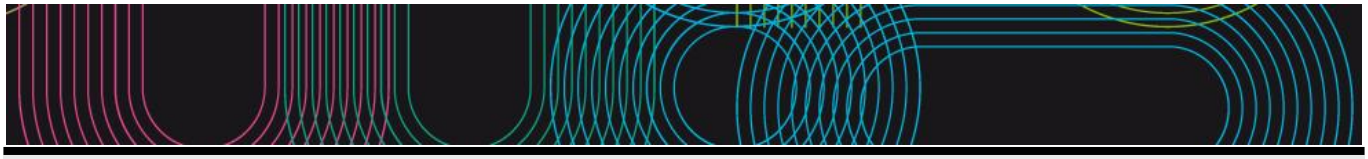

(*)Escola de Enxeñaría de Telecomunicación

Presentatiton

Telecommunications Technical Engineer

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

Master in Industrial Mathematicics

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

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Web page

www.teleco.uvigo.es

(*)Máster Universitario en Enxeñaría de Telecomunicación

Subjects

Year 1st

Code	Name	Quadmester	Total Cr.
V05M145V01101	A Enxeñaría de Telecomunicación na Sociedade da Información	1st	5
V05M145V01102	Tratamento de Sinal en Comunicacións	1st	5
V05M145V01103	Radio	1st	5
V05M145V01104	Tecnoloxías de Rede	1st	5
V05M145V01105	Tecnoloxías de Aplicación	1st	5
V05M145V01106	Deseño de Circuitos Electrónicos Analóxicos	1st	5
V05M145V01201	Dirección de Proxectos de Telecomunicación	2nd	5
V05M145V01202	Electrónica e Fotónica para Comunicacións	2nd	5
V05M145V01203	Sistemas Electrónicos Dixitais Avanzados	2nd	5
V05M145V01204	Comunicacións Dixitais Avanzadas	2nd	5
V05M145V01205	Procesado de Sinal en Sistemas Audiovisuais	2nd	5
V05M145V01206	Comunicacións Multimedia	2nd	5
V05M145V01207	Comunicacións Ópticas	2nd	5
V05M145V01208	Antenas	2nd	5
V05M145V01209	Laboratorio de Radio	2nd	5
V05M145V01210	Enxeñaría de Internet	2nd	5
V05M145V01211	Redes sen Fíos e Computación Ubicua	2nd	5
V05M145V01212	Enxeñaría Web	2nd	5
V05M145V01213	Circuítos Mixtos Analóxicos e Dixitais	2nd	5
V05M145V01214	Codeseño Hardware/Software de Sistemas Empotrados	2nd	5
V05M145V01215	Deseño e Fabricación de Circuítos Integrados	2nd	5

Year 2nd

Code	Name	Quadmester	Total Cr.
V05M145V01301	Procesado de Sinal en Tempo Real	1st	5
V05M145V01302	Sistemas Avanzados de Comunicacións	1st	5
V05M145V01303	Procesado Estatístico de Sinal	1st	5
V05M145V01309	Tecnoloxías para o Desenvolvemento Web	1st	5
V05M145V01310	Desenvolvemento en Aplicacións Móbiles	1st	5
V05M145V01311	Satélites	1st	5
V05M145V01312	Sistemas Radio en Banda Ancha	1st	5
V05M145V01313	Comunicacións Móbiles e sen Fíos	1st	5
V05M145V01317	Microwave and Millimetre Wave Circuit Design and CAD	1st	5
V05M145V01318	Seguridade Multimedia	1st	5
V05M145V01321	Computación Distribuída	1st	5
V05M145V01322	Análise de Datos	1st	5
V05M145V01323	Redes Sociais e Económicas	1st	5
V05M145V01324	Prácticas en Empresas I	1st	5
V05M145V01325	Prácticas en Empresa II	1st	5
V05M145V01326	Prácticas en Empresas III	1st	5
V05M145V01401	Traballo Fin de Máster	1st	30

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	Type	Year	Quadmester
	5	Mandatory	1st	1st
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		Typology
CB3	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.	- Know be
CG7	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.	- know
CG9	CG9 The ability to understand the responsibility and professional ethics of the activity of the profession of Telecommunications Engineering.	- Know be
CG13	CG13 The knowledge, understanding and ability to implement the necessary legislation in the exercise of the profession of Telecommunications Engineering.	- know - Know How
CE15	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.	- Know How
CT3	CT3 Understanding Engineering in a framework for sustainable development.	- Know be
CT4	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.	- know - Know be

Learning outcomes	
Learning outcomes	Competences

Knowledge of what the profession of Telecommunicationis Engineering is and what represents.	CG7 CG13 CT4
Taking of consciousness of the social responsibility, ethical and environmental of Telecommunication Engineering.	CB3 CG9 CT3 CT4
Contact with other disciplines in which the technologies of Telecommunication integrate for the development of the society: bioengineering, solar energy, nanotechnologies, tele-medicine, teleassistance, teleeducation.	CE15

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	
	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.
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	Evaluated Competencess
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	CG7 CG9 CT3
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	CB3 CG7 CG9 CG13 CT4
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	CB3 CG9 CE15 CT4
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	CB3 CG7 CG9 CG13 CE15 CT3 CT4

Other comments and July 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, 2006
O. Pérez Sanjuán , De las señales de humo a la Sociedad del Conocimiento, COIT-AEIT, 2006
O. Pérez Sanjuán , Detrás de la cámara, COIT-AEIT, 2008
VV.AA., Design Thinking for Educators, www.designthinkingforeducators.com/toolkit/, 2012
J. Cabanelas, Vía Vigo: el Cable Inglés – el Cable Alemán, Instituto de Estudios Vigueses, 2013

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	Type	Year	Quadmester
	5	Mandatory	1st	1st
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		Typology
CG4	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.	- know - Know How
CG8	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.	- Know How - Know be
CE1	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.	- know - Know How
CE2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.	- know - Know How
CE3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.	- know

Learning outcomes	
Learning outcomes	Competences
Ability to apply multirate processing, adaptive filtering, block-based transform and spectral estimation techniques to communication and multimedia systems	CG4 CE1
Ability to implement advanced signal processing techniques in diverse fields of application: bioengineering, bioinformatics, etc.	CG4 CG8
Ability to apply signal processing techniques to the modeling and simulation of communication systems	CG4 CE1 CE2
Ability to simulate the physical layer of cable, wireline, satellite systems in fixed/mobile communication environments.	CG4 CG8 CE2 CE3

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	
	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	Evaluated Competencess
Long answer tests and development	Final test in which the student must solve a series of exercises.	40	CG4 CE1 CE2

Reports / memories of practice	Written reports corresponding to the different lab assignments.	40	CG4 CG8 CE1 CE2
Jobs and projects	Written report describing the developed design and obtained results for the final project.	20	CG4 CG8 CE1 CE2 CE3

Other comments and July 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, 2000

S. Mitra, Digital Signal Processing: A Computer Based Approach., 4th, 2011

Behrouz Farhang-Boroujeny, Signal Processing Techniques for Software Radios, 2nd, 2010

P.P. Vaidyanathan, Multirate systems and Filter Banks, , 1993

F. Harris, Multirate Signal Processing for Communication Systems, , 2004

J.G. Proakis and D.G. Manolakis, Digital Signal Processing, 4th, 2006

S. Haykin, Adaptive Filter Theory, 4th, 2001

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	Type	Year	Quadmester
	5	Mandatory	1st	1st
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		Typology
CB2	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.	- Know How
CB4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.	- Know How
CE2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.	- Know How
CE3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.	- Know How
CE5	CE5 The ability to design systems of radio navigation and positioning, as well as radar systems.	- Know How

Learning outcomes	
Learning outcomes	Competences
Capacity to realise basic antenna designs	CB2 CE2
Capacity to calculate link budgets taking into account both signal and perturbations in distinct stages	CB2 CE2 CE3
Capacity to design radionavegation and positioning systems	CB4 CE3 CE5
Capacity to design radar systems	CB4 CE5

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	
	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.
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	Evaluated Competencess
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	CB2 CB4 CE2 CE5
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	CB2 CB4 CE2 CE5
Other	Participation in activities by part of the students, especially of the practices. This section corresponds to the continuous evaluation of the student.	30	CB2 CB4 CE2 CE5

Other comments and July 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 Acun?a, Oscar Rubin?os Lo?pez, Radiocomunicacio?n, 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	Type	Year	Quadmester
	5	Mandatory	1st	1st
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		Typology
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- know
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- know - Know How
CG4	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.	- know - Know How
CG8	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.	- know - Know How
CG12	CG12 To have skills for lifelong, self-directed and autonomous learning.	- know
CE4	CE4 The ability to design and plan networks for transporting, broadcasting and distribution of multimedia signals.	- know - Know How
CE6	CE6 The ability to model, design, implement, manage, operate, and maintain networks, services and contents.	- know - Know How
CE7	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.	- know - Know How
CE12	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.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Know how to model mathematically the essential elements of a network of telecommunications	CB5 CG1 CG4 CG8 CG12 CE4 CE6 CE7

Understand the fundamental results on the capacity for different types of networks	CG1 CG4 CG8 CE4 CE6 CE7
Understand, formulate and solve simple models for analyzing the performance of a computer network	CG1 CG4 CG8 CE4 CE6 CE7 CE12
Know how to plan, design and deploy switched networks and IP networks in any application environment	CB5 CG1 CG4 CG8 CG12 CE4 CE6 CE7
Know and understand the internal architecture of the switching equipment, methods of resource allocation and the basic techniques of providing Quality of Service	CB5 CG1 CG4 CG8 CG12 CE4 CE6 CE12

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

	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	Evaluated Competencess
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	CG4 CG8 CG12 CE4 CE6 CE7 CE12

Long answer tests and development	Final exam covering all the lessons.	50	CG4 CG8 CG12 CE4 CE6 CE7 CE12
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	CB5 CG4 CG8 CG12 CE4 CE6 CE7 CE12

Other comments and July 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, 2014

Villy B. Iversen, Teletraffic Engineering Handbook, Web, 2011

Villy B. Iversen, Teletraffic Engineering and Network Planning, Web, 2010

J.F. Kurose, K.W. Ross, Computer networking: a top-down approach featuring the Internet, 6ª, 2012

Kun I. Park, QoS in packet networks, 1ª, 2005

Pazos Arias, J.J., Suárez González, A., Díaz Redondo, R.P., Teoría de colas y simulación de eventos discretos, , 2003

M.J. Newman, Networks, Oxford Univ. Press, 2012

Diane Teare, Implementing Cisco IP Routing (ROUTE) Foundation Learning Guide, Cisco Press, 2010

Richard Froom, Balaji Sivasubramanian, Erum Frahim, Implementing Cisco IP Switched Networks (SWITCH) Foundation Learning Guide, Cisco Press, 2010

Recommendations

IDENTIFYING DATA				
(*)Tecnoloxías de Aplicación				
Subject	(*)Tecnoloxías de Aplicación			
Code	V05M145V01105			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Mandatory	1st	1st
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		Typology
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- Know How
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- Know How
CG4	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.	- Know How
CG8	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.	- Know How
CG12	CG12 To have skills for lifelong, self-directed and autonomous learning.	- know - Know How
CE4	CE4 The ability to design and plan networks for transporting, broadcasting and distribution of multimedia signals.	- Know How
CE8	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.	- Know How
CE9	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.	- Know How

Learning outcomes	
Learning outcomes	Competences
Know and apply the different communication techniques for communication and distributed computing	CB5 CG1 CG4 CG12 CE4
Know and apply the techniques for data sharing to enable interoperability among systems and/or services	CB5 CG1 CG8 CG12 CE4 CE9

Know and apply how to specify and discover software services to be integrated in complex telematic solutions	CB5 CG1 CG4 CG8 CG12 CE4 CE9
Know and apply virtualization concepts : cloud computing and content distribution networks.	CB5 CG1 CG12 CE4 CE8

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	
	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	Evaluated Competencess

Practical tests, real task execution and / or simulated.	Students willl design and implement software solutions for different small problems.	40	CB5 CG1 CG8 CG12 CE4 CE8
Short answer tests	Written exam wich combines test and short answer questions. No extra material is allowed.	60	CB5 CG4 CG8 CG12 CE8 CE9

Other comments and July 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.

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	Type	Year	Quadmester
	5	Mandatory	1st	1st
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		Typology
CB4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.	- Know How
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- know
CG4	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.	- Know How
CG8	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.	- Know How
CE12	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.	- Know How
CE14	CE14 The ability to develop electronic instrumentation, as well as transducers, actuators and sensors.	- Know How

Learning outcomes	
Learning outcomes	Competences

Know analyse and design analogue electronic circuits of low frequency.	CB4 CG4 CG8 CE12 CE14
Know the parts that constitute an electronic measurement system.	CB5 CG4 CE12 CE14
Know the principle of operation of sensors and their conditioners.	CB5 CG4 CE12 CE14
Know model an analogue electronic system by means of hardware description languages.	CB4 CG4 CG8 CE12 CE14

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
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	Evaluated Competencess
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	CB4 CB5 CG4 CG8 CE12 CE14

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	CB4 CB5 CG4 CG8 CE12 CE14
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	CB4 CB5 CG4 CG8 CE12 CE14

Other comments and July 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. , Ediciones Paraninfo, S.A., 2014
Franco, S., Diseño con amplificadores operacionales y circuítos integrados analógicos, 3ª ed., McGraw-Hill, México D.F., 2004
Fraile Mora, J., García Gutiérrez, P., y Fraile Ardanuy, J., Instrumentación aplicada a la ingeniería, 3ª ed., Editorial Garceta, 2013
Pallás Areny, R., Sensores y Acondicionadores de Señal, 4ª ed., Marcombo, Barcelona, 2003
Pallás Areny, R., Casas, O., y Bragó, R., Adquisición y Distribución de Señales: problemas resueltos, , Marcombo, Barcelona, 2008
Pérez García, M.A., Álvarez Antón, J.C., Campo Rodríguez, J.C., Ferrero Martín F.C., y Grillo Ortega, Instrumentación Electrónica, 2ª ed., Thomson, 2004
Pérez García, M.A., Instrumentación Electrónica: 230 problemas resueltos , 1ª ed., Editorial Garceta, 2012

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	Type	Year	Quadmester
	5	Mandatory	1st	2nd
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		Typology
CG2	CG2 The capacity for managing projects and telecommunication systems facilities, complying with current legislation, ensuring the quality of service.	- know
CG3	CG3 The ability to lead, plan and monitor multidisciplinary teams.	- know
CG6	CG6 The capacity for general direction, technical direction and management of research, development and innovation projects in companies and technological centers.	- know
CG10	CG10 The ability to apply principles of economics and human resources and projects management, as well as legislation, regulation and standardization of telecommunications.	- know
CG13	CG13 The knowledge, understanding and ability to implement the necessary legislation in the exercise of the profession of Telecommunications Engineering.	- know
CE16	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.	- know
CT1	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.	- know
CT5	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.	- know

Learning outcomes	
Learning outcomes	Competences
- Knowledge of procedures for innovation and creativeness.	CG2 CG3 CG6 CG10 CG13 CE16 CT5

- Tools for telecommunications projects management.	CG3 CT1
- Management of ideas and innovation basics.	CG2 CG3 CG6 CG10 CG13 CE16 CT5
- Knowledge of efficient project management.	CG2 CG3 CG6 CG10 CG13 CE16 CT5

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	
	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	Evaluated Competencess
Reports / memories of practice	Practical cases, to be presented as deliverables.	50	CG2 CG3 CG6 CG10 CG13 CE16 CT1 CT5
Jobs and projects	Practical work, to be presented as deliverables and defended in public	30	CG2 CG3 CG6 CG10 CG13 CE16 CT1 CT5
Multiple choice tests	Written exam	20	CG2 CG3 CG6 CG10 CG13 CE16 CT1 CT5

Other comments and July 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, Pirámide

PMI, PMBOK Guide and Standards, 5ª, PMI

F. J. Galán, Coaching Inteligente ACCION, Junio 2011, Esic

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	Type	Year	Quadmester
	5	Mandatory	1st	2nd
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		Typology
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- Know How
CG4	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.	- Know How
CE2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.	- Know How
CE3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.	- Know How
CE12	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.	- Know How
CE13	CE13 The ability to apply advanced knowledge of photonics, optoelectronics and high-frequency electronics.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
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.	CG1 CG4 CE2 CE3 CE12 CE13
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.	CG1 CG4 CE2 CE3 CE13

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	
	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	Evaluated Competencess
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	CE2 CE3 CE12 CE13
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	CE2 CE3 CE12 CE13
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	CE2 CE3 CE12 CE13
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	CE2 CE3 CE12 CE13

Other comments and July 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, Addison-Wesley Pub. Co
Enrique Sánchez, Introducción a los dispositivos y circuitos semiconductores de microondas, 1, Pearson Educacion
Guillermo González, Microwave Transistor Amplifiers: Analysis and Design, 2, Prentice-Hall
Steve C. Cripps, RF Power Amplifiers for Wireless Communications , 1, Artech House
Steve C. Cripps , Advanced Techniques in RF Power Amplifier Design , 1, Artech House
Amnon Yariv, Pochi Yeh, Photonics Optical Electronics in Modern Communications, 6, Oxford University Press
Bahaa E. A. Saleh, Malvin Carl Teich, Fundamentals of Photonics, 2, Wiley
S. O. Kasap, Optoelectronics and Photonics: Principles and Practice, 2, International ed. Pearson
Guillermo González , Foundations of Oscillator Circuit Design, 1, Artech House
Egan, William F., Phase-lock basics, 1, John Wiley & Sons
Rhea, Randall W., HF filter desing and computer simulation , 1, Noble Publishing
Rhea, Randall W., Discrete oscillator design : linear, nonlinear, transient, and noise domains , 1, Artech House

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	Type	Year	Quadmester
	5	Mandatory	1st	2nd
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		Typology
CB4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.	- Know How - Know be
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- Know be
CG4	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.	- Know How
CG8	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.	- Know How - Know be
CE10	CE10 The ability to design and manufacture integrated circuits.	- Know How
CE11	CE11 The knowledge of hardware description languages for high complexity circuits.	- Know How
CE12	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.	- know - Know How
CE14	CE14 The ability to develop electronic instrumentation, as well as transducers, actuators and sensors.	- Know How

Learning outcomes	
Learning outcomes	Competences
The knowledge of the different technologies of integrated circuits manufacture.	CE10
The ability to analyze and design advanced digital circuits.	CG4 CE12
The knowledge of different input/output technologies of digital circuits.	CE14
The ability to design input/output interface circuits.	CE10 CE12 CE14
The knowledge of the methodologies for the design of complex digital circuits.	CB5 CG8 CE12

The ability to design communication components using programmable logic devices.	CB4 CG8 CE11 CE12
The ability to design complex digital electronic systems using hardware description languages.	CE11

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	
	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.
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	Evaluated Competencess
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	CE10 CE11 CE12 CE14
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	CG4 CG8 CE10 CE11 CE12 CE14
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	CB4 CB5 CG4 CG8 CE10 CE11 CE12 CE14

Other comments and July 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, 2011

Ashok K. Sharma, Semiconductor memories : technology, testing, and reliability , , 1997

Charles H. Roth, Jr., Lizy Kurian John, Digital systems design using VHDL , 2ª, 2008

Santosh K. Kurinec, Krzysztof Iniewski, Nanoscale Semiconductor Memories: Technology and Applications (Devices, Circuits, and Systems) , , 2013

William Kleitz, Digital Electronics: A Practical Approach with VHDL, 9ª, 2011

David J. Comer, Digital logic and state machine design , 3ª, 1995

John F. Wakerly, Digital Design. Principles and Practices, 4ª, 2007

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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- know - Know How
CG4	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.	- know - Know How
CG8	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.	- know - Know How
CE1	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.	- know - Know How
CE2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.	- know - Know How
CE3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Handle the mathematical tools needed to model, simulate and evaluate moderns communication systems.	CG1 CG4 CE1 CE2 CE3
Solve problems whose solution does not derive from the application of a standardized procedure.	CG1 CG4 CG8 CE1 CE2 CE3
Understand the principles underlying modern communication standards.	CG1 CG4 CG8 CE1 CE2 CE3

Design transmitters, receivers and measurement equipment for modern communication systems.	CG1 CG4 CG8 CE1 CE2 CE3

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	
	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.
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	Evaluated Competencess
Long answer tests and development	Final exam with short questions on the contents of the subject.	50	CG1 CG4 CG8 CE1 CE2 CE3

Reports / memories of practice	Reports of the practices that employ the techniques seen in the classroom.	50	CG1 CG4 CG8 CE1 CE2 CE3

Other comments and July 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, Cambridge University Press, 2007

David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, First, Cambridge University Press, 2005

Ezio Bliglieri et al. , Principles of Cognitive Radio, First, Cambridge University Press, 2013

Behrouz Farhang-Boroujeny, Signal Processing Techniques for Sotware Radios, Second,

Thomas Cover and Joy Thomas, Elements of Information Theory, Second, Wiley, 2006

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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- know - Know How
CG4	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.	- know - Know How
CE1	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.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Learning to exploit perceptual effects and spatial/temporal redundancy to compress audiovisual information.	CG1 CG4 CE1
Understanding information structure into the MPEG4 standard and the reasons because it is needed.	CG1
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.	CG1 CG4 CE1
Learning to handle audiovisual information to extract metadata and to use them in indexing and retrieval.	CG1
Understanding strcuture and usefulness of MPEG7 standard.	CG1

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	
	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.
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	Evaluated Competencess
Multiple choice tests	These tests are based on theory classes concepts.	20	CG1 CG4 CE1
Reports / memories of practice	The qualification of guided works comprises: achievemnts, documentation, bibliography selection and oral presentation.	80	CG1 CG4 CE1

Other comments and July 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 , 2002

Thiagarajan, Jayaraman, Analysis of the MPEG-1 Layer III (MP3) Algorithm using MATLAB, Morgan & Claypool, 2011

Richardson, Iain E. G., H.264 and MPEG-4 video compression: video coding for next generation multimedia, Wiley, cop., 2004

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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- Know How
CG4	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.	- Know How
CE1	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.	- Know How
CE4	CE4 The ability to design and plan networks for transporting, broadcasting and distribution of multimedia signals.	- Know How
CE6	CE6 The ability to model, design, implement, manage, operate, and maintain networks, services and contents.	- Know How
CE8	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.	- know

Learning outcomes	
Learning outcomes	Competences
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.	CG4 CE1
Understand that a trellis code defines a lattice and why this construction is useful for source coding (Trellis-Code Quantization)	CG4 CE1
Understanding of the different distributed source coding schemes.	CG1 CG4 CE1 CE4 CE8
Implementation of a distributed source coding scheme.	CG1 CG4 CE1 CE6 CE8
Understading of the different schemes of joint source and channel coding.	CG4 CE1 CE4 CE6 CE8

Implementation of a joint and source channel coding scheme.	CG1 CG4 CE1 CE4 CE6
Understanding of the characteristics of different ways of multimedia signal distribution, paying special attention to streaming schemes.	CG1 CE4 CE6 CE8
Asessment of the modularity of new video coding standards (e.g., MPEG-7)	CG1 CE4 CE6 CE8

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	
	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	Evaluated Competencess

Laboratory practises	Numerical simulation programming.	30	CG1 CG4 CE1 CE4 CE6 CE8
Reports / memories of practice	Report on lab practises.	10	CG1 CE1 CE4 CE6
Long answer tests and development	Final exam.	60	CG1 CG4 CE1 CE4 CE6

Other comments and July 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, 2006

, 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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- know - Know How
CG4	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.	- know - Know How
CG8	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.	- know - Know How
CE13	CE13 The ability to apply advanced knowledge of photonics, optoelectronics and high-frequency electronics.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
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.	CG4 CE13
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.	CG4 CE13
3. Knowledge of the basic formats of digital transmission by optical fibre, and of analog transmission in systems fibre-radio.	CG4 CE13
4. Knowledge of some advanced systems for fibre transmission: new modulation formats, coherent systems, non-linear systems and dispersion management.	CG4 CG8 CE13
5. Knowledge of the specific technologies of optical networks WDM and DWDM, and options to design them.	CG1 CG4 CE13
6. Knowledge of the optical network topologies for long distance transmission, metropolitan and regional networks, and access optical networks.	CG1 CG4 CE13
7. Knowledge of security techniques to protect optical networks.	CG4 CG8 CE13
8. Knowledge of free-space optical systems and visible light communications.	CG4 CG8 CE13

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	
	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	Evaluated Competencess
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	CG1 CG4 CG8 CE13
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	CG4 CG8 CE13
Case studies / analysis of situations	It evaluates the work realised by the student in the study of cases proposed in class.	20	CG1 CG4 CG8 CE13

Other comments and July 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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CB2	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.	- know - Know How
CB4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.	- know - Know How
CG4	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.	- know - Know How
CE2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.	- know - Know How
CE3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.	- know - Know How
CE5	CE5 The ability to design systems of radio navigation and positioning, as well as radar systems.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
To understand the phenomena of electromagnetic radiation and receiving signals	CB4 CG4
Know the main parameters that characterise the behaviour of the transmitting and receiving antennas	CB4 CG4 CE2 CE3 CE5
Know the distinct types of antennas according to their applications and operating frequencies	CB4 CG4 CE2 CE3 CE5
To be able to understand and develop models to simulate the behavior of the antennas and predict their characteristic parameters	CB4 CG4 CE2 CE3 CE5
To be able to cope antenna design exercises for certain specifications	CB2 CB4 CG4 CE2 CE3 CE5

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	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	Evaluated Competencess
Short answer tests	Conceptual questions on the course syllabus.	10	CB2
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	CB2 CB4
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	CB2 CB4

Other comments and July 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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CB1	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.	- know - Know How
CB2	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.	- know - Know How
CG8	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.	- know - Know How
CE2	CE2 The ability to develop radio communication systems: antenna, equipment and subsystems design; channel modeling; link budgeting; and planning.	- know - Know How
CE3	CE3 The ability to implement systems by cable, line, satellite, in fixed and mobile communication environments.	- know - Know How
CE5	CE5 The ability to design systems of radio navigation and positioning, as well as radar systems.	- know - Know How
CE13	CE13 The ability to apply advanced knowledge of photonics, optoelectronics and high-frequency electronics.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
* Knowledge of the basic instrumentation for measuring radiofrequency, microwaves, millimeter and sub-millimeter waves	CB1 CB2 CG8 CE2 CE3 CE5 CE13
* 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.	CB1 CB2 CG8 CE2 CE3 CE5 CE13
* Knowdlege of experimental characterization techniques regarding the mechanisms of signal propagation.	CB1 CB2 CG8 CE2 CE3 CE5 CE13

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
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	Evaluated Competencess
Laboratory practises		50	CE2 CE3 CE5 CE13
Short answer tests		50	CB1 CB2 CG8

Other comments and July 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 , , Springer
M. E. Van Valkenburg, Network analysis, , Prentice-Hall
Walter Tuttlebee, Software defined radio : Enabling technologies, , John Wiley & Sons
Wes Hayward, Introduction to radio frequency design, , American Radio Relay League
George Brown, Radio and electronics cookbook, , Oxford : Newnes
John Davies, Newnes radio and RF engineer's pocket book, , Oxford : Newnes
Y.T. Lo, S.W. Lee, Antenna handbook, , Van Nostrand Reinhold
Rajeswari Chatterjee, Antenna theory and practice, , John Wiley and Sons
Yi Huang, Kevin Boyle, Antennas : from theory to practice, , Wiley
Walter C. Johnson, Transmission lines and networks, , Mac Graw-Hill
Brian C. Wadell, Transmission line design handbook, , Artech House
Fuqin Xiong, Digital modulation techniques, , Artech House

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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- Know How
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- Know How
CG4	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.	- Know How
CG8	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.	- Know How
CG12	CG12 To have skills for lifelong, self-directed and autonomous learning.	- Know How
CE4	CE4 The ability to design and plan networks for transporting, broadcasting and distribution of multimedia signals.	- Know How
CE6	CE6 The ability to model, design, implement, manage, operate, and maintain networks, services and contents.	- Know How
CE7	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.	- Know How
CE8	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.	- Know How

Learning outcomes	
Learning outcomes	Competences
Knowledge and know-how about advanced channel coding techniques	CG4 CE4 CE6
To understand the operations and properties of large distributed systems in the Internet. Deep knowledge and insights about advanced communication system	CG1 CG4 CE4 CE6 CE7 CE8

To learn how to analyze and put into use multi path transmission techniques and congestion control algorithms on different types of networks	CB5 CG4 CG8 CE4 CE6 CE7 CE8
To understand the design principles, the operation and performance of large data centers in the Internet	CB5 CG1 CG4 CG12 CE6 CE7 CE8
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.	CB5 CG1 CG4 CG8 CG12 CE4 CE6 CE7 CE8

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	
	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	Evaluated Competencess
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	CG1 CG4 CG8 CG12 CE4 CE6 CE7 CE8
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	CB5 CG1 CG4 CG8 CG12 CE4 CE6 CE7 CE8

Other comments and July 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, , Cambridge University Press, 2014

R. Srikant, L. Ying, Communication networks. An optimization, control and stochastic networks perspective, , Cambridge University Press, 2013

M. Medard, A. Sprintson, Network coding. Fundamentals and applications, , Academic Press, 2011

X. Guang, Z. Zhang, Linear network error correcting coding, , Springer, 2014

K. Hwang, G. C. Fox, J. J. Dongarra, Distributed and cloud computing: from parallel processing to the Internet of things, , Morgan Kaufmann, 2012

M. J. Kavis, Archtecting the cloud: design decisions for cloud computing service models, , Wiley, 2014

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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CB1	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.	- know
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- Know How
CG3	CG3 The ability to lead, plan and monitor multidisciplinary teams.	- Know How
CG8	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.	- Know How
CG12	CG12 To have skills for lifelong, self-directed and autonomous learning.	- Know How
CE4	CE4 The ability to design and plan networks for transporting, broadcasting and distribution of multimedia signals.	- know
CE6	CE6 The ability to model, design, implement, manage, operate, and maintain networks, services and contents.	- know
CE7	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.	- know
CE9	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.	- know
CE24	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.	- know

Learning outcomes		
Learning outcomes		Competences

(*) 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.	CB1 CB5 CG3 CG8 CG12 CE4 CE6 CE7 CE9 CE24

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	
	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	Evaluated Competencess
Master Session	A theoretical (written) examination (T) will be held at the end of the course.	35	CB1 CE4 CE6 CE7 CE9 CE24
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	CB1 CB5 CG3 CG8 CG12 CE7
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 and July 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, 2007

Kaveh Pahlavan, Prashant Krishnamurthy, Networking Fundamentals: Wide, Local and Personal Area Communications, 1, 2009

Pei Zheng, Larry L. Peterson, Bruce S. Davie, Adrian Farre, Wireless Networking Complete, 1, 2009

F. Adelstein, Sandeep K.S. Gupta, Golden G. Richard III, Loren Schwiebert, Fundamentals of Mobile and Pervasive Computing, 1, 2005

Jean-Philippe vasseur, Adam Dunkels, Interconnecting smart objects with IP, 1, 2010

James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6, 2012

Recommendations

IDENTIFYING DATA				
(*)Enxeñaría Web				
Subject	(*)Enxeñaría Web			
Code	V05M145V01212			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CB1	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.	- know
CB2	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.	- know - Know How
CB3	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.	- know
CB4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.	- Know How
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- Know How
CG5	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.	- Know How
CG6	CG6 The capacity for general direction, technical direction and management of research, development and innovation projects in companies and technological centers.	- Know How
CG8	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.	- know - Know How
CE6	CE6 The ability to model, design, implement, manage, operate, and maintain networks, services and contents.	- Know How
CE8	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.	- know - Know How

Learning outcomes	
Learning outcomes	Competences

Know the evolution of the Web and understand the technologies in use today	CB5 CG8 CE8
Know and be able to use advanced search techniques for both Web documents and other resources accessible through the Web	CB1 CB2 CB4 CB5 CG8 CE8
Know and be able to use mechanisms to represent and manage knowledge on the Web	CB1 CB2 CB3 CB5 CE8
Know to propound, analyze and design innovative Web applications using the models and patterns that predominate in the Web	CB2 CB4 CG5 CG6 CG8 CE6 CE8

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

	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	Evaluated Competencess
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	CB1 CB4 CB5 CE8
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	CB2 CB3 CB4 CG8 CE8
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	CB3 CB4 CG5 CG6 CG8 CE6 CE8

Other comments and July 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, 2011
G. Antoniou, P. Groth, F. van Harmele, R. Hoekstra, A Semantic Web Primer (3th Edition), MIT Press, 2012
S. Casteleyn, F. Daniel, P. Dolog, M. Matera, Engineering Web Applications, Springer, 2009
G. Shroff, The Intelligent Web: Search, smart algorithms, and big data, Oxford University Press, 2014
W.B. Croft, D. Metzler, T. Strohman, Search Engines: Information Retrieval in Practice, Pearson, 2010
J. Leskovec, A. Rajaraman, J. Ullman, Mining of Massive Datasets, Cambridge University Press, 2014

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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CB1	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.	- know
CG4	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.	- know
CG8	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.	- Know How
CE11	CE11 The knowledge of hardware description languages for high complexity circuits.	- Know How
CE12	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.	- Know How
CE14	CE14 The ability to develop electronic instrumentation, as well as transducers, actuators and sensors.	- know

Learning outcomes	
Learning outcomes	Competences
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	CB1
To know the modeling of mixed electronic systems by using the mathematical basis of the continuous analog systems and discrete systems.	CG4
The ability to combine different methods and resources for the design of complex systems that include analog and digital circuits.	CG8
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.	CE11
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.	CE12
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.	CE14

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	
	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	Evaluated Competencess

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	CG8 CE12 CE14
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	CB1 CG4 CE11 CE14
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	CG8 CE11 CE12 CE14
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	CB1 CG4 CE14

Other comments and July 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, IEEE Press, John Wiley & Sons, Inc.

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

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

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

F. Maloberti, Data Converters, 2008, Springer

Steven W. Smith, The Scientist and Engineer’s Guide to Digital Signal Processing, 1997, California Technical Publishing

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

S. J. Orfanidis, Introduction to signal Processing, 1997, Prentice Hall International, Inc.

Alfi Moscovici, High Speed A/D Converters: Understanding Data Converters Through SPICE, 2006, Kluwer Academic Publishers

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

Recommendations

Subjects that it is recommended to have taken before

(*)Deseño de Circuitos Electrónicos Analóxicos/V05M145V01106
(*)Sistemas Electrónicos Dixitais Avanzados/V05M145V01203

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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	
CG8	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.	
CE11	CE11 The knowledge of hardware description languages for high complexity circuits.	
CE12	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	
Learning outcomes	Competences
To learn the codesign methods to design applications based on embedded microprocessors in FPGAs.	CB5 CE11 CE12
To get to know the microprocessors that can be implemented in commercial FPGAs.	CB5 CE11 CE12
To handle the necessary software tools for the development of embedded applications by means of FPGAs.	CB5 CE11 CE12
To design application specific peripherals and their connection to the buses of the embedded microprocessors.	CB5 CG1 CG8 CE11 CE12

To design real applications with embedded microprocessors in FPGAs.	CB5 CG1 CG8 CE11 CE12

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

	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	Evaluated Competencess
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	CB5 CE11 CE12
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	CB5 CG8 CE11 CE12
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	CB5 CG1 CG8 CE11 CE12
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	CB5 CG1 CG8 CE11 CE12

Other comments and July 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, 2012
ÁLVAREZ RUIZ DE OJEDA, L.J., Diseño Digital con FPGAs, Vision Libros, 2013

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	Type	Year	Quadmester
	5	Optional	1st	2nd
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		Typology
CB4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.	- know
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- Know How
CG8	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.	- Know How
CE10	CE10 The ability to design and manufacture integrated circuits.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Know the design methodologies of electronic integrated circuits	CE10
Know the basic topologies used in analog electronic circuits	CE10
Can analyze and dimension the devices that form the basic topologies of analog circuits	CB5 CG8 CE10
Know aid software tools integrated circuit design	CE10
Know how an electronic circuit is specified for manufacturing	CB4 CE10

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
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	Evaluated Competencess
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	CB4 CE10
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	CB4 CG8 CE10

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	CB4 CB5 CG8 CE10

Other comments and July 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, 2010

Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley & Sons, 2009

Behzad Razavi , Design of Analog CMOS Integrated Circuits, McGraw Hill, 2000

Recommendations

IDENTIFYING DATA				
(*)Procesado de Sinal en Tempo Real				
Subject	(*)Procesado de Sinal en Tempo Real			
Code	V05M145V01301			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	English			
Department				
Coordinator	Martín Herrero, Julio			
Lecturers	Martín Herrero, Julio			
E-mail	julio@uvigo.es			
Web				
General description	We deal with different architectures and techniques for realtime signal processing, including digital signal processors (DSP) and multicore computing platforms (CPUs and massively parallel GPUs). Standards such as OpenCL, OpenMP, PPL and AMP will be addressed. Our main focus will be on hands-on, practical work and the capability to adapt to new, emerging, constantly evolving technologies and tools.			

Competencies		
Code		Typology
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- know - Know How - Know be
CG8	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.	- know - Know How - Know be
CE21	CE21/PS1 Manage implementation of signal processing systems options to accelerate computationally complex algorithms.	- know - Know How - Know be

Learning outcomes	
Learning outcomes	Competences
To handle advanced architectures for realtime signal and video processing	CG1 CG8 CE21
To apply advanced techniques of DSP programming in realtime signal applications	CG1 CG8 CE21
To understand the basic principles of realtime signal and video processing on standard GPUs and general purpose GPU	CG1 CG8 CE21
To understand and apply the fundamentals of realtime application programming on graphic processing units, using multiplatform programming interfaces (OpenCL)	CG1 CG8 CE21

Contents	
Topic	
High and low level DSP programming	High and low level DSP programming
GPU programming fundamentals	GPU programming fundamentals
General purpose programming of GPUs (GPGPU)	General purpose programming of GPUs (GPGPU)
OpenCL programming and integration in different architectures	OpenCL programming and integration in different architectures

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	8	0	8
Practice in computer rooms	17	0	17
Projects	0	95	95
(*)Cartafol	0	0	0
Long answer tests and development	2	0	2
Practical tests, real task execution and / or simulated.	3	0	3
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies

	Description
Master Session	General introductions to fundamental concepts
Practice in computer rooms	Individual hands-on work on computing platforms and/or simulators to implement and compare study cases
Projects	In-depth practical development of an application/algorithm according to the specific interests of each student

Personalized attention

	Description
Projects	Doubts will be solved and guidance provided for the autonomous work of the student during lab sessions and also in prearranged individual tutoring sessions
Practice in computer rooms	Doubts will be solved and guidance provided for the autonomous work of the student during lab sessions and also in prearranged individual tutoring sessions

Assessment

	Description	Qualification	Evaluated Competencess
Long answer tests and development	Questions on general fundamental concepts of realtime signal processing	30	CG1 CG8 CE21
Practical tests, real task execution and / or simulated.	Programming of realtime algorithms	70	CG1 CG8 CE21

Other comments and July evaluation

The assessment is continuous by default, based on the work carried on by the students during the lab classes and in their personal project. This can provide up to 100% of the final mark. There is an optional written final exam at the end of the period of classes, which can be used to raise the continuous evaluation mark, or as 100% of the qualification for those students not willing to follow the continuous assessment. Those students not succeeding in the first call will have access to a second call, where the whole mark will come out from the final written exam.

Sources of information

Sen M. Kuo, Bob H. Lee, Wenshun Tian , Real-Time Digital Signal Processing, 2, 2006

Gerassimos Barlas, Multicore and GPU Programming: An Integrated Approach, 1, 2014

Khronos Group, The OpenCL specifications, 2.0, 13 July 2013

Matthew Scarpino, OpenCL in Action, 1, November 2011

Raymond Tay, OpenCL Parallel Programming Development Cookbook, 1, August 2013

Recommendations

Subjects that it is recommended to have taken before

(*)Tratamento de Sinal en Comunicacións/V05M145V01102

IDENTIFYING DATA				
(*)Sistemas Avanzados de Comunicacións				
Subject	(*)Sistemas Avanzados de Comunicacións			
Code	V05M145V01302			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	English			
Department				
Coordinator	Mosquera Nartallo, Carlos			
Lecturers	Mosquera Nartallo, Carlos			
E-mail	mosquera@gts.uvigo.es			
Web				
General description	This course covers the application of advanced mathematical tools to address some challenges in new and emerging satellite and terrestrial communication systems, with special emphasis on lower layers and system considerations.			

Competencies		
Code		Typology
CG4	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.	- know - Know How
CE22	CE22/PS2 Ability to understand the impact of the requirements of the telecommunications systems design services, with special emphasis in the lower layers, while maintaining a global vision of the solutions employed in modern commercial systems of communications.	- know - Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Understand the impact of telecommunication services requirements on system design, with special emphasis on lower layers.	CG4 CE22
Acquire a global view of the solutions developed for modern commercial communication systems.	CG4 CE22

Contents	
Topic	
1. Convex optimization	1.1 Fundamentals of convex optimization 1.2 Lagrange duality 1.3 Network utility maximization
2. Multiple-access channels	2.1 Capacity regions 2.2 Random access schemes
3. Random matrices	3.1 Principles of random matrix theory 3.2 Applications in communications engineering

Planning			
	Class hours	Hours outside the classroom	Total hours
Seminars	10	30	40
Troubleshooting and / or exercises	0	20	20
Master Session	18	45	63
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
Seminars	Different communication systems, ranging from satellite to maritime scenarios, will be presented with special emphasis in those challenges which are at the core of modern solutions and require advanced mathematical tools.
Troubleshooting and / or exercises	Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis, software tools or both.
Master Session	Advanced mathematical tools will be introduced as background material to address practical solutions in modern communication systems.

Personalized attention	
	Description
Master Session	The instructor will be available during his regular office hours.
Seminars	The instructor will be available during his regular office hours.
Troubleshooting and / or exercises	The instructor will be available during his regular office hours.

Assessment			
	Description	Qualification	Evaluated Competencess
Troubleshooting and / or exercises	Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis, software tools or both. If the solution is not turned in within the allocated deadline, the corresponding assignment will not be graded.	40	CG4 CE22
Short answer tests	Final exam with short questions and exercises.	60	CG4 CE22

Other comments and July evaluation

The students need to obtain 50 out of 100 points to pass the course. In addition, a minimum grade of 30% is required in the final exam.

The grades obtained from the weekly assignments are only valid for the current academic year, and cannot be redone after the corresponding deadline. A student can decide to opt out the evaluation of the weekly assignments; in such a case, his/her final score will be fully based on the final exam. This applies also 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 her/his taking the final exam.

All the homeworks and exam will be given in English.

Sources of information

Books:
Dimitri P. Bertsekas, "Convex Optimization Theory", Athena Scientific, 2009.
Stephen Boyd, Lieven Vandenberghe, "Convex Optimization", Cambridge University Press, 2004.
Papers will be also recommended during the course.

Recommendations

Subjects that it is recommended to have taken before

(*)Comunicacións Dixitais Avanzadas/V05M145V01204

Other comments

Attendance to physical classes is mandatory. If a minimum 80% attendance is not fulfilled, the grade will be entirely based on the final exam.

IDENTIFYING DATA				
(*)Procesado Estatístico de Sinal				
Subject	(*)Procesado Estatístico de Sinal			
Code	V05M145V01303			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	English			
Department				
Coordinator	López Valcarce, Roberto			
Lecturers	López Valcarce, Roberto			
E-mail	valcarce@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Statistical Signal Processing, encompassing both estimation and detection theory, can be found at the core of many decision-making and information-extracting systems, including communications, audio and image processing, biomedicine, radar, and big data systems, just to name a few. In this course an introduction to the basics of estimation and detection theory is provided. Since the course is targeted to electrical engineering students, the focus is on the development of practical estimation and detection algorithms amenable to implementation in digital processing systems.			

Competencies		
Code		Typology
CG4	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.	- know - Know How
CG8	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.	- know - Know How
CE23	CE23/PS3 Ability to apply methods of statistical processing of signal communications systems and audiovisual.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Ability to apply statistical estimation techniques in communications and multimedia systems	CE23
Ability to apply statistical detection techniques in communications and multimedia systems	CE23
Ability to determine and interpret fundamental limits in estimation and detection problems	CG4 CE23
Ability to evaluate the performance of estimation and detection techniques, by analytical as well as by Monte Carlo simulation methods	CG8 CE23

Contents	
Topic	
Part 1: Parameter Estimation	- The statistical estimation problem. Performance metrics: bias, variance, MSE. Minimum Variance Unbiased Estimator (MVUE). - Fisher Information and Cramer-Rao bound. Slepian-Bangs formula. Asymptotic CRB for Gaussian processes. Sufficient statistics. - Best Linear Unbiased Estimator (BLUE) and Maximum Likelihood Estimator (MLE): definition, properties, and examples.
Part 2: Detection Theory	- Hypothesis tests: types. Performance metrics: false positives and false negatives. ROC curves. - Neyman-Pearson theorem: likelihood ratio. - Detection under the Bayesian philosophy: probability of error, risk, optimum detector. - Examples: deterministic and random signals

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	21	42	63
Practice in computer rooms	7	0	7
Autonomous troubleshooting and / or exercises	0	28	28
Autonomous practices through ICT	0	25	25
Long answer tests and development	2	0	2

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

Methodologies

	Description
Master Session	Presentation of main topics, possibly with audiovisual aids.
Practice in computer rooms	Computer-based simulation in the lab of statistical signal processing applications to communications and multimedia, via Monte Carlo methods. Performance analysis.
Autonomous troubleshooting and / or exercises	Students will be given a series of short homework assignments throughout the course that they should turn in by the set deadline.
Autonomous practices through ICT	Computer-based simulation of statistical signal processing applications to communications and multimedia, via Monte Carlo methods. Performance analysis.

Personalized attention

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

Assessment

	Description	Qualification	Evaluated Competencess
Autonomous troubleshooting and / or exercises	Students will be given a series of short homework assignments throughout the course that they should turn in by the set deadline.	40	CG4 CG8 CE23
Long answer tests and development	Final test in which the student must solve a series of exercises and/or answer a series of questions.	60	CG4 CG8 CE23

Other comments and July evaluation

Students may choose one of the following two assessment options:

1) Continuous assessment: Final grade will consist of:

- comprehensive test (up to 6 points)

- homework assignments (up to 4 points)

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

Homework grades from the first call will be kept for the second call, in which the student will be allowed to 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

S. M. Kay, Fundamentals of Statistical Signal Processing, vol. I: Estimation Theory, 1, 1993

S. M. Kay, Fundamentals of Statistical Signal Processing, vol. II: Detection Theory, 1, 1998

L. L. Scharf, Statistical signal processing: detection, estimation and time series analysis , 1, 1991
T. K. Moon, W. C. Stirling, Mathematical Methods and Algorithms for Signal Processing, 1, 2000
IEEE, http://ieeexplore.ieee.org/, ,

Recommendations

Subjects that it is recommended to have taken before

(*)Tratamento de Sinal en Comunicacións/V05M145V01102

IDENTIFYING DATA				
(*)Tecnoloxías para o Desenvolvemento Web				
Subject	(*)Tecnoloxías para o Desenvolvemento Web			
Code	V05M145V01309			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	Spanish			
Department				
Coordinator	Rodríguez Pérez, Miguel			
Lecturers	Rodríguez Pérez, Miguel			
E-mail	Miguel.Rodriguez@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Description of the most current techniques applications for the development of Web applications. The course will tech the students to develop multiplatform applications based on the HTML5 foundation.			

Competencies		
Code		Typology
CB1	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.	- know
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- Know be
CG12	CG12 To have skills for lifelong, self-directed and autonomous learning.	- Know be
CE35	CE50/OP20 Ability to deploy and manage server software application logic of a web service managers, to design and manage non-relational data bases , and understand the functional division of an existing Web application between the client and the server itself	- Know How

Learning outcomes	
Learning outcomes	Competences
The students will be able to design, develop and manage the whole infrastructure of a web application, comprising even the object server and the database. Besides, they will be able to develop the application logic and to create responsive user interfaces using web technologies.	CB1 CB5 CG12 CE35

Contents	
Topic	
Web applications architecture	
HTML5: A tagged language in permanent evolution	New HTML tags New APIs
Web applications	The javascript language Javascript frameworks: AngularJS
Content presentation: CSS3	A new box model Responsive design
Server side technologies	Programmable object servers: NodeJs Information management with non-relational databases

Planning			
	Class hours	Hours outside the classroom	Total hours

Master Session	10	0	10
Laboratory practises	8	0	8
Presentations / exhibitions	2	5	7
Tutored works	5	0	5
Autonomous practices through ICT	0	95	95

*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 main concepts treated in the subject, and description of the technologies employed. The presentation will be based, most of the time, practical examples.
Laboratory practises	In the labs the students will face several practical sessions –supervised by the professors– where they will settle the concepts learnt in the theoretical classes.
Presentations / exhibitions	Students will prepare a public presentation of the work carried out during the autonomous practices
Tutored works	A project with a fairly large magnitude will be posed to be developed as a teamwork during all the semester. This work will be supervised by the professors with periodic weekly meetings.
Autonomous practices through ICT	A project with a fairly large magnitude will be posed to be developed as a teamwork during all the semester.

Personalized attention	
	Description
Autonomous practices through ICT	During tutoring time, the professors will be able to help the students either individually in the understanding of the theoretical concepts explained in the master sessions and/or in the demonstrative lab activities. In this works, the teacher will check the progress of the group task. There will also be discussions about the different solutions proposed by the group members and the share of the workload among the group members will also be checked.
Tutored works	During tutoring time, the professors will be able to help the students either individually in the understanding of the theoretical concepts explained in the master sessions and/or in the demonstrative lab activities. In this works, the teacher will check the progress of the group task. There will also be discussions about the different solutions proposed by the group members and the share of the workload among the group members will also be checked.

Assessment			
	Description	Qualification	Evaluated Competencess
Autonomous practices through ICT	The group project will determine the greater part of the final qualification. The value of the note will depend of the correction of the solution presented by the group, of the report that accompanies it, of the implication of the student in the development of the same and of the quantity of technologies presented in the subject employed in practice.	80	CB1 CB5 CG12 CE35
Presentations / exhibitions	The students will have to expose in an oral proof the work realized of autonomous way. Of the clarity of this exhibition and of the answers that can give to the questions that formulate him the professors, depends 20% of the note.	20	CG12

Other comments and July evaluation

Continuous evaluation:

To opt to the continuous evaluation, it is necessary to attend at least to 80% of the practical laboratory sessions and produce the partial deliveries of the group project.

Each delivery will be evaluated individually, being the total mark of the practice the result to ponder 50% of the note obtained in the last delivery with the average of the previous deliveries. Each mark will be shared by all the members of the group.

The final mark of the subject will be the pondered average among the practical mark (80%) and the note of the exhibition of the work (20%), that will be individually evaluated.

Final evaluation:

The students that prefer the final evaluation will have to indicate so to the professor before the date of the first partial delivery of the group project. In such case, his partial deliveries will not be taken into account for his mark, (although they are taken into consideration for those group members that had chosen the continuous evaluation). The final mark will be 80% of the mark obtained in the final delivery of the work and 20% of the exhibition.

Second evaluation:

In the extraordinary evaluation students will be requested make some small modifications to the group project individually. For those students that had chosen final evaluation, this delivery will represent 80% of the final mark while the remaining 20% corresponds with the individual presentation.
In the case of the students of continuous evaluation, the mark of the practice will be the largest of: 50% of the new delivery and the previous partial deliveries (50%) or 100% of the new delivery. The remaining 20% corresponds with the exhibition of the work.

Sources of information
HTML5: Up and Running, Mark Pilgrim, 1ª, 2010
Learning AngularJS, Ken Williamson, 1ª, 2015
The book of CSS3, Peter Gasston, 2ª,
Smashing Node.js: JavaScript Everywhere, Guillermo Rauch, 2ª, 2012
https://developer.mozilla.org/en/docs/Web, Web technology for developers, ,
MongoDB: The Definitive Guide, Kristina Chodorow, 2ª, 2013

Recommendations

IDENTIFYING DATA				
(*)Desenvolvemento en Aplicacións Móbiles				
Subject	(*)Desenvolvemento en Aplicacións Móbiles			
Code	V05M145V01310			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	Spanish Galician English			
Department				
Coordinator	López Bravo, Cristina			
Lecturers	Costa Montenegro, Enrique Gil Castiñeira, Felipe José López Bravo, Cristina			
E-mail	clbravo@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The course "Development of Mobile Applications" shows an overview of the ubiquitous panorama, in particular of the mobile applications and of the different operating systems in which they run. Mobile applications market has big growth expectations due to the huge number of active mobile devices around the world (several millions), the deployment of smart cities or the evolution of the Internet to the Internet of Everything (people, processes, data and objects). Along the course, an example mobile application (a game) will be developed, through which the different characteristic and functionalities of the Android platform will be introduced: user interfaces, activities, services, context integration, data sharing and security. Besides, those who join the course have to develop their own project, which should include all the phases of development of a mobile application, from the initial design to the publication in online software shops such as Google Play. The documentation of the course will be available in English. The master sessions and the follow-up of the tutored works will be in English, as well.			

Competencies		
Code		Typology
CB2	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.	- know - Know How
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- Know How - Know be
CG8	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.	- Know How
CE33	CE46/OP16 Ability to understand the current development of mobile and ubiquitous services and market developments .	- know
CE34	CE47/OP17 Ability to design, create, integrate sources of context, and working group on the development of a mobile application	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Acquire an overview of the ubiquitous panorama, in particular of the mobile applications and of the different operating systems in which they run.	CE33
Learn how to build mobile applications including different elements (interaction with the user, context integration, interconnection with other devices, notifications, ...)	CB2 CB5 CG8 CE34

Work in group to propose, build and defend a mobile application.	CB2 CB5 CG8 CE33 CE34

Contents	
Topic	
Movile Operating Systems	- Overview of the leading operating systems for mobile devices (Android, IOS, Windows Phone). - Versions. - Market evolution.
Android Operating System	- Android architecture. - Components of an Android application: activities, services, content providers and broadcast receivers. - Applications life cycle.
Mobile applications in the market	- Planning the development of an application. - Publication of applications. - Description of mobile applications available in the market.
Building Android applications	- Android Studio SDK - Android emulator - Activities and intents - Services and notifications - Menus and preferences - User interfaces with views - Concurrency - Data persistence - Context integration: localization, sensors - Interconnection: bluetooth, wifi

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	4	4	8
Laboratory practises	12	36	48
Tutored works	4.5	49.5	54
Presentations / exhibitions	0.5	0.5	1
Multiple choice tests	1	1	2
Practical tests, real task execution and / or simulated.	3	9	12
*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 professors of the course present the main theoretical contents related to the development of applications for mobile devices.
Laboratory practises	Students will complete guided and supervised practices in the laboratory about the basic aspects of Android mobile applications.
Tutored works	In groups, design, development and test of a mobile application. Students and professors will have regular meetings to check the correct evolution of the tutored works.
Presentations / exhibitions	Presentation and defense of the mobile application that has been developed throughout the course.

Personalized attention	
	Description
Laboratory practises	The professors of the course will provide individual attention to the students during the course, solving their questions. In addition, the professors will advise and guide the students while performing their tasks, both in the laboratory and during the tutored works.

Tutored works	The professors of the course will provide individual attention to the students during the course, solving their questions. In addition, the professors will advise and guide the students while performing their tasks, both in the laboratory and during the tutored works.
Presentations / exhibitions	The professors of the course will provide individual attention to the students during the course, solving their questions. In addition, the professors will advise and guide the students while performing their tasks, both in the laboratory and during the tutored works.

Assessment			
	Description	Qualification	Evaluated Competencess
Tutored works	Whenever possible, the students will be divided in groups, to design, build and test an application for mobile devices. The result will be evaluated after the delivery, taking into account key aspects such as correction, quality, performance and functionalities of the developed application. Likewise, during the development of the project, professors will make a continuous follow-up of the design and the evolution of the implementation.	45	CB2 CB5 CG8 CE33 CE34
Presentations / exhibitions	At the end of the course, each group of students has to present and defend in English the developed application for mobile devices. The defence has to include a practical demonstration of the use of the application.	10	CG8 CE33 CE34
Multiple choice tests	After each master session, students will make a multiple choice test (in English) to evaluate the understanding of the presented topics.	20	CE33
Practical tests, real task execution and / or simulated.	In each practice session students will demonstrate the proper functioning of the developments carried out during the session.	25	CB2 CG8 CE33 CE34

Other comments and July evaluation

FIRST OPPORTUNITY

Following the guidelines of the degree, two assessment systems will be offered to students attending this course: continuous assessment and final assessment. Before the end of the second week of the course, students must declare if they opt for the continuous assessment or the final assessment. Those who opt for the continuous evaluation system may not be listed as "not presented" if they make a delivery or an assessment test after the communication of their decision.

Continuous assessment system

Those students who opt for continuous assessment system must:

- Take a set of tests with multiple choice questions. These partial tests will be done at the end of each master session. These tests will account for 20 % of the overall grade of the course.
- Take a set of practical tests in the laboratory. These tests will be performed at the end of each practice session. These tests will account for 25 % of the overall grade of the course.
- Design, build and defend a mobile application (tutored work). This task will account for 55 % of the overall grade of the course. A 10 % is reserved for the presentation and defence of the developed mobile application. Though this task will be developed in groups (whenever possible), professors will make a continuous follow-up of the activities performed by each student of a group. If the performance of a student is not in line with the rest of his/her teammates, his/her expulsion of the group might be considered, or he or she might be assessed individually.

The final grade of the course will be equal to the weighted arithmetic mean of the three indicated tasks. To pass the course the final grade must be greater or equal to five.

Final assessment system

Those students who opt for the final assessment system must:

- Take a final test with short answer or multiple choice questions (a 20 % of the overall grade of the course).
- Make and demonstrate the proper functioning of the practices in the laboratory (a 25 % of the overall grade of the course).
- Design, build and defend a mobile application (tutored work), individually or if it is possible in groups (a 55 % of the overall grade of the course, with a 10 % reserved for the presentation and defence of the developed mobile application).

- Deliver a *dossier* that includes all the details about the development of the practices in the laboratory and, especially, about the tutored work.

The final grade of the course will be equal to the weighted arithmetic mean of the three indicated tasks, if the *dossier* is delivered, or zero otherwise. To pass the course the final grade must be greater or equal to five.

SECOND OPPORTUNITY
The course final exam will only be held for students who failed the course in the first opportunity.
The assessment will consist in doing one, two or three of the following tasks, depending on the marks achieved in the equivalent tasks during the first opportunity:

- Make a final test with short answers or multiple choice questions (a 20 % of the overall grade of the course).
- Make and demonstrate the proper functioning of the practices in the laboratory (a 25 % of the overall grade of the course).
- Design, build and defend a mobile application (tutored work), individually or if it is possible in groups (a 55 % of the overall grade of the course, with a 10 % reserved for the presentation and defence of the developed mobile application).
- In addition, those who opt for the final assessment system should deliver a *dossier* that includes all the details about the development of the practices in the laboratory and, especially, about the tutored work.

If the mark of any of the tasks in the first opportunity, equivalent to these, is greater or equal to five, the student can choose between keeping his/her marks of the first opportunity or repeating the assessments again.

OTHER COMMENTS

- The obtained grades are only valid for the current academic year.
- The use of any material during the tests will have to be explicitly authorized.
- In case of detection of plagiarism in any of the tasks/tests done, the final grade will be "failed (0)" and the professors will communicate the incident to the head of the school to take the measures that they consider appropriate.

Sources of information

Joshua J. Drake, Android hackers's handbook, 1ª, John Wiley & Sons

Wei-Meng Lee, Beginning Android 4 Application Develeoment, 1ª, Wrox

Jesús Tomás Gironés, El gran libro de Android, 3ª, Marcombo

Recursos en Internet

- Android Developers [http://developer.android.com/index.html]
- Android Developer NanoDegree [https://www.udacity.com/course/android-developer-nanodegree--nd801]
- Programming Mobile Applications for Android Handheld Systems: Part 1 [https://www.coursera.org/course/androidpart1]
- Programming Mobile Applications for Android Handheld Systems: Part 2 [https://www.coursera.org/course/androidpart2]
- Android programning course: learn how to bluid your own applications [http://www.sgoliver.net/blog/curso-de-programacion-android/]

Recommendations

Other comments

It is recommended to have Java programming skills

IDENTIFYING DATA				
(*)Satélites				
Subject	(*)Satélites			
Code	V05M145V01311			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	English			
Department				
Coordinator	Aguado Agelet, Fernando Antonio			
Lecturers	Aguado Agelet, Fernando Antonio Pérez Fontán, Fernando			
E-mail	faguado@tsc.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The contents of this course cover the basics of satellite standards, system engineering, the different segments of satellite systems, an introduction to product assurance and assembly, integration and verification procedures as well as an introduction to satellite operations. The course will be entirely conducted in English; the use of Spanish or Galego will be optionally allowed in the last exam.			

Competencies		
Code		Typology
CB2	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.	- Know How
CG3	CG3 The ability to lead, plan and monitor multidisciplinary teams.	- Know How
CG4	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.	- Know How
CE18	CE18/RAD1 Capacity of elaborating, strategic planning, direction, coordination and technical and economic management of spatial projects applying spatial systems engineering standards, with knowledge of the processes a satellite operation.	- Know How

Learning outcomes	
Learning outcomes	Competences
To know and apply ECSS management space project standards.	CE18
To know the basics of the system engineering applied to space projects.	CB2 CG3 CE18
To know the mission life cycle of a space mission.	CB2 CE18
To know the documentation generated in each engineering phase in a space mission	CB2 CG3 CE18
To know and ellaborate the main technical studies and budgets in a space mission.	CG3 CG4 CE18
To know applicable methodologies and standards to product assurance (PA) and Assembly, Integration and Verification (AIV) procedures in a space project.	CB2 CG3 CE18
To know the basics of satellite operation procedures and standards	CE18

Contents	
Topic	
International space project standards	ECSS, NASA, INCOSE.
Space project life cycle	Documentation and reviews.

Segments of a satellite project	- Space Segment. - Ground Segment. - User Segment. - Launchers.
Satellite subsystems	- Communication. - Mechanical & Thermal. - Power. - ADCS. - Propulsion. - On-board computer.
Product Assurance and Assembly, Integration and Verification Procedures in a space project.	- Product Assurance (PA) in space projects. - Assembly, Integration and Verifications (AIV) plans and procedures in space projects.
Introduction to satellite operations	- Telemetry and Telecommand definition. - Operation procedures.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	19	57	76
Seminars	10	20	30
Short answer tests	1	18	19

*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	We describe the different aspects of the subject providing all the necessary educational material.
Seminars	Every student will apply the theoretical knowledge to different practical tasks covering the main part of the contents of the subject with the help of the software suites.

Personalized attention

	Description
Master Session	The students will have the opportunity to attend tutorial hours with the university lecturers in the schedule that will be established and published in the subject web-page. They may also send their queries by email.
Seminars	The students will have the opportunity to attend tutorial hours with the university lecturers in the schedule that will be established and published in the subject web-page. They may also send their queries by email.

Assessment

	Description	Qualification	Evaluated Competencess
Master Session	The evaluation will be based on the documentation written by the student for a proposed project.	45	CB2 CG3 CE18
Seminars	The students will perform simulations using the Satellite Toolkit (STK) software. The evaluation will be based on the students' assistance to the seminars, his or her participation on the seminars and a final report.	35	CB2 CG4 CE18
Short answer tests	A final test to complement the evaluation of the contents presented in the master sessions. The test will be individual with time limit.	20	CE18

Other comments and July evaluation

Sources of information

James R. Wertz, David F. Everett and Jeffery J. Puschell, Space Mission Engineering: The New SMAD, 4, Microcosm Press

, http://www.ecss.nl, ,

, http://www.incose.org/, ,

, NASA Systems Engineering Handbook, SP-2007-6105. Rev 1, NASA

Peter Fortescue (Editor), John Stark (Editor), Graham Swinerd (Editor), Spacecraft Systems Engineering, 3, Wiley

, http://help.agi.com/StartTraining/StartTraining.htm, ,

Recommendations

Subjects that it is recommended to have taken before

(*)Deseño de Circuitos Electrónicos Analóxicos/V05M145V01106
(*)Comunicacións Móbiles e sen Fíos/V05M145V01313

IDENTIFYING DATA				
(*)Sistemas Radio en Banda Ancha				
Subject	(*)Sistemas Radio en Banda Ancha			
Code	V05M145V01312			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	English			
Department				
Coordinator	García Sánchez, Manuel			
Lecturers	García Sánchez, Manuel Santalla del Río, María Verónica			
E-mail	manuel.garciasanchez@uvigo.es			
Web	http://www.faitic.uvigo.es			
General description	Wideband radio systems.			

Competencies		
Code		Typology
CE19	CE19/RAD2 Ability to perform theoretical design, experimental band systems measurement and practical implementation broadband for current applications	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Theoretical and experimental knowledge of wideband systems	CE19
Knowledge of designs of wideband active and passive elements	CE19
Fundamentals of wideband signal generation and reception	CE19
Fundamentals of wideband signal measurement	CE19

Contents	
Topic	
Introduction	Definitions and basic concepts Communicaction systems Radio systems. Antennas. Radioelectric spectrum. Modulation. Radio channel. Propagation channel.
Description of the radio channel	Free space Undistorted transmission Attenuation. Multipath Fading. Doppler spread. Delay spread. Frequency selective channels.
Mathematical description	Narrowband Statistical amplitude distributions Doppler spectrum Wideband Bello formulation

Channel sounders	Narrowband Doppler. Nyquist limit. Wideband. Frequency domain sounders: VNA Time domain sounders. RF pulse. Sliding correlation sounders. Sounder design and performance assesment. Narrowband sounder with spectrum analyzer 0 span. VNA based sounder. Sliding correlation sounder.
Channel sounders lab	Buliding a wideband sounder to measure the radio channel.
Wideband modulations	Delay spread. Inter symbol interference. Irreducible BER. Frequency hopping: GSM OFDM. Guard interval. Pilot tones. Equalization. PAPR. Amplifiers. DVB-T. CDMA. Processing gain. Noise. Adquisition and tracking. RAKE receiver. 3G. Power control. Cellular breathing.
UWB systems	1. Definition. Specificities. Regulation 2. Channel characteristics. 3. Impulse radio UWB. 4. Multiband OFDM approach to UWB. 5. Applications
UWB radar	1. Fundamentals. 2. Applications: - Ground penetrating radar - Medical imaging
Wideband aand UWB ntennas	1. Wideband antennas. Definition and requirements. 2. Characterization of wideband antennas 3. Examples and applications. 4U WB antennas. Definition and requirements. 5. Characterization of UWB antennas 6. Examples and applications.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	20	40	60
Laboratory practises	4	28	32
Tutored works	5	20	25
Short answer tests	1	7	8
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Master Session	Master lecture given by the teacher
Laboratory practises	Building and testing wideband radio channel sounders
Tutored works	These are tutorial type classes for discussion and follow-up of the previously assigned project.

Personalized attention	
	Description
Master Session	The students will have the opportunity to ask their doubts and questions during the learning activities, attending to scheduled meetings with the lecturer, or by means of email
Laboratory practises	The students will have the opportunity to ask their doubts and questions during the learning activities, attending to scheduled meetings with the lecturer, or by means of email
Tutored works	The students will have the opportunity to ask their doubts and questions during the learning activities, attending to scheduled meetings with the lecturer, or by means of email

Assessment			
	Description	Qualification	Evaluated Competencess
Master Session	Short answer test	60	CE19

Laboratory practises	Report	20	CE19
Tutored works	Work report	20	CE19

Other comments and July evaluation

First call:

Following the guidelines of the master we offer to the students two schemes of evaluation: continuous assessment and final assessment. The students will have to opt by one of the two schemes before a given date.

Second call: just final exam.

Sources of information

J.D. Parsons, The Mobile Radio Propagation Channel, ,

H. Schulze, Theory and applications of OFDM and CDMA, ,

Recommendations

IDENTIFYING DATA				
(*)Comunicacións Móbiles e sen Fíos				
Subject	(*)Comunicacións Móbiles e sen Fíos			
Code	V05M145V01313			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	English			
Department				
Coordinator	Vazquez Alejos, Ana			
Lecturers	Pérez Fontán, Fernando Vazquez Alejos, Ana			
E-mail	analejos@uvigo.es			
Web	http://http://faitic.uvigo.es			
General description	This subject introduces the student in the technology of the main present mobile and wireless communication systems, with training in analysis of coverage and quality planning at radio interface level.			

Competencies	
Code	Typology
CE20 CE20/RAD3 Ability to analyse and specify the basic parameters of a mobile or wireless radio network, as well as of quality of service.	- Know How

Learning outcomes	
Learning outcomes	Competences
Know the reference architectures of the 2G/3G/4G cellular systems, and also for short range radio systems and standards: WLAN, WPAN and others.	CE20
Ability to compute the coverage and capacity of a mobile communications site and estimate the cellular radius.	CE20
Dimensioning and capacity planning of mobile and wireless systems.	CE20
Ability to carry out a mobile network deployment planning.	CE20
Ability to select the radio technology most appropriate to a given application.	CE20

Contents	
Topic	
Unit 1. Overview of mobile, cellular, WLAN, WPAN, and other wireless radio communication systems.	1.1. Introduction to mobile and wireless systems. 1.2. Mobile and wireless radio propagation channel.
Unit 2. Dimensioning and quality of service planning in mobile and wireless radio systems.	2.1. The cellular concept. 2.2. Cellular design fundamentals. 2.3. Dimensioning of a mobile radio system. 2.4. Quality of service.
Unit 3. Review of the standards of current cellular systems.	3.1. 2G mobile phone systems: GSM and GPRS. 3.2. 3G mobile phone systems: CDMA, UMTS, 3G, 3G+. 3.3. Next Generation Mobile phone systems: LTE 5G. 3.4. Security vulnerability in mobile communications systems.
Unit 4. Review of the standards of current wireless systems.	4.1. Introduction to wireless systems and services: WLAN, WPAN, BAN. 4.2. Design fundamentals: dimensioning and quality of service. 4.3. Security vulnerability in wireless communications systems.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	22	22	44
Case studies / analysis of situations	4	40	44
Troubleshooting and / or exercises	4	2	6

Autonomous troubleshooting and / or exercises	0	10	10
Short answer tests	0	1	1
Practical tests, real task execution and / or simulated.	0	10	10
Self-assessment tests	0	10	10
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Master Session	Presentation of the contents of the subject by teachers; it includes explaining the theoretical concepts; introduction of lab practices, on-line tests and exercises/problems of autonomous realisation.
Case studies / analysis of situations	Conducting case studies in laboratory with delivery of a memory/report to be assessed.
Troubleshooting and / or exercises	Resolution of problems and/or exercises in ordinary classroom.
Autonomous troubleshooting and / or exercises	Solving by the student of problems related with the subject applied to specific cases. The student must develop the analysis and resolution of the problems in an autonomous form. These exercises are proposed weekly in attendance hours and they are guided by the professor on the resolution.

Personalized attention	
	Description
Master Session	Students may attend customized teacher's office in the schedule that teachers establish for this purpose in the early going of course and that will be published on the website of the subject. They may also raise any inquiries electronically.
Autonomous troubleshooting and / or exercises	Students may attend customized teacher's office in the schedule that teachers establish for this purpose in the early going of course and that will be published on the website of the subject. They may also raise any inquiries electronically.
Case studies / analysis of situations	Students may attend customized teacher's office in the schedule that teachers establish for this purpose in the early going of course and that will be published on the website of the subject. They may also raise any inquiries electronically.
Troubleshooting and / or exercises	Students may attend customized teacher's office in the schedule that teachers establish for this purpose in the early going of course and that will be published on the website of the subject. They may also raise any inquiries electronically.
Short answer tests	Students may attend customized teacher's office in the schedule that teachers establish for this purpose in the early going of course and that will be published on the website of the subject. They may also raise any inquiries electronically.
Practical tests, real task execution and / or simulated.	Students may attend customized teacher's office in the schedule that teachers establish for this purpose in the early going of course and that will be published on the website of the subject. They may also raise any inquiries electronically.
Self-assessment tests	Students may attend customized teacher's office in the schedule that teachers establish for this purpose in the early going of course and that will be published on the website of the subject. They may also raise any inquiries electronically.

Assessment			
	Description	Qualification	Evaluated Competencess
Autonomous troubleshooting and / or exercises	It will evaluate the resolution of problems delivered to each student for troubleshooting in an autonomous form.	15	CE20
Short answer tests	Final examination consists of a multiple choice test for assessing the skills acquired by students by solving simple problems and questions of theory. This test includes closed questions with different alternative of answer. Students select an answer from a limited number of possibilities.	35	CE20
Practical tests, real task execution and / or simulated.	For each lab practice (case studies / analysis of situations) a report of results must be presented for assessment.	35	CE20

Self-assessment tests	Multiple choice questions tests for each unit of the subject content. The questionnaires are performed through Faitic platform that shows the results after completing each test. Students perform the tests in an autonomous form, and indications are given during attendance and office hours.	15	CE20

Other comments and July evaluation

According to the specific guidelines of the degree, students enrolled in the subject can choose one of the two proposed assessment systems: continuous assessment or final evaluation.

Continuous assessment

Continuous assessment involves performing throughout the semester of the paragraphs disaggregated in the above table. Each of the blocks is of mandatory fulfillment in the form of continuous assessment, and to pass the subject a minimum of 1/3 of the note assigned to each of the sections and the final mark accumulated within the five sections to be achieved must overcome at least 50% of the final grade. The short answer test is multiple choice and is done the day indicated in the official exam schedule.

Continuous assessment involves making over quarter of all proposed tasks: active participation in the sessions of classroom and laboratory practices, autonomous work as solving exercises and online self-assessment tests (questionnaires), and performing the final short answer test. These tasks are not recoverable, that is, if a student does not satisfy the stipulated timing the teacher has no obligation to repeat, and also they will be only valid for the academic year in which they are made.

Evaluation by final exam

In compliance with the regulations of the University of Vigo, a student who does not opt for continuous assessment should be eligible for the highest rating by the final exam, which will consist of three parts:

- Part 1: realization of laboratory practices and delivery of reports due (35% of the final grade).

- Part 2: test exam (50% of the final grade).

- Part 3: troubleshooting (20% of the final grade).

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

Extraordinary exam (July)

For students who followed the continuous assessment, those ones who want to retain the mark obtained in the first part of the continuous assessment (70%) may choose to perform only the test (30%) provided they have exceeded the minimum requirement in each block .

For students who chose the final evaluation, the note will be the final exam that will consist of three parts: a practical examination (pass /non-pass), a standard test exam (50%) and an examination of problems (50%) .

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

Sources of information

Oriol Sallent, Fundamentos de diseño y gestión de sistemas de comunicaciones móviles celulares, 2014, Publicacions Acadèmiques Digitals de la UPC

Mª Teresa Jiménez Moya, Juan Reig Pascual, Lorenzo Rubio Arjona, Problemas de comunicaciones móviles , 2006, Universidad Politécnica de Valencia

Jose María Hernando Rábanos, Comunicaciones Móviles, 2004, Editorial Universitaria Ramón Areces

José Manuel Huidobro Moya, Comunicaciones móviles : sistemas GSM, UMTS Y LTE, 2012, RA-MA

Recommendations

Subjects that continue the syllabus

(*)Antenas/V05M145V01208
(*)Laboratorio de Radio/V05M145V01209
(*)Redes sen Fíos e Computación Ubicua/V05M145V01211
(*)Satélites/V05M145V01311
(*)Sistemas Avanzados de Comunicacións/V05M145V01302

Subjects that it is recommended to have taken before

(*)Radio/V05M145V01103

IDENTIFYING DATA				
(*)Microwave and Millimetre Wave Circuit Design and CAD				
Subject	(*)Microwave and Millimetre Wave Circuit Design and CAD			
Code	V05M145V01317			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	English			
Department				
Coordinator	Fernández Barciela, Mónica			
Lecturers	Fernández Barciela, Mónica			
E-mail	monica.barciela@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Communications systems are at the mercy of the available technology to fabricate their transceivers. To understand the complexities of modern communications transceivers, their performance requirements and limitations, especially in the microwave and mm-wave frequency bands, it is mandatory to have a closer look to their underlying electronics and fabrication methods. And this look requires not only a theoretical background in active devices and circuit design methodologies or fabrications methods, but most importantly, a practical background in circuit design, fabrication, measurement and performance evaluation. The student has already acquired this theoretical background through previous subjects. The present subject aim to provide the student with some practical background by fully designing, fabricating in hybrid integrated technology and characterizing a circuit prototype, in fact one of the analogue building components of modern transceivers for working in the microwave band (power amplifier, oscillator or mixer). Most of the presential hours of the subject and personal work of the student will be devoted to the design and fabrication of this prototype. Besides this practical work, some presential hours will be devoted to describe the design rules and methodologies of advanced transceiver circuit modules working in microwave and mm-wave bands.			

Competencies		
Code		Typology
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- know - Know How
CG4	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.	- know - Know How
CG8	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.	- Know How
CE32	CE38/OP8 Ability to design, manufacture (in hybrid technology) and characterize the analog components of transceivers of communications in microwave and millimeter-wave bands	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Learn to design analogue advanced active circuits (linear and nonlinear) for emitters and receivers for communications in the microwave and milimeter wave frequency bands.	CG1 CG4 CE32
Learn to design high frequency circuits for the optoelectronic interface in optical communications systems.	CG1 CG4 CE32
Learn the fabrication techniques of integrated circuits (hybrid and monolithic) for communications in the high frequency bands. Learn how to apply one of these techniques in circuit prototype fabrication.	CG1 CG4 CG8 CE32
Learn to characterize and asses the performance of microwave circuits for communication transceivers.	CG1 CE32

Contents	
Topic	
1. Advanced circuit design for communication transceivers in the microwave and millimeter wave bands.	a. Linear and Nonlinear Circuit Design Techniques. -CAD-based design and component models. -Measurement-based design. - S-parameters vs X-parameters b. Advanced Low Noise Amplifier Design c. High Eficiency Power Amplifier Design d. High Frequency Oscillator Design e. Frequency Converter Design
2. High frequency circuit design for optoelectronic transceivers in optical communications systems.	Broadband Amplifier Design Techniques
3. Fabrication techniques for Hybrid and Monolithic Microwave Integrated Circuits	Hybrid MIC processing techniques MMIC technologies and foundry processing techniques.
4. Advanced linear and nonlinear characterization techniques, and corresponding instrumentation, to guide design and evaluate performance.	Device linear characterization techniques and instruments: VNAs. Device nonlinear characterization techniques and instruments: NVNAs, VSAs, etc.
5. A Case Study: CAD-based prototype design, fabrication and performance evaluation.	Prototype Design using ADS simulator Prototype fabrication in Hybrid-MIC technology using microstrip transmission lines Prototype characterization to evaluate performance.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	5	10	15
Practice in computer rooms	14	0	14
Laboratory practises	4	0	4
Tutored works	0	78	78
Tutored works	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	It will be given in a classroom with the aid of a slate board and a video projector. Main concepts in the Chapters will be described, with the exception of the last Chapter that it will not be covered here, since it is an application work (case study) by the student. These classes are designed to aid in adquiring competencies: CG1,4,8 and CE38/OP8.
Practice in computer rooms	During these classes, with the aid of a commercial microwave circuits simulator, it will be designed by the student a circuit prototype, among those described in the subject. This work will be completed with through tutorized personal work by the student. These classes are designed to aid in adquiring competencies: CG1,4,8 and CE38/OP8.
Laboratory practises	The previously designed prototype by the student, during the practices in computer rooms and his/her personal work, will be fabricated in hybrid MIC technology and characterized using adequate instrumentation. These classes are designed to help in adquiring competencies: CG1,4,8 and CE38/OP8.
Tutored works	With the aid of the hours of practice in computer rooms, and through his/her personal work, the student will be guided to fully design - working individually- a circuit prototype. Then, he/her will fabricate this prototype and evaluate its performance during the laboratory practices. The student will write a final report of his/her work. This project with require most of the student effort in the subject. These classes are designed to help in adquiring competencies: CG1,4,8 and CE38/OP8.
Tutored works	Each student will prepare - working individually- a short writen report about one of the topics covered in the subject. This work will by assesed by an oral presentation in which he/she will answer short questions about the work. These classes are designed to help in adquiring competencies: CG1,4,8 y CE38/OP8.

Personalized attention	
	Description
Practice in computer rooms	During the scheduled experimental and computer practices, the lecturer will guide the student work and solve doubts that may arise as a consequence of the designated tasks. The student will have available additional time for tutorship, in which to solve his/her doubts and questions with respect to the designated personal works.
Laboratory practises	During the scheduled experimental and computer practices, the lecturer will guide the student work and solve doubts that may arise as a consequence of the designated tasks. The student will have available additional time for tutorship, in which to solve his/her doubts and questions with respect to the designated personal works.

Assessment			
	Description	Qualification	Evaluated Competencess
Tutored works	The student will design, fabricate in Hybrid Technology and evaluate the performance of a microwave circuit prototype. The assesment will be performed through the circuit design, the quality of the fabricated prototype, the final measured prototype performance and a written report.	90	CG1 CG4 CG8 CE32
Tutored works	The student will write a report about a topic related to the subject. The assesment will be performed taking into account the quality of the report and the answers to short questions during the oral presentation of the work.	10	CG1 CG4 CG8 CE32

Other comments and July evaluation

A) First summons :
The work of the student in the subject will be evaluated through the development of the two tutorized works:
1. The circuit prototype: design, fabrications, performance evaluation, and written report (90% of the total subject qualification).
2. The written report about a given topic and his/her answers to the short questions. (10% of the total subject qualification).

If the student does not obtain the minimum qualification to pass the subject in the first summons and has been present at least in 80% of the presential hours, the lecturer will suggest changes/improvements to the prototype design and written report about the topic, for the second summons.

B) The second summons:

Those students who have been present at least in 80% of the presential hours will have the opportunity to re-design his/her previous prototype design and improve the written report of the topic. Each of these tasks will be assigned the same qualification percentage as in the first summons
Those students who have not been present in at least 80% of the presential hours, will have two weeks to design, fabricate, measure, evaluate performance and write a report of a circuit prototype chosen by the lecturer. The assessment of this work will be 100% of the subject qualification.

Sources of information

, Artículos técnicos (revistas científicas, notas de aplicación, información fabricante componentes,...), ,
, Manuais dos equipos e simulador, ,
Steve C. Cripps, Advanced Techniques in RF Power Amplifier Design, 1, Artech House
Guillermo Gonzalez, Foundations of Oscillator Circuit Design, , Artech House
D. Root , X-Parameters: Characterization, Modeling, and Design of Nonlinear RF and Microwave Components, 1, Cambridge
Guillermo Gonzalez , Microwave Transistor Amplifiers: Analysis and Design, 2, Prentice Hall

Recommendations

Subjects that it is recommended to have taken before

(*)Electrónica e Fotónica para Comunicacións/V05M145V01202

IDENTIFYING DATA				
(*)Seguridade Multimedia				
Subject	(*)Seguridade Multimedia			
Code	V05M145V01318			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	English			
Department				
Coordinator	Pérez González, Fernando			
Lecturers	Pérez González, Fernando			
E-mail	fperez@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Multimedia security is an increasingly important topic as most of the information exchanged nowadays over the Internet is multimedia. Traditional data protection solutions like cryptography only solve the problem partially, because contents, once decrypted, are no longer protected. In addition, there is a rising concern over the integrity of multimedia contents: modern editing tools jeopardize our trust on video, images or audio. Fortunately, a number of research groups and companies have addressed these problems and ingenious solutions exist. This course presents advanced topics in multimedia security, with emphasis on cryptography, watermarking, forensics and signal processing in the encrypted domain. Teaching and exams are in English.			

Competencies		
Code		Typology
CG4	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.	- know - Know How
CG8	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.	- know - Know How
CE31	CE37/OP7 Ability to model, operate, manage, and deal with the full cycle and bagging of networks, services and applications considering the quality of service, direct and costs of operation, the plan of implementation, monitoring, security, scaling and maintenance, managing and ensuring the quality of the development process	- Know How

Learning outcomes	
Learning outcomes	Competences
Handle the most advanced information protection methods.	CG4 CG8 CE31
Understand the potential and limitations of the different methods.	CG4 CG8 CE31
Handle the use of different algorithms in current multimedia communications environments.	CG4 CG8 CE31
Understand technical material in an autonomous way.	CG4 CG8 CE31

Contents
Topic

Introduction to cryptography.	Application to multimedia systems. Integration with source and channel coding. Block and stream ciphers. Hashing and MAC codes. Specific algorithms.
Conditional access systems.	Requirements. History and state of the art. Design of a conditional access system.
Secret sharing.	Simple secret sharing systems. Visual cryptography.
Data hiding and watermarking.	Basic concepts. Watermarking versus data hiding. Spread-spectrum watermarking. Quantization-based watermarking. Application to images and video.
Forensic signal processing.	Quantization detection and estimation. Filtering detection and identification. Resampling detection and estimation. Source ballistics.
Signal Processing in the Encrypted Domain.	Privacy metrics and notions. Homomorphic encryption. Garbled cicruits. Signal representation and cipher blowup. Applications.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	14	28	42
Laboratory practises	9	42	51
Reports / memories of practice	0	30	30
Long answer tests and development	2	0	2

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

Methodologies

	Description
Master Session	The course is structured in several topics in multimedia security, including cryptography, watermarking, forensics and signal processing in the encrypted domain. Competences: CG4, CG8, CE31
Laboratory practises	Lab practices will cover different aspects of multiple-input data hiding, watermarking and forensics. This will allow students to practically implement and considerably expand some of the concepts seen in the lectures. Competences: CG4, CG8, CE31

Personalized attention

	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 published in the course webpage.
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 published in the course webpage.

Assessment

	Description	Qualification	Evaluated Competencess
Reports / memories of practice	Reports of the practices and additional personal work that employ the techniques seen in the classroom. Quality of the reports and correctness of the results will be evaluated. Reports will be individual or collective, depending on the size of the unit that carried out the practices.	70	CG4 CG8 CE31

Long answer tests and development	Final exam with short questions on the contents of the subject.	30	CG4 CG8 CE31

Other comments and July evaluation

A minimum score of 30% 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 year.

Sources of information

Cox, Miller, Bloom, Fridrich, Kalker, Digital Watermarking and Steganography, 2nd, Morgan Kauffman

Troncoso-Pastoriza, Perez-Gonzalez, Secure Signal Processing in the Cloud: enabling technologies for privacy-preserving multimedia cloud processing, Signal Processing Magazine, IEEE

A.J. Menezes, Handbook of Applied Cryptography, 1996, CRC Press

A. Piva, An Overview of Image Forensics, Signal Processing, Hindawi

Recommendations

Subjects that it is recommended to have taken before

(*)Procesado Estatístico de Sinal/V05M145V01303

IDENTIFYING DATA				
(*)Computación Distribuída				
Subject	(*)Computación Distribuída			
Code	V05M145V01321			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	Spanish Galician English			
Department				
Coordinator	Mikic Fonte, Fernando Ariel			
Lecturers	Burguillo Rial, Juan Carlos Mikic Fonte, Fernando Ariel Rodríguez Hernández, Pedro Salvador			
E-mail	mikic@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course will provide a vision of group of the most usual technologies inside the distributed computing. They will tackle subjects such as the distributed transactions and the replication; the grid computing, cloud computing, and cluster computing; the distributed artificial intelligence; and the parallel and evolutionary computing.			

Competencies		
Code		Typology
CB2	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.	- know - Know How
CB4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.	- know - Know How
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- know - Know How
CG8	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.	- know - Know How
CE24	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.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
To earn skills in the design, development and management of distributed systems.	CB2 CG8 CE24
To undertand the functional bases of the distributed systems.	CB4 CB5 CE24
To know the distinct concepts related with the distributed computing: clustering, grids, cloud computing and ubiquitous computing.	CB5 CG8 CE24
To earn skills for the application of intelligent systems in the distributed computing.	CB2 CB5 CG8 CE24
To learn how to distribute the execution of tasks for the resolution of problems and optimisation by means of evolutionary and parallel computing.	CB2 CB4 CG8 CE24

Contents	
Topic	
1. Transactions	1. Concurrency problems 2. Recoverability problems 3. Deadlocks 4. Optimistic concurrency control 5. Timestamps
2. Replication	1. System model and group communication 2. Fault-tolerant services 3. Case studies of high available services 4. Transactions with replicated data
3. Grid, Cluster, and Cloud computing	1. Basic concepts of grid computing 2. Basic concepts of cluster computing. 3. Basic concepts of cloud computing.
4. Distributed artificial intelligence	1. Intelligent agents and multiagent systems 2. Theory of games applied to multiagent systems: coordination, competition, negotiation, auctions, electronic trade 3. Complex distributed systems and auto-organised ones
5. Parallel and evolutionary computation	1. Distributed Computing and parallelization 2. Algorithms and evolutionary programming: genetics, memetics, differential evolution, intelligence of swarm. 3. Optimisation by means of evolutionary technics and parallelization

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	17	0	17
Autonomous practices through ICT	7.5	0	7.5
Autonomous troubleshooting and / or exercises	0	92.5	92.5
Short answer tests	3	0	3
Reports / memories of practice	0	2.5	2.5
Systematic observation	2.5	0	2.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Master Session	Theoretical classes with practical cases. Besides, problems will be proposed for solving them in autonomous way.
Autonomous practices through ICT	Practices in laboratory realised by means of computers connected in network and/or virtual machines.
Autonomous troubleshooting and / or exercises	Work of study on the contents of the theoretical classes, as well as of support to the realisation and achievement of the practices of laboratory.

Personalized attention	
	Description
Autonomous practices through ICT	The personalised attention will carry out in the practical part of the course, as in the tutorial time.
Systematic observation	The personalised attention will carry out in the practical part of the course, as in the tutorial time.

Assessment			
	Description	Qualification	Evaluated Competencess
Short answer tests	Examinations composed by a series of short answer questions and/or test type ones that the student will have to answer in the classroom individually.	70	CB2 CB4 CB5 CG8 CE24

Reports / memories of practice	Detailed report of the tasks during the realisation of the practices of laboratory carried out in group.	20	CB2 CB4 CG8 CE24
Systematic observation	Observation by the professor of the work carried out by the students in the classroom during the realisation of the practices of laboratory carried out in group. Level of participation in those practices.	10	CB2 CB4 CB5 CG8 CE24

Other comments and July evaluation

The students can decide being evaluated according to a model of continuous evaluation (reviewed previously) or realise a final examination. The fact a student answer the first examination of continuous evaluation means he/she opts by this model of evaluation (in contrary case he/she opts by the model of final examination). Once the students opt by the model of continuous evaluation their qualification will not be able to be never "No presented".

1- CONTINUOUS EVALUATION

To surpass the course requires a minimum qualification of 5 points. The qualification will be the result to add the qualifications received in each one of the following parts:

- Written exam 1:
  - Dates: On the fourth week of the course
  - Individually
  - Contents: Given until this moment
  - Type: Series of short answer questions and/or test type ones
  - Maximum punctuation = 5 points
- Written exam 2:
  - Dates: Official calendar (coinciding with the final examination for those that opted by this modality)
  - Individually
  - Contents: Given until this moment excepting those that already were evaluated in the written exam 1.
  - Type: Series of short answer questions and/or test type ones
  - Maximum punctuation = 2 points
- Practices:
  - Dates: Weeks 6, 7, and 8
  - In group
  - Maximum punctuation = 3 points

2- FINAL EXAMINATION

To surpass the course requires a minimum qualification of 5 points.

- Written exam:
  - Dates: Official calendar
  - Individually
  - Contents: Given in the whole course (including practical).
  - Type: Series of short answer questions and/or test type ones
  - Maximum punctuation = 10 points

3- EXTRAORDINARY EVALUATION

The students will be evaluated using the modality of "final examination"

Sources of information

REFERENCE BIBLIOGRAPHY

"Cloud computing bible". Barrie Sosinsky. Wiley Publishing, Inc. 2011. ISBN: 978-0-470-90356-8

"Grid Computing and Cluster Computing". C. S. R. PRABHU. PHI Learning Pvt. Ltd. 2008. ISBN: 9788120334281

"Distributed systems. Concepts and design". George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair. Fifth Edition,

published by Addison Wesley, May 2011. ISBN 0-13-214301-1

"Introduction to Grid Computing". Bart Jacob, Michael Brown, Kentaro Fukui, , Nihar Trivedi. http://www.redbooks.ibm.com/redbooks/pdfs/sg246778.pdf

- Michael Wooldridge, An Introduction to Multiagent Systems, Addison-Wesley, 2a, 2009.

- Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach,, Prentice Hall, 3a, 2014.

- A.E. Eiben, J.E. Smith. Introduction to Evolutionary Computing (Natural Computing Series). Springer, 2008.

- Dan Simon. Evolutionary Optimization Algorithms. Wiley, 1e, 2013.

- Rauber, Thomas, Rünger, Gudula. Parallel Programming for Multicore and Cluster Systems. Springer, 2013.

NOTE: Additional materials will be provided.

Recommendations

IDENTIFYING DATA				
Data analysis				
Subject	Data analysis			
Code	V05M145V01322			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	Spanish			
Department				
Coordinator	González Castaño, Francisco Javier			
Lecturers	Díaz Redondo, Rebeca Pilar Fernández Vilas, Ana González Castaño, Francisco Javier			
E-mail	javier@det.uvigo.es			
Web	http://http://faitic.uvigo.es			
General description	Data analysis with a practical approach: data extraction and cleansing, data characterization with techniques such as statistical regression, clustering or outlier analysis, and knowledge generation with techniques such as intuitive visualization or automatic classification.			

Competencies		
Code		Typology
CB2	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.	- know - Know How
CB3	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.	- know
CG4	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.	- know - Know How
CG8	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.	- know
CE25	CE25/TE2 bility to manage the acquisition, structuring, analysis and visualization of data, extracting information and underlying knowledge, critically assessing the results, and applying it to strategic decision-making and innovation in different areas.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
- Knowledge of the different stages of knowledge extraction and the areas of application of data mining.	CB2 CB3 CG4 CG8 CE25
- Knowledge of the importance of the preparation of the data and how to apply the main pre-processing techniques.	CB2 CG4 CG8 CE25
- Knowledge of the main techniques of data mining as well as the necessary premises for its application to a particular stage.	CB2 CB3 CG4 CG8
- Knowldge of the different types of data mining results evaluation and how to apply them.	CE25
- Knowledge of statistical software and how to apply it to on-line and off-line data mining.	CG4 CE25
-Ability to to schedule, develop and evaluate a data analysis process.	CG4 CG8 CE25
New	

Contents	
Topic	
Statistical analysis of data	- Correlation and causation. - Regressions. - Intervals of confidence and error. Hypothesis tests.
Data mining	- Cleaning, integration, reduction and transformation of data. - Classification and clustering.
Computational analysis of data	- Large-scale data analysis. - Visualisation of data and results. - Application scenarios.

Planning	Class hours	Hours outside the classroom	Total hours
Projects	2	36	38
Laboratory practises	8	16	24
Master Session	20	40	60
Short answer tests	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
Projects	In groups, the students will solve a practical case of data analysis in an application scenario.
Laboratory practises	During the course, students will develop solutions in laboratiry sessions to grasp the course content.
Master Session	Lectures that will illustrate the course content with small exercises. These will be solved by the lecturer of the students themselves, alone or in groups. The goal is to foster discussion and knowledge of course competencies.

Personalized attention	Description
Laboratory practises	Personal attention during official tutoring hours and via the FAITIC platform.

Assessment	Description	Qualification	Evaluated Competencess
Short answer tests	Short-answer written exam (around week 5)	40	CE25
Jobs and projects	Working groups will deliver their projects during the last week of the course. Then, a public defense will be scheduled in the official examination date.	60	CB2 CB3 CG4 CG8 CE25

Other comments and July evaluation

During the bimester, the evaluation of the course will only take place according to the continuous evaluation system.

CONTINUOUS EVALUATION

It will be based on the aforementioned methodologies. The grading of the activities is as follows:

1. Short answer test: Around the fifth week (4 points maximum).
2. Project: To be defended at the official examination date (6 points maximum)

To pass the course, the student must obtain 1,5/4 points at least in the short answer test and an overal mark (across all possible activities) above 5 points. The maximum mark is 10 points.

The contents of the short answer test and the project will be balanced for a reasonable preparation effort.

FINAL COURSE EVALUATION

Final course evaluation, as an alternative to continuous evaluation, will consist on a single exam covering the whole course content, theoretical and/or practical. The maximum mark of this exam will be 10 points. The minimum mark to pass the exam is 5 points.

Sources of information

- Advanced Statistics from an Elementary Point of View. Michael J. Panik. Academic Press; 1 edition (October 28, 2005) ISBN-10: 0120884941 ISBN-13: 978-0120884940

- OpenIntro Statistics: Second Edition. David M. Diez, Christopher D. Barr, Mine C. Cetinkaya-Rundel. CreateSpace Independent Publishing Platform. ISBN-10: 1478217200 ISBN-13: 978-1478217206

- R in a Nutshell, 2nd Edition. Joseph Adler. O'Reilly Media. ISBN-10: 144931208X ISBN-13: 978-1449312084

Recommendations

IDENTIFYING DATA				
(*)Redes Sociais e Económicas				
Subject	(*)Redes Sociais e Económicas			
Code	V05M145V01323			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
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	Social and Economic networks tackles the dynamic and structural study of networks of relation between agents that arise in the fields of the telecommunication, the economy and the sociology. They study , in particular, dynamic models of diffusion of information, of contagion, of strategic balance and of training of coalitions. The theoretical contents apply to a practical case of study.			

Competencies		
Code		Typology
CB1	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.	- know
CB3	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.	- Know How
CG4	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.	- Know How
CG8	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.	- Know How
CE26	CE26/TE3 Ability to understand and know to exploit the processes of training and dissemination of information in social networks, applying them to the improvement of Internet	- Know How
CE27	CE27/TE4 Ability to design and manage distributed systems based on learning and incentive	- Know How

Learning outcomes	
Learning outcomes	Competences
Understand the static and dynamic phenomena that explain the structure of the social networks	CG4 CE26
Know how to analyse the mechanisms of training of networks in strategic terms	CG4 CG8 CE26 CE27
Know how to model and apply to real data the processes of diffusion of information in social networks	CB1 CB3 CE26 CE27
Know how apply the procedures of structural and dynamic analysis of the networks to analyse complex systems in the technological fields, biological, economic and social.	CB1 CB3 CG4 CG8 CE26 CE27

Know how to use the dynamics of learning in networks to characterise phenomena	CB1 CB3 CG4 CE27

Contents	
Topic	
1. Basic models	To. Empirical evidence b. Random networks c. Descriptive parameters, centrality and importance d. Scaling laws
2. Training of networks	To. Random models: static training *b. Random models: dynamic training *c. Strategic training: stability, efficiency and incentives
3. Diffusion and learning in social networks	To. Simple diffusion *SIR, *SIS and other *b. Learning and reinforcement in networks *c. Games in networks: *complementos and strategic substitutes
4. Applications	a. Recommendations/punctuations b. Virality c. Origins of rumours d. Trending topics d. Meritocracy. Identification of experts and leaders

Planning			
	Class hours	Hours outside the classroom	Total hours
Projects	14	56	70
Master Session	14	35	49
Jobs and projects	1	2	3
Troubleshooting and / or exercises	1	2	3
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Projects	Development of a practical project of analysis and modeling of a network of diffusion: technological, social, biological or economic. It will consist in the structural and dynamic explanation of the observable phenomena in the data that describe the network.
Master Session	Synthetic exposition in the classroom of the basic concepts that support the subject.

Personalized attention	
	Description
Master Session	*Tutorización Personalised on the concepts and technical of analysis of the networks of diffusion of information and of relations. Support and guide to the realisation of the practical project of the students.

Assessment			
	Description	Qualification	Evaluated Competencess
Jobs and projects	Evaluation of the technical hypotheses, methods of analysis, results and contributions of the project realised.	50	CB1 CB3 CG4 CG8 CE26 CE27

Troubleshooting and / or exercises	Correction of the exercises proposed. They will deliver by writing.	50	CB1 CB3 CG4 CG8 CE26 CE27

Other comments and July evaluation

We leave to discretion of the students two methods of alternative evaluation in the subject: continuous evaluation and single evaluation. The continuous evaluation will consist in the realisation of a project (50% of the qualification) and in the resolution written of problems along the course (50% of the qualification). The single evaluation will consist in the realisation of a final examination writing (60% of the qualification) and in the development of a practical project (40% of the qualification) that will be due before the last day of the official period of examinations.

The students will choose one or another modality of evaluation in the moment in that the project is announced. They will be considered not presented in case no explicit election is made at in this moment. Those who do not pass the subject at the earliest opportunity of the announcement have of a second opportunity in the month of July in which his knowledge will be tested with a written examination or his project will be assessed again if it had been improved or modified. The weights of each one of the tests (examination and project) will be the same that in the ordinary period of evaluation according to the modality that had chosen.

The qualification of the test has only effects in the academic course in that they were awarded, with independence of the itinerary of evaluation chosen.

Sources of information

A. D. Barbour, L. Holst and S. Janson, Poisson Approximation, , Oxford Science Publications, 1992

B. Bollobas, Random Graphs, 2ª, Cambridge University Press, 2001

R. Durrett, Random Graph Dynamics, , Cambridge University Press, 2006

D. Easley, J. Kleinberg, Networks, Crowds, and Markets: Reasoning About a Highly Connected World, , Cambridge University Press, 2010

G. Grimmett, Percolation, 2ª, Springer, 1999

S. Janson, T. Luczak, A. Rucinski, Random Graphs, , Wiley, 2000.

R. Meester and R. Roy, Continuum Percolation, , Cambridge University Press, 1996

Recommendations

IDENTIFYING DATA				
(*)Prácticas en Empresas I				
Subject	(*)Prácticas en Empresas I			
Code	V05M145V01324			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language	Spanish			
Department				
Coordinator	Marcos Acevedo, Jorge			
Lecturers	Marcos Acevedo, Jorge			
E-mail	acevedo@uvigo.es			
Web				
General description				

Competencies		
Code		Typology
CB2	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.	- Know How
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- know
CG8	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.	- Know How
CG9	CG9 The ability to understand the responsibility and professional ethics of the activity of the profession of Telecommunications Engineering.	- Know be
CG10	CG10 The ability to apply principles of economics and human resources and projects management, as well as legislation, regulation and standardization of telecommunications.	- Know How
CG12	CG12 To have skills for lifelong, self-directed and autonomous learning.	- Know be
CG13	CG13 The knowledge, understanding and ability to implement the necessary legislation in the exercise of the profession of Telecommunications Engineering.	- know

Learning outcomes	
Learning outcomes	Competences
Experience in the practice of the profession of ingineering of Telecommunication and his usual functions in some real company environment.	CB2 CB5 CG8 CG9 CG10 CG12 CG13

Contents	
Topic	
Item	The student will realise a stay in the company developing own functions of a/to Engineer/to of Telecommunication.

Planning			
	Class hours	Hours outside the classroom	Total hours
External practises	125	0	125
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies

	Description
External practises	Stay in a company developing functions of an Telecommunication Engineer.

Personalized attention	
	Description
External practises	The student will have a tutor inside the company that will guide him and will supervise in the specific tasks that it will have to develop inside the company; and an academic tutor -professor of the University of Vigo- that will define together with the tutor of the company the general frame of the activity of the student, checking that it adjusts to the profile/quotation studied by the student.

Assessment

	Description	Qualification	Evaluated Competencess
External practises	The evaluation will realise in function of: 1) The memory of activities 2) The evaluation of the company tutor	100	CB2 CB5 CG8 CG9 CG10 CG12 CG13

Other comments and July evaluation

REPORT OF ACTIVITIES: The student must submit a report explaining the activities undertaken during practices, specifying its duration, departments of the company that were conducted, training received (courses, software, etc.), the level of integration within the company and personal relationships.
The report must also include a section of conclusions, containing a reflection on the adequacy of the lessons learned during the university studies to performance practice (negative and positive aspects significant related to the development of practices). It also assessed the inclusion of information on the professional and personal experience with the practices (personal assessment of learning achieved over practices or own contributions and suggestions on the structure and operation of the company visited).
The assessment of memory will be 60% of the final qualification.
COMPANY TUTOR EVALUATION: The company tutor will submit a report assessing aspects with the practices carried out by students: punctuality, attendance, responsibility, teamwork ability and integration in the enterprise, quality of work done, etc.
The assessment of the tutor in the company will be 40% of the final qualification.

Sources of information

The sources of information will be provided by the company advisor (and, where applicable, by the academic advisor) dynamically as they depend on the student activities undertaken in the company host; and may be from technical manuals for operation and maintenance of different technical equipment up even scientific or research is in the R & D departments.

Recommendations

Other comments

It is recommended that the student have the greatest possible number of subjects studied and / or passed.

IDENTIFYING DATA				
(*)Prácticas en Empresa II				
Subject	(*)Prácticas en Empresa II			
Code	V05M145V01325			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language				
Department				
Coordinator	Marcos Acevedo, Jorge			
Lecturers	Marcos Acevedo, Jorge			
E-mail	acevedo@uvigo.es			
Web				
General description				

Competencies		
Code		Typology
CB2	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.	- Know How
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- know
CG8	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.	- Know How
CG9	CG9 The ability to understand the responsibility and professional ethics of the activity of the profession of Telecommunications Engineering.	- Know be
CG10	CG10 The ability to apply principles of economics and human resources and projects management, as well as legislation, regulation and standardization of telecommunications.	- Know How
CG12	CG12 To have skills for lifelong, self-directed and autonomous learning.	- Know be
CG13	CG13 The knowledge, understanding and ability to implement the necessary legislation in the exercise of the profession of Telecommunications Engineering.	- know

Learning outcomes	
Learning outcomes	Competences
Experience in the practice of the profession of ingineering of Telecommunication and his usual functions in some real company environment.	CB2 CB5 CG8 CG9 CG10 CG12 CG13

Contents	
Topic	
(*)Tema	(*)O alumno realizará unha estancia na empresa desenvolvendo funcións propias dun/a Enxeñeiro/a de Telecomunicación.

Planning			
	Class hours	Hours outside the classroom	Total hours
External practises	125	0	125
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies

	Description
External practises	Stay in a company developing functions of an Telecommunication Engineer.

Personalized attention	
	Description
External practises	The student will have a tutor inside the company that will guide him and will supervise in the specific tasks that it will have to develop inside the company; and an academic tutor -professor of the University of Vigothat will define together with the tutor of the company the general frame of the activity of the student, checking that it adjusts to the profile/quotation studied by the student.

Assessment

	Description	Qualification	Evaluated Competencess
External practises	(*)Prácticas externas La evaluación se realizará en función de: 1) La memoria de actividades 2) La evaluación del tutor en la empresa	100	CB2 CB5 CG8 CG9 CG10 CG12 CG13

Other comments and July evaluation

REPORT OF ACTIVITIES: The student must submit a report explaining the activities undertaken during practices, specifying its duration, departments of the company that were conducted, training received (courses, software, etc.), thelevel of integration within the company and personal relationships.
The report must also include a section of conclusions, containing a reflection on the adequacy of the lessons learned during the university studies to performance practice (negative and positive aspects significant related to the development of practices). It also assessed the inclusion of information on the professional and personal experience with the practices (personal assessment of learning achieved over practices or own contributions and suggestions on the structure and operation of the company visited).
The assessment of memory will be 60% of the final qualification.
COMPANY TUTOR EVALUATION: The company tutor will submit a report assessing aspects with the practices carried out by students: punctuality, attendance, responsibility, teamwork ability and integration in the enterprise, quality of work done, etc.
The assessment of the tutor in the company will be 40% of the final qualification.

Sources of information

The sources of information will be provided by the company advisor (and, where applicable, by the academic advisor) dynamically as they depend on the student activities undertaken in the company host; and may be from technical manuals for operation and maintenance of different technical equipment up even scientific or research is in the R & D departments.

Recommendations

Other comments

It is recommended that the student have the greatest possible number of subjects studied and / or passed.

IDENTIFYING DATA				
(*)Prácticas en Empresas III				
Subject	(*)Prácticas en Empresas III			
Code	V05M145V01326			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	5	Optional	2nd	1st
Language				
Department				
Coordinator	Marcos Acevedo, Jorge			
Lecturers	Marcos Acevedo, Jorge			
E-mail	acevedo@uvigo.es			
Web				
General description				

Competencies		
Code		Typology
CB2	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.	- Know How
CB5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way	- know
CG8	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.	- Know How
CG9	CG9 The ability to understand the responsibility and professional ethics of the activity of the profession of Telecommunications Engineering.	- Know be
CG10	CG10 The ability to apply principles of economics and human resources and projects management, as well as legislation, regulation and standardization of telecommunications.	- Know How
CG12	CG12 To have skills for lifelong, self-directed and autonomous learning.	- Know be
CG13	CG13 The knowledge, understanding and ability to implement the necessary legislation in the exercise of the profession of Telecommunications Engineering.	- know

Learning outcomes	
Learning outcomes	Competences
Experience in the practice of the profession of ingineering of Telecommunication and his usual functions in some real company environment.	CB2 CB5 CG8 CG9 CG10 CG12 CG13

Contents	
Topic	
(*)Tema	(*)O alumno realizará unha estancia na empresa desenvolvendo funcións propias dun/a Enxeñeiro/a de Telecomunicación.

Planning			
	Class hours	Hours outside the classroom	Total hours
External practises	125	0	125
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies

	Description
External practises	Stay in a company developing functions of an Telecommunication Engineer.

Personalized attention	
	Description
External practises	The student will have a tutor inside the company that will guide him and will supervise in the specific tasks that it will have to develop inside the company; and an academic tutor -professor of the University of Vigo that will define together with the tutor of the company the general frame of the activity of the student, checking that it adjusts to the profile/quotation studied by the student.

Assessment

	Description	Qualification	Evaluated Competencess
External practises	(*)Prácticas externas Prácticas externas La evaluación se realizará en función de: 1) La memoria de actividades 2) La evaluación del tutor en la empresa	100	CB2 CB5 CG8 CG9 CG10 CG12 CG13

Other comments and July evaluation

REPORT OF ACTIVITIES: The student must submit a report explaining the activities undertaken during practices, specifying its duration, departments of the company that were conducted, training received (courses, software, etc.), the level of integration within the company and personal relationships.
The report must also include a section of conclusions, containing a reflection on the adequacy of the lessons learned during the university studies to performance practice (negative and positive aspects significant related to the development of practices). It also assessed the inclusion of information on the professional and personal experience with the practices (personal assessment of learning achieved over practices or own contributions and suggestions on the structure and operation of the company visited).
The assessment of memory will be 60% of the final qualification.
COMPANY TUTOR EVALUATION: The company tutor will submit a report assessing aspects with the practices carried out by students: punctuality, attendance, responsibility, teamwork ability and integration in the enterprise, quality of work done, etc.
The assessment of the tutor in the company will be 40% of the final qualification.

Sources of information

The sources of information will be provided by the company advisor (and, where applicable, by the academic advisor) dynamically as they depend on the student activities undertaken in the company host; and may be from technical manuals for operation and maintenance of different technical equipment up even scientific or research is in the R &D departments.

Recommendations

Other comments

It is recommended that the student have the greatest possible number of subjects studied and / or passed.

IDENTIFYING DATA				
The Final Master Degree Work				
Subject	The Final Master Degree Work			
Code	V05M145V01401			
Study programme	(*)Máster Universitario en Enxeñaría de Telecomunicación			
Descriptors	ECTS Credits	Type	Year	Quadmester
	30	Mandatory	2nd	1st
Language	Spanish English			
Department				
Coordinator	Fernández Veiga, Manuel			
Lecturers	Fernández Veiga, Manuel			
E-mail	mveiga@det.uvigo.es			
Web	http://faiticuvigo.es			
General description	The Master Thesis (TFM) forms part, like module, of the plan of studies of the title of Master in Engineering of Telecommunication. It is an original and personal work that each student realises of autonomous form under educational permission, and has to allow him show of form integrated the acquisition of the formative contents and the competitions associated to the title. His definition and contents are explained of form more extensive in the rule for the realisation of the TFM, whose content can consult in the web of the School of Telecommunication Engineering.			

Competencies		
Code		Typology
CB1	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.	- know
CG1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.	- Know How
CG5	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.	- Know How
CG8	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.	- Know How
CG11	CG11 The ability to communicate (oral and written) conclusions, and the knowledge and reasons holding them, to specialists and non-specialists in a clear and unambiguous way.	- Know How - Know be
CG12	CG12 To have skills for lifelong, self-directed and autonomous learning.	- Know How - Know be
CE17	CE17/TFM Embodiment, presentation and defense, once all credits of the curriculum are passed, of an original exercise performed individually in front of a university jury, consisting of a comprehensive project of Telecommunication Engineering with professional nature, in which skills acquired in the teachings are synthesized.	- Know How

Learning outcomes	
Learning outcomes	Competences
Research, *ordenación and structuring of information on some subject related with the Engineering of Telecommunication	CB1 CG8 CG12
Preparation by heart of project in which they collect : antecedents, problematic or state of the art, aims, phases of the project, development of the project, conclusions and future lines.	CG1 CG8 CG11 CE17
Design of prototypes, computer programs, circuits, procedures, etc, according to specifications	CB1 CG1 CG5 CG8 CG12

Contents	
Topic	
The contents of the *TFM define in the individual proposals offered by the professors tutors, according to the willing rule by the Academic Commission of *Máster, whose content can consult through the web of the School of Engineering of Telecommunication.	The subject of each work is specific, given the individual character of the work.

Planning			
	Class hours	Hours outside the classroom	Total hours
Previous studies / activities	0	60	60
Case studies / analysis of situations	0	20	20
Others	10	0	10
Projects	0	630	630
Troubleshooting and / or exercises	0	30	30
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Previous studies / activities	Research, reading and work of documentation, proposals of resolution of problems and/or exercises that will realise in the classroom or the laboratory of autonomous form by the *alumnado.
Case studies / analysis of situations	It carries out a critical analysis of similar problems to the posed in the *TFM, with the end to extract ideas, *analogías, methods or partial results that help in the resolution of the problem posed in the *TFM.
Others	The student receives personalised attention of his tutor about the general approach, the definition of aims and the plan of development of his *TFM, as well as orientation more specific and explanations *sonde the particular technical problems that involves.
Projects	The student, of individual way, resolves a scientific problem-technical of interest, of original and notable form, on the thematic specific assigned, and is able to draft a memory written with the hypotheses, the solution and the conclusions reasoned of his work.
Troubleshooting and / or exercises	The student studies the possible solutions to a scientific problem-technical proposed for his *TFM, and elaborates a solution of synthesis (analytical, meteorological, experimental or combined) that allow him reach the aims that had foreseen.

Personalized attention	
	Description
Others	Each tutor will devote a time to attend personally to each one of the students of *TFM to his charge, to orient his work and guide the process of learning, as well as to review and correct the memory and the oral presentation.

Assessment			
	Description	Qualification	Evaluated Competencess
Projects	The evaluation will do by means of the presentation and defence in front of a Court of the individual work realised by the student under the *tutoría of a professor of the degree, or a professor or extraneous engineer to the University, represented by a professor of the degree. In the evaluation, the Court will be able to take into account the opinions or the report reasoned of the professor tutor, as well as appearances like the quality of the presentation, the review of the state of the art, the quality of the technical proposal, the novelty and importance of the results, the capacity of initiative of the student, etc. System of qualifications: it will express by means of numerical final qualification of 0 to 10 according to the valid legislation.	100	CB1 CG1 CG5 CG8 CG11 CG12 CE17

Other comments and July evaluation

All the information related with the *TFM can consult in the web of the School of Engineering of Telecommunication.

Sources of information

Recommendations