFYING DATA				
Navigation systems and satellite communications				
Subject	Navigation systems and satellite communications			
Code	V05G300V01912			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Aguado Agelet, Fernando Antonio			
Lecturers	Aguado Agelet, Fernando Antonio Mosquera Nartallo, Carlos			
E-mail	faguado@tsc.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The contents of this course cover the basics of satellite navigation and satellite communication systems: GPS and Galileo, the different segments of satellite communication systems, and an introduction to the planning and development standards. The course will be entirely conducted in English; the use of Spanish or Galego will be optionally allowed in the last exam.			

Competencies	
Code	
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CE67	(CE67/OP10) Applying conceptual, theoretical and practical tools of telecommunications in the development and applications of navigation and satellite communications systems.
CE68	(CE68/OP11) The ability for selection of navigation and satellite communications systems and subsystems.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes			
Learning outcomes	Competences		
To know the planning and development standards of satellite systems.	CG2 CG3	CE67 CE68	CT3
To know the different alternatives of communication and navigation satellite systems, their different segments (space, ground and user) and the type of orbits.	CG3 CG4	CE67 CE68	CT2 CT3
To know the more usual systems and services for satellite communications, including their technological capabilities and limitations.	CG3	CE67 CE68	CT3
To know and apply satellite navigation systems: GPS, Galileo, and other systems.	CG2 CG3 CG4	CE67 CE68	CT2 CT3

Contents	
Topic	
Introduction	- System definition - Standards - Regulations - Allocated frequency bands

Elements of a System	- Ground Segment - Space Segment - Launch Segment - User Segment
Architecture of the Communication Subsystems	Subsystems: - Antennas - Payload: transponders
Introduction to Satellite Communications	- Main elements in a communications payload - Signal propagation impairments - Link budget - Multibeam satellites
Satellite Communication Services	- Fixed Satellite Services (FSS) - Broadcast Satellite Services (BSS) - Mobile Satellite Services (MSS)
Introduction to Navigation Systems (GNSS)	- GPS, Galileo, Glonass, and other systems.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	21	42	63
Practices through ICT	13	39	52
Laboratory practical	4	8	12
Mentored work	3	9	12
Problem and/or exercise solving	1	10	11

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

Methodologies

	Description
Lecturing	We describe the different aspects of the subject providing all the necessary educational material, including the possibility of using the flipped learning methodology. Through this methodology the competencies CG2, CG3, CG67, CG68, CT2 and CT3 are developed.
Practices through ICT	Every student will apply the theoretical knowledge to different practical tasks covering the main part of the contents of the subject with the help of the software suites. Through this methodology the competencies CG3, CG4, CG67, CG68 and CT3 are developed.
Laboratory practical	Every student will apply in a practical way the different theoretical knowledge in a specific context. Through this methodology the competencies CG3, CG4, CG67, CG68 and CT3 are developed.
Mentored work	The student will work in groups, with the support of the university lecturers, to apply, extend and personalize the contents covered in the theoretical and laboratory hours. Through this methodology the competencies CG4, CG67, CG68, CT2 and CT3 are developed.

Personalized assistance

Methodologies	Description
Mentored work	The students will have the opportunity to attend tutorial hours (face-to-face or virtually) with the university lecturers in the schedule that will be established and published in the subject web-page. They may also send their queries by email.

Assessment

	Description	Qualification	Evaluated Competencess		
Practices through ICT	The students will perform laboratory practice where they will work with concepts studied in the theoretical classes. The practices will be carried out in groups of 2 people. The final grade will be individual, including the assessment of the student's participation during the sessions as well as the individual final report and, in some practices an individual test.	40	CG3 CG4	CE67 CE68	CT3

Laboratory practical	Each student will perform field practices. The evaluation will be performed by means of a report for a total weight of 10% of the final mark. The practices will be carried out in groups of 2 people. The final grade will be individual, including the assessment of the student's participation during the sessions as well as the individual final report and, in some practices an individual test.	10	CG3 CG4	CE67 CE68	CT3
Mentored work	The evaluation of the group work will be taken into account as well as the understanding, maturity, importance and originality of the work and interaction between the group. The tutored works will be carried out in groups of 2 people. The final grade will be individual, including the assessment of the student's participation during the sessions as well as the individual final report.	5	CG3 CG4	CE67 CE68	CT2 CT3
Problem and/or exercise solving	A final test to evaluate the contents presented in the master sessions. The test will be individual with time limit.	45	CG2 CG3 CG4	CE67 CE68	CT2 CT3

Other comments on the Evaluation

The teaching language will be English.

Both, documentation and presentations of this subject will be exclusively in English.

English shall be used for writing the reports to evaluate the laboratory practices and the tutored works.

The students can use English, Spanish or Galego to respond the final test.

The subject will be evaluated through one of two possible procedures. At the beginning of the term, the student will choose the assessment methodology, exam-based or continuous evaluation:

Exam-based evaluation:

- The final exam will include questions and/or numerical problems related with the contents presented in master sessions, laboratory practices and tutored works. It will be necessary to obtain 5 points over 10 to pass the exam.

Continuous evaluation. The subject will be assessed throughout the entire term:

- Laboratory practices: each student will have to perform different tasks with a total weight of 40% of the final mark.
- Tutored works: each student will participate in different tutored works proposed during the lecture period. This part will be evaluated by written reports. These reports will have a total weight of 5% of the final mark.
- Outdoor study/field practices: each student will perform field practices. A report must be turned in to get a maximum score of 10% of the final grade.
- Final test: This exam will be the final assessment of the continuous evaluation, and it will have a total weight of 45% of the final mark.
- A grade will be necessarily assigned to those students taking the course in continuous evaluation mode.

Second call: the student will have to take an exam which will include questions and/or numerical problems related with the contents presented in the master sessions, the laboratory practices and the tutored works (100% of the final mark). Those students following the continuous evaluation can optionally take this exam for the 45% of the final grade.

All the different grades are only valid for the current course, and will expire after the second call in case someone needs to take the course again.

End of program call: There will be an exam with questions and/or numerical problems related with the contents presented in master sessions, laboratory practices and tutored works. It will be necessary to obtain 5 points over 10 to pass the exam.

Improper behavior in the form of cheating in any of the assesment tests and reports will result in failing the course, and will be reported to the Director of the Telecommunication Engineering School.

Sources of information

Basic Bibliography

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Elliott D. Kaplan, Christopher J. Hegarty, editors, **Understanding GPS : principles and applications**, 2nd. 2006,
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Recommendations

Subjects that are recommended to be taken simultaneously

Remote sensing/V05G300V01911

Subjects that it is recommended to have taken before

Radio Communication Systems/V05G300V01512

Contingency plan

Description

=== ADAPTATION OF THE METHODOLOGIES TO COMPLETE VIRTUAL TEACHING ACTIVITIES===

GROUP A

* Teaching methodologies modified

They could be reinforced with the flipped learning methodology.

* Planning modified

No modification of the planning is contemplated

* Tests modified

No modification of the tests is contemplated. The tests will be done at home.

GROUP B

* Teaching methodologies modified

They could be reinforced with the flipped learning methodology.

* Planning modified

For the GPS lab activity, the measuring of GPS data signals using the lab equipment will be substituted by collecting data using free IOS and/or Android APPs.

The visit to the Ground Station during operation of a satellite will be substituted by a remote class, including the remote operation of the satellite using a VPN to access to the Ground Segment Software.

For the GNURadio activity, the simulation will use pre-recorded data instead of using live data during a pass of an NOAA satellite. For the simulation of the AX.25 protocol, the radio transceivers will be simulated by a representative GNU block or by pre-recorded data.

* Tests modified

No modification of the tests is contemplated. The tests will be done at home.

IDENTIFYING DATA				
Digital processing in real time				
Subject	Digital processing in real time			
Code	V05G300V01913			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Cardenal López, Antonio José			
Lecturers	Cardenal López, Antonio José			
E-mail	cardenal@gts.uvigo.es			
Web				
General description	This course is designed to provide the student with basic knowledge about the design and implementation of real-time digital signal processing (DSP) algorithms. The main objective for the student is to obtain knowledge about the different platforms available for this purpose in scenarios with real-time restrictions, and to learn the practical issues related with the implementation of DSP algorithms in such platforms. Knowledge acquired on lectures will be reinforced by laboratory practices. For this purpose a Digital Signal Processor development board, will be employed. The course will be taught in Spanish, but all teaching materials will be in English.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CE69	(CE69/OP12) The ability to implement digital signals processing schemes in programming devices.
CE70	(CE70/OP13) The ability to interact digitally with radio signals.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes	Competences		
Know the architectures for applications in real time.	CG3	CE69	CT2
Develop applications in real time on selected architectures.	CG3 CG4	CE69	CT2
Adapt the knowledges of digital signal processing to real time tasks.	CG3 CG4	CE69 CE70	CT3
Propose digital solutions for its integration in radio transceptors.	CG4	CE70	CT3

Contents	
Topic	
Topic 1 Elementary concepts	Definition of real-time processing. Real-time restrictions for digital signal processing. Overview of hardware platforms for real time digital signal processing.
Topic 2 Time-domain algorithms.	Signal generation. Advanced structures for IIR filters. Finite-precision effects.
Topic 3 Frequency-domain Algorithms	Fast Fourier Transform (FFT). Discrete Cosine Transform. Goertzel algorithm
Topic 4 Introduction to Digital Signal Processors.	DSP architecture. Arithmetic-logic unit. Address-Generation Unit. Program flow control. Performance measures.
Topic 5 High level programming for DSP	Development systems structure. Fixed point programming techniques. Optimising high level code.
Practice 1: Introduction to the development system	Compiling, runing and debugging programs on the DSP development system. Signal generation using lool¡k-up tables

Practice 2: Signal generation	Signal generation using polynomials.
Practice 3: FIR filters	Fixed point FIR filter programming.
Practice 4: IIR filters (I)	IIR filters: coefficient quantization and scaling.
Practice 5: IIR filters (II)	IIR filters: overflow.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	21	42	63
Mentored work	7	35	42
Laboratory practical	12	24	36
Essay questions exam	2	7	9

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

Methodologies

	Description
Lecturing	Presentation of main topics in class. Multimedia material will be made available in faitic before classes take place. Personal study. Support from the instructors through tutorial help. Individual activity. Through this methodology the competencies CG3, CE69, CT2 and CT3 are developed.
Mentored work	Group work on a project centered in a practical application using the DSP development board employed in the laboratory.Group activity. Through this methodology the competencies CG3, CG4, CE69, CE70, CT2 and CT3 are developed.
Laboratory practical	Practical exercises on a DSP development board. Matlab will be used for designing filters, and for simulation purpose if necessary. Individual activity. Through this methodology the competencies CG4, CE69, CE70, CT2 and CT3 are developed.

Personalized assistance

Methodologies	Description
Laboratory practical	In practical sessions, each student must solve his/her own tasks. The teacher will be available during the session to solve any problem/question or doubt the student may have.
Lecturing	Lectures are develop within a continuous interaction framework, where students can answer questions delivered by the teacher. They could also solve their particular doubts during the sessions.
Mentored work	Tutored works are developed in small working groups. The works are followed during meetings between the groups and the teacher. In those meetings the students can interact and ask their questions to the teacher.

Assessment

	Description	Qualification	Evaluated Competencess		
Mentored work	Group work centred in a practical application of real-time signal processing, using the DSP development board.	20	CG3 CG4	CE69	CT3
Laboratory practical	Evaluation of practical exercices using the DSP development board.	70	CG3 CG4	CE69 CE70	CT2
Essay questions exam	Written exam encompassing all the material exposed in the classroom and laboratory. The teacher will provide the students support to solve any questions related to the exam.	10	CG3 CG4	CE69	CT3

Other comments on the Evaluation

The course will be taught in Spanish, but all teaching materials will be in English.

Evaluation

Students shall be offered two evaluation systems: continuous assessment or evaluation at the end of the semester.

Continuous assessment

The continuous assessment of the course will consist in:

- 5 individual practices developed on the DSP development board. These practices will account for 70% of the final grade.
- 1 project to be carried out in group that will account for 20% of the final grade.
- A written exam encompassing all the material exposed in the classroom and in the laboratory. It will take place in the

dates scheduled by the school. It will account for 10% of the final grade.

The final qualification of the student will be computed as a weighted sum (70%, 20% and 10%,respectively) of the qualifications of laboratory, group project and final exam.

The contents and the weight of each continuous assessment exercise are the following:

- Introduction: signal generation using look-up tables (10%)
- Signal generation using polynomials (15%)
- FIR filter programming (15%)
- IIR filter programming (I) (15%)
- IIR filter programming (II) (15%)
- Project: (20%)

It will be consideredthat the student has chosen continuous assessment when he delivers the firsttwo practices of the subject. The choice of continuous assessment means that the student can not have a final grade of "not presented".

Exam-Only assessment

1. **First call**. Should a student decide not to be graded through continuous assessment,he will have a written examination opportunity that will take place thesame day of the final exam for all the students. The exam will cover all the material mastered in the classroom and the laboratory. Students should communicate their intention to renounce to be graded through continuous assessment at least a week before the date of the final exam.
2. **Second call**. Students who do not pass the course at the end of the semester have an opportunity to retest on the end of the academic year. Previously to the exam, students will be asked to choose to be evaluated by continuous assessment system or only by the final exam. In the former case, they will have the opportunity to improve the continuous assessment grade by means of redoing and improving selected practices.
3. **End-of-program call.** The student will have a written examination covering all the material mastered in the classroom and the laboratory.

Ethical code

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

Sources of information

Basic Bibliography

Sen M. Kuo, Bob H. Lee, **Real-Time Digital Signal Processing,: Implementations, Application and Experiments with the TMS320C55X**, John Wiley & Sons,

Complementary Bibliography

Sanjit K. Mitra, **Digital Signal Processing: A Computer Based Approach**, McGraw-Hill,

Alan V. Oppenheim, Ronald W. Schafer, **Discrete-Time Signal Processing**, Prentice Hall,

Recommendations

Subjects that it is recommended to have taken before

Multimedia Signal Processing/V05G300V01513

Contingency plan

Description

In case of online tuition, then the planning and evaluation will be maintained as described in the guide.
Lecturing and laboratory sessions will be taught remotely.
For the laboratory sessions, students must have a computer with the Matlab program installed. The software tools of the development board used in the course, will be supplied through Faitic.
The evaluation tests will be carried out using the tools provided by the University.

IDENTIFYING DATA				
Digital Communications				
Subject	Digital Communications			
Code	V05G300V01914			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Pérez González, Fernando			
Lecturers	Mosquera Nartallo, Carlos Pérez González, Fernando			
E-mail	fperez@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course covers the fundamentals of modulations that are used in practically all modern communication standards, including digital terrestrial television, WiFi, fourth-generation mobile communications (LTE), digital radio, visible light communications (LiFi). Contents, teaching and exams are in English. Students may participate in classes and answer to exams preferably in English, but Spanish and Galician are also accepted.			

Competencies	
Code	
CG4	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.
CG9	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.
CG12	CG12 The development of discussion ability about technical subjects
CE71	(CE71/OP14) The ability to analyze the physical layer in modern digital communications systems.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	Competences		
Acquire the intuition and needed math skills to understand the role played by diversity in improving the provision of communication systems.	CG4 CG9 CG12	CE71	CT2
Develop the capability of analyzing the physical layer of current telecommunication systems.	CG4 CG9 CG12	CE71	CT2
Handle the necessary tools to understand the different aspects of the physical layer of communications system a system and put them to practice when it comes to simulating, designing or dimensioning.	CG4 CG9 CG12	CE71	CT2
Strengthen the capacity to follow a technical class in English.	CG9 CG12	CE71	CT4

Contents	
Topic	
Subject 1: Multicarrier modulations	1.Introduction. 2 Analog and digital OFDM modulations 3 Diagram of an OFDM transmitter. 4 Effect of the channel on the received signal. 5 Diagram of an OFDM receiver. 6 OFDM seen as a block process.

Subject 2: Equalization, coding and synchronization in multicarrier modulations.	1. Pilot carriers. 2 ZF and MMSE equalization. 3 Zero-padding methods. 4 Coded OFDM (COFDM). 5 Carrier synchronization algorithms. 6 Timing recovery algorithms. 7 Channel state information estimation.
Subject 3: Advanced digital communications.	1 Convolucional coding. 2 Trellis coding. 3 Advanced channel coding: turbo and LDPC codes.
Subject 4: Applications	1 Digital Radio/TV standards. 2 OFDM wireless communications standards. 3 OFDM cable communications standards. 4 OFDM in visible light communications.

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	14.4	57.6	72
Mentored work	7.2	0	7.2
Lecturing	19	21	40
Problem and/or exercise solving	2	0	2
Report of practices, practicum and external practices	0	14.4	14.4
Essay	0	14.4	14.4

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

Methodologies

	Description
Laboratory practical	Lab practices will consist in the demodulation of Digital Radio Mondiale (DRM) signals. This will allow students to practically implement some of the concepts seen in the lectures: OFDM, demodulations, synch recovery,... Competences: CG4, CG9, CG12, CE71, CT2, CT4
Mentored work	Guided work with design considerations for a practical system based on OFDM. Competencias: CG4, CG9, CG12, CE71, CT2, CT4
Lecturing	The course is structured in four main subjects that revolve around the concept of multicarrier modulations. Each subject will be taught through lectures in the classroom. Competences: CG4, CG9, CG12, CE71, CT2, CT4

Personalized assistance

Methodologies	**Description**
Lecturing	The teachers will provide individualized and personalized attention to students during the course, soving their doubts and questions. Doubts will be answered during the master session, or during the office hours. Office hours will be given at the beginning of the course and published in the subject's webpage.
Laboratory practical	The teachers will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered during the office hours. Office hours will be given at the beginning of the course and published in the subject's webpage.
Mentored work	The teachers will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered during the office hours. Office hours will be given at the beginning of the course and published in the subject's webpage.
Tests	**Description**
Report of practices, practicum and external practices	The teachers will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered during the office hours. Office hours will be given at the beginning of the course and published in the subject's webpage.
Essay	The teachers will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered during the office hours. Office hours will be given at the beginning of the course and published in the subject's webpage.

Assessment

	Description	Qualification	Evaluated Competencess		
Problem and/or exercise solving	Final exam with short questions on the contents of the subject, that will include also some questions on the projects. Evaluated competences: CG4, CG9, CG12, CE71, CT2.	20	CG4 CG9 CG12	CE71	CT2
Report of practices, practicum and external practices	Deliverables for the lab project. 50% of the final grade corresponds to tasks associated to a lab project. Along the course there will be six milestones, corresponding to each of the stages for the Matlab implementation of a simplified OFDM receiver. The weight given to each of these tasks is the following: Task 1 (Demodulation to baseband): 5% Task 2 (Mode detection and temporal allignment): 5% Task 3 (Frequency error correction): 10% Task 4 (Frame synchronization): 10% Task 5 (Channel estimation and equalization - I): 10% Task 6 (Channel estimation and equalization - II): 10% Evaluated competences: CG4, CG9, CG12, CE71, CT2, CT4.	50	CG4 CG9 CG12	CE71	CT2 CT4
Essay	Short report related to one of the digital communications standards/systems that employ the techniques seen in the lectures. The report will consist of the answers to a list of questions that will be handed at the beginning of the course, related to practical design aspects of a digital communications system using OFDM. Evaluated competences: CG4, CG9, CE71, CT2.	30	CG4 CG9	CE71	CT2

Other comments on the Evaluation

In those cases in where the student decides not to carry out the continuous evaluation tasks, the final score will be solely based on the exam with short questions of the subject. This applies as well to the second call.

In case of collective reports, the respective contribution of each student must be clearly stated, and the final score will be personalized as a function of such contribution. An interview with the lecturer may be required in order to assess the individual contributions.

Once the student turns in any of the deliverables, he/she will be considered to be following the continuous evaluation track. Any student that chooses the continuous evaluation track will get a final score, regardless of he/she takes the final exam.

Continuous evaluation tasks cannot be redone after their corresponding deadlines, and are only valid for the current year.

Sources of information

Basic Bibliography

M. Engels, Ed, **Wireless OFDM Systems. How to make them work?**, Springer-Verlag,

Antonio Artés, Fernando Pérez González, Carlos Mosquera et al., **Comunicaciones Digitales**, Pearson,

Complementary Bibliography

Ye Li, G.L. Stuber, **Orthogonal Frequency Division Multiplexing for Wireless Communications**, Springer-Verlag,

J.R. Barry, E.A. Lee, D.G. Messerschmitt, **Digital Communication**, Kluwer,

Recommendations

Subjects that it is recommended to have taken before

Principles of Digital Communications/V05G300V01613

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===

Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee,

at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===

In such case, the teaching and evaluation would be done totally or partially online.

IDENTIFYING DATA

Basics of bioengineering

Subject	Basics of bioengineering			
Code	V05G300V01915			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Hermida Domínguez, Ramón Carmelo			
Lecturers	Hermida Domínguez, Ramón Carmelo			
E-mail	rhermida@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course provides an introduction to several aspects of biomedical engineering, including basic concepts of human physiology, description of most common systems and biomedical signals, and a brief introduction to several electromedical systems. This course will be tough and evaluated in English. All the documentation for this course will be in English.			

Competencies

Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG9	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.
CG10	CG10 The ability for critical reading of scientific papers and docs.
CE72	(CE72/OP15) The knowledge of biomedical engineering elements and techniques and their application in solving therapy, monitoring and diagnostic problems.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes

Learning outcomes	Competences		
Know the systemic structure of the human physiology.	CG3 CG10	CE72	CT3
Identify biomedical signals and learn their utility in the clinical environment.	CG3 CG4 CG9 CG10	CE72	CT2 CT3 CT4
Adapt the adquired knowledge to propose solutions for the design of systems for diagnosis, monitorization and therapy.	CG3 CG4 CG9 CG10	CE72	CT2 CT3 CT4
Strengthen the capacity to follow a technical class in English.	CG9 CG10		CT4

Contents

Topic	
1. Introduction to biomedical engineering.	Physiology and anatomy of the circulatory system. Measurements in the cardiovascular system. Nervous and endocrine systems. Introduction to chronobiology.

2. Biomedical signals and systems.	Linear least-square estimation. Model comparison and analysis of variance. Techniques for model construction. Introduction to rhythmometry.
3. Diagnosis, monitorization, and therapy.	Criteria for the diagnosis of vascular risk. Ambulatory blood pressure monitoring. Treatment of hypertension: Current approaches. Chronotherapy for cardiovascular risk reduction. Early identification and prevention of complications in pregnancy.
4. Electromedical systems.	Diagnosis by X rays. Nuclear medicine. Ultrasounds. Nuclear magnetic resonance. Biotelemetry. Telemedicine.

Planning

	Class hours	Hours outside the classroom	Total hours
Mentored work	2	35	37
Presentation	7	9	16
Problem solving	10	15	25
Lecturing	21	42	63
Problem and/or exercise solving	2	7	9

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

Methodologies

	Description
Mentored work	The student, in groups, prepares a document on an application of Biomedical Engineering. Through this methodology the students will develop the competencies CG3, CG4, CG9, and CE72.
Presentation	Exhibition by the students in front of the professor and the rest of students of the work realized in small groups. Through this methodology the students will develop the competencies CG9 and CG72.
Problem solving	Some topics will be complemented with problem resolution. Through this methodology the students will develop the competencies CG3, CG4, CG9, and CE72.
Lecturing	Exposition by the professor of the main concepts of each topic. This will be complemented by the student´s own work with recommended readings to extend the concepts explained in the classroom. Through this methodology the students will develop the competencies CG3, CG4, CG9, CG10, CE72, CT2, CT3, and CT4.

Personalized assistance

Methodologies	Description
Lecturing	These will be complemented by questions/answers encouraging the participation of every student.
Mentored work	Details pertaining to each assigned work will be discussed with each student.
Problem solving	Resolution of every exercise will be discussed with each student, as needed.

Assessment

	Description	Qualification	Evaluated Competencess		
Mentored work	Composition, in small groups, of a monographic document related to one of the electromedical systems in bioengineering (nuclear medicine, ultrasounds, magnetic resonance, biotelemetry, telemedicine).	20	CG9 CG10	CE72	CT4
Presentation	Exhibition by the students of the tutored work, and discussion of the findings with the professor and other students.	10	CG9 CG10	CE72	CT4
Problem solving	Short questions on the problems solved in the practices in relation to the contents of the master sessions.	40	CG3 CG4	CE72	CT2 CT3
Problem and/or exercise solving	The final exam will consist on small questions and problems in relation to the master sessions, laboratory practices, and presentation of the tutored works.	30	CG3 CG4	CE72	CT2 CT3

Other comments on the Evaluation

Following the own guidelines of the degree, two systems of assessment will be offered to the students registered in this

course: continuous assessment and exam-only assessment.

All the students that wish to renounce to the continuous assessment (election by default), will have to communicate it to the professor before the beginning third week of class.

The continuous assessment will be based on the grades obtained in the tutored works and their exposition, as well as in three intermediate tests. The tutored work will be evaluated in terms of composition, accuracy and style and the grade will be the same for all members of the group. Individualized evaluation will be based on the exposition of the work (timing, clarity, accuracy) and the answers to specific questions by other students. The grades obtained throughout the continuous evaluation will only be valid for the current academic year. The tests of the continuous assessment are not recoverable, that is to say, if somebody cannot make them the professors are not obligated to repeat them. For a student under continuous assessment his/her final grade cannot be "not presented".

The students that do not opt by the continuous assessment will have to make a final examination, with theory and problems on all the contents of the course. This exam will be graded between 0 and 10, and this will be the final grade obtained.

The second chance of examination at the end of the academic year, as well as the exam for the extraordinary test (end of the degree), will have a similar structure to the final examination of those students who do not choose the continuous assessment.

All tests will be performed in English.

In case of detection of plagiarism in anyone of the tests, the final qualification will be FAIL (0) and the fact will be communicated to the direction of the Centre for the timely effects.

Sources of information

Basic Bibliography

Guyton & Hall, **Textbook of Medical Physiology**, 13th edition, W.B. Saunders Company, 2015

Weisberg S, **Applied Linear Regression**, 4ª Ed., J Wiley & Sons,, 2013

Hermida RC, Smolensky MH, Ayala DE, et al., **2013 ambulatory blood pressure monitoring recommendations for the diagnosis of adult hypertension, assessment of cardiovascular and other hypertension-associated risk, and attainment of therapeutic go**, 30, Chronobiol Int, 2013

Complementary Bibliography

Webster JG, **Medical Instrumentation. Application and Design**, 4th edition, Wiley, 2009

Cook RD, Weisberg S, **Residuals and Influence in Regression**, Chapman Hall, 1982

Enderle J, Blanchard S, Bronzino J., **Introduction to Biomedical Engineering.**, 3rd edition., Academic Press, 2012

Recommendations

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===

If teaching were not face-to-face, the planning will be maintained, both for groups A and groups B, but virtual teaching would be used.

=== ADAPTATION OF THE TESTS ===

Regarding the assessment, and providing that it would not be possible to carry out exams in-person, the following must be taking into account:

- All the continuous assessment tests would be maintained.

The rest of the conditions of the assessment system will not be modified.

IDENTIFYING DATA				
Application Design with micro-controllers				
Subject	Application Design with micro-controllers			
Code	V05G300V01921			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Costas Pérez, Lucía			
Lecturers	Costas Pérez, Lucía Valdés Peña, María Dolores			
E-mail	lcostas@uvigo.es			
Web	http://cursos.faitic.uvigo.es/moodle3_1920/course/view.php?id=34			
General description	Design and development of microcontroller-based applications, including design methodologies to develop real time applications, peripheral components configuration and connectivity. The scope of these contents will be adapted to the academic level reached by the students. Teachers will speak in spanish or galician language. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CE58	(CE58/OP1) The ability to design hardware and software systems based on microcontrollers.
CE59	(CE59/OP2) The ability to use software tools for microcontrollers simulation.

Learning outcomes		
Learning outcomes		Competences
Ability to know in deep the configuration methodologies of real time microcontrollers.		CE58
Ability to know in deep the hardware design of the microcontroller-based electronic systems.		CE58
Ability to know in deep the software design of the microcontroller-based electronic systems.		CE58 CE59
Ability to go deeper into the development of microcontroller-based electronic systems.		CE58 CE59

Contents	
Topic	
Introduction. Previous topics review.	Introduction. Previous topics review. PIC18F45K20. Internal Structure. Arithmetic and Logic Unit. Control Unit. Program memory. Data memory. Peripherals. Watch Dog Timer (WDT).
Instruction set. Addressing modes.	Introduction: Instruction Set. Transfer Instructions. Arithmetic Instructions. Logic Instructions. Jumps. Addressing Modes.
Timers.	Introduction. Timers/Counters: TMR0/TMR1/TMR2/TMR3.
Excepctions and interrupts.	Introduction. Excepctions. Interrupts. Interrupt Response. Registers.
Analog interface.	Introduction. ADC. ADC Operation. Analog Comparator Module.
Compare Mode.	Introduction. Capture Mode. Compare Mode. PWM. ECCP1: Enhanced Mode.
MSSP: Master Synchronous Serial Port SPI. I2C	Introduction. Registers. SPI Mode. I2C Mode.
Power-Managed modes.	Introduction. Different Modes. Switching between modes.
Input/Output.	Introduction. I/O Structure. Ports (A B C D E). Configuration Registers. Parallel Slave Port. Signal Coupling.

Planning			
	Class hours	Hours outside the classroom	Total hours
Laboratory practical	12	38	50
Lecturing	12	33	45

Problem solving	5	15	20
Project based learning	7	22	29
Problem and/or exercise solving	2	0	2
Problem and/or exercise solving	2	0	2
Laboratory practice	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
Laboratory practical	The students will perform simulations and electronic circuits. The student develops the competencies CE58 and CE59.
Lecturing	The lecturer will explain in the classroom the subject contens. The student develops the competency CE58.
Problem solving	The lecturer will solve exercices related to the subject contens. The student develops the competencies CE58 and E59.
Project based learning	The students have to develop a project. The lecturers will help and monitor them. The student develops the competencies CE58 and CE59.

Personalized assistance

Methodologies	Description
Project based learning	The Laboratory teacher will resolve the doubts of students at the schedule established and published on the school website.
Laboratory practical	The Laboratory teacher will resolve the doubts of students at the schedule established and published on the school website.
Lecturing	The teacher will resolve the doubts of students at the schedule established and published on the school website.
Problem solving	The teacher will resolve the doubts of students at the schedule established and published on the school website.

Assessment

	Description	Qualification	Evaluated Competencess
Project based learning	Students will be asked to elaborate a report related to the project they have to carry out. The lecturer will also assess individually the student's work developed during the laboratory sessions. Competencies CE58 and CE59 are assessed.	40	CE58 CE59
Problem and/or exercise solving	Exam to evaluate the knowledge acquired by the student after the first part of the subject. It is carried out in a classroom session. Competency CE58 is assessed.	20	CE58
Problem and/or exercise solving	Exam to evaluate the knowledge acquired by the student related to the second part of the subject. Competency CE58 is assessed.	20	CE58
Laboratory practice	The tasks developed during the lab sessions will be included and assessed in the project. Competencies C58 and CE59 are assessed.	20	CE58 CE59

Other comments on the Evaluation

CONTINUOUS ASSESSMENT:

A continuous assessment learning scheme will be offered to the students:

- Two partial exams will be held related to the theory (A sessions). - The student has to elaborate a report describing the project (B and C sessions).

The first partial exam will take place in the classroom . If the student passes this part, he/she is not required to retake it. In this case, after finishing the term, he/she has to take only the second partial exam. The date will be specified in the academic calendar.

Teachers will speak in spanish or galician language. Usually, exams will be written in spanish.
In partial exams, a minimum score (5 out of 10) is required in order to get a pass. In order to assess the project, the lecturer will consider the quality of the final report (40%), the work in the laboratory and the student□s behavior (60%).
To pass the subject, it is necessary that the mark of each one of the exams or the project are equal or greater than 5 over 10. The final mark (FM) is calculated as the weighted average of the three individual marks. The formula will apply a weight

of 40% to the theory mark (TM) and a 60 % to the project mark (PM):

FM = 0,4*TM + 0,6*PM (1)

The mínimum passing score required in order to get a pass in the subject is 5. In case the students do not pass any of the tasks of the subject, the final mark (FM2) will be:
FM2= Minimum{4.5, FM}

Being FM the mark applying (1).

When a student takes the first partial exam, it is considered that he/she choose the continuous assessment scheme.

Second call: The assessment policy in this call follows the same scheme, the students have to take the exam and present the monitored project.

EXAM-ONLY ASSESSMENT (SECOND CALL AND END-OF-PROGRAM CALL):

Students who refuse the continuous assessment scheme will be assessed by means of a final exam to evaluate the theory. The exam will be the same for them as for the students who fail the first partial exam. The assessment of the laboratory for these students will be carried out by means of a laboratory exam. The date will be fixed within the examination period. In this case, the final mark (FM) is calculated as the weighted average of the two individual marks. The formula will apply a weight of 50% to the theory mark (TM) and a 50% to the laboratory mark (LM):

FM = 0,5*TM + 0,5*LM (2)

To pass the subject, it is necessary that the mark of each one of the exams are equal or greater than 5 over 10. The minimum passing score required in order to get a pass in the subject is 5.

In case the students do not pass any of the tasks of the subject, the final mark (FM2) will be:

FM2= Minimum{4.5, FM}

Being FM the mark applying (2).

IMPORTANT REMARK: Students who refuse the continuous assessment scheme have to contact the lecturer at least two weeks before the exam date.

Sources of information

Basic Bibliography

http://ww1.microchip.com/downloads/en/DeviceDoc/41303F.pdf, **PIC18FXXK20 Data Sheet**,

Complementary Bibliography

F. E. Valdés Pérez, R. Pallás Areni, **Microcontroladores. Fundamentos y Aplicaciones con PIC.**, Marcombo,

http://ww1.microchip.com/downloads/en/DeviceDoc/52116A.pdf, **PICkit 3 In-Circuit Debugger/Programmer User Guide**,

http://ww1.microchip.com/downloads/en/DeviceDoc/41370C.pdf, **PICkit 3 Debug Express PIC18F45K20 MPLAB® C Lessons**,

Recommendations

Subjects that it is recommended to have taken before

Programmable Electronic Circuits/V05G300V01502
Electronic Instrumentation and Sensors/V05G300V01621

Contingency plan

Description

In case of online tuition, then the planning will be as follows:

A, B y C will be carried out using the Campus Remoto. If it is possible, hardware resources will be supplied to the students in order to:

- Solve exercices related to the subject. The teacher will try to guide the debugging process.

- Develop the project. B and C sessions will be used to present the project and to solve the doubt of students.

The evaluation will be carried out as follows:

- Exams will be carried out using the Campus Remoto.

- The assessment policy will be maintained.

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained

* Teaching methodologies modified

* Non-attendance mechanisms for student attention (tutoring)

* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Pending tests that are maintained
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Tests that are modified
[Previous test] => [New test]

* New tests

* Additional Information

IDENTIFYING DATA				
Optoelectronic devices				
Subject	Optoelectronic devices			
Code	V05G300V01922			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Moure Rodríguez, María José			
Lecturers	Cao Paz, Ana María Moure Rodríguez, María José			
E-mail	mjmoure@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject deals with the optoelectronic properties of semiconductors and their application in electronic devices for detection, emission, amplification and conversion of optical/electrical signals. Devices include light-emitting diodes, lasers diodes, photodiodes, phototransistors and solar cells. The contents of the course and the laboratory activities coverage the basic operating principles, design considerations, driving circuits and applications of optoelectronic devices. The subject will enable students to apply the physics of optoelectronic devices in optical sensors design and fiber optic communications. Emphasis will also be place on understanding the data sheets of optoelectronic components and their applications to different technologies. Finally integrated optoelectronics, display and image sensor technologies are introduced. Subject of the English Friendly Program. International students can ask teaching staff for: a) teaching materials and bibliographic references in order to follow the subject in English, b) attending office hours in English, c) tests and assessments in English. In addition, all the documentation for this subject has be written in English.			

Competencies	
Code	
CG9	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.
CG12	CG12 The development of discussion ability about technical subjects
CG14	CG14 The ability to use software tools to search for information or bibliographical resources.
CE60	(CE60/OP3) The ability to design circuits based on optoelectronics devices used in telecommunication systems.
CE61	(CE61/OP4) The ability to acquire, condition and process the information obtained from optoelectronic sensors.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes			
Learning outcomes	Competences		
To know the fundamentals of different optoelectronic devices.		CE61	
The capability to analyze the data sheets and to compare different optoelectronic devices.	CG12 CG14	CE61	
To know of the applications of electronic devices.		CE60	
The capability to design basic circuits for driving photoemitter devices.		CE60	
The capability to design basic circuits for photodetection.		CE60 CE61	
To know different optoelectronic sensors.		CE61	
To know the architecture and the operating modes of displays.		CE60	
To know of the architecture and characteristics of image sensors.		CE60 CE61	
The ability to select the more suitable devices according to each application.	CG12 CG14	CE60 CE61	
To know in depth the applications related to Telecommunications.	CG9	CE60	CT4

Contents
Topic

Unit 1: Introduction	Fundamentals and classification of optoelectronic devices. Radiometric and photometric units and their relationships.
Unit 2: Light Emitting Diodes	Principles of LED operation. Types of LEDs and properties. Parameters and characteristics. Driving circuits. Basic applications.
Unit 3: Optoelectronic Detectors	Light Dependent Resistors: principles of LDR operation, properties, parameters, driving circuits and applications. Photodiodes: principles of photoconductive detectors, types, parameters, driving circuits and applications. Phototransistor: principles of phototransistor operation, types, parameters, driving circuits and applications. Photodetector comparison.
Unit 4: Solar Cells	Photovoltaic detectors: principles and properties. Manufacture and performance of solar cells, parameters and characteristics. Applications.
Unit 5: Laser Diodes	Principles of Laser operation. Types of lasers. Laser diode operation. Driving circuits and applications.
Unit 6: Image Sensors	Principles of CCD and CMOS operation. Parameters and characteristics. Color detection. Applications.
Unit 7: Optical Sensors	Principles of optical sensing. Internal design, types, parameters and applications of: optocouplers, optical encoders, object sensors, code-bar readers, humidity sensors, color detection, distance sensors, anemometers, temperature sensors and biomedical sensors.
Unit 8: Display Technologies	Principles of Liquid Crytal Display operation. Principles of LED and Organic LED displays. Introduction to plasma, electroluminescence and digital light processor technologies.
Unit 9: Introduction to Fiber Optics	Fiber Optic fundamentals. Classification of fibers. Fiber optic emitters and detectors. Principles of fiber optic communications. Principles of fiber optic sensors.
Laboratory Practices	1. Basic optoelectronic circuits. LEDs and LDRs. Laboratory measurements. 2. Analog optical modulation. Optical detectors based on photodiodes and phototransistors. 3. Optoelectronic sensors for object sensing. 4. Digital communications based on fiber optic. 5. Optical circuits for color measurement. 6. LASER sensor for distance measurement. Measurements using a spectrometer. 7. Other optoelectronic sensors.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	15	30	45
Case studies	4	8	12
Project based learning	6	30	36
Presentation	1	3	4
Laboratory practical	14	9	23
Problem and/or exercise solving	2	24	26
Report of practices, practicum and external practices	0	4	4

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

Methodologies

	Description
Lecturing	The professor explains the theoretical contents of the course, encouraging critical discussion and the student involvement. Reading assignments for each session will be previously available via FaiTIC, and students are expected to come to the theoretical class having completed the assigned reading. In the master sessions the competencies CE60 and CE61 are developed.
Case studies	The study and analysis of actual technological solutions completes the theoretical presentations. This activity includes the study of different alternatives, commercial devices or systems, cost and power estimation, environmental impact and performance analysis. Through the case studies the competencies CE60, CE61 and CG12 are developed.
Project based learning	This activity focuses on applying the techniques described in the lecture classes and the skills developed at laboratory to a project implementation. These sessions are developed in a laboratory with skilled equipment. Students should obtain well founded solutions, choosing appropriate methods and devices. These projects are planned and tutored in small size groups. In the projects the competencies CG9, CG12, CG14 and CT4 are mainly developed.

Presentation	The project developed by the students must be oral presented by the authors. Through the oral presentations the competencies CG9 and CG12 are developed.
Laboratory practical	During laboratory sessions the student learns the design, hardware implementation, verification and measurement of basic optoelectronics circuits. All the sessions are guided and supervised by the professor. In the laboratory practices, the competencies CE60, CE61 and CG14 are developed.

Personalized assistance

Methodologies	Description
Lecturing	Students have the opportunity to solve doubts in personalized attention sessions. The appointment with the corresponding professor should be required and agreed by e-mail, preferably in the hours which are published in the faculty website.
Laboratory practical	Students have the opportunity to solve doubts in personalized attention sessions. The appointment with the corresponding professor should be required and agreed by e-mail, preferably in the hours which are published in the faculty website.
Project based learning	Each group of students developing a project will attend periodic follow-up meetings.

Assessment

	Description	Qualification	Evaluated Competencess		
Project based learning	The students should present a tutored project which deserves the 40% of the final qualification. The progress of this job will be supervised from continuous assessment but the final work should be oral presented by the authors.	40	CG9 CG12 CG14	CE60 CE61	CT4
Problem and/or exercise solving	The student must pass a short answer test which covers all of the contents taught in the theoretical classes or laboratory practices. This test will deserve the 30% of the final qualification.	30		CE60 CE61	
Report of practices, practicum and external practices	The assistance to the laboratory practices is mandatory: at least the student should complete 6 of the 7 sessions. The implementation of the circuits described in the practice guidelines and the reports submitted at the end on each session will deserve the 30% of the final qualification.	30	CG9 CG12 CG14	CE60 CE61	CT4

Other comments on the Evaluation

1. Continuous assessment

The course can be passed with full marks from continuous assessment, with no need to sit the final exam. If the students assist to more than 2 laboratory sessions means that they follow the continuous assessment.

The weighting and content of each continuous assessment part are as follows:

1.1 Test (NTest):

- It consists on a short answer questionnaire carried out preferably using the FaiTic platform.
- It covers all of the contents taught in the theoretical classes or laboratory practices.
- The date will be approved by the Academic Commission of the Grade and it will be published at the beginning of the course.
- The student pass this part if he/she gets a mark greater than or equal to 5.

1.2 Laboratory practices (NPrac):

- The student should complete 6 of the 7 sessions in order to pass this part.
- The student should correctly implement the circuits described in the guidelines of the practice and submit a report corresponding to each laboratory session. The qualification of each practice depends on these achievements.
- It can be developed individually or by groups of 2 students. In this last case and if both attend the practice, the qualification is the same for the 2 students.
- The student will pass this part if he/she gets an average greater than or equal to 5. The weighting of each practice is the same to obtain the NPrac mark.

1.3 Project (NPro):

- It should be oral presented by the authors.
- It can be developed individually or by groups of 2 students. In this last case, the 85% of the qualification is common for both members of the group meanwhile the 15% represents the individual qualification obtained from the oral presentation of each student.
- The student will pass this part if he/she gets a mark greater than or equal to 5.

1.4 Final qualification of continuous assessment (Final_ca)

The final qualification of continuous assessment is obtained as follows:

Final_ca: = (NTest*0.3 + NPrac*0.3 + NPro*0.4) if NTest is greater than or equal to 5 and NPrac is greater than or equal to 5 and NPro is greater than or equal to 5;

Final_ca = min [(NTest*0.3 + NPrac*0.3 + NPro*0.4), 4] in other case;

The student who fails one or more of the parts of continuous assessment has another opportunity to pass any part in the final assessment:

- He/she can make a written long answer exam and this mark replaces NTest.
- He/she student can improve his/her laboratory mark (NPrac) by means of an exam. This exam consists of several problems related to the contents of laboratory practices.
- He/she can complete and present his/her project (NPro) before the date of the final exam.

2. Eventual assessment, second call and end-of-program call

In those cases in which the student decides not to carry out the continuous evaluation tasks, the final qualification is based on:

- A final exam comprising all the topics of the subject. It usually consists of several questions and problems and lasts about 2.5 hours. The pass mark for this exam is 5 out of 10 and deserves 60% of the final qualification (NEx).
- The students should also present a project with the same objectives and complexity of the project developed in continuous assessment. This project deserves 40% of the final qualification (NPro) and should be presented before the date of the final exam.

The final qualification (Final_ex) is obtained as follows:

Final_ex = (NEx*0.6 + NPro*0.4) if NEx is greater than or equal to 5 and NPro is greater than or equal to 5;

Final_ex = min [(NEx*0.6 + NPro*0.4) , 4] in other case.

This assessment system applies as well to the second call and the end-of-program call.

3. Other comments

- The exams will be written in Spanish. The student can use the Spanish, English or Galician for the reports, works or presentations.
- The grades obtained from the continuous assessment and final exams 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.
- In the case that plagiarism is detected in any of the tasks/exams done/taken, the final score for the subject will be 'fail' (0) and the teachers will inform the School authorities so that they take the actions that they consider appropiate.

Sources of information
Basic Bibliography
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Complementary Bibliography
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Wilson J., Hawkes J., **Optoelectronics. An introduction**, 3, Prentice-Hall, 1998
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Kasap, Ruda, Boucher, **Cambridge Illustrated Handbook of Optoelectronics and Photonics**, Cambridge University Press, 2009

Yu F.T.S., Yang X., **Introduction to Optical Engineering**, Cambribge University Press, 1997
Uiga E., **Optoelectronics**, Prentice-Hall, 1995
Midwinter J.E., Guo Y.L., **Optoelectronics and Lightwave Technology**, Wiley, 1992
Holst G.C., **CCD Arrays, Cameras and Displays**, Optical Engineering Press, 1998
Carr J. J., **Electro-Optics. Electronic Circuit Guidebook**, Prompt Publications, 1997
Göpel Ed. W., Hesse J., Zemel J.N., **Sensors. A comprehensive Survey**, 1992
Goetzberger A., Knobloch J., Voss B., **Crystalline Silicon Solar Cells**, Wiley, 1998
Watson J., **Optoelectrónica**, Limusa, 1993
Smith S.D., **Optoelectronic Devices**, Prentice Hall, 1995
Theuwissen A.J.P., **Solid-state Imaging with Charge-Coupled Devices**, Kluwer, 1995
Lasky R.C., Österberg U.L., Stigliani D.P., **Optoelectronics for Data Communication**, 1995
Wood D., **Optoelectronic Semiconductors Devices**, Prentice Hall, 1995
Goff D.R., **Fiber Optic Reference Guide. A Practical Guide to Communications Technology**, Focal Press, 2002
Marston R.M., **Circuitos de optoelectrónica**, CEAC, 2000
Moure M.J., **Apuntes de DOE**, 2017
Cao A.M., **Prácticas de DOE**, 2017

Recommendations

Contingency plan

Description

Whenever physical access to the University is not possible, the theoretical classes, personalized attention, assessment processes, explanation and supervision of practices or projects will be carried out using the Campus Remoto tool together with the support of the FaiTic platform and e-mail.

The laboratory practices that can be not developed in the specialized laboratories at the University will be replaced by one or more of the following alternatives:

 Demonstration practices in which the students must attend to them and participate remotely.
 Simulation practices that the students must develop and submit results reports.
 Practices developed with electronic circuits that the students can assembly at home and submit a results report.

In any of the aforementioned cases, the practices maintain the weight of each one in the final grade and their development can be done individually or by groups of 2 students according to the guidelines that the teaching staff which will be published in time.

The project will be replaced by a theoretical and/or experimental work related to the contents of the subject maintaining its weight in the final grade. In this case, it can be done individually or in groups of 2 students according to its characteristics and/or its length. The work and guidelines will be published by the teaching staff well in advance.

IDENTIFYING DATA				
Design and synthesis of digital systems				
Subject	Design and synthesis of digital systems			
Code	V05G300V01923			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Álvarez Ruiz de Ojeda, Luís Jacobo			
Lecturers	Álvarez Ruiz de Ojeda, Luís Jacobo			
E-mail	jalvarez@uvigo.es			
Web	http://www.faitic.uvigo.es			
General description	This course will be taught and assessed in English. The course documentation is in English. The main learning goals of this course are: Introduction to VHDL for synthesis. Design and synthesis of synchronous digital systems. Development, synthesis and verification of programmable digital circuits, using VHDL for its application in the field of the Telecommunications.			

Competencies	
Code	
CG1	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.
CG9	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.
CG13	CG13 The ability to use software tools that support problem solving in engineering.
CE62	(CE62/OP5) The ability to design and synthesize complex digital systems by hardware description language.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	Competences		
To be able to distinguish the differences between the use of Hardware Description Languages for simulation and for synthesis.	CG13	CE62	
To deepen the understanding of synchronous digital design techniques using VHDL for synthesis.	CG13	CE62	
To acquire skills at designing complex synchronous digital systems using VHDL.	CG1 CG9 CG13	CE62	CT4

Contents	
Topic	
LESSON 1 THEORY (2 h.). INTRODUCTION TO COMPLEX DIGITAL SYSTEM DESIGN AND SYNTHESIS.	1.1.- Introduction. 1.2.- Types of digital integrated circuits. Microprocessors. DSPs. ASICs. FPGAs. 1.2.1.- Comparative analysis. 1.3.- Field Programmable Gate Arrays (FPGAs). 1.4.- Complex application specific digital system design by means of FPGAs. 1.4.1.- Sequential processing systems. Operational unit. Control Unit. 1.4.2.- Continuous processing systems.

LESSON 2 THEORY (2 h.). ADVANCED DIGITAL SYSTEM DESIGN.	2.1.- Introduction. 2.2.- General rules for the design of digital systems. 2.2.1.- Hierarchical design. 2.2.2.- Technology independent design. 2.2.3.- Design timing. 2.2.4.- Design for reuse. 2.2.5.- Design for verificability. 2.2.6.- Design documentation. 2.3.- Intellectual Property (IP) cores.
LESSON 3 THEORY (2 h.). INTRODUCTION TO SYNTHESIS OF DIGITAL SYSTEMS DESCRIBED IN VHDL.	3.1.- Introduction. 3.2.- Definition of synthesis. Basic concepts on synthesis. 3.3.- Conversion of a VHDL description to real hardware. Differences between the original VHDL model and the result of the synthesis / implementation. Timing simulation model. 3.4.- Recommendations for the description in VHDL synthesisable of distinct types of circuits. 3.5.- Examples of synthesisable models of commonly used circuits.
LESSON 4 THEORY (4 h.). VHDL ADVANCED SENTENCES.	4.1.- Introduction. 4.2.- Access to files. 4.2.1.- Memory initialisation. 4.2.2.- Testbench stimuli. 4.3.- Generic data type. Parameterisable circuits. 4.4.- Libraries and packages. 4.5.- Subprograms. 4.5.1.- Functions. 4.5.2.- Procedures. 4.6.- Conditional compilation.
LESSON 5 THEORY (6 h.). VHDL FOR SYNTHESIS. RESTRICTIONS.	5.1.- Introduction. 5.2.- IEEE standard for synthesis. 5.3.- Time sentences (After, Wait). 5.4.- Loops (Loop). Loops generate. 5.5.- Real data type. Type conversion. 5.6.- Complex arithmetical operations. Division (/). 5.7.- Complex mathematical functions. (Without, Cos, Log). 5.8.- Two-dimensional matrices. (Array). 5.9.- Exercises of non- synthesisable models and equivalent synthesisable circuits.
LESSON 6 THEORY (2 h.). ARITHMETICAL CIRCUITS DESIGN IN VHDL.	6.1.- Introduction. 6.2.- Representation of binary numbers with decimal part. Fixed point. Floating point. 6.3.- Design of fixed point applications. 6.4.- Design of floating point applications. 6.5.- Implementation of arithmetical circuits in FPGAs.
LESSON 7 THEORY (1 h.). VERIFICATION OF COMPLEX DIGITAL SYSTEMS.	7.1.- Introduction. 7.2.- Verification through simulation. 7.2.1.- Signals. Delay models. Definition of driver. 7.2.2.- Design analysis and simulation. Simulation cycle. Delta delay. 7.2.3.- Recommendations for VHDL simulation. Examples. Testbench design. 7.2.4.- Differences between functional and timing simulation. 7.3.- Verification through timing analysis. 7.4.- Verification through test in a development board. 7.5.- Exercises.
LESSON 1 LABORATORY (4 h. TYPE B). PRACTICAL TUTORIAL OF DIGITAL SYSTEM DESIGN AND SYNTHESIS.	1.1.- Introduction. 1.2.- Basic digital system design in synthesisable VHDL. 1.3.- Testbench design in VHDL. 1.4.- Implementation of digital systems in FPGAs. 1.5.- Testing digital systems.
LESSON 2 LABORATORY (2 h. TYPE B). DIGITAL SYSTEM DEBUGGING. VIRTUAL LOGICAL ANALYSERS.	2.1.- Introduction. 2.2.- Xilinx virtual logical analyser. Chipscope core. 2.3.- Parameters of the Xilinx virtual logical analyser. 2.4.- Implementation of the Xilinx virtual logical analyser. 2.5.- Analysis of a digital system by means of the Xilinx virtual logical analyser.

LESSON 3 LABORATORY. (15 h. = 8 H. TYPE B + 7 h. TYPE C). DESIGN OF A MEDIUM-COMPLEXITY DIGITAL SYSTEM IN SYNTHESISABLE VHDL.	3.1.- Introduction. Task explanation. (2 h. TYPE B) 3.2.- Project based learning. Discussions on the most suitable approach. (6 h. TYPE C) 3.2.- Design of a medium-complexity digital system in synthesisable VHDL. (6 h. TYPE B) 3.3.- Oral presentation. (1 h. TYPE C)

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	4	8	12
Project based learning	15	31.5	46.5
Laboratory practical	6	7.5	13.5
Project based learning	14	51	65
Presentation	1	8	9
Introductory activities	2	2	4

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

Methodologies

	Description
Lecturing	Conventional lectures. Through this methodology the outcome CE62/OP5 is developed.
Project based learning	Problem based learning (PBL): Problem solving. It will consist mainly of the design of non-synthesisable models and synthesisable circuits in VHDL. To solve them, the student has to previously develop certain outcomes. Through this methodology the outcomes CG9, CG13 and CE62/OP5 are developed.
Laboratory practical	VHDL design of digital circuits and circuit implementation in FPGAs. Through this methodology the outcomes CG9, CG13 and CE62/OP5 are developed.
Project based learning	Project based learning. The students must design a digital system in VHDL to solve a problem. In order to do that, the students must plan, design and implement the necessary steps. The project development will be implemented in laboratory hours (type B). Besides, in type C hours there will be discussions and one-to-one interaction with the teacher. Activities to develop in the groups C: Analysis and debate about the project approach and different alternatives. Analysis and follow-up of the proposed solution. Design implementation. Analysis and debate of results. Oral presentations of the project results. Through this methodology the outcomes CG1, CG9, CG13 and CE62/OP5 are developed.
Presentation	Presentations/exhibitions: Exhibition of the results of the project developed. Through this methodology the outcomes CG1 and CG9 are developed.
Introductory activities	Introduction to the subject key topics both theoretical and practical. Through this methodology the outcomes CG13 and CE62/OP5 are developed.

Personalized assistance

Methodologies	Description
Project based learning	In class the teacher will assist the students. Besides, the students will have the opportunity to consult with the teacher in office hours which will be published in the faculty website.
Laboratory practical	In class the teacher will assist the students. Besides, the students will have the opportunity to consult with the teacher in office hours which will be published in the faculty website.
Project based learning	In class the teacher will assist the students. Besides, the students will have the opportunity to consult with the teacher in office hours which will be published in the faculty website.

Assessment

Description	Qualification	Evaluated Competencess

Project based learning	Resolution of theoretical problems and exercises. The majority of them will be focused on the design of non-synthesisable models and synthesisable circuits in VHDL. The problems will be based on the theoretical topics. It will be necessary to teach to the professor the operation of each one of the models and circuits. The correct application of the theoretical concepts to the problems will be assessed, based on the published criteria. It will be necessary to deliver the documentation requested by the professor for each one of the exercises.	50	CG13	CE62	
Project based learning	Laboratory Project. Design of a medium-complexity synthesisable digital system in VHDL. It will be necessary to deliver the design source files. The assessment will be based on the operation of the digital system and the correct application of the theoretical concepts, according to the published criteria.	40	CG1 CG9 CG13	CE62	CT4
Presentation	It will be necessary to do an oral presentation of 15 minutes as a maximum about the work, according to the index supplied by the teacher.	10	CG1 CG9		CT4

Other comments on the Evaluation

The total mark will be the sum of the marks obtained in the different tasks of the subject.

The global mark of the theoretical problems has to be equal or greater than 5 over 10 in order to pass the subject.

The mark of the Laboratory Project has to be equal or greater than 5 over 10 in order to pass the subject.

The students will be offered two assessment systems: continuous assessment and single assessment.

All the students, whether they follow the subject continuously or want to be assessed in the single assessment (first or second opportunity or extraordinary assessment), will have to do the tasks described in the previous section.

The students that do not attend classes regularly will also have to do the same tasks as the students who attend classes.

The final mark will be expressed in numerical form ranging from 0 to 10.

CONTINUOUS ASSESSMENT:

The students are considered to have chosen the continuous assessment when they have done 2 laboratory practices and/or 2 reports of theoretical exercises.

The students that have chosen continuous assessment, but do not pass the course, will have to do the single assessment at the second opportunity.

The students that pass the course by means of continuous assessment will not be allowed to repeat any task in the single assessment in order to improve the mark.

The different tasks should be delivered in the date specified by the teacher, otherwise they will not be assessed for the continuous assessment.

The students will develop the theoretical exercises and the laboratory practices individually.

The laboratory projects will be developed in groups of two students during the continuous assessment but the students will be assessed individually. To achieve this, the students will be required to explain during the oral presentation which parts of the project each of them has developed.

The students who want to be assessed in the continuous assessment can only miss two sessions as a maximum. If they miss more than 2 sessions, it will be compulsory to do an additional individual task or an examination.

SINGLE ASSESSMENT (first opportunity, second oportunity) AND **EXTRAORDINARY CALL**:

The students that opt for the single assessment (whether it is at the first or the second opportunity) or for the extraordinary call will have to do all the theoretical and practical tasks and the project individually.

The tasks for the single assessment must be delivered before the official date of the examination set by the faculty.

In case the students pass the theoretical exercises (TE) and the Laboratory Project (LP), that is, the mark of each part >= 5,

the final mark (FM) will be the weighted sum of the marks of each part of the subject:

FM = 0,50 * TE + 0,40 * LP + 0,10 * OP

In case the students do not pass any of the two main parts of the subject, the theoretical exercises (TE) or the Laboratory Project (LP), that is, the mark of any part < 5, the final mark (FM) will be:

FM = Minimum [4,5 ; (FM = 0,50 * TE + 0,40 * LP + 0,10 * OP)]

Where:

TE = Global mark of the theoretical exercises and problems.

LP = Laboratory Project.

OP = Oral presentation.

Theoretical exercises and problems.

Each one of the theoretical exercises and problems proposed in the theoretical sessions will be marked from 0 to 10. Its influence in the total mark of the subject will be weighted in function of the number of exercises assigned.

The majority of the exercises will consist in the design of non-synthesisable models and synthesisable circuits in VHDL.

It will be necessary to deliver the required source files.

The total mark will be the sum of the marks of each one of the exercise reports divided by the number of reports:

TE = (Report 1 + ... + Report N) / N

The estimated number of exercises is 10.

Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the exercises, the final mark will be FAIL (0), and the incident will be reported to the corresponding academic authorities for appropriate action

Sources of information

Basic Bibliography

CHU, PONG P., **RTL Hardware Design Using VHDL: Coding for Efficiency,Portability, and Scalability**, John Wiley & Sons Inc, 2006

ÁLVAREZ RUIZ DE OJEDA, L.J., **Diseño Digital con FPGAs**, Visión libros, 2013

Complementary Bibliography

ASHENDEN, PETER J., **The Designer's Guide to VHDL**, 3, MorganKaufmann Publishers, 2008

Standard IEEE VHDL Language Reference Manual (IEEE Srd 1076-2001), IEEE, 2001

CHU, PONG P., **FPGA Prototyping by VHDLExamples**, John Wiley & Sons Inc, 2008

Recommendations

Subjects that it is recommended to have taken before

Programmable Electronic Circuits/V05G300V01502

Other comments

The students will have previously followed the subjects Digital Electronics and Programmable Electronic Circuits. They give the necessary knowledge to understand the topics of this course.
It is not necessary to have passed them.
The students of the specialisation Electronic Systems, should have previously followed the subject Electronic Systems for Signal Processing, but it is not indispensable.

Contingency plan

Description

In case of having to teach partly or entirely online because of health and safety recommendations, the same teaching methodologies and the same assessment methods will be maintained.

IDENTIFYING DATA				
Advanced electronic sensors				
Subject	Advanced electronic sensors			
Code	V05G300V01924			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Mariño Espiñeira, Perfecto			
Lecturers	Costas Pérez, Lucía Mariño Espiñeira, Perfecto Pastoriza Santos, Vicente			
E-mail	pmarino@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main purpose of this subject is to train students in order that they become well-qualified to understand the physical principles and current techniques employed in the most recent electronic sensors technology. Course outline: + Optical fiber sensors. + Laser sensors. + Microelectromechanical sensors (MEMS). + Image sensors. + Integrated sensors. + Intelligent sensors. + Acoustic wave sensors. + Biosensores. The main goal of the laboratory sessions (practical work) is to enable the students to acquire sufficient understanding and knowledge to: + Analyze the parameters and main features of the sensors. + Know the applications of each group of sensors. + Manage specific software tools developed to design (virtual) instruments that allow store, display and analyze recorded data. The documentation of the course will be in English. It will be taught in Galician and Spanish. It will be assessed in Spanish.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG9	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.
CE63	(CE63/OP6) The ability to design and use optoelectronic sensors, micromechanical sensors (MEMS) and acoustic wave sensors.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes			
Learning outcomes	Competences		
Knowledge of the modes of operation and applications of fiber optic sensors.	CG3	CE63	
Knowledge of the modes of operation and applications of microelectromechanical sensors.	CG3	CE63	
Knowledge of the modes of operation and applications of acoustic wave sensors.	CG3	CE63	
Ability to select and work with next generation electronic sensors.	CG4	CE63	
Ability to work in groups and to develop communications skills in order to elaborate and present technical reports related to the subject.	CG9	CE63	CT4

Contents	
Topic	
Unit 1: Fiber Optic Sensors I.	Introduction. Classification. FOS types. Basic structure. Extrinsic, intrinsic and evanescent wave sensors. Applications. Interferometric FOS. Applications.
Unit 2: Fiber Optic Sensors II.	Multisensory FOS systems. Distributed and multiplexed FOS. OTDR reflectometry. OFDR reflectrometry. Fiber Bragg grating. Applications. Intelligent systems. Laser vibrometry and interferometry. Applications.
Unit 3: Integrated Optical Sensors.	Introduction. Classification of optical integrated waveguides. Materials. Devices. Interferometry in IO. Active integrated optic devices; detectors and sources. Sensors. Biosensors. OF-IO Coupling. Applications.
Unit 4: Microelectromechanical Sensors (MEMS).	Microelectronic technologies. MEMS fabrication processes. MEMS materials. MEMS Sensors. Micromachined free space integrated micro optics. CMOS Microsensors. Applications.
Unit 5: Image Sensors and Displays I.	Introduction. Display specifications. Display classification. Illumination technologies. Image capture technology: CCD and CMOS. Night vision technology: PMTs y IR cameras.
Unit 6: Image Sensors and Displays II.	Introduction to pyrometry. Operating principle General features. Disappearing filament pyrometer. Conditioning. Bolometric detector. Quantum detectors. Radiometers. IR cameras. Applications.
Unit 7: Acoustic Wave Sensors (AWS).	Classification. Materials features. Comparative study of AWS sensors. Applications. FPW microsensor. FPW integrated systems. Coatings for AWS. Pattern recognition in electronic nose.
Unit 8: Virtual Reality Sensors.	Introduction. Tactile response systems. RV features. Architectures. Neuronal processes. Mechanoreceptors. Projective field. Visual tactile synesthesia. Visual immersion systems. UAV (Unmanned Aerial Vehicle) systems.
Unit 9: Sensor Technology in Particle Physics.	Introduction. Specific instrumentation standars: CAMAC, FASTBUS and SCI. The standard model. Features of the standard model. Beta decay. Evolution of particle accelerators. Particle Detectors in accelerators. Nuclear medicine applications.

Planning	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	1	2
Lecturing	17	8	25
Mentored work	3	12	15
Laboratory practical	12	58	70
Studies excursion	2	0	2
Project based learning	7	29	36
*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. Individual task. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.
Lecturing	The lecturer will explain in the classroom the main contents of the subject. The students individually 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 at the office. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.
Mentored work	The students have to manage basic concepts to search and select information in order to get a deeper understanding in some specific fields related to the subject. The lecturer will propose in the classroom the topic of this individual task and monitor the students work in personalized attention sessions. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.
Laboratory practical	Small-group activities designed to apply the main concepts and definitions of the subject. The student 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 student has to develop and demonstrate autonomous learning and collaborative skills. He/she is supposed to be able to manage bibliography and recently acquired knowledge. Possible questions can be answered in the laboratory sessions or at the lecturers office. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.

Studies excursion	Large-group activities designed to apply, contrast and observe the knowledge within a particular context in an outdoor space. The student will acquire more knowledge about a specific type of sensors through a guided visit to a site where these sensors are being used. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.
Project based learning	Project-based learning: students have to develop a group activity that goes on over a period of time and address a specific problem. They have to design, schedule and carry out a set of tasks to achieve a solution. The assessment will be based on the quality of the proposed solution, the depth of content understanding demonstrated and the final presentation. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.

Personalized assistance

Methodologies	Description
Lecturing	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will answer the students questions and also give instructions to guide the studying and learning process.
Laboratory practical	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will help students understand the work to be developed in the laboratory (components, circuits, instrumentation and tools).
Mentored work	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will help students to deal with the monitored work.
Project based learning	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject website at the beginning of the term. The lecturers will be available to help students in order to deal with the contents of the subject, the practices as well as the monitored work.

Assessment

	Description	Qualification	Evaluated Competencess		
Mentored work	The lecturers will consider the quality of the results obtained, their analysis, the final report, and the classroom presentation. Marks will be assigned in a 10 points scale. In these works, the skills CG3, CG4, CG9, CE63, and CT4 will be evaluated.	50	CG3 CG4 CG9	CE63	CT4
Laboratory practical	The lecturers will check the level of compliance of the students with the goals related to the laboratory skills. They will consider the work of the students carried out before the practical session to prepare the proposed tasks, the attendance, and the quality of the work done. The mark for this part (FML: Final Mark of Laboratory) will be graded in a 10 points scale. In these practices, the skills CG3, CG4, CG9, CE63, and CT4 will be assessed.	30	CG3 CG4 CG9	CE63	CT4
Project based learning	The lecturers will consider the quality of the results obtained, their analysis, and the classroom presentation. Marks will be (GPM: Group Project Mark) assigned in a 10 points scale. In these tasks, the skills CG3, CG4, CG9, CE63, and CT4 will be evaluated.	20	CG3 CG4 CG9	CE63	CT4

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 go to the lectures regularly (less than 10% unjustified absence), or miss at most one B laboratory session, or miss at most one C group project session, ***they will be assessed by continuous assessment.*** An attendance register will be made at each session.

The subject comprises three different parts: theory (50 %), laboratory practical (30%) and group project (20%). Once a task has been assessed, the students cannot do/repeat the task at a later date. The marks are valid only for the current academic course. The final grade for the students which have selected this option, may not be "no standing".

1.a Theory

In the first weeks of the course each student will be asked to carry out a task individually with the help of the lecturer about a topic related to the subject. In order to assess the task, the lecturer will consider the quality of the results obtained, their

analysis, the final report, and the classroom presentation. The students will be informed of the deadline by the lecturer. Marks will be (TWM: Tutored Work Mark) assigned in a 10 points scale. If the students present their works after the deadline the WM will be 0.

The final mark of this part will be:

FMT (Final Mark of Theory) = TWM (Tutored Work Mark)

It is compulsory to get a score of FMT >= 5 and to have attended a lectures regularly (less than 10% unjustified absence) to pass this part by continuous assessment.

1.b Laboratory

Six laboratory sessions and one outdoor study are scheduled. Each practical session lasts approximately 120 minutes and the students will work in pairs.

The lecturers will assess the individual student work. They will consider the individual work carried out before the laboratory session to prepare the proposed tasks, the laboratory attendance, as well as the student work in the laboratory.

In the first session, the practice 1 will be performed. The mark of this session (P1M: Practice 1 Mark) will be assigned in a 10 points scale.

In the remaining sessions, a practical work related to process control modules available in laboratory will be carried out. In order to assess this work, the lecturer will consider the quality of the results obtained, their analysis, and the classroom presentation. The final mark of this part, (LWM: Laboratory Work Mark) , will be graded in a 10 points scale.

The outdoor study will be also assessed in a 10 points scale (OSM: Outdoor Study Mark).

The final mark of this part is calculated as the weighted sum of the three individual marks:

FML (Final Mark of Laboratory) = 0.15·P1M + 0.75·LWM + 0.10·OSM

Attendance at these classes is compulsory to pass this part by continuous assessment. If the student miss more than one session without a valid documented reason (medical, bereavement or other) he/she will be assigned a grade of 0 for this part (FML=0).

1.c Group project

The classroom workload will be carried out in the C group project sessions. In the first session lecturers will present the objectives and the schedule of the project. They also assign a specific project to each group. In this sessions the lecturer will monitor the group work and the individual student work.

In order to assess the project, the lecturer will consider the quality of the results obtained, their classroom presentation and analysis, and the quality of the final report. The students will be duly informed of the report deadline by the lecturer. The final mark of this part, (GPM: Group Project Mark) , will be assessed in a 10 points scale.

In order to pass this part by continuous assessment, the student can not miss more than one project sessions and only if this absence is duly justified.

1.d Final mark of the subject

In order to past the subject by continuous assessment, students will be required:

+ to obtain FMT >= 5, and

+ no more than one missed practical session, and

+ no more than one missed group project session.

The weighted *points* from all assessed parts are added together to calculate the final *mark(FM)*. The following weightings will be applied: 50% theory, 30% laboratory and 20% group project.

FM = 0.50·FMT + 0.30·FML + 0.20·GPM

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

However, when:

+ FMT < 5, or

+ more than one missed practical session, or

+ more than one missed group project session,

the final mark (FM) will be the minimum value among them.

FM = min{ FMT, FML, GPM }

2. Single assessment

If a student prefers a different educational policy he/she can take an exam on a scheduled *date*. The date will be specified in the academic calendar. This exam will comprise three parts (similar to the activities completed by the continuously assessed students):

+ an **exam** or a task monitored by a tutor (**tutored work**),

+ a **practical exam**,

+ a previously assigned **project**.

The tutored work and the project will be assigned following the procedure described in advance by the lecturer.

2.a Theory

2.a.1 Theory Exam or Tutored Work

In order to pass the theory, the student will have to attend to an exam or a tutored work:

+ the exam with short or long answer questions. Marks will be (EM: Exam Mark) assigned in a 10 points scale.

+ to evaluate the tutored work the lecturer will consider the results, the presentation, the analysis and the quality of the final report. Marks will be (TWM: Tutored Work Mark) assigned in a 10 points scale.

2.a.2 Theory Final Mark

The final mark of theory (FMT) will be:

FMT = EM (Exam Mark) if the exam has been carried out.

FMT = TWM (Tutored Work Mark) if the tutored work has been carried out.

2.b Laboratory

In order to pass the laboratory part, the student will have to attend to a practical exam. In this exam the student will be asked to deal with some of the electronic circuits developed in the practical sessions as well as some short answer questions related to these sessions. Marks will be (LEM: Laboratory Exam Mark) assigned in a 10 points scale.

The final mark of laboratory (FML) will be FML = LEM (Laboratory Exam Mark).

2.c Project

In order to assess the project, the lecturer will consider the quality of the results obtained, their analysis, and the classroom presentation. Marks will be (GPM: Group Project Mark) assigned in a 10 points scale.

2.d Final mark

In order to pass the subject, it is mandatory:

+ FMT >= 5, and

+ FML >= 5, and

+ GPM >= 5.

The final mark will be the weighted average of the marks obtained by the student in the different parts. The final mark (FM) will apply a weight of 50% to the final theory mark (FMT), a 30% to the laboratory final mark (FML) and a 20 % to the group project mark (GPM).

FM = 0,50·FMT + 0,30·FML + 0,20·GPM

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

However, when:

+ FMT < 5, or

+ FML < 5, or

+ GPM < 5,

the final mark will be the minimum value among them.

FM = min{ FMT, FML, GPM }

3. Second opportunity and extraordinary call

The assessment policy in these calls will follow the scheme described in the single assessment. Dates will be specified in the academic calendar. The lecturer will assign the tutored work and the project to the student. The student has to contact to the lecturer according to an established procedure. The procedure will be published in advance.

Marks obtained in the previous continuous or single assessment are kept if the student have got a pass in some parts. Moreover, students cannot take an exam, develop a project or a tutored work task if they have got a pass previously.

The final mark will be the weighted average of the marks obtained by the student as it has described in section 2.

4. Others

The subject will be taught in Galician and Spanish. It will be assessed in Spanish.

Sources of information

Basic Bibliography

Pérez García, M.A., Álvarez Antón, J.C., Campo Rodríguez, J.C., Ferrero Martín F.C., y Grillo Ortega, **Instrumentación Electrónica**, 2ª ed., Thomson, 2004

Pérez García, M.A., **Instrumentación Electrónica**, 1ª ed., Ediciones Paraninfo, S.A., 2014

Pallás Areny, R., **Sensores y Acondicionadores de Señal**, 4ª ed., Marcombo D.L., 2003

Norton, H.N., **Sensores y analizadores**, Gustavo Gili D.L., 1984

Fraile Mora, J., García Gutiérrez, P., y Fraile Ardanuy, J., **Instrumentación aplicada a la ingeniería**, 3ª ed., Editorial Garceta, 2013

Martín Fernández, A., **Instrumentación electrónica. Transductores y acondicionadores de señal y sistemas de adquisición de datos**, 2ª ed., Dpto. de publicaciones de la E.U.I.T.T. de Madrid,, 1990

Complementary Bibliography

del Río Fernández, J., Shariat-Panahi, S., Sarriá Gandul, S., y Lázaro, A.M., **LabVIEW: Programación para Sistemas de Instrumentación**, 1ª ed., Editorial Garceta, 2011

Recommendations

Subjects that it is recommended to have taken before

Programmable Electronic Circuits/V05G300V01502
Microelectronics Design/V05G300V01622
Analogue Electronics/V05G300V01624
Power Electronics/V05G300V01625
Engineering of Electronic Equipment/V05G300V01523
Electronic Instrumentation and Sensors/V05G300V01621
Data Acquisition Systems/V05G300V01521
Electronic Systems for Signal Processing/V05G300V01522
Electronic Systems for Digital Communications/V05G300V01623

Other comments

It recommends to have passed the following subjects:
+ Electronic Technology/V05G300V01401
+ Digital Electronics/V05G300V01402
+ Analogue Electronics/V05G300V01624
+ Data Acquisition Systems/V05G300V01521
+ Electronic Instrumentation and Sensors/V05G300V01621

Contingency plan

Description

In case of exclusively online teaching, then the planning will be as follows:
*The teaching in groups A, B and C will be taught through classrooms on the Remote Campus.
*In A sessions, the same content described in the guide will be developed. The tasks in B sessions will try to adapt, as far as possible, to be able to be carried out with simulators; and in C sessions, the students will carry out a project assigned by the teacher.

In case of exclusively online teaching, the evaluation will be as follows:
*The objective tests will be carried out synchronously in classrooms of the Remote Campus.
*If the outdoor study is not carried out, the final mark of laboratory (FML) will be: FML = 0.20·P1M(Practice 1 Mark) + 0.80·LWM(Laboratory Work Mark)

IDENTIFYING DATA				
Industrial Communications				
Subject	Industrial Communications			
Code	V05G300V01925			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Domínguez Gómez, Miguel Ángel			
Lecturers	Domínguez Gómez, Miguel Ángel Poza González, Francisco			
E-mail	mdgomez@uvigo.es			
Web	http://faitic.uvigo.es			
General description	There are more electronic units of control in the systems used in diverse areas of the engineering (industrial control, automotion, domotic, aircrafts, ships, etc.). These units must be connected between them of an efficient way and in real time to transmit all the necessary information. The use of industrial communications networks has had a very big peak in the last years and the knowledge of the different fieldbus protocols existing in the market is of big interest for the engineering. This subject intends that the student know the different protocols of communications that exist in various areas of application and acquires the capacity to choose the most adapted solution for a determinate problem. In accordance with the exposed, will treat the following contents: * Introduction to industrial communications systems * Introduction to fieldbuses * Standards * General Characteristics * Applications * Study of the most used protocols * Tools of design and analysis			

Competencies	
Code	
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CG14	CG14 The ability to use software tools to search for information or bibliographical resources.
CE64	(CE64/OP7) Comprehension and command of basic concepts of industrial communication networks of field buses.

Learning outcomes		
Learning outcomes		Competences
Understanding and control of the industrial communications systems.		CE64
Understanding and control of the basic concepts of industrial communications networks (fieldbuses).		CE64
Understanding and control of fieldbuses applications and the most important protocols.		CE64
Capacity to choose the better solution for a determinate problem of communication.	CG6	CE64
Capacity to design simple industrial communication systems.	CG6 CG14	
Basic knowledges of software tools for analysis and design.	CG6 CG14	
Capacity of use and configurate communication hardware modules.	CG6 CG14	

Contents	
Topic	
Theme 1: Communication networks	OSI and TCP/IP models. Local Area Networks (LAN). Wide Area Networks (WAN). Wireless and mobile communication systems. Interconnection resources. Hierarchy.
Theme 2: Fieldbuses	Origin. Main characteristic. standardization. Applications.
Theme 3: CAN/LIN	History. Applications. Main characteristic. Physical layer. Data link layer. Media access control. Frames format. Coding of frames. Errors management.

Theme 4: CAN controller MCP2515	Features. Device overview. Message transmission and reception. Timing configuration. Error detection. Interrupts. Modes of operation.
Theme 5: Domotic fieldbuses: KNX	Basic concepts (domotic, inmotic, digital home). Physical levels of transmission. Main protocols used in domotic. KNX (Generalities, main characteristic, topology, telegram).
Theme 6: PROFIBUS	Physical layer. Topology. Data link layer. Media access control. Transmission methods. Timers. Structure of the frames.
Theme 7: WorldFIP	Physical layer. Data link layer. Variables and messages. Media access control. Frames format. Timers. Bus arbitrator. Producers/Consumers entities.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	4	8	12
Lecturing	12	36	48
Mentored work	15	52	67
Laboratory practical	6	12	18
Essay questions exam	5	0	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	Presentation of the course. Presentation of the laboratory practices and the instrumentation and software to use. Through this methodology the competencies CG6, CG14 and CE64 are developed.
Lecturing	Exhibition by professor of the contents. Personal homework of the student reviewing the concepts seen in the classroom and preparing the topics using the proposed bibliography. Identification of doubts that require to be resolved in personalised attention.Through this methodology the competencies CG6, CG14 and CE64 are developed.
Mentored work	A work about a specific protocol will be assigned to the students, individually or in group. This work will have to be exposed and argued in class.Through this methodology the competency CG14 is developed.
Laboratory practical	Activities of application of the theoretical knowledges purchased. It will learn to handle specific software of design, simulation and analysis of industrial communication networks. They will program simple hardware modules of some protocol studied in theory. Personal work of the student preparing the practices using the available documentation and reviewing the related theoretical concepts. Preparation and analysis of results. Identification of doubts that require to be resolved in personalised attention.Through this methodology the competency CG6 is developed.

Personalized assistance

Methodologies	Description
Lecturing	The students will be able to attend to personalised tutorials in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts about the contents given in the Master Sessions and will be oriented about how to deal with them.
Mentored work	The students will be able to attend to personalised tutorials in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts and will be oriented about the work that they have to do and present in the last weeks of classes.
Laboratory practical	The students will be able to attend to personalised tutorials in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts about the development of the laboratory practices, the handle of the software of design, simulation and analysis and the specifications and operation of the modules and kits that they use.

Assessment

	Description	Qualification	Evaluated Competencess	
Mentored work	Work that have to do the students and present in class. It will evaluate the work and the quality of the implementation and presentation.	40	CG6 CG14	
Laboratory practical	The work of the student in the laboratory will be evaluated, as well as the memories that should be deliver of the practices.	20	CG6 CG14	CE64
Essay questions exam	Exams that will be realised in the classroom after a set of exposed subjects to evaluate the knowledges acquired by the student.	40		CE64

Other comments on the Evaluation

1. First call (continuous assessment)

Following the own guidelines of the degree and the agreements of the academic commission, a system of continuous assessment will be offered to the students. Evaluation will be in Spanish.

1.a Proofs of short answer

There will be 3 proofs of short answer (type test and/or questions) properly programmed along the course. These proofs will be valued from 0 up to 10 and the final mark will be the average (NPRC):

NPRC = (NPRC1 + NPRC2 + NPRC3)/3

The proofs are not recoverable,that is to say, that if a student cannot attend the day in that they are programmed, the professor has no obligation to repeat them. The mark of the proofs that were missed will be of 0.

1.b Personalized works

A work will be assigned to the students, individually or by groups (depending of the number of students) in the first weeks of the course. This work should be delivered and presented in the last weeks of the course. The presentation of the works will be properly programmed by the professors. The implemented work and its presentation will be valued with a final mark (NT) from 0 up to 10. If the work is done in group, every student of the group will be valued with the same mark which will be the mark of the work (NT).

The student that does not deliver the work or does not present it in the indicated day will have a mark of 0.

1.c Laboratory practices

Each practice will be valued from 0 up to 10 taking into account the work made in the laboratory. The final mark of laboratory (NPL) will be the average of the qualifications obtained in the practices:

NPL = (NPL1 + NPL2 + □ + NPLn)/n

Practices can be done individually or by groups (depending of the number of students). If practices are done in group, every student of the group will be valued with the same mark (NPL).

The practices are not recoverable, that is to say, that if a student cannot attend the day in that they are programmed, the professor has no obligation to repeat them. The mark of the practices that were missed will be of 0.

1.d Final mark

The final mark (NF) will be:

NF = 0,4*NPRC + 0,4*NT + 0,2*NPL

2. First call (exam-only assessment)

The students that do not pass by continuous assessment (final qualification less than 5), will be able to present to a final exam.

The final exam will be in the dates provided for the School and will consist in a proof of short answer (type test and/or questions) (NPRC), the delivery and presentation of a work that the professors will have assigned to the student and the delivery of a laboratory work (NPL) previously assigned to the student by the professors. Each one of these parts will be valued from 0 up to 10. The students will be able to present to all these parts or which they consider appropriate. They will conserve the mark of the continuous assessment in the parts that do not present.

The calculation of the final mark will be as it was explained in the section 1.d.

3. Second call and end-of-program call

The second call and end-of-program call will have the same format that the exam-only assessment (final exam) and will be in the dates provided for the School.

The students who present to these calls can only do all the parts or only which they consider appropriate. They will conserve the mark of the first call (continuous assessment or exam-only assessment) in the parts that they do not take.

The calculation of the final mark will be as it was explained in the section 1.d. The final mark will be the best of the obtained by the student in the diferent calls.

4. Validity of the qualifications

The qualifications of the student will be valid only for the academic course in which they were obtained.

Sources of information

Basic Bibliography

Oliva N. y otros, **Redes de comunicaciones industriales**, 1ª, UNED, 2013

Complementary Bibliography

Castro M.A. y otros, **Comunicaciones industriales: principios básicos**, 1ª, UNED, 2007

Castro, M.A. y otros, **Comunicaciones industriales: sistemas distribuidos y aplicaciones**, 1ª, UNED, 2007

Recommendations

Other comments

It is recommended to have passed or be taking all the subjects of the Electronic Systems module

Contingency plan

Description

If the sanitary situation caused by the COVID-19 requires a stage of teaching no face-to-face, the adaptations that would carry out in this subject would be the following:

* Classes of theory:
The classes of theory would carry out of way no face-to-face (on-line) using the more suitable and available resources and applications (Faitic, Remote Campus, Videos of presentations with audio, etc.).

* Practical classes:
The hardware practices would be suspended and only the simulation practices would be done in a remote way.

* Work:
If it is not possible to supply to the students the necessary material so that they can do the work home, only the parts with posibility of simulation will be done.

* Exams:
they would make in a no face-to-face way (on-line) by using Faitic and Remote Campus.

IDENTIFYING DATA				
Image processing and analysis				
Subject	Image processing and analysis			
Code	V05G300V01931			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Alba Castro, José Luis			
Lecturers	Alba Castro, José Luis			
E-mail	jalba@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject is the continuation of the one of 3º Image Processing Fundamentals. The student will acquire knowledges and competence on high level techniques to analyse images and extract information of interest for different applications. The subject is taught and evaluated in English. The documentation is in English.			

Competencies	
Code	
CG4	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.
CG9	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.
CG10	CG10 The ability for critical reading of scientific papers and docs.
CG12	CG12 The development of discussion ability about technical subjects
CE73	(CE73/OP16) The ability to construct, exploit and manage artificial vision, medical imaging, and multimedia data base systems.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	Competences		
Understand the foundations of standard techniques to analyze images	CG10 CG12		CT2
Apply image analysis techniques in computers	CG9 CG12	CE73	CT4
Understand the foundations of image description techniques in advanced standards	CG10 CG12		CT2
Identify different analysis necessities for different imaging systems	CG9 CG12	CE73	CT4
Design an image analysis and description system	CG4 CG9	CE73	CT4

Contents	
Topic	
Analysis of image.	Overview of color spaces. Segmentation based in colour, textures, shapes and models. Extraction of descriptive and invariant characteristics. Examples in actual problems.
Description and classification of objects.	Clustering. Image descriptors. Classical and probabilistic decisors. Classification. Convolutional Neural Networks (CNN). Examples in actual problems.
Aplications	RGB image processing. Medical image processing. Real-time video processing

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	10	10	20
Mentored work	24	82	106
Presentation	3	6	9
Introductory activities	3	0	3
Objective questions exam	2	0	2
Report of practices, practicum and external practices	0	10	10
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Each 3-hour class will include one hour of explanation of subject contents, encouraging critical discussion and assimilation through computer programming and visualization.
Mentored work	Each 3-hour session will include 2 hours of "hands-on" working to assimilate the explained concepts through problem-based learning (PBL). Every Problem/Task will take 4 or 5 weeks of the subject during which the student will have to discover, alone or with the professor guidance, what he needs to solve the problem effectively.
Presentation	The third and last task will be presented in front of the class mates. The students from the same group will have to split the presentation, so both of them explain one part of the work.
Introductory activities	In the first class of the course, concepts learned in FPI and the programming tools for the course will be reviewed.

Personalized assistance	
Methodologies	**Description**
Introductory activities	The introductory activities are related to motivation for learning how to to develop projects in real-life.
Lecturing	During the master sessions, the teacher asks questions to the class and/or specific student to grab their attention about the current topic.
Mentored work	This methodology gives a lot of room for personalized attention. The teacher sits with each of the groups and guides every student through the step-by-step process of building a solution.
Presentation	Every time a student has to deliver a presentation (in the last guided task and also when challenged to beat another group in a specific subtask), the teacher explains him/them how to improve the impact of their presentation.

Assessment					
	Description	Qualification	Evaluated Competencess		
Objective questions exam	Each part of the subject has theoretical concepts that are explained in class. The concepts are assessed through these tests, that are also formally linked to the delivery of each guided task. They are meant to grade each student individually. They help to assess general competence A82. The concepts are discussed in class and also individually through the e-learning platform and/or counseling hours.	20	CG10 CG12	CE73	
Report of practices, practicum and external practices	Each part of the subject is learnt through a hands-on guided task. Most of the teacher's time is devoted to discuss, both in group and individually, how to go step by step through the process of building a solution. The score of the guided task includes: the follow-up of each student, the techniques used, the results achieved, the quality of the report and the oral presentation of the last one. The guided tasks help to assess general competences A4, A82, B1 and B3.	80	CG4 CG9	CE73	CT2 CT4

Other comments on the Evaluation

Teaching and assessment is in english.

Attendance is compulsory in continuous assessment, unless special circumstances are alleged. Continuous assessment will be based on the student lab work and guided tasks related to contents of the subject.

There will be an official final exam (first call) scheduled by the "Junta de Escuela" that the students that didn't pass the continuous assessment will have to take if they want to pass the course. This final exam will be scored from 0 to 10 points and includes all the topics explained during the course and also concepts and techniques explained for the guided tasks. To

pass this exam the student has to score, at least, 5 points. The students that are eager to improve their continuous assessment score can also take the final exam (first call). In this case the final score of the course will be the maximum score of the final exam and continuous assessment.

Throughout the semester, the students will be receiving feedback about his performance on the continuous assessment, along with the scores obtained in the tests and guided tasks. Delivering any of the guided tasks or sitting any test will automatically mean that the student is following the course in the continuous assessment mode. That means that he will appear as "presented" in the records of the subject even if the final exam is not taken.

The continuous assessment contains the next milestones:

Guided task 1: linked to the image analysis topic (25%). 20% for the computer work and 5% for the test.

Guided task 2: linked both to the image analysis and classification topics (25%). 10% for the computer work and 5% for the test.

Guided task 3: linked to all topics (40%). 30% for the computer work an 10% for the test.

Report and public presentation of the 3rd guided task (10%).

The second call will only be held for students who failed the course both in continuous assesment mode or the first call. The score of the subject will be the score of this exam. The exam will be scored between 0 and 10. To pass the subject, at least 5 points are needed.

Sources of information

Basic Bibliography

Rafael C. Gonzalez, Richard E. Woods, **Digital Image Processing**, 3ª (2008),

Robert Laganière, **OpenCV 2 Computer Vision Application Programming Cookbook**, 2011,

Complementary Bibliography

Richard O. Duda, Peter E. Hart, David G. Stork, **Pattern Classification**, 2ª (2001),

Recommendations

Subjects that it is recommended to have taken before

Fundamentals of Image Processing/V05G300V01632
Imaging Systems/V05G300V01633

Contingency plan

Description

=== ADAPTATION OF THE METHODOLOGIES ===
If the circumstances force the on-line Teaching
will give the sessions of synchronous form using the Remote Campus of the University of Vigo.

=== ADAPTATION OF THE EVALUATION ===
If the circumstances force the on-line Evaluation
The tests of theoretical contents will be done on-line.
The presentation of the last work will be done in a synchronous form or by means of a prerecorded video
The Remote Campus of the University of Vigo will be used.

IDENTIFYING DATA				
Multimedia technology and computer graphics				
Subject	Multimedia technology and computer graphics			
Code	V05G300V01932			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Pena Giménez, Antonio			
Lecturers	Pena Giménez, Antonio			
E-mail	apena@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Topics related to Virtual Environments (video games, augmented reality, virtual reality). A videogame is developed in a multidisciplinary group, with students from other degrees. The development engine is Unity and programming language is C #.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG9	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.
CG12	CG12 The development of discussion ability about technical subjects
CE74	(CE74/OP17) The ability to construct, exploit and manage image and synthetic video generation systems and interactive multimedia applications.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	Competences		
Understand the foundations of the synthesis of image by computer.	CG3 CG12	CE74	CT3
Apply methods of synthesis of image by computer.	CG3 CG12	CE74	CT3
Apply methods of synthesis of effects of audio by computer.	CG3 CG12	CE74	CT3
Develop multimedia applications.	CG3 CG9	CE74	CT3 CT4

Contents	
Topic	
Computer image synthesis	Approach to the associated electronics with the graphic processing boards on computers.
Audio 3D	Programming the soundscapes in a three-dimensional virtual environment. Mixing of different sound sources (environment, dialogues, effects, ...).
Virtual Reality, Enhanced Reality	Description of the mathematics underlying the creation of a Virtual Environment. Description and issues of virtual reality and augmented reality applications.
Video games	Multidisciplinarity in the construction of a video game. Notions of video game design. Pipeline in the development of a video game. Management and programming of a virtual environment engine (Unity).

Planning

	Class hours	Hours outside the classroom	Total hours
Project based learning	7	59.5	66.5
Practices through ICT	16	8.5	24.5
Lecturing	17	26	43
Flipped Learning	0	14	14
Problem and/or exercise solving	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
Project based learning	Collaborative work in a small multidisciplinary group, with students from other Degrees of the University of Vigo, for the elaboration of a video game, following the professional production process of the related industry, from an initial concept to a final product. Group work, role assignments, working in common, planning, technical reports and oral presentation are considered. Through this methodology, competencies CG3, CG9, CE74, CT3, CT4 are developed.
Practices through ICT	Management and adjustment of the engine of a Virtual Environment. Programming of components in virtual objects. Through this methodology, competencies CG3, CG12, CE74, CT3 are developed.
Lecturing	Exposition by the teacher of the contents of the subject, encouraging the critical discussion of the concepts. The theoretical bases of algorithms and procedures used to solve problems are laid down. Through this methodology, competencies CG3, CG12, CE74, CT3 are developed.
Flipped Learning	Written and / or audiovisual material is provided to study and prepare an online test. This activity is prior to the master class or computer room sessions where doubts will be solved and challenges will arise. Through this methodology, competencies CG3, CE74 are developed.

Personalized assistance

Methodologies	Description
Lecturing	Tutoring to solve issues related to master sessions or lab practice is implemented either individually or in reduced groups (no more than 2-3 students). E-mail confirmation to match the date of the appointment is needed.
Practices through ICT	Tutoring to solve issues related to master sessions or lab practice is implemented either individually or in reduced groups (no more than 2-3 students). E-mail confirmation to match the date of the appointment is needed.
Project based learning	During group projects an individualized tracking of the student is developed. Cross-evaluation within the group and autoevaluation may be used.

Assessment

	Description	Qualification	Evaluated Competencess		
Project based learning	Assessment of a collaborative work, developed along the semester, including a written report and oral presentation.	50	CG3 CG9	CE74	CT3 CT4
Practices through ICT	Work assessment in the computer room.	15	CG3 CG12	CE74	CT3
Flipped Learning	Automatic corrected online test.	10	CG3	CE74	
Problem and/or exercise solving	Written test with short questions and problems to solve.	25	CG3 CG12	CE74	CT3

Other comments on the Evaluation

*** "Students who choose continuous assessment" conditions:**

A student follows the continuous assessment system if she/he assigns a document that will be delivered and collected during weeks 1-3, so the collaborative work can begin.

If a student has participated in continuous assessment and does not pass the course he/she will receive a grade of fail, regardless of he/she takes the written exam or not.

CONDITIONS TO PASS THE SUBJECT

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 4 (on the same scale) in each of the partial marks (written exam and collaborative group, respectively).

If some of these conditions are not fulfilled, then the final grade (on a ten-points scale) will be the minimum between the final mark and the value "4".

*** "Students who choose for exam-only assessment" conditions:**

The possibility of a final examination will be provided to students who do not opt for the continuous assessment.

In order to ensure that students acquire a balanced minimum on the subject competences, they will pass the course if they meet both 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 4 (on the same scale) in each of the sections of the exam. These sections, respectively, correspond with:

* contents included in all activities

* project developed in group, including group internals, management, writing of technical reports and oral presentations.

If some of these conditions are not fulfilled, then the final grade (on a ten-points scale) will be the minimum between the final mark and the value "4".

--- SECOND CALL

Two different situations:

=> Students that are evaluated using continuous assessment:

Two options to choose (just before the exam begins):

* repeat the written exam included in the continuous assessment planning an be evaluated under the "Students who choose continuous assessment" conditions, described above.

* be evaluated with the same final exam of students who choose for exam-only assessment, under the "Students who choose for exam-only assessment" evaluation conditions, described above. No other activities are considered.

=> Students who choose for exam-only assessment:

A final examination will be provided to students who do not opt for the continuous assessment, and are evaluated under the "Students who choose for exam-only assessment" conditions, described above. No other activities are considered.

Sources of information
Basic Bibliography
Jeremy Gibson, **Introduction to Game Design, Prototyping, and Development (Game Design and Development)**, Ed. 1, Addison Wesley, 2014
Fletcher Dunn, Ian Parberry, **3D Math Primer for Graphics and Game Development**, Ed. 2, A K Peters/CRC Press, 2011
Unity, **Unity web: API description, tutorials and more. (https://unity3d.com)**,
Complementary Bibliography
Jason Gregory (Editor), **Game Engine Architecture**, Ed. 2, A K Peters/CRC Press, 2014
Durant R. Begault, **3-D sound for virtual reality and multimedia (https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20010044352.pdf)**, Ed. 1, 1994
Eric Lengyel, **Mathematics for 3D Game Programming and Computer Graphics**, Ed. 2, Course Technology, 2011
Guy Somberg, **Game Audio Programming: Principles and Practices**, Ed. 1, CRC Press, 2016
Steven M. LaValle, **Virtual Reality (http://vr.cs.uiuc.edu/vrbooka4.pdf)**, Ed. 1, University of Illinois, 2017
Robert Nystrom, **Game Programming Patterns (http://gameprogrammingpatterns.com/contents.html)**, Ed. 1, 2014
Dieter Schmalstieg, Tobias Hollerer, **Augmented Reality: Principles and Practice (Usability)**, Ed. 1, Addison-Wesley Professional, 2016

Recommendations

Subjects that are recommended to be taken simultaneously

Image processing and analysis/V05G300V01931
Audiovisual production/V05G300V01935

Subjects that it is recommended to have taken before

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

Other comments

There will be group work sessions on Wednesday mornings, alternating between the Campus of Vigo and Pontevedra. The University will provide free round trip transportation from the Escola de Enxeñaría de Telecomunicación or the Facultad de Ciencias Sociais e a Comunicación, respectively.

Multidisciplinary groups will be formed by students of the following three subjects: (1) Video Games: design and development, 4th year, Degree in Audiovisual Communication. (2) Multimedia Technology and Computer graphics, 4th year, Degree in Telecommunication Engineering Technologies, Sound and Image module. (3) Intelligent systems programming, 4th year, Degree in Telecommunication Engineering Technologies, Telematics module. The activity is coordinated by teachers of the Teaching Innovation Group: ComTecArt (Communication, Technology and Art in Virtual Environments).

Contingency plan

Description

* If circumstances force online teaching in A, B and C groups
Sessions will take place in a syncronous way using the Campus Remoto platform of Universidade de Vigo.

* If circumstances force online evaluation
The written exam will take place in a synchronous way, either by delivering a scanned copy of the student□s answers or using an oral exam. The rest of the assessment tasks will be managed online too.
The Campus Remoto platform of Universidade de Vigo will be used.

IDENTIFYING DATA				
Advanced acoustics				
Subject	Advanced acoustics			
Code	V05G300V01933			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Sobreira Seoane, Manuel Ángel			
Lecturers	García Lomba, Guillermo Sobreira Seoane, Manuel Ángel			
E-mail	msobre@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this subject, the use of advanced calculation methods in Acoustics are introduced. The Finite Element Method (FEM) and the Boundary Element Method (BEM) are applied to study problems of acoustic radiation, diffraction and modal analysis (calculation of mode shapes and resonance frequencies). Statistical Analysis Methods (SEA) are also introduced and applied to the calculation of flanking transmission in buildings.			

Competencies	
Code	
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.
CE75	(CE75/OP18) The ability to elaborate noise maps and their geographical information display.
CE76	(CE76/OP19) The ability to apply numerical methods in acoustical problem solving.
CE77	(CE77/OP20) The ability to indentify industrial noise problems and to design appropriate control solutions.

Learning outcomes	Competences	
Knowledge on the application of numerical methods in acoustics.	CG2	CE75
Knowledge on the application of calculation models of sound transmission in structures.	CG5	CE76
Knowledge on design techniques of mufflers.	CG7	CE77
Capacity for understanding the results of complex acoustic measures and relate them with the calculations obtained by means of simulations.		
Knowledge of noise control measures in industrial environments.		

Contents	
Topic	
Introduction.	Review of acoustic concepts: impedance, boundary conditions, Helmholtz and Euler equations.
The Finite Elements Method in Acoustics (FEM)	Theoretical introduction to the Finite Element Method. Radiation Problems with FEM. Diffraction Problems. Modal analysis with FEM: resonance frequencies and modes
The Boundary Element Method in Acoustics (BEM)	Introduction to the Boundary Element Method in Acoustics. Integral equation of Kirchhoff Helmholtz. Application to radiation and diffraction problems. The calculation of resonances in BEM.
Calculation methods based in S.E.A. Calculation of sound transmission in buildings.	Building Acoustics: acoustic insulation in buildings and determination of the flanking transmission. Calculation method of the international standard ISO 12354.
Other calculation methods.	Ray tracing and application to evaluation of sound propagation outdoors. Prediction of noise levels in industrial plants. Noise control.

Planning

	Class hours	Hours outside the classroom	Total hours
Mentored work	6	24	30
Practices through ICT	12	9	21
Previous studies	0	15	15
Lecturing	19	38	57
Problem and/or exercise solving	2	8	10
Essay	2	10	12
Report of practices, practicum and external practices	1	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
Mentored work	The student have develop two projects and deliver the corresponding reports for evaluation. Through this methodology the general competencies CG2, CG5, CG7 and the specific competency CE77 are developed. Transversal competencies as CT3 and CT4 are also developed.
Practices through ICT	The student will work with different software packages to apply the different calculation methods presented un the subject. 1. CAD and mesh generation: FreeCAD and Gmsh. 2. Finite Element calculations : COMSOL. 3. Boundary Element calculations: OpenBEM. 4. Calculations in building acoustics. Through this methodology the specific competencies CE 75, CE67 and CE77 are developed
Previous studies	The students must study and prepare with the sources of information given before the lectures and the practical sessions. Through this methodology the general competencies CG2, CG5, CG7 and the specific competencies CE75, CE76 and CE77 are developed.
Lecturing	Lectures will be given, developing the main theoretical concepts of the subject. Through this methodology the general competencies CG2, CG5, CG7 and the specific competencies CE75, CE76 and CE77 are developed.

Personalized assistance

Methodologies	Description
Lecturing	Lectures are developed within a continuous interaction framework, where students can answer questions delivered by the teacher. They could also solve their particular doubts during the sessions.
Mentored work	Tutored works are developed in small working groups. The works are followed during meetings between the groups and the teacher. In those meetings the students can interact and ask their questions to the teacher.
Practices through ICT	In practical sessions, each student must solve his/her own tasks. The teacher will be available during the session to solve any problem/question or doubt the student may have.

Assessment

	Description	Qualification	Evaluated Competencess	
Mentored work	Tutored practical project, with the delivery of a final report. The learning aims related to the ability to elaborate projects and application of calculation methods (numerical methods) are assessed. Learning aims related to the identification of problems are also assessed (through the application of numerical calculations).	50	CG2 CG5 CG7	CE75 CE77
Problem and/or exercise solving	Written test, with short questions on the theory of the subject. Evaluation of learning aims involving knowledge of legislation and how to perform measurements.	25	CG2 CG5	
Essay	Questions and report of the practical tasks. Evaluation of those learning aims related to noise measurement and analysis of acoustic problems using numerical calculations.	25	CG5 CG7	CE76 CE77

Other comments on the Evaluation

Following the guidelines of the degree, two systems of evaluation are offered: continuous assessment (recommended) and a final examination. Evaluation with only a final examination will be only allowed in situations in which it is imposible to follow the recommended system .

LANGUAGE: Any student can choose which language will use during the assessment process (English, Spanish).

CONTINUOUS ASSESSMENT:

In order to be qualified following the continuous assessment process, the student will have to assist at least to the 80% of the programmed activities. The continuous assessment will be carried out by using the methodologies/tests previously described. Once a student has signed a document of agreement with the process of continuous assessment, he/she will enrolled in the continuous assesment process and in no case he/she will be assesed as "not shown up".

- The short answer test will be done in some of the last weeks of the semester, in the dates approved and published by the academic committee of the degree (CAG).
- Tutored works will be developed in small groups. The final grade will be weighted taking into account the results of a cross assesment survey. To consider as "satisfactory" the contribution of each student to the group a minimum grade of 2 over 5 points is stablished.
- The students have to shown good skills in all the assesed learning aims (at least 4 over 10 points in each learning aim assesed).

The final mark will be obtained through the addition of the marks obtained during the process with the weights given before. At least five over ten points should be obtained to pass the subject. If it happens that the minimum requirement (4 over 10 points in all the learming outcomes) is not fullfilled and the weighted average is greater than 5 points, the final mark will be 4 over 10 points.

The final examination for those students following the countinuous assessment process will be similar to the short answer test and will take place in the published official dates. This final examination will be compulsory for students who have not reached the minimum required mark and optional for students willing to get a higher grade. Those students having less than four points in some of the practical tasks should deliver those aditional jobs required by the teachers of the subject prior the date of the final examination.
Second call:

- A student following the continuous evaluation process could choose between:

1. A short answer test examination, similar to the written test of the coutinuous assessment process, to be done in the published official date. The marks obtained in the practical tasks and tutored works during the continuous assessment process are preserved and the final grade will be obtained following the same methodology than the described previously. Those students having less than four points in some of the practical tasks should deliver those aditional jobs required by the teachers of the subject prior the date of the final examination.
2. Give up the marks obtained during the continuous assessment process and take the final exam corresponding to the exam-only assessment.

EXAM-ONLY ASSESSMENT:

A final examination is available for those students that for some reason could not follow the continuous evaluation assessment process which will take place in the published official date. The final examination will be designed to guarantee that the students show that all the learning aims have been reached in the same degree as all the students who have followed the continous assessment process. The student should get 5 over 10 points to pass the subject.

The subject is assessed in a 0 to 10 points scale and it is considered "passed" if the final mark is equal or greater than 5.

EXTRAORDINARY CALL:

The same criteria as in case of exam only assessment will be followed for the extraordinary call.

Sources of information

Basic Bibliography

Ciskowski R.D. and Brebbia C.A., **Boundary Element Methods in Acoustics**,

CEN European Standards, **EN 12354-1:2000. Building Acoustics - Estimation of acoustic performance of buildings from the performance of elements - Part 1: Airborne sound insulation between rooms**,

Reddy, J.N., **An introduction to the Finite Element Method,**, 2ª y 3ª ed,

Complementary Bibliography

Johnson C., **Numerical solution of PDE by the finite element method.**,

Quarteroni A, Valli A., **Numerical approximation of partial differential equations**,

Juhl, P.M., **The Boundary Element Method for Sound Field Calculations**,

Recommendations

Subjects that it is recommended to have taken before

Room Acoustics/V05G300V01635
Fundamentals of Acoustics Engineering/V05G300V01531

Contingency plan

Description

In this subject a PREVENTIVE, more than REACTIVE,panning is followed to avoid that in case of exceptional alarm state the planning of the subject is affected.
Besides it is to foresee that, to individual title, some student or any of the professors could see forced to keep in quarantine, well by contagion or by contact with some positive of *COVID. Therefore it proposes :

EDUCATIONAL METHODOLOGIES:

1. It will keep always all the available educational material in the on-line platform of the subject (*FAITIC).
2. The platform *FAITIC will be the mechanism of communication of incidences, so much to particular level like community. In her it will publish , if necessary, a protocol of concrete performance in front of some concrete emergency.
3. It will supply , in case to be necessary, temporary access to a licence *COMSOL so that the students (or some student in particular) can make the practices of remote form in case of confinement/quarantine.

EVALUATION:

The proofs that require *presencialidad (proofs written and presentation of works) will make of on-line form. Anyway, any student affected to individual title by a confinement will have the possibility to make on-line evaluation although it keep the *presencialidad of the proof.

The specific details on dates and methodology of on-line evaluation will publish with *antelación in the platform of *teleenseñanza (*FAITIC).

IDENTIFYING DATA				
Legislation and noise measurement techniques				
Subject	Legislation and noise measurement techniques			
Code	V05G300V01934			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Torres Guijarro, María Soledad			
Lecturers	Torres Guijarro, María Soledad			
E-mail	soledadtorres@uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this subject, the main methods of measurement of environmental noise are discussed. The European an national regulations on noise and acoustic insulation are also presented. As part of the measurement process, a guide for the evaluation of the measurement uncertainty in acoustics is also presented. The teaching will be in English.			

Competencies	
Code	
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.
CE78	(CE78/OP21) The ability to write essays on environmental, construction and automation acoustics.
CE79	(CE79/OP22) The ability to elaborate specific acoustic essay procedures.

Learning outcomes		
Learning outcomes		Competences
Knowledge of the regulations on the field of acoustic engineering.	CG2	
Knowledge of the usual international standards on acoustic measurements.	CG2	
Ability to write technical and reports, measurement reports on fields related to acoustic engineering.	CG5 CG7 CG8	
Ability to design measurement procedures matching the regulations and standard specifications.		CE78 CE79

Contents	
Topic	
Introduction: noise, its description and annoyance.	Classification of noise and descriptors. The assessment of noise. General overview of measurements in acoustics. Nose levels, vehicle noise: pass by measurements, sound power determination.
Description and measurement of environmental noise	Characterization of the noise sources. Influence of the propagation conditions. Noise measurements.
Environmental noise regulations in Europe.	The EU Environmental Noise Directive. Directive 2002/49/EC of the European Parliament and of the Council of 25th June 2002 relating to the assessment and management of environmental noise. National noise regulations.
Acoustic Insulation, description and regulations in Europe.	Acoustic insulation, descriptors. National Code Buildings in Europe, and the regulations on acoustic insulation.

Measurement uncertainty.	The need to assess the measurement uncertainty: quality management in laboratories. The guide for expression of uncertainty in measurement- GUM. Measurement Uncertainty in Acoustics.

Planning			
	Class hours	Hours outside the classroom	Total hours
Mentored work	6	24	30
Laboratory practical	12	9	21
Previous studies	0	15	15
Lecturing	19	38	57
Problem and/or exercise solving	2	8	10
Report of practices, practicum and external practices	2	10	12
Essay	1	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
Mentored work	The student has to develop in group and write a report on two projects: 1. Procedure to describe and assess environmental noise un a real scenario. 2. Project of acoustic insulation according to the simplified method described in the CTE-DB HR (Spanish Building Code, document for protection against noise). Through this methodology the competencies CG2, CG5, CG7, CG8, CE78, CE79 are developed.
Laboratory practical	Laboratory practises in group on: 1. Characterization and assessment of noise annoyance. Spatial and temporal sampling. 2. Measurement of vehicle pas-by noise. 3. Measurement of acoustic insulation in buildings. 4. Uncertainty budget of the measurements made in the practical session 3. 5. Estimation of uncertainties by the Monte Carlo method. Through this methodology the competencies CG2, CG5, CG7, CG8, CE78, CE79 are developed.
Previous studies	The students must individually study and prepare with the sources of information given before the lectures and the practical sessions. Through this methodology the competencies CG2, CG5, CG8, CE78, CE79 are developed.
Lecturing	Lectures will be given, developing the main concepts of the subject. Through this methodology the competencies CG2, CG5, CG7, CG8, CE78, CE79 are developed.

Personalized assistance	
Methodologies	**Description**
Lecturing	Doubts can be solved in the rests of the classes and in the teacher tutorial sesions. These tutorial sessions will be done individually or in short groups (with a maximum of 2-3 students). The tutorial sessions are typically agreed with the professor. The meetng requests can be done personally or by email. The tutorial sessions are preferably done in the schedules and place officially reserved for them.
Mentored work	The projects have its own classes of C group in which the students of each team consult their doubts about the project and the professor is with them helping to define the project and giving them support for the development of their particular project. They are classes with a very pleasant interaction.
Laboratory practical	In the classes of practices is a good moment to consult doubts with the professor. The professor moves between the tables and some students take advantage of the proximity of the professor to consult doubts of the own class or punctual doubts of other classes.
Tests	**Description**
Problem and/or exercise solving	The doubts, questions and discussions on topics related to the subject can be carried out in tutoring sessions which can be attended either individually or in small groups (maximum 3 students) Previous appointment with the professor is needed. The appointment will be requested and agreed by email, preferably in the hours and places previously scheduled and officially published.
Report of practices, practicum and external practices	The doubts, questions and discussions on topics related to the subject can be carried out in tutoring sessions which can be attended either individually or in small groups (maximum 3 students) Previous appointment with the professor is needed. The appointment will be requested and agreed by email, preferably in the hours and places previously scheduled and officially published.

Essay	The doubts, questions and discussions on topics related to the subject can be carried out in tutoring sessions which can be attended either individually or in small groups (maximum 3 students) Previous appointment with the professor is needed. The appointment will be requested and agreed by email, preferably in the hours and places previously scheduled and officially published.

Assessment

	Description	Qualification	Evaluated Competencess	
Mentored work	Tutored practical project, with the delivery of a final report and oral presentation of results. The individual grade of group work is obtained as the weighted sum of: 1) the common grade of the group (60%); 2) The individual grade (40%), obtained from one or more of the following assessment methods: peer assessment by the other members of the group, oral questions during presentations of the work, written questions about the content of the work.	30	CG2 CG5 CG7 CG8	CE78 CE79
Problem and/or exercise solving	Written test, with short questions on the theory of the subject.	40	CG2 CG5 CG7	CE78 CE79
Report of practices, practicum and external practices	Questions and report of the practical tasks.	30	CG2 CG5 CG7	CE78 CE79

Other comments on the Evaluation

TEACHING LANGUAGE: English

ASSESSMENT LANGUAGE: The student can choose to do the written test in English or Spanish.

Following the guidelines of the degree, two systems of evaluation are offered: CONTINUOUS ASSESSMENT (recommended) and EXAM-ONLY ASSESSMENT. Exam-only assessment will be only allowed in situations in which it is imposible to follow the recommended system.

In case of detection of plagiarism in any of the tests (short tests, reports of the laboratory practices, reports of the directed works or final exam), the final grade will be of FAIL (0) and the fact will be communicated to the Centre Management for the opportune effects.

FIRST CALL

A) CONTINUOUS ASSESSMENT:

The continuous assessment will be based in the evaluation of practical task, projects and two tests. Once a student has signed a document of agreement with the process of continuous assessment, it will be understood that the student has submitted to the call, and the final degree will be obtained by the application of the criteria described bellow, regardless of whether or not the final exam is taken.

The subject is assessed in a 0 to 10 points scale and is considered "passed" if each activity is graded equal or greater than 4, and the final grade obtained is equal or greater than 5. The final grade with be obtained from the weighted sum of the grade obtained in the following tasks with the given weights. If in anyof the activities the grade does not reach 4 but the average exceeds 5, thefinal grade will be 4.

Types and weights of the activities:

1. Tutored works: 30 % of the final grade. Two reports will be delivered: the first halfway through the term and the second at the end. The individualized part of the assessment will be done through cross-evaluation, oral questions during presentations, and written exam questions.
2. Reports of practical tasks (Weight: 40 %).
3. Short answer tests: A short answer test is included in the process of continuous assessment, at the end of the term, with a weight of 40% on the final grade.

B) EXAM-ONLY ASSESSMENT

A final examination is available for those students that for some reason could not follow the continuous evaluation assessment process. In this case the final examination will consist in a short answer test, and some additional questions

related with the practical tasks and projects.The subject is assessed in a 0 to 10 points scale and it is considered "passed" if the final grade obtained is equal or greater than 5.

SECOND CALL

There is scheduled date for a final examination retake, for those students that either dropped out during the semester or failed. Prior the examination, a student can choose to follow the continuous assessment or the exam-only assessment. In the former selection, the grades obtained in the projects and practical tasks will be taken into account and the student will only answer to the short answer test. If the later, the student will have also to answer a full examination as described before.

END-OF-PROGRAM CALL

The exam will consist of a short answer test. This final exam will be rated between 0 and 10 points. It includes all the topics of the course. To pass, at least five points are needed. No other activity is valued.

Sources of information

Basic Bibliography

DIRECTIVE 2002/49/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 June 2002 relating to the assessment and management of environmental noise,

ISO Standard, **ISO 1996-1. Acoustics -- Description, measurement and assessment of environmental noise -- Part 1: Basic quantities and assessment procedures**,

ISO Standard, **ISO 1996-2. Acoustics -- Description, measurement and assessment of environmental noise -- Part 2: Determination of environmental noise levels**,

UNE EN ISO 11819-1:2002 Measurement of the influence of road surfaces on traffic noise Part 1 Statistical pass-by method,

ISO 16283-1 (2014). Acoustics Field measurement of sound insulation in buildings and of building elements,

Ley 37/2003 del Ruido,

Real Decreto 1367/2007,

Decreto 106_2015 sobre contaminación acústica de Galicia,

Documento Básico de protección frente al ruido del Código Técnico de la Edificación,

ISO 717- 1 (2013) Acoustics Rating of sound insulation in buildings and of building elements, Part 1 Airborne sound insulation,

ISO IEC Guide 98-3 Guide to the expression of uncertainty in measurement, GUM (1995),

ISO 12999-1-(2014) Uncertainties in building acoustics,

A Beginners Guide to Uncertainty of Measurement (1999), National Physical Laboratory (NPL),

Estimating Uncertainties in Testing (2001), National Physical Laboratory (NPL),

Sonometer uncertainty (2004), National Physical Laboratory (NPL),

Complementary Bibliography

RODRIGO AVILÉS LÓPEZ, ROCÍO PERERA MARTÍN, **Manual de acústica ambiental y arquitectónica**, Paraninfo, 2017

Recommendations

Subjects that it is recommended to have taken before

Room Acoustics/V05G300V01635
Fundamentals of Acoustics Engineering/V05G300V01531
Sound Processing/V05G300V01634

Contingency plan

Description

=== ADAPTATION OF THE METHODOLOGIES ===
In the event that face-to-face activities are suspended at the University of Vigo, its continuation will be carried out as follows:
* Group A teaching: Master sessions will be done through the remote campus, recording the sessions so that they can be followed non-synchronously.
* Group B teaching: Group B practices will be adapted, as far as possible, so that students can do them individually at home. Their schedule will also be adapted so that students can use the measurement equipment in turns.
* Group C teaching: Group C projects will be adapted, as far as possible, so that students can carry them out at home. Their schedule will also be adapted so that students can use the measurement equipment in turns.
* Assessment: The assessment will be carried out on the scheduled dates, using the Remote Campus for supervision and resolution of doubts, and Fatic for delivery of questions and collection of test solutions.

IDENTIFYING DATA				
Audiovisual production				
Subject	Audiovisual production			
Code	V05G300V01935			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Fernández Santiago, Luis Emilio			
Lecturers	Fernández Santiago, Luis Emilio			
E-mail	faraon@uvigo.es			
Web	http://faitic.uvigo.es			
General description	General knowledge of the processes of production and realization of Audio and video, aim to achieve the skills needed to work in a team of production/realization, mainly in the technical positions. using cameras, edition systems and creation of CG content. The documentation will be in English			

Competencies	
Code	
CG4	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.
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.
CG12	CG12 The development of discussion ability about technical subjects
CE80	(CE80/OP23) The ability to conceptually and technically manage the phases in an audiovisual production.
CE81	(CE81/OP24) The ability to creatively and skillfully use the technical equipment for production development.
CE82	(CE82/OP25) The ability to use specific software applications in audiovisual production.
CE83	(CE83/OP26) The ability to organize an audiovisual production.
CT2	CT2 Understanding Engineering within a framework of sustainable development.

Learning outcomes	Competences		
Know the stages and the techniques of an Audiovisual production.	CG4 CG8 CG12	CE80	
Identify the various audiovisual structures.		CE80	
Know use the necessary technologies to develop an audiovisual production.	CG4 CG12	CE80 CE81 CE82	CT2
Know use of the postproduction software tools.		CE81 CE82	
Know how to manage an audiovisual project.	CG8	CE80 CE81 CE83	CT2

Contents	
Topic	
The audiovisual production: characteristic and production and realization workflow.	Workflow for Vfx, 3DCGI and interactive. Pipelines. Production charts.
Creation of contents and catchment of sound and image.	Basics of video cameras handling. Basics os Audio for film.
Audiovisual structures, linear and interactive.	The script as a technical document. Technical breakdown.
Computer Generated Image.	Producción assets (geometry, shaders, animation) Graphic and render Engines.
Virtual enviroments: elements and creation of the levels.	Layouts, terrains, lighting.

Postproduction systems.	NLE. Basics of Video composicion: Layers and channels. Color, grading and Conform.
Production and realization techniques.	Audiovisual language basics.
Audiovisual projects Management.	Gestion of media, data and control of a production. Pipelines And Workflows.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	21	21	42
Problem solving	7	7	14
Mentored work	2	12	14
Laboratory practical	14	35	49
Laboratory practice	14	14	28
Objective questions exam	2	0	2
Report of practices, practicum and external practices	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Theoretical sessions on concepts of visual language, formats, equipment and their use. Elements of linear and interactive visual production, workflows and integration of technical personnel in production teams. CG8 CG12 CE80 CE82 CT2
Problem solving	Common or hypothetical Production situations will be proposed, requesting a solution using methods seen in the subject. CG4 CG12 CE81 CT2
Mentored work	Portions of AV projects will be carried out autonomously and in groups. Both in linear and interactive production. CG8 CE80 CE83
Laboratory practical	Practical classes on obtaining images and sounds, Creation of synthetic elements and postproduction for the creation of audiovisual products. The work is done in work groups, with rotation in the positions to ensure individual contact with the different resources. CG12 CE81 CE82

Personalized assistance	
Methodologies	**Description**
Laboratory practical	Use of audiovisual production equipment and software, question time during workshop, access to office and questions via email or message. Individual report about the contents.
Mentored work	Access to office and questions via email or message.
Tests	**Description**
Laboratory practice	Use of audiovisual production equipment and software, question time during workshop, access to office and questions via email or message. Individual report about the contents.
Objective questions exam	Access to office and questions via email or message before test. Later ofice revision.
Report of practices, practicum and external practices	Report on personal participation in group works. About the whole process regardless of the role played.

Assessment					
	Description	Qualification	Evaluated Competencess		
Laboratory practice	Insertion of elements in graphic engine. (Individual) 20% Recording a scene. (Group)20% Editing a scene. (Individual) 25%	65	CG4	CE81 CE82	CT2

Objective questions exam	Test, theoretical contents and practical concepts of the subject.	20	CG8	CE80 CE81 CE82 CE83	
Report of practices, practicum and external practices	Report on the assessment of the production process in the different cases and conclusions of the practices.	15	CG8 CG12	CE83	CT2

Other comments on the Evaluation

Breakdown of Practices:

Insertion of elements in graphic engine. (Individual) 20% (~ 4 week)Recording a scene. (Group) 20% (~ 18 week)Editing a scene. (Individual) 25% (~ 13 week)

Students must determine in the first delivery of material if they choose continuous assessment, in this case the final grade couldn't be "not presented".

The practices are recoverable until the time of qualification, unless continuous assessmet had been chosen..

In group practices, the work of each member will be supervised by the lecturer.

The eventual assessment requires the delivery of the practices, being the group as individual (the student will need to set up a human team to do this).

On the second call and extraordinary call it will be necessary to pass a test (30% -theoretical contents and practical concepts of the subject) and questions (30% -knowledge of the production process and formats) and A practical exercise of solvency working with autonomous camera and edition NLE O (xor) insertion of elements in graphic engine O (Xor) development of production flow from a technical script. (40%) It is not necessary to exceed a minimum threshold in each grade to pass the course. The note will be the sum of the percentages.

The grade of the test from the first opportunity could be saved for the second, in the same course, if the student wishes so.

Sources of information

Basic Bibliography

Dunlop, Renee, **Production Pipeline Fundamentals for Film and Games**, 1st Edition, Focal Press, 2014

Zwerman, Susan & Okun, Jeffrey A., **The VES Handbook of Visual Effects: Industry Standard VFX Practices and Procedures**, 2nd ed, 2014

MMILLERSON, GERALD. OWENS, JIM, **Television production**,

Complementary Bibliography

ALTEN, STANLEY, **Audio in media**,

TRIBALDOS, CLEMENTE, **Sonido profesional**,

RUMSEY, FRANCIS. MCCORMICK, TIM, **Sonido y grabación; Introducción a las técnicas sonoras**, 2ª edición,

ONDAATJE, MICHEL, **The Conversations: Walter Murch and the Art of Editing Film**,

BRINKMANN, R., **The art and science of digital compositing**, 2nd ed,

HERRERO, JULIO CESAR, **Manual de teoria de la información y telecomunicación**, 2009,

Glor, Flax & Sardella, Andrea, **Filmmaking Simplified: Practical Techniques for Getting More out of Any Production**, Edition: 1, kindle,

Recommendations

Subjects that are recommended to be taken simultaneously

Image processing and analysis/V05G300V01931
Multimedia technology and computer graphics/V05G300V01932

Subjects that it is recommended to have taken before

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

Contingency plan

Description

METHODOLOGIES

Laboratory practical

Practical lectures on obtaining of images and sounds, Creation of synthetic elements and postproduction for the creation of audiovisual products.
If it is not possible to have professional material, the contents will be adapted to creation with devices of common use (smartphones, personal computers...).
The work is done by work groups, with rotation in the positions to ensure individual contact with the different resources.
The tasks that can be developed by on-line groups will remain as they are, the dimension of the groups for face-to-face tasks will adjust to the number determinated by the authorities and, if needed, the capture of images will be individual, advoiding the physical meeting of the group.

EVALUATION

Laboratory practical
Recording of a scene. (Group)20%
The recording of images for the test will be adapted for individual or groups of the size regulated by goverment.

IDENTIFYING DATA				
Multimedia services				
Subject	Multimedia services			
Code	V05G300V01941			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Blanco Fernández, Yolanda			
Lecturers	Blanco Fernández, Yolanda García Méndez, Silvia			
E-mail	yolanda@det.uvigo.es			
Web	http://www.faitic.es			
General description	The aim of this subject is to provide the students with the theoretical foundations and the practical skills that allow them to understand the basic principles of the digital treatment of the multimedia information. To this aim, the main standards in the field of the audiovisual content processing are presented, as well as the mechanisms available for the transmission of data through different types of networks and the different types of services that can be offered to the end user, with special attention to digital terrestrial TV broadcasting (DTTV) and transmission over IP networks (IPTV). The practical part of the subject will allow the students to experiment with the design and development of telematic services based on the transmission of multimedia streams, along with the programming of interactive services about digital television broadcasting and video-on-demand. The documentation of the subject will be available in English. International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
CE84	(CE84/OP27) The ability to apply the techniques based on computer, networks and distributed applications and services, in the broadcasting and interchange of audiovisual information.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Learning outcomes	Competences		
Understand the basic foundations of the digital treatment of the multimedia information.	CG3	CE84	
Know the main standards in the field of the processing of the multimedia information.	CG6		
Understand the foundations and the main mediums adopted in digital TV broadcasting.	CG6	CE84	
Know the basic foundations of the transmission of audiovisual information through telematic networks.	CG3	CE84	CT3
Acquire skills in the design and development of telematic services based on exchanging audiovisual contents.	CG3	CE84	CT3
Acquire skills for the programming of telematic services in the scope of interactive digital television.		CE84	

Contents	
Topic	
1. Multimedia systems: Foundations and basic concepts	a. Digitalization of audio and video signals. b. Format for storage of audio and video signals. c. Conditional access and digital rights management.

2. Terrestrial Digital TV broadcasting	a. Architecture b. Transport of bitstreams c. Signaling d. Middlewares e. Mobile Digital Television
3. IP Television and video-on-demand	a. Architecture b. Data distribution. VoD and nVoD. c. Broadcasting, multicasting and P2P d. Systems and protocols e. Signaling

Planning

	Class hours	Hours outside the classroom	Total hours
Project based learning	6	31	37
Practices through ICT	5	18	23
Practices through ICT	9	20	29
Presentation	1	4	5
Lecturing	20	35	55
Objective questions exam	1	0	1

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

Methodologies

	Description
Project based learning	The students, organized in groups of 2-3 people (as per professor's criteria), will implement the project planned for group classes. The goal is to boost a collective discussion to identify the key points when it comes to developing the functionalities of each project. These methodologies will assess the skills CG3, CG6 and CT3.
Practices through ICT	The professor will propose practices in which the students will deal with the main concepts explained in the subject, putting the focus on the coding formats adopted in the transmission of multimedia information. The doubts arisen during the autonomous work of the students will allow to promote the debate of the group to agree the best solution for each problem. These methodologies will assess the skills CE84 and CG3.
Practices through ICT	The professor will propose practices in which the students will deal with the main concepts explained in the subject, putting the focus on possible applications in the realm of Terrestrial Digital TV and transmission of television over IP. The doubts arisen during the autonomous work of the students will allow to promote the debate of the group to agree the best solution for each problem. These methodologies will assess the skills CE84, CG3 and CG6.
Presentation	The students, organized into groups of 2-3 people (as per professor's criteria), will expose to their mates the main design decision and implementation details of the Project planned for group classes, besides showing how it works. The aim is to argue the advantages and problems of each model, promoting the debate around the proposal of each group. These methodologies will assess the skills CG3, CG6 and CT3.
Lecturing	Classes where the main theoretical concepts of the subject will be explained, by proposing examples and possible application scenarios in the context of the transmission of multimedia streams. These methodologies will assess the skills CG3 and CG6.

Personalized assistance

Methodologies	Description
Lecturing	The professor will address the doubts raised by each student during the public presentation of the contents that will be explained in master sessions.
Project based learning	In the computer room, the professor will carry out a personalized follow-up of the member of each group, with the goal of fixing possible deficiencies and guiding right decisions when facing design and implementation of the project.
Practices through ICT	The personalized attention will be based on following-up the work of each student, by tracking the solutions proposed for each problem proposed in the practices in the computer room.
Practices through ICT	The personalized attention will be based on following-up the work of each student, by tracking the solutions proposed for each problem proposed in the practices in the computer room.

Presentation	The personalized attention will be based on following-up the work of each group, by tracking the solutions proposed for the system developed during type C-teaching.

Assessment

	Description	Qualification	Evaluated Competencess	
Project based learning	The students, organized in groups of 2-3 people (according to the criterion of the professor), will develop a project about Digital TV broadcast or video streaming over IP. This project must include the code and the necessary documentation to justify the main design decisions and implementation details. The mark of each member of the group (up to 2,5 points) will depend on the following criteria: (i) the quality of the documentation related to the part of the project this student has made, and (ii) the relevance and usefulness of the developed functionalities.	30	CG3 CG6	CT3
Practices through ICT	The students, organized in groups of 2 people, will deliver a report in which they will describe the solution proposed for a first practice in B sessions, which will be about the main formats of coding adopted in the transmission of the multimedia information over telematic networks. In case to be necessary, the submission will include the software used in the development of the solution proposed.	15	CG3	CE84
Practices through ICT	The students, organized in groups of 2 people, will deliver a report that describes properly the solution proposed for the second of the practical proposals in B sessions, which will be about Digital TV broadcast. The proposed solutions must include the coding adopted in the development of the practice, as well as a rigorous discussion about design decisions and implementation details.	15	CG3 CG6	CE84
Presentation	The students, organised in groups of 2-3 people (according to the criterion of the professor), will describe the main decisions of design and details of implementation of the project proposed in C sessions. Each member of the group must identify which part of the project has developed, showing its real-time functioning during the presentation. The mark of each member (up to 1,5 points) will depend on the following criteria: (i) the particular level of knowledge about his/her contribution, (ii) its complexity, and (iii) his/her personal performance during the exhibition.	10	CG3 CG6	CT3
Objective questions exam	Each student will take --individually and without material of support-- an exam including multiple-choice tests and short-answer questions, which is aimed at assessing his level of understanding on the theoretical concepts explained in the subject. This exam will be held on the official date approved by the Board of School. Any type of support material is not allowed in this exam.	30	CG3 CG6	

Other comments on the Evaluation

Lessons will be explained in Spanish, although the material about the subject will be available in English.

There exist two mechanisms for the assessment of students in this subject: continuous assessment (CA) and exam-only assessment (EA). Regardless of the considered assessment mechanism, the pass mark for the subject is 5 out of 10.

The students must choose one of the possible mechanisms by bearing in mind the following conditions:

- CA includes the 5 tests described above.
- By the submission of the first B practice, the student makes a commitment to be assessed via CA, thus renouncing the EA mechanism. In virtue of this commitment, the final remark of these students cannot be "Not taken".
- Students who do not submit the first practice renounce to the CA, thus being assessed through the EA mechanism. Note that it will not be possible to join the CA in the next tests.
- The schedule of the midterm/intermediate exams will be approved in the Comisión Académica de Grado (CAG) and will be available at the beginning of each academic semester.
- CA tests will be carried out only in the dates defined by the professors. These CA tests cannot be repeated later.
- The grades obtained in the CA and other exams and practical projects are only valid for the current academic year.
- CA will be just considered in the first call to pass the subject. In the second one and in the extraordinary call only EA will be valid.
- Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the tests or

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

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

- CA tests will be 100% of the final remark of the student. This assessment mechanism consists of five CA tests that have been previously described (a multiple-choice test, two practices during B sessions, delivery of code and documentation of the practical project proposed for group classes, and the presentation of its main design and implementation decisions, including a real-time demo of its functioning). Note that the student makes a commitment to follow-up CA by submitting the first practice of B sessions, thus renouncing the EA mechanism.

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

- A final exam that these students will take in the official date published at http://www.teleco.uvigo.es. This test will include short-answer questions and/or multiple-choice tests, along with problems and practical use cases to be analyzed and resolved. The weight of this exam in the final remark is 50%. Note that support materials are not allowed.
- Submission of a practical project that will include software and documentation to justify design decisions and describe implementation details. The weight of this project in the final remark is 50%. Note that that each student must submit this project individually.

Students who did not pass the subject in the first call, will have **a second call** where they cannot be assessed via CA, so that **only EA is valid**. Therefore, these students must (i) take the final exam (in the official date published at http://www.teleco.uvigo.es) and (ii) submit individually the practical project (in the date published by professors at www.faitic.uvigo.es), as described above for the EA mechanism. The weight of each part in the final remark will be 50%. The same assessment mechanism is valid for the **extraordinary call**.

Sources of information

Basic Bibliography

Wes Simpson, **Video over IP IPTV, Internet video, H.264, P2P, Web TV, and streaming: a complete guide to understanding the technology**, Elsevier, 2008

Frantisek Korbel, **FFmpeg Basics: Multimedia handling with a fast audio and video encoder**, CreateSpace, 2012

Yolanda Blanco Fernández, Martín López Nores, **Construcción de sistemas y servicios VoIP con software de código abierto**, Andavira editora, 2012

Complementary Bibliography

Jan Lee Ozer, **Video Encoding by the Numbers: Eliminate the Guesswork from your Streaming Video**, Doceo Publishing, 2016

José J. Pazos Arias, Carlos Delgado Kloos, Martín López Nores, **Personalization of Interactive Multimedia Services: a research and development perspective**, Nova Science Publishers, 2008

George Lekakos, Konstantinos Chorianopoulos, Georgios Doukidis, **Interactive Digital Television: technologies and applications**, IGI Publishing, 2007

Liliana Ardissono, Alfred Kobsa, Mark Maybury, **Personalized Digital Television: targeting programs to individual viewers**, Kluwer Academic Publishers, 2004

Digital Video Broadcasting Consortium, **DVB Standards**,

Recommendations

Other comments

It is recommended to have taken or to be taking the following subjects of the Telematics-related module:

+ Operating systems
+ Architecture and Technology of Networks
+ Security
+ Concurrent and Distributed Programming
+ Networks and Switching Theory
+ Multimedia Networks

+ Systems of Information
+ Architectures and Telematic Services

Contingency plan

Description

In the case of on-line teaching, the subject will be organized as follows:

- Sessions A: synchronous classes will be carried out weekly through the Remote Campus. The questions posed by the students will be answered by means of (i) FaiTIC forums in order to give greater visibility to the doubts raised from each student, and (ii) virtual tutoring through the Remote Campus, with previous appointment.

- Sessions B: synchronous classes will be carried out weekly through the Remote Campus. The doubts raised from the students will be solved through FaiTIC forums and virtual tutoring.

- Sessions C: virtual sessions will be carried out with each group of students in order to review the functionalities proposed in each project and technologies adopted for the implementation.

The virtual assessment of the subject will consider the conditions described in the "Assessment" section of this document, including the same number of tests and identical weighting. The assessment process will be organized as follows:

- Sessions A: the theoretical tests (both in continuous as in single assessment) will be carried out virtually on the dates approved by the Centre, using the tools provided by the University of Vigo.

- Sessions B: the practices proposed during the B sessions will be reviewed and assessed through virtual sessions in the Remote Campus.

- Sessions C: the final presentation of the project, including design, details of implementation and operation proof will be carried out virtually through the tools provided by the University of Vigo.

IDENTIFYING DATA				
Wireless and mobile networks				
Subject	Wireless and mobile networks			
Code	V05G300V01942			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	López Bravo, Cristina			
Lecturers	Fondo Ferreiro, Pablo López Bravo, Cristina			
E-mail	clbravo@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The subject "Wireless and Mobile Networks" (redes sen fíos e móbiles) examines the area of wireless and mobile networks, one of the technological basis of the present society, studying the existing challenges for the communications protocols, and looks at the opportunities that provides continuous connectivity even in movement. The focus of this subject will be on network protocols above physical layer (nevertheless, it will touch the most important physical layer properties). The documentation will be available in english. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG9	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.
CE85	(CE85/OP28) The ability to analyze, plan and deploy wireless communication networks for different coverage ranges: metropolitan, local and short range.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	Competences		
Understand the main concepts of wireless communications.	CG3	CE85	CT2 CT3
Understand the main concepts of mobile communications.	CG3	CE85	CT2 CT3
Know the main protocols used in wireless communication networks.	CG3	CE85	CT2 CT3
Know the architectures used in wireless communication networks.	CG3	CE85	CT2 CT3
Ability to design mobile wireless networks.	CG4 CG9	CE85	CT2 CT3 CT4

Contents	
Topic	
Introduction to wireless communications	Channel characteristics Multiple access Modulation
Principles of operation of wireless networks	Mobility management Introduction to ubiquitous computing Ad hoc networks, routing Security Network topologies
Wide area networks	Architecture Mobile networks Network topologies Case study
Local networks	Architecture: ad hoc and infrastructure based networks User authentication approaches Security Case study
Low range networks	Architecture Bandwidth/power consumption balance Personal communication Industrial communication

Planning	Class hours	Hours outside the classroom	Total hours
Lecturing	19	38	57
Mentored work	6	28	34
Laboratory practical	13	39	52
Report of practices, practicum and external practices	0	3	3
Systematic observation	1	0	1
Essay	1	0	1
Problem and/or exercise solving	2	0	2
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	Description
Lecturing	Professors present the main theoretical contents related to wireless and mobile networks. Through this methodology the competencies CG3 and CE85 are developed.
Mentored work	Team development of the design, implementation and validation of a protocol, system, application or service. Through this methodology the competencies CG3, CG4, CG9, CE85, CT2, CT3 and CT4 are developed.
Laboratory practical	Students will complete guided and supervised practices. Through this methodology the competencies CG3, CG4 and CE85 are developed.

Personalized assistance	
Methodologies	**Description**
Lecturing	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered during the master sessions or during tutorial sessions. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website. Tutorial sessions could also be agreed by appointment.
Mentored work	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered during the supervising sessions or during tutorial sessions. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website. Tutorial sessions could also be agreed by appointment.
Laboratory practical	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered during the lab sessions or during tutorial sessions. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website. Tutorial sessions could also be agreed by appointment.

Assessment

	Description	Qualification	Evaluated Competencess		
Lecturing	Students will be individually evaluated to asses what they have learned in master sessions. Two exams will be done: one at the middle of the term, and one at the end.	30	CG3	CE85	
Mentored work	Students will be divided in groups to complete the design, implementation and validation of a protocol, a system, an application or service. The result will be evaluated after the delivery, having into account key aspects such as the correction, the quality, the performance and the functionalities. In addition, during the implementation of the works, the design and the evolution of the development will be evaluated. The evaluation will be by group and by person: each one of the members of a team must document his/her tasks and answer the questions related to them.	50	CG3 CG4 CG9	CE85	CT2 CT3 CT4
Laboratory practical	Students will fill lab reports, individually, to asses the correct realization and understanding of the laboratory tasks.	20	CG3 CG4	CE85	

Other comments on the Evaluation

In order to pass the course it is necessary to complete the different parts of the course (master sessions, practices in labs, and tutored works). The final grade will be the **weighted geometric mean** of the grades of the different parts (i.e. it is not possible to pass the subject with a zero in one part). If "x" is the grade obtained for the master sessions, "y" for the practices in labs, and "z" for the tutored works, the final grade will be FG = x^0.3*y^0.2*z^0.5.

During the first month, students must declare if they opt for continuous or eventual assessment. Students who select continuous assessment and submit the first task or lab report may not be listed as "Not Present".

Students that opt by the eventual assessment procedure, must submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the tutored work. In addition, during the first month of the course, professors will notify students if they have to do the tutored work individually, in the case they opt for unique assessment.

Second call and extraordinary calls

The assessment system will be the same as the eventual assessment of the first call.

Students that have opted by the continuous assessment procedure, can decide to maintain the grades of the parts they have already passed in the first call or discard them.

Other comments

The documentation will be in English. The course will be tough in Spanish and Galician (including exams). However students will be able to answer in English, Spanish or Galician, as they prefer.

The grades obtained are only valid for the current academic year.

Although the tutored work will be completed (if possible) in groups, the performance of each student in his or her group will be analyzed continuously

Although the tutored work will be completed (if possible) in groups, the performance of each student in his or her group will be monitored continuously. In the case in which the performance of a member of the group wouldn't be adequate compared with the performance of his or her team mates, he or she could be excluded from the group and/or qualified individually.

The use of any material during the tests will have to be explicitly authorized.

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

Sources of information

Basic Bibliography

Coty Beard, William Stallings, **Wireless communication networks and systems**, 1, Pearson Education, 2013

Viajy Garg, **Wireless Communications and Networking**, 1, Morgan Kaufmann-Elsevier, 2007

Pei Zheng, Larry L. Peterson, Bruce S. Davie, Adrian Farre, **Wireless Networking Complete**, 1, Morgan Kaufmann-Elsevier, 2010

Kaveh Pahlavan, Prashant Krishnamurthy, **Networking Fundamentals: Wide, Local and Personal Area Communications**, 1, Wiley and Sons, 2009

Kevin Townsend, Carles Cufí, Akiba, Robert Davidson, **Getting started with Bluetooth Low Energy**, 1, O'Reilly, 2014

Complementary Bibliography

James F. Kurose, Keith W. Ross, **Computer Networking: A Top-Down Approach**, 7, Pearson Education, 2017

Recommendations

Subjects that it is recommended to have taken before

Data Networks: Technology and Architecture/V05G300V01542

Contingency plan

Description

In case of online tuition, the methodologies used and the tests performed will be the same as in the case of in-person tuition. The only expected modification is that they will be carried out via Remote Camnpus and Faitic, instead of the School classrooms and laboratories.

ADITIONAL REFERENCES

- Prof. Dr. Otto Spaniol, RWTH Aachen University (Mobile Communications Slides): http://www.nets.rwth-aachen.de/content/teaching/lectures/sub/mobil/WS07-08/
- Technical Overview of IEEE 802.11 WLAN Standards: http://cp.literature.agilent.com/litweb/pdf/5990-9697EN.pdf
- Wi-Fi Alliance: http://www.wi-fi.org/
- Bluetooth Specifications: https://www.bluetooth.com/specifications
- Bluetooth Technology: https://www.bluetooth.com/develop-with-bluetooth/developer-resources-tools/developer-training-videos
- Bluetooth mesh networking: https://www.bluetooth.com/blog/introducing-bluetooth-mesh-networking/
- ZigBee Alliance: http://www.zigbee.org
- Ramón Agustí, Francisco Bernardo, Fernando Casadevall, Ramón Ferrús, Jordi Pérez-Romero, Oril Sallent, LTE: Nuevas tendencias en comunicaciones móviles, Fundación Vodafone España, 2010. http://www.vodafone.es/static/fichero/pre_ucm_mgmt_002620.pdf

IDENTIFYING DATA

Intelligent systems programming

Subject	Intelligent systems programming			
Code	V05G300V01943			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Burguillo Rial, Juan Carlos			
Lecturers	Burguillo Rial, Juan Carlos Costa Montenegro, Enrique García Méndez, Silvia			
E-mail	jrial@uvigo.es			
Web	http://http://faitic.uvigo.es			
General description	Technologies related to artificial intelligence, machine learning and intelligent distributed systems (e.g. on the Internet of Things) have significantly impacted the labor market in the past decade. In this course we will address these concepts, starting with the notion of agent, to understand what it is, how to build it and how these agents can interact to model and solve complex problems giving rise to multi-agent systems. In the second part of the course, concepts of game theory and self-organized systems will be introduced. Finally, in the last part of the course, classic artificial intelligence techniques will be reviewed, the basic concepts of machine learning, deep learning; as well as the current platforms/libraries that facilitate its design and development. As part of the practices of the subject, students will learn to program intelligent systems, using classic artificial intelligence techniques and machine learning libraries. They will also carry out a common work, in a group, where they will extend what they have learned in class to topics of their personal interest and developed on Android mobile terminals. This course will be taught in English. However, students have the possibility to interact with teachers in Spanish or Galician if necessary. All the documentation for the course will be in English.			

Competencies

Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG9	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.
CE86	(CE86/OP29) The ability to program computer applications and services based on artificial intelligence.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes

Learning outcomes	Competences		
To understand the basic concepts of intelligent systems: search, reasoning and learning.	CG3 CG4 CG9		CT2 CT3 CT4
To know the main concepts related with intelligent agents and multiagent systems.	CG3	CE86	CT2 CT3
To understand the basic concepts of software engineering in intelligent systems.	CG3	CE86	
To achieve a suitable level of expertise in the use of IDEs for programming intelligent systems.		CE86	CT2

To acquire skills in the design and development of intelligent services applied to electronic devices.	CE86	CT2 CT3 CT4
To acquire skills for the application of intelligent systems in complex telematic services.	CE86	CT2 CT3 CT4

Contents	
Topic	
Introduction to Intelligent Systems	a) Searching b) Reasoning c) Learning
Intelligent Agents	a) Defining an intelligent agent b) Architectures for intelligent agents c) Learning and adaptability
Multiagent Systems	a) Distributed Artificial Intelligence and multiagent systems b) Communication between agents: KQML, FIPA-ACL c) Coordination and protocols of interaction d) Mobile agents
Agent-oriented Software Engineering	a) Programming and methodologies oriented to agents b) Agents vs. Objects c) Agents vs. Expert Systems d) The JADE development platform
Multiagent Systems and Game Theory	a) Cooperation vs. Competition b) Negotiation c) Auctions d) Electronic Commerce
Multiagent Systems and Self-organization	a) Defining a self-organized system b) The concept of emergence
Learning in Intelligent Systems	a) Machine Learning techniques b) Reinforcement Learning c) Neural Networks d) Deep Learning

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	0	2
Lecturing	16	32	48
Laboratory practical	14	42	56
Debate	2	0	2
Discussion Forum	0	2	2
Mentored work	7	28	35
Objective questions exam	1	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	We start doing a generic introduction to the aims, and the global contents of the subject together with the results expected at the end of the course. This activity will be performed individually.
Lecturing	We describe the different topics of the subject providing the necessary educational material. Through this methodology the competencies CG3, CG4, CT2, CT3 and CT4 are developed. This activity will be performed individually.
Laboratory practical	Every student must perform practical tasks in the laboratory to understand better the contents explained along the master lessons. Through this methodology the competencies CG3, CG4, CG9, CE86, CT2 and CT3 are developed. This activity will be performed individually.
Debate	In the classes there will be open discussion, among groups of students, in order to focus on a topic of subject content, the analysis of a case, the outcome of a project, exercise or problem previously developed a keynote address. Through this methodology the competencies CG3, CG4, CG9, CE86, CT2, CT3 and CT4 are developed. This activity will be performed individually.

Discussion Forum	The students must perform some activities within the TEMA platform at FAITIC in order to discuss topics related to the subject. Through this methodology the competencies CG3, CE86, CT2, CT3 and CT4 are developed. This activity will be performed individually.
Mentored work	The students must perform a project in group, with the support of the professor, to extend and personalize the topics seen along the theoretical and practical classes. At the same time, we will try that the students perform such project demos using Android terminals. Through this methodology the competencies CG3, CG4, CG9, CE86, CT2, CT3 and CT4 are developed.

Personalized assistance

Methodologies	Description
Lecturing	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.
Mentored work	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.
Laboratory practical	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.
Debate	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.
Discussion Forum	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.

Assessment

	Description	Qualification	Evaluated Competencess		
Laboratory practical	The students will perform a practical task in the laboratory, where they will work with the concepts studied in the theoretical classes.	35	CG3 CG4 CG9	CE86	CT2 CT3
Debate	Discussions done along classes related with expositions done or read previously.	5	CG3 CG4 CG9	CE86	CT2 CT3 CT4
Discussion Forum	Short answers and interaction done individually by students within the TEMA platform to discuss topics related with the subject.	5	CG3	CE86	CT2 CT3 CT4
Mentored work	Evaluation of the works developed: understanding, maturity, importance and originality of the work and interaction between the group.	25	CG3 CG4 CG9	CE86	CT2 CT3 CT4
Objective questions exam	Three successive tests to evaluate the contents given up to that time in the course. The tests will be individual and with time limit.	30	CG3 CG4	CE86	

Other comments on the Evaluation

The elements that are part of the evaluation of the subject are the following:

- **Questionnaires**: along the course the student will fill 3 questionnaires that will contribute 10% to the final mark (each one).

- **Laboratory practice**: each student will have to perform a set of practical tasks in the laboratory that will contribute 35% to the final mark.

- **Group tutored work**: each student will have to do a work in group, about one among several possible topics, that will contribute 25% (20% work done + 5% presentation) to the final mark shared by all group members. Nevertheless, the teachers will follow the work done by every group member, and they will also perform a peer review of the work done. In the case that a student would perform clearly lower than his/her mates, he/she will be rated individually (see note*).

- **Class participation**: students will discuss in class about expositions done by the professor, and this contributes up to a 5% to the final mark.
- **Forum participation**: students should interact individually in the forum of the subject to achieve up to a 5% to the final mark. To achieve such percentage the student should provide at least two relevant contributions.

Therefore, we have: Final Mark = Questionnaires (3*x10% = 30%) + Lab. practice (35%) + Tutored work (25%) + Class participation (5%) + Forum (5%) = 100%.

The students need to pass the questionnaires, the practical task and the tutored work with at least 4 points over 10 to calculate the average final mark. If any of the marks is below 4, then the final mark will never be higher than 4 points over 10.

The schedule of the midterm/intermediate exams will be approved in the Comisión Académica de Grado (CAG) and will be available at the beginning of each academic semester.

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

Following the degree guidelines, the students that will follow this subject can choose between two possibilities: continuous assessment and eventual assessment at the end of the semester.

Continuous assessment: the student follows the continuous assessment since the moment he/she fulfills two questionnaires. From that moment we assume that he/she will participate in the subject, independently of the participation in the extraordinary call.

First Call: if the continuous assessment is not performed, then the student will have to perform a final exam that substitutes the questionnaires done along the course, in addition to provide the practical tasks and the equivalent work to be done as part of the continuous assessment.

Second Call: the student will have to perform the part not passed previously.

Extraordinary Call: the student will have to perform a final exam that substitutes the questionnaires done along the course, in addition to provide the practical tasks and the equivalent work to be done as part of the continuous assessment.

This subject will be evaluated in English, but students have the possibility to interact in Spanish with the teachers at any time.

The questionnaires and tasks, proposed and performed along the module, are only valid for the current course.

***NOTE: Multidisciplinar Group Tutored Work (optional)**
In this subject, and as a part of an innovation project at UVIGO, some students have the possibility to join a multidisciplinary group (MDG) with other three subjects: (1) Video Games: design and development, 4th year, Degree in Audiovisual Communication. (2) Multimedia Technology and Computer graphics, 4th year, Degree in Telecommunication Engineering Technologies, Sound and Image module. (3) Intelligent systems programming, 4th year, Degree in Telecommunication Engineering Technologies, Telematics module. The activity is coordinated by teachers of the Teaching Innovation Group: ComTecArt (Communication, Technology and Art in Virtual Environments).

The activities and tasks to be performed by the students of this subject in the MDG will be related with using artificial

intelligent techniques in videogames. The students that would join this multidisciplinary tutored work will not participate in the ordinary groups C. Besides, each MDG will only join one student from this subject, so he/she will be rated individually in such case.

The participation in the MDG is optional, and if there are more request than available positions; then those students will be ranked and selected according to the global grade mark, provided by the Escola de Enxeñaría de Telecomunicación Secretary.

There will be group work sessions on Wednesday mornings, alternating between the Campus of Vigo and Pontevedra. The University will provide free round trip transportation from the Escola de Enxeñaría de Telecomunicación or the Facultad de Ciencias Sociais e a Comunicación, respectively.

Sources of information

Basic Bibliography

Michael Wooldridge,, **An Introduction to Multiagent Systems**, 2a, Addison-Wesley, 2009

Juan C. Burguillo, **Self-organizing Coalitions for Managing Complexity**, doi.org/10.1007/978-3-319-69898-4, 1a, Springer International Publishing, 2018

Jordi Torres, **First Contact with Deep Learning, practical introduction with Keras**, ISBN 978-1-983-21155-3, 1a, WHAT THIS SPACE, 2018

Complementary Bibliography

Travis Booth, **Deep Learning with Python: A Hands-On Guide for Beginners**, 1a, Independently published, 2019

Stuart Russell, Peter Norvig, **Artificial Intelligence: A Modern Approach,**, 3a, Prentice Hall, 2014

François Chollet, **Deep learning with Python**, 1a, Manning Publications, 2018

Recommendations

Other comments

The only requirement for the students, in order to follow this subject, is to have a basic understanding of Java programming.

Contingency plan

Description

In the case that the teaching would be exclusively remote, the classes of the subject will be developed in a similar way, but using the platforms provided by the University.

Virtual classes will be taught weekly through the Remote Campus, either the theoretical sessions (groups A), the practical sessions (groups B) or group work (groups C). In the cases of B or C group activities, students will perform the practices using their personal computers.

The means enabled for the resolution of the doubts raised by the students will include online consultation forums or tutoring at the teacher's virtual office.

The non-face-to-face assessment of the subject will be governed by the conditions described in the teaching guide for the face-to-face teaching modality, including the same number of evaluations, identical weighting and minimum grades. The theoretical and practical exams will be carried out virtually, using the platforms provided by the University.

IDENTIFYING DATA

Integrated systems design

Subject	Integrated systems design			
Code	V05G300V01944			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Gil Castiñeira, Felipe José			
Lecturers	Fondo Ferreiro, Pablo Gil Castiñeira, Felipe José Rodríguez Hernández, Pedro Salvador			
E-mail	felipe@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Embedded systems are part of almost all the diary activities that involve an electronic device (the alarm clock, the mobile phone, the car...). This course introduces the main concepts behind modern embedded systems that include an operating system, and puts them in practice through a series of exercises and projects. The documentation will be provided in English. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies

Code	
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
CG4	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.
CG9	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.
CE87	(CE87/OP30) The ability to understand the specific requirements for integrated circuits with strict real time restrictions.
CE88	(CE88/OP31) The ability to formulate and solve problems of design and development of integrated systems.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes

Learning outcomes	Competences		
Know the technological base which supports the most recent investigations in the study and design of integrated systems.	CG3	CE87	
Understand the basic aspects of the special requirements inherent to embedded systems with hard real time restrictions	CG3	CE87	CT3
Adopt a global view of the problem of programming environments with real-time restrictions, and know the proper tools for dealing with them, so that embedded systems can be addressed with a system level approach.	CG3 CG4 CG9	CE88	CT2 CT4
Understand the basic elements of fault prevention and fault tolerance	CG3	CE88	
Master the concepts related to the organisation of this kind of systems software	CG3 CG4 CG9	CE88	CT4
Handle the tasks scheduling and resources sharing techniques in embedded systems	CG3 CG4	CE88	
Become familiar with the use of abstraction platforms for developing embedded systems	CG4 CG9	CE88	

Contents	
Topic	
Concept of embedded system	Definition of embedded system Real-time systems Characteristics
Operating systems for embedded systems	Operating systems with real-time restrictions Multitasking: threads and processes Synchronization
Arquitecturas de sistemas integrados	Microprocessor architecture. Peripherals. Buses.
Process scheduling	Cyclic executives Priority-driven scheduling: DMS, EDF Access synchronization
Reliability and fault tolerance	Fault prevention and fault tolerance Static and dynamic redundancy Security, reliability and dependability
Distributed embedded systems	Communication mechanisms Field buses
Abstraction platforms for the development of embedded systems	Android Linux (as a platform)
Communication with sensors and actuators	I/O Hardware Coping with concurrency The Analog/Digital interface

Planning			
	Class hours	Hours outside the classroom	Total hours
Presentation	1	5	6
Laboratory practical	14	0	14
Seminars	6	10	16
Project based learning	0	53	53
Lecturing	20	40	60
Problem and/or exercise solving	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Presentation	Presentation by the students of the developed projects results. Through this methodology the competencies CT2, CT4, CG4, CG9, CE87 and CE88 are developed.
Laboratory practical	Development of guided and supervised assignments. Through this methodology the competencies CT2, CT3, CG3, CG4, CE87 and CE88 are developed.
Seminars	Meetings of the professors with the students for tracking the current status and further planning the project activities. Through this methodology the competencies CT2, CT4, CG4, CG9, CE87 and CE88 are developed.
Project based learning	We use learning projects based training: students carry out a project along the semester to resolve a complex problem by means of planning, design and implementation of a series of activities. Through this methodology the competencies CT2, CT3, CT4, CG3, CG4, CG9, CE87 and CE88 are developed.
Lecturing	Professors present the main theoretical contents related to embedded systems with real-time restrictions. Through this methodology the competencies CT3, CG3, CE87 and CE88 are developed.

Personalized assistance	
Methodologies	**Description**
Lecturing	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered during the master sessions or during tutorial sessions.
Laboratory practical	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Te professors will guide and help the students to complete the assigned laboratory practises. Questions will be answered during the lab sessions or during tutorial sessions.

Seminars	In addition to the attention to the group, the professors of the subject will provide individual attention adadpted to the students during the group supervision sessions, or during tutorial sessions.
Project based learning	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. The professors will guide and help the students to complete the assigned project. Questions will be answered during the supervising sessions, group supervising sessions, or during tutorial sessions.

Assessment

	Description	Qualification	Evaluated Competencess		
Presentation	Once their project is implemented, the students will perform a public presentation of its design, development and results. Each member of the group must present the tasks that he or she completed, and provide satisfactory answers to the questions made by the professors.	5	CG4 CG9	CE87	
Laboratory practical	The students will fill individual questionnaires to asses the correct realization and understanding of the laboratory tasks.	10	CG3 CG4	CE87 CE88	
Seminars	A continuous tracking of the design and evolution of the implementation will be held during the realization of the project. Each student must collect and show evidences of her/his individual work. Periodically, the students will present the state and results of their projects, as well as the scheduled tasks. If these results are not satisfactory, a penalization of the 20% of the grade could be applied.	5	CG4 CG9	CE87 CE88	
Project based learning	The students will be divided in groups for accomplishing the design, implementation and proof of an embedded system. The result will be evaluated after the his delivery, assessing aspects such as correction, quality, performance and functionalities. In addition, during the implementation of the project, the design and the evolution of the development will be evaluated. If the intermediate results are not satisfactory, a penalization of the 20% of the grade could be applied. The evaluation will be by group and by person: each one of the members of a team must document his/her tasks and answer the questions related to them.	40	CG3 CG4 CG9	CE87 CE88	CT2 CT3 CT4
Problem and/or exercise solving	Students will be evaluated to asses what they have learned in master sessions.	40	CG3	CE87 CE88	

Other comments on the Evaluation

In order to pass the course it is necessary to complete the different parts of the subject (master sessions, practices in labs, and projects). The final grade will be the **weighted geometric mean** of the grades of the different parts (i.e. it is not possible to pass the subject with a zero in one part). If "x" is the grade obtained for the master sessions, "y" for the practices in labs, and "z" for the project, the final grade will be:

grade = x^0.4*y^0.1*z^0.5

During the first month, students must provide a written declaration to opt for final assessment. In other case, it will be considered that they opt for continuous assessment. Students who select continuous assessment and submit the first task or questionnaire may not be listed as "Absent".

Students who opt for the final assessment procedure must pass the short answer test (40%), submit a project (50%) and submit the laboratory practises (10%). These parts will be evaluated as indicated in the tests description section. The final grade will be the **weighted geometric mean** of the grades of the different parts. Besides, they must submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the project. In addition, during the first month of the course, professors will notify students who opted for final assessment if they have to do the tutored work individually.

Students who opt for continuous assessment must submit each laboratory report before the deadlines that will be notified at the beginning of the course.

Although the project will be developed in groups, the ongoing activities of each student in a group will be monitored individually. In case a student's performance is below his or her group mates, he or she could be expelled from the group or graded on a individual basis.

Intermediate milestones may be required for the project. Those intermediate milestones will be notified at the beginning of the course.

Second opportunity and extraordinary opportunities to pass the course

The end of course exam will only be held by students who failed the end of semester exams.

In order to pass the course it is necessary to complete the different parts of the subject: pass the short answer test (40%), submit a project (50%) and submit the laboratory practises (10%). These parts will be evaluated as indicated in the tests description section. The final grade will be the **weighted geometric mean** of the grades of the different parts. Besides, it will be necessary to submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the project.

Students that have opted by the continuous assessment procedure, can decide to maintain the grades of the parts they have already passed in the first opportunity or discard them.

Extraordinary opportunities to pass the course

In order to pass the course it is necessary to complete the different parts of the subject: pass the short answer test (40%), submit a project (50%) and submit the laboratory practises (10%). These parts will be evaluated as indicated in the tests description section. The final grade will be the **weighted geometric mean** of the grades of the different parts. Besides, it will be necessary to submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the project.

Other comments

The grades obtained are only valid for the current academic year.

Although the tutored work will be completed (if possible) in groups, each student should keep a record of his or her activities. In the case in which the performance of a member of the group wouldn't be adequate compared with the performance of his or her team mates, he or she could be excluded from the group and/or qualified individually.

The use of any material during the tests will have to be explicitly authorized.

The assessment will be performed in any of the official languages in Galicia. If a student wishes to be tested in English, it must give written notice to teachers with 15 days in advance.

In case of detection of plagiarism or unethical behavior in any of the tasks/tests done, the final grade will be "failed (0)" and the professors will communicate the incident to the academic authorities to take the appropriate measures.

Sources of information

Basic Bibliography

A. Burns & A. Wellings, **Sistemas de Tiempo Real y Lenguajes de Programación**, 3,

E.A. Lee & S.A. Seshia, **Introduction to Embedded Systems**, 1,

Complementary Bibliography

P. Marwedel, **Embedded System Design**, 2,

P. Barry & P. Crowley, **Modern Embedded Computing**, 1,

S. Barrett & J. Kridner, **Bad to the Bone: Crafting Electronics Systems with Beaglebone and BeagleBone Black**, 1,

Recommendations

Subjects that it is recommended to have taken before

Distributed and Concurrent Programming/V05G300V01641
Operating Systems/V05G300V01541

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
Since in the subject uses specific equipment for "laboratory practices" and for "learning based in projects", in case a distance learning scenario is activated we will proceed as follows:

- In case we have sufficient material or of budget to adquire it, devices will be sent to students to complete the tasks at home.
- Otherwise, practices or parts of the project not completed will be replaced by others that do not require specific hardware (although an embedded board, such as a BeagleBoard, Raspberry Pi or similar, may be needed) or that are performed on simulators.

IDENTIFYING DATA				
New computerised services				
Subject	New computerised services			
Code	V05G300V01945			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Álvarez Sabucedo, Luis Modesto			
Lecturers	Álvarez Sabucedo, Luis Modesto Santos Gago, Juan Manuel			
E-mail	lsabucedo@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The global aim of the course is to provide the students with a global outlook of the new technologies in the area of the telematic services. Therefore, the contents of this course will be open and in line with the technological evolution in the most active fields of the new technologies. The subject will be taught in Spanish and the contents will be available in English.			

Competencies	
Code	
CG4	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.
CG9	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.
CE89	(CE89/OP32) The ability to design and construct new computer services.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	Competences		
To identify new applications of telematic services.	CG4	CE89	CT4
Knowledge of the main tools and environments for the development of new telematics services.	CG4 CG9		
To acquire skills to develop new telematic services.		CE89	

Contents	
Topic	
Supporting technologies	Metadata PWA Support for recommendations Distributed Web
Horizontal services	IoT Cloud Computing Big data Blockchain. Cryptocurrencies. Payments on the net.
eServices	eLearning, eCommerce, eGovernment

Planning	Class hours	Hours outside the classroom	Total hours
Lecturing	16	40	56
Laboratory practical	14	28	42
Case studies	5	25	30
Introductory activities	3	6	9
Essay	1	3	4

Essay	1	4	5
Essay questions exam	2	2	4

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

Methodologies

	Description
Lecturing	Theoretical contents and their practical application will be presented during the lectures. Student are expected to play an active role during lectures.This methodology will impact in all the competences addressed in the subject.
Laboratory practical	During practical sessions, it will be developed a semantic project with the support of adhoc software tools. This methodology will impact in all the competences addressed in the subject.
Case studies	Use cases will presented to the students. Thus, they will be able to analyze and to study them in depth in order to prepeare their academic projects. This methodology will impact in all the competences addressed in the subject.
Introductory activities	Program of the subject will be presented along with the methodologies used, the classroom, practical contents, final project, final and continuous evaluation criteria, and, in general, all aspects of the subject. This methodology will impact in all the competences addressed in the subject.

Personalized assistance

Methodologies	**Description**
Lecturing	During these sessions, any questions that may arise will be addresseed. Also during the tutoring sesions, questions that may arise will be resolved.
Laboratory practical	In the practical sessions, a closer attention will be paid to the tasks assigned to the students. Also, any questions that may arise will be addressed. Also during the tutoring sesions, questions that may arise will be resolved.
Case studies	In these sessions, any questions that may arise will be addressed. Also during the tutoring sesions, questions that may arise will be resolved.
Tests	**Description**
Essay	In these sessions, any questions that may arise will be addressed. Also during the tutoring sesions, questions that may arise will be resolved.
Essay	In these sessions, any questions that may arise will be addressed. Also during the tutoring sesions, questions that may arise will be resolved.
Essay questions exam	In these sessions, any questions that may arise will be addressed.

Assessment

	Description	Qualification	Evaluated Competencess	
Essay	It will consist of the presentation of two practical-projects using the concepts presented in the subject. It will take place during the development of the course. Marks of each work will be the same for all the members in the group.	25	CG4 CG9	CE89
Essay	It will consist of the presentation of a project that carries out a telematic-based solution. It will take place at the end of the course. Marks of each work will be the same for all the members in the group.	25	CG4 CG9	CE89
Essay questions exam	It will involve all the contents of the course. It will take place at the end of the course	50	CG4 CG9	CE89

Other comments on the Evaluation

1. Continuous assessment

The subject will be taught in Spanish and the contents will be available in English.

The course can be passed with full marks from continuous assessment, with no need to sit the final exam.

Students who sit any of the assessment tests may not be listed as "Not Present".

The weighting and content of each continuous assessment test are as follows:

Assessment 1 (50%):

· All contents presented along the course.

· It will take place at the end of the course.

Assessment 2 (25%):

· It will consist of the presentation of a practical-projects (specified in due course).

Assessment 3 (25%):

· It will consist of a presentation of a holistic project involving telematic based services

· At the end of the course.

It is mandatory to pass each part of the continuous assessment (that is, the minimum score of each part must be 5 out of 10). In case of not passing any part of the continuous evaluation, the remaining grades will be adjusted by a factor of 0.5.

All students presenting a project will get the same marks.

The course may be passed only with continuous assessment.

2. Exam-only assessment

· There is a final exam at the end of the semester and another at the end of the course. All content presented along the course is included in this exam.

· Students sitting this final exam will be asked to submit in advance some works to be done according to specific instructions on each call. These works must be original and will involve task related to assessments 2 and 3. Should the work not be original, the student will be banned from the subject. The pass mark for this test is 5 out of 10. It is mandatory to pass the project presentation also.

Sources of information

Basic Bibliography

Professors of the subject, **Slides for classes**, http://faitic.uvigo.es,

Complementary Bibliography

R. Baeza-Yates y B. Ribeiro-Neto., **Modern Information Retrieval**,

Arasu, A., Cho, J., García-Molina, H., Paepcke, A., y Raghavan, S., **Searching the web**, ACM Transactions on Internet Technology, Vol. 1, N,

S. Chakrabarti, B. Dom, D. Gibson, J. Kleinberg, P. Raghavan, and S. Rajagopalan., **Automatic resource compilation by analyzing hyperlink structure and associated text.**, In Proceedings of the 7th World-wide web conferenc,

S. Brin y L. Page, **The anatomy of a large-scale hypertextual Web search engine.**, 7th International World Wide Web Conference, Brisb,

Lassila, O., y Swick,R.R., **Resource Description Framework (RDF) Model and Syntax Specification**, World Wide Web Consortium Recommendation. Accesib,

DCMI Home, http://dublincore.org,

IEEE Learning Technology Standards Committee (LTSC), http://ltsc.ieee.org/wg12. Standard accesible en,

Bashir, I., **Mastering blockchain**, Packt Publishing Ltd,, 2017

Bashir, I., **Mastering blockchain**, Packt Publishing Ltd,, 2017

Brian Curran, **What is Interplanetary File System IPFS? Complete Beginner□s Guide**, https://blockonomi.com/interplanetary-file-system/, 2018

Recommendations

Contingency plan

Description

In case of impossibility to attend to the educational center, the telematic support will be used. This will apply to both groups A and B. Groups C will be adapted to group tutoring, also with telematic support. The evaluation tests will keep their weight and will be done via telematic support.

IDENTIFYING DATA				
Mobility I				
Subject	Mobility I			
Code	V05G300V01951			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				
Web				
General description				

Competencies
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies
Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee,

at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained

* Teaching methodologies modified

* Non-attendance mechanisms for student attention (tutoring)

* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Pending tests that are maintained
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Tests that are modified
[Previous test] => [New test]

* New tests

* Additional Information

IDENTIFYING DATA				
Mobility II				
Subject	Mobility II			
Code	V05G300V01952			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				
Web				
General description				

Competencies
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies
Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee,

at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained

* Teaching methodologies modified

* Non-attendance mechanisms for student attention (tutoring)

* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Pending tests that are maintained
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Tests that are modified
[Previous test] => [New test]

* New tests

* Additional Information

IDENTIFYING DATA				
Mobility III				
Subject	Mobility III			
Code	V05G300V01953			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				
Web				
General description				

Competencies
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies
Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee,

at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained

* Teaching methodologies modified

* Non-attendance mechanisms for student attention (tutoring)

* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Pending tests that are maintained
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Tests that are modified
[Previous test] => [New test]

* New tests

* Additional Information

IDENTIFYING DATA				
Mobility IV				
Subject	Mobility IV			
Code	V05G300V01954			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				
Web				
General description				

Competencies
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee,

at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained

* Teaching methodologies modified

* Non-attendance mechanisms for student attention (tutoring)

* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Pending tests that are maintained
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Tests that are modified
[Previous test] => [New test]

* New tests

* Additional Information

IDENTIFYING DATA				
Mobility V				
Subject	Mobility V			
Code	V05G300V01955			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				
Web				
General description				

Competencies
Code

Learning outcomes	
Learning outcomes	Competences

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies
Description

Personalized assistance

Assessment		
Description	Qualification	Evaluated Competencess

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee,

at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained

* Teaching methodologies modified

* Non-attendance mechanisms for student attention (tutoring)

* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Pending tests that are maintained
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Tests that are modified
[Previous test] => [New test]

* New tests

* Additional Information

IDENTIFYING DATA				
Externships: Internships I				
Subject	Externships: Internships I			
Code	V05G300V01981			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Marcos Acevedo, Jorge			
Lecturers	Marcos Acevedo, Jorge			
E-mail	acevedo@uvigo.es			
Web	http://faitic.uvigo.es			
General description	(*)Estancia nunha empresa desenvolvendo funcións propias dun/a Enxeñeiro/a Técnico/a de Telecomunicación relacionadas co perfil profesional cursado polo alumno (Sistemas de Telecomunicación, Telemática, Sistemas Electrónicos ou Son e Imaxe) e supervisado por profesorado do Centro e persoal da empresa.			

Competencies	
Code	
CG4	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.
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CG12	CG12 The development of discussion ability about technical subjects
CG13	CG13 The ability to use software tools that support problem solving in engineering.
CE21	CE21/ST1 The ability to construct, exploit and manage telecommunication networks, services, process and applications, considered as systems of receiving, transporting, representation, processing, storage, management and presentation of multimedia information from the point of view of transmission systems.
CE22	CE22/ST2 The ability of applying the basic techniques of telecommunication networks, services and applications for mobile and fixed environments, personal, local or long distance, with different bandwidth, including telephony, radio broadcasting, TV and data, from the point of view of transmission systems.
CE23	CE23/ST3 The ability to analyze the components and their specifications for guided and non-guided communications systems
CE24	CE24/ST4 The ability to select circuits, subsystems and systems of radiofrequency, microwaves, broadcasting, radio link and radio determination.
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.
CE26	CE26/ST6 The ability to analyze, codify, process and transmit multimedia information using analogical and digital signal processing techniques.
CE27	CE27/TEL1The ability to construct, operate and manage telecommunication networks, services, processes and applications considered as systems to receive, transport, represent, process, store, manage and present multimedia information from the computer services point of view.
CE28	CE28/TEL2 The ability to apply the techniques that are basis of computer networks, services and applications, such as management, signaling and switching, routing and securing systems (cryptographic protocols, tunneling, firewalls, charging mechanisms, authentication and content protection) traffic engineering (graph theory, queuing theory and teletraffic) rating, reliability and quality of service in both fixed, mobile, personal, local or long distance environments with different bandwidths, including telephony and data.
CE29	CE29/TEL3 The ability to build, operate and manage computer services using planning, sizing and analytical tools
CE30	CE30/TEL4 The ability to describe, program, assess and optimize communication protocols and interfaces at different network architecture layers .
CE31	CE31/TEL5 The ability to follow the technological progress of transmission, switching and processing to improve computer networks and services.
CE32	CE32/TEL6 The ability to design networks and service architectures.
CE33	CE33/TEL7 The ability to program network and distributed applications and services.
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.

CE35	CE35/SI2 The ability to analyze, specify, carry out and maintain systems, equipments, heads and installations of TV, audio and video for mobile and fixed environments.
CE36	CE36/SI3 The capacity to implement projects at places and installations for the production and recording of audio and video signals.
CE37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.
CE38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.
CE39	(CE39/SE1): The ability to construct, exploit and manage the receiving, transporting, representation, processing, storage, manage and presentation multimedia information from the electronic systems point of view.
CE40	(CE40/SE2): The ability to select electronic circuits and devices specialized in transmission, forwarding or routing, and terminals for fixed and mobile environments.
CE41	(CE41/SE3):The ability to make the specification, implementation, documenting and tuning of electronic systems and equipment (both instrumentation and control oriented), considering the corresponding technical aspects and the regulations.
CE42	(CE42/SE4): The ability to apply electronics as support technology in other fields and activities and not only in information and communication technologies.
CE43	(CE43/SE5): The ability to design analogical and digital electronics circuits of analogical to digital conversion and vice versa, of radiofrequency, of feeding and electrical energy conversion for computing and telecommunication engineering.
CE45	(CE45/SE7): The ability to design interface, data capturing and storage devices, and terminals for services and telecommunication systems.
CE46	(CE46/SE8): The ability to specify and use electronic instrumentation and measurement systems.
CE47	(CE47/SE9): The ability to analyze and solve interference and electromagnetic compatibility problems .
CT2	CT2 Understanding Engineering within a framework of sustainable development.

Learning outcomes

Learning outcomes	Competences		
Experience in the exert of the profession of Technical Engineer of Telecommunication and of his more usual functions (according to the programme of the student) in some real surroundings of company.	CG4 CG5 CG12 CG13	CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE45 CE46 CE47	CT2

Contents

Topic	
Item	To define by the company advisor and the academic advisor.

Planning

	Class hours	Hours outside the classroom	Total hours
Practicum, External practices and clinical practices	147	0	147

Report of practices, practicum and external practices(Repetida non usar)	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
Practicum, External practices and clinical practices	The student develops own functions in a company as an Telecommunication Engineer with determinate profile by the technology that the student have studied (Systems of Telecommunication, Electronic Systems, Telematic or Sound and Image)

Personalized assistance

Methodologies	Description
Practicum, External practices and clinical practices	The student will have a advisor inside the company that will guide him and will supervise in the specific tasks that it will have to develop inside the company; and an academic advisor -professor of the University of Vigothat will define together with the advisor of the company the general frame of the activity of the student, checking that it adjusts to the profile studied by the student.

Assessment

	Description	Qualification	Evaluated Competencess		
Practicum, External practices and clinical practices	It will value so much the aptitude like the attitude of the student in the development of the activities entrusted.	90	CG4 CG5 CG12 CG13	CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE45 CE46 CE47	CT2

Report of practices, practicum and external practices(Repetida non usar)	The memory presented by the student will have to adjust to the indications collected in the rules of practices in valid company (University of Vigo and intern of the degree in Engineering of Technologies of Telecommunication).	10	CG4 CG5 CG12 CG13	CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE45 CE46 CE47

Other comments on the Evaluation

The tutor of the company will deliver a report valuing appearances related with the practices realised by the student:punctuality, assistance, responsibility, capacity of work in team and integration in the company, quality of the workrealised, etc.
The student/to will have to deliver an explanatory memory of the activities realised during the practices, specifying hislength, the units or departments of the company in that they realised , the training received (courses, computerprograms, etc.), the level of integration inside the company and the relations with the personnel.
The memory has to include also a section of conclusions, that will contain a reflection on the suitability of theeducations received during the career for the exert of the practice (positive and negative appearances more significantrelated with the development of the practices). It will value , besides, the inclusion of information on the professionaland personal experience obtained with the practices (personal assessment of the learning achieved along the practices,and suggestions or own contributions on the structure and operation of the company visited).
If the memory presented by the student does not reach the quality and minimum requirements, the student will have opportunity torectify it for his *re-evaluation in the extraordinary announcement of July.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

It recommends have studied the three first courses of the degree.

Contingency plan

Description

=== ADAPTATION OF THE METHODOLOGIES ===
* Educational Methodologies that keep
Any because the subject consists of the permanence in a company developing activities adapted to the degree

* Educational Methodologies that modify
All. The subject sewed in the stay in the company of the student during a time. In the case that the teaching was exclusively no face-to-face, the practice in the company only will be able to make if it does in the remote.

* Modifications (if they proceed) of the contents to give
There are no changes
* Additional Bibliography to facilitate the self-learning
There are not
* Other modifications
There are not more modifications

=== ADAPTATION OF THE EVALUATION ===
Unchanged

IDENTIFYING DATA				
Externships: Internships II				
Subject	Externships: Internships II			
Code	V05G300V01982			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Marcos Acevedo, Jorge			
Lecturers	Marcos Acevedo, Jorge			
E-mail	acevedo@uvigo.es			
Web	http://faitic.uvigo.es			
General description	(*)Estancia nunha empresa desenvolvendo funcións propias dun/a Enxeñeiro/a Técnico/a de Telecomunicación relacionadas co perfil profesional cursado polo alumno (Sistemas de Telecomunicación, Telemática, Sistemas Electrónicos ou Son e Imaxe) e supervisado por profesorado do Centro e persoal da empresa.			

Competencies	
Code	
CG4	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.
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
CG12	CG12 The development of discussion ability about technical subjects
CG13	CG13 The ability to use software tools that support problem solving in engineering.
CE21	CE21/ST1 The ability to construct, exploit and manage telecommunication networks, services, process and applications, considered as systems of receiving, transporting, representation, processing, storage, management and presentation of multimedia information from the point of view of transmission systems.
CE22	CE22/ST2 The ability of applying the basic techniques of telecommunication networks, services and applications for mobile and fixed environments, personal, local or long distance, with different bandwidth, including telephony, radio broadcasting, TV and data, from the point of view of transmission systems.
CE23	CE23/ST3 The ability to analyze the components and their specifications for guided and non-guided communications systems
CE24	CE24/ST4 The ability to select circuits, subsystems and systems of radiofrequency, microwaves, broadcasting, radio link and radio determination.
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.
CE26	CE26/ST6 The ability to analyze, codify, process and transmit multimedia information using analogical and digital signal processing techniques.
CE27	CE27/TEL1The ability to construct, operate and manage telecommunication networks, services, processes and applications considered as systems to receive, transport, represent, process, store, manage and present multimedia information from the computer services point of view.
CE28	CE28/TEL2 The ability to apply the techniques that are basis of computer networks, services and applications, such as management, signaling and switching, routing and securing systems (cryptographic protocols, tunneling, firewalls, charging mechanisms, authentication and content protection) traffic engineering (graph theory, queuing theory and teletraffic) rating, reliability and quality of service in both fixed, mobile, personal, local or long distance environments with different bandwidths, including telephony and data.
CE29	CE29/TEL3 The ability to build, operate and manage computer services using planning, sizing and analytical tools
CE30	CE30/TEL4 The ability to describe, program, assess and optimize communication protocols and interfaces at different network architecture layers .
CE31	CE31/TEL5 The ability to follow the technological progress of transmission, switching and processing to improve computer networks and services.
CE32	CE32/TEL6 The ability to design networks and service architectures.
CE33	CE33/TEL7 The ability to program network and distributed applications and services.
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.

CE35	CE35/SI2 The ability to analyze, specify, carry out and maintain systems, equipments, heads and installations of TV, audio and video for mobile and fixed environments.
CE36	CE36/SI3 The capacity to implement projects at places and installations for the production and recording of audio and video signals.
CE37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.
CE38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.
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CE42	(CE42/SE4): The ability to apply electronics as support technology in other fields and activities and not only in information and communication technologies.
CE43	(CE43/SE5): The ability to design analogical and digital electronics circuits of analogical to digital conversion and vice versa, of radiofrequency, of feeding and electrical energy conversion for computing and telecommunication engineering.
CE44	(CE44/SE6): The ability to understand and use feedback theory and electronic control systems.
CE45	(CE45/SE7): The ability to design interface, data capturing and storage devices, and terminals for services and telecommunication systems.
CE46	(CE46/SE8): The ability to specify and use electronic instrumentation and measurement systems.
CE47	(CE47/SE9): The ability to analyze and solve interference and electromagnetic compatibility problems .
CT2	CT2 Understanding Engineering within a framework of sustainable development.

Learning outcomes

Learning outcomes	Competences		
Experience in the exert of the profession of Technical Engineer of Telecommunication and of his more usual functions (according to the programme of the student) in some real surroundings of company.	CG4 CG5 CG12 CG13	CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE44 CE45 CE46 CE47	CT2

Contents

Topic	
Item	To define by the company advisor and the academic advisor.

Planning

	Class hours	Hours outside the classroom	Total hours

Practicum, External practices and clinical practices	147	0	147
Report of practices, practicum and external practices(Repetida non usar)	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
Practicum, External practices and clinical practices	The student develops own functions in a company as an Telecommunication Engineer with determinate profile by the technology that the student have studied (Systems of Telecommunication, Electronic Systems, Telematic or Sound and Image)

Personalized assistance

Methodologies	Description
Practicum, External practices and clinical practices	The student will have a advisor inside the company that will guide him and will supervise in the specific tasks that it will have to develop inside the company; and an academic advisor -professor of the University of Vigothat will define together with the advisor of the company the general frame of the activity of the student, checking that it adjusts to the profile studied by the student.

Assessment

	Description	Qualification	Evaluated Competencess		
Practicum, External practices and clinical practices	It will value so much the aptitude like the attitude of the student in the development of the activities entrusted.	90	CG4 CG5 CG12 CG13	CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE45 CE46 CE47	CT2

Report of practices, practicum and external practices(Repetida non usar)	The memory presented by the student will have to adjust to the indications collected in the rules of practices in valid company (University of Vigo and intern of the degree in Engineering of Technologies of Telecommunication).	10	CG4 CG5 CG12 CG13	CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE45 CE46 CE47

Other comments on the Evaluation

The tutor of the company will deliver a report valuing appearances related with the practices realised by the student: punctuality, assistance, responsibility, capacity of work in team and integration in the company, quality of the workrealised, etc.

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The memory has to include also a section of conclusions, that will contain a reflection on the suitability of the educations received during the career for the exert of the practice (positive and negative appearances more significant related with the development of the practices). It will value , besides, the inclusion of information on the professional and personal experience obtained with the practices (personal assessment of the learning achieved along the practices,and suggestions or own contributions on the structure and operation of the company visited).

If the memory presented by the student does not reach the quality and minimum requirements, the student will have opportunity to rectify it for his re-evaluation in the extraordinary announcement of July.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

It recommends have studied the three first courses of the degree.

Contingency plan

Description

=== ADAPTATION OF THE METHODOLOGIES ===

* Educational Methodologies that keep

Any because the subject consists of the permanence in a company developing activities adapted to the degree

* Educational Methodologies that modify

All. The subject sewed in the stay in the company of the student during a time. In the case that the teaching was exclusively no face-to-face, the practice in the company only will be able to make if it does in the remote.

* Modifications (if they proceed) of the contents to give
There are no changes
* Additional Bibliography to facilitate the self-learning
There are not
* Other modifications
There are not more modifications

=== ADAPTATION OF THE EVALUATION ===
Unchanged

IDENTIFYING DATA				
Final Year Dissertation				
Subject	Final Year Dissertation			
Code	V05G300V01991			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Type	Year	Quadmester
	12	Mandatory	4th	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Caeiro Rodríguez, Manuel			
Lecturers	Caeiro Rodríguez, Manuel			
E-mail	mcaeiro@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The Bachelor Thesis (TFG) is a constituent part, as a unit module, of the curriculum of Degree in Engineering of Technologies of Telecommunication. It is an original and personal work that each student will realise autonomously under educational supervision, and has to allow him to show in a comprehensive form the acquisition of the formative contents and the competences associated to the title. Its definition and contents are explained in detail in the regulation for the realisation of the Bachelor's thesis approved by the Academic Commission of Degree, whose content appears in the web of the School of Engineering of Telecommunication.			

Competencies	
Code	
CB1	Students have demonstrated knowledge acquisition and understanding in the field of study. This knowledge begins based on general secondary education, and it is typically at a level that, although advanced textbooks would support it, includes some aspects at the forefront of their field of study.
CB2	Students can apply their knowledge to their jobs in a professional way and they have competences that are typically demonstrated through devising and sustaining arguments and solving problems within their field of study.
CB4	Students can communicate information, ideas, problems and solutions to both general and specialized public.
CG1	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.
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.
CG4	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.
CG9	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.
CG10	CG10 The ability for critical reading of scientific papers and docs.
CG14	CG14 The ability to use software tools to search for information or bibliographical resources.
CE90	(CE90/TFG)Original and individual exercise to be defended before an examining board consisting of a project in a specific technology of Telecommunication Engineering and of a professional nature, where the abilities acquired from the teachings are integrated and synthesized.
CT1	CT1 Development of sufficient autonomy to carry out works within the area of Telecommunications in interdisciplinary contexts.
CT2	CT2 Understanding Engineering within a framework of sustainable development.
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes		
Learning outcomes	Competences	
Search, management and structuring of information on any topic	CB2 CG2 CG10 CG14	CT1

Development and writing of a project document which are collected: history, state of the art or problematic, objectives, project phases, project development, conclusions and future lines.	CB2	CG1 CG10		CT1 CT2 CT4
Prototyping, programming simulation software, etc., according to specifications.	CB4	CG1 CG2 CG4 CG9	CE90	
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.	CB1	CG1	CE90	CT1 CT2 CT4

Contents

Topic	
The contents of each TFG will be defined in individual proposals offered by tutors and approved by the Academic Degree Commission under the rules for carrying out the Bachelor Thesis, the content of which is available on the website of the School of Telecommunication Engineering.	Each TFG will have different contents

Planning

	Class hours	Hours outside the classroom	Total hours
Previous studies	0	20	20
Project based learning	0	20	20
Presentation	0	8	8
Mentored work	30	210	240
Essay	2	10	12

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

Methodologies

	Description
Previous studies	Search, read and work documentation, troubleshooting suggestions and / or exercises to be performed in the classroom and / or laboratory ... independently by students.
Project based learning	The student presents the results obtained in the preparation of a document on the subject matter. It will be carried out individually, and both in writing (memory) and orally.
Presentation	Students must prepare and defend the work in front of a jury.
Mentored work	The student, individually, produces a paper on the subject matter, or he/she prepares seminars, research, memoirs, essays, summaries, etc.

Personalized assistance

Methodologies	Description
Mentored work	Each student receives academic advice by his/her supervisor concerning the specific topic of the Bachelor's thesis. Students will meet regularly with their supervisors for tracking of their progress.
Previous studies	Each student receives academic advice by his/her supervisor concerning the specific topic of the Bachelor's thesis. Students will meet regularly with their supervisors for tracking of their progress.
Project based learning	Each student receives academic advice by his/her supervisor concerning the specific topic of the Bachelor's thesis. Students will meet regularly with their supervisors for tracking of their progress.
Presentation	Each student receives academic advice by his/her supervisor concerning the specific topic of the Bachelor's thesis. Students will meet regularly with their supervisors for tracking of their progress.

Assessment

	Description	Qualification	Evaluated Competencess
Essay	A panel of three teachers for each of the mentions of the Degree shall be appointed. The evaluation was carried out according to the rules for carrying out the Final Year Work and assessment rubric approved by the Academic Degree Committee, whose contents are available on the website of the school of Telecommunication Engineering.	100	

Other comments on the Evaluation

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

All information related to the TFG is available on the website of the School of Telecommunication Engineering at the following link:

http://www.teleco.uvigo.es/index.php/es/estudios/gett/planificacion-academica/tfg

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

Having passed all necessary subjects to obtain the Bachelor degree except the TFG, or enroll simultaneously in all subjects.

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained
In the event that teaching must be done online, all methodologies are maintained.

* Non-attendance mechanisms for student attention (tutoring)
In the event that teaching must be carried out online, the tutoring sessions may be carried out by telematic means (email, videoconference at the Remote Campus, FAITIC forums, ...) under the modality of prior agreement.

=== ADAPTATION OF THE TESTS ===
In the event that teaching must be done online, the evaluation scheme will be maintained.