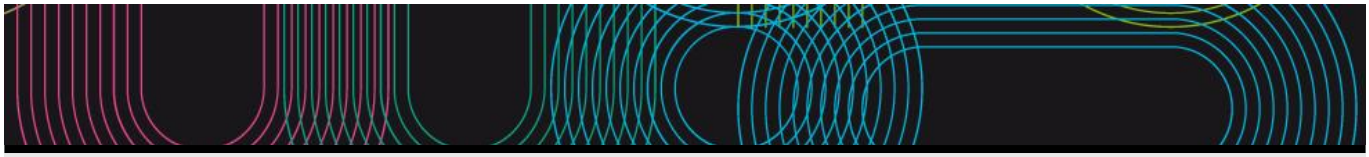

(*)Escola de Enxeñaría de Telecomunicación

Presentatiton

Telecommunications Technical Engineer

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

Master in Industrial Mathematicics

Equipo Directivo y Coordinación

EQUIPO DIRECTIVO DEL CENTRO

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 Infraestructuras: Miguel Ángel Domínguez Gómez (teleco.subdir.infraestructuras@uvigo.es)

COORDINACIÓN DEL GRADO

Coordinadora General: Generosa Fernández Manín (teleco.grao@uvigo.es)

Coordinador del Módulo de Formación Básica: José Ramón Fernández Bernárdez (jramon.fernandez@uvigo.es)

Coordinadora del Módulo de Telecomunicación: Yolanda Blanco Fernández (Yolanda.Blanco@det.uvigo.es)

Coordinadora del Módulo de Sistemas Electrónicos: Lucía Costas Pérez (lcostas@uvigo.es)

Coordinadora del Módulo de Sistemas de Telecomunicación: María Vera Isasa (mirentxu@uvigo.es)

Coordinador del Módulo de Sonido e Imagen: Antonio Pena Giménez (apena@gts.tsc.uvigo.es)

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

Coordinadora del Módulo de Optatividad: Ana Vázquez Alejos (analejos@uvigo.es)

Coordinador de Proyectos: Carlos Mosquera Nartallo (mosquera@gts.tsc.uvigo.es)

Coordinador de Movilidad: Enrique Costa Montenegro (teleco.subdir.internacional@uvigo.es)

Coordinador de Prácticas Externas: Jorge Marcos Acevedo (teleco.practicas@uvigo.es)

Coordinador del TFG : Manuel Fernández Veiga (teleco.subdir.academica@uvigo.es)

Coordinador del Plan de Acción Tutorial: Artemio Mojón Ojea (teleco.pat@uvigo.es)

COORDINACIÓN DEL MASTER EN INGENIERÍA DE TELECOMUNICACIÓN

Coordinadora general: Edita de Lorenzo Rodríguez (teleco.master@uvigo.es)

COORDINACIÓN DEL MASTER EN MATEMÁTICA INDUSTRIAL

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

Web page

www.teleco.uvigo.es

(*)Máster Universitario en Enxeñaría de Telecomunicación

Subjects

Year 1st

Code	Name	Quadmester	Total Cr.
V05M145V01101		1st	5
V05M145V01102		1st	5
V05M145V01103		1st	5
V05M145V01104		1st	5
V05M145V01105		1st	5
V05M145V01106		1st	5
V05M145V01201		2nd	5
V05M145V01202		2nd	5
V05M145V01203		2nd	5
V05M145V01204		2nd	5
V05M145V01205		2nd	5
V05M145V01206		2nd	5
V05M145V01207		2nd	5
V05M145V01208		2nd	5
V05M145V01209		2nd	5
V05M145V01210		2nd	5
V05M145V01211		2nd	5
V05M145V01212		2nd	5
V05M145V01213		2nd	5
V05M145V01214		2nd	5
V05M145V01215		2nd	5

IDENTIFYING DATA				
(*)A Enxeñaría de Telecomunicación na Sociedade da Información				
Subject	(*)A Enxeñaría de Telecomunicación na Sociedade da Información			
Code	V05M145V01101			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Mandatory	1st	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	Cuiñas Gómez, Íñigo			
Lecturers	Caeiro Rodríguez, Manuel Cuiñas Gómez, Íñigo Fernández Iglesias, Manuel José Mariño Espiñeira, Perfecto			
E-mail	inhigo@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject looks for proposing the students to practical usage of the most technical concepts of Telecommunication Engineering for solving problems and offer services to the society in which they live: it pretends that they take consciousness that the activity of the engineer is not an isolated fact but it transforms the world (at small and at large scale). This leads to two fundamental ideas: 1) The society, people that conform it, have problems that can be resolved by the engineers: the function of the Engineering is to resolve or mitigate problems of the society in which it frames , not to create them. Knowing how it has resolved situations in the past can help to face problems in the future (history oriented to future action, no to the contemplation of the past). 2) The engineering activities have direct influence in the own society, in how people live or in how they relate. In fact, the big changes of the last decades have been starred directly by contributions of the field of the Engineering of Telecommunication. This influence has to go accompanied of taking of consciousness of the ethical responsibility.			

Competencies	
Code	
A3	CB3 Students must integrate knowledge and handle complexity of formulating judgments based on information that was incomplete or limited, including reflections on social and ethical responsibilities linked to the application of their knowledge and judgments.
B7	CG7 The capacity for implementation and management of manufacturing processes of electronic and telecommunications equipment; guaranteeing safety for persons and property, the final quality of the products, and their homologation.
B9	CG9 The ability to understand the responsibility and professional ethics of the activity of the profession of Telecommunications Engineering.
B13	CG13 The knowledge, understanding and ability to implement the necessary legislation in the exercise of the profession of Telecommunications Engineering.
C15	CE15/GT1 The ability to integrate technologies and systems of Telecommunication Engineering, with general character, and at broader and multidisciplinary contexts such as bioengineering, photovoltaic conversion, nanotechnology, telemedicine.
D3	CT3 Understanding Engineering in a framework for sustainable development.
D4	CT4 Awareness of the need for training and continuous quality improvement, developing values of the dynamics of scientific thought, showing a flexible, open and ethical attitude in front of different opinions or situations, particularly on non-discrimination based on sex, race or religion, respect for fundamental rights, accessibility, etc.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Knowledge of what the profession of Telecommunicationis Engineering is and what represents.	B7 B13 D4

Taking of consciousness of the social responsibility, ethical and environmental of Telecommunication Engineering.	A3 B9 D3 D4
Contact with other disciplines in which the technologies of Telecommunication integrate for the development of the society: bioengineering, solar energy, nanotechnologies, tele-medicine, teleasistance, teleeducation.	C15

Contents

Topic	
Seminar on the Engineering in the Society	Engineers (to be possible former students at the School) speak us on their professional activity, or advise us on appearances of professional development (EuroPass, professional association, activity ambits). At the end, the students answer poll/questionnaires to move them to think on the topics. The answers will be used for debates in another session. Related competencies: CE15 and CT4
Debates on the seminar	After the conferences, debates of half hour treating to look for the ethical implications or the influence that the described engineering activity has on the society. Related competencies: CB3
Professional attributions and their history	Eight historical professional attributions . Historical development of systems or applications related: * Television * Wire communications (small history: Vigo and the football in Spain) * Radioelectric spectrum (management: attributions, etc.) * Internet * Mobile telephony (including effects on health) * Experts official reports. Related competencies: CG13 and CT3
Ethical implications of the Engineering	Two cases, extracted from the actuality and related with engineering activities with influence in the society. In previous classes or in FaiTIC, lecturers provide information of the cases and can distribute roles (commissions to students or to groups that defend a determinate posture or opinion). Presentation of the case and debate in sessions of two hours by case. Related competencies: CG9
In a multidisciplinary society	The proposal for the work in groups C is centered in the resolution of problems or situations of the society in which we live, no strictly related with the Telecommunication Engineering, so that the students comprise his implication in multiple fields of the society and how can influence in her with solutions posed from his competencies and engineering skills. It does not treat to manufacture or program a solution, but to look for a proposal that was feasible, now or in a future with technology more developed, and that it was acceptable socially. The process would be based in techniques of Design Thinking. Using a simple personality test, we create the groups looking for higher heterogeneity: so, the possibility of creating ideas and solutions grows. In group A, presentations of the solutions that the groups C find to the problems. Related competencies: CG7, CE15, CT3 and CT4

Planning

	Class hours	Hours outside the classroom	Total hours
Seminars	14	15	29
Projects	5	70	75
Master Session	9	10	19
Long answer tests and development	2	0	2

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

Methodologies

	Description

Seminars	Teaching in seminar format, in which the student participates very actively in the evolution of the classes deepening in a specific subject, expanding it and relating it with contents oriented to the professional practice; including the participation in scientific events and/or informative, organised or no in the own School; the organisation of debates that allow sharing ideas and proposals, guided by lecturers, both face-to-face or on-line; and the study of cases/analysis of situations (analysis of a problem or real case, with the purpose to know it, interpret it, resolve it, generate hypothesis, diagnose it and going deep in alternative procedures of solution, to see the application of the theoretical concepts in the reality). These activities can have related a load of autonomous work of the student. Subjects as "Seminar on Engineering and Society", "Ethic implications of Engineering", and related debates, are taught following this methodology. Competencies worked: with this methodology we work the competencies CB3, CG7, CG9, CG13 and CT4
Projects	Realisation of works, individual or in group, for the resolution of a case or a concrete project, as well as the presentation of the results by writing and/or by means of a presentation that can follow different formats: oral, poster, multimedia. They include the integrated Methodologies: learning based in problems (LBP), resolution of problems of design proposed by the professor, and education based in projects of learning (PBL). Teachers will create groups, using as selection criteria the results of a personality test done by the students at first session. The objective is to obtain heterogeneous groups, and externally selected, as at an actual company. The student, in group, prepares a work providing a solution to a clear-cut problem according to the methodology Design Thinking, identifying situations of the daily life that a priori do not relate with the Telecommunication. Design Thinking methodology develops with the following steps: finding, interpreting, thinking, experimenting, and evolving. The solution has to take into account both technical and legal, environmental, social and sustainability aspects. Following Design Thinking methodology, the first step will be searching for news on a subject proposed by each group (for example location of missing aeroplanes in the sea, integration vs. exclusion of communities in risk of vulnerability -elderly, third world, rural-, etc.). Students will pose imaginative solutions and will treat to find a proposal that would be reasonable, although it can not being still implementable given the current technological development. The groups will begin for locating real news related. From them, they will treat to identify possible technological or procedural solutions . They will have to look for technical and scientific information on these and, finally, elaborate a report and a presentation. The result of this activity will be documented through a service on line type forum or wiki. Also, a document of presentation or video will produce to be used in the final presentation of the work developed to the class. Both results will be evaluated based on previously known rubrics. The interaction with the lecturers will be face-to-face with five meetings of one hour, and through forums during the research of information, and by email for the exchange of ideas. The subject "At a Multidisciplinary Society" fits with this methodology. Competencies worked: with this methodology work the competencies CB3, CE15/GT1, CG9 and CT4
Master Session	Explanation of the contents of the subject; it includes explanation of concepts; introduction of practices and exercises; and resolution of problems and/or exercises in ordinary classroom. The subject "Professional attributions and its history" fits with this methodology. Competencies worked: with this methodology work the competencies CG7, CG9 and CT3

Personalized attention	
Methodologies	**Description**
Master Session	Meeting activity between lecturer and student in which they debate and resolve questions or doubts related with the contents of the matter and with the competitions associated. It can be face-to-face or on line.
Seminars	Meeting activity between lecturer and student in which they debate and resolve questions or doubts related with the contents of the matter and with the competitions associated. It can be face-to-face or on line.
Projects	Meeting activity between lecturer and student in which they debate and resolve questions or doubts related with the contents of the matter and with the competitions associated. It can be face-to-face or on line.

Tests	Description
Long answer tests and development	Meeting activity between lecturer and student in which they debate and resolve questions or doubts related with the contents of the matter and with the competitions associated. It can be face-to-face or on line.

Assessment

	Description	Qualification	Training and Learning Results			
Seminars	Systematic observation: In the seminars we will value the participation in the debates (with the speakers of the seminar Engineering in the Society;, between the students in the sessions of debate in classroom, and in the argumentation in ;Ethical implications of the Engineering). It will be able to support the evaluation in proofs of short answer. In these observations we will evaluate the competencies CB3, CG7, CG9, CG13 and CT4	30	A3	B7 B9 B13		D4
Projects	The realisation of the works in groups will be evaluated in two parts: the own dynamics of the works and the presentations. The student will receive 15% of the note by the own work; evaluated to 50% by the lecturer that directs the work and by the group of professors of the matter. Related to the presentation, the student will receive another 15%, evaluated by his/her mates (evaluation by pairs) according to a rubric that will be approved before the beginning of the works. With these works we will evaluate the competencies CB3, CE15/GT1, CG9 and CT4	30	A3	B9	C15	D4
Master Session	Short answer tests: there will be 4 proofs, of 5-10 minutes length, that will liberate contents of the previous subjects. In these short proofs we will evaluate the competencies CG7, CG9 and CT3	40		B7 B9		D3
Long answer tests and development	The final examination, in case it would be needed, will consist of questions of development, in which the student will have to show the purchased knowledge, initiative to propose solutions to problems no necessarily of telecommunication, and he/she will also have to expose his opinion on conflicts of professional ethics, showing his capacity to provide opinions on situations that involve to the society.	0	A3	B7 B9 B13	C15	D3 D4

Other comments on the Evaluation

The continuous assessment tests allow students to obtain a final grade based solely on their path along the course, and consist of:

One. 4 short-answer tests, with 10% of the total grade each, totaling 40%.

Two. Systematic observation in the seminars, which account for 30%.

Three. Evaluation of supervised work (15%) and the presentation of them (15%).

Continuous assessment tasks are not recoverable, and they are only valid for the current year. A student is assumed to have opted for continuous assessment when he/she has been made two of the short-answer tests and has participated in two debate activities. A student who chooses to continuous assessment is deemed to have been presented to the subject, whether they are present or not to the final exam.

If a student, having submitted to continuous assessment, chooses the final exam, the final grade for the course will be the average of the two.

Under the regulations of the University of Vigo, the student who wishes may choose 100% of the final grade by a single final exam. The final exam is one that is done in the official dates marked on School Board in the months of December or January (or July in the case of special consideration), and who are obliged to attend those students who have not opted for continuous assessment and want to pass the subject. The final exam will consist of a development test, as described in the evaluation section.

The resit exam will have a similar structure to the final exam.

Sources of information

C. Rico, **Crónicas y testimonios de las Telecomunicaciones españolas**, COIT-AEIT,

O. Pérez Sanjuán, **De las señales de humo a la Sociedad del Conocimiento**, COIT-AEIT,

O. Pérez Sanjuán, **Detrás de la cámara**, COIT-AEIT,

VV.AA., **Design Thinking for Educators**, www.designthinkingforeducators.com/toolkit/,

J. Cabanelas, **Vía Vigo: el Cable Inglés el Cable Alemán**, Instituto de Estudios Vigueses,

Recommendations
Subjects that continue the syllabus
(*)Dirección de Proxectos de Telecomunicación/V05M145V01201

IDENTIFYING DATA				
(*)Tratamento de Sinal en Comunicacións				
Subject	(*)Tratamento de Sinal en Comunicacións			
Code	V05M145V01102			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Mandatory	1st	1st
Teaching language	Spanish			
Department				
Coordinator	López Valcarce, Roberto			
Lecturers	López Valcarce, Roberto			
E-mail	valcarce@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course presents several of the signal processing techniques most commonly found in the design and implementation of communication systems, with focus on digital processing schemes. Covered aspects include sampling and quantization, block and adaptive estimation, block transform coding, efficient resampling and filtering methods.			

Competencies	
Code	
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C1	CE1 The ability to apply methods of information theory, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing systems and audiovisual communications.
C2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.
C3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.

Learning outcomes	
Expected results from this subject	Training and Learning Results
(*)Conocimiento de los principales modelos de la mecánica de fluidos	
Ability to apply multirate processing, adaptive filtering, block-based transform and spectral estimation techniques to communication and multimedia systems	B4 C1
Ability to implement advanced signal processing techniques in diverse fields of application: bioengineering, bioinformatics, etc.	B4 B8
Ability to apply signal processing techniques to the modeling and simulation of communication systems	B4 C1 C2
Ability to simulate the physical layer of cable, wireline, satellite systems in fixed/mobile communication environments.	B4 B8 C2 C3

Contents	
Topic	
Chapter 1: Block-based Transforms in Communications and Multimedia	- DFT: formulation and properties. - Frequency Analysis based on DFT. Windowing. - DFT-based digital modulation schemes: DMT, OFDM. - DCT: formulation and properties. - Transform domain coding.

Lab Assignment 1: Sampling and quantization	- Aliasing - Baseband and bandpass sampling - Quantization noise - Converter overload - Spurious-free dynamic range - Sampling jitter
Lab Assignment 2: Simulation of a multicarrier-based digital communication system	-Experimental study of the diverse effects and tradeoffs involved in the design of the transmitter and receiver of a multicarrier communication system.
Chapter 2: Adaptive Filtering and Estimation	- Minimum Mean Squared Error criterion - LMS adaptive filters - Least Squares criterion - Power spectral density estimation: Welch's periodogram
Lab Assignment 3: Adaptive Filtering	- LMS and NLMS Algorithms - Simulation in a channel equalization context - Simulation in an echo/interference cancellation context
Chapter 3: Multirate Processing and Filter Banks	- Sampling rate conversion: decimation, interpolation, multirate filters - Filter Banks: framework, classes. The DFT as a filter bank. Wavelet transform and application to image coding. - Efficient implementation: polyphase decomposition. Filter banks as transmultiplexers.
Final Project	- The student will develop the design of a signal processing system involving several aspects covered during the course, and meeting a series of specifications/requirements.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	18	18	36
Laboratory practises	20	20	40
Autonomous practices through ICT	0	40	40
Long answer tests and development	2	0	2
Reports / memories of practice	0	5	5
Jobs and projects	0	2	2

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

Methodologies

	Description
Master Session	Presentation of main topics, possibly with audiovisual aids. Applied/theoretical problem sessions.
Laboratory practises	Under the guidance of the instructor, the student will develop the design and/or simulation of a signal processing system involving several of the techniques studied during the course.
Autonomous practices through ICT	Computer-based simulation of signal processing applications to communications and multimedia.

Personalized attention

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

Assessment

	Description	Qualification	Training and Learning Results	
Long answer tests and development	Final test in which the student must solve a series of exercises.	40	B4	C1 C2
Reports / memories of practice	Written reports corresponding to the different lab assignments.	40	B4 B8	C1 C2
Jobs and projects	Written report describing the developed design and obtained results for the final project.	20	B4 B8	C1 C2 C3

Other comments on the Evaluation

Students may choose one of the following two assessment options:

1) Continuous assessment: Final grade will consist of:

- comprehensive test (up to 4 points)

- lab reports (up to 4 points)

- final project (up to 2 points)

A minimum grade of 30% in the comprehensive test is required in order to pass the course.

Lab report grades from the first call will be kept for the second call, in which the student will be allowed to resubmit the final project and/or take a new comprehensive test.

2) One-shot assessment: The final grade is the one achieved in the comprehensive test, for both the first and second call.

Any kind of plagiarism will result in automatically failing the course.

Sources of information
T. K. Moon, W. C. Stirling, **Mathematical methods and algorithms for signal processing**, 1st,
S. Mitra, **Digital Signal Processing: A Computer Based Approach.**, 4th,
Behrouz Farhang-Boroujeny, **Signal Processing Techniques for Software Radios**, 2nd,
P.P. Vaidyanathan, **Multirate systems and Filter Banks**,
F. Harris, **Multirate Signal Processing for Communication Systems**,
J.G. Proakis and D.G. Manolakis, **Digital Signal Processing**, 4th,
S. Haykin, **Adaptive Filter Theory**, 4th,

The instructors will make available to the students via Faitic all relevant materials related to the course (slides, class notes, etc.)

Recommendations

IDENTIFYING DATA				
(*)Radio				
Subject	(*)Radio			
Code	V05M145V01103			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Mandatory	1st	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	Arias Acuña, Alberto Marcos			
Lecturers	Arias Acuña, Alberto Marcos Rubiños López, José Óscar Vazquez Alejos, Ana			
E-mail	marcos@com.uvigo.es			
Web				
General description	In this compulsory matter of first semester, the student familiarises with the radiocommunication systems, beginning with the antenna properties, continuing with the study of the noise and interferences and finalising with the calculation of the link budget in different propagation scenarios. These concepts apply to the study of the services of radar and radiolocalization.			

Competencies	
Code	
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
A4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.
C2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.
C3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.
C5	CE5 The ability to design systems of radio navigation and positioning, as well as radar systems.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Capacity to realise basic antenna designs	A2 C2
Capacity to calculate link budgets taking into account both signal and perturbations in distinct stages	A2 C2 C3
Capacity to design radionavegation and positioning systems	A4 C3 C5
Capacity to design radar systems	A4 C5

Contents	
Topic	
1. Basic design of antennas	1.1 Fundamental electromagnetic laws 1.2 Trasmitting antenna 1.3 Receiving antenna 1.4 Bands of frequency 1.5 Types of antennas 1.6 Friis Formula 1.7 Transmission losses

2. Models of noise and interferences	2.1 Thermal Noise 2.2 Antenna Noise 2.3 Noise Factor and noise temperature of a receptor 2.4 Concept and types of interferences 2.5 Characterisation of the interference 2.6 Concept of availability, fading and diversity 2.7 Systems limited by noise and by interference
3. Link budget for different propagation modes	3.1 Propagation in low frequencies. Surface and ionospheric waves. Electrical field received. 3.2 Tropospheric propagation. 3.3 Propagtion losses
4. Design of Radionavigation systems	4.1 Fundamentals of radionavigation 4.2 Types of radionavigation systems 4.3 Satellite radionavigation systems 4.4 Design of a radionavigation system
5. Design of radar systems	5.1 Fundamentals of radar systems. Radar cross section 5.2 Types of radar systems 5.3 Design of a radar system

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	20	20	40
Seminars	4	24	28
Laboratory practises	13	13	26
Short answer tests	1	10	11
Long answer tests and development	1	10	11
Other	1	8	9

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

Methodologies

	Description
Master Session	Exhibition of the contents of the subject; it includes exhibition of concepts; introduction of practices and exercises; and resolution of problems and/or exercises in ordinary classroom.
Seminars	Teaching for few students; they participates very actively in the evolution of the classes deepening in a specific subject, expanding it and relating it with contents oriented to the professional practice. These activities can have related a load of autonomous work of the student.
Laboratory practises	Application, to practical level, of the knowledges and skills adquired in the theoretical classes, by means of practices realised with equipment of test and measure. Also including practical of laboratory realised on computers (simulations, analysis, processed, etc.), exercises of programming, on-line realised works, etc.

Personalized attention

Methodologies	**Description**
Master Session	The students will have occasion to attend to personalised tutorials in the office of the professor in the schedule that the professors will establish for this effect to principle of course and that will publish in the page of the subject They will be able to also arouse his queries by telematic way.
Seminars	The students will have occasion to attend to personalised tutorials in the office of the professor in the schedule that the professors will establish for this effect to principle of course and that will publish in the page of the subject They will be able to also arouse his queries by telematic way.
Laboratory practises	The students will have occasion to attend to personalised tutorials in the office of the professor in the schedule that the professors will establish for this effect to principle of course and that will publish in the page of the subject They will be able to also arouse his queries by telematic way.
Tests	**Description**
Short answer tests	The students will have occasion to attend to personalised tutorials in the office of the professor in the schedule that the professors will establish for this effect to principle of course and that will publish in the page of the subject They will be able to also arouse his queries by telematic way.
Long answer tests and development	The students will have occasion to attend to personalised tutorials in the office of the professor in the schedule that the professors will establish for this effect to principle of course and that will publish in the page of the subject They will be able to also arouse his queries by telematic way.
Other	The students will have occasion to attend to personalised tutorials in the office of the professor in the schedule that the professors will establish for this effect to principle of course and that will publish in the page of the subject They will be able to also arouse his queries by telematic way.

Assessment

	Description	Qualification	Training and Learning Results	
Short answer tests	Final examination: it consists in a proof for the evaluation of the competencies adquired by the students by means of the resolution of simple problems and short questions of theory.	50	A2 A4	C2 C5
Long answer tests and development	Final exam: it consists in a proof for the evaluation of the competencies adquired by the students. They will have to develop, organise and present the knowledges adquired during the course.	20	A2 A4	C2 C5
Other	Participation in activities by part of the students, especially of the practices. This section corresponds to the continuous evaluation of the student.	30	A2 A4	C2 C5

Other comments on the Evaluation

In accordance with the memory of the title, and since, in fulfillment of the rule of the University of Vigo, a student that do not opt by continuous evaluation can obtain the maximum qualification by means of the final examination, the final examination, that will consist of the proof of short answer and the proof of development will be able to represent between 70% for the students that opt by continuous evaluation and 100% of the final note in case of not opting by the continuous evaluation.

Sources of information

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

Recommendations

Subjects that continue the syllabus

(*)Antenas/V05M145V01208
(*)Laboratorio de Radio/V05M145V01209
(*)Satélites/V05M145V01311
(*)Sistemas Radio en Banda Ancha/V05M145V01312

IDENTIFYING DATA				
(*)Tecnoloxías de Rede				
Subject	(*)Tecnoloxías de Rede			
Code	V05M145V01104			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Mandatory	1st	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	López Ardao, José Carlos			
Lecturers	López Ardao, José Carlos			
E-mail	jardao@det.uvigo.es			
Web	http://www.socialwire.es			
General description	This subject has a two-fold objective. On the one hand, it is a formative supplement within the scope of the Network Technologies, for students of the GETT that did not study the speciality of Telematic Engineering, covering basic concepts of this. And, on the other hand, it gets a deeper insight in these contents, and also in those seen in the subject Redes de Ordenadores (Computer Networks) (2nd GETT).			

Competencies	
Code	
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
B12	CG12 To have skills for lifelong, self-directed and autonomous learning.
C4	CE4 The ability to design and plan networks for transporting, broadcasting and distribution of multimedia signals.
C6	CE6 The ability to model, design, implement, manage, operate, and maintain networks, services and contents.
C7	CE7 The capacity for planning, decision making and packaging of networks, services and applications, taking into account the quality of service, direct and operating costs, plan implementation, monitoring, safety procedures, scaling and maintenance, as well as managing and ensuring quality in the development process.
C12	CE12 The ability to use programmable logic devices, as well as to design advanced electronic systems, both analog and digital. The ability to design communications components such as routers, switches, hubs, transmitters and receivers in different bands.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Know how to model mathematically the essential elements of a network of telecommunications	A5 B1 B4 B8 B12 C4 C6 C7
Understand the fundamental results on the capacity for different types of networks	B1 B4 B8 C4 C6 C7

Understand, formulate and solve simple models for analyzing the performance of a computer network	B1 B4 B8 C4 C6 C7 C12
Know how to plan, design and deploy switched networks and IP networks in any application environment	A5 B1 B4 B8 B12 C4 C6 C7
Know and understand the internal architecture of the switching equipment, methods of resource allocation and the basic techniques of providing Quality of Service	A5 B1 B4 B8 B12 C4 C6 C12

Contents	
Topic	
1. Network Modeling (I)	a) Links: Statistical Multiplexing and queues b) Loss and Delay Analysis in queues
2. Network Modeling (II)	a) Queue Networks b) Network Capacity. Maximum flow minimum cut c) Utility Function
3. Switching	a) Switching Architectures b) IQ and OQ Switches c) MaxWeight Schduling d) Low complexity Scheduling Algorithms
4. Design and planning of networks Ethernet	a) Management and planning of VLANs. VTP b) Advanced STP c) Link Aggregation d) Planning Guidelines
5. Intradomain Routing	a) Intradomain Routing Algorithms b) RIP and RIPv2 c) OSPF
6. Interdomain Routing	a) BGP
7. Design and planning of IP networks	a) ACLs and traffic filtering b) Route Maps and Prefix Lists c) NAT d) DHCP e) The network of an ISP
8. Traffic Engineering and MPLS	a) Traffic Engineering b) MPLS: Description and basic concepts c) Label Distribution: LDP d) MPLS-TE
9. Quality of Service	a) Basic Concepts of QoS b) Traffic shaping and policing c) Active Queue Management (AQM) d) Bandwidth Sheduling e) QoS in Ethernet: 802.1p f) QoS in IP
10. IPv6 Networks	a) The IPv6 protocol. Differences with IPv4 b) Transition: Dual stack and IPv4-on-IPv6 tunnels c) Routing in IPv6 d) DNS and IPv6 e) ICMPv6 and Neighbor Discovery

11. Multimedia	a) Types of service and multimedia applications: VoIP, IPTV, VoD b) Impact of the delay and losses in multimedia applications c) Objective and Subjective Quality d) Transport in real time: RTCP, RTP, RTSP e) Signaling in IP networks: SIP f) Streaming Multimedia Systems: Streaming UDP and HTTP

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practises	6	6	12
Autonomous practices through ICT	0	10	10
Master Session	30	60	90
Long answer tests and development	2	0	2
Long answer tests and development	2	0	2
Troubleshooting and / or exercises	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
Laboratory practises	Practices of design, planning and architecture in different network scenarios and with different protocols, using GNS3 emulator. This methodology is related to the competencies CB5, CG1, CG8, CG12, CE4, CE6 and CE7
Autonomous practices through ICT	The practices of laboratory will entail the development of autonomous practices by the student. With this methodology will work the competitions CB5, CG1, CG8, CG12, CE4, CE6 and CE7
Master Session	Exposition of the ideas, concepts, technical and algorithms belonging to the lessons of the course. This also includes the resolution of problems and theoretical questions in the classroom, and two sessions of an hour for midterm exams, and a session of two hours for the final exam. With this methodology will work the competitions CG1, CG4, CG8, CE4, CE6, CE7 and CE12

Personalized attention

Methodologies	Description
Master Session	Individually personalized attention and attendance will be dispensed. The tutorial schedule will be announced at the beginning of the course. No appointment is necessary.
Laboratory practises	Individually personalized attention and attendance will be dispensed. The tutorial schedule will be announced at the beginning of the course. No appointment is necessary.

Assessment

	Description	Qualification	Training and Learning Results	
Long answer tests and development	Two exams will be done. The first one will cover lessons 1 to 3 and the second one lessons 4 to 7. Each partial exam has a 15% weight.	30	B4 B8 B12	C4 C6 C7 C12
Long answer tests and development	Final exam covering all the lessons.	50	B4 B8 B12	C4 C6 C7 C12
Troubleshooting and / or exercises	Participation in activities of in the virtual environment. This will essentially consists of the resolution of selected problems, ideas contests proposed by teachers, and participating in forums for questions and answers. This participation has a 20% weight in the final grade.	20	A5 B4 B8 B12	C4 C6 C7 C12

Other comments on the Evaluation

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

Continuous Evaluation (CE) will consist of three previous tests and a final exam

- Two midterm exams (ME1 and ME2) in weeks 5 and 9, covering, respectively, the contents of the lessons 1 to 3, and 4 to 7. Each midterm exam has a 15% weight in the Final Qualification (FQ).
- Participation in the online activities (OA) in virtual environment, that represent 20% of the Final Qualification (FQ).
- A final exam (FE) covering all contents, with a weight of 50% of the Final Qualification (FQ).

FQ-CE = 0.15x(ME1 + ME2) + 0.2xAO + 0,5xFE

Single evaluation (SE) will only consist of the same FE at the end of the term.

It is considered that a student chooses CE when presenting to the first midterm exam (ME1), election to be held until end of course.

Students who do not present to this EP1 compulsorily opt for the Single Evaluation.

A new final exam (FE) will be done in the official dates in July, in order to improve the qualification with respect to May,

The qualifications for all exams, partial or final, and activities will affect only the actual academic year.

Sources of information
R. Srikant & Lei Ying, **Communication Networks**, Cambridge University Press,
Villy B. Iversen, **Teletraffic Engineering Handbook**, Web,
Villy B. Iversen, **Teletraffic Engineering and Network Planning**, Web,
J.F. Kurose, K.W. Ross, **Computer networking: a top-down approach featuring the Internet**, 6ª,
Kun I. Park, **QoS in packet networks**, 1ª,
Pazos Arias, J.J., Suárez González, A., Díaz Redondo, R.P., **Teoría de colas y simulación de eventos discretos**,
M.J. Newman, **Networks**, Oxford Univ. Press,
Diane Teare, **Implementing Cisco IP Routing (ROUTE) Foundation Learning Guide**, Cisco Press,
Richard Froom, Balaji Sivasubramanian, Erum Frahim, **Implementing Cisco IP Switched Networks (SWITCH) Foundation Learning Guide**, Cisco Press,

Recommendations

IDENTIFYING DATA				
(*)Tecnoloxías de Aplicación				
Subject	(*)Tecnoloxías de Aplicación			
Code	V05M145V01105			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Mandatory	1st	1st
Teaching language	Spanish English			
Department				
Coordinator	Díaz Redondo, Rebeca Pilar			
Lecturers	Díaz Redondo, Rebeca Pilar Fernández Vilas, Ana			
E-mail	rebeca@det.uvigo.es			
Web	http://http://http://faitic.uvigo.es/			
General description	Students will obtain a global picture of the main technological resources to design telematics applications. Basic problems like distributed computing, interoperability and services discovering will be addressed. These concepts will be study in the framework of the cloud computing paradigm.			

Competencies	
Code	
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
B12	CG12 To have skills for lifelong, self-directed and autonomous learning.
C4	CE4 The ability to design and plan networks for transporting, broadcasting and distribution of multimedia signals.
C8	CE8 The ability to understand and know how to apply the operation and organization of the Internet, new generation Internet technologies and protocols, component models, middleware and services.
C9	CE9 The ability to solve convergence, interoperability and design of heterogeneous networks with local, access and trunk networks; as well as the integration of telephonic, data, television and interactive services.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Know and apply the different communication techniques for communication and distributed computing	A5 B1 B4 B12 C4
Know and apply the techniques for data sharing to enable interoperability among systems and/or services	A5 B1 B8 B12 C4 C9
Know and apply how to specify and discover software services to be integrated in complex telematic solutions	A5 B1 B4 B8 B12 C4 C9

Know and apply virtualization concepts : cloud computing and content distribution networks.	A5 B1 B12 C4 C8

Contents	
Topic	
1. Cloud computing: overview	a. Service models (IaaS, PaaS, SaaS) and deployment models b. Reference architectures for cloud applications: virtualization
2. Cloud Computing: AWS	a. Commercial platforms: AWS b. Data Storage
3. Distributed computing	a. Parallel computing b. Distributed computing c. Taking decisions in distributed systems
4. Data management	a. Choosing data store types b. Data storage approaches c. Distributed File Systems
5. Parallel computing	a. MapReduce b. Hadoop

Planning			
	Class hours	Hours outside the classroom	Total hours
Laboratory practises	3	21	24
Master Session	32	34	66
Practical tests, real task execution and / or simulated.	3	30	33
Short answer tests	2	0	2
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Laboratory practises	Students will design and develop small prototypes and software solutions to reinforce the theoretical concepts explained in master sessions.
Master Session	Teachers will combine both concepts explanation and toy examples resolution. Resolution of small situations at class will foster debates, especially if it is done in groups.

Personalized attention	
Methodologies	**Description**
Master Session	Students will develop different software solutions. They will be weekly monitored in order to assess their progress and receive personalized recommendations about their solutions.
Laboratory practises	Students will develop different software solutions. They will be weekly monitored in order to assess their progress and receive personalized recommendations about their solutions.

Assessment					
	Description	Qualification	Training and Learning Results		
Practical tests, real task execution and / or simulated.	Students willl design and implement software solutions for different small problems.	40	A5	B1 B8 B12	C4 C8
Short answer tests	Written exam wich combines test and short answer questions. No extra material is allowed.	60	A5	B4 B8 B12	C8 C9

Other comments on the Evaluation

Students can follow up a continuous assessment model or decide to do a final exam. This selection should be done by 7th week. Once a student selects "continuous evaluation" his/her mark will never be "not taken".

1- CONTINUOUS ASSESSMENT

Final mark within this assessment schema will be composed by adding the marks obtained after the assessment of the following assignments:

- Writing exam
    - Dates: official calendar
    - Maximum score = 6 points
    - Minimum score required to pass = 2 points
- 2 intermediate practical assignments
    - Dates: 9th week, 13th week
    - Maximum score = 4 points

2- FINAL EXAM
Final mark within this assessment schema will be composed by adding the marks obtained after the assessment of the following assignments:

- Writing exam
    - Dates: official calendar
    - Maximum score = 6 points
    - Minimum score required to pass = 2 points
- 1 practical assignment
    - Dates: last week
    - Maximum score = 4 points

3- EXTRAORDINARY ASSESSEMENT
Students will be assessed using the "final exam" schema.

Sources of information

4.1 Basic bibliography

[2] "*Architecting the cloud*". Michael J. Kavis. 2010, Wiley

4.2 Complementary bibliography

[1] "*Cloud computing: principles and paradigms*". Rajkumar Buyya, James Broberg, Andrzej Goscinski. 2014, Wiley.

[3] "*Cloud Computing Bible*". Barrie Sosinsky. 2010, John Wiley & Sons

Recommendations

IDENTIFYING DATA				
(*)Deseño de Circuitos Electrónicos Analóxicos				
Subject	(*)Deseño de Circuitos Electrónicos Analóxicos			
Code	V05M145V01106			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Mandatory	1st	1st
Teaching language	Spanish Galician English			
Department				
Coordinator	Pastoriza Santos, Vicente			
Lecturers	Costas Pérez, Lucía Pastoriza Santos, Vicente			
E-mail	vpastoriza@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main purpose of this subject is that the student acquires the knowledge and the skills to be able to analyze and design analogue electronic circuits of low frequency, which are most frequently used in data acquisition systems and electronic instrumentation systems. Course outline: +Introduction to electronic systems for signal acquisition: functional block diagrams and architectures. +Feedback: definition and topologies. +Introduction to sensors: definition and classification. +Introduction to signal conditioning circuits. Auxiliary circuits: linearization circuits. Level-shifting circuits. Precision rectifiers. Voltage references. Voltage-to-current conversion. Analog switches and multiplexers. +Amplification in electronic measurement systems: instrumentation amplifiers, programmable amplifiers, and isolation amplifiers. +Active filters. +Sample-and-hold circuits, digital-to-analog and analog-to-digital converters. The main goal of the laboratory sessions (practical work) is to enable the students to acquire sufficient understanding and knowledge to: + Assemble electronics circuits. + Use of laboratory instrumentation to measure of physical variables on circuits. + Detect and correct assembly errors. + Manage specific software tools developed to design, simulation and analysis of analogue electronic system.			

Competencies	
Code	
A4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C12	CE12 The ability to use programmable logic devices, as well as to design advanced electronic systems, both analog and digital. The ability to design communications components such as routers, switches, hubs, transmitters and receivers in different bands.
C14	CE14 The ability to develop electronic instrumentation, as well as transducers, actuators and sensors.

Learning outcomes	
Expected results from this subject	Training and Learning Results

Know analyse and design analogue electronic circuits of low frequency.	A4 B4 B8 C12 C14
Know the parts that constitute an electronic measurement system.	A5 B4 C12 C14
Know the principle of operation of sensors and their conditioners.	A5 B4 C12 C14
Know model an analogue electronic system by means of hardware description languages.	A4 B4 B8 C12 C14

Contents	
Topic	
Unit 1: Introduction	Analog systems for signal acquisition: Architectures. Functional block diagrams. Feedback: Definition. Topologies. Series-Parallel feedback. Through this unit the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Unit 2: Auxiliary circuits	Sensors and signal conditioners: Sensors: Definition and classification. Signal conditioners for resistive sensors: The voltage divider. Wheatstone bridge. Other conditioning circuits. Linearization circuits. Level-shifting circuits: DC level shifter and gain calibration. Precision rectifiers: Half-wave rectifiers and full-wave rectifiers. Voltage references and current sources: Voltage references: Introduction. Performance specifications. Basic circuit. Self-regulated circuit. Thermal stabilization. Voltage-to-current converter circuits: Introduction. Floating-load converters. Grounded-load converters. Analog Switches and Multiplexers Switches: Definition. Types. Applications. Commercial devices. Multiplexers: Definition. Types. Specifications. Through this unit the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Unit 3: Amplification in signal acquisition systems	Instrumentation amplifiers: Introduction. Definition and ideal characteristics. Real model. Basic configurations. Specifications. Functional block diagram. Applications. Commercial amplifiers and their data sheets. Programmable amplifiers: Introduction. Types. Pin Programmable Gain Amplifier. PGA: Programmable Gain Amplifier. Commercial amplifiers and their data sheets. Isolation amplifiers: Introduction. Classification criteria. Types: capacitive coupled, transformer coupled, and optically coupled. Basic structure. Applications and limitations. Examples. Commercial amplifiers and their data sheets. Through this unit the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.

Unit 4: Active filters	introduction: Fundamentals. Basic filter types. Real parameters. Description by transfer function: Introduction. Transfer function: poles and zeros, stability analysis and frequency response. First order and second order filters. Approximation of filter transfer function: Steps in the realization of active filters. Filter specifications. Mathematical approximation of the characteristic function. Transfer function normalization. Transfer function normalization. Transformation from one type of filter into another. Polynomial approximations: Butterworth and Chebyshev. Synthesis: Introduction. Methods. Direct design. Basic topologies of direct synthesis: voltage control voltage source (KRC or Sallen-Key) and Multiple Feedback (MFB). Cascade design. Comparison of methods. Scaling. Through this unit the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Unit 5. Sample-and-hold circuits. Digital-to-analog and analog-to-digital converters	Sample-and-hold circuits: Background. Specifications. Architectures. Commercial devices. Digital-to-analog converters: Introduction. Fabrication parameters. Errors. Linear resistive network. Weighted resistive network. R-2R resistor ladder network. Analog-to-digital converters: Introduction. Fabrication parameters. Errors. Full-flash converters. Semi-flash converters (sub-ranging). Pipeline converters. Integrating converters: single or double analogue slope. Successive approximation converters. Commercial devices. Through this unit the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
(*)Práctica 1: Circuítos auxiliares.	(*)Montaxe e verificación dun circuíto que se comporta como fonte de tensión de referencia. Montaxe e verificación dun circuíto que se comporta como fonte de corrente. Nesta práctica traballaranse as competencias CB4, CB5, CG4, CG8, CE12 e CE14.
(*)Práctica 2: Amplificador de instrumentación.	(*)Montaxe e análise dun amplificador de instrumentación baseado en tres operacionais a partir de compoñentes discretos. Montaxe e análise dun amplificador de instrumentación comercial con ganancia axustable por potenciómetro. Nesta práctica traballaranse as competencias CB4, CB5, CG4, CG8, CE12 e CE14.
(*)Práctica 3: Filtros activos.	(*)Montaxe dun filtro activo. Identificación da topoloxía, a orde, e o tipo de filtro. Cálculo a súa frecuencia de corte teórica. Comprobación da súa resposta en frecuencia utilizando o xerador de funcións e o osciloscopio. Representar a magnitude da resposta en frecuencia do filtro (diagrama de magnitude de Bode). Nesta práctica traballaranse as competencias CB4, CB5, CG4, CG8, CE12 e CE14.
(*)Práctica 4: Sistema de medida dunha variable física baseada nun sensor comercial.	(*)Deseño do circuíto de acondicionamento dun sistema de medida baseado nun sensor comercial a partir dos circuítos utilizados e as habilidades adquiridas nas prácticas previas. Nesta práctica traballaranse as competencias CB4, CB5, CG4, CG8, CE12 e CE14.
(*)Práctica 5: Estimación e análise dos parámetros característicos dunha tarxeta de adquisición de datos comercial.	(*)Estimación dos devanditos parámetros nas canles de entrada/saída analóxicos/dixitais dunha tarxeta de adquisición de datos comercial. Nesta práctica traballaranse as competencias CB4, CB5, CG4, CG8, CE12 e CE14.

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	2	3
Master Session	13	19	32
Troubleshooting and / or exercises	8	12	20
Others	5	12	17
Laboratory practises	10	10	20
Multiple choice tests	3	30	33
*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. In these sessions, the skills CB4, CB5, CG4, CG8, CE12 and CE14 will be worked.
Master Session	The lecturer will explain in the classroom the main contents of the subject. The students have to manage the proposed bibliography to carry out a self-study process in a way that leads to acquire the knowledge and the skills related to the subject. The lecturer will answer the students questions in the classroom or at the office. In these sessions, the skills CB4, CB5, CG4, CG8, CE12 and CE14 will be worked.
Troubleshooting and / or exercises	Actividad complementaria de las sesiones magistrales en la que se formulan problemas y/o ejercicios relacionados con la asignatura. El estudiante deberá desarrollar las soluciones adecuadas de los problemas y/o ejercicios propuestos en el aula y de otros extraídos de la bibliografía. Se identificarán posibles dudas que se resolverán en el aula o en tutorías personalizadas. En estas clases se trabajarán las competencias A4, A5, A9, A13, A30 y A32.
Others	Actividad complementaria de las sesiones magistrales, los estudiantes deberán realizar un proyecto teórico-práctico en un tiempo determinado para resolver un problema mediante la planificación, diseño y realización de una serie de actividades. En grupos reducidos se definirán las actividades, se analizarán las posibles soluciones y alternativas de diseño, se identificarán los elementos fundamentales y se analizarán los resultados. El trabajo autónomo será guiado y supervisado por el profesor en el transcurso de las sesiones de tutoría en grupo (horas tipo C). Todas las sesiones tendrán lugar en el laboratorio. En estas clases se trabajarán las competencias A4, A5, A9, A13, A30 y A32.
Laboratory practises	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 lecturer s office. In these practises, the skills CB4, CB5, CG4, CG8, CE12 and CE14 will be worked.

Personalized attention	
Methodologies	**Description**
Master Session	Sesión magistral: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre los contenidos impartidos en las sesiones magistrales y se les orientará sobre como abordar su estudio. Resolución de problemas y/o ejercicios: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre los problemas y/o ejercicios propuestos y resueltos en el aula así como de otros problemas y/o ejercicios que puedan aparecer a lo largo del estudio de la asignatura. Otros: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. El profesorado atenderá dudas y consultas de los estudiantes sobre el proyecto teórico-práctico propuesto. Prácticas de laboratorio: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre el desarrollo de las prácticas de laboratorio, el manejo de la instrumentación, el montaje de circuitos y las herramientas de programación.

Troubleshooting and / or exercises	Sesión magistral: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre los contenidos impartidos en las sesiones magistrales y se les orientará sobre como abordar su estudio. Resolución de problemas y/o ejercicios: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre los problemas y/o ejercicios propuestos y resueltos en el aula así como de otros problemas y/o ejercicios que puedan aparecer a lo largo del estudio de la asignatura. Otros: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. El profesorado atenderá dudas y consultas de los estudiantes sobre el proyecto teórico-práctico propuesto. Prácticas de laboratorio: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre el desarrollo de las prácticas de laboratorio, el manejo de la instrumentación, el montaje de circuitos y las herramientas de programación.
Laboratory practises	Sesión magistral: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre los contenidos impartidos en las sesiones magistrales y se les orientará sobre como abordar su estudio. Resolución de problemas y/o ejercicios: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre los problemas y/o ejercicios propuestos y resueltos en el aula así como de otros problemas y/o ejercicios que puedan aparecer a lo largo del estudio de la asignatura. Otros: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. El profesorado atenderá dudas y consultas de los estudiantes sobre el proyecto teórico-práctico propuesto. Prácticas de laboratorio: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre el desarrollo de las prácticas de laboratorio, el manejo de la instrumentación, el montaje de circuitos y las herramientas de programación.
Others	Sesión magistral: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre los contenidos impartidos en las sesiones magistrales y se les orientará sobre como abordar su estudio. Resolución de problemas y/o ejercicios: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre los problemas y/o ejercicios propuestos y resueltos en el aula así como de otros problemas y/o ejercicios que puedan aparecer a lo largo del estudio de la asignatura. Otros: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. El profesorado atenderá dudas y consultas de los estudiantes sobre el proyecto teórico-práctico propuesto. Prácticas de laboratorio: Los estudiantes tendrán ocasión de acudir a tutorías personalizadas o en grupos en el despacho del profesorado en el horario que se establecerá a tal efecto a principio de curso y que se publicará en la página web de la asignatura. En dichas tutorías se atenderán dudas y consultas de los estudiantes sobre el desarrollo de las prácticas de laboratorio, el manejo de la instrumentación, el montaje de circuitos y las herramientas de programación.

Assessment

	Description	Qualification	Training and Learning Results
Others	El estudiante deberá realizar un proyecto teórico-práctico que será evaluado teniendo en cuenta los resultados obtenidos, la presentación y análisis de los mismos, así como la calidad de la memoria final entregada. La nota final del proyecto (NPT: Nota del Proyecto Tutelado) estará comprendida entre 0 y 10 puntos. En este trabajo se evaluarán las competencias A4, A5, A9, A13, A30 y A32.	10	A4 B4 C12 A5 B8 C14

Laboratory practises	Se evaluarán las competencias adquiridas por el estudiante sobre los contenidos de las prácticas de laboratorio de la asignatura. Para ello, se tendrá en cuenta el trabajo de preparación previa, la asistencia y el trabajo desarrollado durante las sesiones en el laboratorio. La nota final de prácticas de laboratorio (NPL) estará comprendida entre 0 y 10 puntos. En estas prácticas se evaluarán las competencias A4, A5, A9, A13, A30 y A32.	30	A4 B4 C12 A5 B8 C14
Multiple choice tests	Pruebas objetivas, pruebas de teoría, que se realizarán después de cada grupo de temas expuestos en las sesiones magistrales para evaluar los conocimientos adquiridos por el estudiante. La nota final de estas pruebas objetivas (NPO) estará comprendida entre 0 y 10 puntos. En estas pruebas se evaluarán las competencias A4, A5, A9, A13, A30 y A32.	60	A4 B4 C12 A5 B8 C14

Other comments on the Evaluation

1. Evaluación continua

Siguiendo las directrices propias de la titulación y los acuerdos de la comisión académica se ofrecerá a los alumnos que cursen esta asignatura un sistema de evaluación continua.

Se entiende que los alumnos que realicen 1 prueba objetiva (prueba de teoría) o que falten como máximo a 1 sesión de prácticas de laboratorio **optan por la evaluación continua** de la asignatura.

La evaluación de la asignatura se divide en pruebas objetivas (60%) y pruebas prácticas (40%). Las calificaciones de las tareas evaluables serán válidas sólo para el curso académico en el que se realizan.

1.a Pruebas objetivas (tipo test y/o preguntas cortas)

Se realizarán 2 pruebas parciales objetivas (PO), pruebas de teoría, debidamente programadas a lo largo del curso. La primera prueba se realizará en horario de teoría y será comunicada a los alumnos con suficiente antelación. La segunda prueba se realizará el mismo día que el examen final que se celebrará en la fecha que establezca la dirección de la Escuela. Las pruebas no son recuperables, es decir, que si un estudiante no puede asistir el día en que estén programadas el profesor no tiene obligación de repetirlas.

Cada prueba constará de una serie de preguntas cortas y/o de tipo test y/o resolución de problemas y/o ejercicios. La nota de cada prueba (PO) se valorará de 0 a 10 puntos. La nota de las pruebas a las que falte será de 0 puntos. Para superar esta parte de pruebas objetivas será necesario obtener al menos 5 puntos de 10 en cada una de ellas (PO1 > = 5 y PO2 >= 5). Si se ha obtenido menos de 5 puntos de 10 en la primera prueba (PO1 < 5), el alumno podrá recuperar dicha parte el mismo día de la segunda prueba objetiva.

Si PO1 > = 5 y PO2 >= 5 entonces la nota final obtenida en las pruebas objetivas (NPO) será la media aritmética de las notas de las pruebas:

NPO = (PO1 + PO2)/2

en caso contrario la nota será:

NPO = 5 -Suma(Ai)/2 siendo Ai = max({0; 5-POi}) para i= 1, 2.

1.b Pruebas prácticas

1.b.1 Prácticas de laboratorio

Se realizarán 5 sesiones de prácticas de laboratorio de 2 horas en grupos de 2 alumnos. Cada una de ellas se evaluará únicamente el día de la práctica.

Para la valoración de esta parte se tendrá en cuenta el trabajo de preparación previa, la asistencia y el trabajo desarrollado durante las sesiones en el laboratorio. Cada práctica se valorará con una nota (PL) entre 0 y 10 puntos. La nota de las prácticas a las que se falte será de 0. La nota final de las prácticas de laboratorio (NPL) será la media aritmética de todas ellas:

NPL = Suma(PLi)/5; i= 1, 2, ..., 5.

Para superar esta parte práctica será necesario obtener al menos 5 puntos de 10 en NPL. Además, el alumno sólo podrá faltar a 1 sesión de laboratorio, y sólo si se trata de una falta debidamente justificada.

1.b.2 Proyecto tutelado

En la primera sesión de tutoría en grupo (horas tipo C) se presentarán todas las actividades a realizar y se asignará el

proyecto concreto a cada estudiante. El trabajo presencial se llevará a cabo en las restantes sesiones de tutoría en grupo (horas tipo C).

Para evaluar el proyecto se tendrán en cuenta los resultados obtenidos, y la calidad de la presentación y análisis de los mismos. El proyecto se valorará con una nota (NPT: Nota del Proyecto Tutelado) de 0 a 10 puntos.

Para superar esta parte práctica la nota final del proyecto tutelado (NPT) tendrá que ser de al menos 5 puntos de 10 y el estudiante no podrá haber faltado a más de 1 sesión. La falta deberá ser debidamente justificada.

1.c Nota final de la asignatura

En la nota final (NF), las pruebas objetivas tendrán un peso del 60% y las pruebas prácticas el restante 40% (el 30% de NF corresponderá a la nota final obtenida en las prácticas de laboratorio (NPL) y el 10% de NF a la nota obtenida en el proyecto tutelado (NPT)). Para aprobar la asignatura será imprescindible haber superado la parte de pruebas objetivas (parte de teoría), la parte de prácticas de laboratorio y la parte del proyecto tutelado. En este caso la calificación final será la suma ponderada de las notas de cada parte:

NF = 0,60·NPO + 0,30·NPL + 0,10·NPT

En el caso de no haber alcanzado el mínimo de 5 puntos en alguna de las pruebas parciales objetivas (PO1 < 5 o PO2 < 5), o de no haber superado alguna de las partes prácticas (NPL < 5 o NPT < 5), o de haber faltado a más de 1 sesión de prácticas de laboratorio o a más de 1 sesión de proyecto tutelado, la nota final será la obtenida con la siguiente expresión:

NF = 0,60·NA + 0,30·NB + 0,10·NC, donde:

NA = 5 -Suma(Ai)/2 siendo Ai = max({0; 5-POi}) para i= 1, 2.

NB = min({5; NPL})

NC = min({5; NPT})

Para aprobar la asignatura será necesario obtener una nota final NF>=5.

2. Examen final

Los alumnos que no opten por la evaluación continua podrán presentarse a un examen final que constará de una serie de actividades evaluables similares a las que se contemplan en la evaluación continua. Así, en las fechas establecidas por la dirección de la Escuela para la realización del examen final, los estudiantes que no hayan optado por la evaluación continua deberán realizar dos pruebas objetivas, una prueba práctica en el laboratorio, y entregar una memoria final de un proyecto tutelado previamente asignado.

Las dos pruebas objetivas constarán de una serie de preguntas cortas y/o de tipo test y/o resolución de problemas y/o ejercicios. Estas prueba objetivas, PO1 y PO2, se valorarán de 0 a 10 puntos.

La prueba práctica realizada en el laboratorio se valorará de 0 a 10 puntos y la nota final de prácticas de laboratorio (NPL) será la calificación obtenida.

Para evaluar el proyecto tutelado se tendrán en cuenta los resultados obtenidos, y la calidad de la presentación y análisis de los mismos. El proyecto se valorará con una nota (NPT) de 0 a 10 puntos.

Para aprobar la asignatura será imprescindible haber obtenido un mínimo de 5 puntos sobre 10 en PO1, PO2, NPL y NPT. En este caso la calificación final será la obtenida con la siguiente expresión:

NF = 0,60·NPO + 0,30·NPL + 0,10·NPT, donde:

NPO será la media aritmética de las notas de las pruebas objetivas:

NPO = (PO1 + PO2)/2

En el caso de no haber alcanzado el mínimo de 5 puntos en alguna de las pruebas objetivas (PO1 < 5 o PO2 < 5), o de no haber superado alguna de las pruebas prácticas (NPL < 5 o NPT < 5), la nota final será la obtenida con la siguiente expresión:

NF = 0,60·NA + 0,30·NB + 0,10·NC, donde:

NA = 5 -Suma(Ai)/2 siendo Ai = max({0; 5-POi}) para i= 1, 2.

NB = min({5; NPL})

NC = min({5; NPT})

Para aprobar la asignatura será necesario obtener una nota final NF>=5.

3. Segunda oportunidad para superar la asignatura

Esta oportunidad constará de una serie de actividades evaluables similares a las que se contemplan en la evaluación continua. Tendrá el mismo formato que el examen final y se celebrará en la fecha que establezca la dirección de la Escuela. Para la asignación del proyecto tutelado el estudiante debe apuntarse previamente siguiendo el procedimiento indicado por el profesorado con suficiente antelación.

A los estudiantes que se presenten a esta segunda oportunidad se les conservará la nota que hayan obtenido en la primera (evaluación continua o examen final) en las partes a las que no se presenten. Además, en esta ocasión los estudiantes sólo podrán presentarse a aquellas pruebas que no hayan superado en la primera oportunidad.

El cálculo de la nota final de la asignatura se realizará tal y como se explica en el apartado 2.

Sources of information
Pérez García, M.A., **Instrumentación Electrónica**, 1ª ed.,
Franco, S., **Diseño con amplificadores operacionales y circuítos integrados analógicos**, 3ª ed.,
Fraile Mora, J., García Gutiérrez, P., y Fraile Ardanuy, J., **Instrumentación aplicada a la ingeniería**, 3ª ed.,
Pallás Areny, R., **Sensores y Acondicionadores de Señal**, 4ª ed.,
Pallás Areny, R., Casas, O., y Bragó, R., **Adquisición y Distribución de Señales: problemas resueltos**,
Pérez García, M.A., Álvarez Antón, J.C., Campo Rodríguez, J.C., Ferrero Martín F.C., y Grillo Ortega, **Instrumentación Electrónica**, 2ª ed.,
Pérez García, M.A., **Instrumentación Electrónica: 230 problemas resueltos**, 1ª ed.,

Recommendations
Subjects that continue the syllabus
(*)Circuítos Mixtos Analóxicos e Dixitais/V05M145V01213

IDENTIFYING DATA				
(*)Dirección de Proxectos de Telecomunicación				
Subject	(*)Dirección de Proxectos de Telecomunicación			
Code	V05M145V01201			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Mandatory	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	González Castaño, Francisco Javier			
Lecturers	González Castaño, Francisco Javier Lorenzo Rodríguez, María Edita de			
E-mail	javier@det.uvigo.es			
Web	http://http://faitic.uvigo.es			
General description	A real approach to telecommunications projects management, including knowledge of telecommunications companies and how they are organized, and novel methodologies for project management and human resoruce management. Knowledge of the main operational divisions: executive, technical, commercial and support.			

Competencies	
Code	
B2	CG2 The capacity for managing projects and telecommunication systems facilities, complying with current legislation, ensuring the quality of service.
B3	CG3 The ability to lead, plan and monitor multidisciplinary teams.
B6	CG6 The capacity for general direction, technical direction and management of research, development and innovation projects in companies and technological centers.
B10	CG10 The ability to apply principles of economics and human resources and projects management, as well as legislation, regulation and standardization of telecommunications.
B13	CG13 The knowledge, understanding and ability to implement the necessary legislation in the exercise of the profession of Telecommunications Engineering.
C16	CE16/GT2 The capacity for the development, direction, coordination, and technical and financial management of projects on telecommunications systems, networks, infrastructure and services, including supervision and coordination of the accompanying work subprojects; common telecommunications infrastructures in buildings or residential areas, including projects on digital home; telecommunications infrastructure in transport, and environment; with the corresponding energy supply facilities, and evaluation of electromagnetic emissions and electromagnetic compatibility.
D1	CT1 Being able to predict and control the evolution of complex situations by developing new and innovative working methodologies matched to the specific scientific / research, technological or professional fields, generally multidisciplinary, in which their activities are conducted.
D5	CT5 Encourage cooperative work, communication skills, management, planning and acceptance of responsibilities in an environment of multilingual and multidisciplinary work, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes	
Expected results from this subject	Training and Learning Results
- Knowledge of procedures for innovation and creativeness.	B2 B3 B6 B10 B13 C16 D5
- Tools for telecommunications projects management.	B3 D1

- Management of ideas and innovation basics.	B2 B3 B6 B10 B13 C16 D5
- Knowledge of efficient project management.	B2 B3 B6 B10 B13 C16 D5

Contents	
Topic	
Telecommunications companies	- A career in the industry - Structure of a telecommunications company - Management roles Related competencies: CG3, CG6, CT5
Human resource management	- Motivational strategies - Performance analysis - Multidisciplinary coordination Related competencies: CG3, CG6, CT5
Work methodology	- Good practice methodologies - Project methodologies - Certifications Related competencies: CT1, CG5
Regulatory issues	- Specific regulations of Telecommunications Engineering - R&D regulations - Other (environmental, ethics, ...) Related competencies: CG2, CG10, CG13, CE16, CG5

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	10	10	20
Tutored works	5	25	30
Seminars	20	40	60
Reports / memories of practice	2	6	8
Jobs and projects	2	4	6
Multiple choice tests	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Master Session	Classroom lectures Related competencies: all
Tutored works	Group work on selected course contents Related competencies: all
Seminars	Invited conferences and discussion on their topics Related competencies: all

Personalized attention	
Methodologies	**Description**
Master Session	- Tutoring in official hours. - Course materials in TEMA platform (http://faitic.uvigo.es).
Tutored works	- Tutoring in official hours. - Course materials in TEMA platform (http://faitic.uvigo.es).

Seminars	- Tutoring in official hours. - Course materials in TEMA platform (http://faitic.uvigo.es).

Assessment

	Description	Qualification	Training and Learning Results		
Reports / memories of practice	Practical cases, to be presented as deliverables.	50	B2 B3 B6 B10 B13	C16	D1 D5
Jobs and projects	Practical work, to be presented as deliverables and defended in public	30	B2 B3 B6 B10 B13	C16	D1 D5
Multiple choice tests	Written exam	20	B2 B3 B6 B10 B13	C16	D1 D5

Other comments on the Evaluation

According to the degree directives, students will be granted two evaluation methodologies, continuous evaluation and evaluation at the end of the course. The former will consist in the preparation and defense of two assignments, at the middle and the end of the course, respectively.

Evaluation at the end of the course will consist in an exam at the official examination date including all course content.

In the second evaluation option, overall evaluation will consist in an exam at the official examination date including all course content.

Class atendance is mandatory.

Sources of information

E. Bueno Campos, **Organización de Empresas: estructura, procesos y modelos**, 2ª,
PMI, **PMBOK Guide and Standards**, 5ª,
F. J. Galán, **Coaching Inteligente ACCION**, Junio 2011,

Recommendations

IDENTIFYING DATA				
(*)Electrónica e Fotónica para Comunicacións				
Subject	(*)Electrónica e Fotónica para Comunicacións			
Code	V05M145V01202			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Mandatory	1st	2nd
Teaching language	Spanish English			
Department				
Coordinator	Fernández Barciela, Mónica			
Lecturers	Fernández Barciela, Mónica Fraile Peláez, Francisco Javier Isasi de Vicente, Fernando Guillermo			
E-mail	monica.barciela@uvigo.es			
Web				
General description	The aim of the subject is that the student adquires knowledge on the actual implementation of transceivers for the modern communication systems that transmit in the radiofrequency and optical bands bands. In the case of RF and MW transceivers, the student will learn to evaluate performance, select and design components and analog circuits (active and passive) for them. As an learning aid, the student will use commercial circuit simulators. In the field of the optical communications, the student will learn the operation of the basic transmission and reception components and active optoelectronical subsystems , and will be able to characterise them and select them as function of the optical system to be designed. In this subject the student will handle technical and scientific bibliography in English language.			

Competencies	
Code	
B1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
C2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.
C3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.
C12	CE12 The ability to use programmable logic devices, as well as to design advanced electronic systems, both analog and digital. The ability to design communications components such as routers, switches, hubs, transmitters and receivers in different bands.
C13	CE13 The ability to apply advanced knowledge of photonics, optoelectronics and high-frequency electronics.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Learn to evaluate preformance, select and design components and analog subsystems (active and passive) for communication transceptors in diferent frequency bands (radiofrequency, microwaves). As learning aid, the student will use circuit simulators.	B1 B4 C2 C3 C12 C13
Learn the operation of the components and basic transmission and reception active optoelectronical subsystems in optical communications and photonic processing, and being able to characterise them and select them as function of the optical system to design.	B1 B4 C2 C3 C13
Handle technical documentation and scientific bibliography in English	C13

Contents
Topic

1. Introduction to circuit design for RF and Microwave transceptors	a. Analog circuits for communication transceptors. b. Transceptor technologies for communication systems transmitting at different frequency bands. Applications. c. Basic concepts. Transmission lines. S parameters. Smith Chart. Impedance matching.
2. Passive circuit design	Couplers, filters and phase shifters.
3. Introduction to microwave linear amplifier design	a. Power and power gain definitions. Gain and noise circles. b. Stability. Stability circles. Bias and stabilization networks.
4. Microwave linear amplifier design	a. Maximum transducer gain design b. Low noise ampliifiiers c. Broadband amplifiers
5. Power amplifier design	a. Loadline and power contours. b. Operating Classes. c. Designing for linearity and efficiency.
6. Frequency converters design	Frequency multipliers and mixers.
7. Signal generators	a. Oscillator design. VCOs b. PLL basics c. PLL based synthesiers. d. Direct digital synthesis.
8. Photonics	a. Semiconductors optical properties. b. Fabry-Perot lasers and DFB. c. Photodetectors. Static and dynamic regime. d. Electro-optic and electro-absorbing modulators.

Planning

	Class hours	Hours outside the classroom	Total hours
Practice in computer rooms	8	0	8
Master Session	29	72.5	101.5
Short answer tests	1	0	1
Troubleshooting and / or exercises	2	4	6
Practical tests, real task execution and / or simulated.	0	8.5	8.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies

	Description
Practice in computer rooms	With the aid of a commercial microwave and RF circuit simulator, it will analysed various passive (matching networks, filters, couplers, etc.) and active (amplifiers, oscillators) circuits. It will be defined and evaluated different figures of merit and other parameters that will be used for circuits performance analysis. The work of the student in these practice classes will be evaluated: 1. In continuous evaluation: by answering in writting short questions delivered by the end of some of the practices, and with the microwave circuit design to be performed by the student. 2. In evaluation performed only in a final examination: by means of questions and circuit designs related with the work performed during the practical classes. In these practices the student with work towards achieving competencies: CE2, CE3, CE12 y CE13
Master Session	It will take place in a classroom with video projection facilities and blackboard. During these sessions it will be described in detail most of the contents in the subject programme. Competencies under work: CE2, CE3, CE12 y CE13

Personalized attention

Methodologies	Description
Master Session	The student will have available office hours in which the subject lecturers will solved his/her questions related to the practices in computer rooms or during master sessions. Besides, while in computer room practices, the lecturer will approach each student, guiding his/her work and answering his/her questions.
Practice in computer rooms	The student will have available office hours in which the subject lecturers will solved his/her questions related to the practices in computer rooms or during master sessions. Besides, while in computer room practices, the lecturer will approach each student, guiding his/her work and answering his/her questions.

Assessment

	Description	Qualification	Training and Learning Results
Practice in computer rooms	In the case of continuous evaluation, during the practices the student will provide written answers to several related questions. In the case of evaluation by single final examination, this part will be also evaluated in that examination. In these practices are evaluated competencies: A20, A21, A30, A31	10	C2 C3 C12 C13
Short answer tests	There will be 2 short examinations, one of them in the same date as the final examination of the students that do not follow continuous evaluation. The two short examinations and the final examination will include short answer tests. In these short examintaions it will be evaluated competencies : A20, A21, A30, A31	30	C2 C3 C12 C13
Troubleshooting and / or exercises	The 2 short examinations, mentioned above, and the Final Exam will include exercises resolution. Competencies under evaluation: A20, A21, A30, A31	40	C2 C3 C12 C13
Practical tests, real task execution and / or simulated.	For students following continous evalutation, it will be mandatory to perform a circuit desing using the circuit simulator, work proposed by the lecturer. Competencies under evaluation :A20, A21, A30, A31	20	C2 C3 C12 C13

Other comments on the Evaluation

A) If the student chooses continuous evaluation:

1. It will be compulsory the assistance to the practises in the computer room, as well as the realisation of a design of a microwave circuit by means of the circuit simulator. This design will be proposed by the lecturer and it will be an autonomous work of the student.
The evaluation of the practises will be a 10% of the total subject qualification, and the evaluation of the circuit design will be a 20%. That is to say, the sum of the evaluation of the practical classes and the design will add up to a 30% of the subject qualification.
2. The rest of the subject assessment (up to a 70% of the subject qualification) will be performed by two short exams that will contain exercises resolution, and/or short answers tests. The first short exam will assess up to a 30%, and the second up to a 40%, of the subject qualification.
Before realising the second short exam, the student must inform the lecturers about his choice of the method of evaluation.

B) If the student chooses a final exam:
It will only be considered the score he/she obtained in the final examination: in the exercises resolution (in the extensive version) and in the short question test related to: the theoretical part, and the practices in the computer room.

Second Assessment (July):
In July the students who did not pass the subject in May, will be assessed by an similar exam as that described in previous B option.
In particular, the students that in May chose continuous evaluation and declare the want to keep the scores obtained in the practises and in the design (that will add up to a 30% of the subject qualification), will perform a reduced version of the final examination described in the previous paragraph (and will add up to a 70% of the subject qualification).

Sources of information

D.M. Pozar, **Microwave Engineering**, 3,
Enrique Sánchez, **Introducción a los dispositivos y circuitos semiconductores de microondas**, 1,
Guillermo González, **Microwave Transistor Amplifiers: Analysis and Design**, 2,
Steve C. Cripps, **RF Power Amplifiers for Wireless Communications**, 1,
Steve C. Cripps, **Advanced Techniques in RF Power Amplifier Design**, 1,
Amnon Yariv, Pochi Yeh, **Photonics Optical Electronics in Modern Communications**, 6,
Bahaa E. A. Saleh, Malvin Carl Teich, **Fundamentals of Photonics**, 2,
S. O. Kasap, **Optoelectronics and Photonics: Principles and Practice**, 2,
Guillermo González, **Foundations of Oscillator Circuit Design**, 1,
Egan, William F., **Phase-lock basics**, 1,
Rhea, Randall W., **HF filter desing and computer simulation**, 1,
Rhea, Randall W., **Discrete oscillator design : linear, nonlinear, transient, and noise domains**, 1,

Recommendations

Subjects that continue the syllabus

(*)Microwave and Millimetre Wave Circuit Design and CAD/V05M145V01317

IDENTIFYING DATA				
(*)Sistemas Electrónicos Dixitais Avanzados				
Subject	(*)Sistemas Electrónicos Dixitais Avanzados			
Code	V05M145V01203			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Mandatory	1st	2nd
Teaching language	Spanish English			
Department				
Coordinator	Moure Rodríguez, María José			
Lecturers	Moure Rodríguez, María José Valdés Peña, María Dolores			
E-mail	mjmoure@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The objective of this course is to provide students with the ability to design complex or high frequency digital systems. Firstly, the electrical characteristics, power consumption, speed and fan-out of digital integrated circuits and the technologies of semiconductor memories are studied. Subsequently, the interface with external peripherals and the methodology for designing synchronous sequential systems are analyzed. Finally, the course focuses on the design of digital communications systems implemented using high density of integration programmable circuits. Meanwhile, throughout all contents, emphasis is placed in the VHDL description of high complexity digital systems.			

Competencies	
Code	
A4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C10	CE10 The ability to design and manufacture integrated circuits.
C11	CE11 The knowledge of hardware description languages for high complexity circuits.
C12	CE12 The ability to use programmable logic devices, as well as to design advanced electronic systems, both analog and digital. The ability to design communications components such as routers, switches, hubs, transmitters and receivers in different bands.
C14	CE14 The ability to develop electronic instrumentation, as well as transducers, actuators and sensors.

Learning outcomes	
Expected results from this subject	Training and Learning Results
The knowledge of the different technologies of integrated circuits manufacture.	C10
The ability to analyze and design advanced digital circuits.	B4 C12
The knowledge of different input/output technologies of digital circuits.	C14
The ability to design input/output interface circuits.	C10 C12 C14
The knowledge of the methodologies for the design of complex digital circuits.	A5 B8 C12
The ability to design communication components using programmable logic devices.	A4 B8 C11 C12
The ability to design complex digital electronic systems using hardware description languages.	C11

Contents

Topic	
Technologies of digital integrated circuits	CMOS technology: operating modes, logic gates and fabrication.
CMOS integrated circuits	Design metrics. Input/output. Timing parameters.
Sequential design	Synchronizers. State machine design.
Advanced VHDL	VHDL description of complex digital systems. Advanced structures.
Semiconductor memories	SRAM and DRAM memories, EEPROM. FLASH and PCM memories. Design of memory interfaces. VHDL description.
Sampling and signal reconstruction	ADC and DAC circuits. Sampling and reconstruction. Conversion errors.
Arithmetic in FPGAs	Numerical formats, overflow, precision, arithmetic circuits. VHDL description.
Retiming and pipeline techniques	Critical path and latency. Tecniques for the reduction of time delays. Hardware cost.
Frequency synthesis	Numeric controlled oscillators (NCOs). Parameters and design tecniques. Implementation using reconfigurable devices
Series vs. parallel implementations	Design techniques. Parallelism degree. Timing response. Hardware cost.
Laboratory Practices	Design of a storing and data transference system. Design of a complex interface with standard peripherals.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	18	25	43
Laboratory practises	10	5	15
Projects	9	30	39
Short answer tests	2	20	22
Practical tests, real task execution and / or simulated.	0	5	5
Jobs and projects	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Master Session	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.
Laboratory practises	During laboratory sessions students apply the design methods described in the master sessions. All the sessions are guided and supervised by the professor. The in-person sessions are developed in a laboratory with skilled equipment.
Projects	This activity focuses on applying the techniques described in the lecture classes and the skills developed at laboratory to a project implementation. The in-person 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.

Personalized attention	
Methodologies	**Description**
Master Session	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 timetable and place officially assigned. Besides, the group of students developing a project will attend periodic follow-up meetings.
Laboratory practises	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 timetable and place officially assigned. Besides, the group of students developing a project will attend periodic follow-up meetings.
Tests	**Description**
Jobs and projects	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 timetable and place officially assigned. Besides, the group of students developing a project will attend periodic follow-up meetings.

Assessment

	Description	Qualification	Training and Learning Results
Short answer tests	An objective evaluation will be realized at the end of the bimester. This exam asses all of the contents taught in the theoretical classes.	30	C10 C11 C12 C14
Practical tests, real task execution and / or simulated.	This evaluation are realized during the practical sessions. The assistance to the laboratory practices is mandatory and the student should complete at least 4 of the 5 sessions. The implementation of the circuits described in the practice guidelines and the reports submitted at the end on each session will deserve the 20% of the final qualification.	20	B4 C10 B8 C11 C12 C14
Jobs and projects	During the fisrt part of the bimester a job will be assigned to each student individually. This task will be related to any topics of the course and deserves the 20% of the final qualification. The students should also present a tutored project which deserves the 30% 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.	50	A4 B4 C10 A5 B8 C11 C12 C14

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. Students who assist to more than 2 laboratory sessions are graded using continuous assessment.

The weighting and content of each continuous assessment part are as follows:

1.1 Test (NExam):

- It covers all of the contents taught in the theoretical classes and includes short exercises or problems.
- The date of this test will be the same of the final exam.
- The student pass this part if he/she gets a mark greater than or equal to 4 over 10.

1.2 Laboratory practices (NPrac):

- The student should complete 4 of the 5 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.

1.3 Job (NTask):

- This task will be assigned to each student individually.
- The student should present a written report of this task**.**

1.4 Project (NPro):

- It can be developed individually or by groups of 2 students.
- It should be oral presented by the authors.
- The student will pass this part if he/she gets a mark greater than or equal to 4 over 10.

1.4 Final qualification of continuous assessment (Final_ca)

The final qualification (Final_ca) of continuous assessment is obtained as follows:

Final_ca: = (NExam*0.3 + NPrac*0.2 + NTask*0.2 + NPro*0.3) if NExam and Npro are greater than or equal to 4;

Final_ca = min [(NExam*0.3 + NPrac*0.2 + NTask*0.2 + NPro*0.3), 4.5] in other case;

The student who fails one or more of the parts of continuous assessment has another opportunity to pass the following parts in the final exam:

- He/she can improve his/her assigned job and this mark replaces the previous one (NTask).
- He/she can complete and present his/her project and this mark replaces the previous one (NPro).

2. Final exam and qualification

There is a final exam at the end of the bimester and in July.

- In the final exam, all content is evaluated. It usually consists of several questions and problems and lasts 2 hours. The pass mark for this exam is 4 out of 10 and deserves 50% of the final qualification (NExam).
- The students must present the results and reports of the same practices developed in continuous assessment. This practices represent 20% of the final qualification (NPrac).
- In order to pass the subject the students should present a project with the same objectives and complexity of the project developed in continuous assessment. This project deserves 30% of the final qualification (NPro) and it is necessary to obtain a mark greater o equal to 4 out of 10 in order to pass the course.

Final_ex = (NExam*0.5 + NPrac*0.2 + NPro*0.3) if NExam and Npro are greater than or equal to 4;

Final_ex = min [(NExam*0.5 + NPrac*0.2 + NPro*0.3), 4.5] in other case;

3. Other comments

- 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 be out of reach of the student.

Sources of information

Neil Weste, David Harris, **CMOS VLSI Design. A circuits and systems perspective**, 4ª,

Ashok K. Sharma, **Semiconductor memories : technology, testing, and reliability**,

Charles H. Roth, Jr., Lizy Kurian John, **Digital systems design using VHDL**, 2ª,

Santosh K. Kurinec, Krzysztof Iniewski, **Nanoscale Semiconductor Memories: Technology and Applications (Devices, Circuits, and Systems)**,

William Kleitz, **Digital Electronics: A Practical Approach with VHDL**, 9ª,

David J. Comer, **Digital logic and state machine design**, 3ª,

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

In addition to the bibliography above, the student have access to the following support material:

- Slides of the course which cover the contents of theoretical sessions.
- Documentation for laboratory which includes the guidelines of the practices, the manual of the CAD tools and the data sheets of the devices.

This material is available via the FaiTIC platform (http://faitic.uvigo.es)

Recommendations

IDENTIFYING DATA				
(*)Comunicacións Dixitais Avanzadas				
Subject	(*)Comunicacións Dixitais Avanzadas			
Code	V05M145V01204			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
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 presents advanced topics in digital communications with emphasis on modulations, coding and detection. Teaching and exams are in English.			

Competencies	
Code	
B1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C1	CE1 The ability to apply methods of information theory, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing systems and audiovisual communications.
C2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.
C3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Handle the mathematical tools needed to model, simulate and evaluate moderns communication systems.	B1 B4 C1 C2 C3
Solve problems whose solution does not derive from the application of a standardized procedure.	B1 B4 B8 C1 C2 C3
Understand the principles underlying modern communication standards.	B1 B4 B8 C1 C2 C3
Design transmitters, receivers and measurement equipment for modern communication systems.	B1 B4 B8 C1 C2 C3

Contents
Topic

Lectures 1-4: MIMO communications	- Introduction. Array, spatial diversity and spatial multiplexing gains. MIMO channel and signal models. - MIMO transmitter design. Principles of precoding for MIMO. Space-time coding. Multiuser MIMO transmitter design. - MIMO receiver design. Multiuser MIMO receiver design. - MIMO channel capacity.
Lecture 5: Synchronization and spectrum sensing in cognitive radio.	- Motivation and requirements. Spectrum management. Synchronization in cognitive radio. Spectrum sensing.
Lecture 6: Dirty paper coding.	- Code design. Costa's theorem. Opportunistic low SNR codes. Applications in downlink channels.
Lecture 7: OFDM and beyond.	- Principles of orthogonal frequency division multiplexing. Filterbanks and multicarrier. Cooperative diversity.

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practises	14	29.4	43.4
Master Session	14	57.6	71.6
Long answer tests and development	2	0	2
Reports / memories of practice	0	8	8

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

Methodologies

	Description
Laboratory practises	Lab practices will cover different aspects of multiple-input multiple-output (MIMO) communications. This will allow students to practically implement and considerably expand some of the concepts seen in the lectures. Competences: CG1, CG4, CE1, CE2, CE3
Master Session	The course is structured in several advanced topics in digital communications with emphasis on multiple-input multiple-output (MIMO) communications. Competences: CG1, CG4, CG8, CE1, CE2, CE3

Personalized attention

Methodologies	**Description**
Master Session	Students will have the opportunity to meet in person with the instructor at some office hours that will be announced at the beginning of the course. The schedule will be published in the course webpage.
Tests	**Description**
Reports / memories of practice	Students will have the opportunity to meet in person with the instructor at some office hours that will be announced at the beginning of the course. The schedule will be published in the course webpage.

Assessment

	Description	Qualification	Training and Learning Results	
Long answer tests and development	Final exam with short questions on the contents of the subject.	50	B1 B4 B8	C1 C2 C3
Reports / memories of practice	Reports of the practices that employ the techniques seen in the classroom.	50	B1 B4 B8	C1 C2 C3

Other comments on the Evaluation

A minimum score of 35% with respect to the maximum possible score in the final exam is required to pass the course.

In those cases in which the student decides not to carry out the continuous evaluation tasks, the final score will be solely based on the exam with questions of the subject. This applies as well to the second call.

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 yea.

Sources of information
Ezio Biglieri et al., **MIMO Wireless Communications**, First,
David Tse and Pramod Viswanath, **Fundamentals of Wireless Communication**, First,
Ezio Bliglieri et al., **Principles of Cognitive Radio**, First,
Behrouz Farhang-Boroujeny, **Signal Processing Techniques for Sotware Radios**, Second,
Thomas Cover and Joy Thomas, **Elements of Information Theory**, Second,

Recommendations

Subjects that it is recommended to have taken before
(*)Tratamento de Sinal en Comunicacións/V05M145V01102

IDENTIFYING DATA				
(*)Procesado de Sinal en Sistemas Audiovisuais				
Subject	(*)Procesado de Sinal en Sistemas Audiovisuais			
Code	V05M145V01205			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	English			
Department				
Coordinator	Martín Rodríguez, Fernando			
Lecturers	Martín Rodríguez, Fernando			
E-mail	fmartin@uvigo.es			
Web	http://http://faitic.uvigo.es			
General description	In this course we will describe the main compression and coding tecniques for audiovisual signals, paying special attention to MPEG4 standard. We will also explain the main characteristics of MPEG-7 standard for multimedia content description and retrieval.			

Competencies	
Code	
B1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
C1	CE1 The ability to apply methods of information theory, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing systems and audiovisual communications.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Learning to exploit perceptual effects and spatial/temporal redundancy to compress audiovisual information.	B1 B4 C1
Understanding information structure into the MPEG4 standard and the reasons because it is needed.	B1
Understanding main processes applied on audio and video signals to guarantee perceptual quality while reducing bitrate. Knowledge of the main algorithms that are part of standards.	B1 B4 C1
Learning to handle audiovisual information to extract metadata and to use them in indexing and retrieval.	B1
Understanding strcuture and usefulness of MPEG7 standard.	B1

Contents	
Topic	
Introduction to audiovisual compression and coding.	Human perception, redundancy and importance. Compression standards history. Analysis and description of spatial/temporal video structure.
Video coding.	Video compression standards: MPEG 1, 2 & 4; H.261, H.263, H.264 (AVC).
Audio coding.	Audio compression estandards: MPEG 1, 2, 4 (MP3, AAC).
Advanced audiovisual description.	MPEG7. Advanced audiovisual description. Multimedia content managment. Information retrieval.

Planning			
	Class hours	Hours outside the classroom	Total hours
Practice in computer rooms	10	30	40
Tutored works	10	50	60
Master Session	8	8	16
Multiple choice tests	1	0	1
Reports / memories of practice	1	7	8

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

Methodologies	
	Description
Practice in computer rooms	Working especific concepts from the theory (master) sessions. We will use computer tools.
Tutored works	Work about the explained concepts, sometimes going beyond. Normally, works are initiated in computer lab work and it will spread over more than one week. Students (in pairs), have to discover (on their own or with teacher assistance) what they need to solve the problem. Results (or at least, part of them) will be presented in public.
Master Session	Basic concepts exposition.

Personalized attention	
Methodologies	**Description**
Practice in computer rooms	Assistance is possible during all presential activities. Professor will give advice and guidance in the practical works and will also help in understanding theoretical concepts. Students can use the scheduled assistance hours whenever they need.
Tutored works	Assistance is possible during all presential activities. Professor will give advice and guidance in the practical works and will also help in understanding theoretical concepts. Students can use the scheduled assistance hours whenever they need.
Master Session	Assistance is possible during all presential activities. Professor will give advice and guidance in the practical works and will also help in understanding theoretical concepts. Students can use the scheduled assistance hours whenever they need.
Tests	**Description**
Reports / memories of practice	Assistance is possible during all presential activities. Professor will give advice and guidance in the practical works and will also help in understanding theoretical concepts. Students can use the scheduled assistance hours whenever they need.

Assessment				
	Description	Qualification	Training and Learning Results	
Multiple choice tests	These tests are based on theory classes concepts.	20	B1 B4	C1
Reports / memories of practice	The qualification of guided works comprises: achievemnts, documentation, bibliography selection and oral presentation.	80	B1 B4	C1

Other comments on the Evaluation

There will be a final exam for those students that did not pass under the continuous assesment, the date will be scheduled by the school officials. Students are also allowed to go directly to the final exam skipping all continuous assesment activities.This exam will be assesed between 0 and 10 and includes all concepts in theory classes and also the techniques being explained commonly for the guided works. To pass, students must achieve a minimum of 5 points.

Extraordinary exam in July will consist of another exam for students failing to pass in may (after continuous evaluation and final exam). This new exam will be governed by the same rules of final exam in may.

Sources of information

Fernando Pereira and Touradj Ebrahimi, **The MPEG-4 book**, MSC Press Multimedia Series, Pearson Education,

Thiagarajan, Jayaraman, **Analysis of the MPEG-1 Layer III (MP3) Algorithm using MATLAB**, Morgan & Claypool,

Richardson, Iain E. G., **H.264 and MPEG-4 video compression: video coding for next generation multimedia**, Wiley, cop.,

There exist wirtten material by professor (slides) that will be used in class and made avaliable via faitic in PDF format.

Recommendations

Subjects that are recommended to be taken simultaneously

(*)Comunicacións Multimedia/V05M145V01206

Subjects that it is recommended to have taken before

(*)Tratamento de Sinal en Comunicacións/V05M145V01102

IDENTIFYING DATA				
(*)Comunicacións Multimedia				
Subject	(*)Comunicacións Multimedia			
Code	V05M145V01206			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	English			
Department				
Coordinator	Comesaña Alfaro, Pedro			
Lecturers	Comesaña Alfaro, Pedro			
E-mail	pcomesan@gts.tsc.uvigo.es			
Web				
General description	In the subject "Multimedia Communications" lattices are presented as both source coding and channel coding tools. After commenting some generalities about another source coding strategy, namely Trellis Code Quantization, more advanced coding problems, as distributed source coding and joint source-channel coding, are considered. Finally, the characteristics of different multimedia signal distributions schemes, as well as services enabled by new video coding standards, are introduced.			

Competencies	
Code	
B1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
C1	CE1 The ability to apply methods of information theory, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing systems and audiovisual communications.
C4	CE4 The ability to design and plan networks for transporting, broadcasting and distribution of multimedia signals.
C6	CE6 The ability to model, design, implement, manage, operate, and maintain networks, services and contents.
C8	CE8 The ability to understand and know how to apply the operation and organization of the Internet, new generation Internet technologies and protocols, component models, middleware and services.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Understanding the fundamental characterisitcs of a lattice, and the properties we must take into account when facing a source coding problem and a channel coding problem.	B4 C1
Understand that a trellis code defines a lattice and why this construction is useful for source coding (Trellis-Code Quantization)	B4 C1
Understanding of the different distributed source coding schemes.	B1 B4 C1 C4 C8
Implementation of a distributed source coding scheme.	B1 B4 C1 C6 C8
Understading of the different schemes of joint source and channel coding.	B4 C1 C4 C6 C8
Implementation of a joint and source channel coding scheme.	B1 B4 C1 C4 C6

Understanding of the characteristics of different ways of multimedia signal distribution, paying special attention to streaming schemes.	B1 C4 C6 C8
Asesment of the modularity of new video coding standards (e.g., MPEG-7)	B1 C4 C6 C8

Contents	
Topic	
1) Lattices	1) Definition 2) Basic properties
2) Advanced source coding	1) Trellis Code Quantization
3) Distributed source coding	1) Lossless coding 2) Lossy coding
4) Joint source-channel coding	1) Shannon's separability principle 2) JSCC practical examples
5) Multimedia content distribution	1) DVB 2) DVD 3) IPTV
6) Additional services	1) Services supported by modern video coding standards

Planning			
	Class hours	Hours outside the classroom	Total hours
Laboratory practises	13	44	57
Master Session	15	30	45
Reports / memories of practice	0	21	21
Long answer tests and development	2	0	2
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Laboratory practises	15 hours of PC lab. Programming of computational simulations. The student will simulate, by using a numerical calculus programming language (as Matlab) the multimedia communications systems introduced in this subject. Competencies: CG1, CG4, CE1, CE4, CE6, CE8.
Master Session	15 hours of theoretical lessons, where practical cases will be introduced. Furthermore, autonomous homework exercises will be proposed. Competencies: CG1, CG4, CE1, CE4, CE6, CE8.

Personalized attention	
Tests	**Description**
Reports / memories of practice	The personalized attention will be mainly focused on both the practical part of the subject, and the consulting hours; they will be mainly related to the realization of practical homeworks.

Assessment				
	Description	Qualification	Training and Learning Results	
Laboratory practises	Numerical simulation programming.	30	B1 B4	C1 C4 C6 C8
Reports / memories of practice	Report on lab practises.	10	B1	C1 C4 C6
Long answer tests and development	Final exam.	60	B1 B4	C1 C4 C6

Other comments on the Evaluation

In order to do the weighted average of the different qualifications (corresponding to continual assessment), the student should submit all the mentioned tasks. Furthermore, a minimum mark of 40% should be achieved in the final exam.

Those student who choose to be evaluated by final assessment will have to do the final exam (based on long answer and development questions), as well as a practical exam.

The same rules are applied to the second call.

Plagiarism/copy in any of the tasks described above implies automatic failure.

Sources of information

Cover and Thomas, **Elements of information theory**, Wiley,
Artículos científicos especificados por el profesorado,

Recommendations

Subjects that it is recommended to have taken before

(*)Tratamento de Sinal en Comunicacións/V05M145V01102

Other comments

Even if this subject has not a series of mandatory prerrequisites, it is highly recommended that the student has a minimal background on:

- Statistics.
- Signal Processing.
- Channel coding.
- Source coding.
- Internet networks and protocols.

IDENTIFYING DATA				
(*)Comunicacións Ópticas				
Subject	(*)Comunicacións Ópticas			
Code	V05M145V01207			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	English			
Department				
Coordinator	Curty Alonso, Marcos			
Lecturers	Curty Alonso, Marcos			
E-mail	mcurty@com.uvigo.es			
Web	http://faitic.uvigo.es			
General description	We review, in the first place, the physical foundations of optical fibre technology: propagation in fibre and both active and passive optical devices. Next, we analyse different advanced systems for fibre transmission and optical networks, and we discuss techniques to evaluate and design them.			

Competencies	
Code	
B1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C13	CE13 The ability to apply advanced knowledge of photonics, optoelectronics and high-frequency electronics.

Learning outcomes	
Expected results from this subject	Training and Learning Results
1. Functional knowledge of the essential photonic devices for optical communications: LEDs and lasers, photodetectors, optical modulators, couplers, circulators, AWG, fibre amplifiers, semiconductor optical amplifiers, optical filters, single-mode fibres, multi-mode fibres and multicore fibres.	B4 C13
2. Knowledge of the noise models used to characterise the optical transmitter subsystems, optical amplifiers and receivers, and capacity to calculate its impact in terms of the signal to noise ratio and error probability.	B4 C13
3. Knowledge of the basic formats of digital transmission by optical fibre, and of analog transmission in systems fibre-radio.	B4 C13
4. Knowledge of some advanced systems for fibre transmission: new modulation formats, coherent systems, non-linear systems and dispersion management.	B4 B8 C13
5. Knowledge of the specific technologies of optical networks WDM and DWDM, and options to design them.	B1 B4 C13
6. Knowledge of the optical network topologies for long distance transmission, metropolitan and regional networks, and access optical networks.	B1 B4 C13
7. Knowledge of security techniques to protect optical networks.	B4 B8 C13
8. Knowledge of free-space optical systems and visible light communications.	B4 B8 C13

Contents
Topic
1. Introduction to optical communication systems 1.1. Reasons for optical transmission

2. Foundations of optical communications	2.1. Non-monochromatic propagation in linear optical fibres. 2.2. Basic active devices: lasers, LEDs, photodetectors, optical modulators and doped fibre amplifiers. 2.3. Basic passive devices: couplers, splitters and filters.
3. Advanced optical devices	3.1. Active devices: SOA, fibre lasers and Raman amplifiers. 3.2. Passive devices: AWG, gratings, circulators, plastic fibres and multicore fibres.
4. Non-linear effects in fibres and dispersion management	4.1. Stimulated Raman Scattering 4.2. Stimulated Brillouin Scattering 4.3. Dispersion management
5. Digital systems ETDM	5.1. Introduction 5.2. ETDM systems with optical amplifiers 5.3. Dispersion compensation in ETDM systems
6. Advanced optical systems	6.1. Systems fibre-radio. 6.2. Coherent links and new formats.
7. Optical networks	7.1. Systems WDM and DWDM 7.2. Switching technologies 7.3. Wavelength conversion. 7.4. Security in optical networks
Laboratory exercise 1. Dispersion in multi-mode fibres	Characterisation of both the intermodal and intramodal dispersion on a graded index fibre
Laboratory exercise 2. Optical modulator	Characterisation of an optical modulator
Laboratory exercise 3. Systems DWDM	Characterisation of DWDM systems working in third telecom window

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	18	54	72
Laboratory practises	6	6	12
Case studies / analysis of situations	2	12	14
Long answer tests and development	2	12	14
Short answer tests	1	5	6
Case studies / analysis of situations	1	6	7

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

Methodologies

	Description
Master Session	The 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.
Laboratory practises	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.
Case studies / analysis of situations	It consists of activities that complement the master sessions and allow a better understanding of the theoretical concepts.

Personalized attention

Methodologies	Description

Master Session	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 it is published on the website of the course. These office hours can be employed to solve doubts related to: 1. The concepts presented in class or included in the syllabus of the course. 2. The exercises performed in the lab. 3. The case studies considered during the course.
Laboratory practises	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 it is published on the website of the course. These office hours can be employed to solve doubts related to: 1. The concepts presented in class or included in the syllabus of the course. 2. The exercises performed in the lab. 3. The case studies considered during the course.
Case studies / analysis of situations	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 it is published on the website of the course. These office hours can be employed to solve doubts related to: 1. The concepts presented in class or included in the syllabus of the course. 2. The exercises performed in the lab. 3. The case studies considered during the course.

Assessment

	Description	Qualification	Training and Learning Results	
Long answer tests and development	At the end of the semester, the students will perform a final test that covers all the contents of the course.	30	B1 B4 B8	C13
Short answer tests	After the last lab session, the student will perform a test (20%) about the exercises done in the lab. Moreover, before the beginning of chapter 5, the students will perform a test (30%) about the contents of the first 4 chapters of the course.	50	B4 B8	C13
Case studies / analysis of situations	It evaluates the work realised by the student in the study of cases proposed in class.	20	B1 B4 B8	C13

Other comments on the Evaluation

We will offer to the students two possible assessment systems: continuous evaluation or final evaluation at the end of the course.

Each student has to decide on one of these two options by the third week of the course. In principle, the professor considers that the student decides continuous evaluation unless the student explicitly indicates by written statement to the professor that he decides final evaluation at the end of the course.

Continuous evaluation:

The continuous evaluation comprises a series of tasks that the student has to realise along the course (70%), together with a long answer test (30%) that he/she performs at the end of the course. These tasks include (a) the completion of one short answer test about the first four chapters of the subject (30%) and that it will take place the fourth week of the course, and the completion of one short answer test about the lab (20%) and that it will take place after the last lab exercise, and (b) the assessment of the activities realised by the student related with the 'case studies' (20%) that has to be completed by the seventh week of the course. 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 do them afterwards. Also, they are only valid for the present academic year.

Those students who decide to opt for a continuous evaluation will have to fulfill the following conditions in order to pass the course: (a) perform at least 2 out of the 3 lab exercises; (b) obtain, at least, 8 points out of 20 in the 'case studies'; (c) obtain, at least, 12 points out of 30 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 evaluation 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.

Evaluation at the end of the semester:

In addition to the system of continuous evaluation described above, the student can opt for a final examination only. This final evaluation 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 final examination. 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.

Evaluation in July:

Those students who opted for a continuous evaluation and fulfill the requirements (a) and (b) above, will be able, if they so wish, to keep the mark obtained in the tasks performed during the continuous evaluation (70%). In such a case, they will only take a long answer test (30%). To pass the course, these students will have to obtain, at least, 12 points out of 30 in the long answer test, and obtain a minimum of 50 points in total.

Alternatively, these students can also opt for a final examination only, 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 evaluation.

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

In the case of choosing a final exam only, the professor may demand the student to deliver some additional tasks, which will be notified to the student one month prior to the final exam. These tasks have to be delivered at the day of the final examination. 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.

Sources of information

There is no single book that covers all the contents of this subject. The bibliography below is only recommended. The class notes and the additional material given during the course constitutes the exact guide for this subject.

Additional bibliography:

Recommendations

Subjects that it is recommended to have taken before

(*)Electrónica e Fotónica para Comunicacións/V05M145V01202

IDENTIFYING DATA				
(*)Antenas				
Subject	(*)Antenas			
Code	V05M145V01208			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	English			
Department				
Coordinator	Díaz Otero, Francisco Javier			
Lecturers	Díaz Otero, Francisco Javier			
E-mail	fjdiazotero@gmail.com			
Web				
General description	The subject devotes to the study of antennas and covers from their electromagnetic bases to their practical design, going through the models of analysis and simulation of the behaviour of the antennas.			

Competencies	
Code	
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
A4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
C2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.
C3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.
C5	CE5 The ability to design systems of radio navigation and positioning, as well as radar systems.

Learning outcomes	
Expected results from this subject	Training and Learning Results
To understand the phenomena of electromagnetic radiation and receiving signals	A4 B4
Know the main parameters that characterise the behaviour of the transmitting and receiving antennas	A4 B4 C2 C3 C5
Know the distinct types of antennas according to their applications and operating frequencies	A4 B4 C2 C3 C5
To be able to understand and develop models to simulate the behavior of the antennas and predict their characteristic parameters	A4 B4 C2 C3 C5
To be able to cope antenna design exercises for certain specifications	A2 A4 B4 C2 C3 C5

Contents
Topic

1. Electromagnetic antennas Basics Competencies related: CE2, CE3, CE5	1.1 Generalities 1.2 Phenomenon of electromagnetic radiation 1.3 Properties of the field of radiation 1.4 The antenna in transmission 1.5 The antenna in reception 1.6 The antenna in systems of communications and in radar
2. Modeling antennas Competencies related: CB4, CG4	2.1 Linear Antennas 2.2 Aperture Antennas 2.3 Arrays
3. Types of antennas CB4, CG4, CE2, CE3, CE5	3.1 Wire Antennas 3.2 Printed and Slot Antennas 3.3 Horns, lens and reflectors

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	15	15	30
Troubleshooting and / or exercises	3	6	9
Case studies / analysis of situations	8	24	32
Autonomous practices through ICT	0	26	26
Short answer tests	1	6	7
Practical tests, real task execution and / or simulated.	1	6	7
Long answer tests and development	2	12	14
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Master Session	Presentation of the contents on the subject under study, instructions and exercises or projects to be developed by the student. Competencies CB2, CE2, CE3, CE5
Troubleshooting and / or exercises	Problems and / or exercises related to the subject. The student should develop appropriate or correct solutions through the exercise routines, applying formulas or algorithms, applying transformation methods available and interpretate the results. Complement of the Master session Competencies CB2, CG4, CE2.
Case studies / analysis of situations	Analysis of a fact, problem or real event in order to learn, interpret it, solve it, generate hypotheses, compare data, complete knowledges, diagnose it and train in alternative procedures of solution. Competencies CB2, CG4, CE2, CE3, CE5.
Autonomous practices through ICT	Activities of application of the knowledges to concrete situations and of acquisition of basic skills related with the matter object of study. They will be developed through ICT in an autonomous way. Competencies CB2, CB4, CG4, CE2.

Personalized attention	
Methodologies	**Description**
Master Session	Students will have the opportunity to attend to personalized sessions in the teacher's office in the schedule that the teachers will establish at the beginning of the course for this purposes. They may also pose questions electronically.
Troubleshooting and / or exercises	Students will have the opportunity to attend to personalized sessions in the teacher's office in the schedule that the teachers will establish at the beginning of the course for this purposes. They may also pose questions electronically.
Case studies / analysis of situations	Students will have the opportunity to attend to personalized sessions in the teacher's office in the schedule that the teachers will establish at the beginning of the course for this purposes. They may also pose questions electronically.
Autonomous practices through ICT	Students will have the opportunity to attend to personalized sessions in the teacher's office in the schedule that the teachers will establish at the beginning of the course for this purposes. They may also pose questions electronically.

Assessment			
	Description	Qualification	Training and Learning Results
Short answer tests	Conceptual questions on the course syllabus.	10	A2

Practical tests, real task execution and / or simulated.	It will value the quality of the homeworks assigned, the participation and attitude showed in the classes, as well as the oral presentation of the work.	60	A2 A4
Long answer tests and development	Final examination: Evaluation of the competencie that includes open questions on a subject. The students have to develop, relate, organise and present the knowledges that have on the matter in an extensive answer to a practical situation posed.	30	A2 A4

Other comments on the Evaluation

It will be offered to the students enrolled in this class two systems of evaluation: continuous evaluation and evaluation at the end of the semester.

1. CONTINUOUS EVALUATION
The system of continuous evaluation will consist in:

- A short test to be held in class around the mid-teaching period. 10% rating. Rating EC1, with a maximum of 1 point.
- An exercise about antenna design for a particular application. It will be held autonomously through the use of software simulation tools. The student will prepare and deliver a report to be presented in class at the end of the semester. Rating EC2, with a maximum of 6 points. The 6 points of this exercise will be distributed as follows: 2 points for active participation in the sessions (in C groups) dedicated to the design and presentation and discussion; 2 points for the quality of the proposed solution; 1 point for the quality of the report submitted; and 1 point for the quality of the oral presentation.
- An extended-response exercise in which problems of analysis and design of antennas for specific applications will be solved. It will be held the same day fixed for the regular final exam for the course. 30% rating. Rating EC3, with a maximum of 3 points.
- The continuous assessment tests are not recoverable, ie, if a student can not fulfill them within the stipulated period the teacher is not required to repeat them.
- The final score for continuous assessment (EC) was calculated as the sum of the scores on the three planned tests: EC =EC1 + EC2 + EC3.
- The score on the assessable tasks (EC) will be valid only for the academic year in which they are made.

It is understood that a student receives this rating system when he has made the first test,given the memory of the second and made the corresponding oral presentation.At this time the student will be considered as well as presented to the exam.

2. FINAL EVALUATION OF SEMESTER

It involves:

- A final exam that will assess competencies CB2, CG4, CE2, CE3, CE5. 40% rating. EF1 score, with a maximum of 4 points.
- The day of the examination the student will deliver a report on an antenna design previously assigned. The student will give an oral presentation at a public meeting in the shortest possible time respecting the compatibility with other tests of the same course and certification. Rated EF2 with a maximum of 6 points.
- The EF1 and EF2 partial qualifications may be held only until the call of July and within the ongoing course.

3. RECOVERY IN THE CALL OF JULY

It will follow the same procedure as the evaluation at the end of the semester. Students, communicating it previously to the start of the exam, may retain their previous note EF1 part (or alternatively EC1 EC3 +) or the EF2 (or EC2) part.

COMMENTS:

- Before the completion or delivery date of each test, the procedure and review of scores will be published within a reasonable period of time.
- Every student that comes to the final test is considered as presented. It will also be considered as presented to the test every student who qualifies for the continuous assessment system in the terms described above.

- It is considered that the subject is approved if the final grade is equal to or greater than 5.

Sources of information

C.A.Balanis. "Antenna Theory. Analysis and Design", 3rd ed. Wiley, 2005.

W.L.Stutzman, G.A.Thiele. Antenna Theory and Design. Wiley, 2nd ed. 1998.

R.S.Elliot. "Antenna Theory and Design". Prentice Hall, d. Rev. 2003.

R.E.Collin. "Antennas and Radiowave Propagation". Mc Graw Hill, 1985.

P.S.Kildal. Foundations of Antenas. A Unified Approach. Studentlitteratur. Sweeden,

T.A. Milligan, "Modern Antenna Design", 2nd Ed. Wiley, 2005.

Recommendations

Subjects that continue the syllabus

(*)Comunicacións Móbiles e sen Fíos/V05M145V01313
(*)Satélites/V05M145V01311
(*)Sistemas Radio en Banda Ancha/V05M145V01312

Subjects that are recommended to be taken simultaneously

(*)Laboratorio de Radio/V05M145V01209

Subjects that it is recommended to have taken before

(*)Radio/V05M145V01103

IDENTIFYING DATA				
(*)Laboratorio de Radio				
Subject	(*)Laboratorio de Radio			
Code	V05M145V01209			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	English			
Department				
Coordinator	Torío Gómez, Pablo			
Lecturers	Torío Gómez, Pablo			
E-mail	ptorio@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Intensification in the knowledge of the diverse systems of radius applying a practical methodology of analysis and synthesis			

Competencies	
Code	
A1	CB1 The knowledge and understanding needed to provide a basis or opportunity for being original in developing and/or applying ideas, often within a research context.
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.
C3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.
C5	CE5 The ability to design systems of radio navigation and positioning, as well as radar systems.
C13	CE13 The ability to apply advanced knowledge of photonics, optoelectronics and high-frequency electronics.

Learning outcomes	
Expected results from this subject	Training and Learning Results
* Knowledge of the basic instrumentation for measuring radiofrequency, microwaves, millimeter and sub-millimeter waves	A1 A2 B8 C2 C3 C5 C13
* Knowledge of the main configurations for measuring characteristic parameters of different subsystems: Measure of impedance, transmission and reflection coefficients, noise factor, dynamic margin, and field strength level.	A1 A2 B8 C2 C3 C5 C13
* Knowdlege of experimental characterization techniques regarding the mechanisms of signal propagation.	A1 A2 B8 C2 C3 C5 C13

Contents
Topic

The students will realise some of the following practical:
1. Basic instrumentation.
2. Measures of active elements.
· Measure of parameters of transmission and reflection in quadripoles
· Measure of the noise factor
· Measure of reception parameters (noise, selectivity, sensitivity, dynamic margin....)
· Effect of the LNA in the sensitivity of the receptor and with this measured of propagation.
· Measure of amplifiers of power of RF: efficiency, gain,...
· Measure of parameters of oscillators.
3. Measure of passive elements
· Measured of passive filters of RF: losses, selectivity,....
· Measure of the frequency of cut of a wave guide
· Measured of antennas: diagrams, gain and join up electromagnetic.
· Measure of common elements of microwaves: circulators, directional couplers,...
4. Measures of propagation.
· Measure of mitigation with distance
· Measured of mitigation with obstacles. Analysis of the phenomena of transmission and reflection.
· Statistical study of the variability of the signal
5. Use of a radar.
6. Measures of electromagnetic compatibility.
7. Measures in millimeter and sub-millimeter bands
8. Design, setting and measure of a LNA
9. Design, setting and measure of an oscillator of RF.
10. Analog modulations
11. Digital modulations
11. Network analyzers
12. Software Defined Radio (rowing sports club)
13. Digital Video Broadcasting Terrestrial (DVB-T)
14. Digital Radio Mondiale (DRM)

Planning

	Class hours	Hours outside the classroom	Total hours
Case studies / analysis of situations	2	10	12
Laboratory practises	22	65	87
Master Session	4	20	24
Short answer tests	2	0	2

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

Methodologies

	Description
Case studies / analysis of situations	Practical demonstrations
Laboratory practises	Setting and measure of circuits and telecommunication systems. Employing specific instrumental.
Master Session	Explanation of the theoretical-practical basis of the work to be developed by the students in the laboratory.

Personalized attention

Methodologies	Description
Laboratory practises	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.
Master Session	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.

Case studies / analysis of situations	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.

Assessment

	Description	Qualification		Training and Learning Results
Laboratory practises		50		C2 C3 C5 C13
Short answer tests		50	A1 A2	B8

Other comments on the Evaluation

Two evaluation systems are offered:

CONTINUOUS EVALUATION, that is the ordinary recommended method, around which educational activities are scheduled, and an option ofNOT CONTINUOUS EVALUATION, which is recommended for those situations in which it results impossible to follow the ordinary method
CONTINUOUS EVALUATIONThe continuous evaluation consists of the proofs that detail to continuation:* Laboratory practices (Weight: 50%)* Proof of short answer (Weight: 50%)
NOT CONTINUOUS EVALUATIONThe not continuous evaluation consists of:* Examination on laboratory practice (Weight: 50%)* Proof of short answer (Weight: 50%)
RETAKE:The student been evaluated by Continuous Evaluation can opt between two possibilities the same day of the examination:* Realise again the Proof of short answer in the official date assigned by the Centre and be evaluated according to the stipulated for the system of "CONTINUOUS EVALUATION"* Be evaluated with an only final examination in the official date assigned by the Centre, as the stipulated for the system of "NOT CONTINUOUS EVALUATION".
The student not been evaluated by continuous Evaluation:* will be evaluated with an only final examination in the official date assigned by the Centre, as the stipulated for the system of "NOT CONTINUOUS EVALUATION"

Sources of information

Ulrich Reimers, **DVB : The family of international standards for digital video broadcasting**,
M. E. Van Valkenburg, **Network analysis**,
Walter Tuttlebee, **Software defined radio : Enabling technologies**,
Wes Hayward, **Introduction to radio frequency design**,
George Brown, **Radio and electronics cookbook**,
John Davies, **Newnes radio and RF engineer's pocket book**,
Y.T. Lo, S.W. Lee, **Antenna handbook**,
Rajeswari Chatterjee, **Antenna theory and practice**,
Yi Huang, Kevin Boyle, **Antennas : from theory to practice**,
Walter C. Johnson, **Transmission lines and networks**,
Brian C. Wadell, **Transmission line design handbook**,
Fuqin Xiong, **Digital modulation techniques**,
Besides the literature mentioned the student will have as support material:

- Scripts of theory: this material contains the theoretical basis of what is discussed in more detail in the master sessions.

- Scripts of practices: formulations and problems of each practice session.

- Copy of the artwork used in the master sessions.

- Tasks and proposed problems.

Recommendations

Subjects that continue the syllabus

(*)Comunicacións Móbiles e sen Fíos/V05M145V01313
(*)Satélites/V05M145V01311
(*)Sistemas Radio en Banda Ancha/V05M145V01312

Subjects that are recommended to be taken simultaneously

(*)Antenas/V05M145V01208
(*)Comunicacións Ópticas/V05M145V01207

(*)Electrónica e Fotónica para Comunicacións/V05M145V01202

Subjects that it is recommended to have taken before

(*)Radio/V05M145V01103
(*)Tratamento de Sinal en Comunicacións/V05M145V01102

IDENTIFYING DATA				
(*)Enxeñaría de Internet				
Subject	(*)Enxeñaría de Internet			
Code	V05M145V01210			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	Spanish English			
Department				
Coordinator	Fernández Veiga, Manuel			
Lecturers	Fernández Veiga, Manuel			
E-mail	mveiga@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Internet Engineering presents and analises the star of the art on the deployment, operations and configuration of large distributed systems in the Internet. The subject covers the study of advanced channel coding techniques, software defined networking, multipath transmission, and also the architecture and main technical challenges of large data centers. A review of network and service virtualization techniques is also included. Students will achieve skills for innovation and research i the field of network engineering.			

Competencies	
Code	
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
B12	CG12 To have skills for lifelong, self-directed and autonomous learning.
C4	CE4 The ability to design and plan networks for transporting, broadcasting and distribution of multimedia signals.
C6	CE6 The ability to model, design, implement, manage, operate, and maintain networks, services and contents.
C7	CE7 The capacity for planning, decision making and packaging of networks, services and applications, taking into account the quality of service, direct and operating costs, plan implementation, monitoring, safety procedures, scaling and maintenance, as well as managing and ensuring quality in the development process.
C8	CE8 The ability to understand and know how to apply the operation and organization of the Internet, new generation Internet technologies and protocols, component models, middleware and services.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Knowledge and know-how about advanced channel coding techniques	B4 C4 C6
To understand the operations and properties of large distributed systems in the Internet. Deep knowledge and insights about advanced communication system	B1 B4 C4 C6 C7 C8
To learn how to analyze and put into use multi path transmission techniques and congestion control algorithms on different types of networks	A5 B4 B8 C4 C6 C7 C8

To understand the design principles, the operation and performance of large data centers in the Internet	A5 B1 B4 B12 C6 C7 C8
To command the principles of network & services virtualization. To learn how to perform resource allocation, to compare alternative architectures and comprehend the underlying Internet economic forces.	A5 B1 B4 B8 B12 C4 C6 C7 C8

Contents	
Topic	
1. The Internet ecosystem	1.1 Technology. Normalisation. Prospective 1.2 Service provisioning 1.3 Economy of Internet
2. Advanced channel coding	2.1 Capacity-approaching codes 2.2 Capacity-achieving-codes 2.3 Network coding 2.4 Erasure coding
3. Datacenter architectures	3.1 Datacenter structure and architecture 3.2 Advanced & efficient switching systems
4. Datacenter networking	4.1 Ethernet bridging & virtual bridging 4.2 VLAN partitioning and extension 4.3 Other tunneling technologies
5.Software defined networking	5.1 Software defined networking: concepts, elements and products 5.2 Network function virtualization
6. Resource allocation	6.1 Resource allocation in cloud systems 6.2 Load balancing techniques 6.3 Randomized policies. Optimal allocations 6.4 Auctioning

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	14	28	42
Projects	16	64	80
Long answer tests and development	2	0	2
Jobs and projects	1	0	1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Master Session	Descriptive exposure of concepts, technical, problems and solutions of the state of the art in the discipline. Emphasis on the critical thinking ability to assess the models, the decisions and the operations of the systems under study.
Projects	Development of an engineering project: design, planning, costs, dimensioning, configuration and testing, deployment and maintenance of a cloud-computing infrastructure.

Personalized attention	
Methodologies	**Description**
Master Session	The students can attend to the personalized attention hours in order to clarify, argue or solve any technical difficulty uncovered during the development of the project. Personalised attention is also provided for in-depth discussion of concepts and solutions covered in the lectures.
Projects	The students can attend to the personalized attention hours in order to clarify, argue or solve any technical difficulty uncovered during the development of the project. Personalised attention is also provided for in-depth discussion of concepts and solutions covered in the lectures.

Assessment				
	Description	Qualification		Training and Learning Results
Long answer tests and development	Written examination written, closed books, two hours length. The students will answer questions of conceptual and logical character on any one of the systems, components, algorithms or technologies that have covered in the lectures.	50		B1 C4 B4 C6 B8 C7 B12 C8
Jobs and projects	Functional and performance tests of the assigned engineering project. Critical assessment of the technical solutions, the design decisions of design and the implementation.	50	A5	B1 C4 B4 C6 B8 C7 B12 C8

Other comments on the Evaluation

The student must choose between two alternative, mutually exclusive assessment method: continuous assessment or final assessment.

The continuous evaluation options consists in a final written exam (50% of the qualification) and the completion of an engineering project (50% of the qualification). This project will be due the last working day preceding the start of the examination period. The final assessment option consists in a final written exam (60% of the qualification) and in the completion of an engineering project (40% of the qualification). This project will be due the last working day preceding the start of the examination period. The examinations of the continuous and the final assessment options may not be equal.

The students must declare their preferred assessment type right after the programming assignment is announced. A student will be considered as defective (not active) upon not manifesting any preference at this point.

The students who fail the course will be given a second opportunity July to do so. Their academic achievements will be re-evaluated, both with a written exam (theoretical knowledge) and a review of their engineering project looking for improvement or changes. The weights are the same they were committed to, according to their choice.

Any assigned grade will only be valid during the academic year where it is awarded.

Sources of information

P. van Mieghem, **Performance analysis of communications networks and systems**,

R. Srikant, L. Ying, **Communication networks. An optimization, control and stochastic networks perspective**,

M. Medard, A. Sprintson, **Network coding. Fundamentals and applications**,

X. Guang, Z. Zhang, **Linear network error correcting coding**,

K. Hwang, G. C. Fox, J. J. Dongarra, **Distributed and cloud computing: from parallel processing to the Internet of things**,

M. J. Kavis, **Archtecting the cloud: design decisions for cloud computing service models**,

Recommendations

Subjects that it is recommended to have taken before

(*)Tecnoloxías de Rede/V05M145V01104

IDENTIFYING DATA				
(*)Redes sen Fíos e Computación Ubicua				
Subject	(*)Redes sen Fíos e Computación Ubicua			
Code	V05M145V01211			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Rodríguez Rubio, Raúl Fernando			
Lecturers	Rodríguez Rubio, Raúl Fernando			
E-mail	rrubio@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The subject "wireless networks and ubiquitous computing" mainly focus on the study of wireless technologies that support the inherent connectivity and communications in such environments where mobile users interact among them and with other devides distributed all along the path they are passing through, to implement and/or enjoy numerous and new services and applications. With lesser depth, other questions related to hardware/software aspects of the smart objects that will be involved in this kind of wireless/mobile communications/applications, will also be studied.			

Competencies	
Code	
A1	CB1 The knowledge and understanding needed to provide a basis or opportunity for being original in developing and/or applying ideas, often within a research context.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B3	CG3 The ability to lead, plan and monitor multidisciplinary teams.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
B12	CG12 To have skills for lifelong, self-directed and autonomous learning.
C4	CE4 The ability to design and plan networks for transporting, broadcasting and distribution of multimedia signals.
C6	CE6 The ability to model, design, implement, manage, operate, and maintain networks, services and contents.
C7	CE7 The capacity for planning, decision making and packaging of networks, services and applications, taking into account the quality of service, direct and operating costs, plan implementation, monitoring, safety procedures, scaling and maintenance, as well as managing and ensuring quality in the development process.
C9	CE9 The ability to solve convergence, interoperability and design of heterogeneous networks with local, access and trunk networks; as well as the integration of telephonic, data, television and interactive services.
C24	CE24/TE1 Ability to understand the fundamentals of distributed systems and distributed computing paradigms, and its application in the design, development and management in grid, ubiquitous computing scenarios and cloud systems.

Learning outcomes	
Expected results from this subject	Training and Learning Results
(*) To understand the fundamentals of wireless communications. To understand the basic concepts behind mobile communications. To know the main protocols and architectures used in wireless and mobile networks. Knowledge of the basis and main concepts of ubiquitous/pervasive computing. To understand the relationship/dependence between ubiquitous computing and context information (context-aware computing). To know different pervasive computing systems . Knowledge of recent advances and trends related to ubiquitous computing.	A1 A5 B3 B8 B12 C4 C6 C7 C9 C24

Contents
Topic

Fundamentals of wireless networks.	Channel characteristics; medium access control; mobility management; routing and discovery; securiry issues; power safe.
Architectures and standards.	Wireless access/local/personal area networks; wireless sensor networks; TCP/IP issues related with the connectivity/communication of wireless/mobile devices.
Basis of ubiquitous computing.	Context-aware computing; service architecture; data dissemination and management; sinchronization and consistency; service discovery.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	18	36	54
Laboratory practises	10	52	62
Forum Index	0	4	4
Long answer tests and development	2	0	2
Reports / memories of practice	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
Master Session	Explanation, by teachers, of the main theoretical contents related to wireless networks and ubiquitous computing. (Competences CE4, CE6, CE7, CE9)
Laboratory practises	Several activities will be developed: 1) Implementation by learners of guided and supervised exercises in the lab. 2) A laboratory project of a certain magnitude will be defined - related to the design, implementation or testing of a some protocol, system, application, or service - to be developed in a group throughout the semester. This work will be supervised by teachers with regular meetings each 10/15 days. (Competences CB5, CG8, CG3, CG12) 3) And, finally, students will have to read, present and defense -in front of the class mates- the main ideas that lie behind certain technical/scientific articles related to the course contents. (Competences CB5, CG12).
Forum Index	An educational social network will be used to stimulate discussion and other online activities that involve collaborative and/or competitive participation of students.

Personalized attention

Methodologies	Description
Master Session	 During tutorial sessions, teachers will offer personal attention either individually -to strengthen or guide the student in understanding the theoretical concepts explained in masterclasses or lab sessions- or in groups -to supervise the work associated with the big project that the students must carry out as a team. In the tutorial group sessions -that are mandatory (about one hour each 15 days)- the solutions proposed by the members of the group will be discussed and reviewed, and the professors will check and promote a fairly participation of each member of the different teams.
Laboratory practises	 During tutorial sessions, teachers will offer personal attention either individually -to strengthen or guide the student in understanding the theoretical concepts explained in masterclasses or lab sessions- or in groups -to supervise the work associated with the big project that the students must carry out as a team. In the tutorial group sessions -that are mandatory (about one hour each 15 days)- the solutions proposed by the members of the group will be discussed and reviewed, and the professors will check and promote a fairly participation of each member of the different teams.

Assessment

	Description	Qualification	Training and Learning Results
Master Session	A theoretical (written) examination (T) will be held at the end of the course.	35	A1 C4 C6 C7 C9 C24

Laboratory practises	Attendance of these sessions are mandatory. If for some reason one is lost, the students will have to retake it doing some supplementary homework defined ad hoc by the teachers. Any concept studied in these practises may also be required in the final theoretical examination (T). The 50% of the assesment of the subject will be tied to the project work (P) in which the student will be involved. This partial grade will be evaluated after delivery, assessing issues such as the correctness, the quality, the originality, and the functionalities of the implementation, as well as the associated presentation and/or final report. Also during the development of the project, the teachers will supervise how things are being done by the group to assess the individual involvement of each student in the development. And the remaining 15% will come from debate sessions, promoted by teachers ahead of time, and where we are going to evaluate the understanding of the addressed topic and the quality and clarity of the presentation that the speaker will stand up to other peers, or the participation of the listeners in the discussions.	65	A1 A5	B3 B8 B12	C7
Forum Index	The assessment of the students' participation in this online activity is integrated together with the activity labeled as "debate" within the laboratory practises assesment.	0			

Other comments on the Evaluation

The assessment of the subject can follow either the "continuous evaluation" philosophy or a lonely and "final examination". The student will choose the "continuous evaluation" option if he/she attends any of the control sessions -with the exception of the first one where the teamworks will be assigned- associated to the project work (P) - within laboratory practises.

The students that do not follow the continuous assessment, must take a special final examination that will be composed of three parts: a theory examination, like the final one in the continuous evaluation (T), an aptitude test in the laboratory (to verify the authenticity of the authorship of the project), and a practical project that must be developed individually (P, substitute of the supervised teamwork within continuous assessment). The whole mark, in this case, will be the mean between the theoretical exam and the project work, provided that the student pass the aptitude test in the lab.

Finally, the extraordinary examination session in july will have the same characteristics than the special final examination just described, but the students will be able to inherit the partial mark of any activity (T or/and P) if that has been passed during the same academic year, independently of the assesment modality that the student had chosen.

The use of any supporting documentation during theoretical exams must be explicitly authorized by the professors.

Sources of information

Viajy Garg, **Wireless Communications and Networking**, 1,

Kaveh Pahlavan, Prashant Krishnamurthy, **Networking Fundamentals: Wide, Local and Personal Area Communications**, 1,

Pei Zheng, Larry L. Peterson, Bruce S. Davie, Adrian Farre, **Wireless Networking Complete**, 1,

F. Adelstein, Sandeep K.S. Gupta, Golden G. Richard III, Loren Schwiebert, **Fundamentals of Mobile and Pervasive Computing**, 1,

Jean-Philippe vasseur, Adam Dunkels, **Interconnecting smart objects with IP**, 1,

James F. Kurose, Keith W. Ross, **Computer Networking: A Top-Down Approach**, 6,

Recommendations

IDENTIFYING DATA				
(*)Enxeñaría Web				
Subject	(*)Enxeñaría Web			
Code	V05M145V01212			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Santos Gago, Juan Manuel			
Lecturers	Álvarez Sabucedo, Luis Modesto Santos Gago, Juan Manuel			
E-mail	Juan.Santos@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The Web, initially conceived as a simple system for the telematic distribution of information, has become, as a whole, in the database more extensive and heterogeneous existing today. Furthermore, the Web has become an important platform for delivery of sophisticated electronic services in very different domains, such as commerce, education, public and private administration, health, leisure, etc. The fundamental objective of this course is to explore the main techniques and mechanisms that underlie the development of Web applications, i.e. the software applications that provide services to users through a Web browser. It is not the aim of this course to delve into the technologies for building dynamic web pages (it is assumed here that the student has previous knowledge of these issues), but to analyse the techniques and acquire the skills necessary, on the one hand, to be able to locate and use the existing implicit "knowledge" on the Web and, on the other hand, to be able to design and develop services accordingly to the software distribution models that dominate the Web.			

Competencies	
Code	
A1	CB1 The knowledge and understanding needed to provide a basis or opportunity for being original in developing and/or applying ideas, often within a research context.
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
A3	CB3 Students must integrate knowledge and handle complexity of formulating judgments based on information that was incomplete or limited, including reflections on social and ethical responsibilities linked to the application of their knowledge and judgments.
A4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B5	CG5 The capacity for development, strategic planning, direction, coordination and technical and financial management of projects in all fields of Telecommunication Engineering following quality and environmental criteria.
B6	CG6 The capacity for general direction, technical direction and management of research, development and innovation projects in companies and technological centers.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C6	CE6 The ability to model, design, implement, manage, operate, and maintain networks, services and contents.
C8	CE8 The ability to understand and know how to apply the operation and organization of the Internet, new generation Internet technologies and protocols, component models, middleware and services.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Know the evolution of the Web and understand the technologies in use today	A5 B8 C8

Know and be able to use advanced search techniques for both Web documents and other resources accessible through the Web	A1 A2 A4 A5 B8 C8
Know and be able to use mechanisms to represent and manage knowledge on the Web	A1 A2 A3 A5 C8
Know to propound, analyze and design innovative Web applications using the models and patterns that predominate in the Web	A2 A4 B5 B6 B8 C6 C8

Contents	
Topic	
The Web The contents of this topic are related to the achievement of competency CE8	Historical evolution and current state Underlying technologies
Searching information on the Web The contents of this topic are related to the achievement of competencies CB1, CB2, CB4, CB5 and CE8	Algorithms based on Information Retrieval techniques Algorithms based on link analysis Metadata and text indexing Processing large volumes of data
Knowledge Representation on the Web The contents of this topic are related to the achievement of competencies CB1, CB2, CB3, CB4, CB5 and CE8	Computational logic and logical inference The Semantic Web: Knowledge on the Web accessible to machines Semantic Web technologies Folksonomies and social tagging
Models of software components for the Web The contents of this topic are related to the achievement of competencies CB2, CB5, CE6 and CE8	Reference models and architectures Description of Web services Common development patterns on the Web
Case Studies The contents of this topic are related to the achievement of competencies CB2, CB3, CB4, CB5, CG5, CG6, CG8, CE6 and CE8	Recommendation services Social Web Internet of Things Collective Web intelligence

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	14	14	28
Autonomous practices through ICT	8	16	24
Projects	3	27	30
Short answer tests	2	6	8
Reports / memories of practice	1	10	11
Jobs and projects	2	22	24
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Master Session	The first session of the course is aimed to present the context in which the subject is framed and to describe the specific activities to be undertaken by the student to achieve the predefined learning objectives. In the subsequent sessions the fundamental concepts addressed in the course are presented in class by the faculty, emphasizing the more complex aspects and proposing possible application scenarios. This methodology is mainly focused to the achievement of the competencies CB1, CB5 and CE8.

Autonomous practices through ICT	The faculty proposes a number of exercises in order to practice with the concepts and techniques discussed in the theoretic lectures. In particular, it is envisaged the realization of practical exercises to be solved in the laboratory about i) search algorithms of general information and ii) access and manipulation of information represented by techniques of Knowledge Representation on the Web. This methodology is mainly focused to the achievement of the competencies CB3, CB4, CB5 and CE8.
Projects	The students, organized in groups of 3 or 4 people, will have to carry out a complete case study, consisting of the proposal, design, development and presentation of a web application that makes use of the technologies and techniques discussed in first part of the course. This methodology is mainly focused to the achievement of the competencies CB2, CB4, CG5, CG6, CG8, CE6 and CE8.

Personalized attention

Methodologies	Description
Projects	The faculty will regularly monitor the work done by the members of the groups formed for the implementation of practices and projects.

Assessment

	Description	Qualification	Training and Learning Results		
Short answer tests	Students will conduct individually, without supporting material, a knowledge test. This test will consist of a written exam in which questions relating to theoretical concepts covered in the keynote sessions arise.	35	A1 A4 A5		C8
Reports / memories of practice	Students must submit a report for each of the practical exercises proposed by the faculty. The reports must describe quantitatively and qualitatively the solutions adopted, justifying its use over other alternatives when relevant.	30	A2 A3 A4	B8	C8
Jobs and projects	En una primera fase, los estudiantes deben presentar una propuesta de proyecto innovador que hace uso de las tecnologías y técnicas discutidas en el curso. This proposal will be presented in class and analyzed and valued by classmates (peer review) and by the lecturer according to a predefined rubric. The rubric will be made available to students before the start of the project. In a second phase, at project completion, each group must provide a report that documents the design of the proposed solution and the achieved results. This report will be evaluated by the lecturer based on the attainment of the initial objectives and the quality of the solution used to achieve them.	35	A3 A4	B5 B6 B8	C6 C8

Other comments on the Evaluation

Two evaluation systems will be offered to the students in this course: Continuous Evaluation and Single Evaluation (at the end of the semester). The student must choose, in the first week of class, the modality that will continue. Once the choice is made, the student may not change the system.

Regardless of the evaluation system chosen, the pass mark for the course is 5 out of 10. Below the characteristics of both systems and the particularities of the subsequent calls are detailed.

Continuous Evaluation

The student must carry out 5 assessment activities that can be divided into 3 groups:

- 1 theoretical exam (theory assessment). The score of this test corresponds to the Grade of Theory (GTheory)
- 2 practical exercises (practical assessment). Each exercise has the same weight in the group and their mean corresponds to the Grade of Practice (GPractice)
- 2 assessment activities related to the development of a project (project assessment). The first activity involves the presentation of a project proposal and has a relative weight of 0.4. The second activity concerns the evaluation of the project elaboration. The weighted average of these activities corresponds to the Grade of Project (GProject).

The student must obtain a minimum grade of 3.5 (out of 10) in each of the groups to pass the course. As long as this condition is met, the final Mark (M) of the student is the weighted average of scores in each group, based on the following relation:

M = 0,35 * GTheory + 0,3 * GPractice + 0,35 * GProject

If the student has not achieved a score of 3,5 in any of the groups, the final Mark will be the minimum between 4 and the value obtained according to the above relation.

In addition, the following rules must be observed:

- A student attending any scheduled activity of the continuous evaluation modality is considered he/she definitely has chosen that evaluation system, and he/she may not appear as "No Presented" in the transcripts.
- The continuous assessment activities are not recoverable. That is, if a student does not attend any of them at the scheduled date, the faculty has no obligation to repeat it.

Single Evaluation

Students who chooses the Single Evaluation system shall submit the software and the report of a project whose functionality, scope and formats will be agreed upon with the faculty (at least one month prior to the delivery date). In addition, the student must take a written examination that includes both theoretical questions and problems and practical exercises. The date of the examination, and delivery of the project, will be established on the School Board and officially communicated through appropriate channels.

The final Mark in this evaluation system is the harmonic mean of the scores obtained in the examination and in the project.

Evaluation of subsequent calls

The second call will be governed by a procedure similar to the Single Evaluation system. Thus, the student must submit a project report and take a written exam. However, if the student had a score higher than 4 in the project (whether by continuous or single evaluation system) he/she would not be required to submit the project report and he/she would keep the previous score. When submitting the project report, the valid score will be always the mark of the new submission. Similarly, if the student had a score higher than 4 in the theoretical part of the single evaluation system or a mean score over 4 between the scores of theory and practice of the continuous evaluation system, the student may waive the exam, in which case the score would be the previously obtained.

None of the marks obtained in the course, regardless of the chosen system of evaluation will be retained for subsequent courses.

Sources of information

R. Baeza-Yates, B. Ribeiro-Neto, **Modern Information Retrieval. The concepts and technology behind search (Second Edition)**, Addison Wesley,

G. Antoniou, P. Groth, F. van Harmele, R. Hoekstra, **A Semantic Web Primer (3th Edition)**, MIT Press,

S. Casteleyn, F. Daniel, P. Dolog, M. Matera, **Engineering Web Applications**, Springer,

G. Shroff, **The Intelligent Web: Search, smart algorithms, and big data**, Oxford University Press,

W.B. Croft, D. Metzler, T. Strohman, **Search Engines: Information Retrieval in Practice**, Pearson,

J. Leskovec, A. Rajaraman, J. Ullman, **Mining of Massive Datasets**, Cambridge University Press,

Recommendations

IDENTIFYING DATA				
(*)Circuítos Mixtos Analóxicos e Dixitais				
Subject	(*)Circuítos Mixtos Analóxicos e Dixitais			
Code	V05M145V01213			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	Spanish English			
Department				
Coordinator	Quintáns Graña, Camilo			
Lecturers	Quintáns Graña, Camilo			
E-mail	quintans@uvigo.es			
Web				
General description	The majority of the electronic systems are a mixture of analogic and digital circuits. Due to this fact, besides studying them separately, it is necessary to consider them as a whole and to know their specific characteristics. From a point of view of the electrical signal, the mixed circuits can use both digital signals with analogic information and analogic signals with digital information. Combining the digital data domain with the analogic and temporal is of fundamental importance for designing complex systems. This subject introduces the students in the multidisciplinary study of the different kind of circuits which conform the electronic systems.			

Competencies	
Code	
A1	CB1 The knowledge and understanding needed to provide a basis or opportunity for being original in developing and/or applying ideas, often within a research context.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C11	CE11 The knowledge of hardware description languages for high complexity circuits.
C12	CE12 The ability to use programmable logic devices, as well as to design advanced electronic systems, both analog and digital. The ability to design communications components such as routers, switches, hubs, transmitters and receivers in different bands.
C14	CE14 The ability to develop electronic instrumentation, as well as transducers, actuators and sensors.

Learning outcomes	
Expected results from this subject	Training and Learning Results
To know and to understand the basics of mixed circuits in order to obtain new applications that combine different methods and resources for the design of complex systems	A1
To know the modeling of mixed electronic systems by using the mathematical basis of the continuous analog systems and discrete systems.	B4
The ability to combine different methods and resources for the design of complex systems that include analog and digital circuits.	B8
The knowledge of the characteristics of the description languages modeling the analog and digital mixed electronic circuits. To be able of modeling mixed electronic systems using hardware description languages.	C11
Knowing how to combine different methods and resources for the design of complex systems that include analog and digital circuits. To design matching circuits from analog to digital signal processors efficiently. Besides of the output signals from analog systems to digital processors.	C12
To know how to design specific digital filters and modulators for sampling and reconstruction of signals. To know how to use the modulation techniques for conditioning of sensors and for generating electrical signals to actuators.	C14

Contents
Topic

Unit 1: Introduction to mixed analog and digital electronic circuits.	Mixed circuits characteristics. Modeling, simulation and applications of mixed circuits. Introduction to hardware description languages for analog / digital mixed circuits.
Unit 2: Introduction to direct signal coupling techniques from analog to digital processors.	Introduction. Coupling technology in base band and by modulation. Measurement of time constants. PWM modulation. Sigma-Delta Modulation. Phase modulation. Frequency Modulation. Resources for coupling analog signals to digital processors.
Unit 3: Oversampling Techniques for digital processing of analog signals.	Oversampling techniques. Resolution gain. Reshaping of the quantization noise spectrum. First-order modulator. Modeling, simulation and test of sigma-delta modulators.
Unit 4: Sigma-delta modulators circuits.	Design of sigma-delta modulators with different topologies. Operating parameters. Low-pass and band-pass modulators.
Unit 5: Introduction to multistage A/D converters.	Pipelined A/D converters. Basic steps, timing and alignment. Test methods.
Unit 6: Digital filter circuits for signal sampling and reconstruction applications.	VHDL synthesis of digital filters. Decimation filters. Equalizer filters. Data format. Optimization.
Unit 7: Digital synthesis of signals to feed analog systems.	Methods of digital synthesis of analog signals. Direct synthesis. IIR filters. Modeling of digital synthesizers of analog signals with hardware description languages.
Unit 8: Applications of the mixed electronic systems to the instrumentation.	Analogical-and-digital measurement electronic systems. Direct converting circuits of physical variables to digital signals. Resistance-to-digital, capacity-to-digital and inductance-to-digital converters.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	13	26	39
Laboratory practises	13	26	39
Short answer tests	1	13	14
Practical tests, real task execution and / or simulated.	2	20	22
Multiple choice tests	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
Master Session	Exhibition of the contents of the subject; it includes exhibition of concepts; introduction of practices and exercises; and resolution of problems and/or exercises in ordinary classroom.
Laboratory practises	Application, at a practical level, of the knowledge and skills acquired in the lectures by mean of practices undertaken with test and measurement equipment, either in the laboratory or in other place.

Personalized attention

Methodologies	Description
Master Session	The professor will attend personally doubts and queries of the students on the study of the theoretical concepts, the exercises or the practices of laboratory. The tutorships will do in the office of the professor in the schedule that establish at the beginning of the course and that will publish in the Web page of the subject.
Laboratory practises	The professor will attend personally doubts and queries of the students on the study of the theoretical concepts, the exercises or the practices of laboratory. The tutorships will do in the office of the professor in the schedule that establish at the beginning of the course and that will publish in the Web page of the subject.

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practises	It values the participation of the student in the practices of laboratory: preparation of previous tasks, fulfillment of the aims posed in each practice and back tasks in which the student analyses the results, compares them with the expected and presents the conclusions. They can apply to the tests of continuous or final assessment.	25	B8 C12 C14

Short answer tests	Tests that include direct questions about an specific topic. The student has to answer of direct form in virtue of the knowledge that has on the subject. The answer is brief. They can apply to the tests of continuous evaluation or to the final examination.	25	A1 B4	C11 C14
Practical tests, real task execution and / or simulated.	Tests that include activities of laboratory and/or TIC, problems or cases to resolve. The students have to give answer to the activity formulated by reflecting, in a practical way, the theoretical and practical knowledge that have been learnt in the subject, using, if it is necessary, the equipment or instrumentation of the practices carried out in the course. They can apply to the tests of continuous or final assessment.	25	B8	C11 C12 C14
Multiple choice tests	Tests that include direct questions about an specific topic with answers of multiple selection. They can apply to the tests of continuous or final assessment.	25	A1 B4	C14

Other comments on the Evaluation

1. Continuous evaluation

The continuous evaluation is divided in four parts (with their respective weights): the progress in the practices in the laboratory (25%), the practical test (25%), a test of short answers (25%) and a test of multiple choices (25%). The final mark is on a maximum of 10 points.

The final mark is the sum of the partial marks obtained in each part, if the students fulfill the following conditions:

- Have carried out a minimum of the 80% of the practices of laboratory.
- Obtain a minimum mark of the 40% in each part of the evaluation.

If it does not fulfill any of the previous requirements, the final mark will be the sum of the marks of each part, but limited to the 40% of the maximum note (4 points).

To pass, the students have to obtain an equal total punctuation or upper to the 50% of the maximum mark (5 points).

The practical test will take place in the last session of laboratory classes. The tests of multiple choice and the short answers will can be divided in two sessions spread along the period of teaching.

2. Final exam

Students who fail the course in continuous assessment will take a final exam.

The final exam will consist of a practical and a theoretical test, each corresponding to 50% of the total mark. To pass the student must obtain at least the 40% in each part and must sum a total of at least 5 points.

3. Call for recovery

The call for recovery will be like the final exam.

Sources of information

R. Schreier y G.C. Temes, **Understanding Delta-Sigma Data Converters**, 2005,

U. Meyer-Base, **Digital Signal Processing with Fiel Programmable Gate Arrays**, 2014,

Charles H. Roth, Lizy Kurian John, **Digital Systems Design using VHDL**, 2008,

C. Quintáns, **Simulación de Circuitos Electrónicos con OrCAD 16 DEMO**, 2008,

F. Maloberti, **Data Converters**, 2008,

Steven W. Smith, **The Scientist and Engineer□s Guide to Digital Signal Processing**, 1997,

G.I. Bourdopoulos, et al, **Delta-Sigma modulators : modeling, design and applications**, 2003,

S. J. Orfanidis, **Introduction to signal Processing**, 1997,

Alfi Moscovici, **High Speed A/D Converters: Understanding Data Converters Through SPICE**, 2006,

Libin Yao, Michel Steyaert and Willy Sansen, **. Low-Power Low-Voltage Sigma-Delta Modulators in nanometer CMOS**, 2006,

Recommendations

Subjects that it is recommended to have taken before

(*)Deseño de Circuitos Electrónicos Analóxicos/V05M145V01106

IDENTIFYING DATA				
(*)Codeseño Hardware/Software de Sistemas Empotrados				
Subject	(*)Codeseño Hardware/Software de Sistemas Empotrados			
Code	V05M145V01214			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Poza González, Francisco			
Lecturers	Poza González, Francisco			
E-mail	fpoza@uvigo.es			
Web	http://www.faitic.uvigo.es			
General description	The documentation of the subject will be in English. Some lectures could be given in English. The main learning goals of this course are: To learn the codesign methods to design applications based on embedded microprocessors in FPGAs. To get to know the microprocessors that can be implemented in commercial FPGAs. To handle the necessary software tools for the development of embedded applications by means of FPGAs. To design application specific peripherals and their connection to the buses of the embedded microprocessors. To design real digital applications with embedded microprocessors in FPGAs.			

Competencies	
Code	
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C11	CE11 The knowledge of hardware description languages for high complexity circuits.
C12	CE12 The ability to use programmable logic devices, as well as to design advanced electronic systems, both analog and digital. The ability to design communications components such as routers, switches, hubs, transmitters and receivers in different bands.

Learning outcomes	
Expected results from this subject	Training and Learning Results
To learn the codesign methods to design applications based on embedded microprocessors in FPGAs.	A5 C11 C12
To get to know the microprocessors that can be implemented in commercial FPGAs.	A5 C11 C12
To handle the necessary software tools for the development of embedded applications by means of FPGAs.	A5 C11 C12
To design application specific peripherals and their connection to the buses of the embedded microprocessors.	A5 B1 B8 C11 C12
To design real applications with embedded microprocessors in FPGAs.	A5 B1 B8 C11 C12

Contents	
Topic	
LESSON 1 THEORY. INTRODUCTION TO THE DESIGN OF EMBEDDED SYSTEMS. (1 h.)	1.1.- Introduction. 1.2.- Programmable Systems On Chip (PSOC). 1.3.- Hardware / Software Codesign. Codesign phases. 1.4.- Xilinx Vivado and SDK tools for codesign of embedded systems.
LESSON 2 THEORY. XILINX ARM MICROPROCESSOR. (0'5 h.)	2.1.- Introduction. 2.2.- Internal architecture of the ARM microprocessor. 2.2.1.- Structure of the ARM microprocessor. 2.2.2.- Memory Map. 2.2.3.- Basic peripherals. Timer. UART RS232. Interrupt Controller. 2.2.4.- Optional Peripherals. SPI, I2C, USB, CAN.
LESSON 3 THEORY. ARCHITECTURE OF THE XILINX ZYNQ FAMILY SOCs. (0'5 h.)	3.1.- Introduction. 3.2.- Internal Architecture of the Xilinx Zynq SOCs family. 3.2.1.- Processing System (PS). ARM microprocessor. Peripherals. 3.2.2.- Programmable Logic (PL). Logical resources. 3.2.3.- Interconnection resources. 3.2.4.- Technology. 3.2.5.- Other characteristics.
LESSON 4 THEORY. CONNECTION OF PERIPHERAL CIRCUITS TO THE XILINX ARM MICROPROCESSOR. (1 h.)	4.1.- Introduction. 4.2.- Interface for basic peripherals. GPIO. 4.3.- Interface for advanced peripherals. IPIF. 4.4.- Interface for user coprocessors
LESSON 5 THEORY. SOFTWARE DEVELOPMENT FOR THE XILINX ARM MICROPROCESSOR. (1 h.)	5.1.- Introduction. 5.2.- Structure of the routines for handling of peripherals. 5.3.- Interrupt handle. 5.4.- Program debugging.
LESSON 6 THEORY. HARDWARE / SOFTWARE PARTITIONING. (1 h.)	6.1.- Introduction. 6.2.- Examples of hardware / software codesign. 6.3.- Distribution of tasks between hardware and software.
LESSON 7 THEORY. DESIGN PROJECT. DESIGN OF PERIPHERALS FOR XILINX EMBEDDED MICROPROCESSORS. (5 h.)	7.1.- Design of the assigned peripheral, using the more suitable hardware and software combination.
LESSON 1 LABORATORY. VIVADO ENVIRONMENT FOR THE DESIGN OF EMBEDDED SYSTEMS BASED IN XILINX 32-BIT MICROPROCESSORS. (2 h.)	1.1.- Introduction. 1.2.- Xilinx Vivado. 1.2.1.- Codesign Flow. 1.2.2.- Wizard for the creation of embedded systems. 1.2.3.- Addition of predefined peripherals (IP cores). 1.3.- Design of basic examples of embedded systems based in the ARM microprocessor. 1.4.- Implementation of the developed systems in Digilent evaluation boards.
LESSON 2 LABORATORY. DESIGN OF BASIC PERIPHERAL CIRCUITS FOR THE XILINX EMBEDDED MICROPROCESSORS. (2 h.)	2.1.- Introduction. 2.2.- Use of predefined peripherals. IPs. 2.2.- Development of basic user peripherals. GPIO.
LESSON 3 LABORATORY. DESIGN OF ADVANCED PERIPHERAL CIRCUITS FOR THE XILINX EMBEDDED MICROPROCESSORS. (2 h.)	3.1.- Introduction. 3.2.- Development of advanced user peripherals (Custom IP). 3.3.- Development of user coprocessors.
LESSON 4 LABORATORY. SDK ENVIRONMENT FOR THE DESIGN OF SOFTWARE FOR THE XILINX 32-BIT MICROPROCESSORS. (2 h.)	4.1.- Introduction. 4.2.- Xilinx SDK. Software Development Kit. 4.2.1.- GNU tools (GCC, ASsembler). 4.2.2.- Editor. Compiler. Linker. 4.2.3.- Supplied Libraries. 4.2.4.- Software analysis. Software profiler. 4.3.- Design Examples. 4.3.1.- Timer handled by interruption
LESSON 5 LABORATORY. HARDWARE/SOFTWARE VERIFICATION OF EMBEDDED APPLICATIONS. (2 h.)	5.1.- Introduction. 5.2.- Simulation of embedded systems. 5.3.- Debugging of embedded systems by means of the XMD debugger included in SDK 5.4.- Debugging of embedded systems by means of the GNU debugger included in SDK. 5.5.- HW/SW Co-Verification of embedded systems by means of Xilinx Chipscope hardware analyser and the GNU software debugger.
LESSON 6 LABORATORY. DESIGN PROJECT. DESIGN OF AN APPLICATION BASED IN XILINX 32-BIT MICROPROCESSORS. (9 h.: 5 h. type B + 4 h. type C)	6.1.- Design and test of the assigned application.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	5	10	15
Troubleshooting and / or exercises	5	20	25
Laboratory practises	10	10	20
Tutored works	9	48	57
Presentations / exhibitions	1	7	8

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

Methodologies	
	Description
Master Session	Conventional lectures. Through this methodology the outcomes CE11 and CE12 are developed.
Troubleshooting and / or exercises	Problem based learning (PBL): Problem solving. Design of synthesizable circuits in VHDL and software programs in C language. To solve them, the student has to previously develop certain outcomes. Through this methodology the outcomes CB5, CG1, CG8, CE11 and CE12 are developed.
Laboratory practises	VHDL design of digital circuits and circuit implementation in FPGAs and development of software programs in C language. Integration of both to build an embedded system in a FPGA. Through this methodology the outcomes CB5, CG8, CE11 and CE12 are developed.
Tutored works	Project based learning. The students must design an embedded system to solve a problem. In order to that, the students must plan, design and implement the necessary steps. Through this methodology the outcomes CB5, CG1, CG8, CE11 and CE12 are developed
Presentations / exhibitions	Exhibition of the results of the project developed. Through this methodology the outcomes CB5, CE11 and CE12 are developed.

Personalized attention	
Methodologies	**Description**
Master Session	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.
Presentations / exhibitions	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 practises	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.
Troubleshooting and / or exercises	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.
Tutored works	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	Training and Learning Results	
Troubleshooting and / or exercises	Problem Based Learning. Resolution of exercises and theoretical problems. The majority of them will be focused on the theoretical approach to the design of a peripheral of an embedded system. The problems will be based on the theoretical topics. It will be necessary to show to the professor the operation of each one of the circuits and programs. 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.	25	A5 B1 C11 B8 C12	

Laboratory practises	Design circuits and programs in the laboratory sessions corresponding to the laboratory lessons 1 to 5. It will be necessary to show to the professor the operation of each one of the circuits and programs. 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.	25	A5	B8	C11 C12
Tutored works	Project Based Learning. Laboratory Project. Design of an embedded system. It will be necessary to deliver the files source of the work realized. It will be necessary to deliver the design source files. The assessment will be based on the operation of the embedded system and the correct application of the theoretical concepts, according to the published criteria.	40	A5	B1 B8	C11 C12
Presentations / exhibitions	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	A5		C11 C12

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.

All the students, both those who follow the subject continuously and those who want to be assessed in the final exam at the end of the term or in the extraordinary exam in July, 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, according to the valid regulation (Royal decree 1125/2003 of 5 September; BOE 18 September). Following the guidelines of the degree the students will be offered two assessment systems: continuous assessment and final assessment at the end of the term.

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 final assessment in July.

 The students that pass the course by means of continuous assessment will not be allowed to repeat any task in the final 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, the laboratory practices and the laboratory projects in groups of two students during the continuous assessment.

 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.

FINAL ASSESSMENT:

 The students that opt for the final assessment will have to do all the theoretical and practical tasks and the project individually.

 The tasks for the final assessment have to be delivered before the official date of the examination set by the faculty.

In case the students pass the theoretical exercises (TE), the laboratory practices (LAB) 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 = 0'25 * TE + 0'25 * LAB + 0'40 * LP + 0'10 * OP

In case the students do not pass any of the three main parts of the subject, that is, the mark of any task < 5, the final mark (FM) will be:

FM = Minimum [4'5; (FM = 0'25 * TE + 0'25 * LAB + 0'40 * LP + 0'10 * OP)]

Where:

TE = Global mark of the theoretical exercises and problems.

LAB = Guided Laboratory Practices.

LP = Laboratory Project.

OP = Oral presentation.

ASSESSMENT CRITERIA.

1) Realization of guided laboratory practices.

It will evaluate the correct operation of the circuits and programs developed in the laboratory sessions. Each laboratory lesson 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 hours assigned to each lesson.

That is, the mark of the practices corresponding to the laboratory lessons 1 to 5 will be obtained through the following formula:

LAB = (Lesson 1L + Lesson 2L + Lesson 3L + Lesson 4L + Lesson 5L) / 5

The total mark of the guided laboratory practices (LAB) will correspond to 25% of the total mark of the subject. It will be necessary to deliver the required source files. The assessment criteria refer only to the functionality of the circuits and programs developed, that is, the circuits and programs have to work perfectly to obtain the maximum mark.

2) 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 a peripheral for an embedded system and the approach to the design of a complete embedded system with its peripherals.

The assessment criteria are the following:

2.1) Suitable distribution of tasks between □hardware□ and □software".

2.2) Suitable organization of the □hardware□ and suitable structure of the C program.

2.3) Correct design (CORR).

Optimization of the VHDL description and the C programs. Synchronous design. Reusable design.

2.4) Functionality (FUNC).

If the exercise asks for it, the behavioral simulation and synthesis of the VHDL, as well as the simulation of the C programs have to work perfectly.

2.5) Documentation (DOC).

i. Design source files.

ii. Enough comments in the VHDL and C files to explain the sentences used.

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 = (Exercise 1 + □ + Exercise N) / N

3) Autonomous Laboratory Project.

This project consists in the design of an embedded system. The assessment criteria are the following:

3.1) Suitable distribution of tasks between □hardware□ and □software".

3.2) Suitable organization of the hardware system and suitable structure of the C program.

3.3) Correct design (CORR). System entirely synthesizable. Suitable hierarchy arrangement. Design totally synchronous.

Technology independent design. Reusable design.

3.4) Analysis of the design and the implementation in FPGAs (ANA). Analysis of the FPGA logical resources used and their justification. Analysis of the internal system delays. Analysis of the chosen implementation options. Optimal utilization of the FPGA logical resources. Achievement of an optimal processing speed. Verification with Chipscope.

3.5) Functionality (FUNC). Software Simulation. Software Debugging. Behavioral and Timing Simulation of the different hardware circuits. Simulation of the complete embedded system (hardware + software). Debugging of the complete embedded system (hardware + software). Board test of the complete embedded system (hardware + software). All the sections have to work perfectly to obtain the maximum mark.

6) Documentation of the design and the implementation with FPGAs (DOC).

3.6.1) Document.

i. Clear structure and order.

ii. Clear and sufficient explanations for the understanding of the work developed.

iii. Include suitable figures.

iv. Include important data.

3.6.2) Source design files.

i. Sufficient comments in the VHDL files for its understanding.

ii. Sufficient comments in the C files for its understanding.

For the Autonomous Laboratory Project (LP), it will be necessary to do an oral presentation.

3.7) Laboratory Project Oral Presentation.

The work developed during the laboratory project will be presented. The assessment criteria are the following:

i. Clear structure and presentation order.

ii. Clear explanations.

iii. Enough explanations to understand the project.

iv. Suitable figures.

v. Relevant data.

Sources of information

ÁLVAREZ RUIZ DE OJEDA, L.J., POZA GONZÁLEZ, F., **Diseño de aplicaciones empotradas de 32 bits en FPGAs con Xilinx EDK 10.1 para Microblaze y Power-PC**, Vison Libros,

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

Recommendations

Subjects that are recommended to be taken simultaneously

(*)Sistemas Electrónicos Dixitais Avanzados/V05M145V01203

IDENTIFYING DATA				
(*)Deseño e Fabricación de Circuítos Integrados				
Subject	(*)Deseño e Fabricación de Circuítos Integrados			
Code	V05M145V01215			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	Fariña Rodríguez, José			
Lecturers	Cao Paz, Ana María Fariña Rodríguez, José			
E-mail	jfarina@uvigo.es			
Web				
General description	The objectives in mind are: 1) To know and understand the design methodologies of Integrated Circuits (ICs) based on CMOS technology. 2) To know the basic topologies used in analog electronic circuits. 3) To know how to analyze and dimensioning the devices of the basic topologies of analog circuits in CMOS technology. 4) To know and be capable to use software tools for the design of integrated circuits. 5) To know to specify an integrated circuit for manufacturing in CMOS technology.			

Competencies	
Code	
A4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C10	CE10 The ability to design and manufacture integrated circuits.

Learning outcomes	
Expected results from this subject	Training and Learning Results
Know the design methodologies of electronic integrated circuits	C10
Know the basic topologies used in analog electronic circuits	C10
Can analyze and dimension the devices that form the basic topologies of analog circuits	A5 B8 C10
Know aid software tools integrated circuit design	C10
Know how an electronic circuit is specified for manufacturing	A4 C10

Contents	
Topic	
Chapter 1: Introduction (1h)	Course introduction. Objectives and course planning. Basic concepts of microelectronic design of integrated circuits (ICs).
Chapter 2: Manufacturing sequence for ICs (1h)	Introduction to ICs manufacturing. Planar technology. Manufacturing sequence of ICs in CMOS technology. Structure of MOS transistors. Manufacturing example: CMOS inverter. Masks pattern (layout). Technological design rules. Methodologies and tools for design assistance.
Chapter 3: Physical structure of basic devices and routing strategies (1h)	Specification of the physical structure of MOS transistor. Specification of the physical structure of a resistor. Specification of the physical structure of a capacitor. Strategies for performing transistors with high aspect ratio. Strategies for matched transistors.

Chapter 4: Basic amplifier topologies (2h)	Common source topology. Common drain topology. Common gate topology. Cascode topology. Push_Pull amplifier. Physical design examples.
Chapter 5: Current mirror (3h)	Current sources. Basic structure of a current mirror. Analysis of functioning. Frequency response. Cascode topology. Physical design examples.
Chapter 6: Differential pair (3h)	Differential pair structure. DC analysis. AC analysis. Specifications and design of the physical structure of a self-biased differential amplifier topology. Common mode rejection ratio. Matching of transistors. Slew rate limitations. Physical design examples.
Chapter 7: Operational amplifier (2h)	Two stages operational amplifier. Design parameters. Operational Transconductance Amplifier (OTA). Examples of physical designs.
Chapter 8: Preparing for manufacturing (2h)	Distribution in the base plane. Pad and terminals. Specification formats. Packages.
Laboratory session 1: Introduction to design tools for ICs (2h)	Introduction to design tools for analog ICs. Current mirror example. Electric simulation. Design Rules Check (DRC) and layout extraction.
Laboratory session 2: Design of self-biased differential pair (2h)	Electrical specification. Characterization of DC operating parameters. Characterization of AC operating parameters.
Laboratory session 3: Design of self-biased differential pair II (2h)	DRC and layout extraction. Layout versus schematic (LVS). Post-layout simulation.
Laboratory session 4: Design of a transconductance amplifier (2h)	Electrical Specification. Physical specification. Operation testing.
Laboratory session 5: Preparing for manufacturing (2h)	For the circuit obtained in Laboratory session 4, perform the required steps to create the information needed in order to send the circuit to manufacture.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	14	28	42
Troubleshooting and / or exercises	4	28	32
Laboratory practises	9	22.5	31.5
Short answer tests	1	4	5
Troubleshooting and / or exercises	1	5.5	6.5
Practical tests, real task execution and / or simulated.	1	7	8

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

Methodologies

	Description
Master Session	The professor will present the relevant concepts of the course. Before each lecture, students must carry out a preparation analysis of the topics to be addressed. The aim is to encourage active participation of students, who may ask questions or expose doubts during the session. For a better understanding of certain content, practical examples or case studies will be discussed
Troubleshooting and / or exercises	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.
Laboratory practises	Students work in groups of two people. They will work with IC CAD tools for IC design, in which they will carried out the definition of an electronic circuit both electrical and physical level, the verification of compliance with specifications and design preparation for manufacturing. Attendance will be recorded and performance of each group in each lab assignment will be evaluated.

Personalized attention

Methodologies	Description
Master Session	The teaching staff will attend doubts and enquiries of the students about the theoretical contents, previous preparation of laboratory practices as well as its contents. Professors will also resolve the doubts and enquiries of students about specifications, theoretical and practical aspects of the assigned project as well as those about the content and structure of the explanatory report. In addition, students will be guided about the structure and contents of the sessions of presentation and defense of the results achieved in the project. Students will have the opportunity to attend personalized or group mentoring.

Laboratory practises	The teaching staff will attend doubts and enquiries of the students about the theoretical contents, previous preparation of laboratory practices as well as its contents. Professors will also resolve the doubts and enquiries of students about specifications, theoretical and practical aspects of the assigned project as well as those about the content and structure of the explanatory report. In addition, students will be guided about the structure and contents of the sessions of presentation and defense of the results achieved in the project. Students will have the opportunity to attend personalized or group mentoring.
Troubleshooting and / or exercises	The teaching staff will attend doubts and enquiries of the students about the theoretical contents, previous preparation of laboratory practices as well as its contents. Professors will also resolve the doubts and enquiries of students about specifications, theoretical and practical aspects of the assigned project as well as those about the content and structure of the explanatory report. In addition, students will be guided about the structure and contents of the sessions of presentation and defense of the results achieved in the project. Students will have the opportunity to attend personalized or group mentoring.

Assessment

	Description	Qualification	Training and Learning Results
Short answer tests	As part of the continuous evaluation, it will take place in mid-course an individual written test of 30 minutes, in one of the lecture sessions. This test will involve 10% of the final grade. 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. Another written test of 60 minutes will be held in the date of the final exam. This test will have two parts and it is compulsory in whole for students not in continuous evaluation. Students in continuous evaluation can also voluntarily complete the first part since the contents correspond to the first written test. In that case, the score they will receive in this part of the course evaluation will be the one achieved in this second test. The second part of the test is mandatory for all students. Each of the parts will involve 10 % of the final qualification. To pass the course, students must achieve in each part a mark of 4 or higher in a 0-10 scale (or in the intermediate test, where appropriate). Competences CE10 and CB4 will be assessed in these tests.	20	A4 C10
Troubleshooting and / or exercises	As part of the continuous evaluation, it will take place in mid-course an individual written test of 30 minutes, in one of the lecture sessions. This test will involve 10% of the final grade. 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. Another written test of 60 minutes will be held in the date of the final exam. This test will have two parts and it is compulsory in whole for students not in continuous evaluation. Students in continuous evaluation can also voluntarily complete the first part since the contents correspond to the first written test. In that case, the score they will receive in this part of the course evaluation will be the one achieved in this second test. The second part of the test is mandatory for all students. Each of the parts will involve 10 % of the final qualification. To pass the course, students must achieve in each part a mark of 4 or higher in a 0-10 scale (or in the intermediate test, where appropriate). Competences CE10 and CB4 will be assessed in these tests.	20	A4 B8 C10

Practical tests, real task execution and / or simulated.	The evaluation of the practical tests will be performed from memory supporting and public presentation of results. Each group of students you must submit a report of the work has been carried out, indicating expresses the contribution of each to the whole, as well as methodology followed for the distribution and coordination of tasks. The evaluation of the work will be based on the following aspects: - Analysis of alternatives - Correct implementation and design verification - Design compaction - Use of appropriate strategies to minimize the effects of imperfections in the manufacturing process and to ensure good matching of the electrical characteristics between components or devices that like this require it by functional reasons. - Information for integrated circuit manufacturing. - Formal aspects: clarity and order, including figures and appropriate and outstanding data, as well as explanations in a concrete and comprehensive way. Each student will have an individual public exposure of the project has personally performed (including tasks planning and coordination if applicable). The presentations of the students from each group will be out in the same session, 1 hour. Each student will have 5 minutes for their presentation. At the end of the presentation, students must answer questions from teachers and other students present. The evaluation will be based on both the content and formal aspects of the presentation and the answers to questions. It may also assess positively to students who perform relevant questions. The explanatory report should be submitted at least two days before public presentation of work. To pass the course, the student will need obtain at least a score of 5 over 10 in memory, get to least a score of 5 out of 10 in public presentation. In the evaluation of the practical tests, the memory note will weigh 70% and the presentation 30%. In this test the CE10, CB4, CB5 and CG8 skills are evaluated.	60	A4 B8 C10 A5

Other comments on the Evaluation

- Final test will be 50% of the overall grade of the course. It will consist of two parts: short answer questions and resolution of problems. The part of the questions will represent 40 % of the test qualification and the part of resolution of problems the other 60%. In order to calculate the grade it is necessary to obtain at least 50 % of the maximum score for each part.
- 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 the public presentation. The project qualification will involve 50% of the overall grade of the course. In the final qualification of the project, the memory report has a corresponding percentage of 70% and the other 30% is obtained from the qualification of the presentation. In order to calculate the grade it is necessary to obtain at least 50 % of the maximum score for each part.

Students not passing the course in the first call will have the opportunity to attend a second call. To pass the course, students must achieve in each part at least 50 % of the maximum score.

Sources of information

R. Jacob Baker, **CMOS Circuits desing, Layout and Simulation**, John Wiley & Sons,

Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, **Analysis and Design of Analog Integrated Circuits**, John Wiley & Sons,

Behzad Razavi, **Design of Analog CMOS Integrated Circuits**, McGraw Hill,

Recommendations