(*)Escola de Enxeñaría de Telecomunicación

(*)Páxina web

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www.teleco.uvigo.es

(*)Presentación

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A Escola Enxeñaría de Telecomunicación oferta para o curso académico 2017-18 un grao e dous másteres totalmente adaptados ao Espacio Europeo de Educación Superior, verificados pola ANECA axustándose á Orde Ministerial CIN/352/2009. A continuación indicanse os enlaces de acceso aos dípticos informativos dos tres títulos.

Grao en Enxeñaría de Tecnoloxías de Telecomunicación

http://teleco.uvigo.es/images/stories/documentos/gett/diptico-uvigo-eet-grao-gal.pdf

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

Máster en Enxeñaría de Telecomunicación

http://teleco.uvigo.es/images/stories/documentos/met/diptico-uvigo-eet-master-gal.pdf

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

Máster Interuniversitario en Matemática Industrial

http://teleco.uvigo.es/images/stories/documentos/promocion/M2i_Presentacion.pdf

www: http://m2i.es

(*)Equipo directivo

(*)

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COORDINACIÓN DO MESTRADO INTERUNIVERSITARIO EN MATEMÁTICA INDUSTRIAL

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

Degree in Telecommunications Technologies Engineering

Subjects

Year 1st

Code	Name	Quadmester	Total Cr.
V05G300V01101	Empresa: Fundamentos de empresa	1st	6
V05G300V01102	Física: Fundamentos de mecánica e termodinámica	1st	6
V05G300V01103	Informática: Arquitectura de ordenadores	1st	6
V05G300V01104	Matemáticas: Álxebra lineal	1st	6
V05G300V01105	Matemáticas: Cálculo I	1st	6
V05G300V01201	Física: Análise de circuítos lineais	2nd	6
V05G300V01202	Física: Campos e ondas	2nd	6
V05G300V01203	Matemáticas: Cálculo II	2nd	6
V05G300V01204	Matemáticas: Probabilidade e estatística	2nd	6
V05G300V01205	Programación I	2nd	6

Year 2nd

Code	Name	Quadmester	Total Cr.
V05G300V01301	Comunicación de datos	1st	6
V05G300V01302	Programación II	1st	6
V05G300V01303	Transmisión electromagnética	1st	6
V05G300V01304	Procesado dixital de sinais	1st	6
V05G300V01305	Física: Fundamentos de electrónica	1st	6
V05G300V01401	Tecnoloxía electrónica	2nd	6
V05G300V01402	Electrónica dixital	2nd	6

V05G300V01403	Redes de ordenadores	2nd	6
V05G300V01404	Técnicas de transmisión e recepción de sinais	2nd	6
V05G300V01405	Fundamentos de son e imaxe	2nd	6

Year 3rd

Code	Name	Quadmester	Total Cr.
V05G300V01501	Servizos de internet	1st	6
V05G300V01502	Circuítos electrónicos programables	1st	6
V05G300V01511	Circuítos de radiofrecuencia	1st	6
V05G300V01512	Sistemas de comunicacións por radio	1st	6
V05G300V01513	Tratamento de sinais multimedia	1st	6
V05G300V01521	Sistemas de adquisición de datos	2nd	6
V05G300V01522	Sistemas electrónicos de procesado de sinal	1st	6
V05G300V01523	Enxeñaría de equipos electrónicos	1st	6
V05G300V01531	Fundamentos de enxeñaría acústica	1st	6
V05G300V01532	Sistemas de audio	1st	6
V05G300V01533	Vídeo e televisión	1st	6
V05G300V01541	Sistemas operativos	1st	6
V05G300V01542	Arquitectura e tecnoloxía de redes	1st	6
V05G300V01543	Seguridade	1st	6
V05G300V01611	Circuítos de microondas	2nd	6
V05G300V01613	Principios de comunicacións dixitais	2nd	6
V05G300V01614	Infraestruturas ópticas de telecomunicación	2nd	6
V05G300V01615	Redes e sistemas sen fíos	2nd	6
V05G300V01616	Xestión do espectro radioeléctrico	2nd	6
V05G300V01621	Instrumentación electrónica e sensores	2nd	6
V05G300V01622	Deseño microelectrónico	2nd	6
V05G300V01623	Sistemas electrónicos para comunicacións dixitais	2nd	6
V05G300V01624	Electrónica analóxica	1st	6
V05G300V01625	Electrónica de potencia	2nd	6
V05G300V01631	Tecnoloxía audiovisual	2nd	6
V05G300V01632	Fundamentos de procesado de imaxe	2nd	6
V05G300V01633	Sistemas de imaxe	2nd	6
V05G300V01634	Procesado de son	2nd	6
V05G300V01635	Acústica arquitectónica	2nd	6
V05G300V01641	Programación concorrente e distribuída	2nd	6
V05G300V01642	Teoría de redes e conmutación	2nd	6
V05G300V01643	Redes multimedia	2nd	6
V05G300V01644	Sistemas de información	2nd	6
V05G300V01645	Arquitecturas e servizos telemáticos	2nd	6

Year 4th

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

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

IDENTIFYING DATA				
Business: Company Fundamentals				
Subject	Business: Company Fundamentals			
Code	V05G300V01101			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Mandado Vazquez, Alfonso			
Lecturers	Gil Pereiras, María del Carmen González-Portela Garrido, Alicia Trinidad Mandado Vazquez, Alfonso Pérez Pereira, Santos Rodríguez de la Fuente, Marta Suárez Porto, Vanessa María			
E-mail	amandado@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject has like objective give to know the organisation, management and institutional frame of the company.			

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How - Know be
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.	- know - Know How
CE5	CE5/FB5: The necessary knowledge of business concepts, of law and institutional frameworks. business organization and management .	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know - Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Manage the requirements and the products of team to reduce the time of realisation of the projects, and improve the coherence and the precision in the business surroundings.	CG8 CE5
Propose the solutions of improvement and control the set up.	CG4 CT2
Establish the guidelines on the metric and indicators that will be used to allow to the Direction of the company the evaluation and the follow-up of the computer systems	CG4 CT2

Contents	
Topic	
SUBJECT 0: INTRODUCTION	0.1 Glossary of financial terms.
Subject 1: THE *ECONOMIA OF THE COMPANY	1.1 The concept of company. 1.2 The aims of the company. 1.3 The company like system. 1.4 Forms and classes of companies. 1.5 Company and surroundings. 1.6 Surroundings Technologies of Information and Communication.

Subject 2: THE FINANCIAL SYSTEM	2.1. Introduction to the financial system. 2.2. Interest and Discount. 2.3. Incomes. 2.4. Basic operations of passive. 2.5. Basic operations of active. 2.6. Financial products.
Subject 3: THE SYSTEM OF FINANCE	3.1 The financial function. 3.2 The investment in the company. 3.3 Sources of finance of the company.
Subject 4: THE SYSTEM OF PRODUCTION I: GENERAL APPEARANCES	4.1 Investigation, development and technological innovation. 4.2 Function of production. 4.3 Classification of the productive processes. 4.4 The economic programming of the production. 4.5. The productivity: indicators of productivity.
Subject 5: THE SYSTEM OF PRODUCTION II	5.1 The costs of production. 5.2 Capacity of production and location. 5.3 Control of inventories.
Subject 6: THE SYSTEM OF COMMERCIALISATION	6.1 The market. 6.2 The competition. 6.3 The system of commercialisation. 6.4 Marketing-*mix.
Subject 7: THE SYSTEM OF ADMINISTRACION	7.1. The system of direction. 7.2. Human resources. 7.3. The model of prevention of penal risks and the compliance officer.
PRACTICES OF THE MATTER	Practice 1: Typology and nature of the company. Practice 2: Business Surroundings. Practice 3: economic Structure-financial (I). Practice 4: economic Structure-financial (II). Practice 5: economic Structure-financial (III). Practice 6: Analysis of results. Practice 7: Investment I. Practice 8: Investment II. Practice 9: Productivity. Practice 10: Costs of production. Practice 11: Threshold of profitability or Deadlock. Practice 12: business Responsibility. Ethical in the businesses. Practice 13: business Diagnostic.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	28	56	84
Laboratory practises	26	38	64
Multiple choice tests	0	0	0
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	Lesson magistral with material of support and audiovisual means.Realise an exhibition of the main contents of the matter so that the almno can understand the scope of the same and facilitate his understanding. Through this methodology the competencies CG8, CE5, CT2 are developed.
Laboratory practises	Development and resolution of practical cases by means of the use of suitable computer tools for the contents of the matter. The tools to use are inside the available software by the University or will be of free character. Through this methodology the competencies the CG4, CG8, CE5 are developed.

Personalized attention	
Methodologies	Description

Master Session	In the sessions the professor will attend, will orient and will resolve the doubts to the students on the contents tackled in the theoretical classes. The students will have occasion to attend to the tutorías personalised in the dispatch of the professor in the schedule that the professors will establish to such effect in the principle of the course and that will publish. These tutorías are allocated to resolve the doubts and orient to the students on the development of the contents tackled in the theoretical classes, and in the practical classes. Likewise, also it will keep a constant communication between the educational and the alumnado through the Network by means of the platform Fear in Faitic.
Laboratory practises	In the classes of laboratory, the professor will guide and will assist to the students that will work in the classroom resolving cases and questions.

Assessment

	Description	Qualification	Evaluated Competencess
Long answer tests and development	Final proof that can contain partial or totally the contents of the matter developed in the classes of theory and of practices, in base to the results given in the different proofs done during the course. The number of proofs along the cuatrimestre will be of 5 and to be able to approve the asignatura have to approve all, those that do not surpass will go with them to the examination of May or June. The final note will be the average of all. Those that do not present to all, indispensable condition to approve by partial will go to the final examination with all the matter.	100	CG4 CG8 CE5 CT2

Other comments and July evaluation

Will offer two systems of evaluation: evaluation by partial and evaluation at the end of the cuatrimestre. In any one of the two systems of evaluation all the competitions of the matter remain evaluated.
1. Evaluation by partial: The evaluation by partial will consist of a group of proofs scheduled and developed along the course, and that will complete with an examination at the end of the cuatrimestre that will cover total or partially the asignatura (those that have approved the partial and they have presented to all will not have to go with them at the end). The students have right to review his proofs of continuous Evaluation. The proofs will consist in five examinations (subjects 0 and 1, subject 2, subject 3, subjects 4 and 5 and subjects 6 and 7) that will effect when finishing each group of subjects. Each one of them versará on the contents seen until the moment of realisation of the proof, so much in classes of theory as of practices, is by this that all the proofs will have the same weight. Likewise to be able to approve the asignatura, will have to assist to 9 of the 13 planned practices, as well as the resolve and send to each professor the resolution of the same. Himself The student has surpassed all the proofs (that is to say obtains like minimum qualification a 5), will remain exento of the realisation of the examination at the end of the cuatrimestre. The qualification that obtains the student in this case will be the half note ponderada of the scored, in case that it remain him any will present at the end and will save them the notes of the proofs approved, doing half with them for the final note. The student has right to know the qualification obtained in each task and his back review in a reasonable term after his realisation. Likewise, these tasks are not recoverable, that is to say, if a student can not realise them in the day stipulated the professor does not have the duty to repeat them. The qualification obtained in the tasks evaluables will be valid so only for the academic course in which they realise , being his final note the average of all the approved.
2. Students that do not opt by evaluation by partial. To the students that do not opt by the evaluation by partial will offer them a procedure of evaluation that allow them reach the maximum qualification. This procedure will consist in a final examination that include the contents developed in the classes of theory and of practices.
3. On the announcement of recovery for the announcement of recovery: If it has done the diverse examinations: it will have to examine of which has not surpassed, saving the note, in the supposition of have not approved all, until the extraordinary announcement of June/July, in which it will examine of the no approved only if it has not done them: it will have a final proof of all the asignatura. In both cases will have to have realised the practices that program along the course do or no the partial proofs, assisting to them.
4. Qualification of No Presented: A student will consider no presented if, did not participate in the final proof, except which have approved all the partial. In any another case, the student will consider presented and will receive his corresponding note.

All students who are not yet passed all the partial, have been submitted to all throughout the course, their mean mark is over 5.0, and not presented for the final exam will take note: 4,0.

Sources of information
Basic Bibliography
Bueno Campos, E., Curso básico de economía de la empresa, 2004, Pirámide
Fernández Sánchez, E. y otros, Iniciación a los negocios para ingenieros. Aspectos funcionales, 2008, Paraninfo
Complementary Bibliography
Pérez Gorostegui, E., Curso de introducción a la economía de la empresa, 2009, Editorial Universitaria Ramón Areces
Suárez Suárez, A., Curso de economía de la empresa, 2001, Pirámide

Recommendations

IDENTIFYING DATA				
Physics: Fundamentals of Mechanics and Thermodynamics				
Subject	Physics: Fundamentals of Mechanics and Thermodynamics			
Code	V05G300V01102			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Chiussi , Stefano			
Lecturers	Boutinguiza Larosi, Mohamed Chiussi , Stefano Fernández Doval, Ángel Manuel			
E-mail	schiussi@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Introduction to the basic concepts on the general laws of Mechanics and Thermodynamics as well as to their application to the resolution of problems in engineering.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.	- Know How
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- Know How
CE3	CE3/FB3: Comprehension and command of basic concepts about the general laws of mechanics, thermodynamics, electromagnetic fields and waves and electromagnetism and their application to solve Engineering problems.	- know - Know How
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know

Learning outcomes	
Learning outcomes	Competences
Understanding and mastering of the basic concepts on the general laws of Mechanics and Thermodynamics.	CG3 CE3
Ability to use the basic instrumentation to measure physical quantities.	CG3 CG5 CG6 CE3 CT3
Ability to evaluate experimental data.	CG3 CG5 CE3
Ability to solve the elementary technical problems in engineering.	CG3 CE3

Contents
Topic
1.- Physical quantities and units. The International System.
2.- Vectorial tools for Mechanics.

3.- Point Kinematics.
4.- Point Kinetics.
5.- Statics.
6.- Oscillations.
7.- Wave motion.
8.- Zero principle of Thermodynamics. Temperature.
9.- First principle of Thermodynamics.
10.- Second principle of Thermodynamics.
Lab 1.- Measurement instruments. Error and uncertainty. Estimation of uncertainties in direct measurements.
Lab 2.- Measurement of the reaction time to a given stimulus. Measurement of the gravitational acceleration by means of a pendulum. Estimation of uncertainty in indirect measurements.
Lab 3.- Verification of Hooke's Law. Linear fit.
Lab 4.- Longitudinal and transversal standing waves. Measurements by linearization of non-linear relations and linear fit. Graphical representation of measurement results.
Lab 5.- Simple harmonic motion. Free standing oscillation of a spring. Measurements by linearization of non-linear relations and linear fit. Graphical representation of measurement results.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	22	22	44
Case studies / analysis of situations	6	12	18
Troubleshooting and / or exercises	15.5	46.5	62
Laboratory practises	9	13.5	22.5
Multiple choice tests	0.5	0	0.5
Short answer tests	1	0	1
Practical tests, real task execution and / or simulated.	2	0	2

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

Methodologies

	Description
Master Session	Prior personal work: -Preliminary reading of the proposed bibliography on the subject. During the lectures: -Presentation of theoretical concepts. -Experimental demonstrations. -Audiovisual presentations. Ulterior personal work: -Revision of theoretical concepts. -Weak-point identification. -Consult the bibliography. Through this methodology, competencies CG3, CE3, CG5, CG6 are worked out.
Case studies / analysis of situations	Application of the theoretical concepts to simple cases and situations. During the lectures: -Solving of examples. Ulterior personal work: -Solving of cases and situations from the bibliography. -Identification of weak points which require tutorial aid. Through this methodology, competencies CG3, CE3, CG5, CG6 are worked out.

Troubleshooting and / or exercises	Solving of average-difficulty problems involving one or more theoretical concepts. During the lectures: -Presentation of solving strategies and techniques by solving example-problems. Personal work: -Solving of problems from the bibliography. -Identification of weak points which require tutorial aid. Through this methodology, competencies CG3, CE3, CG5, CG6 are worked out.
Laboratory practises	Prior personal work: -Preparation of the practical session by studying the corresponding guide and reviewing the theory. During the practical session: -Description of the experiment highlighting which theoretical concepts are involved. -Training on material and instrumentation handling. -Execution of the experiment. -Preliminary result processing. Ulterior personal work: -Processing and analysis of the results. -Weak-point identification. -Consult the bibliography. Through this methodology, competencies CG3, CE3, CG5, CG6 and CT3 are worked out.

Personalized attention

Methodologies	Description
Master Session	Questions will be solved by the lecturers in their respective tutorial-aid time. Tutorial aid will be given: individually or in small groups (typically of two or three students), by appointment to the corresponding lecturer (unless stated otherwise) and, preferably, in the place and timetable of the corresponding lecturer which will be published at the beginning of the semester. The appointment shall be arranged either by e-mail or in person at the beginning or end of a lecture.
Case studies / analysis of situations	Questions will be solved by the lecturers in their respective tutorial-aid time. Tutorial aid will be given: individually or in small groups (typically of two or three students), by appointment to the corresponding lecturer (unless stated otherwise) and, preferably, in the place and timetable of the corresponding lecturer which will be published at the beginning of the semester. The appointment shall be arranged either by e-mail or in person at the beginning or end of a lecture.
Troubleshooting and / or exercises	Questions will be solved by the lecturers in their respective tutorial-aid time. Tutorial aid will be given: individually or in small groups (typically of two or three students), by appointment to the corresponding lecturer (unless stated otherwise) and, preferably, in the place and timetable of the corresponding lecturer which will be published at the beginning of the semester. The appointment shall be arranged either by e-mail or in person at the beginning or end of a lecture.
Laboratory practises	Questions will be solved by the lecturers in their respective tutorial-aid time. Tutorial aid will be given: individually or in small groups (typically of two or three students), by appointment to the corresponding lecturer (unless stated otherwise) and, preferably, in the place and timetable of the corresponding lecturer which will be published at the beginning of the semester. The appointment shall be arranged either by e-mail or in person at the beginning or end of a lecture.

Assessment

	Description	Qualification	Evaluated Competencess
Multiple choice tests	Multiple-choice questions about theoretical concepts. Solving of elementary cases and situations related to the topics in both the classroom and laboratory syllabi.	25	CG3 CG5 CG6 CE3
Short answer tests	Short answer questions about theoretical concepts. Solving of elementary cases and situations related to the topics in both the classroom and laboratory syllabi.	25	CG3 CG5 CG6 CE3
Practical tests, real task execution and / or simulated.	Practical tests: Solving of problems involving one or more theoretical topics. Execution of real and simulated measurements. Real- and simulated-measurement result processing.	50	CG3 CG5 CG6 CE3

Other comments and July evaluation

(This is a translation, in case of any discrepancy or dispute, the original Spanish version shall prevail.)

Following the particular guidelines of this degree, the students taking this subject will be offered two alternative assessment systems: continuous assessment and single end-of-semester assessment.

It will be assumed that a student chooses continuous assessment if he or she takes and hands the third assessment exercise in (see below) and that he or she chooses single end-of-semester assessment if he or she does not hand the aforementioned exercise in. Once the results of this exercise are handed in, it will be understood that the student has taken the current term's examination call and he or she will be qualified according to the following criterion, regardless of whether he or she takes the final test or not.

1) CONTINUOUS ASSESSMENT

Continuous assessment consists of the exercises detailed below in this guide which are not retakeable, i.e, if a student is not able to take them in the scheduled date the teaching staff will not be required to repeat them.

As a general rule, the marks of each exercise will be published before the next one. The marked exercises may be revised, during the tutorial-aid hours of the corresponding lecturer , along the fourteen days following the publication date of the marks.

The marks obtained in the tests will be only valid for the academic term they have been obtained.

First assessment exercise:

a1) Experimental laboratory exercise comprising the execution of actual measurements and the processing of the results, consisting in taking the experimental laboratory class number 3, individually processing (during the last 30 minutes) the assessable results specified in the corresponding experiment guide and handing them in at the end of the class (mark: between 0 and 1 point).

Second assessment exercise:

b1) Combined test with multiple-choice and short-answer questions and exercises. Questions about theoretical concepts. Solving of elementary cases and situations related to the topics in the classroom syllabus (mark: between 0 and 1 point).

Length: 30 minutes during one of the theory or problem-solving lectures. Its date will appear in the assessment test schedule that the Academic Board of the Degree will approve.

Third assessment exercise:

c1) Experimental laboratory exercise comprising the execution of actual measurements and the processing of the results, consisting in taking the experimental laboratory class number 5, individually processing (during the last 30 minutes) the assessable results specified in the corresponding experiment guide and handing them in at the end of the class (mark: between 0 and 1 point).

Fourth exercise, continuous assessment final test:

Combined test with:

d1) questions and exercises, multiple-choice and short-answer questions, (mark: between 0 and 5 points distributed among them)

e1) solving of one or two problems, (mark: between 0 and 3.4 points distributed between them)

f1) solving of a problem comprising the execution of real or simulated measurements and the processing of the results (mark: between 0 and 1.6 points).

Length: 2 hours in the subject's official examination date.

Overall mark calculation.

g1) will be calculated as the sum of the marks obtained in blocks b1), d1) and e1) plus the lowest of 2 points and the sum of blocks a1), c1) and f1)

$g1 = b1 + d1 + e1 + \min\{ 2 , a1 + c1 + f1 \}$

The overall mark will be the lowest of 10 points or g1) overall mark = min{ 10, g1 }

2) SINGLE END-OF-SEMESTER ASSESSMENT

Final overall test:

Combined test with:

d2) questions and exercises, multiple-choice and short-answer questions, (mark: between 0 and 5 points distributed among them)

e2) solving of one or two problems, (mark: between 0 and 3.4 points distributed between them)

f2) solving of a problem comprising the execution of real or simulated measurements and the processing of the results (mark: between 0 and 1.6 points).

Length: 2 hours in the subject's official examination date.

Overall mark calculation:

g2) will be calculated as the sum of the marks obtained in blocks d2), e2) and f2)

g2 = d2 + e2 + f2

The overall mark will be g2)

overall mark = g2

3) RESIT

Resit exam:

Combined test with:

d3) questions and exercises, multiple-choice and short-answer questions, (mark: between 0 and 5 points distributed among them)

e3) solving of one or two problems, (mark: between 0 and 3.4 points distributed between them)

f3) solving of a problem comprising the execution of real or simulated measurements and the processing of the results (mark: between 0 and 1.6 points).

Length: 2 hours in the subject's official resit date.

Final mark calculation:

The students who did not pass the subject and attend the resit exam will obtain a mark according to the following criteria:

3A) Students who had chosen continuous assessment

g3A) will be calculated as the sum of the marks obtained in blocks b1), d3) and e3) plus the lowest of 2 points and the sum of blocks a1), c1) and f3)

g3A = b1 + d3 + e3 + min{ 2 , a1 + c1 + f3 }

The overall mark will be the lowest of 10 points or g3A)

overall mark = min{ 10, g3A }

3B) Students who had chosen end-of-semester assessment

g3B) will be calculated as the sum of the marks obtained in blocks d3), e3) and f3)

g3B = d3 + e3 + f3

The overall mark will be g3B)

overall mark = g3B

NOTES:

I) All of the aforesaid calculations will be performed with a resolution equal to or better than one hundredth of a point (0,01 point).

II) The overall marks will be rounded to the nearest multiple of 0,1 point (one tenth of a point); if the two nearest multiples of 0,1 point are equidistant, the overall mark will be rounded to the higher of them.

III) The mark scale is established on the understanding that the minimum overall mark necessary to pass the subject is 5,0 points.

Sources of information

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Recommendations

Subjects that continue the syllabus

Fundamentals of Sound and Image/V05G300V01405
Power Electronics/V05G300V01625
Fundamentals of Acoustics Engineering/V05G300V01531

Subjects that are recommended to be taken simultaneously

Mathematics: Linear algebra/V05G300V01104
Mathematics: Calculus 1/V05G300V01105

Other comments

To adequately follow this subject, it is highly advisable to master the contents of high-school subjects on Mathematics and Physics.

IDENTIFYING DATA				
Informatics: Computer Architecture				
Subject	Informatics: Computer Architecture			
Code	V05G300V01103			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Llamas Nistal, Martín			
Lecturers	Arriba Pérez, Francisco de Llamas Nistal, Martín Mikic Fonte, Fernando Ariel Santos Gago, Juan Manuel			
E-mail	martin@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Computers have become an essential tool. This fact is even more clear while studying the "Bachelor of Engineering in Telecommunications Technology" (Grado en Ingeniería de Tecnologías de Telecomunicación), where computers are not only manipulated from a user's --or specialized user's-- point of view, but also from the engineering perspective, as tools to be designed or to be integrated in more complex systems. Hence, the main motivation for the "Computer Architecture" (Arquitectura de Ordenadores) course is to provide students with an understanding of basic computer operation by studying the lower abstraction levels (over the electronic level). The subject "Computer Architecture" (Arquitectura de Ordenadores) is focused on the conventional machine level, describes the operating machine level and shows an example application for the Symbolic Machine domain through the introduction of the Database Management Systems.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How
CE2	CE2/FB2: The basic knowledge about using and programming computers, operative systems, databases and Engineering applied software.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know - Know How
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know

Learning outcomes	
Learning outcomes	Competences
Knowledges of the main concepts related with the architecture of the computers and capacity for his handle through models.	CG3
Capacity for the handle of the systems of representation of the information used in the computers	CG3
Knowledges of the types of instructions more representative and variations more notable and capacity to determine the implications of his use by part of the programmer of conventional machine	CG3 CG4
Knowledges of the main ways of addressing modes in assembler language and capacity for the efficient handling of these.	CG3 CG4 CE2

Acquisition of skills on the design of algorithms and the construction of programs to level of conventional machine	CG3 CG4 CE2 CT2 CT3
Knowledge of the principles and fundamental components of the operating systems	CG3 CE2 CT3
Understanding of the main functions of the operating systems	CG3 CE2 CT3
Knowledge of the fundamental aspects of the databases.	CG3 CE2 CT3
Understanding of the distinct models of organisation of the information in databases	CG3 CE2 CT3
Acquisition of basic skills on the languages of query to databases	CG3 CG4 CE2 CT2 CT3

Contents	
Topic	
1. PRELIMINARIES	Information Representation in computers. von Neumann Model. Structural, procesal and functional models
2. von Neumann Model	Components of von Neumman machine. Simple Machine: Simplez. Central Processing Unit, Arithmetic and Logic Unit, memries, registries, buses. External Communication, active waiting, Introduction to addressing modes
3. Symbolic Representation and Processing .	Representation of basic data elements: integer, character, floating point. Conventions for data storage. Processing operations. Introduction to simbolic processing. Assembler language
4. Instructions and addressing	Instructions and addressing Software considerations. Registries at the conventional machine level. Lenguage for register transfer (RT level). Instruction format. Addressing modes. Stacks and subprograms. Assembler languages
5. Typical conventional machine	Structural Model. Functional Model. Set of instuctions. Addressing modes, Assembler. Examples of programmes. Algortimez
6. Peripheral management	Types of peripherals. Management of variety. Models. Secondary memories. Interruptions. Service Rutines. ADM: justification.
7. Operating Systems	Operative Machine. Introduction to Operating Systems. Definition of an operating system. Interface operating system.
8. Data Bases	Introduction to Data Bases. Relational Model. Entity-relation model. Query languages. Introduction to SQL

Planning			
	Class hours	Hours outside the classroom	Total hours
Laboratory practises	22	27.5	49.5
Introductory activities	5	5	10
Troubleshooting and / or exercises	10	17.5	27.5
Master Session	12	24	36
Self-assessment tests	0	3	3
Practical tests, real task execution and / or simulated.	4	8	12
Short answer tests	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

Laboratory practises	The course includes programming practices that will performed using a simple computer (SIMPLEZ) and a regular computer (ALGORITMEZ). Through this methodology the competencies CG3, CG4, CT2, CT3 and CE2 are developed.
Introductory activities	Presentation of the course contents, methodology, office hours, evaluation, usage of the labs, and any other issue related to the subject. Through this methodology the competences CG3 and CT3 are developed.
Troubleshooting and / or exercises	Programming, information representation, and other problems and exercises will be solved during the classes. Some must be solved by students previously at home, and they will participate actively in the solution of some other problems. Through this methodology the competencies CG, CT2 and CE2 are developed.
Master Session	Theoretical concepts and their practical application will be introduced during the classes. Students will be encouraged to participate by alternating lectures with problem and exercise solving. Therefore, sessions will include lectures and time for exercises and problems. Through this methodology the competencies CG3, CT3 and CE2 are developed.

Personalized attention

Methodologies	Description
Master Session	Students will have the chance to attend tutorial sessions at the teacher´s office. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.
Laboratory practises	Students will have the chance to attend tutorial sessions at the teacher´s office. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.
Troubleshooting and / or exercises	Students will have the chance to attend tutorial sessions at the teacher´s office. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.

Assessment

	Description	Qualification	Evaluated Competencess
Self-assessment tests	Exam questions will be available for students, in order to perform autoevaluation.	0	CG3 CG4 CE2
Practical tests, real task execution and / or simulated.	They will realise three practical exercises in the laboratory of continuous evaluation, and other three short exercises in each turn of laboratory.	50	CG3 CG4 CE2
Short answer tests	They will realise in theory roughly 12 exercises of continuous evaluation, divided in two parts.	50	CG3 CG4 CE2

Other comments and July evaluation

ASSESSMENT

This subject is organized in two parts: Theory and Practice.

We consider the harmonic average of A and B as HA(A,B)=2*A*B/(A+B). If A=B=0 then HA(A,B)=0

And the Arithmetic Average of A and B as AA(A,B)=(A+B)/2

We use the Mixed Average MA(A,B) in order to obtain scores in two different assessment parts (A and B):

if A >= 5 and B >=5 then MA (A,B) =AA(A, B)

else {

if HA(A,B) > 3 then MA(A,B) = HA (A,B)

else MA (A,B) = AA(A,B), max. 3 (i.e. if AA(A,B)>3 then MA(A,B)=3)

}

MA(A,B) is the arithmetic average if A and B are greater or equal to 5. Otherwise, MA(A,B) is the harmonic average. Besides, If the harmonic average is less than 3 then we apply the arithmetic average with a maximum possible score of 3.

The final grade for the course (FG) is as follows, according to theory grade (TG) and Practice Grade (PG): FG = MA(TG, PG)

To pass the course, FG must be greater than or equal than 5.

Both parts can be evaluated by Continuous Evaluation (CE) or by Final Exam (FE).

The FE will consist of Theory and Practice, and will take place in date and time officially established.

CE will consist of the tasks described in this guide, and are not recoverable, i.e., if a student cannot follow them during the stipulated period the teacher does not have the obligation of repeating them.

If one of the subject parts (Theory or Practice) is passed in the final semester examinations, its grade will be kept for the remedial exams where the student only must be evaluated of the other part. If the student has followed CE in part that remains, he/she will keep the grades.

The CE tasks grades are only valid for the current academic course, being discarded in case the student fails the course.

THEORY

The Theory part is divided into two subparts: T1 and T2. T1 covers approximately 66% of the syllabus (up to theme 5 included), while T2 the 100% of the syllabus.

The Theory uses the Blended Flipped Classroom (BFC) method. In a week, one hour class takes place outside the classroom watching videos, and the other hour in the classroom answering questions, solving exercises and assessing.

*CONTINUOUS EVALUATION (CE):

In CE, the student needs to do short exercises (around 10 or 15 minutes) during the weekly class time. The grade in T1 and T2 is calculated using arithmetic average of the (approximately) 7 and 5 exercises proposed for each part. All of these exercises will take place in the classroom and never during the exam period. If a student does not assist to some of these exercises, this will not be repeated.

The theory CE grade is TG=MA(T1,T2);

If the student does not pass the CE but pass T1 or T2, he/she can attend to the examination of the failed part. In this way, The T1 and T2 grades will be kept for remedial examinations.

*SEMESTER FINAL EXAM

Any student, whether or not has followed the CE, can take the Final Exam. If the student followed the CE, he/she may discard the results obtained there, and take the Final Exam . In this case, the valid grade will be the FE, cancelling the grades that he/she had been obtained previously in the CE.

If the student does not pass the CE but pass T1 or T2, he/she can attend to the examination of the failed part. In this way, the grade obtained in CE is deleted, keeping the grade in the passed CE part. The calculation grade in theory is similar to the CE: TG=MA(T1,T2);

This Final Exam will have two exercises (T1 and T2) to be done in 90 minutes and it has a global subject quiz exam (TEST) to be done in 20 minutes.

The final score is:

TG =0,8*MA(T1, T2) + 0,2*TEST

If CE was not followed, the student will have to do T1, T2 and TEST exercises.

* REMEDIAL EXAMS

The Theory Remedial Exam has the same structure as in the Semester Final Exam.

If CE was not followed, the student will have to do T1, T2 and TEST exercises, regardless of the grades in each exercise in Final Semester Exam.

If CE was followed, the student can do the Semester Final Exam , cancelling the grade that he/she had previously obtained in CE.

If the student does not pass the CE but pass T1 or T2, he/she can attend to the examination of the failed part. In this way, the grade obtained in CE is deleted, keeping the grade in the passed CE part. The calculation grade in theory is similar to the AC: TG=MA(T1,T2);

PRACTICE

*CONTINUOUS EVALUATION:

The CE of Practice consists of 3 exercises P1, P2 and P3 . P1 will be about Simplez, P2 about Basic Algoritmez (over 60% of the syllabus) and P3 about Full Algoritmez (100% of the syllabus). The exercises will be done in the laboratory and will last approximately 1 hour. P1 will be around the 4th week, P2 around the 8th and P3 at the final exam day (the exam will be different for those who follow CE than for those who decide to go by FE). P1 and P2 will be held in afternoon shifts.

During the laboratory days, short exams are performed (approximately 30 minutes). These exercises will take place in (approximately) 2 (E1), 6 (E2) and 10 (E3) weeks.

The Practice CE grade is the weighted average of these exercises:
PG=0,07*E1+0,15*P1+0,08*E2+0,27*P2+0,09*E3+0,34*P3

*SEMESTER FINAL EXAM

Any student, whether or not has followed the CE, can take the Final Exam. If the student followed the CE, he/she may discard the results obtained there, and take the Final Exam . In this case, the valid grade will be the FE, cancelling the grades that had been obtained previously in the CE.

This Final Exam will have one exercise about Algoritmez to be done in the laboratory in 1 hour (approximately).

In this case, the Practice Grade is the grade of the Final Exam.

* REMEDIAL EXAM

The student will have a Remedial Exam similar to the Semester Final Exam.

GENERAL ISSUES

All exercises and exams of the subject are scaled from 0 to 10

ACTS: Students who have attended any of the CE exercises (both practice and theory) will be considered as presented and their grade will be obtained by applying the corresponding formulas.

EXAMS: To perform any theory exam (CE1, CE2, T1 and T2) or practice (P1, P2, P3 and Final Exam), including remedial exams, all students must register through the corresponding software tool, for which it will be notified with a minimum term of 5 calendar days.

Note: Prior to an exercise or an exam, the date and procedure for the score review will be published sufficiently in advance.

COMMUNICATIONS WITH STUDENTS: All communications of the teaching organization will be done through the informatics tools used in the course (FAITIC, BeA and e-mail). It is understood that all students read their e-mail (e-mail registered in FAITIC) at least once a day.

ETHICAL CODE: All students are expected to have an ethical behaviour in all exams, ensuring equal opportunities for all students. If an infraction is detected in an exam, the score obtained in that test will automatically be zero (0) and a report will be issued to the School Direction to take actions. These are some examples of unethical behaviour: use of electronic devices (mobile phones, tablets, computers, etc.), copy from another peer, use of unauthorized material in an exam, etc.

Sources of information

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Recommendations

IDENTIFYING DATA

Mathematics: Linear algebra

Subject	Mathematics: Linear algebra			
Code	V05G300V01104			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Martín Méndez, Alberto Lucio			
Lecturers	Martín Méndez, Alberto Lucio Prieto Gómez, Cristina			
E-mail	amartin@dma.uvigo.es			
Web	http://faitic.uvigo.es/			
General description	The subject Linear Algebra is taught in the first quadmester of the first course of the Grado en Ingeniería de Tecnologías de Telecomunicación, with the main objective of providing students with a clear understanding of the complex numbers, systems of linear equations and elementary techniques of matrix algebra as well as an introduction to the fundamental concepts of Vector Spaces which will be needed in later subjects. It will be paid special attention to the applications of Linear Algebra.			

Competencies

Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How - Know be
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How - Know be
CE1	CE1/FB1: The ability to solve mathematical problems in Engineering. The aptitude to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, differential and partial differential equations; numerical methods, numerical algorithms, statistics and optimization	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know - Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know - Know be

Learning outcomes

Learning outcomes	Competences
To know of the basic techniques of linear algebra and matrix algebra which are needed in other subjects that should be studied subsequently in the programme.	CG3 CG4 CE1 CT2 CT3
Skill development the basic operations of matrix algebra.	CG3 CG4 CE1 CT2 CT3
Knowledge of numerical methods for solving systems of linear equations and knowledge of the basic concepts involving vector spaces and linear maps.	CG3 CT3
Knowledge of the properties of vector spaces with inner product.	CE1
Skill development some applications of linear algebra: the method of least squares, singular value decomposition and classification of quadratic forms	CG3 CE1 CT3

To know the arithmetic of complex numbers.	CG3 CG4 CE1 CT2 CT3

Contents	
Topic	
Topic 1. Complex numbers.	Operations with complex numbers. Geometric concepts associated with complex numbers. Euler's formula and its consequences.
Topic 2. Matrices, determinants and systems of linear equations	Matrix operations: addition, scalar multiplication and product of matrices. Matrix inverse. LU decomposition. Block matrices. Determinants. Systems of linear equations. The matrix equation Ax=b. Solution set of a system of linear equations. The matrix of a system of linear equations. Elementary row operations and Gauss' method. Numerical methods for the systems of linear equations.
Topic 3. Vector Spaces and Linear transformations	Linear independence. Subspaces. Basis. Dimension. Rank of a system of vectors and rank of a matrix. Introduction to linear transformations. Matrix of a linear transformation. Composition of linear transformations and the product of matrices.
Topic 4. Matrix diagonalization.	Eigenvalues and eigenvectors. Eigenspace. Matrix diagonalization and diagonalizable matrices.
Topic 5. Orthogonallity.	Real Euclidean inner product. Complex Hermitian inner product. Orthogonallity. Gram-Schmidt. Unitary Diagonalization. Singular value decomposition. Matrix rank reduction. The method of least squares. Quadratic forms.

Planning	Class hours	Hours outside the classroom	Total hours
Laboratory practises	2	2	4
Master Session	38	76	114
Troubleshooting and / or exercises	9	9	18
Troubleshooting and / or exercises	5	5	10
Long answer tests and development	2	2	4

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

Methodologies	Description
Laboratory practises	Solving assigned exercises and model problems. Use of the computer tool MATLAB. Through this methodology the competences CG3, CG4, CE1, CT2 and CT3 are developed.
Master Session	Explanation and development by the teacher of the contents of the various topics in the syllabus. Through this methodology the competences CG3, CE1 and CT3 are developed.
Troubleshooting and / or exercises	Resolution by part of the professor of suitable exercises adapted to each topic. The students will also have to take part in the resolution of exercises in order to strengthen their knowledge. Through this methodology the competences CG3, CG4, CE1, CT2 and CT3 are developed.

Personalized attention

Methodologies	Description
Troubleshooting and / or exercises	Personalized tutoring will be available from all the teachers of the subject. They will be held in the respective offices of the teachers unless announced otherwise.
Laboratory practises	Personalized tutoring will be available from all the teachers of the subject. They will be held in the respective offices of the teachers unless announced otherwise.
Master Session	Personalized tutoring will be available from all the teachers of the subject. They will be held in the respective offices of the teachers unless announced otherwise.

Tests	Description
Troubleshooting and / or exercises	Personalized attention will be available for assistance in the revision of tests and exams.

Assessment

	Description	Qualification	Evaluated Competencess
Troubleshooting and / or exercises	Continuous evaluation consists in four short tests to be given in the class hour and also on homework to be turned-in in class. The approximate planning will be the following: Four one hour tests: 1. Test of topic 1 (week 3 approximately). 2. Test of topic 2 and 3 (week 8 approximately). 3. Test of topic 4 (week 11 approximately). 4. Test of topic 5 (week 15 approximately). Each of these tests will have a weight of 10% in the final grade. Homework will have a weight of 10% in the final grade. The total weight of the continuous evaluation in the final grade will therefore be of 50%.	50	CG3 CG4 CE1
Long answer tests and development	A written two-hour exam of topics 1, 2, 3, 4, and 5 at the end of the semester in date, time and venue determined in the official exams calendar of the School.	50	CG3 CG4 CE1

Other comments and July evaluation

Continuous evaluation:

A student chooses to be graded by continuous evaluation when, after knowing his grade in the first test (topic 1), accepts being evaluated by that method. In that case the final grade is calculated by the formula:

$$N = ((E1 + E2 + E3 + E4) + P + 5\ EF) / 10$$

where E1, E2, E3 y E4 are the points, in a scale 0 to 10, obtained in the four test of the continuous evaluation, P represents the total points, in a scale 0 to 10, obtained in the homework and where EF represents the points, in a scale 0 to 10, obtained in the final exam. A passing grade is N greater or equal to 5. Before doing each test, the procedure and date of revising the grading of that test will be announced. After the test, the grades will be announced in a reasonable amout of time. If a student –for any circumstance– cannot attend a particular test on the date for which it is scheduled, he or she will miss that test and it will not be repeated.

The points obtained in the tests of continuous evaluation will be valid only for the academic year in which they are obtained.

End-of-semester evaluation:

The students who do not choose to be graded by continuous evaluation, will be graded by means of a final exam (which will not be necessarily the same as the one for the students who choosed continuous evaluation). This exam will be graded in a scale of 10 points and the passing grade cutoff will be 5.

July evaluation:

The students who at the end of the semester do not obtain a passing grade will have the opprtunity of writing a second final exam on date, time and venue determined in the official exams calendar of the School. This exam will cover topics 1, 2, 3, 4 and 5. On the day of this second final, the students who were graded by continuous evaluation may choose to be graded exclusively by the second final or to be graded taking into account the points obtained in their continuous evaluation by the same formula used earlier, that is:

$$NR = ((E1 + E2 + E3 + E4) + P + 5\ EFR) / 10$$

where now EFR is the grade, in a scale 0 to 10, in the second final. Again, the passing grade cutoff will be 5.

The students who choose to be graded exclusively by the second final will write an exam (which will not be necessarily the same as the one for the students who made the opposite choice) covering topics 1, 2, 3, 4 and 5 which will be graded in a scale of 10 points and the passing grade cutoff will be 5.

The final grade of a student is the maximum of the grade obtaines by continuous evaluation and the mark obtained in the final exam. A passing grade is the one that is greater or equal to 5.

"No presentado":

A student will obtain a cualification of "No Presentado" in the first edition of the final grades if and only if that student did not choose the continuous evaluation and did not attend the final exam.

A student will obtain a cualification of "No Presentado" in the second edition of the final grades if and only if that student obtained "No Presentado" in the first editin and did not attend the second final.

Éthical Behavior:

It is expected a correct and ethical behavior of all students in all written tests and exams, which are meant to truly reflect the knowledge and abilities attained by each studen. Any unethical behavior detected in a particular test (such as copying or using prohibited material) will result in a grading of 0 in that test and the issue of the corresponding report for the School Director's Office.

Sources of information
Basic Bibliography
D. Poole, Álgebra lineal: Una introducción moderna, 2º, Thomson (2007)
L. Merino; E. Santos, Álgebra lineal con métodos elementales, 1ª, Thomson (2006)
J. de Burgos, Álgebra lineal y geometría cartesiana, 2ª, McGraw-Hill (1999)
Complementary Bibliography
D. C. Lay, Álgebra lineal y sus aplicaciones, 3ª, Pearson Education (2007)

Recommendations
Subjects that continue the syllabus
Physics: Analysis of Linear Circuits/V05G300V01201 Physics: Fields and Waves/V05G300V01202 Mathematics: Calculus 2/V05G300V01203 Mathematics: Probability and Statistics/V05G300V01204 Digital Signal Processing/V05G300V01304 Computer Networks/V05G300V01403

Subjects that are recommended to be taken simultaneously
Mathematics: Calculus 1/V05G300V01105

IDENTIFYING DATA				
Mathematics: Calculus 1				
Subject	Mathematics: Calculus 1			
Code	V05G300V01105			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	1st	1st
Teaching language	Spanish			
Department				
Coordinator	Calvo Ruibal, Natividad			
Lecturers	Calvo Ruibal, Natividad Fernández Manin, Generosa González Rodríguez, Ramón			
E-mail	nati@dma.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The aim that pursue with this subject is that the student know the basic technicians of the differential calculation in one and several real variables and his applications. Al term of this subject it expects that the student have achieved the understanding of the basic concepts of the differential calculation in one and several variables, the handle of the usual differential operators of the mathematical physics and of the technicians of differential calculation for the research of extremes, local approximation of functions and numerical resolution of systems of equations. Besides, it will have to know handle some computer program of symbolic calculation and graphic representation.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CE1	CE1/FB1: The ability to solve mathematical problems in Engineering. The aptitude to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, differential and partial differential equations; numerical methods, numerical algorithms, statistics and optimization	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be

Learning outcomes	
Learning outcomes	Competences
Understanding of the basic concepts of the differential calculation in one and several variables.	CG3 CG4 CE1 CT2 CT3
Knowledge and handle of the usual differential operators of the mathematical physics.	CE1
Knowledge and handle of the technicians of differential calculation for the research of extremes, the local approximation of functions and the numerical resolution of systems of equations.	CG4 CE1 CT2
Knowledge of some computer program of symbolic calculation and graphic representation.	CG3 CT3

Contents	
Topic	
Subject 1. Introduction.	Sets of numbers and functions of one variable.
Subject 2. n-dimensional space.	Scalar product, norm. Vectorial product. Polar, cylindrical and spherical coordinates.
Subject 3. Continuity of functions of one variable.	Limit of a function in a point. Lateral limits. Continuity. Theorem of the intermediate value. Theorem of Bolzano. Method of bisection.
Subject 4. Continuity of functions of several variables.	Functions of several variables. Limits. Continuity. Theorem of Bolzano.
Subject 5. Derivation of functions of one variable.	Derivation of a function in a point. Derivative function, derivative successive, properties. Rule of the chain. Implicit derivation. Derivation of reverse functions.
Subject 6. Applications of the derivative.	Maxima and minimum. Theorem of the mean value. Rule of L'Hopital. Local study of the graphic of a function. Taylor polynomial. Method of Newton.
Subject 7. Differential of functions of several variables.	Directional derivatives. Partial derivatives. Jacobian matriz. Rule of the chain. Higher order derivatives. Differential operators.
Subject 8. Applications of the differential calculation.	Extreme values. Extreme values with equality constraints. Method of Newton.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	38	66.5	104.5
Troubleshooting and / or exercises	10	14	24
Laboratory practises	2	1.5	3.5
Troubleshooting and / or exercises	4	8	12
Troubleshooting and / or exercises	2	4	6

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

Methodologies	
	Description
Master Session	The professor will expose the theoretical contents of the matter. Through this methodology the competencies CG3, CE1 and CT3 are developed.
Troubleshooting and / or exercises	The professor will resolve problems and exercises of each one of the subjects and the student will have to resolve similar exercises. Through this methodology the competencies CG3, CG4, CE1, CT2 and CT3 are developed.
Laboratory practises	The students will use computer tools (Maxima and/or Matlab) to resolve exercises and apply the knowledge purchased in the theoretical classes. Through this methodology the competencies CG3, CG4, CE1, CT2 and CT3 are developed.

Personalized attention	
Methodologies	Description
Master Session	The professor will attend personally the doubts and queries of the students in the schedule of tutorías or by means of email.
Troubleshooting and / or exercises	The professor will attend personally the doubts and queries of the students in the schedule of tutorías or by means of email.

Assessment		
Description	Qualification	Evaluated Competencess

Troubleshooting and / or exercises	First session (1 hour): Subject 1. (Aprox. week 4). Second session (1 hour): Subjects 2, 3 and 4. (Aprox. week 8). Third session (1 hour): Subjects 5 and 6. (Aprox. week 11). Fourth session (1 hour): Subject 7. (Aprox. week 14). The four previous sessions add 50% of the total note.	5 17.5 10 17.5 50	CG3 CG4 CE1
Troubleshooting and / or exercises	Final examination on the subjects 7 and 8 of the matter. The punctuation will be 50% of the total note.	50	CG4 CE1

Other comments and July evaluation

1. Continuous evaluation

A student has opted by the continuous evaluation when he delivers to the teacher (before September 22) the sheet of registration in this type of evaluation. It will not be able to change the option of evaluation. If a student cannot attend a particular test on the date for which it is scheduled, he or she will miss that test and it will not be repeated.

In this case, the final qualification for a student is given by the formula:

N = (1/10) x C + (5/10) x E

C: qualification, between 0 and 50, obtained as the sum of the qualifications of the four sessions of an hour.

E: qualification, between 0 and 10, obtained in the final examination on the subjects 7 and 8 of the matter.

In this mode, a student has successfully completed the course when N is greater than or equal to 5. Qualifications obtained in the tests will be valid only for the academic year in which they are realized.

2. Evaluation at the end of the semester

The students who do not choose to be graded by continuous evaluation, will be graded by means of a final exam (subjects: 1, 2, 3, 4, 5, 6, 7, and 8) and which will not be necessarily the same as the one for the students who choosed continuous evaluation. This exam will be graded in a scale of 10 points and the passing grade cutoff will be 5.

3. Second chance

The students who at the end of the semester do not obtain a passing grade will have the opportunity of writing a second final exam on date, time and venue determined in the official exams calendar of the School. On the day of this second final, the students who were graded by continuous evaluation may choose to be graded exclusively by the second final or to be graded taking into account the points obtained in their continuous evaluation by the same formula used earlier, that is:

NR= (1/10) x C + (5/10) x D

C: Note, between 0 and 50, obtained as the sum of the qualifications of the sessions of an hour.

D: Note, between 0 and 10, obtained in an examination on the subjects 7 and 8 of the matter.

In this mode, a student has successfully completed the course when NR is greater than or equal to 5.

The students who choose to be graded exclusively by the second final will write an exam (subjects: 1, 2, 3, 4, 5, 6, 7, and 8) and which will not be necessarily the same as the one for the students who made the opposite choice. This exam will be graded in a scale of 10 points and the passing gradecutoff will be 5.

4. Qualification of '' Not Present''

A student will obtain a qualification of ''Not Present'' if he did not choose the continuous evaluation and he did not attend the final exams.

5. Ethical behaviour

It is expected a correct and ethical behavior of all students in all written tests and exams, which are meant to truly reflect the knowledge and abilities attained by each student. Any unethical behavior detected in a particular test (such as copying or using prohibited material) will result in a grading of 0 in that test and the issue of the corresponding report for the School Director's Office.

Sources of information

Basic Bibliography

J. Stewart, Cálculo de una variable: conceptos y contextos., 4ª edición, Thomson-Learning, 2010

E. Marsden y A.J. Tromba, Cálculo vectorial, 5ª edición, Pearson-Addison Wesley, 2004

Complementary Bibliography

Recommendations

Subjects that continue the syllabus

Physics: Analysis of Linear Circuits/V05G300V01201
Physics: Fields and Waves/V05G300V01202
Mathematics: Calculus 2/V05G300V01203
Mathematics: Probability and Statistics/V05G300V01204
Digital Signal Processing/V05G300V01304
Electromagnetic Transmission/V05G300V01303

Subjects that are recommended to be taken simultaneously

Mathematics: Linear algebra/V05G300V01104

IDENTIFYING DATA				
Physics: Analysis of Linear Circuits				
Subject	Physics: Analysis of Linear Circuits			
Code	V05G300V01201			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	García-Tuñón Blanca, Inés			
Lecturers	Cardenal López, Antonio José García Mateo, Carmen García-Tuñón Blanca, Inés Gómez Araújo, Marta Prol Rodríguez, Miguel			
E-mail	inesgt@com.uvigo.es			
Web	http://www.faitic.uvigo.es			
General description	The course introduces the fundamentals of the lumped circuit principles and abstractions on which the design of electronic systems is based. These include lumped circuit models for sources, resistors, inductors, and capacitors. It intends to present some techniques to analyze (to determine currents and voltages) such systems: conventional analysis (integer-differential analysis, phasors and impedances in sinusoidal regime) and linear systems theory based analysis (by using the Laplace and Fourier transforms).			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How
CE4	CE4/FB4: Comprehension and command of basic concepts in linear systems and their related functions and transforms; electric circuits theory, electronic circuits, physical principles of semiconductors and logical families, electronic and photonic devices, materials technology and their application to solve Engineering problems.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be

Learning outcomes	
Learning outcomes	Competences
To know the elements and laws involved in lumped circuit analysis.	CE4
To show the ability to analyse linear circuits in different circumstances: -. to know how to choose among different alternatives when solving a problem. -. to know simplifying techniques, their constraints, and how to decide which ones must be used.	CG4 CE4 CT2
To translate the time domain into the transformed domains, by using transforms basic concepts.	CE4
To be able to qualitatively justify the role played by circuit elements and their interactions.	CG3 CE4 CT3
To master the language and symbolism of the discipline	CG3 CE4 CT3

Contents
Topic

Presentation and introduction.	
I: Continuous Response (RPC)	Fundamental and derived magnitudes. Active and passive elements and their functional relationships. Kirchhoff's laws. Analysis by the technique of mesh voltages. Analysis by the techniques of node currents. Simplifying techniques; Thévenin and Norton equivalent circuits.
II: Steady-state sinusoidal response (RSP)	Definition and parameters. Concepts of phasor and impedance. Mesh and node analysis of steady-state sinusoidal regime networks. Divisor circuits. Autoinductance and mutual inductance. Linear and ideal transformers. Power expressions. Thévenin and Norton equivalent circuits.
III: Two-ports	Definition of a two-port circuit. Characteristic parameters. Combining two-ports. A two-port in a circuit.
IV: Transient Response (RT)	Transient regime origin. Conditions of study. Inductors and capacitors in steady-state continuous regime. Single reactive element networks. Two reactive elements networks.
V: Signals and systems	lasses of signals. Some relevant signals: step function, unit impulse function, exponential function, sinusoidal function. Classes of systems. System properties; linear, time invariant systems; response to impulse.
VI: Laplace transform (TL)	Definition. Direct transforms. Inverse transform determination. Application to linear circuits. The transference function. Steady-state response in a circuit. Response for a sinusoidal input.
VII: Frequency domain analysis (RF)	Filter concept. Filter classes. Filter responses. Periodic signals.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	0.5	0	0.5
Master Session	24.5	49	73.5
Practice in computer rooms	22	22	44
Laboratory practises	3	3	6
Troubleshooting and / or exercises	3	9	12
Practical tests, real task execution and / or simulated.	1	3	4
Long answer tests and development	2	8	10

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

Methodologies

	Description
Introductory activities	Presentation of the course: syllabus, bibliography, teaching methodology, and assessment and grading procedures. Through this methodology the competencies CT2 and CT3 are developed.

Master Session	The goal of this methodology is the presentation of the theoretical contents and the practical assessment about students learning abilities. Different exercises and problems related to the specific subject will be solved during these sessions, by the Professor or the students with his/her support, either individually or working in a group. Through this methodology the competencies CG3, CG4, CE4, CT2 and CT3 are developed.
Practice in computer rooms	Theses sessions will consist on a supervised either individual or team problem solving of practical applications related to the theoretical content of the subject. The solutions could be analyzed, checked and compared using computational tools. Al the end of 3 sesions, students will solve a evaluable task in a individual way. Through this methodology the competencies CG3, CG4 and CE4 are developed.
Laboratory practises	Two practical sessions will be carried out in the hardware lab, assembling and measuring circuits tasks will be covered. A total of 4 hours, with 1 hours dedicated to the evaluation of these sessions. Through this methodology the competencies CG3, CG4 and CE4 are developed.

Personalized attention

Methodologies	Description
Master Session	Needs and study matter queries of students will be addres by the professors on tutoring hours.
Laboratory practises	Professors set the pace of the session and resolve any questions that arise during the realization of practice. Also on the schedule tutoring, professors address the needs and queries of the students related to laboratory practices.
Practice in computer rooms	Professors set the pace of the session and resolve any questions that arise during the realization of practice. Also on the schedule tutoring, professors address the needs and queries of the students related to practices in computer rooms.

Assessment

	Description	Qualification	Evaluated Competencess
Practical tests, real task execution and / or simulated.	There will be one test/task (ECHW) related to assembling and measuring circuits. The test will be carried out in Group B timetable. This test is expected to be carried out in week 12 with a maximum mark of 1.5 points. The following skills will be evaluated: teamwork, fit to design specifications and presenting results.	15	CG3 CG4 CE4
Troubleshooting and / or exercises	Three tests will take place in Group A timetable. They are expected to be carried out in week 6 (ECA1 Chapter 1), 10 (ECA2 Chapters 2 to 4) and 15 (ECA3 Chapters 5 to 7). The mark of each of these tests will be: 1.5, 3.0 and 2.5 points respectively. Three tests will take place in Group B timetable. They are expected to be carried out in week 4(ECB1), 8 (ECB2) and 15 (ECB3). The mark of each of these tests will be 0.5 ponits.	85	CG3 CG4 CE4
Long answer tests and development	Additionally to the continuous evaluation system based on the results achieved on the aforementioned tests, the students will have the option of a final examination. This final exam can include test type and/or reasoning questions, problem solving and/or exercises, as well as the development of practical cases. The maximum mark achieved on this exam will be 10 points.	0	CG3 CG4 CE4

Other comments and July evaluation

The student, in agreement to the official academic-year schedule, will have two opportunities during the academic year to pass the course:

1. First opportunity at the end of the semester. The student is free to choose the continuous evaluation system above described, without excluding the possibility to do a final exam. Possible cases:

- Students only doing the continuous evaluation: they are graded with the points obtained in the evaluation.
- Students doing both the continuous evaluation and the exam: they are graded with the best of both qualifications.
- Students only doing the final exam: they are graded with the points obtained in the exam.

2. Extraordinary exam. Students that do not reach the minimum grade at the end of the semester will have the option to do a final extraordinary exam of the full content of the subject, theory and practice. The extraordinary exam can include test type and/or reasoning questions, problem solving and/or exercises, as well as the development of practical cases. The maximum mark achieved on this exam (between 0 and 10) will be the final grade. It will replace the grade obtained during continuous evaluation (sum of the grades obtained during tests and final exam).

Additional comments:

- Students must attend to the group B assigned at the beginning of the semester.
- Group B attendance control will be carried out.
- HW sessions attendance will be mandatory.
- Doing ECA2 or sucessives tests and/or the final exams will prevent the student to get the "Not presented" mark.
- The average grade obtained during continuous evaluation will only be valid only for the corresponding academic year.
- It will be considered that the subject has been passed if the final grade is equal or above 5.

Re-scheduling of tests. In case of missing a test, instructors have not any compulsion to rescheduling.

Test results. Before each test, the date and revision procedure of assigned grading marks will be indicated. Such dates will imply a reasonable delay (in general, not greater than three weeks) between the date of test and the release of the grading marks.

Sources of information

Basic Bibliography

James W. Nilsson, Electric Circuits, 10, Pearson

Material docente, Página web, faitic.uvigo.es,

Complementary Bibliography

J.H. McClellan, R.W. Schafer, M.A. Yoder, Signal Processing First, Pearson Prentice Hall

Recommendations

Subjects that continue the syllabus

Physics: Fundamentals of Electronics/V05G300V01305
Digital Signal Processing/V05G300V01304
Signal Transmission and Reception Techniques/V05G300V01404
Microwave Circuits/V05G300V01611
Radio Frequency Circuits/V05G300V01511
Analogue Electronics/V05G300V01624
Engineering of Electronic Equipment/V05G300V01523

Subjects that are recommended to be taken simultaneously

Mathematics: Calculus 2/V05G300V01203

Subjects that it is recommended to have taken before

Mathematics: Linear algebra/V05G300V01104
Mathematics: Calculus 1/V05G300V01105

Other comments

It is strongly recommended that students are familiar with complex numbers, trigonometric functions, linear equation system solving, elemental function derivatives and computation of simple integrals.

IDENTIFYING DATA				
Physics: Fields and Waves				
Subject	Physics: Fields and Waves			
Code	V05G300V01202			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	1st	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Pino García, Antonio			
Lecturers	Gómez Araújo, Marta González Valdés, Borja Obelleiro Basteiro, Fernando Pino García, Antonio Rubiños López, José Óscar Vera Isasa, María			
E-mail	agpino@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Fields and Waves presents the first contact in the student's degree with the phenomena of electromagnetic waves, which are the physical medium for transmission of information at almost instantaneous speed. Mathematical modeling of electromagnetic fields that provide insights into the behavior of electromagnetic waves in real environments will be introduced.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How
CE1	CE1/FB1: The ability to solve mathematical problems in Engineering. The aptitude to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, differential and partial differential equations; numerical methods, numerical algorithms, statistics and optimization	- know - Know How
CE3	CE3/FB3: Comprehension and command of basic concepts about the general laws of mechanics, thermodynamics, electromagnetic fields and waves and electromagnetism and their application to solve Engineering problems.	- know - Know How
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know - Know be

Learning outcomes	
Learning outcomes	Competences
Resolve problems applying the laws of Ampère, Gauss and Faraday.	CG3 CE1 CE3 CT3
Know and apply the Maxwell Equations	CG3 CE1 CE3 CT3
Calculate the main parameters of the electromagnetic waves: frequency, wavelength, propagation constant, polarization, Poynting vector, phase constant, attenuation constant.	CG3 CE3 CT3
Analyze the propagación of waves in media with and without losses.	CG3 CE3 CT3

Contents

Topic	
1. Vector and differential analysis of fields	1.1 Scalar and vector fields 1.2 Systems of coordinates in space 1.3 Vector Algebra 1.4 Integral Operators 1.5 Differential operators 1.6 Properties of operators
2. Electrostatic fields	2.1 Sources of the electrostatic field 2.2 Equations of the electrostatic field, electric potential 2.3 Electrostatic fields produced by charge distributions 2.4 Equations of Poisson and Laplace 2.5 Electrostatic field in material media
3. Magnetostatic fields	3.1 Sources of magnetostatic field 3.2 Magnetostatic field equations 3.3 Magnetostatic field produced by current distributions 3.4 Magnetostatic filed in material media
4. Maxwell Model	4.1 Maxwell's equations in integral form 4.2 Differential form of Maxwell's equations 4.3 Boundary conditions. 4.4 Energy balance of the electromagnetic field 4.5 Harmonic time variation 4.6 Harmonic time variation in material media
5. Wave equation and its solutions	5.1 Wave equation for time harmonic fields 5.2 Propagation, attenuation and phase constants 5.3 Solutions in rectangular coordinates 5.4 Progressive, stationary and evanescent waves in lossy and losseless media
6. Uniform plane waves	6.1 Expressions of the fields 6.2 Characteristic impedance 6.3 Poynting Vector 6.4 Polarization
7. Waves in the presence of obstacles	7.1 Incident wave, scattered wave and transmitted wave 7.2 Standing waves 7.3 Standing wave pattern 7.4 Polarization and power

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	16	24	40
Case studies / analysis of situations	21	31.5	52.5
Practice in computer rooms	4	6	10
Troubleshooting and / or exercises	12	18	30
Multiple choice tests	1	4.5	5.5
Long answer tests and development	2	10	12

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

Methodologies

	Description
Master Session	Exhibition by the professor of the contents on the matter object of study, theoretical bases and/or guidelines of a work, exercise or project to develop by the student. Through this methodology the competencies CG3, CE1 and CT3 are developed.
Case studies / analysis of situations	Analysis of a fact, problem or real event with the purpose to know it, interpret it, resolve it, generate hypothesis, contrast data, think about it, complete knowledges, diagnose it and train in alternative procedures of solution. This metodology will be used both in large and medium size groups. Through this methodology the competencies CG3, CE1, CE3 and CT3 are developed.
Practice in computer rooms	Activities application of knowledge to specific situations, and the acquisition of basic skills and procedural matters related to the object of study, which are held in computer rooms. Electromagnetic simulators will be used. Through this methodology the competencies CG3, and CE3 and are developed.

Troubleshooting and / or exercises	Problems and/or exercises related with the subject are formulated. The student has to develop the suitable or correct solutions by development of routines, the application of formulas or algorithms, the application of procedures of transformation of the available information and the interpretation of the results. It is a complement of the lectures. Through this methodology the competencies CG3, CE1, CE3 and CT3 are developed.

Personalized attention

Methodologies	Description
Master Session	The student will receive personalized attention during the tutoring hours.
Troubleshooting and / or exercises	The student will receive personalized attention during the tutoring hours.
Case studies / analysis of situations	The student will receive personalized attention during the tutoring hours.
Practice in computer rooms	The student will receive personalized attention during the tutoring hours.

Assessment

	Description	Qualification	Evaluated Competencess
Troubleshooting and / or exercises	Proof in which some problems and/or exercises related with the subject are formulated. The student has to develop the suitable or correct solutions by development of routines, the application of formulas or algorithms, the application of procedures of transformation of the available information and the interpretation of the results.	35	CG3 CE1 CE3
Long answer tests and development	Proof for evaluation of the skills that includes open questions on a subject. The students have to develop, relate, organise and present their knowledge about the subject in an extensive answer.	60	CG3 CE1 CE3
Multiple choice tests	Tests for assessment of acquired skills that include questions with response alternatives (true / false, multiple choice, matching elements ...). Students select an answer from a limited number of possibilities.	5	CG3 CE1 CE3

Other comments and July evaluation

Following the policy guidelines of the Center, the students can choose between two systems of evaluation: continuous evaluation and evaluation at the end of the term.

In all the evaluation tests, the competences CG3, CE1 and CE3 will be evaluated.

1. CONTINUOUS EVALUATION.

- The system of continuous evaluation (EC) will consist of:
  - a) A problem solving test that will be taken around the 4th week of the term. The qualification will be ECa, with maximum score of 0.5 points.
  - b) A multiple choice test that will be taken around the 8th week of the term. The qualification will be ECb, with maximum score of 0.5 points.
  - c) a problems/questions solving test on units/topics 1, 2 and 3 of he syllabus. It will be taken around the 8th week of the term. The effective qualification will be ECc=(4-ECa-ECb)·X/10, where X is the score of this last test in a range from 0 to 10.
- The final qualification of the continuous evaluation (EC) will be obtained as EC1=ECa+ECb+ECc, with a maximum score of 4 points. This way of qualification makes that the student arriving to the test "c" has as minimum Eca+Ecb and he/she can obtain up to 4 points with the test "c".
- Before the completion or delivery of the test, the date and procedure for the review of the obtained grades will be indicated. Students will have the option to know the status of the test and review the correction within a reasonable period of time.
- This test is not recoverable, what means that if a student cannot fulfill it in the stipulated period and terms, teachers will not be committed to repeat it.
- The grade obtained in the continuous evaluation test (EC1) will be valid only for the current academic course.
- It will be understood that a student follows the EC system whenever he takes any of the tests "b" or "c" of the continuous evaluation.

2. END OF THE TERM EXAM

- All the students must take this exam in order to pass the course on first call.
- Students that did not follow the continuous evaluation: their final score will be that of the complete final exam (EF).
- Students that followed the continuous evaluation:
  - They will take only the part of exam corresponding to topics 4 to 7 (EX2), that will be graded from 0 to 6 points and will be saved as the second part of the continuous evaluation (EC2) until the Recovery exam of July (EC2 = EX2).
  - The final score will be EF=EC1+EC2

3. RECOVERY EXAM.

- Students that did not follow the continuous evaluation: the final score will be that of the complete final exam (EF).
- Students that followed the continuous evaluation.
  - The recovery exam will also be divided in two parts: EX1 (topics 1 to 3) with a maximum value of 4 points, and EX2 (topics 4 to 7) with a maximum value of 6 points.
  - The students that followed the continuous evaluation will choose to do: only EX1, only EX2, or both parts. The final grade will be: EF = max(EX1, EC1) + max(EX2, EC2), being EX1 and EX2 the grades obtained in each part of the recovery exam, and EC1, EC2 as described before.

4. NOTES

- It is considered that a student has taken the course when he/she has followed the continous evaluation or has taken any of the two exams (end of term exam or recovery exam). If an student who followed continuous evaluation does not take any of the other two exams (end of term/recovery) he/she will be graded with EC1.
- In order to pass the course, students must receive a grade of 5 or above.

Sources of information
Basic Bibliography
F. T. Ulaby, U. Ravaioli, Fundamentals of Applied Electromagnetics, Global Edition 7/e, Pearson Education Limited, 2015,
D. K. Cheng, Fundamentos de Electromagnetismo para Ingeniería, Addison Wesley, 1998,
Complementary Bibliography
D. K. Cheng, Fundamentals of Engineering Electromagnetics, New International Edition, Pearson, 2013,
J. R. Reitz, F. J. Milford, R. W. Christy, Fundamentos de la Teoría Electromagnética, 4ª Edición, Addison Wesley, 1996,
David J. Griffiths, Introduction to Electrodynamics, 4ª Edición, Pearson Education Limited, 2012,
F. Dios, D. Artigas, et all., Campos Electromagnéticos, Ediciones UPC, 1998,
W. H. Hayt, J. A. Buck, Teoría Electromagnética, 8ª Edición, Mc Graw Hill, 2012,
D. K. Cheng, Field and Wave Electromagnetics, 2ª Edición, Addison Wesley, 1998,
M. F. Iskander, Electromagnetic Fields and Waves, 2ª Edición, Prentice Hall, 2012,

Recommendations
Subjects that continue the syllabus
Electromagnetic Transmission/V05G300V01303

Subjects that are recommended to be taken simultaneously
Mathematics: Calculus 2/V05G300V01203

Subjects that it is recommended to have taken before
Mathematics: Linear algebra/V05G300V01104 Mathematics: Calculus 1/V05G300V01105

IDENTIFYING DATA				
Mathematics: Calculus 2				
Subject	Mathematics: Calculus 2			
Code	V05G300V01203			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	Martínez Varela, Áurea María			
Lecturers	Fernández Manin, Generosa García Lomba, Guillermo Martínez Varela, Áurea María Prieto Gómez, Cristina			
E-mail	aurea@dma.uvigo.es			
Web	http://faitic.uvigo.es/			
General description	The matter of Calculus II of the Degree in Engineering of Technologies of Telecommunication provides basic and common training to the branch of the telecommunication. Such as it figures in the memory of the degree, students should be able to formulate, to solve and to interpret mathematically problems within engineering of telecommunication at the end of the lectures. For this, they should know how to calculate integrals of functions of one and several variables and its meaning and they should handle the basic numerical methods of approximation for this kind of integrals. On the other hand, they should become familiar with the developments of functions in Fourier series. Also, they will have to know how to solve differential equations of first and second order. Finally, they should know to handle the Laplace transform in order to solve differential equations. All of these contents are notable for several matters that they must to study simultaneously or later in the degree.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How - Know be
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How - Know be
CE1	CE1/FB1: The ability to solve mathematical problems in Engineering. The aptitude to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, differential and partial differential equations; numerical methods, numerical algorithms, statistics and optimization	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be

Learning outcomes	
Learning outcomes	Competences
Understanding the basic theory of integration of functions of one and several variables.	CG3 CG4 CE1 CT2 CT3
Managing the transformation of Laplace as a tool of analysis of the linear systems.	CG3 CG4 CE1 CT2 CT3

Knowledge of the necessary theoretical bases for the analysis of Fourier.	CG3 CG4 CE1 CT2 CT3
Knowledge and handle of the simple techniques for the integration of ordinary differential equations.	CG3 CG4 CE1 CT2 CT3

Contents	
Topic	
Theme 1. Integral calculus in R.	The Riemann integral Integrable functions. The fundamental theorem of the integral calculus. The theorem of the half value. The rule of Barrow. Calculus of primitives: integration by parts and change of variable. Improper integrals.
Theme 2. Numerical integration.	Interpolatory quadratures. Properties. Error of interpolation. Particular cases: Poncelet, tapezoidal and Simpson formulas. Formulas of composite quadrature.
Theme 3. The multiple integral in the sense of Riemann.	The double and triple integrals in elementary regions. Change of the order of integration. Theorems of change of variable. Cylindrical and spherical coordinates. Applications.
Theme 4. Orthogonal functions and Fourier series.	Orthogonal functions. Fourier series. Developments of Fourier series for odd and even functions. Convergence. The Fourier transform.
Theme 5. Introduction to ordinary differential equations.	Differential equations. Generalities Concept of solution. Differential equations of first order. Existence and uniqueness of solution. Autonomous equations. Separate variables. Homogeneous equations. Exact equations. Linear equations. Families of curves and orthogonal paths.
Theme 6. Ordinary differential equations of second order.	Differential equations of second order and of upper order. Homogeneous and non homogeneous linear differential equations. Linear differential equations with constant coefficients. Indeterminate coefficients. Variation of parameters. Cauchy-Euler equation.
Theme 7. The Laplace transform.	Definition of the Laplace transform. Properties. Application to the solution of differential equations.

Planning			
	Class hours	Hours outside the classroom	Total hours
Troubleshooting and / or exercises	17	17	34
Laboratory practises	3	6	9
Master Session	28	56	84
Troubleshooting and / or exercises	7	14	21
Practical tests, real task execution and / or simulated.	1	1	2

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

Methodologies

	Description
Troubleshooting and / or exercises	In these hours of work the professor will solve problems of each one of the subjects and will enter new methods of solution no contained in the master classes from a practical point of view. The student also will have to solve problems proposed by the professor with the aim to apply the obtained knowledges. Through this methodology the competencies CG3, CG4, CE1, CT2 e CT3 are developed.
Laboratory practises	In these practices, the computer tools MATLAB or MAXIMA will be used to study and to apply the numerical methods of approximation of integrals described in the Theme 2 of the matter. Through this methodology the competencies CG4, CE1, CT2 e CT3 are developed.
Master Session	The professor will expose in this type of classes the theoretical contents of the matter. Through this methodology the competencies CG3, CE1, CT2 e CT3 are developed.

Personalized attention

Methodologies	Description
Master Session	The professor will attend personally the doubts and queries of the students. He will solve doubts in his office, in the classes of problems, and in the laboratory. Also the Web platform Faitic will be used to help the students. They will have occasion of to attend tutorial sessions in a timetable established at the beginning of the course and which will be published in the Web page of the department.
Troubleshooting and / or exercises	The professor will attend personally the doubts and queries of the students. He will solve doubts in his office, in the classes of problems, and in the laboratory. Also the Web platform Faitic will be used to help the students. They will have occasion of to attend tutorial sessions in a timetable established at the beginning of the course and which will be published in the Web page of the department.
Laboratory practises	The professor will attend personally the doubts and queries of the students. He will solve doubts in his office, in the classes of problems, and in the laboratory. Also the Web platform Faitic will be used to help the students. They will have occasion of to attend tutorial sessions in a timetable established at the beginning of the course and which will be published in the Web page of the department.

Assessment

	Description	Qualification	Evaluated Competencess
Troubleshooting and / or exercises	Five "one hour sessions". 1st session: Theme 1 (4th week aprox.) 2nd session: Theme 3 (8th week aprox.) 3rd session: Theme 4 (11th week aprox.) 4th session: Theme 5 (13th week aprox.) 5th session: Theme 6 (15th week aprox.) These five sessions account for 35% of the score with the following weights: First: 10% (1 point) Second: 10% (1 point) Third: 5% (0,5 points) Forth: 5% (0,5 points) Fifth: 5% (0,5 points) Final exam: 60% (6 points)	95	CG3 CG4 CE1
Practical tests, real task execution and / or simulated.	The students will do a practice of laboratory of the Theme 2 using MATLAB or MAXIMA (8th week aprox.) Its value will be of 5% (0,5 points)	5	CE1

Other comments and July evaluation

The evaluation will preferably be continuous. The student will be enrolled in this kind of assessment if he attends any evaluable session. Once enrolled, it is impossible to unsubscribe from continuous assessment.

The exams of continuous evaluation are not recoverable, ie, if a student can not assist to the test in the date stipulated by the teacher, it is impossible to require the repetition. Before performing each test, both the approximate date of publication of the qualifications and the date and procedure for review them will be communicated. The score obtained at the evaluable tasks will be only valid for the academic year in which the student make them.

In tests of continuous assessment the student will solve problems and exercises of the topics of matter.

1. Continuous assessment.

The final score for a student who makes continuous assessment is given by the formula

N = C + E

C: Note obtained by adding the scores of the six sessions of the items 1, 2, 3, 4, 5 and 6.
E: Note of the final examination of the items 3, 5, 6 and 7.

In this mode **a student will pass the subject when N is greater than or equal to 5**.

2. Final evaluation of the semester.

Those students who fail to continuous assessment may be submitted to a final exam of all topics in the subject on the same date that the final exam of continuous assessment.

These students will be evaluated from 0 to 10 points and **theywill pass the subject when the obtained score is greater than or equal to 5**.

3. Second chance.

Previously to the exam students who chose continuous assessment may choose, if desired, for an exam of the items 3, 5, 6 and 7. The final grade is obtained as

NR = C + ER

C: Note obtained by adding the scores of the six sessions of the items 1, 2, 3, 4, 5 and 6.
ER: Note the final recovery examination of the items 3, 5, 6 and 7.

In this mode a student **will pass the subject when NR is greater than or equal to 5**.

If they do not choose that option, the student will be assessed in all the issues on the subject.

In this other method they will be evaluated from 0 to 10 points. A student **will pass the subject when the obtained score is greater than or equal to 5**.

4. Qualification of not presented.

Finally, a student is considered not presented **if he is not enrolled in the continuous assessment and he does not attend any of the examinations** of the subject. Otherwise he is considered presented.

Sources of information
Basic Bibliography
D. Zill & W.S. Wright, Cálculo de una variable, 4ª, McGraw-Hill (2011)
E. Marsden & A.J. Tromba, Cálculo vectorial, 5ª, Pearson-Addison Wesley (2004)
D.G. Zill & M.R. Cullen, Ecuaciones diferenciales, 3ª, McGraw–Hill (2008)
Complementary Bibliography
A. Quarteroni & F. Saleri, Cálculo científico con Matlab y Octave, 1ª, Springer (2006)

Recommendations

Subjects that are recommended to be taken simultaneously

Physics: Analysis of Linear Circuits/V05G300V01201
Physics: Fields and Waves/V05G300V01202
Mathematics: Probability and Statistics/V05G300V01204

Subjects that it is recommended to have taken before

Mathematics: Linear algebra/V05G300V01104
Mathematics: Calculus 1/V05G300V01105

IDENTIFYING DATA				
Mathematics: Probability and Statistics				
Subject	Mathematics: Probability and Statistics			
Code	V05G300V01204			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	Fernández Bernárdez, José Ramón			
Lecturers	Alonso Alonso, Ignacio Fernández Bernárdez, José Ramón Mojón Ojea, Artemio Oya Díez, Simón Prol Rodríguez, Miguel			
E-mail	jramon.fernandez@uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this subject we review some basic concepts of statistics, probability and random processes. These concepts are necessary in order to easily follow other subsequent subjects.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How - Know be
CE1	CE1/FB1: The ability to solve mathematical problems in Engineering. The aptitude to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, differential and partial differential equations; numerical methods, numerical algorithms, statistics and optimization	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be

Learning outcomes	
Learning outcomes	Competences
Learn how to distinguish between deterministic or random models	CG4 CE1 CT2
Identify a probabilistic model that fits with the needs of a specific problem	CG3 CG4 CE1 CT2 CT3
Propose solutions to simplify statistical models by using deterministic parameters	CG3 CG4 CE1 CT2 CT3

Contents
Topic

Probability theory	Concept of probability. Axiomatic definition. Conditional probability, total probability and Bayes theorems. Independence.
One-dimensional random variables	Concept of random variable (RV). Classification. Cumulative distribution function (CDF) and properties. Discrete random variables: probability mass function. Continuous random varriables: density function. Functions of RV. CDF and discrete RV. Transformation of continuous RV: fundamental theorem. Mean and variance.
Random vectors	CFD and continuous RV. Marginals. Point and line masses. Conditional density. Continuous versions of Bayes and total probability theorems. Two-dimensional transformations: fundamental theorem. Changes of dimension. Correlation and regression.
Estimation and limit theorems	Sample and population. Estimators. Estimation of mean and variance. Sequences of RV. Laws of the large numbers. Central limit theorem.
Stochastic processes	Description of a stochastic process. Statisticis of a stochastic process. Stationarity. Examples.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	24	24	48
Troubleshooting and / or exercises	13.5	28	41.5
Practice in computer rooms	14	7	21
Troubleshooting and / or exercises	1.5	6	7.5
Multiple choice tests	0.5	2	2.5
Other	0.5	1	1.5
Long answer tests and development	2	26	28

*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 divided in five main topics. Each topic will have a theoretical part that will be exposed by the teacher in big group. The students will be required to perform a previous reading of the contents. Through this methodology the competencies CG3, CE1 and CT3 are developed.
Troubleshooting and / or exercises	Each topic will be complemented with problem resolution. The problems could be developed and solved in big or small group. The students will be required to work previously on these problems. Through this methodology the competencies CG3, CG4, CE1, CT2 and CT3 are developed.
Practice in computer rooms	Each topic will be completed with one or several sessions of computer practices. For this, a software developed by the teachers and specific questionnaires for each topic will be used. The students will be required to perform a previous reading of the contents. Through this methodology the competencies CG3, CG4, CE1, CT2 and CT3 are developed.

Personalized attention

Methodologies	Description

Master Session	Students will have the chance to attend tutorial sessions at the teacher´s office. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.
Troubleshooting and / or exercises	Students will have the chance to attend tutorial sessions at the teacher´s office. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.
Practice in computer rooms	Students will have the chance to attend tutorial sessions at the teacher´s office. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.

Assessment

	Description	Qualification	Evaluated Competencess
Troubleshooting and / or exercises	Students must solve a problem, two occasions along the course	25	CG3 CG4 CE1
Multiple choice tests	The students must answer a test.	12.5	CG3 CG4 CE1
Long answer tests and development	Final exam.	50	CG3 CG4 CE1
Other	Students must solve a problem. (part 1) In a later class, each student will correct a problem made by somebody else (part 2).	12.5	CG3 CG4 CE1

Other comments and July evaluation

Following the guidelines of the studies, two evaluation systems will be offered to the students inscribed on this subject: continuous evaluation and evaluation at the end of the semester.

The continuous evaluation consists of several tasks.

A student follows the continuous evaluation system if she/he participates in task 2 (approximately in the seventh week of the semester) or any later task. Task 1 (both, part 1 and part 2) may be performed without opting for the continuous evaluation.

Students who choose continuous evaluation:

Several tasks are evaluated. The approximate task calendar and the weight of each task in the final grade are listed below.

Task 1: Weight 12.5%. Two parts, both with the same weight:

Part 1: Individual resolution of a problem. Week 4

Part 2: Correction of the task 1(part 1) from somebody else. Week 5

Task 2: Individual resolution of a test. Weight 12.5%. Week 10

Task 3: Individual resolution of a problem. Weight 12.5%. Week 12

Task 4: Individual resolution of a problem. Weight 12.5%. Week 14

The last task of the continuous evaluation will be a final exam. This will be a smaller version of the exam to be carried out by students who do not opt for continuous evaluation. The weight of the examination in the final grade will be 50 %

Before the completion or delivery of each task, the date and procedure for the review of the obtained marks will be indicated. Students will have the option to know the status of each task and review the correction within a reasonable period of time (a week, generally).

These tasks are not recoverable, what means that if a student cannot fulfill them in the stipulated period, teachers will not be committed to repeat them.

The obtained grade will be valid only for the current academic course.

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

The final grade for students who opt for continuous evaluation will be calculated as the average between the final exam and the previous tasks marks. To minimize the impact of a possible miss on a task, the average of these will be computed excluding the worst obtained grade.

Students who choose for evaluation at the end of the semester:

The possibility of a final examination will be provided to students who do not opt for the continuous evaluation. This exam will be rated between 0 and 10, and this will be the final grade obtained.

Second chance

Previously to the exam (or at its beginning), students will be asked to choose to be evaluated by continuous evaluation system (described before) or only by the final exam.

The subject is considered passed if the final grade obtained is equal to or greater than 5.

Sources of information
Basic Bibliography
JR Fernández, I. Alonso y A. Mojón, Apuntes de Probabilidad y Estadística, 8 ed, 2018, Faitic
A Mojón, I. Alonso y JR Fernández, Vídeos de la asignatura de Probabilidad y Estadística, 1 ed, 2014, Uvigo tv
X. Rong Li, Probability, Random Signals and Statistics, 1 ed, 1999, CRC Press
R. Cao y otros, Introducción a la estadística y sus aplicaciones, 1 ed, 2001, Pirámide
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H. Stark y J.W. Woods, Probability, Random Processes, and estimation theory for engineers, 2 ed, 1994, Prentice Hall
D. Peña, Estadística, modelos y métodos. Tomo 1: Fundamentos, 2 ed, 1991, AUT
P. Peebles, Principios de probabilidad, variables aleatorias y señales aleatorias, 4 ed, 2006, McGraw-Hill
A. Papoulis, Probability, random variables and stochastic processes, 4 ed, 2002, McGraw-Hill
A. Blanco y S. Pérez-Díaz, Modelos aleatorios en ingeniería, 1 ed, 2015, Paraninfo

Recommendations

Subjects that continue the syllabus

Data Communication/V05G300V01301
Computer Networks/V05G300V01403
Signal Transmission and Reception Techniques/V05G300V01404
Basics of bioengineering/V05G300V01915

Subjects that are recommended to be taken simultaneously

Mathematics: Calculus 2/V05G300V01203

Subjects that it is recommended to have taken before

Mathematics: Linear algebra/V05G300V01104
Mathematics: Calculus 1/V05G300V01105

IDENTIFYING DATA				
Programming I				
Subject	Programming I			
Code	V05G300V01205			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	1st	2nd
Teaching language	Spanish			
Department				
Coordinator	Rodríguez Hernández, Pedro Salvador			
Lecturers	García Palomares, Ubaldo Manuel Pazos Arias, José Juan Ramos Cabrer, Manuel Rodríguez Hernández, Pedro Salvador			
E-mail	pedro.rodriguez@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The aim of the course is to provide students with basic skills to program in a high level language.			

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How
CE6	CE6/T1: The ability to learn independently new knowledge and appropriate techniques for the conception, development and exploitation of telecommunication systems and services	- Know How
CE12	CE12/T7: The knowledge and use of basics in telecommunication networks, systems and service programming.	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know be

Learning outcomes	
Learning outcomes	Competences
Express the solution of a simple problem by means of algorithms using top-down design.	CE12
Identify the data needed to solve a problem and associate them with appropriate datatypes based on their features (size, range, associated operators)	CE12
Code simple algorithms using the basic types of statements: assignment, selection and iteration.	CE12
Declare and define functions with a proper use of parameters.	CE12
Handle I/O operations and file management.	CE12
Define and use structured data types.	CE12
Define and manage dynamic data structures (lists, stacks, queues and trees).	CE12
Create modules and library functions and use them in programs.	CE6 CE12
Predict the result of a sequence of statements, knowing the input data.	CE12
Handle basic tools in an integrated development environment: text editor, compiler, linker, debugger and documentation tools.	CE6

Develop a small scale project following all the phases: requirements analysis, design, implementation, testing and documentation.	CG4 CG9 CE6 CE12 CT2 CT4

Contents

Topic	
Lecture 1: The algorithm and the programming languages.	1. The algorithm and its different representations: flowchart, pseudocode, natural language. 2. Algorithm implementation by means of a programming language. Programming paradigms: modular programming and structured programming. 3. C language and the function main(). Source code and object code. The compiler and the interpreter. 4. Input/output exercises: human-computer interface. The standard input/output files: stdin, stdout. The #include directive. Library functions.
Lecture 2: Grammar and basic elements of C language.	1. The alphabet. Recursive derivations of sintactically valid sequences. Identifiers, numbers. Symbolic constants: The #define directive and macros. Use of the const qualifier. 2. Variables and their attributes: name, value, address, types. Pointer variables. Declaration of simple variables and pointers: the direction & and reference * operators. 3. The sizeof operator. Arithmetical operators. The assignment operator. Automatic type conversion and by means of the cast operator. 4. Syntactic notation for expressions and statements. Simple and compound statements.
Lecture 3: Sequential, iteration and selection statements	1. Evaluation of expressions with relational operators and boolean operators. 2. Decision statements: switch, if, nested if. The ternary operator (?:) 3. The iterative statements and their importance in modular programming: while, do while and for. The break and continue statements.
Lecture 4: Arrays	1. Declaration of array variables. Memory allocation for multidimensional arrays. 2. Unidimensional arrays and pointers: pointer arithmetic. Arrays of characters: the end of string character. Library functions for dealing with arrays of characters. 3.Variable length arrays in standard C99. 4. Dynamic memory allocation for 1 and 2 dimension arrays: the malloc(), calloc(), realloc() functions.
Lecture 5: Functions	1. Functions declaration and definition. Local, static and global variables. Function return value. 2. Actual and formal parameters. Parameter passing by value and by reference: use of pointers. Command line arguments passing to function main( ). 3. Creation and use of function libraries. Library functions for strings handling. 4. Modular compilation. The conditional directives in a header file. 5. Recursive functions: advantages and disadvantages.
Lecture 6: struct variables	1. struct variables: global declaration. Fields of a struct. Pointers to struct. The . (Point) and -> (arrow) operators. 2. struct and a pointer to struct as a funcion parameter and return value. 3. typedef with non trivial declarations. 4. More complex data structures: nested structs, array of structs. 5. Dynamic management in creating linear lists, circular lists and trees. 6. Insertion and removal of variables in a list.
Lecture 7: Files	1. Text files: fopen() and fclose() functions. 2. Different file input/output functions: fprintf (), fscanf(), fgets(), feof(). 3. Functions with direct access to files. 4. Information management between files and lists. 5. Node structure in simple linked lists. 6. File to list conversion and vice versa.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	0	2
Master Session	24	24	48
Laboratory practises	12	14	26
Projects	8	24	32
Practical tests, real task execution and / or simulated.	5	15	20
Other	5	15	20
Reports / memories of practice	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
Introductory activities	Introduction to theoretical and practical activities.
Master Session	Plenary sessions that include the realisation of works and programs. Through this methodology the competencies CE12 and CT2 are developed.
Laboratory practises	During the first weeks of the term the student codifies, compiles and documents programs guided by the instructor. Some of these activities will be evaluated. Through this methodology the competencies CG4, CE12 and CT2 are developed.
Projects	In the last part of the term, the student must complete a low complexity project, under the instructor supervision, which includes individual and in group activities. Through this methodology the competencies CG4, CG9, CE6, CE12, CT2 and CT4 are developed.

Personalized attention	
Methodologies	Description
Master Session	The professors will provide individual attention to the students along the term, solving their doubts and questions. Questions will be answered during the master sessions or during tutorial sessions. The professors will establish timetables for this purpose at the beginning of the term. This schedule will be published on the subject website.
Laboratory practises	The professors will provide individual attention to the students along the term, solving their doubts and questions about the laboratory practises. Questions will be answered during the lab sessions or during tutorial sessions. The professors will establish timetables for this purpose at the beginning of the term. This schedule will be published on the subject website.
Projects	The professors will provide individual attention to the students along the term, solving their doubts and questions about the project. Questions will be answered during the supervising sessions or during tutorial sessions. The professors will establish timetables for this purpose at the beginning of the term. This schedule will be published on the subject website.

Assessment			
	Description	Qualification	Evaluated Competencess
Projects	The student will develop a project in the last weeks of the term, and will submit the C code implementing it The project will be assessed in the final laboratory test.	25	CG4 CG9 CE6 CE12 CT4
Practical tests, real task execution and / or simulated.	Every 4 weeks, the student will take a practical individual test in the laboratory. At the end of the term, the student will take a comprehensive final practical test. All of them will consist in the development of a program in the computer. Those tests will assess the student's progress with the laboratory practices and with the project.	20	CG4 CE12

Other	Every 4 weeks, the student will take an exam that may consist of: - short answer questions - multiple choice questions - troubleshooting and / or exercises This exam will assess the student's mastership of the concepts introduced in the master sessions. At the end of the term, the student will take a comprehensive final exam on the whole contents of the subject.	50	CG4 CE12
Reports / memories of practice	After the second week in the project development, the student will submit a description of its design, in the form of a pseudocode or a flowchart. At the end of the term, the student will submit a report, including the project's documentation.	5	CG4 CE12 CT4

Other comments and July evaluation

The **course planning in lectures** and the estimated time of the **most important assessment milestones** is detailed below:

- Week 1: Theory introduction + Lectures 1 and 2
- Week 2: Lecture 3 | Practice introduction + Practice 1
- Week 3: Lectures 3 and 4 | Practice 2
- Week 4: Lecture 4 + **Theory Test 1** (PT1) | **Laboratory Test 1** (PP1)
- Week 5: Lecture 4 | Practice 3
- Week 6: Lecture 5 | Practice 4
- Week 7: Lecture 5 | Practice 45
- Week 8: Lecture 5 + **Theory Test 2** (PT2) | **Laboratory Test 2** (PP2)
- Week 9: Lectures 5 and 6 | Practice 6
- Week 10: Lecture 6 | Practice fulfilment + Project (1h)
- Week 11: Lecture 6 | Project (2h) + Project design submission (psudocode or flowchart)
- Week 12: Lecture 7 + **Theory Test 3** (PT3) | Project (1h) + **Laboratory Test 3** (PP3)
- Week 13: Lecture 7 | Project (2h)
- Week 14: Project (2h)
- Before the final exams, project submission (coding and documentation)
- Finals: **Final Theory Test** (PTF) - **Final Laboratory Test** (PPF)

In all courses the School offers two evaluation modes: **Continuous evaluation** and **comprehensive evaluation**.
The student must opt to the latter one explicitily, no latter than the week before the Laboratory Test 2 (PT2) is taken.
The **continuous evaluation** will be considered as "passed" if both the student has submitted a report (design, coding and documentation) for the project developed from the 10th to the 14th week, and the final grade (NFC) obtained by the student is at least 5. This final grade is the harmonic mean between the theory and laboratory tests grades, calculated as follows:
NFC = (2*NTC*NPC)/(NTC+NPC)
where:

- Theory Grade by Continuous Evaluation: NTC = 0.1*PT1+0.1*PT2+0.2*PT3+0.6*PTF
- Practice Grade by Continuous Evaluation: NPC = 0.1*PP1+0.1*PP2+0.2*PP3+0.5*PPF+0.1*PDD

The Final Theory Test (PTF) is an exam that may consist of short answer questions and/or multiple choice questions and/or troubleshooting and/or exercises. It assesses the mastership of the contents introduced in the lectures.
The Final Practice Test (PPF) the proper coding in C to deal with a medium level project. While the project development is a group activity, it is assessed individually. Indirectly, the PPF also assesses the mastership of the contents introduced in the lectures and the laboratory practices.
The **Design and Documentation Test** (PDD) assesses the quality of the pseudocode or the flowchart describing the project's design (submitted the 11th week), and project's documentation report submitted before the final exams
The use of the harmonic means implies that the course is not passed if either NPC or NTC has a grade under 3.3.
No test in the continuous evaluation mode is repeatable; that is, the instructor has no obligation to reschedule an evaluated activity missed by a student.
The date and procedures for the revision of the grades will be known before the evaluation tests. The students will have the chance of reviewing the grades preferably within two weeks after the evaluation.
In order to pass the course by the **comprehensive evaluation mode**, the student must submit a project report (design, coding and documentation) similar to the one submitted by the continuous evaluation students, and the final grade obtained by the student must be at least 5. This mode will consist of the same exams as the continuous evaluation one (although with different weight in the final grade), that is, an exam that may consist of short answer questions and/or multiple choice

questions and/or troubleshooting and/or exercises (PTF) and a laboratory test (PPF, which will include the evaluation of the project). The final grade is the harmonic mean between the theory and practice grades, calculated as follows:
NFF = (2*NTF*NPF)/(NTF+NPF)
where:

- Theory Grade by Comprehensive Evaluation: NTF = PTF
- Practice Grade by Comprehensive Evaluation: NPF = 0.9*PPF+0.1*PDD

Both the **continuous evaluation grade** (NFC) and the **comprehensive evaluation grade** (NFF) will be computed to all students that take the final tests (theory and practice). The final grade will be the higher one.
A "No Present" grade will be granted:

- If the student opts for the continuous evaluation mode, when no test is taken after the Laboratory Test 1 (PP1)
- If the student opts for the comprehensive evaluation mode, when no final test (PTF and PPF) is taken.

University regulations allow students to take an additional test to approve the course (extra evaluation). In order to pass the course using this extra evaluation, the student must submit a project report (design, coding and documentation) similar to the one submitted by the continuous evaluation students, and the final grade obtained by the student must be at least 5.
This extra evaluation will consist of an exam that may consist of short answer questions and/or multiple choice questions and/or troubleshooting and/or exercises (Extra Theory Test) and a laboratory test which will include the evaluation of the project (Extra Laboratory Test)). The final grade is the harmonic mean between the theory and practice grades, calculated as follows:
NFE = (2*NTE*NPE)/(NTE+NPE)
where:

- Theory Grade by Comprehensive Evaluation (NTE): if the student takes the Extra Theory Test, NTE will be the grade achieved in that test:

  NTE = PTE

  Otherwise, NTE will be the theory grade obtained for the theoretical tests in his/her regular evaluation.

- Practice Grade by Comprehensive Evaluation (NPE): if the student takes the Extra Laboratory Test, NPE will be the weighed additionof the grade achieved in that test plus the grade obtained inf the design and documentation test:

  NPE = 0.9*PPE+0.1*PDD
  Otherwise, NPE will be the practice grade obtained for the practical tests in his/her regular evaluation.

In both final and extra evaluation, and in both evaluation modes, in case of failure to fulfil the mandatory requirement of submitting the project report, the final grade (computed according to the corresponding formula) will be upper-bounded to a maximum value of 4.5 points.

All the partial and final grades will only be valid for the term the student is enrolled to, that is, in case the student repeates the subject, he or she will not retain any of the grades of the previous year.

If plagiarism is detected in any of the works/test taken, the student will receive a failing grade (0) and the professors will report the fact to the school authorities.

Sources of information
Basic Bibliography
Manuel Caeiro Rodríguez, Enrique Costa Montenegro, Ubaldo García Palomares, Cristina López Bravo, J, Practicar Programación en C, 2014, Andavira
Brian W. Kernighan & Dennis M. Ritchie, El Lenguaje de Programación C, 1986 (reimpreso en 1995), Prentice Hall
Complementary Bibliography
Osvaldo Cairo Battistuti, Fundamentos de Programación, 2006, Pearson Education
José Rafael García-Bermejo Giner, Programación Estructurada en C, 2008, Prentice Hall
James L. Antonakos & Kenneth C. Mansfield Jr., Programación Estructurada en C, 1997 (reimpreso en 2004), Prentice Hall

Jorge A. Villalobos S. & Rubby Casallas G., Fundamentos de Programación: Aprendizaje Activo Basado en Casos, 2006, Prentice Hall

Recommendations

Subjects that continue the syllabus

Programming II/V05G300V01302

Subjects that it is recommended to have taken before

Informatics: Computer Architecture/V05G300V01103

Other comments

Programming II course continues this course in the second year.

IDENTIFYING DATA				
Data Communication				
Subject	Data Communication			
Code	V05G300V01301			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	López García, Cándido Antonio			
Lecturers	Díaz Redondo, Rebeca Pilar Herrería Alonso, Sergio López García, Cándido Antonio Sousa Vieira, Estrella Suárez González, Andrés			
E-mail	candido@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this subject the efficiency and reliability of data transmission using discrete memoryless channels will be analyzed, and the next issues will be introduced: * lossless data compression methods, * linear error control codes, * data link layer protocols, and * multiple access channels protocols and technologies.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CE11	CE11/T6: The ability to conceive, deploy, organize and manage networks, systems, services and Telecommunication infrastructures in residential (home, city, digital communities), business and institutional environments, being responsible for launching of projects and continuous improvement like knowing their social and economical impact.	- Know How
CE17	CE17/T12: The knowledge and usage of concepts of communication network architecture, protocols and interfaces.	- know
CE18	CE18/T13: The ability to differentiate the concepts of access and transport networks, packet and circuit switched networks, mobile and fixed networks, as well as distributed newtwork application and systems, voice, data, video, audio, interactive and multimedia services.	- Know How
CE20	CE20/T15: The knowledge of national, European and international telecommunication regulations and laws.	- know
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know

Learning outcomes	
Learning outcomes	Competences
Understanding the basics of the processes of digital transmission of information, the mathematical models of the channels and the concept of capacity.	CG3 CE17 CT3

Knowledge and ability to analyze the ways of achieving reliable data transmission.	CG3 CG4 CE17 CE20 CT2 CT3
Understanding the methods of sharing multiple access channels, their limits and the factors that affect their performance.	CG3 CE11 CE18 CT3
Master the main technical standards, interfaces and protocols in the field of data transmission and local networks.	CG3 CE20 CT3
Practice with interfaces and protocols in the laboratory, as well as in the development of basic transmission solutions.	CG3 CE20 CT3

Contents

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

Planning

	Class hours	Hours outside the classroom	Total hours

Master Session	28	0	28
Previous studies / activities	0	47	47
Troubleshooting and / or exercises	24	0	24
Autonomous troubleshooting and / or exercises	0	47	47
Long answer tests and development	3	0	3
Short answer 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	Systematic exposition of the theoretical contents of the subject, emphasizing the aims, fundamental concepts and relationships between the different units. Through this methodology the competencies CE11, CE17, CE18, CE20, CG3 and CT2 are developed.
Previous studies / activities	Students will study the theoretical contents of the subject using the textbook and/or further material. Through this methodology the competencies CE11, CE17, CE18, CE20, CG3 and CT2 are developed.
Troubleshooting and / or exercises	Selected problems and/or exercises will be solved in detail, emphasizing the theoretical concepts involved and the methodology of resolution. Through this methodology the competencies CE11, CE17, CE18, CE20, CG4 and CT3 are developed.
Autonomous troubleshooting and / or exercises	Students will try to autonomously solve a problems and/or exercises from a proposed collection. Through this methodology the competencies CE11, CE17, CE18, CE20, CG4 and CT3 are developed.

Personalized attention

Methodologies	Description
Previous studies / activities	Students will receive personalized attention (in the professor's office, during the office hours) to resolve doubts that can arise in the autonomous study of the subject.
Autonomous troubleshooting and / or exercises	Students will receive personalized attention (in the professor's office, during the office hours) to resolve doubts that can arise in the autonomous resolution of exercices.

Assessment

	Description	Qualification	Evaluated Competencess
Long answer tests and development	Two partial examinations. In each one of them we will evaluate all the competencies corresponding to the contents we have seen in class to date of the examination.	70	CG3 CG4 CE11 CE17 CE18 CE20 CT2 CT3
Short answer tests	They will be realised with periodicity roughly twice-weekly during the sessions of type B classes.	30	CG3 CE17 CE18 CT3

Other comments and July evaluation

A continuous evaluation of the learning will be practiced. This evaluation consist of two types of tests: short tests, every two weeks, to evaluate the steady student learning, that will take place during the group B sessions; and two partial examinations, the first one in the midterm and the second one at the end of the class period. These tests will not be repeatable and will only be accountable in the current course.

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

All the students that have not reached at least a score of 5 in the continuous evaluation (included the students not evaluated) can do a final examination, that will include ALL the contents of the subject and that will take place in the exam period scheduled by the Centre. In this case, the final grade of the subject will be the exam score.

All the students that are bound to continuous evaluation or take the final examination will be graded. The students that attend to the second partial exam will be considered bound to continous evaluation.

Those who do not surpass the subject at the earliest opportunity have a second one consistent in the realisation of a new final examination.

In case of plagiarism in any one of the tests (short tests, partial examinations or final examination), the final grade will be FAIL (0) and the fact will be reported to the direction of the Centre for the timely effects.

Sources of information
Basic Bibliography
C. López García, M. Fernández Veiga, Teoría de la Información y Codificación, 2/e, 2013, Andavira editora
Complementary Bibliography
C. López García, M. Fernández Veiga, Cuestiones de Teoría de la Información y Codificación, 2003, Tórculo edicións
J. F. Kurose, K. W. Ross, Computer Networking, 6/e, 2012, Addison Wesley

Recommendations
Subjects that continue the syllabus
Computer Networks/V05G300V01403

Subjects that it is recommended to have taken before
Mathematics: Linear algebra/V05G300V01104 Mathematics: Calculus 1/V05G300V01105 Mathematics: Probability and Statistics/V05G300V01204

IDENTIFYING DATA				
Programming II				
Subject	Programming II			
Code	V05G300V01302			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Fernández Masaguer, Francisco			
Lecturers	Blanco Fernández, Yolanda Fernández Masaguer, Francisco			
E-mail	francisco.fernandez@det.uvigo.es			
Web	http://www.faitic.es			
General description	The general aim of this subject is to provide to the student the theoretical foundations and the practical competitions that allow him analyse, design, develop and debug computer applications following the paradigm oriented to objects. This is an essentially practical subject and in this sense is oriented to the work of the students in the realisation of one or several projects. To facilitate the development of the projects, in the subject will realise firstly a very brief introduction to the discipline of Software Engineering , linking it with the paradigm of the object oriented programming (OOP) and restricting it only to the stages of analysis, design, implementation and debugging. Then we will analyse in detail the elements of OOP, using elements and UML diagrams that they will be used by the students in his developments. To reach this general aim the contents that will be handled in the subject can be summarized in the following items: - Basic concepts of Software Engineering. - Basic concepts of object oriented programming: classes and objects - Encapsulation. Hiding principle. Concepts of decoupling and cohesion - Inheritance, abstraction, polymorphism and reuse - Relations between classes: generalisation, association and dependency. - Communication between objects: methods, events, messages. - Persistence. Storage in files and in databases. - Generation, capture and processing of exceptions. - Introduction tothe UML modeling language.			

Competencies		
Code		Typology
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- know
CG14	CG14 The ability to use software tools to search for information or bibliographical resources.	- know - Know How
CE50	(CE50/T18)The ability to develop, interpret and debug programs using basic concepts of Object Oriented Programming (OOP): classes and objects, encapsulation, relations among classes and objects, and inheritance.	- know - Know How
CE51	(CE51/T19) The ability of basic application of phases of analysis, design, implementation and debugging of OOP programs.	- know - Know How
CE52	(CE52/T20) The ability of manipulation of CASE tools (editors, debuggers).	- know - Know How

CE53	(CE53/T21) The ability of developing programs considering to the basic principles of software engineering quality taking into account the main existing sources of norms, standards and specifications.	- Know How

Learning outcomes

Learning outcomes	Competences
To understand the basic concepts of Object Oriented Programming (OOP).	CG14 CE50
To know the main UML diagrams for the documentation in the phases of analysis and design of programs according to the OOP.	CG6 CG14 CE52 CE53
To develop skills in the process of analysis, design, implementation and debugging of applications according to the OOP, taking into account the main standards and norms of quality.	CG6 CG14 CE51 CE53
To acquire maturity in techniques of development and debugging of programs to allow the autonomous learning of new skills and programming languages.	CG6 CE51 CE52 CE53

Contents

Topic	
1. Introduction to the object oriented paradigm	a. Brief introduction to the subject and its organization. b. Birth of the paradigm c. Foundations: classes and objects d. Concepts of encapsulation, inheritance (generalization), and polymorphism e. Brief Introduction to UML
2. Encapsulation	a. Classes, interfaces and packages b. Methods and member variables. Visibility. Scope of resolution c. Constructor method d. Passing parameters: pointers and references e. Pointers to objects
3. Inheritance	a. Derived classes and types of inheritance b. Abstract Classes c. Multiple Inheritance d. Object class
4. Object oriented design	a. Design foundations b. Use of UML diagrams
5. Polymorphism	a. Overloading and overwriting b. Abstract classes and interfaces c. Generic classes
6. Exception handling	a. Exceptions foundations b. Handling of Java exceptions

Planning

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

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

Methodologies

	Description

Master Session	Classes that will combine the explanation of the concepts involved in the subject and the performance of small exercises. These may be solved by the teacher or by the students, individually and/or in groups. The aim is to encourage debates in class and strengthen the adquisition of skills. Through this methodology the competencies CE50, CE51 and CE53 are developed.
Troubleshooting and / or exercises	In the laboratory, the teacher will pose small challenges to be solved collectively so that the underlying concepts and the different options of resolution can be discussed, and to provide students with the skills object of the subject. Through this methodology the competencies CE50, CE51 and CE53 are developed.
Autonomous troubleshooting and / or exercises	Students will solve independently the problems posed by the teacher in the laboratory. The solutions and the doubts that arise in addressing these problems will be put together to agree the best way of resolution. Through this methodology the competencies CE50, CE51, CE53, CG6 and CG14 are developed.
Case studies / analysis of situations	Putting in common of the designs proposed by the students to solve the project to be carried out during the second part of the course. The comparison of the different proposals will serve to select the best options and as a feedback, if appropriate, to improve the designs. Through this methodology the competencies CE51 and CE52 are developed.
Projects	The students will implement the software system proposed by the teacher during the second part of the course, combining work in the laboratory supervised by the teacher with work out of the laboratory. Through this methodology the competencies CE50, CE53, CG6 and CG14 are developed.

Personalized attention

Methodologies	Description
Troubleshooting and / or exercises	Revision and comments of solved exercises. Glossary of frequent errors to avoid. Recommendations of style and organization.
Projects	Beside commenting with the group, diferent alternatives, recommendations and strategies for the good realization of the project, we examine with group members the level of understanding of the project, particular doubts that can arise, errors of design and code and options of improvement.
Autonomous troubleshooting and / or exercises	Review and comments with each group of the diverse practise proposed during his development phase. Help for compilation and execution errors. Detection and solution of conceptual errors.
Case studies / analysis of situations	Review and general critic of the UML design UML of each group during his development.

Assessment

Description	Qualification	Evaluated Competencess

Projects	Students, organised in groups of two, will deliver the proposed software project at most the first school day after Christmas. This will consist of his final design (UML diagrams), the code and the documentation generated explanatory of the implementation. That the code delivered can be compiled and executed in the laboratory computers will be necessary condition to surpass this proof of evaluation. During the last week of the course, students will have an interview with the professor in the schedule of the laboratory, devoted to show the authorship of the project and realise diverse proofs of functionality. Both members of the group must attend the interview. The issues raised therein will have to be answered individually to be able to ascertain the degree of understanding and implication of the student in the project developed, owing each student identify the parts of the project that has implemented. The adecuate answers wil be used to establish, together with a group of tests of functionality and the analysis of the quality of the code, the individual cualification of each student. In case that a student do not accredit properly the authorship, the project will be considered not valid, and the students will be considered suspense in the corresponding announcement. For the students that accredit properly the authorship, the evaluation of the project will take into account so much the adecuate answers in the authorship interview, like the correct functionality, like the quality of the code and the use of the technics of object oriented programming. The determination of the correct functionality will be realised by means of a group of around 50 tests on the software delivered.	33	CG6 CG14 CE50 CE53
Case studies / analysis of situations	At the end of the 9ª week of the academic course the students, organised in groups of two, will deliver the UML design of a project software. In lective hours the members of each group wil do with the professor a brief authorship interview of this design, which together with the delivered design, wil be used to establish the individual note of each student.	7	CE51 CE52
Troubleshooting and / or exercises	Written exam to be done individually in the date published in www.teleco.uvigo.es for this purpose, which will consist of the combination of the following types of questions: resolution of problems, short questions about the theoretical concepts explained in the master sessions, to justify reasonably if one or more statements are true or false, small tests about theoretical and application aspects. The number and combination of these questions will be defined for each particular exam. Support materials (notes, books, collections of problems) are not allowed.	50	CE50 CE51 CE53
Practical tests, real task execution and / or simulated.	At the end of the 7th week of the academic course the students, organized in pairs, will submit the Java initiation practices proposed in the laboratory. In lective hours the members of each group wil realise with the professor a brief authorship interview of the initiation practices, which together with a group of tests of correct operation on the software delivered, wil be used the establish the individual note of each student.	10	CE50 CE51 CE52 CE53

Other comments and July evaluation

There are two modalities of evaluation of this subject: continuous evaluation (CE) and traditional evaluation (TE). The students will have to choose one of the two modalities taking into account the following conditions:

- The CE includes the 4 proofs described in the evaluation section.

- Whether they opt for the CE or for the TE, students must develop a project. To facilitate the choice between CE and TE, the specifications of the project will be available in Faitic the 4th week of the academic course.

- In the TE the project will be carried out individually.

- The students that choose the CE will submit at the end of the 9th week of the academic course the UML design of the project (corresponding to the 2nd proof described in the evaluation section). By means of this submission the students agree to follow the CE and reject the TE. From this moment these students may not appear as if they have not taken the subject.

- The students that do not submit the UML design of the project in the stipulated date reject the CE, so that they will be evaluated by means of the modality of TE. It is not possible to join the CE in the following intermediate proofs.

- The proofs of CE are not recoverable in any case, and they can not be repeated outside the dates stipulated by the teachers.

- Marks (of proofs of CE or practical projects or exams) are not saved from one course to another.

First announcement. Students that opt for the CE. They will be evaluated as follows:

• Theoretical part:

- Written exam (50%). Individual exam. It corresponds to the 3rd proof described in the evaluation section. The mark of this exam only will be saved for the second announcement if it is equal or higher than 4.5 over 5.

• Practical part:

- Practices of initiation in Java (10%). To be done in pairs. It corresponds to the 4th proof described in the evaluation section.

- Project (40%). To be done in pairs. It is divided in two parts:

1. Design (7%). It corresponds to the 2nd proof described in the evaluation section.
2. Implementation (33%). It corresponds to the 1st proof described in the evaluation section.

The requirements to pass will be:

- A minimum of 1/3 of the total in the theoretical part.

- A minimum of 1/3 of the total in the part of implementation of the project (or 1/3 of the total of the practical exam according to the case).

- A total mark (sum of the 4 proofs) equal or higher than 5.

- If the total mark is equal or higher than 5 but the minimun in some part has not been reached, the final mark will be 4.5 points (failure).

First announcement. Students that opt for the TE. They will be evaluated as follows:

• Theoretical part:

- Written exam (50%). Individual exam. It corresponds to the 3rd proof described in the evaluation section. The mark of this exam only will be saved for the second announcement if it is equal or higher than 4.5 over 5.

• Practical part:

- Individual realization of a software project that will suppose the remaining 50% of the final mark. This project will consist of the design (UML diagrams), the Java code and the generated documentation about the implementation details. The evaluation will take into account correct design, correct functionality, quality of the code and use of techniques of OOP. It must be submitted before the first school day after Christmas holidays.

- Realization of an interview with the teacher with the aim of proving the authorship of the project. This interview will take place in the laboratory hours during the last week of the course. If the student does not accredit properly the authorship did not surpass the announcement, and will have to do the corresponding project to the second announcement.

• The requirements to approve will be:

- A minimum of 1/3 of the total in the theoretical part.

- A minimum of 1/3 of the total in the part of the project (or 1/3 of the total of the practical exam according to the case).

- A total mark (sum of the 2 proofs) equal or higher than 5.

- If the total mark is equal or higher than 5 but the minimun in some part has not been reached, the final mark will be 4.5 points (failure).

Second announcement. The students will be evaluated as follows:

• Theoretical part:

- Written exam (50%). Individual exam. It corresponds to the 3rd proof described in the evaluation section. The mark of this exam will not be never saved for others convocatories.

• Practical part:

It will depend on whether the student has delivered or not the project in the first call. For the students that have followed the CE in the first call, it will be considered that a student has delivered the project when, as least, he/she has submitted an UML design in which he/she has obtained a mark equal or higher than 0.4 of 0.7.

- The students that do not deliver the project in the first announcement or that have not surpassed the authorship interview, will have to do necessarily the extended project of the second announcement. In any case lose the notes of the parts of initiation in Java and UML design if they opted for the CE in the first announcement, that is to say, will be evaluated on 5.

- The practical part to be done for the students that deliver the project in the first call will depend on the mark obtained in the project in that call, as follows:

- *Mark >= 1.5 with CE or Mark >= 2.5 with TE*. They will keep the mark. However, they will be able to improve the mark of the project delivering a new version of the one of the first call together with the new functionalities to be done, that will be published in Faitic. In the same way, they will deliver a document that addresses the changes and updates in the project from the version delivered in the first call.
- *Mark between 1 and 1.5 by CE or Mark between 5/3 < 2.5 with TE*. Must do necessarily the extended project of the second announcement. They will not keep the mark of the project of the first call, but they will keep the marks of the parts of initiation in Java and UML design if they have opted for the CE in the first call.
- *Mark < 1 with CE or Mark < 5/3 by TE*. Must do necessarily the extended project of the second announcement. They will not keep the marks of the parts of initiation in Java and UML design if they have opted for the CE in the first call, that is, they will be evaluated on 5.

• Requirements to pass. The requirements to pass will be:

- A minimum of 1/3 of the total in the theoretical part.

- A minimum of 1/3 of the total of the project without taking into account the marks of the parts of initiation in Java and UML design if they have opted for the CE in the first call (or 1/3 of the total of the practical exam according to the case).

- A total mark (sum of all the proofs) equal or higher than 5.

- If the total mark is equal or higher than 5 but the minimun in some part has not been reached, the final mark will be 4.5 points (failure).

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P. Niemeyer, D. Leuck, Learning Java, 4ª edición, O'Reilly., 2013,
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G. Booch, J. Rumbaugh, I. Jacobson, The Unified Modeling Language User Guide, 2, Addison-Wesley., 2005,
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A. Eberhart, S. Fischer, Java Tools, Wiley, 2002,
M. Page-Jones, “Fundamentals of object-oriented design in UML, Addison-Wesley, 2002,

M. Fowler, UML Distilled: A Brief Guide to the Standard Object Modeling Language, 3ª edicion, Addison-Wesley., 2003,

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Recommendations

Subjects that it is recommended to have taken before

Programming I/V05G300V01205

IDENTIFYING DATA				
Electromagnetic Transmission				
Subject	Electromagnetic Transmission			
Code	V05G300V01303			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Vera Isasa, María			
Lecturers	García-Tuñón Blanca, Inés Gómez Araújo, Marta Santalla del Río, María Verónica Vazquez Alejos, Ana Vera Isasa, María			
E-mail	mirentxu@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Fundamentals of electromagnetic guided and unguided transmission. Analysis of the operating principles of different transmission media models and their characterization in telecommunication engineering.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.	- know - Know How
CE8	CE8/T3: The ability to use software tools for bibliographical resources search or information related with electronics and telecommunications.	- Know How
CE9	CE9/T4: The ability to analyze and specify the main parameters of a communications system.	- know - Know How
CE13	CE13/T8: The ability to understand the electromagnetic and acoustic wave mechanisms of propagation and transmission, and their corresponding receiving and transmitting devices.	- know
CE20	CE20/T15: The knowledge of national, European and international telecommunication regulations and laws.	- know - Know be
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be

Learning outcomes	
Learning outcomes	Competences
Transmissionm line specification: two-wire line, coaxial wire, coaxial models, twisted pair, optical fibre.	CG3 CE8 CE9
Analysing waves of tension and current and stationary wave.	CG5 CE9 CE13
Proposing impedance matching solutions.	CG4
Crosstalk problems evaluation.	CG5 CE13

Antenna radiated field calculation and related parameters: radiation pattern, gain, beam-width, impedance, polarisation, effective area.	CG5 CE9 CE13
Resolving problems of propagation and reception of electromagnetic waves.	CG3 CG4 CE20 CT2 CT3

Contents

Topic	
Introduction	Types of transmission media, advantages and disadvantages, characterisation.
Transmission lines	Getting started with some of the most commonly used transmission lines: two-wire, coaxial, twisted pair. Circuit model of distributed parameters ,general equations, characteristic parameters (characteristic impedance, propagation velocity, attenuation and phase coefficients). Attenuation, dispersion and crosstalk. Transmission line in circuit (reflection coefficient, standing wave ratio, input impedance). Smith Chart.
Waveguides	Transmission modes, cutoff frequency, guided wavelength, wave impedance. Rectangular waveguide.
Optical fiber.	Structure and types. Numerical aperture and acceptance cone. Attenuation and dispersion. Optical sources and receptors.
Radiowaves and antennas	Characteristics of radiowaves: far field, radiation integral. Antenna concept and fundamental parameters (radiation pattern, secondary lobe level, beamwidth, directivity, gain, polarisation, impedance). Reception: power balance in free space (Friis equation), polarization loss factor. Antenna arrays.
Labs	- Management of software tools to search information: technical, scientific and regulation of telecommunications. - Measurement and analysis of voltage and current waves and standing waves. - Optical fiber transmission fundamentals. - Basic impedance matching technics. - Radiation pattern plots. - Measurement of antenna basic parameters. - Problem resolution.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Master Session	18	27	45
Autonomous troubleshooting and / or exercises	7	28	35
Laboratory practises	10	2	12
Practice in computer rooms	8	2	10
Classroom work	8	16	24
Troubleshooting and / or exercises	3	12	15
Multiple choice 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
Introductory activities	Activities focused to take contact and get information about the students and to introduce the subject.

Master Session	Presentation by the teacher of the contents of the subject of study (theoretical basis). Through this methodology the competencies CG3, CE9,CE13,CE20 and CT2 are developed.
Autonomous troubleshooting and / or exercises	Activity in which problems are formulated related to the subject. The student must develop the analysis and solving problems independently. The solutions are provided in ordinary class hours. Through this methodology the competencies CG4, CE9 and CE13 are developed.
Laboratory practises	Application of knowledge to specific situations and acquisition of basic skills and procedures. They are developed in laboratories with specialized equipment. Through this methodology the competencies CG5 and CT3 are developed.
Practice in computer rooms	Activities of acquisition of basic skills related with the matter. Through this methodology the competencies CG3, CE8, CE20 and CT3 are developed.
Classroom work	Activities of acquisition and handle of technics and tools related with the matter. Through this methodology the competencies CG3 and CG4 are developed.

Personalized attention

Methodologies	Description
Master Session	In the tutorial schedule, teaching staff will attend the needs and queries of the students related with the study of the subject.
Laboratory practises	The teaching staff will set the time of the session and will resolve the questions about the practical implementation.
Autonomous troubleshooting and / or exercises	In the tutorial schedule, teaching staff will attend the needs and queries of the students related with the study of the subject.
Practice in computer rooms	The teaching staff will set the time of the session and will resolve the questions about the practical implementation.
Classroom work	The teaching staff will set the time of the session and will resolve the questions about the practical implementation.

Assessment

	Description	Qualification	Evaluated Competencess
Classroom work	Short checks (see other comments)	25	CG4 CG5 CE8 CE20
Multiple choice tests	Tests for evaluation of acquired skills including direct questions about a particular aspect. Students must respond directly and briefly based on their subject knowledge.	35	CG3 CE9 CE13
Troubleshooting and / or exercises	Proof in which the student has to solve a series of problems in a time and conditions established by the teacher, applying the acquired knowledge.	40	CG3 CG4 CE9 CE13

Other comments and July evaluation

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

Continuous assessment

Continuous assessment includes the following tasks performed approximately in the week indicated:

- Classroom work: four short checks carried out in practical hours (weeks 4, 9, 12 and 14) weighing 5%, 5%, 5% and 10%, respectively.
- Test: two quizzes. The first half of the quarter, with a weight of 25%, and the second at the end, weighing 10%.
- Problem solving: two exams. The first half of the quarter, with a weight of 20% and the second at the end, with a weight of 20%.

To pass the subject by this evaluation system, 1/3 of the maximum score of each item in the above table must be obtained and 50% minimum of the global score (sum of the three blocks) must be reached.

These tasks are **not recoverable**, ie if a student cannot fulfill on time the teacher has no obligation to repeat them and will

only be valid for the academic year in which they are made.

The students must decide if they choose the ongoing evaluation after the realization of the first test of problem solving, in which case they receive a grade that corresponds, independently that they present to other tasks or not. Failure to submit to this test implies that the evaluation choice is by final exam. If the score is high as 50% without getting 1/3 in some of the items, the official grade will be 4.5.

Evaluation by final exam

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

- Part I: test on measurement practices (10%) and information search exercise (5%).
- Part II: questions (35%).
- Part III: problem solving (50%).

Second chance

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

Students who have opted for the continuous assessment system may keep the grade (classroom work, test or problem) in which they have exceeded the required minimum.

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

Sources of information
Basic Bibliography
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N.N.Rao, Elements of engineering electromagnetics, 6ª, Pearson, 2004,
J.D. Krauss, Electromagnetismo con aplicaciones, McGraw-Hill, 2000,
D. K. Cheng, Field and Wave Electromagnetics, 2ª, Addison-Wesley, 1989,

Recommendations

Subjects that continue the syllabus

Fundamentals of Sound and Image/V05G300V01405
Signal Transmission and Reception Techniques/V05G300V01404
Microwave Circuits/V05G300V01611
Radio Frequency Circuits/V05G300V01511
Optical Telecommunication Infrastructures/V05G300V01614
Wireless Systems and Networks/V05G300V01615
Radio Communication Systems/V05G300V01512

Subjects that are recommended to be taken simultaneously

Digital Signal Processing/V05G300V01304

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G300V01201
Physics: Fields and Waves/V05G300V01202
Mathematics: Calculus 1/V05G300V01105
Mathematics: Calculus 2/V05G300V01203

IDENTIFYING DATA				
Digital Signal Processing				
Subject	Digital Signal Processing			
Code	V05G300V01304			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Alonso Alonso, Ignacio			
Lecturers	Alonso Alonso, Ignacio Docio Fernández, Laura García Mateo, Carmen Márquez Flórez, Óscar Willian			
E-mail	ignacio.alonso@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Digital signal processing is nowadays a feature of most everyday communications and entertainment devices. The aim of this course is to equip students with a mathematical grounding in general signal and systems analysis. In subsequent course subjects, this knowledge will be applied to specific applications of signals and systems, including audio, image, video and voice signals. Objectives cover the following areas: • Managing signals and systems mathematically and visually, including learning and applying their properties. • Studying the different domains for signal and systems analysis: time domain, frequency domain and Z domain. • Learning how to transfer a problem in one domain to a domain in which it is easier to solve. • Mastering the concept of filter frequency response and learning to interpret the system function. • Understanding the relationship between the poles and zeros of the system function and the frequency response. • Acquiring basic notions of filter design in the Z domain. • Managing specific digital signal processing software. • Applying the above knowledge to simple and practical laboratory examples.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CE48	(CE48/T16) The knowledge of the appropriate techniques to develop and exploit signal processing subsystems .	- know
CE49	(CE49/T17) The ability to analyze digital signal processing schemes.	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know How
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know

Learning outcomes	
Learning outcomes	Competences
Managing specific software for digital signal processing	CG3 CE48 CT3
Applying mathematical knowledge for signal filtering	CG4 CE49 CT2

Mastering filtering operations in frequency domain.	CG4 CE49 CT2
Learning mathematical issues for understanding the processes of sampling and windowing of analog signals.	CG3 CE48 CT3
Analysis of simple processing systems.	CG4 CE49 CT2

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

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Master Session	23	40	63
Laboratory practises	11	22	33
Troubleshooting and / or exercises	15	30	45
Forum Index	0	2	2
Multiple choice tests	1.5	0	1.5
Troubleshooting and / or exercises	4.5	0	4.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Introductory activities	Course presentation: programme, reading materials, teaching methodology and assessment system
Master Session	Instructor presentation of the main concepts of each subject. During the 5 minutes before the lecture, a student will summarize the main concepts presented in the previous session. Students will participate by answering questions during the explanation and by doing exercises. Student will work alone afterwards on the concepts studied in class and on expanding this content using the guidelines provided for each subject. Identification of doubts that need to be resolved in personalized tutorials. Through this methodology the competencies CE48, CG3, and CT3 are developed.

Laboratory practises	Application of Matlab functions and commands for digital signal processing to solve practical exercises. Identification of doubts that need to be resolved in personalized tutorials. Through this methodology the competencies CE49, CG4 and CT2 are developed.
Troubleshooting and / or exercises	Problems and exercises formulated according to the content of the lectures and the guidelines for each subject. Students solve problems and exercises prior to the class in which one or several students explain the solution on the board. Identification of doubts that need to be resolved in personalized tutorials. Through this methodology the competencies CE49, CG4 and CT2 are developed.
Forum Index	The website for the course is included in the TEMA platform (http://faitic.uvigo.es). Subscription to this platform, including a photograph, is mandatory. The website provides all the information related to the course. It also publishes continuous assessment grades and runs forums for students to exchange ideas and discuss doubts. Through this methodology the competencies CE48, CE49, CG3, CG4 , CT2 and CT3 are developed.

Personalized attention

Methodologies	Description
Master Session	Students will have the opportunity to attend personal tutorials in their lecturer’s office at times established by lecturers for this purpose at the beginning of the academic year and published on the course website. These tutorials are aimed at resolving student doubts and providing guidance regarding: • The content of the lectures and approaches to study. • Laboratory projects and the software used. • Problems and exercises proposed and solved in the classroom as well as other problems and exercises arising during the course.
Laboratory practises	Students will have the opportunity to attend personal tutorials in their lecturer’s office at times established by lecturers for this purpose at the beginning of the academic year and published on the course website. These tutorials are aimed at resolving student doubts and providing guidance regarding: • The content of the lectures and approaches to study. • Laboratory projects and the software used. • Problems and exercises proposed and solved in the classroom as well as other problems and exercises arising during the course.
Troubleshooting and / or exercises	Students will have the opportunity to attend personal tutorials in their lecturer’s office at times established by lecturers for this purpose at the beginning of the academic year and published on the course website. These tutorials are aimed at resolving student doubts and providing guidance regarding: • The content of the lectures and approaches to study. • Laboratory projects and the software used. • Problems and exercises proposed and solved in the classroom as well as other problems and exercises arising during the course.

Assessment

	Description	Qualification	Evaluated Competencess
Troubleshooting and / or exercises	These tests are a requirement to pass the subject. See details in the "Other comments and second call" section.	100	CG3 CG4 CE48 CE49 CT2 CT3
Multiple choice tests	These tests are a requirement to pass the subject. See details in the "Other comments and second call" section.	0	CG3 CE48 CE49 CT3

Other comments and July evaluation

ASSESSMENT PROCEDURE:

A. Overview

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

1. **Lab assessment**.
2. **Problem assessment**.

To pass the course it is necessary to pass all two parts.

- For each part one or more tests are performed to obtain an independent grade on each.
- There are tests for each part both during the lecture period and final evaluation periods. In total there are three opportunities to pass each part throughout the academic year.
- A pass grade in any part is valid for the entire academic year.
- The final grade for Lab assessment is a numerical mark between 0 and 10. A student needs a grade equal or greater than 5 to pass the Lab. If the Lab grade is greater than 7, the Lab grade will increase the Course mark (see details below).
- The final grade for the Problem assessment is a numerical mark between 0 and 10.
- The **Course mark** is obtained roughly as follows:
    - If you have passed all two parts and the Lab grade is not greater than 7:
        - Course mark=Problem assessment grade.
    - If you have passed all two parts and the Lab grade is greater than 7:
        - Course mark=minimum [10 , Problem assessment grade + [(Lab grade-7)/3]]
    - If you have not passed any of the two parts:
        - minimum [Problem assessment grade, Lab grade]
    - In case the student has more than one mark for any part, the highest one will be used.

It is also important to note that:

- The course can be passed with full marks from continuous assessment, with no need to sit the final exam.
- Students who have done continuous assessment and have failed any part, at the end of the term or at the end of the academic year, may need to perform only the failed parts.
- Students who sit any of the tests corresponding to Problem assessment will obtain a mark that will be listed in the academic records.

The following sections explain in detail how each part is graded.

B. Details of the assessment procedure

B1. Lab assessments

- Their goal is to determine whether the student has acquired all the knowledge and/or skills corresponding to the laboratory practice, emphasizing the use of MatLab for digital signal processing.
- Content to be assessed: content of the lab manuals and related theory content.
- Type of test: The test consists of a combination of multiple-choice questions and short questions. Students may use MatLab, lab manuals with personal notes, and text book. Students may not use a calculator for this test.
- The final grade for Lab assessment is a numerical mark between 0 and 10. A student needs a grade equal or greater than 5 to pass the Lab. If the Lab grade is greater than 7, the Lab grade will increase the Course mark.
- There are 3 opportunities to pass:
    - Opportunity 1 (Continuous assessment)
        - There will be three mandatory tests in the lab room
        - The test consists of a series of questions at the end of each Practice assignment
        - The tests will be graded between 0 and 10. The student will pass this part if he/she gets an average greater than or equal to 5. It is compulsory to sit all three tests.
        - Exact dates will be announced on the web site at the beginning of the lecture period.
    - Opportunities 2 and 3. A test in the End-of-Term exam period, and a test in the End-of-Academic-Year exam period. Students must obtain a pass grade in this test in order to pass the course. The pass mark for this test is 5 out of 10.
- Remarks:
    - Once the pass grade is obtained, this is valid for the entire academic year.
    - While the pass grade is not obtained, it is possible to sit any of the three opportunities.

B2. Problem Assessment

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

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

C. Other comments

- The grade obtained at the end of the term will be part of the academic record of the student. This grade will be final if the mark is above or equal to 5. Otherwise a provisional fail grade will be recorded on their academic record.
- The provisional mark will become definitive fails for students who do not sit at the end of the academic year exam period, or gets a lower mark. Otherwise the better mark will be part of the academic record and becomes final.
- Tests performed as continuous assessment may not be rescheduled.
- The grades obtained in the lab assessment or problem assessment are only valid for the current academic year.
- The use of books, notes or electronic devices such as phones or computers is not permitted in any test or exam. Mobile phones must be turned off and out of reach of the student. If calculator use is permitted, the calculator must be a conventional scientific calculator. Under no circumstances may calculators be used that allow formulas to be saved or that have libraries that automatically perform operations with complex numbers, calculation of roots, etc.

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Basic Bibliography
J.H. McClellan y R.W. Schafer, R, Signal Processing First, Pearson Prentice Hall, 2003
Complementary Bibliography
A. Quarteroni y F. Saleri, Cálculo científico con Matlab y Octave, Springer, 2006
M. J. Roberts, Señales y Sistemas, McGraw Hill, 2005
A.V. Oppenheim y R.W. Schafer, Tratamiento de señales en tiempo discreto, Prentice Hall, 3ª edición, 2011

Recommendations
Subjects that continue the syllabus
Fundamentals of Sound and Image/V05G300V01405 Signal Transmission and Reception Techniques/V05G300V01404 Fundamentals of Image Processing/V05G300V01632 Sound Processing/V05G300V01634 Audio Systems/V05G300V01532 Imaging Systems/V05G300V01633 Electronic Systems for Signal Processing/V05G300V01522 Multimedia Signal Processing/V05G300V01513 Video and Television/V05G300V01533
Subjects that it is recommended to have taken before
Physics: Analysis of Linear Circuits/V05G300V01201 Mathematics: Linear algebra/V05G300V01104 Mathematics: Calculus 1/V05G300V01105 Mathematics: Calculus 2/V05G300V01203 Mathematics: Probability and Statistics/V05G300V01204

IDENTIFYING DATA				
Physics: Fundamentals of Electronics				
Subject	Physics: Fundamentals of Electronics			
Code	V05G300V01305			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Basic education	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Domínguez Gómez, Miguel Ángel			
Lecturers	Domínguez Gómez, Miguel Ángel Pérez López, Serafín Alfonso Raña García, Herminio José Rodríguez Pardo, María Loreto			
E-mail	mdgomez@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main purpose of this course is to provide students the basis for understanding and mastery of the principles of operation of devices and electronic circuits. It begins with a brief introduction to electronics in order to provide students with a global vision. After, basic concepts about devices and electronic circuits are taught: · Diodes and circuits with diodes, including concepts such as load line, ideal diodes, rectifiers, shaping circuits, logic circuits, voltage regulators and devices physics. · Characteristics of bipolar transistors, analysis of load line, large-signal models, polarization, amplification and small-signal equivalent circuits. · Study of the FET similar to the previous highlighting the MOSFET. · Check the circuit designs studied using SPICE. Mounting and verification using laboratory electronic instrumentation. · Basic concepts about logic digital circuits. On the other hand, in the framework of the course takes place first contact of students with the electronics lab. Therefore, the main objective of the practical part of the course is that the student acquires the bases for a correct management of the most common instruments in the laboratories of electronics. The student, at the end of the course, must know handle the laboratory instruments, should distinguish and characterize the different components, and have practical skills in assembly and measurement. Students will also start with simulation of circuits, in order to introduce them to computer-aided design.			

Competencies		
Code		Typology
CG13	CG13 The ability to use software tools that support problem solving in engineering.	- Know How
CE4	CE4/FB4: Comprehension and command of basic concepts in linear systems and their related functions and transforms; electric circuits theory, electronic circuits, physical principles of semiconductors and logical families, electronic and photonic devices, materials technology and their application to solve Engineering problems.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Understanding and control of the basic concepts of the physical principles of semiconductors.	CE4
Understanding and control of the basic concepts of operation of the electronic and photonic devices.	CE4
Understanding and control of simple electronic circuits based on the electronic and photonic devices and their applications.	CE4
Understanding and control of the basic concepts of the logic families.	CE4
Basic knowledges on CAD (Computer Aided Design) tools for the simulation of electronic circuits.	CG13
Capacity utilization of CAD tools for designing simple electronic circuits.	CG13

Contents

Topic	
Subject 1: Introduction	Electronic systems. Design process. Integrated circuits.
Subject 2: Diodes and circuits with diodes	Characteristics of the diode. Zeners. Analysis of the load line. Ideal model of the diode. Circuits with diodes (rectifiers, clipping and voltage regulator circuits). Small signal equivalent linear circuits. Basic concepts of semiconductors. Physics of the diode. Capacity effects. LED and laser diodes. Photodiodes.
Subject 3: Principles of amplification	General aims: Voltage, current and power gains. Ideal amplifier. Amplifier Models. Limits. Introduction to amplifier frequency response.
Subject 4: Bipolar Junjction Transistors (BJT)	Operation of the npn Bipolar Junction Transistor (BJT). Load-Line Analysis of a Common-Emitter Amplifier. The pnp Bipolar Junction Transistor. Models of circuits. Analysis of circuits with BJTs. Phototransistors and optocouplers.
Subject 5: Analysis of amplifiers with Bipolar Junction Transistors	Small-Signal Equivalent Circuits. Analysis in medium frequencies: the Common-Emitter amplifier, the Emitter-Follower amplifier, the Common-Collector amplifier and the Common-Base amplifier.
Subject 6: Field Effect Transistors (FET)	NMOS Transistor. Analysis of the load line of a simplified NMOS amplifier. Polarization circuits. JFET and depletion MOSFET transistors and channel p devices.
Subject 7: Analysis of amplifiers with Field Effect Transistors	Small-Signal Equivalent Circuits. Analysis in medium frequencies: the Common-Source amplifier and the Source Follower amplifiers.
Subject 8: Digital logic circuits	Digital logic circuits. Basic concepts. Electrical specifications of the logic gates. The inverter CMOS. CMOS gates NOR and NAND.

Planning

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

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

Methodologies

	Description
Introductory activities	Presentation of the subject. Presentation of the laboratory practices and the instrumentation and software to be used. Through this methodology the competencies CG13 and CE4 are developed.
Master Session	Exposition of contents. Later personal work of the student reviewing the concepts seen in the classroom and preparing the subjects using the proposed bibliography. Identification of doubts that require to be resolved in personal tutorships. Through this methodology the competency CE4 is developed.
Troubleshooting and / or exercises	Activity to formulate and resolve problems and/or exercises related with the subject. Complement of the theoretical sessions. Personal work of the student with resolution of problems and/or exercises proposed in the classroom and extracted of the bibliography. Identification of doubts that require to be resolved in personal tutorships. Through this methodology the competency CE4 is developed.
Laboratory practises	Activities of application of the theoretical knowledges. It will learn to handle the typical instrumentation of an electronic laboratory and it will implement basic electronic circuits seen in the theoric sessions. Also they will purchase skills of handle of simulation tools. Personal work of the student preparing the practices using the available documentation and reviewing the theoretical concepts related. Development and analysis of results. Identification of doubts that require to be resolved in personal tutorships. Through this methodology the competency CG13 is developed.

Personalized attention

Methodologies	Description

Master Session	The students will be able to attend to personalised tutorials in the professor´s office in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts about the contents given in the Master Sessions and will be oriented about how to deal with them.
Troubleshooting and / or exercises	The students will be able to attend to personalised tutorials in the professor's office in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts about the problems and/or exercises proposed and resolved in the classroom as well as other problems and/or exercises that can appear along the study of the subject.
Laboratory practises	The students will be able to attend to personalised tutorials in the professor's office in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts about the development of the laboratory practices, the handle of the instrumentation, the setting of the electronic circuits and the software of simulation.

Assessment

	Description	Qualification	Evaluated Competencess
Troubleshooting and / or exercises	Tests will be carried out in the classroom throughout the year to evaluate the competencies of the student to resolve problems and/or the exercises over a part of the contents of the subject.	60	CE4
Practical tests, real task execution and / or simulated.	Tests will be carried out in the laboratory along the course about management of instrumentation, mounting of electronic circuits and simulation. The skills acquired by the student about the contents of the subject laboratory practices will be evaluated.	35	CG13 CE4
Self-assessment tests	Techniques aimed to collect data about the participation of the student in the proposed self-assessment tests.	5	

Other comments and July evaluation

1. Continuous evaluation

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

1.a Self-assessment tests

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

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

NAE = 0.05*AE

1.b Theory

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

NPT = (NPT1 + NPT2 + NPT3)/3

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

The final mark of theory (NT) will be:

NT = 0.6*NPT

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

1.c Practical

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

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

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

1.d Final mark of the subject

It must get a minimum of 4 points out of 10 in theory (NT >= 2.4) and practices (NP >= 1.4) to pass the subject. Also it is necessary to get a minimum of 3 points out of 10 in each of the 3 theory exams (NPT1 >= 3, NPT2 >= 3 and NPT3 >= 3).

The final mark (NF) will be:

If NT >= 2.4 and NP >= 1.4 and NPT1 >= 3 and NPT2 >= 3 and NPT3 >= 3 => NF = NAE + NT + NP

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

2. Final exam

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

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

The practical exam will be carried out in the laboratory in the dates established by the School and it will consist in a practical test which will be evaluated from 0 up to 10 and the final mark of practices (NP) will be the points of the test multiplied by 0.4. It must get a minimum of 4 points out of 10 in the practical exam (NP >= 1.4) to pass the subject.

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

The students who have opted for the continuous evaluation and have failed and present to the final exam, can do it only to the theoretical part or to the practical one or both. They will conserve the mark got in the continuous evaluation of the missed part if the minimums specified in the continuous evaluation process were achieved. The students who take the theoretical part will be able to carry out the blocks they want. The mark of the continous evaluation of the missed blocks (NPT1, NPT2 and NPT3) will be kept. If they do not take the practical part, the practice note (NP) of the continuous evaluation is recalculated multiplying by 0.4 instead of by 0.35.

The final mark (NF) will be:

If NT >= 2.4 and NP >= 1.6 and NPT1 >= 3 and NPT2 >= 3 and NPT3 >= 3 => NF = NT + NP

If NT < 2.4 or NP < 1.6 or NPT1< 3 or NPT2 < 3 or NPT3 < 3 => NF = min {4.5; NT + NP}

3. Recovery

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

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

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

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

4. Validity of the qualifications

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

Sources of information
Basic Bibliography
Hambley, A. R., Electrónica, 2ª ed., Prentice Hall, 2001,
Quintáns, C., Simulación de circuitos electrónicos con OrCAD 16 Demo, Marcombo, 2008, España
Complementary Bibliography

Recommendations
Subjects that continue the syllabus
Digital Electronics/V05G300V01402 Electronic Technology/V05G300V01401
Subjects that it is recommended to have taken before
Physics: Analysis of Linear Circuits/V05G300V01201

IDENTIFYING DATA				
Electronic Technology				
Subject	Electronic Technology			
Code	V05G300V01401			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Raña García, Herminio José			
Lecturers	Baneira Collazo, Fernando Marcos Acevedo, Jorge Pérez Estévez, Diego Quintáns Graña, Camilo Raña García, Herminio José Rodríguez Pardo, María Loreto Valdés Peña, María Dolores			
E-mail	hrana@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course devotes to the utilisation of integrated circuits, in particular operational amplifiers, as well as to the following fields: Electronics of Power, Electrotechnics in his slope of electrical installations and to the conversion of photovoltaic solar energy and thermal.			

Competencies		
Code		Typology
CG13	CG13 The ability to use software tools that support problem solving in engineering.	- Know How
CG14	CG14 The ability to use software tools to search for information or bibliographical resources.	- Know How
CE14	CE14/T9: The ability to analyze and design combinatory and sequential, synchronous and asynchronous circuits and the usage of integrated circuits and microprocessors.	- know - Know How
CE16	CE16/T11: The ability to use different energy sources, especially photovoltaic and thermal ones, as well as the fundamentals of power electronics and electronics	- know - Know How

Learning outcomes	
Learning outcomes	Competences
To know how to analyse and use circuits with operational amplifiers and with other integrated circuits.	CG13 CG14 CE14
To know the foundations of Electrotechnics.	CE16
To know the foundations of the Power Electronics and the basic topologies of the power electronic converters.	CG13 CG14 CE16
Ability to use distinct sources of energy and especially photovoltaic solar energy and thermal solar energy.	CG13 CE16

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

Photovoltaic and thermal solar energy	Photovoltaic and thermal solar installations. Photovoltaic cells. Photovoltaic panels. Photovoltaic systems of energy conversion.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	18	18	36
Laboratory practises	22	22	44
Troubleshooting and / or exercises	6	12	18
Short answer tests	3	15	18
Troubleshooting and / or exercises	3	15	18
Practical tests, real task execution and / or simulated.	4	12	16

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

Methodologies	
	Description
Master Session	The teachers explain the theoretical contents. Through this methodology the competencies CE14 and CE16 are developed.
Laboratory practises	They include circuit mounting and testing and computer electronic circuits simulation. Some practical clases will also include some web search made by the student, about some technical information about some specific electronic devices used in the practical classes (e.g. some kind of transistors or operational amplifiers). Through this methodology the competencies CE14, CE16, CG13 and CG14 are developed.
Troubleshooting and / or exercises	The teacher will solve exercises about most of the chapters. Through this methodology the competencies CE14 and CE16 are developed.

Personalized attention	
Methodologies	Description
Master Session	The students may attend to the professor office in the tutorship time published in the course webpage. Doubts about the contents of the master classes will be resolved in this tutorship time as well as doubts about how to prepare their study.
Laboratory practises	The students may attend to the professor office in the tutorship time published in the course webpage. Doubts arisen to the students about the practices of laboratory, about how to use the instrumentation or about the implementation of the electronic circuits and the simulation software will be resolved in this sessions.
Troubleshooting and / or exercises	The students may attend to the professor office in the tutorship time published in the course webpage. Doubts arisen to the students on the problems and/or exercises proposed and resolved in the classroom will be resolved in this tutorship time as well as other problems and/or exercises that can appear along the study of the subject.

Assessment			
	Description	Qualification	Evaluated Competencess
Short answer tests	They make part of each partial examination of theory, in which they are half of its value. The number of tests and how they work are detailed in "Other comments and second call".	35	CE14 CE16
Troubleshooting and / or exercises	They make part of each partial examination of theory, in which they are half of its value.The number of tests and how they work are detailed in "Other comments and second call".	35	CE14 CE16
Practical tests, real task execution and / or simulated.	They are made in the laboratory. They consist of the kind of tasks made or prepared during the practices of the course: the practical exams consist of: 1) mounting of circuits, taking measures on them and answering questions related with these circuits and 2) simulation circuits equal or similar to the ones studied in the practices and answering questions related with this simulation. In the examinations of practices of laboratory the student will be allowed to use some especific technical information collected by the student during the practices (eg datasheets from manufacturers).	30	CG13 CG14 CE14 CE16

Other comments and July evaluation

A process of continuous assessment based on midterms is established, but the student may choose alternatively a single assessment in a final exam.

Partial proofs are not recoverable, i.e., if a student can not attend the day they are scheduled, teachers do not have obligation to repeat them. The scores for the partial proofs are valid only for the academic year in which they are made.

Note 1: During exams mobile phones must be turned off and kept away. It is not allowed to use them as calculators. The student must have a calculator.

Note 2: It is not allowed to enter the classroom after an examination begins.

Continuous assessment:

For continuous assessment, the contents of theory are divided into three blocks and the contents of laboratory are divided into two blocks.

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

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

Regarding theory:

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

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

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

The partial proofs take place on the usual weekly scheduling of the classes and last 1 hour and 50 minutes each.

They include both one half (in time and in mark) of short answer questions and one half exercises.

Each block of the final theory exam (first, second and third) lasts an hour.

Regarding practices:

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

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

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

The practice note NP is the average mark of the two blocks, if the mark of the student in both partial proofs exceed 4 points. If the student doesn't reach 4 points in one of the two blocks, his/her practice note is the minimum between 3.5 and the average of the two blocks.

The only documentation that can, and should, take the student to the practical tests for use during the lab proofs are manufacturer datasheets about the semiconductors used during practices. The student has to gather them to perform the practices.

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

Final mark:

The final mark NF is NT x 0.7 + NP x 0.3, if NT and NP are both at least 4 points. Otherwise NF is the minimum between 4.5 and NT x 0.7 + NP x 0.3 . NT and NP are calculated as indicated above. The student passes the course in May session if the final mark NF is greater than or equal to 5.

Evaluation by single exam

Students who choose single test evaluation do the same final exam as those other who are assessed by continuous assessment and who have reached the minimum mark in no partial proof. i.e., they have to make all the final examination, both the three blocks of theory and the two blocks of lab practices.

The theory mark NT, the practice mark NP and the final mark NF are calculated in the same way as indicated above, for students assessed by continuous assessment.

Second call

The second call exam consists of two parts:

- A theory proof, 3 hours long. Its mark is NT.

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

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

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

In the second call, all the students may attend to both sections (theory and practice). The rule of“highest mark” which is compulsory for the total mark of all the courses, will apply in this course also extended to each section; i.e., the theory mark of each student to calculate the mark for the second call will be the highest between the May theory mark and the mark in the second call theory proof. The same for the lab mark.

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

Sources of information
Basic Bibliography
Hambley, A. R., Electrónica, Prentice-Hall, 2ª ed. en español, 2001
Hart, D. W., Electrónica de potencia, Prentice-Hall, 2001
Quintáns Graña, C., Simulación de circuitos con OrCAD 16 DEMO, Marcombo, 2008
Complementary Bibliography
Rashid, Muhammad H., Electrónica de potencia: circuitos, dispositivos y aplicaciones, Pearson Education, 2004
Reglamento Electrotécnico para Baja Tensión (REBT) e Instrucciones Técnicas Complementarias (ITC),
Schneider Electric España, S.A., Guía de diseño de instalaciones eléctricas (PDF de uso libre disponible en www.schneiderelectric.es), Schneider Electric España, S.A, 2008
Guirado, R., Tecnología eléctrica, McGraw-Hill, 2006
AENOR, Norma UNE 60617 de Símbolos gráficos para esquemas eléctricos,
Carta, J. A. y otros, "Centrales de energías renovables: Generación eléctrica con energías renovables", Pearson-UNED, 2009

Recommendations
Subjects that continue the syllabus
Analogue Electronics/V05G300V01624 Power Electronics/V05G300V01625

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G300V01201
Physics: Fundamentals of Electronics/V05G300V01305

Other comments

The student should have good knowledge about the course "Física: Fundamentos de Electrónica"/V05G300V01305 ("Physics: Electronics Fundamentals"/V05G300V01305), in both its theoretical contents as well as in the laboratory practic classes.

IDENTIFYING DATA				
Digital Electronics				
Subject	Digital Electronics			
Code	V05G300V01402			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Machado Domínguez, Fernando			
Lecturers	Álvarez Ruiz de Ojeda, Luís Jacobo Machado Domínguez, Fernando Moure Rodríguez, María José Pérez López, Serafín Alfonso			
E-mail	fmachado@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course is an introduction to the basic principles of digital design and the analysis and design of digital circuits and systems. First, logic circuits, basic digital devices and logic gates representation will be introduced. Then, hardware description languages (HDL) based design, description and simulation methods will be described. Combinational and sequential logic design will be explained using the top-down design paradigm. Finally, the common combinational and sequential logic circuits will be described: operation, diagrams, symbols and VHDL description and simulation.			

Competencies		
Code		Typology
CG13	CG13 The ability to use software tools that support problem solving in engineering.	- know - Know How
CG14	CG14 The ability to use software tools to search for information or bibliographical resources.	- know - Know How
CE14	CE14/T9: The ability to analyze and design combinatory and sequential, synchronous and asynchronous circuits and the usage of integrated circuits and microprocessors.	- know - Know How
CE15	CE15/T10: The knowledge and application of the fundamentals of description languages for hardware devices.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Knowledge of digital design principles, components and tools.	CE14 CE15
Ability to analyse and design combinational systems.	CG13 CE14 CE15
Knowledge of the combinational functional blocks and their aplications.	CG14 CE14
Knowledge of the basic storage elements, the sequential blocks and their aplications.	CG14 CE14
Ability to analyse and design synchronous sequential systems.	CG13 CE14 CE15
Knowledge of description and simulation methods based on hardware description languages (HDL).	CG13 CE14 CE15

Contents
Topic

Unit 1: Introduction to digital electronics	Introduction to Digital Electronics. Number systems and digital codes. Boolean Algebra. Truth Tables. Logic Gates. Boolean Funtions Simplification.
Unit 2: Introduction to VHDL	Introduction to hardware description languages. Basic VHDL syntax. Data types and objects. Operators. Concurrent and sequential sentences. Component instantiation.
Unit 3: Basic combinational systems	Functional blocks. Technologies and output types of the digital circuits. Decoders. Encoders. Multiplexers. Demultiplexers. Application examples. VHDL description.
Unit 4: Programmable gate arrays	Introduction to the programmable circuits. PLA and PAL. Application examples.
Unit 5: Arithmetic combinational systems	Comparators. Parity detection and generation. Arithmetic circuits. Application examples. VHDL description.
Unit 6: Sequential logic systems principles	Definition and classification. Latches and flip-flops. Application examples. VHDL description.
Unit 7: Synchronous sequential systems	General theory. Counters. Multibit registers. Shift registers. Application examples. VHDL description.
Unit 8: Synchronous sequential logic design	Synchronous sequential systems design. Application examples. VHDL description.
Unit 10: Memory units	Classification. Active and pasive random access memories. Random access memories. Sequential acces memories. Associative memories.
Unit 9: Programmable logical devices	Introduction to the PLDs. Application examples.

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

Planning

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

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

Methodologies	
	Description
Introductory activities	Subject presentation. Presentation of laboratory sessions, instrumentation and software resources to be used.
Master Session	The lecturer will explain in the classroom the main contents of the subject. The students have to manage the proposed bibliography to carry out a self-study process in a way that leads to acquire the knowledge and the skills related to the subject. The lecturer will answer the students' questions in the classroom or in the office. In these sessions the students will develop the skils CE14 and CE15 ("know").
Laboratory practises	Activities designed to apply the main concepts and definitions of the subject. The students will be asked to acquire the basic skills to manage the laboratory instrumentation, software tools and components in order to construct and test electronic circuits. The students have to develop and demonstrate autonomous learning and collaborative skills. Possible questions can be answered in the laboratory sessions or in the lecturer's office. In these sessions the students will develop the skils CE15, CG13 and CG14 ("know how").
Troubleshooting and / or exercises	Activities designed to apply the main concepts of the subject to solve problems and exercices. The lecturer will explain a set of problems and the students have to solve diferent take-home sets of problems. The answers to selected problems will be provided later on. The lecturer will answer the students' questions in the classroom or at the office. In these sessions the students will develop the skils CE14 and CG15 ("know how").

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

Assessment			
	Description	Qualification	Evaluated Competencess
Laboratory practises	The lecturer will check the level of compliance of the students with the goals related to the laboratory skills. Final mark of laboratory, FML, will be assessed in a 10 points scale. For the evaluation of the laboratory sessions, the lecturer will assess the group work (the same mark for each member) and the individual answers to personalized questions for each session (individual mark).	20	CG13 CG14 CE15
Troubleshooting and / or exercises	The lecturer will check the students' skills to solve exercices and troubleshooting. Marks for each test will be assessed in a 10 points scale. Final mark of theory, FMT, will be assessed in a 10 points scale.	80	CE14 CE15

Other comments and July evaluation

1. Continuous assessment

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

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

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

1.a Theory

Three exercises and troubleshooting tests (ETT) are scheduled. The first and second test (ETT1 and ETT2) will be respectively performed after unit 4 and 7 (~ in weeks 6 and 12), in the usual weekly scheduling of the theoretical classes. The final test (FETT) will be performed during the examination period in the date specified in the academic calendar. Marks for each test will be assessed in a 10 points scale. In order to pass this part, students will be require to obtain at least a mark of 4 in the final test (FETT>=4). In this case the final mark of theory (FMT) will be:

FMT = max{FETT ; (0.2·ETT1 + 0.2·ETT2 + 0.6·FETT)}.

However, when the students do not pass the final test (FETT less than 4), the final mark of theory will be:

FMT = min{4 ; max{FETT ; (0.2·ETT1 + 0.2·ETT2 + 0.6·FETT)}}.

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

1.b Laboratory

Thirteen laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in pairs whenever possible. The first five sessions are guided practices. In these sessions, the instrumentation and software resources will be presented and the students will configure a programmable logic device following the design flow. These five sessions are mandatory but will not be assessed. The following seasons will be assessed by continuous assessment. Each session will be only evaluated according to the developed work at the schedule date. The marks for these laboratory sessions (LSM) will be assessed in a 10 points scale. The lecturer will consider the work of the students carried out before the laboratory session to prepare the proposed tasks, the work in the laboratory to deal with them as well as the student's behavior. Only sessions 6 to 13 will be assessed. A mark of 0 will be obtained for missing sessions. In order to pass the laboratory part, the students can not miss more than two laboratory sessions. In this case, the weighted points from all assessed sessions are added together to calculate the final mark of laboratory (FML):

FML = (LSM6 + LSM7 + LSM8 + LSM9 + LSM10 + LSM11 + LSM12 + LSM13) / 8.

For the students who miss more than two laboratory sessions, the with a final mark of laboratory will be:

FML = min{4 ; (LSM6 + LSM7 + LSM8 + LSM9 + LSM10 + LSM11 + LSM12 + LSM13) / 8}.

1.c Final mark of the subject

The weighted points from all assessed parts are added together to calculate the final mark (FM). The following weightings will be applied: 80% theory (FMT) and 20% laboratory (FML). In order to pass the subject, students will be require to obtain at least a mark of 5 in each part (FMT>=5 and FML>=5). In this case the final mark (FM) will be:

FM = (0.8·FMT + 0.2·FML).

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

FM = min{4, (0.8·FMT + 0.2·FML)}.

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

2. Final exam

The students who prefer a different educational policy can attend an exam on a scheduled date. This exam consist on a theory part and laboratory part. In order to attend the laboratory exam, the students have to contact to the lecturer at least two weeks before the exam. This way, the organization of the laboratory exam will be simpler.

The theory exam will consist on an exercises and troubleshooting test (FETT). Mark for this test will be assessed in a 10 points scale. The final mark of theory (FMT) will be:

FMT = FETT.

The laboratory exam will consist on the resolution of a practical exercise in the laboratory. This practical exercise will be similar to those made in the laboratory sessions. The final mark of laboratory (FML) will be assessed in a 10 points scale.

In order to pass the subject, students will be required to pass the laboratory and theory exams. The minimum mark required to pass each part is of 5 (FMT>=5 and FML>=5). In this case the final mark (FM) will be:

FM = (0.8·FMT + 0.2·FML).

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

FM = min{4 ; (0.8·FMT + 0.2·FML)}.

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

3. Second opportunity to pass the subject

This exam consist on a theory exam and a laboratory exam. Dates will be specified in the academic calendar. In order to attend the laboratory exam, the students have to contact to the lecturer at least two weeks before the final exam.

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

Sources of information
Basic Bibliography
L. J. Álvarez, F. Machado, M.J. Moure, S. Pérez, Electrónica Digital, Curso 2017-2018, Plataforma TEMA
Wakerly J. F., Digital Design. Principles and Practices, 4ª, Pearson/Prentice Hall. 2007
E. Mandado, Sistemas Electrónicos Digitales, 10ª, Marcombo. 2015
Complementary Bibliography
Thomas L. Floyd, Fundamentos de Sistemas Digitales, 11ª, Pearson. 2016
Wakerly J. F., Diseño Digital. Principios y prácticas, 3ª, Prentice Hall. 2001
L.J. Álvarez, E. Mandado, M.D. Valdés, Dispositivos Lógicos Programables y sus aplicaciones, 1ª, Thomson-Paraninfo. 2002
S. Pérez, E, Soto, S. Fernández, Diseño de sistemas digitales con VHDL, Thomson-Paraninfo. 2002
L.J. Álvarez, Diseño Digital con Lógica Programable, 1ª, Tórculo. 2004

Recommendations

Subjects that it is recommended to have taken before

Informatics: Computer Architecture/V05G300V01103
Physics: Fundamentals of Electronics/V05G300V01305

IDENTIFYING DATA				
Computer Networks				
Subject	Computer Networks			
Code	V05G300V01403			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Galician			
Department				
Coordinator	López Ardao, José Carlos			
Lecturers	López Ardao, José Carlos Rodríguez Pérez, Miguel Rodríguez Rubio, Raúl Fernando Sousa Vieira, Estrella			
E-mail	jardao@det.uvigo.es			
Web	http://www.socialwire.es			
General description	Operating principles, architecture, technology and norms of computer networks, especially of Internet. Design-oriented course, complemented by practical skills			

Competencies		
Code		Typology
CG1	CG1: The ability to write, develop and sign projects in the field of Telecommunication Engineering, according to the knowledge acquired as considered in section 5 of this Law, the conception and development or operation of networks, services and applications of Telecommunication and Electronics.	- Know How
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- Know be
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know be
CE11	CE11/T6: The ability to conceive, deploy, organize and manage networks, systems, services and Telecommunication infrastructures in residential (home, city, digital communities), business and institutional environments, being responsible for launching of projects and continuous improvement like knowing their social and economical impact.	- know - Know How
CE17	CE17/T12: The knowledge and usage of concepts of communication network architecture, protocols and interfaces.	- know
CE18	CE18/T13: The ability to differentiate the concepts of access and transport networks, packet and circuit switched networks, mobile and fixed networks, as well as distributed newtwork application and systems, voice, data, video, audio, interactive and multimedia services.	- know
CE19	CE19/T14: The knowledge of methods of networking and routing, as well as the fundamentals of planning and network evaluation based on traffic parameters.	- know
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know be

Learning outcomes	
Learning outcomes	Competences

Comprise the general organization and the basic aspects of operation of communication networks, and particularly of computer networks	CG3 CE17 CT2
Identify and know employ the concepts of switching, access and transport networks and wired and wireless networks	CG3 CE18
Comprise the principles and the organization of distributed applications and services, either data or media oriented	CG3 CE17
Comprise and know how to analyze the operation of the Internet: the architecture, the service model, the data transport, the routing methods and inter-networking, error control and congestion control	CG3 CG6 CE11 CE17 CE19 CT2 CT3
Dominate the technical standards and the fundamental protocols of the Internet	CG3 CG4 CG6 CE17 CE18 CE19
Practical capacity to design, handle and configure computer networks, from the point of view of data switching and transport	CG1 CG9 CE11 CT4

Contents

Topic	
1. Introduction	a) Network Infrastructure: Nodes, links and netwoks b) Circuit and Packet Switching c) Communications Architecture: Layers, encapsulating, models
2. Packet Networks. Internet	a) Performance: Throughput, delays, losses b) The Internet ecosystem
3. Links and subnetworks	a) Concept of link and subnetwork b) Interconnection of networks at level 2: Bridges
4. Ethernet and WiFi	a) Ethernet Switching. b) VLANs and trunking c) Spanning Tree d) WiFi networks
5. Internet and IP	a) Interconnection of subnetworks. Routers b) IP Addressing c) IP datagram format d) Fragmentation e) The ICMP protocol
6. IP Forwarding	a) IP Forwarding mechanism b) Connected and Next-Hop Routes c) The DHCP protocol
7. Name and address translation	a) ARP b) DNS c) NAT
8. Routing	a) Graph theory. Shortest distance paths b) Link state: Dijkstra's algorithm c) Distance vector: Bellman-Ford d) Broadcast routing
9. Internet routing	a) Routing hierarchy b) Intradomain routing: RIP, OSPF c) Interdomain routing: BGP
10. Transport protocols	a) Service model b) TCP & UDP c) Transport connections: establishment, retransmissions, flow control
11. Congestion control	a) Network model b) Dynamics, fairness and stability c) TCP Reno, Vegas, FAST

12. Network security	a) Vulnerabilities. Protection c) Secure network and transport layers c) Denial of service. Spoofing d) Fundamentals of cryptography e) Digital signatures

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	26	39	65
Troubleshooting and / or exercises	10	15	25
Autonomous practices through ICT	6	21	27
Integrated methodologies	0	10	10
Practice in computer rooms	10	9	19
Long answer tests and development	2	0	2
Long answer tests and development	2	0	2

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

Methodologies

	Description
Master Session	Exposition of ideas, concepts, techniques and algorithms that shape every lecture. With this methodology students should acquire competencies CT2, CT3, CG3, CG4, CE11, CE17, CE18 & CE19.
Troubleshooting and / or exercises	Resolution by part of the students of problems and exercises of some of the lessons, and resolution by the teacher in the classroom. With this methodology students should acquire competencies CG3, CG4, CE11, CE17, CE18 & CE19.
Autonomous practices through ICT	The students must develop a network program individually. There will be several presential sessions for tutoring with the professor and for developing, testing and debugging the program in the laboratory where this will be tested and evaluated. With this methodology students should acquire competencies CG1, CG6, CG9, CE11, CE17 & CE19.
Integrated methodologies	Participation in on-line activities (autoevaluation tests and tasks previous to the laboratory sessions) to be proposed along the course . With this methodology students should acquire competencies CG4, CG6, CG9, CE17, CE18, CE19, CT2, CT3, CT4
Practice in computer rooms	Practices in the computers of the computer classroom, guided by the professor. With this methodology students should acquire competencies CG1, CG9, CE17 & CE19.

Personalized attention

Methodologies	Description
Master Session	Individual tuitition will be dispensed to the students in the office hours announced at the beginning of the term.

Assessment

	Description	Qualification	Evaluated Competencess
Autonomous practices through ICT	The students must develop a network program individually. There will be several presential sessions for tutoring with the professor and for developing, testing and debugging the program in the laboratory where this will be tested and evaluated.	20	CG1 CG6 CG9 CE11 CE17 CE19

Integrated methodologies	Participation in on-line activities (autoevaluation tests and tasks previous to the laboratory sessions) to be proposed along the course.	10	CG4 CG6 CG9 CE17 CE18 CE19 CT2 CT3 CT4
Long answer tests and development	Final exam covering all the contents	50	CG3 CG4 CE11 CE17 CE18 CE19 CT2
Long answer tests and development	Two partial exams of short duration (one hour) in the 7th week (between February 26 and March 2) and 13th week (between April 9 and 13), covering units 1 to 4, and 5 to 8, respectively. Each partial exam has a weight of 10% on the final grade	20	CG3 CG4 CE11 CE17 CE18 CE19 CT2

Other comments and July evaluation

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

Continuous Evaluation (CE) consist of 4 previous tests plus a final exam:

- Two partial exams, PE1 and PE2, of short duration (one hour) in the 7th week (between February 26 and March 2) and 13th week (between April 9 and 13), covering units 1 to 4, and 5 to 8, respectively. Each partial exam has a weight of 10% on the final grade.
- The development of a network program (NP). The last day of practical classes must be delivered by the deadline. Compliance with the requirements and quality of software will determine the qualification of this test. **This program must be made and delivered compulsorily on an individual basis**. The PR will represent 20% of the Final Grade (FG), being necessary to reach 3.5 points out of 10 in this test to be able to surpass the subject.
- Participation in online activities (**OA**), which represent 10% of the Final Grade (FG). Throughout the course will be proposed 8 activities to be delivered in the virtual classroom of the subject. These activities will consist of small tasks to be done before or after the practical classes, and self-assessment tests will also be done. In each activity the student will get a certain amount of accumulated points of play throughout the course. In the tests can be obtained between 0 and 10 game points, depending on the number of hits achieved. In the tasks will always have a minimum of points of play by the simple delivery of the task in time and form, and optionally an additional amount can be assigned to perform the task in a satisfactory or correct way. In addition to these 8 activities, teachers will be able to allocate additional points to students for having participated prominently in the class or for actively participating in virtual classroom forums to try to resolve peer doubts. In any case, the maximum mark in this section (10% of the total of the subject) will be obtained by every student who correctly delivers and answers the 8 activities. Students who obtain a score equivalent to twice the average or the median, the lowest of them, will also receive the maximum score. The rest of the students will receive a grade proportional to the minimum between: the score equivalent to the delivery of the 8 tasks, twice the median and twice the average.
- A final exam (**FE**) written on all the contents of the subject, which has a weight of 50% on the Final Grade (FG) and where it is necessary to reach 3.5 points out of 10 to be able to surpass the subject.

FG-CE = 0.1×PE1 + 0.1×PE2 + 0.1×OA + 0.2×NP + 0.5×FE if FE and NP> = 3.5
In case of not reaching in the FE the minimum grade of 3.5, the final grade will be that obtained in FE ==> FG-CE = FE
In case of not reaching in the NP the minimum grade of 3.5 (but in the FE), the final grade will that obtained in the NP ==> FG-CE = NP
It is considered that a student choose CE when presenting to any partial exam, PE1 or PE2, choice that is maintained until

end of course. Failure to submit a continuous assessment test involves a qualification of "0" on that test.
Students who do not take part in any partial exam are obliged to take the Single Evaluation (SE).**Single Evaluation (SE)**
It will consist in the realization of the same FE at the end of the term, and in the delivery of the proposed network program (NP) for those who go through the CE. The delivery dates will also be the same.
The grade of NP in this case is simply APT (with a numeric value 1), if the qualification of this program is equal or greater than 5.0, or NOT APT (with a numeric value 0) if the quelification is less than 5.0 or if the NP is not delivered, in which case the final grade will be 40% of the FE. That is,FG-SE = (0.4 + 0.6 × NP) × FE<u>Second Evaluation (june/july)</u>There will be a second evaluation with a new FE and it will also be allowed to deliver a new NP consisting of a modified version of the program of the first evaluation, and whose specifications will be published with at least 4 weeks with respect to the deadline of the Final Exam. Any students, regardless of having opted for CE or SE, will be able to do this FE and present a new NP. ***Those students that passed the subject in the first evaluation that want to attend the second one will have to present a signed letter asking the subject coordinator to assign them a "Not Presented" mark in the minutes of the first evaluation. The last day to present this letter is the day of the revision of the first evaluation exam.***
For students who chose CE, these FE and NP represent an opportunity to improve the grade in these with respect to the first evaluation, and so the calculation of the final grade considers the best grade obtained.
For students who chose to SE, the FE and the NP are considered joint and inseparable, that is,
FG-SE = Max{(0.4 + 0.6×NP-1st) × FE-1st, (0.4 + 0.6NP-2nd) × FE-2nd}
Those students who had chosen CE but they want to change to SE for this second call, they must communicate it to the coordinator of the subject before the review of the examination of the first call. In this case, the conditions to approve the subject are exactly the same as those of the rest of the students that are presented by SE, being therefore obligatory the delivery of a new PR with the specifications of this second call.
All students that assists to any of the written tests will be considered for evaluation in this subject. The grades of all written tests, partial or final, programs and activities will only take effect in the academic year in which they are proposed.
In case of detection of plagiarism in any of the works/test/exams, the final qualification will be Suspense (0) and this case will be communicated to the academic authorities.
In case of any contradiction that may occur between the different versions of the guide, due to some error in the translation, the version that will prevail is the Galician language version.

Sources of information

Basic Bibliography

J.F. Kurose, K.W. Ross, Computer networking: a top-down approach featuring the Internet, 7, 2016
L. Peterson, B. Davie, Computer networks: a systems approach, 5, 2011

Complementary Bibliography

A. Leon-Garcia, I. Widjaja, Communication networks: fundamental concepts and key architectures, 2, 2003
C. López, M. Rodríguez, S. Herrería, M. Fernández, Cuestiones de redes de datos: principios y protocolos, 1, 2008

Recommendations

Subjects that continue the syllabus

Data Networks: Technology and Architecture/V05G300V01542
Multimedia Networks/V05G300V01643
Network Security/V05G300V01543
Internet Services/V05G300V01501
Network and Switching Theory/V05G300V01642

Subjects that are recommended to be taken simultaneously

Data Communication/V05G300V01301

Subjects that it is recommended to have taken before

Mathematics: Calculus 1/V05G300V01105
Mathematics: Probability and Statistics/V05G300V01204
Programming II/V05G300V01302

Other comments

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

IDENTIFYING DATA				
Signal Transmission and Reception Techniques				
Subject	Signal Transmission and Reception Techniques			
Code	V05G300V01404			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	López Valcarce, Roberto			
Lecturers	Comesaña Alfaro, Pedro Isasi de Vicente, Fernando Guillermo López Valcarce, Roberto Márquez Flórez, Óscar Willian Pedrouzo Ulloa, Alberto Rodríguez Banga, Eduardo			
E-mail	valcarce@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The course "Techniques for Signal Transmission and Reception" is an introduction to the different existent methods for the exchange of information in digital format at the physical layer level. Its main focus is on pulse amplitude modulation (PAM) as illustrative example. The main components of a digital transmitter and receiver are described, as well as the different effects caused by the communication channel and the different performance parameters of a digital system.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- Know How - Know be
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How - Know be
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- Know How
CE7	CE7/T2: The ability to use communication and software applications (ofimatics, databases, advanced calculus, project management, visualization, etc.) to support the development and operation of Electronics and Telecommunication networks, services and applications.	- know - Know How
CE9	CE9/T4: The ability to analyze and specify the main parameters of a communications system.	- know - Know How
CE10	CE10/T5: The ability to evaluate the advantages and disadvantages of different technological alternatives in the implementation and deployment of communication systems from the point of view of signals, perturbations, noise and digital and analogical modulation systems.	- know - Know How
CE20	CE20/T15: The knowledge of national, European and international telecommunication regulations and laws.	- know
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know How - Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Differentiate the blocks and the functionalities of a complete transmission data system.	CG3 CE7 CE9 CE10

Identify the minimum requirements for a reliable data communication.	CG3 CG4 CE9 CE10
Distinguish the fundamental parameters of a complete communications system oriented to data transmission.	CG3 CG4 CE9 CE10
Describe, develop and analyse the different blocks of a data transmission system.	CG3 CG6 CE9 CE10 CE20 CT3
Develop and implement basic circuits for modulation and demodulation of signals.	CG4 CG6 CE9 CE10 CE20 CT2
Use applications of communication and computer (text processing, databases, advanced calculus, management of projects, visualisation, etc.) to support the design of data transmission systems.	CG4 CT2 CT3
Recognise the different quality assessment measures of a digital signal.	CE9 CE10
Statistically analyse the noise and understand its effects.	CG3 CE9 CE10

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

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	24	24	48
Practice in computer rooms	21	31.5	52.5
Troubleshooting and / or exercises	2	8	10

Laboratory practises	6	9	15
Long answer tests and development	2	16	18
Short answer tests	1	5.5	6.5

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

Methodologies

	Description
Master Session	Presentation and discussion of the fundamental theory. Through this methodology, skills CE9, CE10, CE20, CG3, CG4, CG6, CT2, CT3 are developed
Practice in computer rooms	The concepts presented in class will be further illustrated and developed by means of Matlab-based simulation and signal processing tools. Through this methodology, skills CE7, CE9, CE10, CG3, CG4, CT2 are developed
Troubleshooting and / or exercises	A simple problem will be solved after each batch of slides. This problem will help to understand the concepts introduced in that batch of slides. Through this methodology, skills CE9, CE10, CG4 are developed
Laboratory practises	Experimental study with real communication signals by means of Software-Defined Radio tools. This year a new practice, dealing with the modulation and demodulation of digital communications signals, will be introduced. Through this methodology, skills CE9, CE10, CG3, CG6, CT2 are developed

Personalized attention

Methodologies	Description
Laboratory practises	Beyond the initial explanation to the group, the teachers will resolve the individual doubts of the students.
Master Session	The personalized attention will be done at the office hours.
Practice in computer rooms	Beyond the initial explanation to the group, the teachers will resolve the individual doubts of the students.
Troubleshooting and / or exercises	The personalized attention will be done at the office hours. Special group sessions will be organized for solving the proposed problems; in those sessions the students will try to resolve the problems, so questions on the subject will be arised, and will be solved by the teachers.

Assessment

	Description	Qualification	Evaluated Competencess
Long answer tests and development	Final examination. It will cover all of the material covered during the course and will take place during the exam period as established by the Center.	60	CG3 CG4 CG6 CE9 CE10 CE20 CT2
Short answer tests	Three short tests will be given during the semester.	40	CG3 CG4 CG6 CE7 CE9 CE10 CE20

Other comments and July evaluation

For those students that choose the continuous assesment track. Four tests: 10% the first, 15% the second, 15% the third, and 60% the fourth.

The first three tests will take place approximately in weeks 5, 9, and 14. Results will be given within a reasonable time afterwards. These tests are not recoverable, that is to say, if a student does not show up when they take place, the instructors do not have the obligation to repeate them. In each test, the material covered from the start of the course until the previous week (inclusive) will be evaluated. The fourth test will be a shorter version of the exam that students who do not choose the continuous assesment track will have to take.

For those students that do not choose the continuous assessment track. Final examination: 100%

Students will be graded as long as they take any test (either the short-answer tests, or the final exam). Students will be assumed to choose the continuous assesment track as soon as they take any two of the short-answer tests. Students taking at most one of the short answer tests and the final exam will be assumed to choose the final assesment track.

Students choosing the continuous assesment track and not passing the subject will receive the "fail" mark, whether they took the final exam or not.

The mark achieved in the first three short-answer tests will be kept for the second call, but not for subsequent years.

Regarding the second call, students in the continuous assessment track will be allowed to choose if they wish to keep the mark achieved in the short-answer tests, or if they want to be assessed only by the final exam.

Sources of information
Basic Bibliography
A. Artés, F. Pérez González et al., Comunicaciones Digitales, 1, 2007
J. G. Proakis, M. Salehi, Fundamentals of Communication Systems, 1, 2005
Complementary Bibliography
C.R. Johnson Jr., W.A. Sethares, Telecommunication Breakdown, 1, 2004
Bernard Sklar, Digital Communications: Fundamentals and Applications, 2, 2001
B. Razavi, RF Microelectronics, 1, 1998

Recommendations
Subjects that continue the syllabus
Principles of Digital Communications/V05G300V01613

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G300V01201
Mathematics: Probability and Statistics/V05G300V01204
Digital Signal Processing/V05G300V01304

Other comments

It is assumed that the student has basic knowledge of analog and digital signal processing, as well as of probability and statistics.

IDENTIFYING DATA				
Fundamentals of Sound and Image				
Subject	Fundamentals of Sound and Image			
Code	V05G300V01405			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish			
Department				
Coordinator	Martín Rodríguez, Fernando			
Lecturers	Isasi de Vicente, Fernando Guillermo Márquez Flórez, Óscar Willian Martín Rodríguez, Fernando Pena Giménez, Antonio			
E-mail	fmartin@uvigo.es			
Web	http://faitic.uvigo.es			
General description	"Fundamentos de Sonido e Imagen" presents the basic concepts of sound and image, as well as the processes operating over the audiovisual signals.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.	- Know How
CE13	CE13/T8: The ability to understand the electromagnetic and acoustic wave mechanisms of propagation and transmission, and their corresponding receiving and transmitting devices.	- know
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be

Learning outcomes	
Learning outcomes	Competences
Analysing the basic properties of the sound.	CE13 CT3
Explaining different sound production systems: human sound production, musical instruments, machines and other vibrant systems.	CE13 CT3
Interpreting results of acoustic measures and selecting tools for the appropriate analysis.	CG5 CT3
Describing the human perception of sound based on the physiological interface and the psychology of the perception.	CE13 CT3
Reviewing diffrent processes and systems associated to the sound production	CG3 CG5 CT3
Applying the basic rules of the colorimetry.	CG3 CT3
Analysing lens systems.	CG3 CG5 CT3
Choosing the most suitable capture and presentation image sytems.	CG3 CG5 CT3
Choosing the most adapted formats for image and video.	CG3 CG5 CT3

Relating the influence of the coding parameters with the results of compression and quality.	CG3 CG5 CT3

Contents	
Topic	
S1. Acoustic waves	Introduction. Acoustic wave equation. Harmonic plane waves. Spherical waves. Power and Intensity. Diffraction
S2. Sound propagation and transmission	Acoustic field. Propagation.Transmission between different media.
S3. Sound radiation and production	Impedances. Transductors. Mechanical vibration. Radiation of simple sources. Directivity.
S4. Sound perception	Human audition. Auditory losses. Equal loudness contours.
I1. Colorimetry	Fiixed image signals and video signals. Visual human system. Light and colour. Visual effects.
I2. Capture and representation of images	Cameras and lens. Monitors. 3D Visualisation.
I3. Image and video coding	Fixed image: format of colour YUV; standards of compression. Image in movement: H.261 standard; MPEG formats.
Projects S1 and S2. Sound analysis.	Time, frequency and spectrograms.
Projects S3 and S4. Sound measurements	Sound pressure level. Sonometer. Octave-filter banks
Project I1. Colorimetry	Basic functions
Project I2. Fixed images coding	Functions for JPEG coding
Project I 3. Video coding	Time-predictive coding

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Master Session	25	50	75
Troubleshooting and / or exercises	6	12	18
Practice in computer rooms	19	19	38
Forum Index	0	1	1
Multiple choice tests	0	2	2
Long answer tests and development	4	0	4
Short answer tests	1	0	1
Reports / memories of practice	0	10	10

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

Methodologies	
	Description
Introductory activities	Course presentation: programme, reading materials, teaching methodology and assessment system. Developed capabilities: CG3, CG5, CE13, CT3.
Master Session	Instructor presentation of the main concepts of each subject. The student should take the contents of the guiding documents provided for each section. Student will work alone afterwards on the concepts studied in class and on expanding this content using the documents provided for each subject. Identification of doubts that need to be resolved in personalized tutorials. Developed capabilities: CG3, CG5, CE13, CT3.
Troubleshooting and / or exercises	Problems and exercises formulated according to the content of the lectures and the documents for each subject. Students solve problems and exercises prior to the class. Identification of doubts that need to be resolved in personalized tutorials. Developed capabilities: CG3, CG5, CE13, CT3.

Practice in computer rooms	Handling of analysis tools and algorithms. Identifying which one must to be used to solve each specific problem. Identification of doubts that need to be resolved in personalized tutorials. Developed capabilities: CG3, CG5, CE13, CT3.
Forum Index	The website for the course is included in the TEMA platform (http://faitic.uvigo.es). Subscription to this platform, including a photograph, is mandatory. The website provides all the information related to the course. It also publishes continuous assessment grades and runs forums for students to exchange ideas and discuss doubts. Developed capabilities: CG3, CG5, CE13, CT3.

Personalized attention

Methodologies	Description
Troubleshooting and / or exercises	Help with problem solving, in the classroom and/or at the office.
Practice in computer rooms	Help in the classroom and, if necessary at the office or via e-mail.
Master Session	Querry and answer in the classroom and, if necessary, at the office.
Tests	Description
Reports / memories of practice	Querry and answer about report writing. Report correction consists in a brief remark being sent to students (via faitic).

Assessment

	Description	Qualification	Evaluated Competencess
Short answer tests	Exam with questions and problems.	5	CG3
Reports / memories of practice	Report about the work perfomed during several weeks in the computer classroom. This is the only methodology where team work is assessed (teams of two). The qualification is the same for both students.	22.5	CG5
Multiple choice tests	On the faitic website.	7.5	CG3
Long answer tests and development	To evaluate theoretical knowledge and problem resolution.	65	CG3 CG5 CE13

Other comments and July evaluation

CONTINUOUS ASSESSMENT

The continuous assessment consists of several activities. If the student can not do them in the fixed date, this activity will not be evaluated. The grades of these activities will be valid only for the present academic course.
If the student sits for "Exam 1", she/he will be evaluated by continuous assessment. Furthermore, once the student has taken this exam, she/he will be considered to have attended this examination call. Qualification will be computed using the following criteria with no consideration if she/he takes the final exam or not.

Types and assessment of activities:

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

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

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

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

* assessment of sound-related scores

* assessment of image-related scores

If this second condition is not fullfilled, although global mean is equal or greater than 5, qualification will be stated in the records as "fail" (4).

Results for all assessment items will be announced as soon as possible.

NON CONTINUOUS ASSESSMENT

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

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

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

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

* assessment of sound-related scores

* assessment of image-related scores

If this second condition is not fullfilled, although global mean is equal or greater than 5, qualification will be stated in the records as "fail" (4).

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

Second opportunity exam:

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

1. Do again the Exam 2 and be evaluated according what is stipulated for the system of "Continuous Assessment".
2. Be evaluated with a single final exam in the official date assigned by the Centre. The grades for this final exam are between 0 and 10 points. It includes all the subjects of the course, including the laboratory works. "Non Continuous Assessment" rules apply.

⇒ **Studentss not evaluated by Continuous Assessment:**
The grades for this final exam are between 0 and 10 points. It includes all the subjects of the course, including the laboratory works. "Non Continuous Assessment" rules apply. No other activities are assessed.

Sources of information
Basic Bibliography
Finn Jacobsen et al., FUNDAMENTALS OF ACOUSTICS AND NOISE CONTROL, Technical University,
R. J. Clarke, Digital Compression of Still Images and Video, Academic Press.,
Complementary Bibliography
Lawrence Kinsler, Austin Frey, Alán Coppens, James Sanders, FUNDAMENTALS OF ACOUSTICS, John Wiley & son,
T. Perales Benito, Radio y Televisión Digitales: Tecnología de los Sistemas DAB, DVB, IBUC y ATSC, Creaciones Copyright, Madrid
Ulrich Reimers, DVB : the family of international standards for digital video broadcasting, Springer, Berlin

Recommendations
Subjects that continue the syllabus

Room Acoustics/V05G300V01635
Fundamentals of Acoustics Engineering/V05G300V01531

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

Subjects that are recommended to be taken simultaneously

Signal Transmission and Reception Techniques/V05G300V01404

Subjects that it is recommended to have taken before

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

IDENTIFYING DATA				
Internet Services				
Subject	Internet Services			
Code	V05G300V01501			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Burguillo Rial, Juan Carlos			
Lecturers	Álvarez Sabucedo, Luis Modesto Burguillo Rial, Juan Carlos Gil Solla, Alberto			
E-mail	jrial@uvigo.es			
Web				
General description	This subject will provide to the student a global vision of the group of current services of Internet, between which fits to quote the email, the WWW, the technologies XML, the Services Web, the sharing of resources among peers (P2P), the Semantic Web and the cloud computing. This subject will be taught in Spanish.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How - Know be
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- know
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How
CE11	CE11/T6: The ability to conceive, deploy, organize and manage networks, systems, services and Telecommunication infrastructures in residential (home, city, digital communities), business and institutional environments, being responsible for launching of projects and continuous improvement like knowing their social and economical impact.	- Know How
CE18	CE18/T13: The ability to differentiate the concepts of access and transport networks, packet and circuit switched networks, mobile and fixed networks, as well as distributed newtwork application and systems, voice, data, video, audio, interactive and multimedia services.	- know
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know be

Learning outcomes	
Learning outcomes	Competences
To know the basic services of Internet, as well as comprise the basic principles of his operation.	CG3 CG6 CE11 CE18 CT2 CT3 CT4

To dominate the main technical standards in the field of development of telematic services.	CG6 CE11 CE18
To understand the importance of organising the structured information for his suitable utilisation.	CG3 CG4 CE11 CE18 CT2
To Know the basic concepts of semantic management of the information.	CE11 CT2
To understand the principles and the general organisation of a web service.	CG9 CE11 CE18
To improve the skill in the design and development of basic telematic services.	CG4 CG9 CT2 CT3 CT4

Contents

Topic	
1. Internet basic services	a) Electronic mail b) World Wide Web: languages, protocols, architecture and Web applications.
2. XML and related technologies	a) Document Type Definition (DTD), NameSpaces, XML Schema b) Document Object Model (DOM) c) Extensible Stylesheet Language Transformations (XSLT) d) Other related technologies
3. Web Services	a) Simple Object Access Protocol (SOAP) b) Universal Description, Discovery and Integration (UDDI) c) Web Services Description Language (WSDL)
4. Additional services	To) Sharing resources among peers (P2P) b) Semantic Web c) Cloud Computating

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	2	4
Master Session	24	36	60
Practice in computer rooms	26	26	52
Forum Index	0	4	4
Self-assessment tests	0	2	2
Practical tests, real task execution and / or simulated.	2	4	6
Long answer tests and development	2	20	22

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

Methodologies

	Description
Introductory activities	In the first classes we will describe the activities to be performed along the subject, along the theory and along the practices in the computing laboratory.
Master Session	Along the theory classes we will describe the main contents of the subject by means of slides. Theory classes will promote the competences: CT2, CT3 y CT4. Besides, the exam for this part evaluates the competencies: CG3, CG4, CG6, CE11, CE18.

Practice in computer rooms	The subject also will require the development and delivery of 3 practices that the students will perform in the corresponding computer laboratory. The applications to develop in these practices will be done by means of the languages common used in the Internet: Javascript, PHP, Java, etc. These practices evaluate the competences: CG3, CG4, CG6, CG9, CE11, CE18 and promote the competences CT2, CT3 y CT4.
Forum Index	During the course we will discuss several topics, related with the concepts seen in theory, in the forums of the subject. This forum will promote the competences: CG3, CG6, CT2, CT3 and CT4.

Personalized attention

Methodologies	Description
Forum Index	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.
Practice in computer rooms	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.
Tests	Description
Practical tests, real task execution and / or simulated.	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.
Long answer tests and development	In the practical formative activities and tutoring, the professors of the subject will offer personal guidance to each student in the tasks to be performed, with the aim to orient the approach and the methodology. Also they will offer coordination information with other contents and subjects of the study program. It is recommended to consult the doubts with the teachers along the course in order to improve the understanding of the basic concepts, and for performing the tasks and activities to be evaluated.

Assessment

	Description	Qualification	Evaluated Competencess
Self-assessment tests	They will do two test of self-evaluation along the subject on the theoretical concepts that the students have learnt up to such point.	0	CG3 CG4 CG6 CE11 CE18
Practical tests, real task execution and / or simulated.	The code that implements the projects will be evaluated to discover if all works according to the requirements and specifications established by the teachers.	50	CG3 CG4 CG6 CG9 CE11 CE18

Long answer tests and development	There will be a theoretical examination at the end of the subject concerning the contents seen in it. Besides, the student must PASS a practical exam in the laboratory (related with the practical tasks) to check that the student dominates properly his/her own code.	50	CG3 CG4 CG6 CE11 CE18

Other comments and July evaluation

The subject is composed by a theoretical and a practical part. Each one of them have a value of 5 points, having to reach at least a 2 in each part to do the average with the other.

Following the degree guidelines we will offer the students two evaluation possibilities: continuous evaluation and evaluation at the end of the semester.

Continuous evaluation (EC):

- The theoretical part means a final examination (with a value of 5 points). This final examination will be equal for all the students, independently that they have opted or no by the EC. Additionally, the students can get up to 0,5 extra points as a function of their participations in class and/or in the forum of the subject. These points will be added to the final mark, adjusting it to 5 if the result was higher.
- The student follows the continuous evaluation from the moment in that it delivers a practice in time.
- The practical part is composed of three practices, that will cost 1, 2 and 2 points respectively (none of them is strictly compulsory for passing the subject).
- The first practice will be delivered in the 6th teaching week.
- The second practice is valued with 2 points and it will be delivered in the week 15. After the delivery, the student might be able to do a second delivery, if they do not fulfill the requirements established, that will imply some penalty in the mark. After such second delivery, the code provided will be evaluated as is.
- The third practice is also valued with 2 points and can be delivered until the week 16.
- Practice exam: The students will perform a simple practice exam in the laboratory (related with the practices done) to check out that the student dominates properly his/her own code. This practical exam provides a mark (Npp) between 0 and 1. The global mark for the practices will be obtained by multiplying the practice marks and the practical exam mark: Note for practical part = (P1+P2+P3) x Npp. In the case that the resulting value is below 2 points, the student must perform the practices again in the next call, and do again this practical exam.

Evaluation at the end of the semester: The student that have not opted by the EC will have to perform the theoretical examination and deliver, before the day of the final exam, the practical proposals along the subject (with the possible modifications that can be specified), to add a minimum of 5 points in the final mark. Besides, he/she must do the practical exam. Therefore, the conditions imposed are the same than in the EC case, and the only difference is the timing for delivering the practical tasks (notified in time) and that there is no possibility to resubmit a practice.

Passing the subject: Both in the case of EC as assessment at the end of the semester, to approve the student must obtain at least 5 points by adding the theoretical and practical parts (with a minimum of 2 points in each of them) and considering the practical exam.

Evaluation at the end of the second semester: the student will have to perform the part that has not passed (examination and/or practice with its practice exam). The practices can suffer modifications and/or incorporate additional features that will be informed before the 30th of March.

The practical tasks performed in this course are not recoverable and only are valid for the current course.

Sources of information
Basic Bibliography
H.M Deitel et al., Internet and World Wide Web How to Program: International Edition, 5, 2012
Priscilla Walmsley, Definitive XML Schema, 2/E, 2, 2012
Steve Graham et al., Building Web Services with Java: Making Sense of XML, SOAP, WSDL, and UDDI, 2, 2004
Complementary Bibliography
Robert W. Sebesta, Programming the World Wide Web, 8, 2014
Andrew S. Tanenbaum, Computer Networks, 5, 2012

Kevin Howard Goldberg, XML: Visual QuickStart Guide, 2/E, 2, 2008
Michael Papazoglou, Web Services and SOA: Principles and Technology, 2/E, 2, 2012
Thomas Erl, Service-Oriented Architecture: A Field Guide to Integrating XML and Web Services, 1, 2004
W. Stallings, Data and Computer Communications, 9, 2013

Recommendations

Subjects that continue the syllabus

Architectures and Services/V05G300V01645

Subjects that it is recommended to have taken before

Programming II/V05G300V01302
Computer Networks/V05G300V01403

IDENTIFYING DATA				
Programmable Electronic Circuits				
Subject	Programmable Electronic Circuits			
Code	V05G300V01502			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Álvarez Ruiz de Ojeda, Luís Jacobo			
Lecturers	Álvarez Ruiz de Ojeda, Luís Jacobo Moure Rodríguez, María José Poza González, Francisco			
E-mail	jalvarez@uvigo.es			
Web	http://www.faitic.uvigo.es/			
General description	The main learning goals of this course are: Architecture of microprocessors, microcontrollers and configurable devices. Design methods and tools to acquire the necessary skills to design systems based on these devices.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG13	CG13 The ability to use software tools that support problem solving in engineering.	- Know How
CE7	CE7/T2: The ability to use communication and software applications (ofimatics, databases, advanced calculus, project management, visualization, etc.) to support the development and operation of Electronics and Telecommunication networks, services and applications.	- Know How
CE8	CE8/T3: The ability to use software tools for bibliographical resources search or information related with electronics and telecommunications.	- Know How
CE14	CE14/T9: The ability to analyze and design combinatory and sequential, synchronous and asynchronous circuits and the usage of integrated circuits and microprocessors.	- Know How
CE15	CE15/T10: The knowledge and application of the fundamentals of description languages for hardware devices.	- know
CT2	CT2 Understanding Engineering within a framework of sustainable development.	
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	

Learning outcomes	
Learning outcomes	Competences
To understand the basic architecture of microprocessors, microcontrollers and configurable devices (FPGAs).	CG3 CE14 CE15
To know the methods and techniques of design of integrated hardware/software systems (System on Chip – SoC).	CG3 CE14 CE15
To know the hardware and software tools for the design of systems based in programmable devices.	CG13 CE14 CE15
To acquire the skills to use the design tools for the design of digital systems.	CE14 CE15

Ability to design simple integrated systems (System on Chip – SoC) applied to the telecommunications fields.	CG3 CG4 CG13 CE7 CE8 CE14 CE15 CT2 CT3

Contents	
Topic	
LESSON 1 THEORY (1 h.). INTRODUCTION TO FPGAs.	1.1.- Introduction. 1.2.- Definition of FPGA. FPGA classification. 1.3.- FPGA architectures. 1.3.1.- Logical resources. 1.3.1.1.- Configurable Logic Blocks. 1.3.1.2.- Internal Logic Blocks. 1.3.1.3.- Input/Output Blocks. 1.3.1.4.- Embedded circuits. Memories. PLL digital circuits. Arithmetical circuits. Multipliers. DSP blocks. Serial transceivers. 1.3.2.- Interconnection resources. 1.3.2.1.- Interconnection lines. 1.3.2.2.- Configurable connection points. 1.3.3.- Examples of commercial FPGAs. 1.4.- FPGA technologies. 1.4.1.- FPGA manufacturing technologies (LVTTL, LVCMOS, etc.). 1.4.2.- FPGA configuration technologies. 1.4.2.1.- Static RAM technology (SRAM). 1.4.2.2.- Antifuse technology. 1.4.2.3.- Non-volatile memory technology (EEPROM). 1.4.3.- FPGA configuration. Methods. External programmer. In System Programmable (ISP). 1.5.- General characteristic of the FPGAs. 1.6.- Advantages of the FPGAs. 1.7.- Stages of the design of digital systems with FPGAs. 1.7.1.- Design implementation with FPGAs. 1.8.- FPGA CAD tools. 1.9.- FPGA applications. 1.10.- FPGAs versus other circuits. Comparative analysis.
LESSON 2 THEORY (1 h.). XILINX SPARTAN 3 FPGA FAMILY. ARCHITECTURE.	2.1.- Introduction. 2.2.- Xilinx Virtex 2 family architecture. 2.2.1.- Logical resources. CLBs. “Slices”. RAM-based shift registers. 2.2.2.- Internal memories. Distributed memory. Embedded memory. 2.2.3.- Clock circuits. 2.2.4.- Hardware multipliers. 2.2.5.- Input / Output technologies. 2.3.- Spartan 3 vs. Virtex 2. 2.4.- Spartan 3E vs. Spartan 3. 2.5.- Synthesis guidelines.
LESSON 3 THEORY (2 h.). INTRODUCTION TO MICROCONTROLLERS.	3.1.- Introduction. Definition of microcontroller. 3.2.- Internal architecture. Harvard. Von Neumann. 3.2.1.- Control Unit. 3.2.2.- ALU. 3.2.3.- Instruction set. RISC. CISC. 3.3.- External architecture. 3.3.1.- Access to memory. Program memory. Data memory. 3.3.2.- Access to peripherals. Input / Output ports. 3.3.3.- Interrupt control. 3.4.- Integrated peripherals. 3.4.1.- Timers. 3.4.2.- Serial communication. UART RS232. SPI. I2C. 3.4.3.- A/D and D/A converters. 3.5.- Examples of commercial microcontrollers. 3.6.- Microcontroller applications. 3.7.- Tools for programming and verification.

LESSON 4 THEORY (2 h.). XILINX PICOBLAZE MICROPROCESSOR (I).	4.1.- Introduction. 4.2.- Versions of the Xilinx Picoblaze microprocessor. 4.3.- Internal architecture of the Picoblaze microprocessor. 4.4.- Instruction set of the Picoblaze microprocessor.
LESSON 5 THEORY (1 h.). SOFTWARE DEVELOPMENT FOR XILINX PICOBLAZE MICROPROCESSOR.	5.1.- Introduction. 5.2.- Syntax of an assembler program for the Picoblaze microprocessor. 5.3.- Program development with pBlazeIDE environment for Picoblaze .
LESSON 6 THEORY (3 h.). XILINX PICOBLAZE MICROPROCESSOR (II).	6.1.- Introduction. 6.2.- External architecture. 6.2.1.- Input / Output instructions. 6.2.2.- Connection of input peripherals. 6.2.3.- Connection of output peripherals. 6.2.4.- Initial state. 6.2.5.- External interrupts. 6.3.- Design of peripherals for the Picoblaze microprocessor.
LESSON 7 THEORY (1 h.). INTRODUCTION TO SYSTEMS ON CHIP (SOC).	7.1.- Introduction to digital design methods. 7.1.1.- Software method. 7.1.2.- Hardware method. 7.2.- Systems On Chip (SOC). 7.3.- Systems On a Programmable Chip (PSOC). Microprocessors embedded in FPGAs. 7.3.1.- Hardware Microprocessors. 7.3.2.- Software Microprocessors. 7.4.- Embedded microprocessor applications.
LESSON 8 THEORY (4 h.). HARDWARE / SOFTWARE CODESIGN.	8.1.- Introduction. 8.2.- Software design. 8.3.- Hardware design. 8.4.- Stages of hardware / software codesign. 8.5.- Hardware / software partition. 8.6.- Examples hardware / software codesign. 8.7.- Peripheral design. How to split functions between “hardware” and “software”.
LESSON 9 THEORY (6 h.). DESIGN OF COMPLEX SYSTEMS.	9.1.- Introduction. 9.2.- Previous analysis of the most suitable solution. 9.3.- Application specific peripherals. Design methods. 9.3.1.- Practical examples.
LESSON 10 THEORY (2 h.). INTRODUCTION TO CORRECT DESIGN METHODS.	10.1.- Introduction. 10.2.- Design of digital systems with FPGAs. 10.2.1.- Hierarchical design. 10.2.2.- Independent technology design. 10.2.3.- Timing design.
LESSON 11 THEORY (3 h.). SYNCHRONOUS DIGITAL SYSTEM DESIGN.	11.1.- Introduction. 11.2.- Synchronous design. 11.3.- Synchronous sequential systems. FPGA design tips. 11.4.- Synchronisation of input variables.
LESSON 1 LABORATORY (2 h.). STAGES OF DIGITAL SYSTEM DESIGN WITH FPGAs.	1.1.- Introduction. Xilinx ISE tool flow diagram. 1.2.- VHDL description. 1.3.- Behavioural simulation. 1.4.- Synthesis. 1.5.- Implementation. 1.6.- Implementation options for the Xilinx Spartan 3E FPGA family. 1.7.- FPGA Editor. 1.8.- Timing simulation. 1.9.- Timing analysis report. 1.10.- Technology and configuration methods for Xilinx FPGAs. 1.11.- Development boards based on FPGAs of Xilinx. 1.12.- Configuration file (.BIT). 1.13.- FPGA programming. ‘iMPACT’. 1.14.- Digital system testing. Frequent problems. 1.15.- Examples.
LESSON 2 LABORATORY (2 h.). PERIPHERAL CIRCUIT DESIGN FOR THE PICOBLAZE MICROPROCESSOR.	2.1.- Introduction. 2.2.- Guidelines on synchronous design with VHDL. 2.3.- Basic register in VHDL. 2.4.- Data memory in VHDL. 2.5.- Timer in VHDL.

LESSON 3 LABORATORY (2 h.). PERIPHERALS INTERFACE CIRCUIT DESIGN FOR THE PICOBLAZE MICROPROCESSOR.	3.1.- Introduction. 3.2.- Input peripheral interface circuit in VHDL. 3.3.- Output peripheral interface circuit in VHDL. 3.4.- Interrupt storing circuit in VHDL.
LESSON 4 LABORATORY (2 h.). XILINX PICOBLAZE MICROPROCESSOR SOFTWARE TOOLS.	4.1.- Introduction. 4.2.- Program assembler and simulator in Mediatronix. Picoblaze IDE. 4.3.- Basic examples.
LESSON 5 LABORATORY (6 h.). DESIGN OF DIGITAL SYSTEMS BASED ON THE PICOBLAZE MICROPROCESSOR.	5.1.- Introduction. 5.2.- Picoblaze microprocessor source files. 5.3.- Design stages for digital systems based on the Picoblaze microprocessor. 5.3.1.- Choosing the right Picoblaze microcontroller. 5.3.2.- Picoblaze program design. 5.3.3.- Picoblaze program simulation. 5.3.4.- Generation of the necessary VHDL files for the implementation of the Picoblaze Microprocessor in Xilinx Spartan 3E FPGA family. 5.3.5.- Peripheral circuit design for the Picoblaze microcontroller. Additional circuits needed. 5.3.6.- Simulation of the peripheral and additional circuits. 5.3.7.- Implementation of the complete digital system. 5.3.8.- Test of the complete digital system. 5.4.- Design of a basic example with use of interrupts, based on the Picoblaze microprocessor.
LESSON 6 LABORATORY (6 h.). PROJECTS. DESIGN OF PERIPHERALS FOR THE PICOBLAZE MICROPROCESSOR.	6.1.- Design and implementation of a medium-complexity peripheral for the Picoblaze 3 microprocessor, according to the instructions supplied by the teacher through FaiTIC website.
LESSON 7 LABORATORY (6 h.). PROJECTS. DESIGN OF AN EMBEDDED SYSTEM BASED ON THE PICOBLAZE MICROPROCESSOR.	7.1.- Design and implementation of a medium-complexity application example based on the Picoblaze 3 microprocessor, according to the instructions supplied by the teacher through FaiTIC website.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	2	4
Master Session	12	16	28
Troubleshooting and / or exercises	12	19	31
Laboratory practises	14	20	34
Tutored works	6	12	18
Tutored works	6	12	18
Long answer tests and development	2	5	7
Long answer tests and development	2	8	10

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

Methodologies

	Description
Introductory activities	Introduction to the subject key topics both theoretical and practical. Through this methodology the outcome CG3 is developed.
Master Session	Conventional lectures. Through this methodology the outcome CG3 is developed.
Troubleshooting and / or exercises	These sessions will include the realisation of exercises and works by part of the professor and of the students. Through this methodology the outcomes CG3, CG4, CE8/T3, CE14/T9 and CE15/T10 are developed.
Laboratory practises	Guided practices will be set out in these sessions , as well as the realisation of circuits and programs. Through this methodology the outcomes CG3, CG4, CG13, CE7/TE2, CE8/T3, CE14/T9, CE15/T10, CT2 and CT3 are developed.

Tutored works	The students will have to develop a laboratory project which consists of designing circuits and programs. This project is related to the laboratory lesson 6. Through this methodology the outcomes CG3, CG4, CG13, CE7/TE2, CE8/T3, CE14/T9, CE15/T10, CT2 and CT3 are developed.
Tutored works	The students will have to develop a laboratory project which consists of designing circuits and programs. This project is related to the laboratory lesson 7. Through this methodology the outcomes CG3, CG4, CG13, CE7/TE2, CE8/T3, CE14/T9, CE15/T10, CT2 and CT3 are developed.

Personalized attention

Methodologies	Description
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.
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.
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
Laboratory practises	Design of digital circuits in VHDL and assembler programs. It will be necessary to deliver the design source files and show the teacher in the laboratory the operation of each one of the circuits and programs. The assessment will be based on the operation of the circuits and programs developed in the practical sessions corresponding to the laboratory lesson 5, according to the published criteria. Through this methodology the outcomes CG3, CG4, CG13, CE7/TE2, CE8/T3, CE14/T9, CE15/T10, CT2 and CT3 are assessed.	10	CG3 CG4 CG13 CE7 CE8 CE14 CE15 CT2 CT3
Tutored works	Autonomous Project which consists of designing a complex peripheral. The peripheral must be composed of a control unit and an ALU and must be designed following the method analysed in the theoretical lesson 9. The content corresponds with laboratory lesson 6. The assessment will be based on the correct operation of the circuits and programs developed during the laboratory sessions assigned to lesson 6, as well as in the correct application of the theoretical concepts to the job done, according to the published criteria. It will be necessary to show every circuit and program to the teacher in the laboratory. Through this methodology the outcomes CG3, CG4, CG13, CE7/TE2, CE8/T3, CE14/T9, CE15/T10, CT2 and CT3 are assessed.	20	CG3 CG4 CG13 CE7 CE8 CE14 CE15 CT2 CT3

Tutored works	Autonomous Project which consists of designing a medium-complexity embedded digital system. The embedded system must be composed of a microprocessor and its peripherals, as well as the auxiliary circuits needed to work correctly. It will also be necessary to develop a program for the microprocessor in assembler language. The content corresponds with laboratory lesson 7. The assessment will be based on the correct operation of the circuits and programs developed during the laboratory sessions assigned to lesson 7, as well as in the correct application of the theoretical concepts to the job done, according to the published criteria. It will be necessary to show every circuit and program to the teacher in the laboratory. Through this methodology the outcomes CG3, CG4, CG13, CE7/TE2, CE8/T3, CE14/T9, CE15/T10, CT2 and CT3 are assessed.	20	CG3 CG4 CG13 CE7 CE8 CE14 CE15 CT2 CT3
Long answer tests and development	This exam will include two types of questions: 1) Multiple choice questions about the theoretical topics of the subjects. 2) Design problems about circuits and programs, explaining the work done Through this methodology the outcomes CG3, CE14/T9 and CE15/T10 are assessed.	25	CG3 CE14 CE15
Long answer tests and development	Exam based on solving tasks and design problems about circuits and programs, explaining the work done Through this methodology the outcomes CG3, CG4, CE14/T9 and CE15/T10 are assessed.	25	CG3 CG4 CE14 CE15

Other comments and July evaluation

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 18th September).

Following the guidelines of the degree the students will be offered two assessment systems: continuous assessment and final assessment.

CONTINUOUS EVALUATION:

The students must choose at the beginning of the term between continuous assessment or final assessment.

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

The students who have chosen continuous assessment can only miss two laboratory sessions as a maximum.

Theoretical class attendance is considered crucial to achieve success in continuous assessment.

The fact of not attending theoretical classes alone will not imply the loss of the right to continuous assessment, but the student will have to study the theoretical concepts and prepare the laboratory practices on their own.

The students who are following continuous assessment and attend theoretical clases regularly (maximum 2 absences) will be given the following advantages:

· If they fail the first theoretical exam in the middle of the term, they will be given the opportunity to repeat it at the end of the term.

· If they fail the subject at the end of the term, the marks of the parts of the subject (first theoretical exam, second theoretical exam, laboratory) which are above the required minimum will be kept until July'sevaluation.

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 students will develop the laboratory practices and the laboratory projects in groups of two students during the continuous assessment, whenever possible. Both students will be given the same mark if they have attended the laboratory classes together and show that they have worked together in the realisation of the practices and laboratory assignments.

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

To pass the subject, it is necessary that:

· The mark of each one of the theoretical exams is equal or greater than 4 over10.

· The global mark of the laboratory tasks is equal or greater than 4 over 10.

· The student reaches the minimum requirements in the two laboratory assignments.

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

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

In case the students pass all the different tasks, the final mark (FM) will be the weighted sum of the marks of each part of the subject:

FM = 0.25* TE1 + 0.25 * TE2 + 0.10 * LP + 0.20 * AP1 + 0.20 * AP2

In case the students do not pass any of the tasks of the subject (mark of any task < 4), the final mark (FM) will be:

FM =Minimum [4.5; (0.25 * TE1 + 0.25 * TE2 + 0.10 * LP + 0.20 * AP1 + 0.20 * AP2)]

Being:

· TE1 = First partial theoretical examination.

· TE2 = Second partial theoretical examination.

· LP = Mark of the guided laboratory practices corresponding to lessons 5.

· AP1 = Laboratory Autonomous Project that consists of the design of a complex peripheral.

· AP2 = Laboratory Autonomous Project that consists of the design of a medium-complexity embedded system.

ASSESSMENT CRITERIA.

Theoretical examinations.

The first theoretical examination will be scheduled around the eighth week of classes in the place and date determined by the faculty. It will include practical problems and test questions on the topics of theoretical lessons 1 to 8 (except hardware/software partitioning from lesson 8).

The second theoretical examination will be scheduled together with the term’s final examin the place and date determined by the faculty. It will include practical problems on all the topics that have been studied in the subject but,fundamentally, hardware/software partitioning from theoretical lesson 8 and theoretical lessons 9 to 11.

Thestudents will have to answer all the exam questions correctly to obtain the maximum mark.

Laboratory guided practices (only for continuous evaluation).

Only the correct operation of the circuits and programs developed in the laboratory sessions which correspond to the laboratory lesson 5 will be evaluated, according to the evaluation criteria.

The total mark of the assessable laboratory practices (LP) corresponds to the 10% of thetotal mark of the subject. It will be necessary to deliver the required source files.

Autonomous laboratory assignments (only for continuous evaluation).

Assignment1. Complex peripheral. Design of a peripheral for the microprocessor used in the subject. The peripheral has to be formed by a control unit and an ALU,according to the method studied in the theoretical lesson 9 of the subject.

Assignment2. Embedded System. Design of an embedded system based on the microprocessor studied in the theory of the subject. This embedded system has to include the complex peripheral design in assignment 1.

The assessment criteria for both the laboratory practices (laboratory lesson 5) and the two laboratory assignments are the following. All aspects must work and have been developed correctly to obtain the maximum mark. Additional functionality added by the student will be considered.

1) Functionality. (50 %)

Proved by:

· Basic functional simulations (without real delays) (10 %):

• Simulation of the “software” (only in embedded systems).

• Behavioural simulation of the different “hardware” circuits.

• Behavioural simulation of the complete embedded system (“hardware” +“software”) (only in embedded systems).

· Timing simulations (with real delays) (20 %)

• Timing simulation (“Post-route”) of the different “hardware” circuits.

• Timing simulation (“Post-route”) of the complete embedded system (“hardware” +“software”) (only in embedded systems).

· Tests on the development board. (20%)

• Board test of the different “hardware”circuits.

• Board test of the complex peripheral.

• Board test of the complete embedded system (“hardware” + “software”) (only in embedded systems).

2) Design correctness. (20%)

Proved by:

· Suitable “hardware” / “software" partitioning (only in embedded systems).

· Suitable distribution of tasks between the control unit and the ALU (only incomplex peripherals).

· Utilisation of the most suitable “hardware” circuits for each task.

· Suitable hierarchical organisation of the “hardware”.

· Application of synchronous design techniques.

· Optimisation of the VHDL description.

· Suitable structure of the assembler program, with the inclusion of thenecessary subroutines (only in embedded systems).

· Utilisation of the microprocessor interrupts when it is adequate (only inembedded systems).

3) Analysis of the FPGA implementation. (10%)

Analyse the FPGA logical resources used and their justification.

Analyse the internal system delays.

4) Documentation of the design and FPGA implementation. (20 %)

a. Report. It will be necessary to deliver a report of a maximum of 10 pages foreach of the laboratory lessons 5 to 7 that will have to follow the index supplied by the professor. In the report, all these things will be considered:

· Clear structure and order.

· Clear and sufficient explanations for the understanding of the work done.

· Inclusion of suitable and readable figures, included results of simulation.

· Inclusion of relevant data for the understanding of the work done.

b. Source design files.

· Enough comments in the VHDL files to explain the sentences used.

· Enough comments in the assembler files to be understood (only in embeddedsystems).

FINAL ASSESSMENT:

The students that opt for the final assessment (both at the end of the term or inJuly) will have to do a theoretical exam which consists of two parts and a laboratory exam individually.

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

The students that opt for the final assessment will not be allowed to attend the theoretical exams that are hold during the term. Their laboratory tasks will not be evaluated during the term either.

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

To pass the subject, it is necessary that:

· The mark of each one of the theoretical exams is equal or greater than 4 over10.

· The mark of the laboratory exam is equal or greater than 4 over 10.

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

In case the students pass all the different tasks, the final mark (FM) will be the weighted sum of the marks of each part of the subject:

FM = 0.25* TE1 + 0.25 * TE2 + 0.50 * LE

In case the students do not pass any of the tasks of the subject (mark of any task

Sources of information
Basic Bibliography
ÁLVAREZ RUIZ DE OJEDA, L.J.,, Diseño Digital con Lógica Programable, Editorial Tórculo, 2004, Santiago de Compostela
POZA GONZÁLEZ, F., ÁLVAREZ RUIZ DE OJEDA, L.J., Diseño de sistemas empotrados de 8 bits en FPGAs con Xilinx ISE y Picoblaze, Vision libros, 2012, Madrid
Complementary Bibliography
ÁLVAREZ RUIZ DE OJEDA, L.J., Diseño Digital con FPGAs, Vision libros, 2013, Madrid
ÁLVAREZ RUIZ DE OJEDA, L. Jacobo, MANDADO PÉREZ, E., VALDÉS PEÑA, M.D., Dispositivos Lógicos Programables y sus aplicaciones, Editorial Thomson-Paraninfo, 2002,
PÉREZ LÓPEZ, S.A., SOTO CAMPOS, E., FERNÁNDEZ GÓMEZ, S., Diseño de sistemas digitales con VHDL, Thomson-Paraninfo, 2002, Madrid
Ken Chapman, “PicoBlaze 8-bit Embedded Microcontroller User Guide for Spartan-3, Spartan-6, Virtex-5, and Virtex-6 FPGAs (UG129), Xilinx, 2010,
Ken Chapman, KCPSM3, 8-bit Microcontroller for Spartan-3, Virtex-2 and Virtex-2 Pro (KCPSM3_Manual), Xilinx, 2003,

Recommendations
Subjects that continue the syllabus
Design and synthesis of digital systems/V05G300V01923

Subjects that it is recommended to have taken before

Programming I/V05G300V01205
Digital Electronics/V05G300V01402
Physics: Fundamentals of Electronics/V05G300V01305

Other comments

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

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

IDENTIFYING DATA				
Radio Frequency Circuits				
Subject	Radio Frequency Circuits			
Code	V05G300V01511			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Isasi de Vicente, Fernando Guillermo			
Lecturers	Isasi de Vicente, Fernando Guillermo			
E-mail	fisasi@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Main radio system circuits are studied. In this matter main characteristics and structure are treated. The evaluation of this circuits is studied too.			

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How - Know be
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- know - Know How
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.	- know - Know How - Know be
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CE24	CE24/ST4 The ability to select circuits, subsystems and systems of radiofrequency, microwaves, broadcasting, radio link and radio determination.	- know - Know How
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know be

Learning outcomes	
Learning outcomes	Competences
Learn to understand subcircuits' specifications and the impact that have such specifications in whole system. From these specifications learn to develop a circuit that fulfill them proposing solutions of engineering in which prices, terms, availabilities, etc. wich have a paramount importance.	CG4 CG8 CG9 CE24 CE25 CT2 CT4
Learn the effect that each parameter of the specifications of a circuit has in the complete system.	CG6
Learn to analyse the priorities of the parameters in different circumstances.	CG4 CG6 CE24 CE25 CT2 CT4

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

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	2.5	3.5
Master Session	17	42.5	59.5
Practice in computer rooms	2	3	5
Laboratory practises	16.5	33	49.5
Jobs and projects	1	1	2
Short answer tests	4	24	28
Practical tests, real task execution and / or simulated.	0.5	2	2.5

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

Methodologies	
	Description
Introductory activities	Student will be guided to study of previous required knowledge using various sources in order to adequate subject study. Student is encouraged to make use of tutorship hours in order to solve more difficult topics.
Master Session	Lecture at classroom using blackboard and computer about subject theory. Through this methodology the competencies CG4, CG6, CG8, CE24 y CE25 are developed.
Practice in computer rooms	Learning of some EDA (computer design applications) for design and test of radiocommunication systems. Through this methodology the competencies CG4, CG6, CG9, CE24 y CE25 are developed.
Laboratory practises	Radiocommunication systems measurements. Use of radiocommunication circuit measurement equipment. Basic knowledge about radiofrequency circuits manufacturing. Team work using official standards and specifications. Through this methodology the competencies CG4, CG6, CG9, CE24, CE25, CT2 y CT4. are developed.

Personalized attention	
Methodologies	Description
Laboratory practises	In laboratory practises the professor is pays attention to students' work to solve any question. Moreover, students can make use of tutor sessions at professor's office. The timetable of this tutor sessions is announced in subject's web page at the start of course.
Practice in computer rooms	In laboratory practises the professor is pays attention to students' work to solve any question. Moreover, students can make use of tutor sessions at professor's office. The timetable of this tutor sessions is announced in subject's web page at the start of course.
Tests	Description
Jobs and projects	In addition of master classes, students can make use of tutor sessions at professor's office. The timetable of this tutor sessions is announced in subject's web page at the start of course.

Practical tests, real task execution and / or simulated.	In doing tests, student's ability must be shown without help.

Assessment

	Description	Qualification	Evaluated Competencess
Master Session	Class of blackboard in classroom with occasional support of computer,	0	
Laboratory practises	Questions of the professor and evaluation on the fly of the work of laboratory.	10	CG4 CG6 CE24 CE25
Practice in computer rooms	Tests in order to evaluate the correct comprension and ability in use of informatic tools.	5	CG4 CE24 CE25
Jobs and projects	Project to work into a team. A presentation of the results will be done to professor in wich some questions could be asked. The team's member who presents results is chosen by random between all team's members.	20	CG4 CG6 CG8 CG9 CE24 CE25
Short answer tests	Written tests of numerical problems.Three contiunuous assesment (5%, 15%, y 15%) plus one test at the end of course (15%) for students following continuous assesmnt. When a student doesn't follow continuous assesmnt or haven't done three or more continuous assesmnt tests, will do a test at the end of course which will have a value of 50% of the global qualification if student has done lab practises and C group's proyect. If student has not done such practises and proyect, has to contact professor for a practical assesment (50%) and a problems test (50%). To pass the subject it is neccesary to get a minimum average mark of 3 out of 10 in problems tests. If this condition is not accomplished final mark will be 4 if total average is equal or higher than this mark or the total average in other cases.	50	CG4 CG6 CE24 CE25
Practical tests, real task execution and / or simulated.	Evaluation of practic work. Results of the necessary calculations for the development of the practices.	15	CG4 CG6 CG8 CE24 CE25

Other comments and July evaluation

Continuous assesement: To pass the subject by continuous assesment it is mandatory to get a 3 points out of 10 in average out of all problems tests. If this condition is not accomplished final mark will be 4 if total average is equal or higher than this mark or the total average in other cases.

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

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

Final and july examinations:

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

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

If final or july examination is chosen the marks obtained in continous assesment tests has no validity.

Problems tests will be about matters explained in theory lectures and laboratories.

In laboratory, student has to answer practical questions and has to show his ability in the use of laboratory equipment and comprehension of the circuits used in practices.

Sources of information
Basic Bibliography
Apuntes de la asignatura, F. Isasi, 1, Vigo 2012
Complementary Bibliography
Electrónica de comunicaciones, M. Sierra y otros, 1, Madrid 2003
Solid state radio engineering, Kraus, Bostian y Raab, 1, 1980
James W. Nilsson, Susan A. Riedel, Circuitos eléctricos, 7, Madrid, 2005

Recommendations
Subjects that continue the syllabus
Microwave Circuits/V05G300V01611 Wireless Systems and Networks/V05G300V01615

Subjects that it is recommended to have taken before

Physics: Fundamentals of Electronics/V05G300V01305
Signal Transmission and Reception Techniques/V05G300V01404
Electronic Technology/V05G300V01401
Electromagnetic Transmission/V05G300V01303

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

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

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

Ability to understand the concept of coverage and to apply it to the radio link and broadcasting services.	CG2 CE22 CE25 CT2
Ability to analyse the coverage in order to specify the quality of service.	CG4 CE21 CT2

Contents

Topic	
1. RADIATION FUNDAMENTALS	1.1 Electromagnetic Fundamentals 1.2 Antenna parameters in transmission 1.3 Antenna parameters in reception 1.4 Types of antennas
2. LINK BUDGET	2.1 Friis transmission equation 2.2 Propagation losses. 2.3 Band frequencies.
3. NOISE	3.1 Thermal noise. 3.2 Noise in antennas. 3.3 Noise factor and noise-equivalent temperature of a receiver.
4. INTERFERENCE	3.1 Concept and types of interference 3.2 Characterization of interference
5. AVAILABILITY	5.1 Concepts of availability, fading and diversity 5.2 Noise-limited Systems 5.3 Interference-limited Systems
6. RADIOWAVE PROPAGATION	6.1 Propagation at very low frequencies 6.2 Surface wave propagation 6.3 Ionospheric propagation 6.4 Tropospheric Propagation

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	14	14	28
Troubleshooting and / or exercises	7	7	14
Laboratory practises	5	10	15
Autonomous practices through ICT	0	8	8
Case studies / analysis of situations	10	40	50
Reports / memories of practice	0	15	15
Troubleshooting and / or exercises	4	8	12
Long answer tests and development	2	6	8

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

Methodologies

	Description
Master Session	Presentation, by the professor, of the contents of the course (theoretical basis, guidelines for solving exercises/problems or developing a radio communication project). Through this methodology the competencies CG2, CE21, CE22, CE25, CT2 are developed.
Troubleshooting and / or exercises	Resolution, by the student, of problems and/or exercises related with the course. The student not only has to get the suitable or correct solutions by the application of the theory previously explained but also has to interpret correctly the results. Through this methodology the competencies CG4, CE21, CE22, CE25, CT2 are developed.
Laboratory practises	Application of knowledge to specific situations and acquisition of basic skills and procedures in the related field. They are developed in laboratories with specialized equipment. Through this methodology the competencies CG4, CE21, CE22, CE25 are developed.
Autonomous practices through ICT	Application through ICT of the knowledge and the procedural skills that the student has acquired in the course to specific situations. Through this methodology the competencies CG4, CE21, CE22, are developed.

Case studies / analysis of situations	Study and analysis of problems based on real events in order to know them, think about them, interpret them, generate hypothesis, constrast data ... and train in the use of different procedures of solution.Through this methodology the competencies CG4, CE21, CE22, CE25, CT2 are developed.

Personalized attention

Methodologies	Description
Master Session	In this methodology, all the questions that each student can ask will be answered.
Troubleshooting and / or exercises	Each student will be attended in an individual way.
Case studies / analysis of situations	Each student will be attended in an individual way.
Laboratory practises	Each student will be attended in an individual way.
Autonomous practices through ICT	Each student will be attended in an individual way.

Assessment

	Description	Qualification	Evaluated Competencess
Case studies / analysis of situations	Technique that consists of monitoring the student, who will be assessed from his autonomously solving of the proposed tasks (case studies / analysis of situations).	10	CG2 CG4 CE25 CT2
Reports / memories of practice	Evaluation of: - the preparation and development of the lab practices - the reports and memories on lab practices	10	CG4 CE21 CE22 CE25 CT2
Troubleshooting and / or exercises	Two examinations in which the student has to solve a number of exercises by applying the acquired knowledge in the time and conditions established by the professor. The student can take them during the course or together with the final examination, depending on the evaluation system chosen.	40	CG2 CG4 CE22
Long answer tests and development	Final examination: evaluation of the skills acquired by the student. He/she has to develop, relate, organise and present the knowledge acquired in the course.	40	CG2 CG4 CE22 CE25

Other comments and July evaluation

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

1. The continuous assessment includes a series of tasks performed during the course (70%). They are not recoverable, i.e., if a student can not fulfilled them in the time established, the professor is not bound to repeat them. The obtained qualification will be valid only for the current academic course.

The continuous assessment consists of:

a) two examinations (approximately in the weeks 4 and 9);

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

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

d) the final examination.

2. FINAL EXAMINATION at the end of the semester.

FORMULA OF QUALIFICATION

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

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

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

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

Continuous evaluation:

If PEC < 4 points, Qualification = PEC

If PEC >= 4 points, Qualification = 0.5 * E1 + 0.4 * PEC + 0.07 * PM + 0.01 * S)

No continuous Evaluation: Qualification = E1

4. RECOVERY IN the JULY SESSION. Previously to the exam (or at the entrance of the session) the students choose the evaluation system. The qualification formulas are the same.

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

Sources of information
Basic Bibliography
Marcos Arias Acuña, Oscar Rubiños López, Radiocomunicación, 1ª, Andavira Editora, 2011, Andavira Editora, 2011
José María Hernando Rábanos, Transmisión por Radio, 7ª, Editorial Universitaria Ramón Areces, 2013, Editorial Universitaria Ramón Areces, 2013
Complementary Bibliography
John Griffits, Radio Wave Propagation and Antennas. An Introduction, 1st, Prentice Hall, 1985, Prentice Hall, 1985
Robert E. Collin, Antennas and Radiowave Propagation, 1st, Mc Graw Hill, 1985, Mc Graw Hill, 1985
Constantine A. Balanis, Antenna Theory. Analysis and design, 4th, Wiley, 2016, Wiley, 2016
Thomas A.Milligan, Modern Antenna Design, 2nd, Wiley, 2005, Wiley, 2005
Angel Cardama, L. Jofre, J.M. Rius, S. Balnch, M. Ferrando, Antenas, 2ª, Ediciones UPC, 2002, Ediciones UPC, 2002
ITU-R, Recommendations,

Recommendations
Subjects that continue the syllabus
Wireless Systems and Networks/V05G300V01615

Subjects that are recommended to be taken simultaneously

Radio Frequency Circuits/V05G300V01511

Subjects that it is recommended to have taken before

Physics: Fields and Waves/V05G300V01202
Signal Transmission and Reception Techniques/V05G300V01404
Electromagnetic Transmission/V05G300V01303

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

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

Learning outcomes	
Learning outcomes	Competences
Analyze digital signal processing diagrams.	CG3 CE26
Design digital filters from specifications.	CG4 CE26 CT2

Analyze and specify the fundamental parameters of the communication subsystems from the point of view of digital signal processing.	CG4 CE26
Statistical analysis and filtering applied to the coding, processing and transmission of multimedia information.	CG3 CG4 CE26 CT3

Contents

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

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practises	12	24	36
Tutored works	7	35	42
Master Session	21	42	63
Long answer tests and development	2	7	9

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

Methodologies

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

Personalized attention

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

Assessment

	Description	Qualification	Evaluated Competencess
Master Session	Written exam encompassing all the material exposed in the classroom and laboratory .	40	CG3 CG4
Laboratory practises	Individual drills related with the laboratory content. Will be taken in laboratory time, and will last 30 minutes.	40	CG3 CG4 CT3
Tutored works	Projects to be carried out in groups. Different gradings according to levels of participation that will be assessed through cross-evaluation surveys among students.	20	CE26 CT2

Other comments and July evaluation

Evaluation

Following the guidelines of the degree, students shall be offered two evaluation systems: continuous evaluation or evaluation at the end of the semester.

- Continuous evaluation.
- Evaluation at the end of the semester.
- Recovery in the month of June-July.

CONTINUOUS EVALUATION

The continuous evaluation of the course will consist in:

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

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

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

- Laboratory drill 1 (10 %):

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

- Laboratory drill 2 (10 %)

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

- Laboratory drill 3 (10 %):

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

- Laboratory drill 4 (10 %):

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

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

EVALUATION AT THE END OF THE SEMESTER

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

the end of the continuous evaluation process.

Grading Periods

First opportunity to pass the course (December)

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

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

Second opportunity to pass the course (June-July)

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

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

Sources of information
Basic Bibliography
John G. Proakis, Dimitris G. Manolakis., Tratamiento Digital de Señales, Prentice Hall, 2007
Complementary Bibliography
Sanjit K. Mitra., Digital Signal Processing: A Computer Based Approach., Ed. McGraw-Hill, 2001
Alan V. Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing, Prentice Hall, 1999

Recommendations

Subjects that it is recommended to have taken before
Digital Signal Processing/V05G300V01304

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

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

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

Contents	
Topic	
Unit 1. Introduction to data acquisition systems (DAS)	1.1. Introduction 1.2. Components of DAS 1.3. Control systems
Unit 2. Auxiliary circuits	2.1. Level shifter circuits 2.2. Voltage reference 2.3. Voltage-to-current converters
Unit 3. Analog switches and multiplexers	3.1. Analog switches 3.2. Analog multiplexers
Unit 4. Amplification in data acquisition	4.1. Instrumentation amplifiers 4.2. Programmable gain amplifiers 4.3. Isolation amplifiers

Unit 5. Active filters	5.1. Introduction 5.2. First and second order transfer functions 5.3. Transfer functions aproximation 5.4. Active filters synthesis
Unit 6. Sample and hold circuits	6.1. Introduction 6.2. Base circuit 6.3. Practical architectures 6.4. Real parameters 6.5. Commercial devices
Unit 7. Digital-to-analog and analog-to-digital converters	7.1 Digital-to-analog converters (DAC) 7.1.1. Introduction 7.1.2. Transfer function 7.1.3. Parameters and errors 7.1.4. Classification 7.1.5. DAC architectures 7.2. Analog-to-digital converters (ADC) 7.2.1. Introduction 7.2.2. Transfer function 7.2.3. Parameters and errors 7.2.4. Classification 7.2.5. ADC architectures
Practice 0. Introduction	Introduction to laboratory concepts and tools.
Practice 1. Auxiliary circuits	Experimental test and analysis of auxiliary circuits used in signal conditioning stages.
Practice 2. Instrumentation amplifier	Experimental test and analysis of instrumentation amplifiers.
Practice 3. Isolation amplifier	Experimental test and analysis of linear optical isolation amplifiers built from discrete components.
Practice 4. Active filters	Experimental test and analysis of active filter topologies.
Practice 5. Digital-to-analog conversion	Experimental test and analysis of a digital-to-analog converter (DAC) built from discrete components.
Practice 6. Analog-to-digital conversion	Experimental test and analysis of an analog-to-digital converter (ADC) based on an ADC integrated circuit.

Planning

	Class hours	Hours outside the classroom	Total hours
Troubleshooting and / or exercises	4	22.5	26.5
Tutored works	7	20	27
Laboratory practises	14	28	42
Master Session	14	37.5	51.5
Troubleshooting and / or exercises	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
Troubleshooting and / or exercises	The lecturer will solve some exercises related to the subject. Competencies CE43 and CE45 will be addressed in these sessions.
Tutored works	The lecturer will lead the students in a data acquisition system design. Competencies CE43 and CE45 will be addressed in these sessions.
Laboratory practises	Simulations and real assembled circuits will be tested. Competencies CE43 and CE45 will be addressed in these sessions.
Master Session	The lecturer will show some theoretical contents related to the subject. Competencies CE43 and CE45 will be addressed in these sessions.

Personalized attention

Methodologies	Description
Master Session	The teacher will resolve the doubts of the students in his office at the schedule established and published on the school website.
Troubleshooting and / or exercises	The teacher will resolve the doubts of the students in his office at the schedule established and published on the school website.

Tutored works	The teacher will resolve the doubts of the students in his office at the schedule established and published on the school website.
Laboratory practises	The teacher will resolve the doubts of the students in his office at the schedule established and published on the school website.

Assessment

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

Other comments and July evaluation

1. Continuous assessment

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

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

The subject comprises three different parts: theory (50 %), laboratory (30%) and tutored work (20%). Once a task has been assessed, the students can not do/repeat the task at a later date. The marks are valid only for the current academic course.

1.a Theory

Three exercises and troubleshooting tests are scheduled. The exercises and troubleshooting tests (ETT1, ETT2 and ETT3) will be respectively performed after unit 4, 5 and 7 (~ in weeks 5, 9 and 14), in the usual weekly scheduling of the theoretical classes. The first test (ETT1) of the themes 1 to 4, the second test (ETT2) of the theme 5 and third test (ETT3) of the themes 6 and 7.These tests are approximately 60 minutes long.

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

FMT = (ETT1 + ETT2 + ETT3)/3

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

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

1.b Laboratory

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

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

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

1.c Tutored work

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

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

1.d Final mark of the subject

The weighted points from all assessed parts are added together to calculate the final mark (FM). The following weightings will be applied: 50% theory (FMT), 30% laboratory (FML) and 20% tutored work (TWM). In order to pass the subject, students will be required to pass the theory (ETT1>=4, ETT2>=4 , ETT3>=4 and FMT>=5). In this case the final mark (FM) will be:

FM = (0.5·FMT + 0.3·FML + 0.2 TWM).

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

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

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

2. Final Exam

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

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

FMT = (ETT1 + ETT2 + ETT3)/3

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

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

FM = (0.6·FMT + 0.4·FML).

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

FM = min{4 ; (0.6·FMT + 0.4·FML)}.

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

3. Second opportunity to pass the subject

This exam consist on a theory exam and a laboratory exam. Dates will be specified in the academic calendar. n order to attend the laboratory exam, the students have to contact to the lecturer at least two weeks before the exam. This way, the organization of the laboratory exam will be simpler.

The marks obtained in the previous continuous assessment or final exam (FMT, FML or TWM) are kept for those parts in which the student has not attended. The final mark will be calculated as it has described in sections 1 an 2.

Sources of information
Basic Bibliography
Paul Horowitz y Winfield Hill, The Art of Electronics, Cambridge Univ. Press., 1989
Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, WCB/McGraw-Hill, 2002
Franco Maloberti, Data Converters, ISBN 978-0-387-32485-2, 2007
Complementary Bibliography

Analog Devices Library, hhtp;//www.analog.com/library/analogDialogue/archives/43-09/EDCh%206%20Converter.pdf, Capitulos 6.1,6.2,6.3,

Recommendations

Subjects that continue the syllabus

Analogue Electronics/V05G300V01624

Subjects that are recommended to be taken simultaneously

Analogue Electronics/V05G300V01624

Subjects that it is recommended to have taken before

Electronic Technology/V05G300V01401

Other comments

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

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

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- know - Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- know - Know How
CG13	CG13 The ability to use software tools that support problem solving in engineering.	- know - Know How
CE39	(CE39/SE1): The ability to construct, exploit and manage the receiving, transporting, representation, processing, storage, manage and presentation multimedia information from the electronic systems point of view.	- know - Know How
CE45	(CE45/SE7): The ability to design interface, data capturing and storage devices, and terminals for services and telecommunication systems.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Understand the fundamental design principles of the signal processing hardware systems.	CG6 CG13 CE39 CE45
Ability to decide different design strategies depending on the application.	CG4 CE39 CE45 CT2
Ability to choice the most suitable hardware architecture for each application.	CG4 CG6 CE39 CE45

Ability to design basic circuits for audio and image processing.	CG4 CG6 CG9 CG13 CE39 CE45 CT4
Acquire skills in the use of design, simulation and implementation tools of signal processing systems.	CG13 CE39 CE45
Acquire skills to verify the proper operation of complex hardware systems.	CG6 CG13 CE39 CE45
Acquire skills to combine different software tools and hardware platforms.	CG13 CE39 CE45
Ability to document hardware design projects.	CG4 CG9 CT4

Contents	
Topic	
Theory: Theme 1. Introduction	- Basic architecture of electronic signal processing systems: signal conditioning, sampling, conversion, and reconstruction.
Theory: Theme 2. Types of signal processing	-Different hardware and software solutions: DSP and FPGAs. -Processing forms: Serial/Parallel, Hardware/Software. -Hardware cost of regular signal processing circuits. Logical resources used. Processing rate.
Theory: Theme 3. Arithmetic in DSP	-Data types. -Data modification: quantification and overflow. -Arithmetic operations and associated circuits. -Associated concepts: critical path, pipeline and latency.
Theory: Theme 4. Siignal conditioning and sampling	- Example of a real system for signal conditioning and sampling using a FPGA-based development board.
Theory: Theme 5. Design and Implementation of Digital Filters	- Implementation of digital filters in FPGA. - Analysis of full parallel and semi-parallel solutions: hardware costs, operation rates.
Theory: Theme 6. Design of image processing systems	- Examples of basic image processing systems. - Analysis of hardware resources required. - Implementation and performance analysis.
Theory: Theme 7. Design of audio processing systems	- Examples of audio processing systems. - Analysis of required hardware resources. - Implementation and performance analysis.
Theory: Theme 8. Design of signal processing systems for communications	- Examples of signal processing systems for communication applications. - Implementation and performance analysis.
Labs: Design of basic signal processing systems.	- Design, implementation and verification of basic signal processing systems described using VHDL: digital filters, communication applications, image processing, audio processing. - Using the ISE design tool from Xilinx and MATLAB from MathWorks.

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Laboratory practises	14	14	28
Projects	9	54	63
Master Session	14	14	28
Short answer tests	2	6	8
Jobs and projects	2	6	8
Practical tests, real task execution and / or simulated.	0	14	14

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

Methodologies	
	Description
Introductory activities	The theoretical ad practical key topics of the subject, as well as the projects to be developed along the course will be presented by the teacher. CG6, CE39 and CE45 competencies will be worked on.
Laboratory practises	Basic signal processing systems will be implemented using FPGAs. CG6, CG9, CE39, CE45 and CG13 competencies will be worked on.
Projects	Working groups of two or more students will be established. Each group will develop two projects along the course. These projects will address the design of signal processing systems of low and medium complexity, respectively. Additionally, small groups (Groups Type C) will be available allowing monitoring the projects to be developed in the course. Activities to be developed in groups C: Activity 1. Description, analysis and discussion of the systems designed in the first project of the course. Presentation of results. Duscussion of design alternatives. Activity 2. Analysis and monitoring of the proposed solution for the second project. Activity 3. Demonstration of the behavior of systems designed in the second project. Analysis and discussion of results. CG6, CG9, CE39, C345, CG13, CT2, CG4 and CT4 competencies will be worked on.
Master Session	The theoretical content of the course and the introductory activities of both the theoretical and practical contents will be presented. CG6, CE39 and CE45 competencies will be worked on.

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

Assessment			
	Description	Qualification	Evaluated Competencess
Short answer tests	There will be a short-answer test on the theoretical issues of the course. More information is provided in the "Other Comments" section below. This test will assess competencies CE39 and CE45.	20	CE39 CE45

Jobs and projects	There will be two projects during the course. In the first project the student will design a basic signal processing system. The weight of this assessment is 35% of the total grade for the course. The second project will involve the design of a signal processing system of medium complexity and its evaluation will be a 35% of the final grade. More information is provided in the "Other Comments" section that follows. These projects will assess competencies CG4, CG6, CG9, CG13, CE39, CE45, CT2 and CT4.	70	CG4 CG6 CG9 CG13 CE39 CE45 CT2 CT4
Practical tests, real task execution and / or simulated.	The laboratory practices will be continuously evaluated during laboratory hours (Type B hours). The weight of this assessment is 10% of the total grade for the course. These practices will assess competencies CG4, CG6, CG13, CE39, CE45 y CT4.	10	CG4 CG6 CG13 CE39 CE45 CT4

Other comments and July evaluation

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

1.- Continuous assessment

The evaluation of the course is done through continuous assessment, which consists of a theory test, a set of laboratory practices and the delivery of two theoretical-practical works (projects). However, the realization of a final test is also included as an alternative.

The theoretical examination will include the contents of the first three temes of the course and will take place during lecture hours (Type A hours). The weight of this examination will be 2 points out of 10.

The laboratory practices will be performed in groups of two or more students and will be continuously evaluated during laboratory hours (Type B hours). The weight of this assessment is 1 point out of 10. The score will be the same for all the members of a working group.

The first theoretical-practical work will include themes 1 to 5. It will consist of the design of a basic signal processing sysem. This work will be conducted in laboratory and small groups hours (Type B and C hours) in groups of two or more students. As a result of the work a descriptive report of the designed system must be delivered. The weight of this assessment is 3.5 points out of 10.

The second theoretical-practical work will include themes 6 to 8. This work will be conducted in laboratory and small groups hours (Type B and C hours) in groups of two or more students. As a result of the work a descriptive report of the designed system must be delivered and the results discussed later (Type C hours). The weight of this assessment is 3.5 points out of 10 (3 points correspond to the execution and documentation tasks and 0.5 points to de presentation and discussion ones).

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

The final grade for the course will be the sum of the four assessments. To pass the course a student must meet the following conditions:

- Get at least 5 out of 10 in the overall evaluation.

- Get at least 40% of the maximum score for each of the evaluation activities.

Students who fail any of the assessments shall be submitted to the corresponding final exam. Similarly, students who want to improve the grade obtained in any of the assessments may be submitted to final exam.

In the case a student fails to obtain at least 40% of the maximum score in any of the assessment activities, but has above the minimum of 5 out of 10 in the overall assessment, the student will be considered suspended and the note 4.5 will appear in the minutes.

It is understood that the student chooses continuous assessment if he/she conducts the two first laboratory practises, and since then will be considered submitted to this evaluation alternative.

2.- Assessment by final exam.

The final exam will consist of the same evaluative activities covered by continuous assessment. This means that on the date scheduled for the final exam students who have not opted for the continuous assessment should make the theoretical examination of the themes 1 to 3 of the course and deliver the reports of the laboratory practices and of both theoretical-practical works equivalent to that performed by continuous assessment. The theoretical-practical works will be discussed in the week following delivery.

As noted above, those students who have opted for continuous assessment and not passed any assessment activities or want to improve their grade may also pass a final exam only with the theme (or themes) to be considered. In this case the grade will be the highest between the final examination and continuous assessment.

3.- Second call (July)

The second call assessment exam will have two parts, a theoretical examination of the whole themes of the course and a practical one.

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

The practical examination will consist in the final test of a system previously designed and simulated. The student will demonstrate the proper functioning of the system using a FPGA based development board. The teacher will assign the design work to the students at the beginning of the second quadmester. One week before the second call assessment date the student must deliver a descriptive report of the designed system as well as the simulation results.

Both parts of the second call assessment (theoretical examination and practical examination) will represent the 50% of the final grade for the course.

The final grade for the course will be the sum of the two assessments. To pass the course a student must meet the following conditions:

- Get at least 5 out of 10 in the overall evaluation.

- Get at least 40% of the maximum score for each of the evaluation activities.

In the case a student fails to obtain at least 40% of the maximum score in any of the assessment activities, but has above the minimum of 5 out of 10 in the overall assessment, the student will be considered suspended and the note 4.5 will appear in the minutes.

4.- Other comments

- The exams will be written in Spanish. The student can use the Spanish, English or Galician to answer the exam and for the reports, works or presentations.

- The grades obtained from the continuous assessment 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.

- In case of plagiarism is detected in any of the reports/tasks/exams done/taken, the final score for the subject will be 'fail' (0) and the teachers will inform the School authorities so that they take the actions that they consider appropiate.

- In case of plagiarism or abandonment of a member of a work group is detected, his/her score will be 'fail' (0) and will not compute for the score of the rest of the group.

Sources of information
Basic Bibliography
U. Meyer-Baese, Digital signal processing with Field Programmable Gate Arrays, 3th ed., Springer-Verlag, 2007, Berlin Heidelberg - Germany
James H. McClellan, Ronald W. Schafer, Mark A. Yoder, Signal processing first, 1st ed., Pearson Education International, 2003, Upper Saddle River - USA
XUP, University of Strathclyde and Steepest Ascent, DSP for FPGA Primer, 2011,
Complementary Bibliography
John G. Proakis, Dimitris G. Manolakis, Digital signal processing, 4th ed., Pearson Education International, 2007, Upper Saddle River - USA

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

Recommendations

Subjects that are recommended to be taken simultaneously

Programmable Electronic Circuits/V05G300V01502

Subjects that it is recommended to have taken before

Digital Electronics/V05G300V01402
Digital Signal Processing/V05G300V01304

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

Competencies		
Code		Typology
CG1	CG1: The ability to write, develop and sign projects in the field of Telecommunication Engineering, according to the knowledge acquired as considered in section 5 of this Law, the conception and development or operation of networks, services and applications of Telecommunication and Electronics.	- Know How
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.	- know
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- Know How
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.	- know - Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know be
CE41	(CE41/SE3):The ability to make the specification, implementation, documenting and tuning of electronic systems and equipment (both instrumentation and control oriented), considering the corresponding technical aspects and the regulations.	- know - Know How
CE47	(CE47/SE9): The ability to analyze and solve interference and electromagnetic compatibility problems .	- Know How
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know be

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

Ability to manage the knowledge of the organization	CG9 CT4

Contents	
Topic	
Item 1: Introduction	Definitions. Reliability Basics. RAMS Technologies. Statistical functions. Reliability Management.
Item 2: Reliability of electronic components	Definitions. Parameters (Failure rate, MTBF, MTTF). Reliability prediction of electronic components. Regulations.
Item 3: Reliability of electronic systems	Serie systems. Redundant systems. Reliability allocation. Redundancy optimitation. Srtandards.
Item 4: Maintainability and Availability	Definitions and types of maintenance. Parameters (Repair rate, MTTR). Stocks management. Availability of series and parallel systems. Regulations.
Item 5: Safety	Definitions. Electronic systems for safety applications. Safety level or safety category determination for safety electronic systems. Standards.
Item 6: Reliability tools	Failure mode effects analysis and criticalities (FMECA). Fault Tree (FTA). Markov Models. Standards.
Item 7: Essays	Types and test plans. Accelerated tests. Standards.
Item 8: Electromagnetic Interferences	Definitions. Fundamentals of electromagnetic interferences. Sources of interference. Minimization elements. Standards.
Item 9: Dependability management I	R + D + i. Lifecycle. Continuous improvement: management and assurance. Support tools.
Item 10: Dependability management II	HR and strategic management. Teamwork and improvement systems. Support tools.

Planning			
	Class hours	Hours outside the classroom	Total hours
Troubleshooting and / or exercises	6	12	18
Laboratory practises	8	0	8
Tutored works	0	60	60
Case studies / analysis of situations	7	0	7
Master Session	21	36	57

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

Methodologies	
	Description
Troubleshooting and / or exercises	Teaching activities with problems develop, case studies and exercises related to the subject. Also it be used to show existing doubts and also for feedback to teachers. Competencies CG1, CG2, CG6, CE47 and CE41 are used
Laboratory practises	The students learn how to perform reliability calculations by using specific software for this application. Competencies CG2, CE41 and CT4 are used
Tutored works	Sspecific workbs that are related to the content of the subject and in partnership with a company or outside entity. Whenever possible, the student will develop two jobs one of them in collaboration with AENOR and another in collaboration with a company's environment. Competencies CG6, CG8, CG9, CE41, CE47 and CT4 are used
Case studies / analysis of situations	The groups are conducted with a small number of students and are used for the development of group work and learning methodologies teamwork. Competencies CG1, CG2, CE41 and CT4 are used.

Master Session	It will develop in the schedules fixed by the direction of the engineering school. It consist of a presentation by the teacher, of the contents of the subject. Also proceed to solving examples and / or problems that illustrate the problems to be solved adequately. The student may submit all doubts and questions deemed appropriate, during the session. We will promote the more active participation of the student possible. Competencies CG1, CG2, CG6, CG8, CG9, CE41, CE42 and CE47 are used.

Personalized attention

Methodologies	Description
Master Session	The teacher will personally attend doubts and queries of students, on the study of theoretical, laboratory or projects. Students will have opportunity to attend individual tutorials or in groups in the teacher's office on schedule to be established for this purpose at the beginning of the course and to be published on the page of the subject.
Laboratory practises	The teacher will personally attend doubts and queries of students, on the study of theoretical, laboratory or projects. Students will have opportunity to attend individual tutorials or in groups in the teacher's office on schedule to be established for this purpose at the beginning of the course and to be published on the page of the subject.
Tutored works	The teacher will personally attend doubts and queries of students, on the study of theoretical, laboratory or projects. Students will have opportunity to attend individual tutorials or in groups in the teacher's office on schedule to be established for this purpose at the beginning of the course and to be published on the page of the subject.
Case studies / analysis of situations	The teacher will personally attend doubts and queries of students, on the study of theoretical, laboratory or projects. Students will have opportunity to attend individual tutorials or in groups in the teacher's office on schedule to be established for this purpose at the beginning of the course and to be published on the page of the subject.

Assessment

	Description	Qualification	Evaluated Competencess
Troubleshooting and / or exercises	Deliverables, problems and exercises will be assess.	40	CG1 CG2 CG6 CE41 CE47
Tutored works	They will evaluate the contents (methodology of development, conclusions obtained, exhibition of results, capacity of work in team, capacity of work in multidisciplinary team) in the work in collaboration with the company. Also will take into account the opinion of the tutor in the company. The other work in collaboration with AENOR will value the quality of the work realised and the capacity of work in team. For works in team the indivual note will be the same for all members of the team	60	CG6 CG8 CG9 CE41 CE47 CT4

Other comments and July evaluation

The deliverables of the troubles and exercises are provide for guidance, for weeks 2, 4, 6, 8 and 10.
Following the guidelines for the degree and agreements of the academic committee, the students can choose between continuous assessment or the final exam on the date set by the engineering school.
Students who choose the continuous assessment should inform the instructor during the first two weeks of class.
Continuous assessment involves:

a) The students should do the problems and exercises and it will be delivered to the teacher. Maximun rating 4 ponits (40% of the final grade). The students must obtain a minimum of 2 points. These tasks are not recoverable later.

b) The students should do in group two jobs. One of them in collaboration with AENOR and students of the Faculty of Philology and Translation, and another in collaboration, with a company´s environment. Working in partnership with the company will be held in the months of February,March, April and May.The students will go to the company when necessary. Maximum rating 6 points (60% of the final grade). The students must obtain a minimum of 3 points.

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

Students working in groups will have the same grade.

The final exam assessment by the end of the semester or in the extraordinary (June-July), involves:

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

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

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

Sources of information

Basic Bibliography

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

P. Kales, Reliability, Prentice-Hall, 1998, USA

David J. Smith, Reliability, Maintainability and Risk, 8ª, Butterworth Heinemann, 2011, USA

Kececioglu, Dimitri, Reliability Engineering Handbook, DEStech, 2002, USA

Antonio Creus Solé, Fiabilidad y seguridad: Su aplicación en procesos industriales, Marcombo, 2005, España

J. Balcells, F. Daura, R. Esparza e R. Pallás, Interferencias Electromagnéticas en Sistemas Electrónicos, Marcombo, 1991, España

Complementary Bibliography

ISO, UNE-EN ISO 9000:2005: Sistemas de gestión de la calidad. Fundamentos y vocabulario., AENOR, 2005, España

ISO, UNE-ISO 55000:2015: Gestión de activos. Aspectos generales, principios y terminología., AENOR, 2015, España

I. Fernández, A. Camacho, C. Gasco, A.M. Macías, M.A. Martín, G. Reyes, J. Rivas, Seguridad Funcional en Instalaciones de Proceso: Sistemas Instrumentados de Seguridad y Análisis SIL, ISA, 2012, España

Recommendations

Subjects that are recommended to be taken simultaneously

Data Acquisition Systems/V05G300V01521

Subjects that it is recommended to have taken before

Mathematics: Calculus 2/V05G300V01203
Digital Electronics/V05G300V01402
Physics: Fundamentals of Electronics/V05G300V01305
Electronic Technology/V05G300V01401

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

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

Learning outcomes	
Learning outcomes	Competences
* Understand the basic mechanisms of vibration of distinct elements and interpret his relation with the production of sound. * Know the bases of the linear acoustics and understand the concepts of pressure, speed of particle, intensity, power and impedance. * Understand the phenomena of propagation of the sound and to analyse the influence of the medium. * Understand the phenomenon of the radiation of acoustic waves. * Understand the basic mechanisms of the *transducción mechanical-acoustic.	CG3 CG11 CE34 CE37

* Analyse electro-mechanical-acoustic systems by the use of analogies which are based on circuit theory. * Design acoustic systems by using speakers, acoustic boxes and horns. * Analyse different types of microphones from the point of view of their technical specifications and their possible applications.	CG3 CG5 CG11 CE34 CE37
* Interpret technical specifications within working teams. * Apply norms of measuring. * Elaborate trial procedures. * Develop trial procedures. * Process data obtained from trials * Program processing algorithms. * Value technical results. * Write trial reports.	CG6 CG9 CG11 CE34 CE37
* Cooperate and collaborate in working groups to carry out technical projects. * Adapt to new surroundings. * Accept the role allocation in a group. * Contribute to the resolution of conflicts.	CT3 CT4

Contents

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

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	19	38	57
Autonomous troubleshooting and / or exercises	3	6	9
Practice in computer rooms	11	19	30
Laboratory practises	6	6	12
Troubleshooting and / or exercises	0	39	39
Short answer tests	1.75	0	1.75
Short answer tests	0.25	0	0.25
Short answer 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	Oral speech, promoting the critical discussion of the concepts. Theoretical bases of algorithms and procedures used to solve problems are presented. CG3, CG5, CG11, CE34, CE37.
Autonomous troubleshooting and / or exercises	Resolution of exercises as a practical application of the theoretical bases and procedures described in the master sessions. Given a specific situation, the student has to obtain the suitable solution, in a reasoned way, by properly choosing the appropriate formulas and coming to a valid solution. CG3, CG5, CG11, CE34, CE37.
Practice in computer rooms	Handle and adjustment of tools of analysis and algorithms, identifying which is appropriate for a given situation. CG3, CG5, CG6, CG9, CG11, CE34, CE37, CT3, CT4.

Laboratory practises	Cooperative and collaborative work with measuring equipment in reduced groups, and registering of acoustic magnitudes, in laboratoy environments. CG3, CG5, CG6, CG9, CG11, CE34, CE37, CT3, CT4.
Troubleshooting and / or exercises	Given a certain situation, students should obtain the reasoned suitable solution, properly choosing the applicable formulas and arriving to a valid solution. CG3, CG5, CG6, CG11, CE34, CE37.

Personalized attention

Methodologies	Description
Master Session	Doubts may be solved in the tutorial classes. These will take place in the following way: - Individually or in small groups (typically with a maximum of 2-3 people). - Unless the contrary is specified, previous appointment with the professor will be required. The appointment will be requested and acknoledged by email. Place and time will preferrably be as officially scheduled.
Practice in computer rooms	Doubts may be solved in the tutorial classes. These will take place in the following way: - Individually or in small groups (typically with a maximum of 2-3 people). - Unless the contrary is specified, previous appointment with the professor will be required. The appointment will be requested and acknoledged by email. Place and time will preferrably be as officially scheduled.
Troubleshooting and / or exercises	Doubts may be solved in the tutorial classes. These will take place in the following way: - Individually or in small groups (typically with a maximum of 2-3 people). - Unless the contrary is specified, previous appointment with the professor will be required. The appointment will be requested and acknoledged by email. Place and time will preferrably be as officially scheduled.
Autonomous troubleshooting and / or exercises	Doubts may be solved in the tutorial classes. These will take place in the following way: - Individually or in small groups (typically with a maximum of 2-3 people). - Unless the contrary is specified, previous appointment with the professor will be required. The appointment will be requested and acknoledged by email. Place and time will preferrably be as officially scheduled.
Laboratory practises	Doubts may be solved in the tutorial classes. These will take place in the following way: - Individually or in small groups (typically with a maximum of 2-3 people). - Unless the contrary is specified, previous appointment with the professor will be required. The appointment will be requested and acknoledged by email. Place and time will preferrably be as officially scheduled.

Assessment

	Description	Qualification	Evaluated Competencess
Practice in computer rooms	Assessment of the reports describing the results obtained in the computer classroom.	10	CG3 CG5 CG6 CG9 CG11 CE34 CE37 CT3 CT4
Laboratory practises	Exam on the preliminary preparation of the laboratory practices	8'75	CG3 CG5 CG6 CG9 CG11 CE34 CE37 CT3 CT4
Short answer tests	Written exam, with brief questions and problems.	50	CG3 CG5 CG11 CE34 CE37

Short answer tests	Exam on the interpretation exercises of the laboratory practices.	26,25	CG3 CG5 CG6 CG11 CE34 CE37
Short answer tests	Exam on the work done in the computer classroom.	5	CG3 CG5 CG6 CG11 CE34 CE37

Other comments and July evaluation

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

Continuous evaluation (the preferred method, academic activities are linked to this system) and evaluation at the end of the semester (not recommended).

*** Students who choose continuous evaluation:**

Students will follow the continuous evaluation system if they sign a document that will be delivered and collected during weeks 1-3, so that the collaborative work can begin.

Weighing:

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

* Practices in computer rooms (weight: 15%). The evaluation will be done twofold: Reports describing the results obtained in the computer classroom, assessed in flexible groups of two (10%), and practice interpretation, with individual assesment (5%).

* Laboratory practices (weight: 35%). The evaluation will be done twofold: Practice preparation, assessed in small groups (8.25%), and practice interpretation, with individual assesment (26.75%). Attendance to these laboratory practices is considered as compulsory.

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

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

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

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

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

*** Students who choose for evaluation at the end of the semester:**

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

Weighing:

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

* Practises in computer rooms. Individual assesment. (weight: 15%)

* Laboratory practises. Individual assesment. (weight: 35%)

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

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

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

<u>RETAKE</u>

Two different situations:

=> Students that are evaluated using continuous evaluation:

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

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

* To be evaluated with the same final exam as stated in the above section “Students who choose for evaluation at the end of the semester”.

=> Students who choose for evaluation at the end of the semester:

A final examination will be provided to students who do not opt for the continuous evaluation. This final exam will be assessed as stated in the above section “Students who choose for evaluation at the end of the semester”.

Sources of information
Basic Bibliography
Basilio Pueo Ortega, Miguel Romá Romero, Electroacústica : altavoces y micrófonos, Pearson/Prentice Hall
W. Marshall Leach, Jr., Introduction to electroacoustics and audio amplifier design, Kendall/Hunt
Finn Jacobsen et al., FUNDAMENTALS OF ACOUSTICS AND NOISE CONTROL, Technical University of Denmark
Complementary Bibliography
Lawrence E. Kinsler, Fundamentals of acoustics, John Wiley & Sons
Vance Dickason, Loudspeaker Design Cookbook, Audio Amateur Press

Recommendations
Subjects that continue the syllabus
Room Acoustics/V05G300V01635 Audiovisual Technology/V05G300V01631
Subjects that are recommended to be taken simultaneously
Audio Systems/V05G300V01532
Subjects that it is recommended to have taken before
Physics: Analysis of Linear Circuits/V05G300V01201 Physics: Fields and Waves/V05G300V01202 Physics: Fundamentals of Mechanics and Thermodynamics/V05G300V01102 Fundamentals of Sound and Image/V05G300V01405

IDENTIFYING DATA				
Audio Systems				
Subject	Audio Systems			
Code	V05G300V01532			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Pena Giménez, Antonio			
Lecturers	Pena Giménez, Antonio			
E-mail	apena@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The chain of audio systems is presented, from a systemic point of view. Each system is revised: configuration, specifications, quality figures and interaction with other systems.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How - Know be
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.	- know - Know How - Know be
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- know - Know How - Know be
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CG12	CG12 The development of discussion ability about technical subjects	- know - Know How - Know be
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.	- know - Know How - Know be
CE35	CE35/SI2 The ability to analyze, specify, carry out and maintain systems, equipments, heads and installations of TV, audio and video for mobile and fixed environments.	- know - Know How - Know be
CE37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.	- know - Know How
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know How - Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences

Results of learning (SI2.1): ->Understand and discuss levels in audio systems ->Know the differente types of audio amplifier, from a systems point of view. Discuss technical specifications to compare them.	CG3 CG5 CG6 CG12 CE35
Results of learning (SI4.2): -> Select a configuration for taking sound in different scenarios.	CG3 CG12 CE37 CT3
Results of learning (SI1.2): -> Know and understand the operation of dynamic range processors and its application in a chain of audio systems. -> Apply equalization techniques and other processes. ->Schedule and carry out a mixture of sounds from the technical point of view, showing the knowledge of different tools to achieve an artistic result. -> Discuss the influence of the available parameters of a digital audio format of audio in the final quality. ->Explain several elements and interconnection protocols to allow the transport and synchronization of audio signals. Results of learning (SI1.3): -> Understand the basics of spatial audition and 3-d audio systems. -> Understanf the concept 'quality' in a given audio application	CG3 CG12 CE34 CT3
Results of learning Organize a working group to carry out a project, including the following: -> technical ability to collect information, interpret technical specifications, discuss several options and select a combination of audio systems. -> Write progress reports, minutes of meetings and a final technical report . -> Technical meetings, discussion of partial results and oral presentation of the final work in front of a demanding audience. -> Adaptation to new environments , internal management roles in the group and dispute resolution. -> Internalize the importance of the human relationship with the client , preserving a fluent contact.	CG9 CG12 CE37 CT3 CT4

Contents	
Topic	
Specifications.	Level meters. Impedances. Specifications.
Dynamic range and processes.	Dynamic range. Compressors and expansors. Filtering. Effects.
Amplifiers.	Types.Characterization.
Mixture of sounds.	Mixing table.. Bases of a mixture. Mixture in studio and live mixing. Mastering.
Sound take.	Types. Selecting a microphone. Configuration.
Sound quality.	Concept of quality. Estimate of quality.
Spatial audio (3-D).	Spatial audition. 3-d audio systems.
Digital audio.	Audio sampling systems. Specifications and sources of noise. Dithering. Synchronization and transport. MIDI.

Planning			
	Class hours	Hours outside the classroom	Total hours
Practice in computer rooms	14	10.5	24.5
Outdoor study / field practices	0	7	7
Projects	7	52.5	59.5
Autonomous practices through ICT	0	10	10
Master Session	19	24	43
Short answer tests	2	0	2
Multiple choice tests	0	4	4

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

Methodologies	
	Description
Practice in computer rooms	Handle and adjustment of tools of analysis and algorithms, identifying which is appropriate for a given situation. Through this methodology, competencies CT3, CG3 and CE34 are developed.

Outdoor study / field practices	Visits to places where the concepts discussed are applied (radio studio, recording studio, etc.). Due to availability and funding. Through this methodology, competency CE34 is developed.
Projects	Collaborative work in reduced groups. A complex design with a regular monitoring agenda. Role assignments, working in common, planning, technical reports and oral presentation. Through this methodology, competencies CT3, CT4, CG3, CG12, CG5, CG6, CG9, CE34, CE35 and CE37 are developed.
Autonomous practices through ICT	Written and/or audiovisual material is provided to study and prepare an online test. This activity is prior to the master class or practice in computer rooms where doubts will be resolved and challenges will arise. Through this methodology, competencies CG3 and CE35 are developed.
Master Session	Oral speech, promoting the critical discussion of the concepts. Theoretical bases of algorithms and procedures used to solve problems are presented. Through this methodology, competencies CT3, CG3, CG12, CE34, CE35 and CE37 are developed.

Personalized attention

Methodologies	Description
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.
Practice in computer rooms	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.
Projects	During group projects an individualized tracking of the student is developed. Cross-avaliation within the group and autoavaliation may be used.

Assessment

	Description	Qualification	Evaluated Competencess
Practice in computer rooms	Work assessment in the computer room.	10	CG3 CE34 CT3
Projects	Assessment of a collaborative work, developed along the semester, including a written report and oral presentation.	50	CG3 CG5 CG6 CG9 CG12 CE37 CT3 CT4
Short answer tests	Written test with short questions and problems to solve.	35	CG3 CG12 CE34 CE35
Multiple choice tests	Automatic corrected online test.	5	CG3 CE35

Other comments and July evaluation

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

*** "Students who choose continuous evaluation" conditions:**
A student follows the continuous evaluation system if she/he assigns a document that will be delivered and collected during weeks 1-3, so the collaborative work can begin.

Some tasks are evaluated. The approximate task calendar and the weight of each task in the final grade are listed below.

* Collaborative work in a group C (weight: 50%): during approx. 10 weeks each group develops a project. Some evidences

are picked during this period (cross evaluation, written test, etc.) and a final report must be delivered around week 12-14. An oral presentation ends this activity. Individual assessment mark in group work is obtained as the weighted sum of : 1) the mark obtained by the group (55 %) ; 2) individual marks (45 %) , obtained from cross evaluation by the other members of the group, oral questions during presentations, written questions about the content of the work.

* Written exam (weight: 35%): short questions related to group A and B activities, plus additional material. At the end of the semester, the same day when the final exam is planned.

* Automatic corrected online test. (Weight : 5%): prior to the sessions.

* Laboratory tests (Weight: 10%): at the end of the laboratory session.

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

BONUS SYSTEM

* Group: a weekly score of the groups is published. Taken into account different individual and collective evaluations, distinctions (-badges-) are awarded to the best group, the second best and the worst. Their influence on the final score is:
=> Group with more badges as Best: group mark adds 1 point.
=> Group with more badges as Second best: group mark adds 0.5 points.
=> Group with best cumulative score: group mark adds 1.5 points.
=> Group with the second best cumulative score: group mark adds 0.75 points.
=> Group with a better effort in the cumulative trajectory: group mark adds 0.75 points.

* Individual: a monthly score of the students is published, privately. Given different individual evaluations, distinctions are awarded to the best student, the second best and the worst. Its influence on the final score is:
=> Student with more badges as Best: considered for possible honors.
=> Student more badges as Second best: considered for possible honors.

Only one bonus per group or student can be granted. Any bonus may be not granted if there are some reasons that recommend so. In no case, this bonus is negative.

CONDITIONS TO PASS THE SUBJECT

Once bonus points are added, in order to ensure that students acquire a balanced minimum on the subject competences, they will pass the course if they meet these two conditions:
1) get a final mark equal to or greater than 5 (on a ten-points scale)
2) and a score equal to or greater than 4 (on the same scale) in each of the partial marks (written exam and collaborative group, respectively).
If some of these conditions are not fulfilled, then the final grade (on a ten-points scale) will be the minimum between the final mark and the value "4".

*** "Students who choose for evaluation at the end of the semester" conditions:**
The possibility of a final examination will be provided to students who do not opt for the continuous evaluation.
In order to ensure that students acquire a balanced minimum on the subject competences, they will pass the course if they meet both these two conditions:
1) get a final mark equal to or greater than 5 (on a ten-points scale)
2) and a score equal to or greater than 4 (on the same scale) in each of the sections of the exam. These sections, respectively, correspond with:
* contents included in all activities* project developed in group, including group internals, management, writing of technical reports and oral presentations.
If some of these conditions are not fulfilled, then the final grade (on a ten-points scale) will be the minimum between the final mark and the value "4".

--- RETAKE

Two different situations:
=> Students that are evaluated using continuous evaluation:
Two options to choose (just before the exam begins):
* repeat the written exam included in the continuous evaluation planning an be evaluated under the "Students who choose

continuous evaluation" conditions, described above.
* be evaluated with the same final exam of students who choose for evaluation at the end of the semester, under the "Students who choose for evaluation at the end of the semester" evaluation conditions, described above. No other activities are considered.
=> Students who choose for evaluation at the end of the semester:
A final examination will be provided to students who do not opt for the continuous evaluation, and are evaluated under the "Students who choose for evaluation at the end of the semester" conditions, described above. No other activities are considered.

Sources of information
Basic Bibliography
Bruce and Jenny Bartlett, Practical recording techniques, Ed. 7, Focal press, 2016,
Davis, Gary, The Sound reinforcement handbook, 2nd edition, Milwaukee (Winsconsin) : Hal Leonard Corporation,
Complementary Bibliography
Francis Rumsey and Tim McCormick, Sound and recording, Ed. 7, Focal press, 2014,
Philip Giddings, Audio systems: design and installation, Focal press, 1990,

Recommendations
Subjects that continue the syllabus
Sound Processing/V05G300V01634 Audiovisual Technology/V05G300V01631
Subjects that are recommended to be taken simultaneously
Fundamentals of Acoustics Engineering/V05G300V01531
Subjects that it is recommended to have taken before
Fundamentals of Sound and Image/V05G300V01405 Digital Signal Processing/V05G300V01304

IDENTIFYING DATA				
Video and Television				
Subject	Video and Television			
Code	V05G300V01533			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Martín Rodríguez, Fernando			
Lecturers	Martín Rodríguez, Fernando			
E-mail	fmartin@uvigo.es			
Web	http://faitic.uvigo.es			
General description	(*)(*) This subject develops nowadays available video technology: video saving on magnetic and/or optic media, digital television over different transmission media (terrestrial, satellite, cable and IP) and television networks. We assume knowledge of basic image and video formats (JPEG and MPEG) that were studied in the prerequisite FSI (Fundamentos de Son e Imaxe, compulsory in the second year).			

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

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

Contents	
Topic	
Structure of a video production studio.	General overview. Multimedia matrixes. Capturing formats: SDI, HDMI, analog. Auxiliary equipment: caption machines, measurment and control equipment... Playout system.

Video saving.	Magnetic saving. Optical saving. Domestic formats. Introduction to professional formats.
Televisión Digital.	DVB Standard: Digital Video Broadcasting. DVB transmission media: DVB-T, DVB-S, DVB-C. IPTV (Television over IP). Digital Interactive TV (MHP standard). Fundamentals of 3D TV (Coding and Transmission).
Redes de TV.	TV Broadcasting. Satellite TV. Terrestrial networks: emitters, re-emitters, gap-fillers. Cable networks: HFC, FTTB, FTTH. Intra-building networks (residential buildings, hotels, other...).
Lab content 1.	Study of QPSK modulation in DVB-S. Implementation of a simple matlab simulator. Results evaluation.
Lab content 2.	Introduction to terrestrial coverage planning. Development of a small planning application using matlab.
Lab content 3.	Desing of an intra-building TV network for a real example.
Lab content 4.	Assigment about MHP application development.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	21	42	63
Practice in computer rooms	12	9	21
Tutored works	7	49.5	56.5
Multiple choice tests	0	1.5	1.5
Reports / memories of practice	0	6	6
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	Professor makes presentation of contents, encouraging critical discussion. Algorithm and procedures teoretical basis are exposed. Related competencies: CG5, CG6, CE34, CE35.
Practice in computer rooms	Small projects are suggested. Students must obtain well founded solutuions, choosing appropriate methods and coming to a valid solution. Related competencies: CG5, CG6, CE34, CE35.
Tutored works	Lab projects are checked in individual or small group interviews. Professor suggests a qualification (the one the presented work derserves). Possible improvement actions are discussed. Related competencies: CG5, CG6, CE34, CE35.

Personalized attention

Methodologies	Description
Master Session	Query and answer in the classroom and, if necessary, at the office.
Practice in computer rooms	Query and answer in the classroom and, if necessary, at the office (previous appointment). Help via e-mail.
Tutored works	Query and answer at the office (with previous appointment). Help via e-mail.

Assessment

	Description	Qualification	Evaluated Competencess
Tutored works	This consists of small projects proposed in the lab clases (B group). Such works start at B group but are monitored in C group. In such meetings, work state will be analyzed included a qualification (achieved up to the moment). Improvements will be suggested and they could be implemented in B group or via non presential work.	0	CG5 CG6 CE34 CE35

Reports / memories of practice	They are the final version of tutored jobs. Reports are submitted at course ending. Altough we show here the complete qualification, this 25% is due to the work performed in this section and also in the section above. Team work (in pairs). Both students achieve the same qualification.	25	CG5 CG6 CE34 CE35
Multiple choice tests	Multiple choice tests, performed online via faitic platform. There will be three tests. The first one will be about thr first two themes. The second one about the third theme and the third one about the fourth theme. On finishing each theme, professor will announce the dates to take the online test. Each test will deserve a maximum of 0.5 points of the final qualification.	15	CG5 CG6 CE34 CE35
Long answer tests and development	Final written exam in time and place according to school official scheduling.	60	CG5 CG6 CE34 CE35

Other comments and July evaluation

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

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

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

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

Sources of information

Basic Bibliography

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

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

Complementary Bibliography

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

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

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

Recommendations

Subjects that are recommended to be taken simultaneously

Audiovisual Technology/V05G300V01631

Subjects that it is recommended to have taken before

Fundamentals of Sound and Image/V05G300V01405
Digital Signal Processing/V05G300V01304

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

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How - Know be
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CE33	CE33/TEL7 The ability to program network and distributed applications and services.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know How - Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know - Know How - Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences
The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations	CG3 CT3
Knowledge of the main concepts and the principles of design of the operating systems.	CG3 CT3
Ability to identify the components of an operating system, recognise its functions and the interrelationships between them.	CG3 CT3
Knowledge of the lastest advances and tendencies related with operating systems	CG3 CT3
The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	CG4 CT2
Acquisition of basic skills for the configuration and the utilisation of operating system services.	CG9 CE33 CT4

Manage and know the operative associated to the administration of current operating systems.	CG3 CT3

Contents

Topic	
Introduction and general perspective of the Operating systems	• Concept of operating system. • Structure of an operating system. • Types of operating systems. • Emulation and virtualization.
Processor management.	• Concept of process and thread. • Strategies of allocation of capacity of computation.
Memory management.	• Strategies of contiguous allocation. • Concepts of fragmentation, protection, compactation, relocation and sharing of memory. • Strategies of non-conriguous allocation: paging, segmentation and hybrid methods. • Virtual memory.
Permanent storage of the information.	• Functions of a file system. Concepts of file and directory. • Interface with the file system. • File sharing. • File Protection. • File system implementation. • Free space management. • Methods for allocation of space to files.
Input/Output (I/O) management.	• I/O Controllers. • I/O Interfaces. • Secondary and tertiary storage. • Disk scheduling. • Management of disk. • Replication and consistency of the information. RAID and RAIN technologies.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	20	46	66
Practice in computer rooms	13	26	39
Workshops	5	30	35
Short answer tests	1	0	1
Practical tests, real task execution and / or simulated.	1	0	1
Jobs and projects	2	6	8

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

Methodologies

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

Personalized attention

Methodologies	Description

Practice in computer rooms	The professor will be present during the realisation of the practices, answering all the doubts that can arise to the students.
Workshops	The professor will be present during the realisation of the workshops, answering all the doubts that can arise to the students.
Master Session	During the development of the master sessions, the students will be able to interrupt and formulate all the questions or doubts that can arise them.

Assessment

	Description	Qualification	Evaluated Competencess
Short answer tests	Proof of theoretical contents exposed in the master classes.	60	CG3 CG4 CT2 CT3
Practical tests, real task execution and / or simulated.	Validation of the work realised in the sessions of laboratory.	20	CG4 CE33 CT2
Jobs and projects	In the last face-to-face session of workshop, students will deliver and will expose to their mates the design and the proposed solution for their project. This solution will be exposed to debate for students and professors. The professor will do questions to each member of the group, what will allow his individual evaluation.	20	CG4 CG9 CT2 CT4

Other comments and July evaluation

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

Continuous evaluation:

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

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

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

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

Punctuation: Up to 2 points. (L)

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

Punctuation: Up to 2 points. (P)

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

No Continuous Evaluation:

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

Final Call:

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

Sources of information

Basic Bibliography

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Recommendations

Subjects that continue the syllabus

Distributed and Concurrent Programming/V05G300V01641
Information Systems/V05G300V01644

Subjects that are recommended to be taken simultaneously

Network Security/V05G300V01543

Subjects that it is recommended to have taken before

Informatics: Computer Architecture/V05G300V01103
Programming I/V05G300V01205
Programming II/V05G300V01302

IDENTIFYING DATA				
Data Networks: Technology and Architecture				
Subject	Data Networks: Technology and Architecture			
Code	V05G300V01542			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Rodríguez Pérez, Miguel			
Lecturers	Rodríguez Pérez, Miguel Rodríguez Rubio, Raúl Fernando			
E-mail	Miguel.Rodriguez@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The objective of this subject is to teach our students the technical basics that govern the modern computer networks, regarding topics like new switching paradigms, new access technologies or data transport with quality of service.			

Competencies		
Code		Typology
CG1	CG1: The ability to write, develop and sign projects in the field of Telecommunication Engineering, according to the knowledge acquired as considered in section 5 of this Law, the conception and development or operation of networks, services and applications of Telecommunication and Electronics.	- Know How
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- Know How
CE30	CE30/TEL4 The ability to describe, program, assess and optimize communication protocols and interfaces at different network architecture layers .	- Know How
CE32	CE32/TEL6 The ability to design networks and service architectures.	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be

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

Contents	
Topic	
Network virtualization	Tunnels Overlay networks Remote access (VPNs) Addressing and localization

IPv6	Introduction Self-configuration Addressing scopes Transition mechanisms
Advanced switching mechanisms	Label switching (MPLS) MPLS applications VPNs with provider support
Access network technologies	xDSL Cable (HFC, DOCSIS) Optical access networks
Optical switching and transmission	SDH/SONET. Circuit switching, burst switching and packet swithching

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	20	25	45
Laboratory practises	8	12	20
Tutored works	7	42	49
Presentations / exhibitions	2	4	6
Long answer tests and development	4	15	19
Short answer tests	1	0	1
Reports / memories of practice	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	The master lectures follow the usual scheme for this way of teaching; although, in some sessions, we will be able to dedicate 5 or 10 minutes of the class to make a simple examination (some brief questions) that will form part of the continuous evaluation. These short tests intend to motivate our students for a daily work. We impart the competencies CG6, CE32 and CE32 in these master sessions.
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. In such practices they will use real network equipment (routers and switches) and/or virtualization software that will allow their instruction and training on their own. The practices that the teachers will pose will be designed to be done within the respective face-to-face sessions at the School; although the student that like this need will be able to reproduce them at home using free software that will allow to virtualize the network hardware used in the laboratory. Also, the professors will be able to propose optional exercises that the student will be able to do as homework; and review individually in tutorial time. The students should adquire comnpetencies CE30 and CE32 in the lab.
Tutored works	A project with a fairly large magnitude will be posed to be developed as a teamwork during all the semester. This practical work might require in its earliest stage to be set in context doing an additional theoretical study/research. Both works will be supervised by the professors with periodic meetings every 10/15 days (roughly). And finally, they will select some of the best works for their public exhibition before the other groups of the course. The tutored works are related with competencies CG1, CG4, CE30 and CE32.
Presentations / exhibitions	Every group must deliver the right documents where the suggested challenge (project teamwork) have to be explained in a detailed way. Also, the students must prepare a public presentation of the team solution to be defended in front of the rest of the class. The students practice competencie CG4 in the presentations.

Personalized attention

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

Tutored works	During tuitition time, the professors will be able to help the students either individually in the understanding of the theoretical concepts explained in the master sessions and/or in the demonstrative lab activities, or to correct whichever optional homework done out of the class or collectively with the supervision of the teamwork that will share among a group of peers.

Assessment

	Description	Qualification	Evaluated Competencess
Laboratory practises	They will be marked as "passed" or "not passed". To pass them, the student must attend all the sessions of this type. If any unexpected event makes one student to miss one session, he must replace it doing an extra practice that the professor will pose dynamically.	0	
Tutored works	The practical teamwork (project) that the student will face will determine one of the mid-term marks, T, of our continuous evaluation. The quantitative value (between 0-10) will be determined by the correctness of the solution presented by the group, the associated presentation and docs, the individual implication of the student in the developed work and the answers given to a individual interview with each member of the group.	50	CG1 CG4 CG6 CE32
Long answer tests and development	There will be two written exams: a mid-term exam in the middle of the semester (Ep), and a final one (Ef). Both tests are theory examinations and will be evaluated individually between 0 and 10. Students must score at least 3/10 to pass the subject.	37.5	CE30 CE32
Short answer tests	With some periodicity, and within the master sessions, the professors will be able to incorporate brief tests (short response questionnaries), Es. These brief tests, together with the mid-term examination (Ep), compose the complementary part of the theory to the final examination Ef.	12.5	CE30 CE32

Other comments and July evaluation

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

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

For continuous assessment, the final grade is the geometric mean between the work protected note (T) and the corresponding set of tests to answer (Y) rating. Mark Y is calculated as the arithmetic mean between the final exam (Ef) and for the rest of response tests conducted throughout the course (Ec); where Ec is obtained as the arithmetic mean of the partial exam (Ep) and the average short answer test scores(Es). In order to pass the subject, students must obtain at least 3 out of 10 in value Ef and attend all sessions of laboratory practices (unless mediate justified reasons). If this is not accomplished, the final grade is the minimum between Ef and 3.

Ec=½Ep + ½ average(Es)

Y = ½×(Ef+Ec)

FINAL MARK=(T×Y)^½

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

Finally, the extraordinary examination session in July will have the same characteristics than the special final examination just described, but students will be allowed to inherit the partial mark of any activity (T or Ef) if that has been passed during the same academic year, independently of the assessment modality that the student had followed.

Sources of information

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

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

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

Biswanath Mukherjee, Optical WDM networks, Springer, 2006,

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

Recommendations

Subjects that are recommended to be taken simultaneously

Network Security/V05G300V01543

Network and Switching Theory/V05G300V01642

Subjects that it is recommended to have taken before

Computer Networks/V05G300V01403

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

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

Learning outcomes	
Learning outcomes	Competences
Understand the foundations of the cryptographic science	CG3

To acquire the necessary knowledges to ensure the security of a computer or telematic system.	CG3
To acquire skills on the process of analysis of the attacks that can suffer a network and the main mechanisms of defence against them.	CG4 CE28 CT3
Know the main architectures of applicable security to the computer and telematic systems.	CG4 CE28 CT3
Know the main ideas of the norms and standard more important in matter of security in computer systems and communication networks.	CG6 CE28 CT2

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

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	21	38	59
Autonomous troubleshooting and / or exercises	0	10	10
Tutored works	6	28	34
Laboratory practises	11	22	33
Practical tests, real task execution and / or simulated.	1	0	1
Jobs and projects	1	0	1
Long answer tests and development	1	5	6
Long answer tests and development	1	5	6

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

Methodologies	
	Description
Master Session	Exhibition by means of powerpoint presentations and blackboard of the theoric contents of the course. They will develop the theoretical subjects of the matter that do not remain covered by the others methodologies employed. With this methodology, student will adquire part of CG3 y CE28 competences.
Autonomous troubleshooting and / or exercises	The group will solve in an autonomous form the exercises, cuestions or problems of the bulletin not solved in the face-to-face hours. The diverse solutions that arise when tackling each problem, will be put in common to agree the best form of solution. The doubts arisen will be agreed and will be exposed to the tutor in normal tutor time. This methodology is aimed to CG4 and CE28 competences.
Tutored works	Several theoretical and practical works to develop will be explained to the students, between which each group will have to choose one. In the C class type, will expose to each group the aims of the work, hardware and software tools to use, form to tackle it and will realise a follow-up to each group. This methodology, is aimed to adquire part of CG4,CG6, CE28, CT2 and CT3 competences.
Laboratory practises	The student will developed some practices in the laboratory, focused to mature and carry to practice the theoretical concepts , as to improve his ability for the engineering of secure networks and services. This methodology, is aimed to CG6, CE28, CT2 and CT3 competences.

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

Assessment			
	Description	Qualification	Evaluated Competencess
Long answer tests and development	Final exam of the course. This exam will consist of a group of exercises/questions on the contents given in the course.	25	CG3 CG4 CE28
Practical tests, real task execution and / or simulated.	Proof of group in which the teacher will value laboratory practises, reviewing his operation with the members of the group. This proof will be made in the week of the 9 to 13 January. All the members of the group have to be presents at the moment of the presentation. The teacher will do an authorship interview of which the level of participation of each student will be deduced and of which, together with the correct operation, the individual mark of each student will de determined.	25	CG6 CE28 CT3

Jobs and projects	Assessment of the tutee project or work realised by the group (type C). The group will do a demonstration to the teacher of the project or work realised and results obtained. This proof will be made in the week of the 9 to 13 January. All the members of the group have to be presents in the moment of the presentation. The teacher will do an authorship interview of which the level of participation of each student in the proyect will be deduced and of which, together with the correct operation, the individual mark of each student will de determined.	25	CG4 CG6 CE28 CT2 CT3
Long answer tests and development	Partial exam of the course, neccesary for students that follow continuos evaluation. This exam will consist of a group of exercises/questions on the contents given until (included) the week 6 of the theoretic course.	25	CG3 CG4 CE28

Other comments and July evaluation

- CHOICE OF CONTINUOUS EVALUATION.

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

- FIRST ANNOUNCEMENT.

Continuous evaluation (EC). This will be formed by:

1. Laboratory work B, representing 25% of the mark. This work must be delivered via Faitic before day 8 January.
2. Project C, representing 25% of the mak. This project must be delivered via Faitic before the day 8 January.
3. Partial exam of the contents given until the week 6 included, representing 25% of the mark. This exam will do average with the final exam if the student minimun mark is 1/3 of the total mark. If the student mark is lower than this minimun he/she must do another exam of this part in the final exam. This exam will be made in the week 7 of the academic course.
4. Final exam, in the agreed date in Board of School. Two cases are posible:

   - Students with mark greather than minimum in the partial exam. This exam will consist of the subjects given from the 7 week to the end. It will represent 25% of the total mark. To be able to surpass the course the student must obtain in this exam a minimum mark of 3,33 points of 10.
   - Students with mark lower than minimum in the partial exam. This exam will consist of all the subjects given in the course.It will represent 25% of the total mark. To be able to surpass the course the student must obtain in this exam a minimum mark of 3,33 points of 10.

No continuous evaluation. The students that do not choose EC will do a final exam by 80% of the mark, together with B laboratory practise, that will provide the other 20%. It will be necesary to gat a minimum of 1/3 in the theoretic exam to be able to surpass the course.

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

- ANNOUNCEMENT OF END OF FOUR-MONTH PERIOD (JULY)

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

day June 1.

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

- ADDITIONAL NOTES.
    - *Minimal cualification for theory evaluation (long answer tests and development)*. Independently of if continuous or not continuous evaluation, and independently of the announcement, it will be necessary to get a minimun 1/3 over 10 in the theoretical exam (long answer tests and development), for the approval of the course, i.e. 3,33 over 10 for EC and 3,75 over 10 for ET.
    - It will be considered to the student as "no presented" if he/she has not followed continous evaluation and has not presented to the final exam. Equally, if he/she follows EC (continuous evaluation) and has not attended anyone of the A, B and C parts, he/she will be considered as "no presented".
    - The qualifications obtained in the laboratory B and project C will be valid only during the academic course in that they were realised.
    - In the case that the total mark is equal or higher than 5, but the minimun in some part has not been reached, the final mark will be 4.5 points (failure).

Sources of information
Basic Bibliography
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M. Laurent Maknavicius, Wireless and Mobile Network Security, 1ª, Wiley, 2009,
Enisa, Botnets: Detection; Measurement, Disinfection & Defence, Enisa, 2011, https://www.enisa.europa.eu/publications/botnets-measurement-detection-disinfection-and-defence

Recommendations

Subjects that are recommended to be taken simultaneously

Architectures and Services/V05G300V01645
Internet Services/V05G300V01501

Subjects that it is recommended to have taken before

Mathematics: Linear algebra/V05G300V01104
Computer Networks/V05G300V01403

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

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

Learning outcomes	
Learning outcomes	Competences
To learn how to analyze microwave active and passive circuits and components, and to evaluate their specifications and performance. The student will learn how to use S-parameters, electronic instrumentation for measurements in the microwave range and circuit simulators for that purpose.	CG3 CG5 CE23

To learn how to solve exercises, how to perform measurements, how to elaborate and present reports, how to work in a technical team and to transfer knowledge in the field. To learn how to handle technical documentation and scientific bibliography, both in English.	CG4 CG5 CG9 CE24 CE25 CT3 CT4
To learn how to select, analyze and apply semiconductor active devices in circuits for microwave communications subsystems.	CG5 CE23 CE24 CE25
To learn how to analyze and select microwave circuits for optical transmitters and receivers.	CG5 CE23 CE25
To learn how to evaluate and select microwave subsystems. To propose solutions for applications at the different frequency bands for guided (coaxial cable, waveguide...) and wireless transmissions.	CG3 CG5 CE24 CE25 CT2

Contents

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

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practises	4	6	10
Practice in computer rooms	8	12	20
Tutored works	6	12	18
Master Session	19	38	57
Troubleshooting and / or exercises	4	32	36
Reports / memories of practice	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

Laboratory practises	With the aid of different microwave measurement instruments/ components, there will be analyzed passive and active microwave devices / circuits in microstrip technology. It will be defined and evaluated different figures of merit and other tools that will be used in the experimental characterization of these components. An introduction to Vector Network Analyzers with be provided to the student. Their use and calibration procedure will be described. The student work during these laboratory practises will be evaluated: 1. In continuous assessment: by means of a set of short questions to be delivered during some of the practises, and in all or some of the three short examinations involving exercises resolution. 2. In the evaluation in only a final examination: by means of a set of questions related to the work performed in the experimental practices. These practises are designed to help in adquiring competencies CG3,CG5, CE23, CE24, CE25, CT2 y CT3.
Practice in computer rooms	With the aid of a commercial microwave circuits simulator, there will be analyzed different passive components (matching networks, filters, couplers, etc.) and active semiconductor devices (diodes and transistors), and simple amplifier circuits, in agreement with Chapter 8. There will be defined and evaluated diverse figures of merit and other tools that will be in used in the analysis of these components. Also, exercise resolution will be described. The evaluation of the student work in these computed aided practises will be performed: 1. In continuous assessment: by means of short questions to be delivered in writing, during some of the practices, and in all or some of the three short examinations involving exercises resolution. 2. In the evaluation in only a final examination: by means of questions related to the work performed during these practices. These practises are designed to help in adquiring competencies: CG3, CG5, CE23, CE24 y CE25.
Tutored works	The student, as part of a team, will study and develop a theoretical topic or a certain practical design, which later will be evaluated by means of a writing report and an oral presentation. These works are designed to help in adquiring competencies CG4, CG9, CE23, CE24 , CE25, CT2, CT3 y CT4.
Master Session	It will be given in a classroom with the aid of a slate board and a video projector. Most of the concepts in the Chapters will be described in detail and explained. There will be also described exercises resolution. These sessions are designed to help in adquiring competencies CG3, CG5, CG4, CE23, CE24 y CE25.

Personalized attention

Methodologies	Description
Master Session	While in master sessions, the professor will answer the questions addressed by the students. Besides, in office hours, the professor will also be available to the students, providing answers to their questions a more personalized way.
Laboratory practises	During laboratory practises, the professor will guide the work of each student, and answer those questions he/she may ask.
Practice in computer rooms	During practises, the professor will guide the work of each student, and answer those questions he/she may ask.
Tutored works	In tutored works, the professor will guide the work of each student/group, and answer those questions that may arise individually or as a group.

Assessment

	Description	Qualification	Evaluated Competencess
Laboratory practises	In the case of continuous assessment, during the designated time for experimental practices the student will answer in writing to some proposed questions. Besides, in any of the three short examinations, the work performed in the available time for practices may be evaluated. In the case a unique evaluation in a final examination, the work performed in the available time for practices may be evaluated.	7	CG3 CG5 CE23 CE24 CE25 CT2 CT3
Practice in computer rooms	In the case of continuous assessment, during the designated time for practices the student will answer/solve in writing to some proposed questions/exercises. Besides, in any of the three short examinations, the work performed in the available time for practices may be evaluated. In the case a unique evaluation in a final examination, the work performed during practices may be evaluated.	5	CG3 CG5 CE23 CE24 CE25

Troubleshooting and / or exercises	There will be three short examinations, each will contain exercises resolution. Moreover, they may contain a set of short questions related to the master sessions or the practices, both experimental or computer aided.	80	CG3 CG4 CG5 CE23 CE24 CE25
Reports / memories of practice	It will be evaluated both the written report (team work) and the team oral presentation of this work. During the oral presentation, the professor will ask questions to each member of the team and will grade his feedback, individually. The grade of this work for each student will be the sum of the written report grade (team grade) plus the grade of his/her oral presentation.	8	CG4 CG9 CE23 CE24 CE25 CT2 CT3 CT4

Other comments and July evaluation

A) If the student selects continuous assessment:

1. His/her presence in all scheduled experimental and computer aided practices will be mandatory, as well as his/her presence in all scheduled team meetings. In order that his/herwork as part of the team is evaluated, the corresponding written report and oralpresentation will be mandatory. The maximum grade the student might obtain in theevaluation of all the scheduled practices and team work is 20 % of the totalavailable grade for the course.

2. The rest of the student work will be evaluated by means of three shortexaminations that will contain mainly exercises resolution, but that may also contain short questions. These three short examinations, as a whole, add up to 80% of the total course grade.

The First short Examination will take place around the 6th week, and the Second one around the 10th week, term period. Both examinations may last1 hour, and each corresponds to 10% of the total course grade. Before the Second short Examination, the student must send a written communication to the lecturer with his/her decision about the type of evaluation he/she prefers: continuous assessment, or being evaluated only in a Final Examination.

The Third short Examination will take place simultaneously with the Final Examination, performed for those students who do not follow continuous assessment. This short examination is the most important one, and it corresponds to a 60 % of the total subject qualification.

B) In the case of the students who does not choose continuous assessment, the one Final (extended) Examination corresponds to 100% of the course grade. In this examination it will be evaluated exercises resolution, answers to short questions related to the course theoretical part and experimental and computer/simulator aided practices.

The second summons (July):

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

In particular, those students who followed continuous assesment in the first summons may opt now between option B and option A.

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

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

Sources of information

Basic Bibliography
D.M. Pozar, Microwave Engineering, 3, Addison-Wesley Pub. Co
J.M. Miranda y otros, Ingeniería de Microondas, 1, Prentice-Hall
Guillermo González, Microwave Transistor Amplifiers: Analysis and Design, 1, Prentice-Hall
Enrique Sánchez, Introducción a los dispositivos y circuitos semiconductores de microondas, 1, Pearson Educacion
Complementary Bibliography
R.E. Collin, Foundations for Microwave Engineering, 2, Wiley-IEEE Press
P.A. Rizzi, Microwave Engineering, Passive Circuits, 1, Prentice-Hall
S. Y. Liao, Microwave Devices and Circuits, 3, Prentice-Hall

Recommendations

Subjects that are recommended to be taken simultaneously

Radio Frequency Circuits/V05G300V01511

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G300V01201
Physics: Fields and Waves/V05G300V01202
Physics: Fundamentals of Electronics/V05G300V01305
Electronic Technology/V05G300V01401
Electromagnetic Transmission/V05G300V01303

IDENTIFYING DATA				
Principles of Digital Communications				
Subject	Principles of Digital Communications			
Code	V05G300V01613			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Comesaña Alfaro, Pedro			
Lecturers	Comesaña Alfaro, Pedro Pérez González, Fernando			
E-mail	pcomesan@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The basic aims of the subject are the following: - Apply optimisation criteria for the realisation of diagrams of estimate and synchronisation in digital receptors of communications. - Differentiate the blocks and the functionalities of a data transmission system. - Use digital signal processing to transmit and receive analog waveforms. - Apply the basic mechanisms of reduction of the impact of noise in a communications system.			

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

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

Contents	
Topic	
1. Introduction to digital communications.	- The software radio concept - Elements of a digital receiver - Wireless communications, past and present

2. Review of signal processing concepts and communication theory	- Review of Fourier Transforms - Frequency response of random signals. Bandwidth, power spectrum. - Up-conversion and down-conversion. Complex baseband representation, lowpass equivalent channel. - Intersymbol interference and Nyquist pulses. - Maximum likelihood detection in white noise. Probability of error.
3. Timing recovery	- Introduction to the problem of timing recovery. - Frame synchronization. - Synchronization algorithms.
4. Channel estimation and equalization	- Channel estimation - MSE estimation - Frequency selective channels. - LS equalizer. - Adaptation algorithms: pilot-based, decision directed, blind. - Frequency domain equalizers.
5. Carrier recovery	- Phase estimation - Phase Locked Loop. Costas loop. - Decision directed recovery. - Frequency estimation with dual loops.
6. Standards of digital communications	Subject planning to changes in function of the publication of new standard - 802.11to - GSM

Planning

	Class hours	Hours outside the classroom	Total hours
Troubleshooting and / or exercises	6	10.44	16.44
Laboratory practises	12	36	48
Projects	7	35	42
Troubleshooting and / or exercises	0	4	4
Master Session	15	22.5	37.5
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
Troubleshooting and / or exercises	In A hours proposed problems will be resolved. This methodology works competencies: CG3, CG4, CG11, CE26.
Laboratory practises	In B hours the students will work on the lab to create a software defined radio receptor that uses all the basic functionalities studied in the subject. This methodology works competencies: CG4, CG11, CE26.
Projects	In C hours practical projects will be proposed; the students will develop a digital receptor that shows its good operation in the proposed application. The projects will be implemented in small groups. All the members of the group have to understand the operation of all the blocks of the complete receptor that will be submitted at the end of the course. This methodology works competencies: CG3, CG4, CG11, CE26, CT2, CT3.
Troubleshooting and / or exercises	The student will complete some homework/s, individually. This methodology works competencies: CG3, CG4, CG11, CE26.
Master Session	Presentation and discussion of the fundamental concepts associated to the different blocks that constitute a digital receptor. This methodology works competencies: CG4, CG11, CT2, CT3.

Personalized attention

Methodologies	Description
Master Session	The teacher will solve the doubts that each student formulates during the presentation realised in the master session.

Laboratory practises	The students will work in small groups and the teacher will solve the doubts that each group might have.
Projects	The students will work in small groups and the teacher will solve the doubts that each group might have.

Assessment

	Description	Qualification	Evaluated Competencess
Laboratory practises	Short exercises (partial tests) related to the contents explained during the masterclasses and in the laboratory. The students will do three exercises during A hours. Specifically: - Exercise #1: week 4 or 5 - Exercise #2: week 8 or 9 - Exercise #3: week 12 or 13 Each exercise will have a weight of 2/30 in the final mark (Total accumulated mark: 3*2/30 = 20%)	20	CG3 CG4 CE26 CT3
Projects	Realisation of a practical project in groups, that will be evaluated individually in C hours during the last week of the course. This is a mandatory activity for both those students who choose to follow the continuous evaluation, and those who do not, yielding in both cases the 40% of the final mark.	40	CG3 CG4 CG11 CE26 CT2 CT3
Troubleshooting and / or exercises	Resolution of the proposed homework/s. The exercise/s will be completed at home, individually.	10	CG3 CG4 CG11 CE26
Long answer tests and development	Final exam, where the studen will have to solve some exercises; this exam will be the fourth test for those students who chose continuous evaluation. The weight will be 60% for those students that do not follow continuous evaluation, and 30% for those who do.	30	CG3 CG4 CG11 CE26

Other comments and July evaluation

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

Nexercise+Npartials + Nproject + Nexam

where Nexercise denotes the mark corresponding to the solution of proposed problem/s, up to 1 point; Npartials denotes the mark accumulated in the partial tests, up to 2 points; Nproject denotes the mark obtained in the practical project, up to 4 points; and Nexam denotes the mark of the final exam up to 3 points. In order to pass the sbuject, the student has to obtain a minimum mark of 3.5 points (out of 10) in the final exam; if that minimum threshold is not achieved, the final mark of the student will be that obtained in the final exam, although he/she has chosen continuous evaluation.
For those students who did not choose continuous evaluation, the final mark will be obtained as:
Nproject + Nexam

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

The final exam for those students who did not choose continuous evaluation will have an additional exercise in comparison with the exam of those students who chose continuous evaluation.
The student has to choose, after the realisation of the second partial test, if he/she chooses continuous evaluation or not, informing about it to the teacher within the established period of time. Those students who chose continuous evaluation and did not pass the subject will be assigned the qualification "Failed" independently that they present to the final exam or not.
The mark in the partial exams will be considered for the recovery exam, but not for subsequent courses. In recovery exam the students that choose continuous evalution can decide if they want to keep the mark obtained in the partial tests and the

homework/s, or if they want to be evaluated just by considering the final exam (with 60% weight) and the project (40%).

Sources of information
Basic Bibliography
R. W. Heath Jr., Intro. to Wireless Digital Commun.: A Signal Processing Perspective, Pearson-Prentice Hall
Complementary Bibliography
J.R. Barry, E. A. Lee y D. G. Messerschmitt, Digital communication,, 3rd edition, Kluwer Academic Publishers (2004).
A. Artés Rodríguez, F. Pérez González y otros,, Comunicaciones Digitales, Pearson Educación (2007)

Recommendations
Subjects that continue the syllabus
Digital Communications/V05G300V01914

Subjects that it is recommended to have taken before

Signal Transmission and Reception Techniques/V05G300V01404
Multimedia Signal Processing/V05G300V01513

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

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

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

Contents

Topic	
1. Introduction to optical communications	1.1. Reasons for the optical transmission 1.2. Digital transmission in multimode fibres
2. Electromagnetism in dielectrics	2.1. Maxwell equations in dielectrics 2.1. Wave equations in dielectrics 2.3. Refraction index and losses 2.4. Dispersion
3. Monochromatic propagation in flat guides	3.1. Solution to the wave equation in flat guides 3.2. Guided modes: TE and TM 3.3. Modal power 3.4. Normalised parameters
4. Monochromatic propagation in step index fibres	4.1. Solution to the wave equation in step index fibres 4.2. Guided modes 4.3. Modal power 4.4. Weakly guiding fibres 4.5. Losses; transmission windows
5. Propagation of pulses in single-mode fibres	5.1. Pulse distortion in optical fibres 5.2. Propagation of gaussian pulses in single-mode fibres 5.3. Propagation of analog signals in single-mode fibres 5.4. Dispersion minimisation in single-mode fibres
6. Detection of the luminous radiation	6.1. Light detection in semiconductors 6.2. p-i-n photodiodes and APDs 6.3. Photonic noise 6.4. Quantum efficiency and equivalent noise power
7. Sources and optical amplifiers	7.1. Photonic emission: basic concepts 7.2. Light emitting diodes (LEDs) 7.3. Semiconductor lasers (LDs) 7.4. External modulation of the laser 7.5. Doped fibre and semiconductor optical amplifiers
8. Digital systems based on intensity modulation	8.1. Basic concepts of digital transmission in fibre 8.2. Digital receiver: a simplified model 8.3. The Photonic (or quantum) limit 8.4. Interference and equalisation in a digital receiver 8.5. The effect of noise
9. Analog systems based on intensity modulation	9.1. Characteristics of the analog transmission, SCM systems 9.2. Signal-noise ratio 9.3. Distortion 9.4. Frequency planning 9.5. Design considerations
10. Introduction to WDM and to optical networks	10.1. Introduction 10.2. WDM systems 10.3. Optical networks 10.4. Basic topologies of optical networks 10.5. FTTH
Laboratory exercise 1. Measuring the numerical aperture of a multimode fibre	Here we will measure the numerical aperture of a multimode fibre
Laboratory exercise 2. Acousto-optic modulator (AOM)	Here we will built a free-space optical link that uses an AOM together with an He-Ne laser.
Laboratory exercise 3. Optical amplifier	Here we will characterise an erbium doped fibre amplifier (EDFA)
Laboratory exercise 4. Electro-optic modulator	Characterisation of an electro-optic modulator
Laboratory exercise 5. Digital link based on graded index fibres	Here we will characterise a LED and a FP laser. Also, we will analyse the effects that losses and noise have on a digital link based on graded index fibres
Laboratory exercise 6. WDM systems	Here we will characterise the performance of WDM systems working at 1310/1550nm

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Master Session	18	27	45
Troubleshooting and / or exercises	0	12	12
Laboratory practises	12	9	21

Projects	6	39	45
Presentations / exhibitions	1	3	4
Short answer tests	2	8	10
Long answer tests and development	2	10	12

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

Methodologies	
	Description
Introductory activities	Presentation of the subject: program, bibliography, educational methodology and assessment system.
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. Through this methodology the competencies CG3, CG5, CE21 and CE25 are developed.
Troubleshooting and / or exercises	The students can solve problems and/or exercises given by the professor. These exercises are related to the contents presented in the class. Through this methodology the competencies CG3, CG5 and CE21 are developed.
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. Through this methodology the competencies CG3, CG5 and CE25 are developed.
Projects	The students will have to complete several small projects proposed by the professor. These projects require the correct planning, design and realisation of a series of activities and are performed in groups of students. Each project has to be turned over on a given deadline. Through this methodology the competencies CG3, CG5, CE21, CE25 and CT3 are developed.
Presentations / exhibitions	The students will give a small presentation of the completed projects in front of the professor and possibly other students. Through this methodology the competency CG5 is developed.

Personalized attention	
Methodologies	Description
Master Session	The students can use the office hours of the professor to solve doubts related to the subject. The timetable of these office hours will be available at the beginning of the semester and is published on the website of the course.
Troubleshooting and / or exercises	The students can use the office hours of the professor to solve doubts related to the subject. The timetable of these office hours will be available at the beginning of the semester and is published on the website of the course.
Laboratory 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 is published on the website of the course.
Projects	The students can use the office hours of the professor to solve doubts related to the subject. The timetable of these office hours will be available at the beginning of the semester and is published on the website of the course.

Assessment			
	Description	Qualification	Evaluated Competencess
Troubleshooting and / or exercises	The students can solve a series of problems and/or exercises proposed by the professor.	0	

Projects	The students will have to deliver a report for each of the realised projects. Also, the students shall give a presentation of the results obtained within a certain timeframe and follow the conditions established by the professor.	25	CG3 CG5 CE21 CE25 CT3
Short answer tests	Before the lab starts, the students will perform a test (7% of the final mark) about the contents of the the lab notes. Likewise, when finalising the lab, the students will perform a test (23% of the final mark) about the lab exercises.	30	CG5 CE21 CE25
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.	45	CG3 CG5 CE21 CE25

Other comments and July evaluation

Following the guidelines of the degree, we will offer to the students two possible assessment systems: continuous evaluation or final evaluation at the end of the semester.

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

Continuous evaluation:

The continuous evaluation comprises a series of tasks that the student has to realise along the semester (55%), together with a long answer test (45%) that he/she performs at the end of the semester. These tasks include the completion of two short answer tests about the lab (30%), and the realisation of several projects (25%). The two short answer tests about the lab are scheduled for weeks eight and sixteen of the course. Finally, the projects have to be presented on the twelfth, fourteenth and sixteenth weeks, respectively, of the course. The projects will be conducted in groups of students and the mark for each student for this task will be the mark of the group. All these tasks may not be retaken at another point in time. That is to say, if a student cannot fulfill them within the time stipulated by the professor, there is no possibility to fulfil them afterwards. Also, they are only valid for the present academic year.

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

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

Alternatively, these students can also opt for a 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 of (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 by one month before the 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.

In case of detection of plagiarism in any of the works/tasks mentioned in the evaluations above, the final mark will be "fail (0)" and the professors will communicate this fact to the direction of the school such that it can take the measures that it considers appropriate.

Sources of information
Basic Bibliography
J. Capmany, F. J. Fraile Peláez y J. Martí, Fundamentos de Comunicaciones Ópticas, 2ª Edición, Síntesis, 2001,
J. Capmany, F. J. Fraile Peláez y J. Martí, Dispositivos de Comunicaciones Ópticas, 1ª Edición, Síntesis, 1999,
Complementary Bibliography
G. P. Agrawal, Fiber-Optic Communication Systems, 4ª Edición, Wiley-Interscience, 2010,
G. Keiser, Optical Fiber Communications, 5ª Edición, McGraw-Hill, 2014,

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Probability and Statistics/V05G300V01204
Electromagnetic Transmission/V05G300V01303

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

Competencies		
Code		Typology
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.	- Know be
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.	- Know How
CE21	CE21/ST1 The ability to construct, exploit and manage telecommunication networks, services, process and applications, considered as systems of receiving, transporting, representation, processing, storage, management and presentation of multimedia information from the point of view of transmission systems.	- Know How
CE22	CE22/ST2 The ability of applying the basic techniques of telecommunication networks, services and applications for mobile and fixed environments, personal, local or long distance, with different bandwidth, including telephony, radio broadcasting, TV and data, from the point of view of transmission systems.	- Know How
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know

Learning outcomes	
Learning outcomes	Competences
Cellular and wireless network specifications.	CG7 CE22
To apply previously acquired knowledge on wave propagation for the planning of radio networks.	CE21
To specify the various elements (antennas, transmitters and receivers) which make up a global system.	CG2 CE25 CT2
Provide access solutions to communications systems.	CG4 CE22
Develop roll-out models which minimize the social and environmental impact of the radio communication networks, understanding the ethic and moral responsibilities involved in such work.	CG2 CE22 CT2

Contents
Topic

Theory 1. Introduction to radiocommunications	Basic concepts Current situation Wireless LANs Personal networks.
Theory 2. Cellular systems	Fundamental concepts The radio propagation channel Multiple access techniques Interferencr Traffic theory Network sizing up Countermeasures Medium access control. Security and access control. Network management. Mobility management. Quality of service.
Theory 3. Review of cellular and wirelss lan standards and other proposals	2nd generation systems Evolution of 2G systems 3rd generation systems Beyond 3G WLAN systems Other systems and proposals Cognitive access Femtocells.
Lab 1. Statistical analysis of simulated and/or measured time-series	Analysis of simulated and/or experimental time-series
Lab 2. Introduction to multipath effects	Reproducing multipath fading Doppler effect Narrow and wideband channel
Lab 3. Introduction of blockage/shdowing effects	Simulation of the shadowing effect Call handover Interference

Planning

	Class hours	Hours outside the classroom	Total hours
Tutored works	7	14	21
Troubleshooting and / or exercises	6	18	24
Practice in computer rooms	14	28	42
Master Session	13	26	39
Short answer tests	1	0	1
Reports / memories of practice	0	8	8
Troubleshooting and / or exercises	1	0	1
Jobs and projects	0	14	14

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

Methodologies

	Description
Tutored works	Simulation work to be carried out in Matlab language will be proposed to C class gropus where they will go deeper into specific issues discussed in less detail in the theoretical classes. Through this methodology the competencies CG2, CG4, CG7, CT2 and CE21
Troubleshooting and / or exercises	The theoretical treatment of the various topics studied in theoretical classes will be complemented by performing numerical calculations relative to radio network dimensioning. Through this methodology the competencies CG2 and CE22
Practice in computer rooms	In laboratory sessions (type B) various Matlab simulations will be proposed to the students in order to study specific topics which are more suitably aproached this way. Through this methodology the competencies CE21, CE22 and CE25
Master Session	In classroom lectures the more theoretical issues will be presented. Through this methodology the competencies CE21, CE22, CE25 and CT2

Personalized attention

Methodologies	Description

Master Session	The student will be able to consult individually during tutoring hours all his/her doubts arising during the study of the theoretical contents as well as in the resolution of numerical exercises, laboratory work and supervised projects
Tutored works	The student will be able to consult individually during tutoring hours all his/her doubts arising during the study of the theoretical contents as well as in the resolution of numerical exercises, laboratory work and supervised projects
Troubleshooting and / or exercises	The student will be able to consult individually during tutoring hours all his/her doubts arising during the study of the theoretical contents as well as in the resolution of numerical exercises, laboratory work and supervised projects
Practice in computer rooms	The student will be able to consult individually during tutoring hours all his/her doubts arising during the study of the theoretical contents as well as in the resolution of numerical exercises, laboratory work and supervised projects

Assessment

	Description	Qualification	Evaluated Competencess
Short answer tests	Adequate kowledge of the theoretical materials of the lecture will be assessed by means of short response questions during the final exam. A minimum mark of 4 over 10 points may be set for this part.	25	CE21 CE22 CE25 CT2
Reports / memories of practice	For each lab assignment, the students in pairs, will present an individual written report. The evaluation will be carried out by means of (1) the individual reports and (2) an specific part in the final exam. The weights of parts one and two will be 1/3 and 2/3, respectively.	25	CE21 CE22 CE25 CT2
Troubleshooting and / or exercises	In the final exam, there will be a part containing various short numerical problems. A minimum mark of 4 over 10 points may be set for this part.	25	CG2 CE21 CE22 CE25
Jobs and projects	The evaluation of supervised group work (C classes) will be carried out through an individual report where each student wll present his/her conclusions and test results.	25	CG4 CG7 CE21 CE22 CE25

Other comments and July evaluation

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

For those who choose to take the final exam (alternatively to continuous assessment), this will have a weight of 100% of the final grades and will cover all issues dealt with in the theoretical lectures, the problem solving lectures, tutored group work and laboratory.

Above the procedure for carrying out the continuous assessment was presented. The final grades will be the result of four equal weight parts, namely

- a theoretical test consisting of short questions (25%) to take place during the final exam,

- a problem solving test consisting of short numerical calculations (25%) to take place during the final exam,

- the completion of the laboratory work and corresponding reports and specific test in the final exam (25%) and

- the completion of the proposed tutored group work, its corresponding report and oral presentation (25%)

In case a minimum mark was set for any of the parts comprising the overall evaluation and such mark were not achieved, the final grade will be upper bounded by such minimum mark.

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

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

A student will be atributed the "no presentado" grade if he or she has not followed the full continuous assessment route and has not taken the final exam.

For the retake call (July), the grades obtained in the lab work and group work parts will be kept for those students following the continous assessment route and will only be required to take the theory, problems and lab parts of the new final exam.

Sources of information

Basic Bibliography

José María Hernando Rábanos, Comunicaciones Móviles. 2ª ed., Ed. Centro de Estudios Ramón Areces, S.A., 2004

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

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

Complementary Bibliography

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

Simon R. Saunders, Antennas and Propagation for Wireless Communications Systems, Wiley, 1999

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

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

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

Recommendations

Subjects that it is recommended to have taken before

Physics: Fields and Waves/V05G300V01202
Mathematics: Probability and Statistics/V05G300V01204
Fundamentals of Sound and Image/V05G300V01405
Digital Signal Processing/V05G300V01304
Signal Transmission and Reception Techniques/V05G300V01404
Electromagnetic Transmission/V05G300V01303
Radio Frequency Circuits/V05G300V01511
Radio Communication Systems/V05G300V01512

IDENTIFYING DATA				
Radio Spectrum Management				
Subject	Radio Spectrum Management			
Code	V05G300V01616			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	García Sánchez, Manuel			
Lecturers	García Sánchez, Manuel Torío Gómez, Pablo			
E-mail	manuel.garciasanchez@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The management of the radioelectric spectrum, a natural resource, limited and scarce, pursues the most efficient use of the spectrum by means of the application of effective processes, to facilitate the implementation of communication systems and to guarantee minimum interference. To acomplish this objectives, engineering tools, planning, management and technical survey and certification are needed. Besides in this matter study of the SMATV systems and Structured Wiring are included.			

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

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

Interference analysis	CG5 CG6 CG8 CG9 CE21 CE25 CT4
Telecommunications Cabling Standards	CG5 CG6 CG8 CE21 CE25
Field measurements	CG5 CG9 CE21 CE25 CT4

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

Planning			
	Class hours	Hours outside the classroom	Total hours
Laboratory practises	1	2	3
Tutored works	3	45	48
Practice in computer rooms	6	6	12
Outdoor study / field practices	11	11	22

Others	2	25	27
Master Session	19	19	38

*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	Activities of application of the acquired knowledge to particular situations. Acquisition of basic skills related with the matter. Specific measurement equipment as Spectrum Analysers , Field level sounders, etc, will be used. Through this methodology the competencies CG5, CG6, CG8, CG9, CE21, CE25 and CT4 are developed.
Tutored works	The student, alone or in a small group with other students, elaborates a report on a given subject. This includes the search of the information, reading, writting, etc Through this methodology the competencies CG9 and CT4 are developed.
Practice in computer rooms	Activities of application of the acquired knowledge to particular situations. Acquisition of basic skills related with the matter using computer programs. Through this methodology the competencies CG5, CG6, CG8, CG9, CE21, CE25 and CT4 are developed.
Outdoor study / field practices	Field activities. Activities of application of the acquired knowledge to particular situations. Acquisition of basic skills related with the matter. Specific measurement equipment as Spectrum Analysers , Field level sounders, etc, will be used. Through this methodology the competencies CG5, CG6, CG8, CG9, CE25 and CT4 are developed.
Others	Written exam on the contents of the matter. Through this methodology the competencies CG5, CG6, CG7, CG8, CE21 and CE25 are developed.
Master Session	Master lecture given by the teacher. Through this methodology the competencies CG5, CG6, CG7, CG8, CE21 and CE25 are developed.

Personalized attention	
Methodologies	Description
Master Session	The students will be able to resolve doubts and questions during the face-to-face hours of the activity, in schedule of *tutorías or by means of email.
Laboratory practises	The students will be able to resolve doubts and questions during the face-to-face hours of the activity, in schedule of *tutorías or by means of email.
Tutored works	The students will be able to resolve doubts and questions during the face-to-face hours of the activity, in schedule of *tutorías or by means of email.
Practice in computer rooms	The students will be able to resolve doubts and questions during the face-to-face hours of the activity, in schedule of *tutorías or by means of email.
Outdoor study / field practices	The students will be able to resolve doubts and questions during the face-to-face hours of the activity, in schedule of *tutorías or by means of email.

Assessment			
	Description	Qualification	Evaluated Competencess
Laboratory practises	Measurement of signals on panel for distribution of TV signal. This practice is made in groups and the qualification of each student will be the one of the group.	2.5	CE21 CE25
Tutored works	Monographss on subjects related to spectrum management that will be presented in class. They will be evaluated in an individual way in function of the exhibition realised by each student.	15	CG9 CT4
Practice in computer rooms	Calculation of the coverage area of an AM radio station. This practice is made in groups but will be evaluated individually by means of the assistance, the performance during the realisation and by means of the memory of the practice delivered by the group.	5	CG6 CG9 CE21 CE25 CT4

Outdoor study / field practices	Basic use of a spectrum analyzer. Measurement of the bandwidth of a FM signal. Measurement of TDT signals. They will be evaluated by means of a written exam at the end of the practice. Installation of a parabolic antenna. Phase 1 and phase 2 radio station measurements. These practices will be made in groups and the qualification of each student will be the one of the group.	27.5	CG5 CG7 CG9 CE21 CE25 CT4
Others	Written exams of the contents of the matter. Individual evaluation.	50	CG6 CG7 CG8 CE21 CE25

Other comments and July evaluation

1) Following the guidelines of the degree will offer the students two schemes of evaluation in the common call: continuous evaluation and final evaluation. The students will have to opt by one of the two o. The delivery or participation in any one of the tasks of continuous evaluation means that he/she opts by this type of evaluation. The assistance to the practices is compulsory if he/she opts by continuous evaluation.

a) Continuous Evaluation. The continuous evaluation will be made based on the performance of the student during the practical sessions, on the report of the computer practice and on the tests of the others seven practices. The supervised work will be assessed by means of its presentation in a class. There will be two partial written exams of theory, one around the middle of the class period and another at the end. These tasks are not recoverable and only are valid for the current course.

b) Final evaluation. The students that do not opt by continuous evaluation will have an exam of theory (50%) and another of the practical part (50%) in the official date of the exam agreed by the School.

2) Extraordinary call (July). The students that opted previously by continuous evaluation will be able to opt between repeating the exam of theory (50%) or examine again of all the matter (100%) by means of two exams that will cover the theory (50%) and the practical part (50%). They will have to communicate to the coordinator the option they choose before the official date of the exam. The rest of the students will examine of all the matter by means of two exams that will cover the theory (50%) and the practical part (50%).

Sources of information

Basic Bibliography

International Telecomunication Union, National Spectrum management Manual, 2005, www.itu.org

Complementary Bibliography

International Telecomunication Union, ITU-R recommendations, www.itu.org

International Telecomunication Union, Radiocomunication Rules, 2012, www.itu.org

Gretel-COIT, La evolución de la gestión del espectro radioeléctrico, 2007, http://coit.es/descargar.php?idfichero=2523

SETSI, Cuadro Nacional de Atribución de Frecuencias, 2013, http://www.minetur.gob.es/telecomunicaciones/espec

Recommendations

Subjects that it is recommended to have taken before

Signal Transmission and Reception Techniques/V05G300V01404
Electromagnetic Transmission/V05G300V01303
Radio Communication Systems/V05G300V01512

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

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

Learning outcomes	
Learning outcomes	Competences
Knowledge of the distinct types of sensors and his applications.	CG3 CE42 CE46 CT2 CT3
Capacity for the development of electronic circuits of conditioning of signal.	CG4 CG5 CE42 CE46 CT2 CT3
Knowledge and utilisation of computer tools for treatment of data and representation of the information.	CG4 CG5 CE42 CE46
Knowledge of the basic principles of the programmable instrumentation and his utilisation.	CG3 CE42 CE46 CT2 CT3

Contents	
Topic	
Unit 1: Introduction to sensors.	Energy conversions. Concepts of sensor, transducer and actuator. Dynamic and static features. Other features. Selection of sensors.
Unit 2: Temperature resistive sensors. Strain gauges.	Temperature resistive sensors: General features. Types. Conditioning . Application examples. Strain gauges: Basic principles. General features. Types of using. Conditioning . Application examples.
Unit 3: Photoresistive and Optoelectronic. Other resistive sensors.	Photoresistive and Optoelectronic: Basic principles. General features. Encoders. Conditioning. Application examples. Other resistive sensors: Gas sensors. Magnetoresistors. Potentiometers. Basic principles. General features. Conditioning . Application examples.
Unit 4: Capacitive sensors. Inductive and magnetic sensors.	Capacitive sensors: Introduction. Measurements principles. Features. Conditioning. Proximity sensors. Application examples. Inductive and magnetic sensors: Introduction. Basic principles. Variable transformer types. Features. Conditioning. Hall effect sensors. Application examples.
Unit 5: Thermocouples. Other sensors.	Thermocouples: Basic principles. General features. Calibration scales. Conditioning. Application examples. Other sensors: Pyroelectric. Ultrasounds. Magnetostrictive.
Unit 6: Programmable instrumentation.	Programmable instrumentation. Switched instrumentation. Hybrid systems on instrumentation. GPIB bus: General features. Configurations and equipment. Standards IEEE 488.1/488.2. Transference procedures. Standard HS488. GPIB command groups. Basic functions. Integrated circuits. Controllers on cards. SCPI Standard. Design environments for ATE systems.

Unit 7: Standard multiprocessor buses.	Systems on cards. Applications of standard buses. Classification. Types of connectors and cards. Multiprocessor systems. Common memory multiprocessor systems. Multiplexing. Bus arbiters. Arbiter techniques. Asynchronous bus concept. Addressing. Data transfer. Interrupts. Electrical design of high speed buses. ECL and TTL signals. Backplane features.
Unit 8: The VME bus.	Introduction . Functional modules. Subbuses and signals. Data transfer. Types of arbitration. System controller. The interrupt chain. Commercial products.
Unit 9: Standards on programmable instrumentation.	Introduction to VXI and PXI buses. Subbuses and signals. Configurations. Types of devices. Products and systems of development. PCI Express and the switched instrumentation. Ethernet and its LXI version for instrumentation. The AXIEe for high features.
Practice 1: Introduction to the LabVIEW Application Development Environment	Introduction to LabVIEW environment by means of basic examples of programming.
Practice 2: Temperature sensors. NTC thermistor.	Signal conditioning and virtual instrument development for measurement
Practice 3: Optoelectronic sensors. PIN photodiode.	Spectral response analysis.
Practice 4: Capacitive sensors. Accelerometer.	Signal analysis and post-processing, and virtual instrument developing for tilt measurement.
Practice 5: Programmable Instrumentation I.	Frequency response test of two RC circuits via the programmable control of the laboratory instrumentation. The programmable control will realise through a USB connection from the PC to each instrument.
Practice 6: Programmable Instrumentation II.	To develop an application that verify the frequency response of a RC circuit by means of the programmable control of some of the instruments situated in a VXI chassis. The programmable control of each instrument from the PC will realise through a LAN connection and using a GPIB -Ethernet gateway .

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	2	4
Master Session	16	23	39
Laboratory practises	14	12	26
Tutored works	7	28	35
Multiple choice tests	3	43	46

*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 CG3, CG4, CG5, CE42, CE46, CT2 and CT3 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 CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be worked.
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 CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be worked.
Tutored works	The students have to manage basic concepts to search and select information in order to get a deeper understanding in some specific fields related to the subject. This is a group activity. The lecturer will propose in the classroom the topic of this group task and monitor the student's work in personalized attention sessions. In these sessions, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be worked.

Personalized attention	
Methodologies	Description
Master Session	The students can go to the lecturer’s office (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will answer the students’ questions and also give instructions to guide the studying and learning process.
Laboratory practises	The students can go to the lecturer’s office (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will help students understand the work to be developed in the laboratory (components, circuits, instrumentation and tools).
Tutored works	The students can go to the lecturer’s office (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will help students to deal with the monitored work.

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

Other comments and July evaluation

1. *Continuous assessment*

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

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

The subject comprises three different parts: theory (50 %), laboratory (35%) and tutored work (15%). The marks are valid only for the current academic course.

1.a Theory

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

Each theory exam will be comprised short answer tests and long answer development. Marks for each theory exam (TEM) will be assessed in a 10 points scale. The student who miss a exam will be assessed with a mark of 0 for that exam. The classroom attendance (CA) during the academic course will be also assessed in a 10 points scale.

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

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

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

$FMT = (PT1 + PT2)/2$

The minimum mark required to pass the theory is of 4.5 for each test (PTi>=4.5). If the minimum mark in the first test is not achieved (PT1 less than 4.5), the students can repeat this part in the same date of the second exam.

1.b Laboratory

Seven laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in pairs. This part also will be assessed by continuous assessment. Each session will be only evaluated according to the developed work at the schedule date.

The lecturers will assess the individual student work. They will consider the individual work carried out before the laboratory session to prepare the proposed tasks, the laboratory attendance, as well as the student work in the laboratory. Marks for each laboratory session (LSM) will be assessed in a 10 points scale. A mark of 0 will be obtained for missing sessions. The final mark of laboratory (FML) is calculated as the arithmetic mean of the individual laboratory session marks:

$FML = (LSM1 + LSM2 + LSM3 + LSM4 + LSM5 + LSM6 + LSM7)/7$

Attendance at the laboratory classes is compulsory. In order to pass the laboratory part the students can not miss more than two laboratory sessions and the minimum mark required is of 5 (FML>=5). These absences must be excused with a valid documented reason (medical, bereavement or other) otherwise he/she will be assigned a grade of 0 for the laboratory part (FML=0).

1.c Tutored work

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

In order to assess the work, the lecturer will consider the quality of the results obtained, their classroom presentation and analysis, and the quality of the final written report. The students will be duly informed of the deadline by the lecturer. The final mark of this part, tutored work mark (TWM), will be assessed in a 10 points scale. If the students present their works after the deadline the TWM will be 0.

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

1.d Final mark of the subject

The weighted points from all assessed parts are added together to calculate the final mark (FM). The following weightings will be applied: 50% theory (FMT), 35% laboratory (FML) and 15% tutored work (TWM).

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

- theory: FMT>=5 with PT1>=4.5 and PT2>=4.5
- and laboratory: FML>=5 and don't miss more than 2 laboratory sessions.
- and tutored work: TWM>=5 and don't miss more than 1 tutored work session.

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

$FM = 0.5·FMT + 0.3·FML + 0.15·TWM$

However, when the students do not pass all parts, the final mark will be calculated using the following expression:

$FM = \min(\{ 4,5; 0.5·FMT + 0.3·FML + 0.15·TWM \})$

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

2. Final Exam

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

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

FMT = (PT1 + PT2)/2

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

The student will also do a tutored work and prepare a written report to be handed in just before the exam. In order to assess the work, the lecturer will consider the quality of the results obtained, their presentation and analysis, and the quality of the final written report. This work will be assessed in a 10 points scale and this mark will be the final mark of this part (TWM). If the students present their works after the deadline the TWM will be 0.

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

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

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

FM = 0.5·FMT + 0.3·FML + 0.15·TWM

However, when the students do not pass all parts, the final mark will be calculated using the following expression:

FM = min({ 4,5; 0.5·FMT + 0.3·FML + 0.15·TWM })

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

3. Second opportunity to pass the subject.

The assessment policy in this call will follow the scheme described in the previous section (final exam): a theory exam, a laboratory exam and a tutored work. Dates will be specified in the academic calendar. In order to attend the laboratory exam and to assign the tutored work, the students have to contact to the lecturer according to an established procedure. The procedure will be published in advance.

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

The final mark will be calculated as it has described in:

- section 1.d to students with continuous assessment.
- section 2 for all other case.

Sources of information
Basic Bibliography
Black, J. (editor), The system engineering handbook: a guide to building VME bus and VXI bus Systems, Academic Press, 1992, San Diego, EE.UU.
Mariño, P., Las comunicaciones en la empresa: normas, redes y servicios, 2ª ed., RAMA, 2002, Madrid
Norton, H., Sensores y analizadores, Gustavo Gili D.L., 1984, Barcelona
Pérez García, M.A., Instrumentación Electrónica, 1ª ed., Ediciones Paraninfo, S.A., 2014, Madrid

Pérez García, M.A., Álvarez Antón, J.C., Campo Rodríguez, J.C., Ferrero Martín, F.J., y Grillo Orteg, Instrumentación Electrónica, 2ª ed., Thomson, 2004, Madrid

Complementary Bibliography

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

Recommendations

Subjects that are recommended to be taken simultaneously

Programmable Electronic Circuits/V05G300V01502
Analogue Electronics/V05G300V01624
Data Acquisition Systems/V05G300V01521

Subjects that it is recommended to have taken before

Digital Electronics/V05G300V01402
Physics: Fundamentals of Electronics/V05G300V01305
Electronic Technology/V05G300V01401

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

Competencies		
Code		Typology
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- know - Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CG13	CG13 The ability to use software tools that support problem solving in engineering.	- Know How - Know be
CE42	(CE42/SE4): The ability to apply electronics as support technology in other fields and activities and not only in information and communication technologies.	- know
CE43	(CE43/SE5): The ability to design analogical and digital electronics circuits of analogical to digital conversion and vice versa, of radiofrequency, of feeding and electrical energy conversion for computing and telecommunication engineering.	- know - Know How
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know be

Learning outcomes	
Learning outcomes	Competences
To know and understand integrated circuits (ICs) and micro-electro-mechanical systems (MEMs) fabrication processes.	CE42
To know and understand CMOS fabrication processes for ICs and MEMs, as well as the corresponding design methodologies and the steps in the development of an IC.	CG6 CE43
To know and be capable of analizing the physical structure of resistors, capacitors, and transistors in CMOS technology.	CG6 CG9 CE43 CT4
To know and understand the basic aspects of MEMs design and their basic structures	CE42
To be capable of working with CAD tools for the design of CMOS ICs	CG6 CG9 CG13 CT4

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

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	18	45	63
Practice in computer rooms	13	19.5	32.5
Projects	6	27	33
Presentations / exhibitions	1	2.5	3.5
Short answer tests	1	3.5	4.5
Troubleshooting and / or exercises	2	7	9
Practical tests, real task execution and / or simulated.	1	3.5	4.5

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

Methodologies	
	Description

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

Personalized attention

Methodologies	Description
Master Session	Professors will personally assist students with doubts and questions they may have about either theoretical contents. Office hours will be scheduled for both individual and group sessions.
Practice in computer rooms	Professors will personally assist students with doubts and questions they may have about lab assignments. Office hours will be scheduled for both individual and group sessions.
Projects	Professors will personally assist students with doubts and questions they may have about the development of the projects. Office hours will be scheduled for both individual and group sessions.
Presentations / exhibitions	Professors will personally assist students with doubts and questions they may have about the preparation of the public presentations. Office hours will be scheduled for both individual and group sessions.

Assessment

	Description	Qualification	Evaluated Competencess
Projects	Each group of students will deliver the design carried out in the project in the format of the integrated circuit design tool. To pass the course, the design must meet technological standards and it shall comply the required specifications. In addition, each group must submit a detailed project report, with explicit information about the contribution of each of them to the whole, as well as the methodology followed for the distribution and coordination of tasks. Based on this division of tasks, it can be assigned an individual mark to each of the group members. The evaluation of the projects will be based on the following aspects: - Theoretical calculations carried out for design. - Analysis of design alternatives. - Successfully implementation and design verification for compliance with specifications. - Layout compaction. - Use of adequate layout strategies to minimize the effects of imperfections in the manufacturing process and to assure good matching of the electrical characteristics of the sets of components or devices that require it for functional reasons. - Formal issues: structure, clarity, conciseness, and completeness of the report. Use of suitable figures and discussion of significant data. Reports must be submitted on the date indicated in the planning of the course and it will be at least two days prior to the public presentation. To pass the course, students must achieve at least a mark of 5 or higher in a scale of 0-10 in the project (design and reporting). Competencies CE43, CG6, CG9, CG13, and CT4 will be assessed in these projects.	20	CG6 CG9 CG13 CE43 CT4

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

Practical tests, real task execution and / or simulated.	All students, in continuous evaluation or not, must complete Lab Assignment 2 and deliver a written report with the achieved results and conclusions. The report is due before the last scheduled lab session. Lab assignment 2 and the corresponding report account for 15% of the global mark. A continuous evaluation 1-hour lab test using an IC CAD tool will be held in the last scheduled lab session. Another similar test will be held in the date of the final exam. It is compulsory for students not in continuous evaluation. Students in continuous evaluation can also voluntarily complete it. In that case, the score they will receive in this part of the course evaluation will be the one achieved in this second test. Lab tests account for 15% of the global mark. To pass the course, students must achieve a mark or 4 or higher in a 0-10 scale in both Lab Assignment 2 and the lab test. Competencies CE43 and CG13 will be assessed in this part	30	CG13 CE43

Other comments and July evaluation

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

Students not in continuous evaluation will be evaluated as follows:

- Final written and lab tests will account for the same percentage of the global mark as in the case of students in continuous evaluation.
- They must develop a project and deliver the corresponding report and public presentation (in the same sessions and with the same criteria as students in continuous evaluation). Reports are due two days before public presentation.
- They must complete Lab Assignment 2 and deliver a written report with the achieved results and conclusions.

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

Students not passing the course in the first call will have the opportunity to attend a second call. Requirements to pass the course will be the same as in the first call. In the second call, students must complete the two written tests and the lab test. No new projects and presentations will be allowed except for students not having achieved the minimum required scores on them. Project reports are due seven days before the date of the test.

Students who achieved the minimum scores in written and lab tests but not in project reports or presentations, will not need to complete the tests again, but only deliver project reports and presentations. However, they can voluntarily (in written) give up tests scores (at least seven days before the date of the second call) and complete all the tests again.

Sources of information

Basic Bibliography

José Antonio Rubio Solà, Diseño de circuitos y sistemas integrados, Universidad Politécnica de Cataluña (2003)

Stephen A. Campbell, Fabrication Engineering at the Micro-and Nanoscale, 4ª, Oxford University Press (2012)

J. Franca, Y. Tsividis (eds.), Design of analog VLSI circuits for telecommunications and signal processing, Prentice Hall (1994)

Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

Analogue Electronics/V05G300V01624

Subjects that it is recommended to have taken before

Digital Electronics/V05G300V01402
Physics: Fundamentals of Electronics/V05G300V01305
Electronic Technology/V05G300V01401

Other comments

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

IDENTIFYING DATA

Electronic Systems for Digital Communications

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

Competencies

Code		Typology
CG11	CG11 To approach a new problem considering first the essential and then the secondary aspects	- know - Know How
CG13	CG13 The ability to use software tools that support problem solving in engineering.	- know - Know How
CE40	(CE40/SE2): The ability to select electronic circuits and devices specialized in transmission, forwarding or routing, and terminals for fixed and mobile environments.	- know - Know How

Learning outcomes

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

Contents

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

Unit 5. High-speed synchronous serial communication systems	High-speed synchronous serial communication protocols. Differential technologies. Standards and practical implementations.
Unit 6. Wireless communication systems	Wireless communication protocols. Wiireless networks characteristics and configurations.
Unit 7. Short range wireless communication systems	Wireless communication protocols of short range and low consumption. WPAN Networks. Characteristics and analysis of the wireless sensors networks. Standards and practical implementations.
Unit 8. Radio frequency identification systems. Near-field communications	RFID technology. Near-field communications. Standards and practical implementations.

Laboratory	
Block 1. Wired asynchronous serial communication circuits	Design, implementation and test of an asynchronous serial communication circuit. Transceivers.
Block 2. Wired synchronous serial communication circuits	Design, implementation and test of a synchronous serial communication circuit. Clock recovery.
Block 3. Wireless communication circuits	Design, implementation and test of a wireless communication circuit. Using and configuring communication modules.
Block 4. Project: Design and implementation of a digital communications system	Design, implementation and test of a digital communication system. Applying theoretical and practical concepts.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	12	12	24
Troubleshooting and / or exercises	4	4	8
Laboratory practises	8	20	28
Integrated methodologies	13	52	65
Short answer tests	3	12	15
Jobs and projects	2	8	10

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

Methodologies

	Description
Master Session	The lecturer will explain in the classroom the main contents of the subject. The students have to manage the proposed bibliography to carry out a self-study process in a way that leads to acquire the knowledge and the skills related to the subject. The lecturer will answer the students' questions in the classroom or in the office. In these sessions the students will develop the skills CE40 and CG11 ("know").
Troubleshooting and / or exercises	Activities designed to apply the main concepts of the subject to solve problems and exercices. The lecturer will explain a set of problems and the students have to solve diferent take-home sets of problems. The lecturer will answer the students' questions in the classroom or in the office. In these sessions the students will develop the skill CE40 ("know").
Laboratory 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. Possible questions can be answered in the laboratory sessions or in the lecturer's office. In these sessions the students will develop the skills CE40 and CG13 ("know how").
Integrated methodologies	Project-based learning: Students have to develop a group project that goes on over a period of time and addresses a specific problem. They have to design, schedule and carry out a set of tasks to achieve a solution. Each group will present the proposed solution and a project report. In these sessions the students will develop the skills CE40, CG11 and CG13 ("know how").

Personalized attention

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

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

Assessment

	Description	Qualification	Evaluated Competencess
Laboratory practises	The lecturer will check the level of compliance of the students with the goals related to the laboratory skills. The final mark of laboratory, FML, will be assessed in a 10 points scale. For the evaluation of the laboratory sessions, the lecturer will assess the group work (the same mark for each member), the individual preliminary tasks and the answers to personalized questions for each session.	20	CG13 CE40
Short answer tests	The lecturer will check the level of compliance of the students with the goals related to the theory skills. The final mark of theory, FMT, will be assessed in a 10 points scale.	30	CE40
Jobs and projects	The lecturer will consider the results and the quality of the analysis performed in the developed project. The group project mark (GPM) will be assessed in a 10 points scale. For the evaluation of the project, the lecturer will assess the group work (the same mark for each member) and the individual oral presentation of the developed project.	50	CG11 CG13 CE40

Other comments and July evaluation

1. Continuous assessment

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

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

The subject comprises three different parts: theory (30 %), laboratory (20%) and group project (50%). Once a task has been assessed, the students can not do/repeat the task at a later date. The marks are valid only for the current academic course.

1.a Theory

Two short answer tests (SAT) are scheduled. The first test (SAT1) will be performed after unit 5, in the usual weekly scheduling of the theoretical classes. The second test (SAT2) will be performed during the examination period in the date specified in the academic calendar. Marks for each test will be assessed in a 10 points scale. The minimum mark required to pass this part is of 4 (SATi>=4). The final mark of theory (FMT) is calculated as the arithmetic mean of the individual marks:

FMT = (SAT1 + SAT2)/2

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

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

1.b Laboratory

Four laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in pairs. This part also will be assessed by continuous assessment. Each session will be only evaluated according to the developed work at the schedule date. The lecturer will consider the work of the students carried out before the laboratory session to prepare the proposed tasks, the work in the laboratory to deal with them as well as the student's behavior.

Marks for each laboratory session (LSM) will be assessed in a 10 points scale. A mark of 0 will be obtained for missing sessions. In order to pass the laboratory part the students can not miss more than one laboratory sessions. The final mark of laboratory (FML) is calculated as the arithmetic mean of the individual laboratory session marks:

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

1.c Group project

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

1.d Final mark of the subject

The weighted points from all assessed parts are added together to calculate the final mark (FM). The following weightings will be applied: 30% theory (FMT), 20% laboratory (FML) and 50% group project (GPM). In order to pass the subject, students will be required to pass the theory, laboratory and group project parts. In this case the final mark (FM) will be:

FM = (0.3·FMT + 0.2·FML + 0.5 GPM)

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

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

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

2. Final Exam

The students who prefer a different educational policy can attend an exam on a scheduled date. This exam will comprise three parts (similar to the activities completed by the continuously assessed students): theory exam, laboratory exam and project.

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

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

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

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

FM = (0.3·FMT + 0.2·FML + 0.5 GPM)

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

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

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

3. Second opportunity to pass the subject

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

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

Sources of information
Basic Bibliography
F. Machado, V. Pastoriza, F. Poza, Sistemas Electrónicos para Comunicaciones Digitales, Curso 2016/2017, Plataforma TEMA
P. Mariño, Las comunicaciones en la empresa. Normas, redes y servicios, 2ª Ed., Ra-Ma
S. Mackay, E. Wright, D. Reynders, J. Park., Practical industrial data networks : design, installation and troubleshooting, 1ª Ed., Newnes-Eslsevier
Complementary Bibliography
R. Faludi, Building wireless sensor networks, 2011, O'Reilly
H. Lehpamer, RFID design principles, 2012, Artech House
B. Sklar, Digital communications. Fundamentals and applications, 2ª Ed., Prentice-Hall

Recommendations

Subjects that are recommended to be taken simultaneously

Data Acquisition Systems/V05G300V01521

Subjects that it is recommended to have taken before

Digital Electronics/V05G300V01402
Programmable Electronic Circuits/V05G300V01502

IDENTIFYING DATA				
Analogue Electronics				
Subject	Analogue Electronics			
Code	V05G300V01624			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Raña García, Herminio José			
Lecturers	Quintáns Graña, Camilo Raña García, Herminio José			
E-mail	hrana@uvigo.es			
Web	http://webs.uvigo.es/ario/docencia/eangrado/eangrado.htm			
General description	This subject studies the feedback concept, and its applications to amplifiers. The opamps and their applications are also studied.			

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

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

Contents	
Topic	
Feedback amplifiers I	Feedback concept. Sample and mix networks. Feedback topologies. Feedback law.
Feedback amplifiers II	Negative and positive feedback. Parameters for the study of feedback. Benefits and draws of feedback. Effect on the uniform of gain. Effect on the harmonic distortion. Effect on the input and output impedances.

Feedback amplifiers III	Methods for the analysis: Simple or using matrix. Topology identifying. Amplifier without feedback, but with the load effect of the feedback network. The gain of the feedback amplifier. The input and the output impedances of the feedback amplifier.
Feedback amplifiers IV	Effect of the feedback on the frequency response. Bandwidth and stability. The effect of poles on the amplifier (one pole, two poles and three poles). Gain and phase margins. Nyquist criteria. Root places. Compensation methods.
Sine waveform oscillators	Barkhausen criteria. Design of a sinusoidal oscillator. RC oscillator. LC oscillator. Oscillator based on quartz crystals.
Operational amplifiers I	Internal structure of an operational amplifier. Current mirrors. Active loads. Voltage references. Technologies for the operational amplifiers: bipolars, bifet, cmos.
Operational amplifiers II	Analysis of the operational amplifier in the non inverting mode, using feedback. Voltage follower. Converters I-V and V-I. Integrator. Derivator. Applications.
Operational amplifiers III	Half-wave inverter rectifier . Full-wave inverter rectifier. Relaxation oscillator. Generator of triangle waves. Sinusoid oscillators based on the operational amplifier.
Power amplifiers	Output stages in class A, B and A-B. Full amplifier in class B. Full amplifier in class A-B. Introduction to the class-D amplifiers.
Regulated power supplies	Linear regulated power supplies. Protection to over current. Low drop-out (LDO).
Lab work 1	The effect of the feedback on a two-stage amplifier .
Lab work 2	Linear applications. Voltage-to-current converter. Integrator.
Lab work 3	Half-wave inverter rectifier. Full-wave inverter rectifier. Peack detector. Slope detector.
Lab work 4	Operational-based relaxation oscillator. Operational-based sinusoidal oscillator.
Lab work 5	Power amplifiers. Class B. Class A-B.
Lab work 6	Design of an active load. Design of a voltaje regulated supply.

Planning

	Class hours	Hours outside the classroom	Total hours
Tutored works	7	20	27
Laboratory practises	12	38	50
Master Session	15	27.5	42.5
Troubleshooting and / or exercises	4	22.5	26.5

Short answer tests	0.5	0	0.5
Troubleshooting and / or exercises	1	0	1
Short answer tests	0.5	0	0.5
Troubleshooting and / or exercises	1	0	1
Practical tests, real task execution and / or simulated.	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
Tutored works	The lecturer will lead the students in order to design an amplifier. Competencies CE42, CE43 and CE44 will be addressed in these sessions.
Laboratory practises	Simulations and real assembled circuits will be tested. Competencies CE42, CE43 and CE44 will be addressed in these sessions.
Master Session	The lecturer will show some theoretical contents related to the subject. Competencies CE42, CE43 and CE44 will be addressed in these sessions.
Troubleshooting and / or exercises	The lecturer will solve some exercises related to the subject. Competencies CE42, CE43 and CE44 will be addressed in these sessions.

Personalized attention	
Methodologies	Description
Troubleshooting and / or exercises	The teacher will resolve the doubts of the students at the schedule established and published on the school website.
Tutored works	The teacher will resolve the doubts of the students at the schedule established and published on the school website.
Laboratory practises	The teacher will resolve the doubts of the students at the schedule established and published on the school website.
Master Session	The teacher will resolve the doubts of the students at the schedule established and published on the school website.

Assessment			
	Description	Qualification	Evaluated Competencess
Tutored works	Every student has to create a document about the assigned work. Competencies CE42, CE43 and CE44 will be assessed in these works.	10	CE42 CE43 CE44
Short answer tests	First short answer test in the classroom. Competencies CE42, CE43 and CE44 will be assessed in these tests.	15	CE42 CE43 CE44
Troubleshooting and / or exercises	First exercise test in the classroom. Competencies CE42, CE43 and CE44 will be assessed in this test.	15	CE42 CE43 CE44
Short answer tests	Second short answer test. Competencies CE42, CE43 and CE44 will be assessed in this test.	15	CE42 CE43 CE44
Troubleshooting and / or exercises	Second exercise test. Competencies CE42, CE43 and CE44 will be assessed in this test.	15	CE42 CE43 CE44
Practical tests, real task execution and / or simulated.	Laboratory-work exam based on simulations and real circuits. Competencies CE42, CE43 and CE44 will be assessed in this test.	30	CE42 CE43 CE44

Other comments and July evaluation

NOTE: The timing of the partial exams might suffer some changes, due to time restrictions. The exact timing will be indicated along the course.

CONTINUOUS EVALUATION OPTION:

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

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

The two partials take place in the classroom, within the class time. These partials are approximately 90 minutes long. The first 30 minutes will be dedicated to an exam with short answers. The rest 60 minutes will be dedicated to an exam with long answers.

Inside each partial, the 90 minutes exam and the 30 minutes exam have the same weight.

In order to pass a partial exam (the first or the second), the student is required to obtain at least a mark of 5 over 10.

The student that passes only one partial will only have to try the other one at the final exam option.

The lab-work is evaluated using a unique exam, in the laboratory. The weight is 30%.

Tutored works are assessed using a report that every student should be done. The weight is 10%.

When a student attends the first partial, he or she accepts to follow the continuous assessment. Students that do not attend to the first partial will be assessed by means of a final exam.

The mark that a student obtains in the lab-work is maintained until July, except if the student does not want. In this case, the student will have to do partials and lab exams in July.

In order to pass the subject, once partials have been passed, the student has to obtain a global mark (GM) of at least 5 points in ten. The global mark is calculated following the next formula:

GM = 0.6 * TM + 0.3*LM + 0.1*RM

where

TM = Mean value of the partial marks; LM = lab mark; RM = report mark

The first partial is preview to take place around the sixth week. The second partial will take place in the last week.

The lab exam will take place in the lab, the day of the last lab session.

FINAL EXAM OPTION:

The students that do not follow the continuous assessment will be assessed by means of a final exam. The exam will consist of three parts: the first part of the themes 1 to 5, the second part of the themes 6 to 10 and the third part of lab-work in the laboratory.

In order to pass the subject, the student has to obtain a mark of at least 5 points over ten for the first and second parts. In this case, the global mark (GM) is calculated following the next formulae:

GM = 0.6 * TM + 0.4*LM

where:

TM = Average mark of the first and second part of the exam; LM = lab mark

If the student does not obtain a mark of at least 5 in the first part or in the second part, the global mark would be the least mark between 4 or the GM taken from the early formulae.

IMPORTANT:

If a student did not enter the continuous assessment mode but is interested in participate in the final exam, he or she should talk with the professor at least two weeks before the day of the exam. Contact can be by e-mail. This help in the organization of the lab work exam.

RECOVERY EXAM

The recovery exam (June-July) shares the same structure than the final exam.

Sources of information

Basic Bibliography

Sergio Franco, Design with operational amplifiers and analog integrated circuits, third edition, McGraw-Hill,

Hambley, Allan R., Electrónica, 2ª ed., Pearson-Prentice Hall, 2001,

Complementary Bibliography

Paul Horowitz y Winfield Hill, The Art of Electronics, Cambridge Univ. Press,

Horenstein, Mark N., Microelectrónica, 2ª ed., Prentice Hall, 1997,

Malik, Norbert, Circuitos electrónicos, Prentice Hall, 1996,

Rashid, Muhammad, Circuitos microelectrónicos, Thomson, 2002,

Sedra, Adel, Circuitos microelectrónicos, 5ª ed., McGraw-Hill, 2006,

Recommendations

Subjects that are recommended to be taken simultaneously

Data Acquisition Systems/V05G300V01521

Subjects that it is recommended to have taken before

Electronic Technology/V05G300V01401

Other comments

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

IDENTIFYING DATA				
Power Electronics				
Subject	Power Electronics			
Code	V05G300V01625			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	López Sánchez, Óscar			
Lecturers	Doval Gandoy, Jesús López Sánchez, Óscar			
E-mail	olopez@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main goal of this subject is to provide students with the knowledge about the basics of power electronics. Contents include power semiconductor devices, AC-DC converters, DC-DC converters, DC-AC converters and basic concepts about the control of these power converters.			

Competencies		
Code		Typology
CE43	(CE43/SE5): The ability to design analogical and digital electronics circuits of analogical to digital conversion and vice versa, of radiofrequency, of feeding and electrical energy conversion for computing and telecommunication engineering.	- Know How
CE44	(CE44/SE6): The ability to understand and use feedback theory and electronic control systems.	- Know How

Learning outcomes	
Learning outcomes	Competences
Knowledge about power electronics semiconductor devices.	CE43
Knowledge about the operation of the basic topologies of electronic converters used in conversion of electrical energy.	CE43
The ability to understand and analyse power electroncis circuits.	CE43 CE44
The ability to analyse and design the control loop of power electronics converters.	CE43 CE44
The ability to design basic circuits used in power electronic converters.	CE43 CE44

Contents	
Topic	
Chapter 1: Introduction to power electronics	Introduction, overview of power electronics, applications.
Chapter 2: Power electronic devices	Diode, MOSFET, IGBT. Switching, drivers, thermal analysis, association of devices, electrical protection.
Chapter 3: Magnetics in power electronics	Basics, inductors, transformers, magnetic materials.
Chapter 4: AC to DC power conversion	Three phase rectifiers. Non-controlled rectifiers, controlled rectifiers. Resistive load, inductive load, capacitive filter. Input AC Introduction to the power factor correction.
Chapter 5: DC to AC power conversion	Basics of DC to AC power conversion. Single phase and three phase inverters. Square wave inverters, PWM inverters. Modulation techniques.
Chapter 5: DC to DC power conversion	Basic DC to DC converter topologies. Converters without isolation and with isolation. Control in DC to DC power converters.
Laboratory exercise 1. Power electronic semiconductor devices.	MOSFET transistor, switching characteristics. Current and voltage characteristics.
Laboratory exercise 2. AC to DC power conversion	Non-controlled three phase rectifier, controlled three phase rectifier. Input/ output current and voltage.

Laboratory exercise 3. DC to AC power conversion	DC to AC converter. Input/ output current and voltage.
Laboratory exercise 4. DC to DC power conversion	Non-isolated and isolated DC to DC converter. Input/ output current and voltage.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	21	42	63
Laboratory practises	12	24	36
Autonomous troubleshooting and / or exercises	7	28	35
Troubleshooting and / or exercises	2	14	16
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Master Session	Presentation by the professor of the contents on the subject, guidelines for the work to develop by the student.Competencies CE43 and CE44 will be worked.
Laboratory practises	Practical application of the theoretical concepts. Competencies CE43 and CE44 will be worked.
Autonomous troubleshooting and / or exercises	Proposal of problems and/or exercises related with the subject contents. Students have to obtain the correct solutions. The professor will support and will help students to solve the problems. Competencies CE43 and CE44 will be worked.

Personalized attention	
Methodologies	Description
Master Session	The students can attend tutorials in the professor office on dates and hours published in the web of the subject.
Laboratory practises	The students can attend tutorials in the professor office on dates and hours published in the web of the subject.
Autonomous troubleshooting and / or exercises	The students can attend tutorials in the professor office on dates and hours published in the web of the subject.

Assessment			
	Description	Qualification	Evaluated Competencess
Laboratory practises	The laboratory practices are evaluated in a continuous way (session to session) taking into account his previous preparation and the execution in the laboratory.	10	CE43 CE44
Autonomous troubleshooting and / or exercises	Every week, students are commissioned the execution of tasks and the delivery of a execution report.	10	CE43 CE44
Troubleshooting and / or exercises	Each exam is composed by exercises and problems related to the theoretical concepts and laboratory practices. The number of exams and examination rules are detailed in "Other comments"	80	CE43 CE44

Other comments and July evaluation

For their evaluation, each student should select between continuous evaluation or evaluation by final examination.

1. Continuous evaluation

The continuous evaluation is carried out by means of the execution of several weekly tasks, the preparation and execution of the laboratory practices, and the execution of two tests of partial evaluation.

1.1 Weekly tasks

Weekly, the professor will commission to the students to execution of several tasks and the delivery of an execution report. By the realization of the tasks and the delivery of the reports the students will be able to obtain the up to 10% of the qualification of the subject. The qualifications of the weekly tasks will be valid only for the current academic year.

1.2 Laboratory practices

Students will realize four sessions of laboratory practices in groups of two. Each group member will obtain an individual mark for each season that will evaluate the previous preparation and the execution of the practice in the laboratory. The sessions without assistance will be marked with a zero. The final mark of the laboratory practices will be the average of the marks of the four sessions. By the correct preparation and execution of all laboratory practices the students will be able to obtain up to 10% of the qualification of the subject. The qualifications of the laboratory practices will be valid only for the current academic year and the following one.

1.2 Tests of partial evaluation

Students will realize two written tests of partial evaluation. The partial test are not recoverable, that is, if a student can not attend one test, the professors do not have obligation to repeat it. The qualifications of the partial tests will be valid only for the current academic year. It is considered that a student choose the continuous evaluation and renounces to be evaluated by final exam if it attends the first the partial tests.

1. **First partial test:** students will be evaluated of the contents taught to date of the test. The students will be able to obtain in this test up to 40% of the final qualification. This test will be held on week 8, approximately.
2. **Second partial test:** students will be evaluated of the contents taught to date of the test that were not included in the first partial test. The students will be able to obtain in this test up to 40% of the final qualification. This test will be held on a date and place chosen by the Dean of the Faculty for the final examination.

2. Evaluation by final examination

The final examination consists of theoretical questions, problems and exercises that covers the whole contents of the subject. The students will be able to obtain in this exam up to 100% of the final qualification. This exam will be held on the date and place chosen by the Dean of the Faculty..

3. Extraordinary examination (June-July)

The extraordinary examination consists of theoretical questions, problems and exercises that will evaluate the whole contents of the subject. The students will be able to obtain in this exam up to 100% of the final qualification. This exam will be held on the date and place chosen by the Dean of the Faculty.

Sources of information
Basic Bibliography
Mohan, Ned, Power electronics: converters, applications, and design, John Wiley and Sons, 2003,
Barrado, Andrés, Problemas de electrónica de potencia, Pearson Prentice Hall, 2007,
Rashid, Muhammad H., Electrónica de potencia: circuitos, dispositivos y aplicaciones, Pearson Education, 2004,
Hart, Daniel W., Electrónica de potencia, Prentice-Hall, 2001,
Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

Programmable Electronic Circuits/V05G300V01502

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G300V01201
Physics: Fields and Waves/V05G300V01202
Physics: Fundamentals of Mechanics and Thermodynamics/V05G300V01102
Digital Electronics/V05G300V01402
Physics: Fundamentals of Electronics/V05G300V01305
Electronic Technology/V05G300V01401

Other comments

This version in English of the guide is a translation of the original one in Galician. In the case that, by mistake, there exists differences between them the original one in Galician is what prevails.

IDENTIFYING DATA				
Audiovisual Technology				
Subject	Audiovisual Technology			
Code	V05G300V01631			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Torres Guijarro, María Soledad			
Lecturers	Martín Rodríguez, Fernando Torres Guijarro, María Soledad			
E-mail	marisol@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this subject the student will learn to design audiovisual systems,with respect to sound take and sound reinforcement, image take and visual coating, synchronisation, wiring, connections and supply. Indoor and outdoor applications of audiovisual networks, as well as distinct multimedia platforms, will be analysed.			

Competencies		
Code		Typology
CG1	CG1: The ability to write, develop and sign projects in the field of Telecommunication Engineering, according to the knowledge acquired as considered in section 5 of this Law, the conception and development or operation of networks, services and applications of Telecommunication and Electronics.	- know - Know How
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- know - Know How - Know be
CG12	CG12 The development of discussion ability about technical subjects	- know - Know How - Know be
CE36	CE36/SI3 The capacity to implement projects at places and installations for the production and recording of audio and video signals.	- know - Know How - Know be
CE38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.	- know - Know How - Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Understand which elements have an influence on audiovisual quality.	CE36 CE38
Design a system of sound take and sound reinforcement given a certain enclosure, comparing different subsystems and elements.	CG1 CG6 CE36
Create atmospheres addressing acoustic and visual appearances	CG12 CE36
Design the wiring and connections of an audiovisual network for his control and supply	CG1 CG6 CE36 CE38
Analyse different indoor and outdoor applications of Audiovisual Networks.	CE36 CE38

Apply and analyse distinct multimedia systems: videoconference, streaming, audiovisual databases, synchronisation, metadata processing, exchange of multimedia contents.	CG6 CG12 CE38
Organize a working group to carry out a project, including the following: * technical ability to collect information, interpret technical specifications of equipment, discuss different options and select a combination of certain equipment. * use of theoretical calculations and simulation software tools to support the design of sound systems and visual coating. * conduction of meetings, discussion of partial results and oral presentation of a definitive work in front of a demanding audience. * writing of progress reports, minutes of meetings and a final technical report. * adaptation to new environments, management of internal roles in the group and conflict resolution.	CG6 CG9 CG12 CT4

Contents

Topic	
Sound reinforcement	Sizing and distribution in the processes of take and presentation of sound
Visual overlay	Design of systems of visual take and presentation indoor and outdoor. Sizing and distribution of the visual coverage, in the processes of take and presentation
Connections and supply	Design of the wiring and connecting of an audiovisual network and his supply. Audiovisual networks, indoor and outdoor applications.
Synchronisation and control	Synchronisation of audio and video signals in an audiovisual network. Control systems. Audiovisual quality: sound/image interaction. Ambient creation addressing visual and acoustic issues
Multimedia systems	Videoconference, streaming, audiovisual databases, synchronisation, metadata procesing, exchange of multimedia contents

Planning

	Class hours	Hours outside the classroom	Total hours
Practice in computer rooms	12	0	12
Projects	7	57	64
Master Session	21	42	63
Short answer tests	2	0	2
Reports / memories of practice	0	9	9

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

Methodologies

	Description
Practice in computer rooms	Use and adjustment of analysis tools and algorithms, identifying which one should be used in each situation. With this methodology they work the CE36 competence.
Projects	Collaborative work in reduced groups on a complex design that applies several topics covered in the subject. The work is periodically followed-up and it fosters working in group, role sharing, information sharing, planning and public defending of results. With this methodology they work the CG1, CG6, CG9, CG12, CE36, CE38 and CT4 competences.
Master Session	Presentation by the teacher of the contents of the subject, fostering the critical discussion of the concepts. The theoretical grounds of algorithms and procedures used to resolve problems are given. With this methodology they work the CG1, CG6, CG12, CE36 and CE38 competences.

Personalized attention

Methodologies	Description
Master Session	Doubts can be solved in the rests of the classes and in the teacher tutorial sesions. These tutorial sessions will be done individually or in short groups (with a maximum of 2-3 students). The tutorial sessions are typically agreed with the professor. The meetng requests can be done personally or by email. The tutorial sessions are preferably done in the schedules and place officially reserved for them.
Practice in computer rooms	In the classes of practices is a good moment to consult doubts with the professor. The professor moves between the tables and some students take advantage of the proximity of the professor to consult doubts of the own class or punctual doubts of other classes.

Projects	The projects have its own classes of C group in which the students of each team consult their doubts about the project and the professor is with them helping to define the project and giving them support for the development of their particular project. They are classes with a very pleasant interaction.

Assessment

	Description	Qualification	Evaluated Competencess
Projects	Assessment of a project, developed through the four-month period, including the preparation and public presentation of a report. The corresponding individual mark to the works done in group is obtained as a ponderated sum of: 1) the common mark of the group (60%); 2) the individual mark (40%), obtained from one or various of the following methods of evaluation: cross-evaluation by the other members of the group, oral questions during the presentations of the works, written questions about the content of the work.	40	CG1 CG6 CG9 CG12 CE36 CE38 CT4
Short answer tests	Assessment of a written exam, with brief questions and problems.	50	CG1 CG6 CG12 CE36 CE38
Reports / memories of practice	Assessment of a written inform that describes the work of several weeks in the computer classroom.	10	CE36

Other comments and July evaluation

Following the study programme guidelines, the student can choose between two assessment methods: CONTINUOUS ASSESMENT, that is the recommended method linked to the educational activities and NON CONTINUOUS ASSESSMENT, only recommended for those students which can not follow the first method.

CONTINUOUS ASSESSMENT

The continuous assessment consists of the tests detailed in the following. The student opts by the continuous assessment method once she/he signs the document of commitment that will be available at week 1-3, so that she/he can begin the work in the corresponding group. Once signed, it is assumed that the student has taken the examination session and will be given the mark resulting of the application of the criterion detailed in the following, regardless of wheter she/he takes the final exam or not.

Types and assessment of activities:

Reports of the practical sessions (Weight: 10%): will be assessed around weeks 6 and 11.

Projects (Weight 40%): will be assessed around week 12. The individualized part of the assessment will be done through cross-evaluation, oral questions during presentations, and/or written exam questions.

Proof of short answer (Weight: 50%): it coincides with the final exam date. It includes all the contents of the subject.

The final note corresponds to the sum of the marks obtained in all the activities weighted by the corresponding percentages. The student should obtain, at least, a grade of 4 points over ten in each type activity, and a final grade of 5 points to pass the subject. If in any of the activities the grade does not reach 4 but the average exceeds 5, the final grade will be 4.

NON CONTINUOUS ASSESSMENT

If the student does not sign the document of commitment, she/he will be evaluated through a final examination in the official date assigned by the Centre. This exam will consist of two parts, of equal weight in the final mark: a written part that may include all the topics of the subjet, and an oral part relative to additional work. This additional work should be presented previously to the teacher. The student may take part in the continuous assessment activities of the practical sessions, but they will not be assessed in her/his case. The additional work to deliver will be specified in week 6 of term, and will have to be delivered to the teacher a week before the final exam.

The student should obtain, at least, a grade of 4 points over ten in each type activity, and a final grade of 5 points to pass the subject.

Sources of information

Basic Bibliography

John Eargle, JBL Sound system design reference manual, 3, JBL, 1999,

Complementary Bibliography

John Eargle, Chris Foreman, Audio Engineering for Sound Reinforcement, Hal Leonard, 2002,

Gary Davis and Ralph Jones, Sound Reinforcement Handbook, Hal Leonard, 1989,

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Hilary Wyatt y Tim Amyes, Postproducción de Audio para TV y Cine, Escuela de Cine y Video de Andoain, 2005,

Rüdiger Ganslandt, Harald Hofmann, Handbook of Lighting Design, ERCO Edition

José Luis Sánchez Bote, Sistemas de refuerzo sonoro, Universidad Politécnica de Madrid, 2013, Madrid

José María Mellado, Fotografía de alta calidad: las técnicas y métodos definitivos., CS6. Anaya multimedia, 2013, Madrid

Ben Simonds, Blender master class : a hands-on guide to modeling, sculpting, materials, and rendering, No Starch Press, 2013, San Francisco

Recommendations

Subjects that are recommended to be taken simultaneously

Room Acoustics/V05G300V01635
Imaging Systems/V05G300V01633

Subjects that it is recommended to have taken before

Fundamentals of Sound and Image/V05G300V01405
Audio Systems/V05G300V01532
Video and Television/V05G300V01533

IDENTIFYING DATA				
Fundamentals of Image Processing				
Subject	Fundamentals of Image Processing			
Code	V05G300V01632			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Martín Herrero, Julio			
Lecturers	Martín Herrero, Julio			
E-mail	julio@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Introduces to the student the basics of digital image processing			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How - Know be
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How - Know be
CG10	CG10 The ability for critical reading of scientific papers and docs.	- Know How
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.	- know - Know How - Know be
CE38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.	- know - Know How - Know be
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know - Know How - Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know - Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Understand the nature and organisation of digital images	CG3 CG10 CE34 CE38
Learn to process digital images	CG3 CG4 CG10 CE34 CE38 CT2 CT3

Learn how to program a computer to process a digital image	CG3 CG4 CG10 CE34 CE38 CT2 CT3
Understand how the fundamental technics of image processing work	CG3 CG10 CE34 CE38
Apply fundamental processing technics to solve specific problems with images or groups of images	CG3 CG4 CE34 CE38

Contents

Topic	
Basic preprocessing.	Histogram. Brightness and contrast.
Global and local operators.	Linear and nonlinear filters.
Binary and greyscale mathematical morphology.	Erosion. Dilatation. Opening. Closing.
Geometrical transformations. Image transforms.	Affine transformations.
Image compression.	JPEG. JPEG 2000.
Image restoration.	Linear and nonlinear filters.

Planning

	Class hours	Hours outside the classroom	Total hours
Practice in computer rooms	12	23.5	35.5
Tutored works	7	43	50
Master Session	21	41.5	62.5
Practical tests, real task execution and / or simulated.	2	0	2

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

Methodologies

	Description
Practice in computer rooms	Handling and tuning analytic tools and algorithms, identifying which ones to use in different scenarios. All learning aims are addressed.
Tutored works	Groupwork developing the contents dealt with in the classroom, with personalised attention. All learning aims are addressed.
Master Session	Master talks by the teacher on central topics, promoting critical discussion of concepts. All learning aims are addressed.

Personalized attention

Methodologies	Description
Practice in computer rooms	Implementation of image processing methods within an image processing and visualization framework with graphic user interface, programming in C and C++.
Tutored works	Construction of an image processing chain able to fulfill a high level task by means of a succession of low level methods chosen and tuned by the students from among those explained along the course.

Assessment

	Description	Qualification	Evaluated Competencess

Practice in computer rooms	Personalised monitoring of the student's work in the laboratory, with feedback. All teaching aims specified in the corresponding section of this guide are evaluated.	50	CG3 CG4 CG10 CE34 CE38 CT2 CT3
Tutored works	Assessment of the work done, its contents and its presentation, and the knowledge about it that each student individually has. All teaching aims specified in the corresponding section of this guide are evaluated.	50	CG3 CG4 CG10 CE34 CE38 CT2 CT3
Practical tests, real task execution and / or simulated.	Real programming and problem solving. All teaching aims specified in the corresponding section of this guide are evaluated.	0	CG3 CG4 CG10 CE34 CE38 CT2 CT3

Other comments and July evaluation

The assistance to class under continuous evaluation is compulsory, unless exceptional circumstances concur. Continuous evaluation is used for assessment, based in the work of the student in the classroom and at home. There is a final exam in the official date marked by the Board of School in May, for those students that have not passed the continuous evaluation. This final exam will be marked between 0 and 10 points. It covers all the subjects seen during the semester. To approve, the student has to obtain, at least, five points. Students wishing to improve their continuous evaluation marks can also attend the final exam: in this case the mark of this exam will be the final mark. The students that have passed the continuous evaluation and are satisfied with their mark do not need to attend the final exam. Along the semester the students will receive feedback on their progress, and the final mark of continuous evaluation will be communicated to the students well before the final exam. The delivery of the personal work the last week of class will imply the official participation in continuous evaluation.

The extraordinary evaluation of July will be an extraordinary final exam, for those students that have not passed neither the continuous evaluation neither the final exam in May. The final mark will be the mark of the extraordinary final exam in both cases. This extraordinary final exam will be marked between 0 and 10 points, and covers all the subjects. To approve, the student has to obtain, at least, five points.

Note that there are two final exams, but both correspond to a single and the same call ("convocatoria").

Sources of information

Basic Bibliography

Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 3ª, Prentice Hall,

Complementary Bibliography

Robert Laganière, OpenCV Computer Vision Application Programming Cookbook, Packt Publishing, 2014,

Jasmin Blanchette, Mark Summerfield, C++ GUI Programming with Qt 4, Prentice Hall, 2008,

Recommendations

Subjects that continue the syllabus

Image processing and analysis/V05G300V01931

Subjects that are recommended to be taken simultaneously

Imaging Systems/V05G300V01633

Subjects that it is recommended to have taken before

Programming I/V05G300V01205
Fundamentals of Sound and Image/V05G300V01405
Digital Signal Processing/V05G300V01304

IDENTIFYING DATA				
Imaging Systems				
Subject	Imaging Systems			
Code	V05G300V01633			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Martín Herrero, Julio			
Lecturers	Martín Herrero, Julio			
E-mail	julio@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The study of several families of systems of generation of images, including artificial vision, remote sensing and medical image.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG10	CG10 The ability for critical reading of scientific papers and docs.	- Know How
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.	- know - Know How
CE66	(CE66/OP9) The ability for selection of circuits, subsystems and systems of remote sensing.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Know most common imaging (capture) systems for medical diagnosis, essay and remote sensing.	CG3 CG10 CE34 CE66
Understand the principles of operation of such systems.	CG3 CG10 CE34 CE66
Knowledge about the capabilities and limitations of such systems.	CG3 CG10 CE34 CE66
Knowledge about the most common applications of such systems.	CG3 CG10 CE34 CE66

Contents	
Topic	
Computer vision systems	Illumination systems (LED, laser, fluorescent), monochrome cameras, Bayer and 3 CCD color cameras, matrix and line cameras, framegrabbers, multicamera systems (mono/stereo)
Medical image and non destructive testing (NDT) systems	Generation and processing of echography, X-ray, computerized axial tomography, nuclear magnetic resonance, and positron emission scanner.

Satellital, airborne and proxy remote sensing	Acquisition, processing and applications of panchromatic images, monoband, multispectral, and hyperspectral, active and passive in UV / VIS / SWIR / NIR / FIR / Thermal / GHz, Radar and Lidar.

Planning

	Class hours	Hours outside the classroom	Total hours
Practice in computer rooms	12	23.5	35.5
Tutored works	7	43	50
Master Session	21	41.5	62.5
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
Practice in computer rooms	Handling and tuning analytic tools and algorithms, identifying which ones to use in different scenarios. We will work mainly in C/C++. Competencies: CG3, CG10, CE34, CE66.
Tutored works	Groupwork developing the contents dealt with in the classroom, with personalised attention. Competencies: CG3, CG10, CE34, CE66.
Master Session	Master talks by the teacher on central topics, promoting critical discussion of concepts. All learning aims are addressed.

Personalized attention

Methodologies	Description
Practice in computer rooms	Doubts can be solved in the teacher's office hours, individually or in small groups. Except otherwise noted, upon previous appointment with the teacher via email, preferably in the schedules and location officially reserved.
Tutored works	Doubts can be solved in the teacher's office hours, individually or in small groups. Except otherwise noted, upon previous appointment with the teacher via email, preferably in the schedules and location officially reserved.

Assessment

	Description	Qualification	Evaluated Competencess
Practice in computer rooms	Personalised monitoring of the student's work in the laboratory, with feedback. All teaching aims specified in the corresponding section of this guide are evaluated.	50	CG3 CG10 CE34 CE66
Tutored works	Assessment of the work done, its contents and its presentation, and the knowledge about it that each student individually has. All teaching aims specified in the corresponding section of this guide are evaluated.	50	CG3 CG10 CE34 CE66
Long answer tests and development	All teaching aims specified in the corresponding section of this guide are evaluated.	0	CG3 CG10 CE34 CE66

Other comments and July evaluation

The assistance to class under continuous evaluation is compulsory, unless exceptional circumstances concur. Continuous evaluation is used for assessment, based in the work of the student in the classroom and at home. There is a final exam in the official date marked by the Board of School in May, for those students that have not passed the continuous evaluation. This final exam will be marked between 0 and 10 points. It covers all the subjects seen during the semester. To approve, the student has to obtain, at least, five points. Students wishing to improve their continuous evaluation marks can also attend the final exam: in this case the mark of this exam will be the final mark. The students that have passed the continuous evaluation and are satisfied with their mark do not need to attend the final exam. Along the semester the students will receive feedback on their progress, and the final mark of continuous evaluation will be communicated to the students well before the final exam. The delivery of the personal work the last week of class will imply the official participation in continuous evaluation.

The extraordinary evaluation of July will be an extraordinary final exam, for those students that have not passed neither the continuous evaluation neither the final exam in May. The final mark will be the mark of the extraordinary final exam in both cases. This extraordinary final exam will be marked between 0 and 10 points, and covers all the subjects. To approve, the student has to obtain, at least, five points.

Note that there are two final exams, but both correspond to a single and the same call ("convocatoria").

Sources of information

Basic Bibliography

Erik Reinhard et al., Color Imaging: Fundamentals and Applications, 1ª, A K Peters, 2008,

John Robert Schott, Remote Sensing: The Image Chain Approach, 1ª, Oxford University Press, 2007, Oxford

Michael Vollmer and Klaus-Peter Möllmann, Infrared Thermal Imaging: Fundamentals, Research and Applications, 1ª, Wiley-VCH, 2010,

Arnulf Oppelt, Imaging Systems for Medical Diagnostics, 2ª, Wiley-VCH, 2005,

Complementary Bibliography

Oleg S. Pianykh, Digital Imaging and Communications in Medicine (DICOM), 2ª, Springer, 2012,

Recommendations

Subjects that are recommended to be taken simultaneously

Fundamentals of Image Processing/V05G300V01632

Subjects that it is recommended to have taken before

Fundamentals of Sound and Image/V05G300V01405

Other comments

Simultaneously taking the subject Fundamentals of Image Processing is highly recommended.

Abundant digital bibliographic material will be provided to the students through the subject's web, covering all the subject matter in the program.

IDENTIFYING DATA				
Sound Processing				
Subject	Sound Processing			
Code	V05G300V01634			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Rodríguez Banga, Eduardo			
Lecturers	Rodríguez Banga, Eduardo			
E-mail	erbanga@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course describes the main techniques of the sound processing, with special emphasis on real applications. Students are shown s the basic principles of these techniques and how the same principles may give rise to different algorithms or systems depending on the type of signal to process (speech or audio, for instance). This course also makes an introduction to the principles of underwater acoustic and ultrasounds as well as their applications.			

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- know - Know How
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.	- know - Know How
CE37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.	- know - Know How
CE38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know

Learning outcomes	
Learning outcomes	Competences
Understand the production and perception mechanisms of the sound.	CG4
Understand some basic techniques for sound processing.	CG4 CE34 CE38
Development of basic speech and audio coders.	CG4 CE34 CE38
Analyse speech and audio specifications and standards.	CG4 CG6 CE34 CE38
Use of coding standards on concrete applications.	CG4 CG6 CE34 CE38 CT2

Understand the basic principles of ultrasounds.	CG4 CE37
Understand the basic principles of underwater acoustics.	CG4 CE37
Analyse concrete applications of ultrasounds.	CG4 CE37 CT2
Analyse concrete applications of underwater acoustics.	CG4 CE37 CT2
Adaptation of learnt techniques to other applications.	CG4 CT2

Contents

Topic	
Voice production and perception	Voice generation. Physiology. General characteristics of a speech signal. Perception. Auditive physiology.
Analysis of speech and audio signals	Short term analysis. Time and spectral parameters. Linear Prediction Techniques. Psychoacoustic models.
Speech coding	Waveform coding. Parametric coding. Hybrid coding. Standards. Applications.
Audio Coding	Main characteristics of an audio signal. Time-frequency analysis : filterbanks and transforms. Coding. Standards. Applications.
Underwater acoustics and ultrasounds	Propagation of acoustic waves in water. Applications. Ultrasounds. Applications

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	21	42	63
Practice in computer rooms	12	9	21
Tutored works	7	57	64
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
Master Session	The teacher makes a presentation of some relevant contents of the subject. Some concepts may be illustrated by means of computer simulation. Students are encouraged to make questions and discuss some proposed problems and exercises. The main objective of these sessions is to provide the students with the theoretical background so that they can develop all the subject competences. Therefore, every subject competence is developed in these sessions.
Practice in computer rooms	Students will carry out computer simulations using Matlab, which will help them to better understand the concepts introduced in the theory sessions and to discover new ones. All the subject competences are developed in these sessions.
Tutored works	The students will be grouped into teams which will develop one or several tasks proposed by the teacher. The number of students in a team will be established taking into account the number of students enrolled and the complexity of the proposed tasks. Each team work will be supervised by the teacher who, in addition to evaluate the team work, may establish procedures for self and cross evaluation. Tutored works are thought to develop CG4 and CG6 competences, as well as CE34, CE38 and CT2.

Personalized attention

Methodologies	Description
Practice in computer rooms	The teacher will establish mechanisms to determine the degree of understanding of the main concepts by the students.
Tutored works	At the regular team meetings the teacher will track the work of each student. In addition , the teacher will establish additional mechanisms such as, for instance, cross-evaluation of the student work by his/her team mates.

Assessment			
	Description	Qualification	Evaluated Competencess
Tutored works	The evaluation of a team work will be done through the collection of evidences and/or tests during its developement, at personal and group levels, a final report and a presentation and/or test about the work. A final report will be delivered to the teacher around the 13th week of the teaching period. The precise date will be established at the beginning of this period. In order to pass this course a minimum score will be required in the tutored work as explained in the section “Other comments and July evaluation”.	50	CG4 CG6 CE34 CE38 CT2
Short answer tests	Final exam with several questions referred to the contents of the subject. In order to pass this course a minimum score will be required in the final exam as explained in the section “Other comments and July evaluation”.	50	CG4 CG6 CE34 CE37 CE38 CT2

Other comments and July evaluation

The previously proposed evaluation method will apply to students who follow the recommended continuous evaluation (C.E.) procedure.In order to not handicap his potentia lteam mates,the student will have a brief period to decide whether or not follows the C.E. procedure (as an orientation,the first two weeks of the semester). Students attending only the final exam may obtain the maximum grade in the subject. However, these students will have to answer some additional questions related to the proposed team works in order to demonstrate that they have acquired the same skills that students following C.E.

The July evaluation will consist of a final exam, but students who followed C.E. may choose to keep the grade obtained in the team work instead of answering the additional questions related to these works.

Students will pass the course if they get a final mark equal to or greater than 5 (on a ten-points scale) and a score equal to or greater than 4 (on the same scale) in both the tutored work and the final exam. The individual mark of the tutored work will be obtained as the sum of the mark of the individual tests (30% of the grade of the tutored work) and the mark obtained jointly by the group (70%), although the latter will be weighted according to the results of the cross-evaluations and the teacher's opinion about the student's personal contribution to the group work. Normally the weighting factor will be 1, although factors less than 1 will be applied to students that hinder the normal progress of the group or show poor participation or understanding in the tasks of the supervised work. Likewise, the teacher will be able to reward those students who stand out significantly for their contribution to the team work with a weighting factor of up to 1.2, especially in case of unexpected difficulties.

Just in case a student has no grade on the tutored work, or chooses to leave it out at the second call in July, the score obtained in the group of questions related to the tutored work will be considered the grade on the tutored work and the score on the remaining questions will be the final-exam grade. The final mark will be calculated as the sum of the previous scores (tutored work and final exam) achieving 4 points, and dividing this sum by two. In case of not achieving the required 4 points in both parts, the maximum final mark will be 4. If both marks are below 4, the final grade will be the lowest of both marks divided by two.

Sources of information

Basic Bibliography

Andreas Spanias, Ted Painter and Venkatraman Attii, Audio Signal Processing and Coding, Wiley-Interscience, 2007. ISBN: 978-0471791478

Wai C. Chu, Speech Coding Algorithms: Foundation and Evolution of Standardized Coders, John Wiley & Sons, 2003. ISBN: 978-0471373124

X. Lurton, An Introduction to Underwater Acoustics. Principles and Applications, Springer, 2nd edition, 2010. 978-3540784807

Douglas O'Shaughnessy, Speech Communications. Human and Machine, Wiley-IEEE Press, 2nd edition. 1999. ISBN: 978-0780334496.

Boss, M. and Goldberg, R. E., Introduction to digital audio coding and standards, Kluwer Academic Publishers, 2003. ISBN: 978-1-4615-0327-9

Complementary Bibliography

Dutoit, T. and Marqués F., Applied signal processing : a matlab-based proof of concept, Springer, 2009. ISBN: 978-0-387-74534-3

Kuttruff, H., Acoustics. An introduction, Taylor & Francis, 2007.ISBN: 978-0415386807

D. Ensminger and F. B. Stulen, Eds., Ultrasonics. Data, Equations, and Their Practical Uses, CRC Press, 2009. ISBN: 978-0824758301

Recommendations

Subjects that it is recommended to have taken before

Fundamentals of Sound and Image/V05G300V01405
Digital Signal Processing/V05G300V01304

Other comments

It is assumed that the student has some basic skills in Matlab.

IDENTIFYING DATA				
Room Acoustics				
Subject	Room Acoustics			
Code	V05G300V01635			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Sobreira Seoane, Manuel Ángel			
Lecturers	Sobreira Seoane, Manuel Ángel			
E-mail	msobre@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Architectural acoustics, develops the fundamental theoretical principles of the architectural acoustics, in the fields of room acoustics and acoustic isolation. The aims of the subject are: provide a sufficient theoretical background that allow the understanding of the behaviour of the sound filed in rooms; define the parameters that allow to evaluate the acoustic quality of rooms; develop the techniques of design that allow to optimise the acoustic behaviour of rooms; detail the parameters that allow to evaluate the acoustic isolation in buildings and introduce the problematic of the calculation of the acoustic insulation in the buildings and building elements.			

Competencies		
Code		Typology
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.	- know - Know How
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.	- know - Know How
CE36	CE36/SI3 The capacity to implement projects at places and installations for the production and recording of audio and video signals.	- Know How
CE37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.	- Know How

Learning outcomes	
Learning outcomes	Competences
Knowledge on the theoretical fundamentals of room acoustics. Ability to analyse the acoustic behaviour of rooms and identify acoustic problems. Capacity to design solutions to acoustic problems in rooms. Capacity to write expert technical reports on room acoustics measurement test and analysis. Ability to check and assess the acoustic quality of rooms. Capacity to design different kind of rooms matched to the specific acoustic requirements (recording studios, control rooms, conference rooms and classrooms).	CG2 CG5 CE36 CE37

Contents	
Topic	
Introduction	Basic concepts in acoustics. Acoustic power, sound pressure, sound intensity. Levels and decibels.
Statistital theory in acoustics.	Average sound pressure in rooms. Reverberation time: Sabine and Eyring equations.
Absorbents and Acoustic Diffusers.	Porous absorbing materials. Membrane and Helmhotz resonators. Acoustic diffusers.
Wave theory in rooms.	Three dimensional wave equation.Resonant frequencies and resonant modes in rooms. Modal density. Frequency response of rooms. The influence of dimension relations and frequency response.

Geometrical theory.	Method of the virtual image. Reflections in flat surfaces. The acoustic behaviour of curved surfaces
Acoustic design of rooms.	Descriptors of room acoustics. Echoes in rooms. Focalization effects in rooms. Acoustic behaviour of audience: seat dip. Geometrical design of rooms. Design of conference rooms and classrooms. Recording studios: LEDE and Non-Environment design techniques.
Acoustic insulation.	Introduction to the acoustic insulation. Acoustic isolation of single panels. Insulation of double walls. Introduction to the flanking transmission evaluation in buildings. Noise control in buildings.

Planning

	Class hours	Hours outside the classroom	Total hours
Tutored works	7	28	35
Practice in computer rooms	12	9	21
Previous studies / activities	0	15	15
Master Session	19	38	57
Troubleshooting and / or exercises	2	10	12
Short answer tests	2	8	10

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

Methodologies

	Description
Tutored works	The students will have to develop and write a report on three small projects: 1. Design and building Helmholtz and membrane resonators. 2. Design and acoustic measurements on scale models. 3. Software to calculate acoustic reflectors and diffusers Through this methodology the general competencies CG2, CG5 and the specific competency CE36 and CE37 are developed.
Practice in computer rooms	During practical sessions, the student will learn the use use of software to measure and analyse the impulse response of rooms. Through this methodology the general competencies CG5 and the specific competency CE36 and CE37 are developed.
Previous studies / activities	The students must study and prepare with the sources of information given before the lectures and the practical sessions. Through this methodology the general competencies CG2, CG5 and the specific competency CE36 and CE37 are developed.
Master Session	Lectures will be given, developing the main theoretical concepts of the subject. Through this methodology the general competencies CG2, CG5 and the specific competency CE36 and CE37 are developed.

Personalized attention

Methodologies	Description
Master Session	Lectures are develop within a continuous interaction framework, where students can answer questions delivered by the teacher. They could also solve their particular doubts during the sessions.
Tutored works	Tutored works are developed in small working groups. The works are followed during meetings between the groups and the teacher. In those meetings the students can interact and ask their questions to the teacher.
Practice in computer rooms	In practical sessions, each student must solve his/her own tasks. The teacher will be available during the session to solve any problem/question or doubt the student may have.

Assessment

	Description	Qualification	Evaluated Competencess
Tutored works	Tutored practical project, with the delivery of a final report. The learning aims containing the develompent of the ability to develop projects are assesed through this practical tutored works.	35	CE36 CE37

Practice in computer rooms	Practical tasks, solved in a computer lab with specific acoustic software.	15	CG2 CG5
Troubleshooting and / or exercises	Written examination, solving calculation problems. Evaluation of the learning aims, mainly in those aspects related to "know how to carry calculations out" in the field of room acoustics.	25	CG5
Short answer tests	Short answers related to the theoretical content of the subject. Evaluation of the knowledge of regulations in the matter of room acoustics.	25	CG2

Other comments and July evaluation

Following the guidelines of the degree, two systems of evaluation are offered: continuous assessment (recommended) and a final examination. Evaluation with only a final examination will be only allowed in situations in which it is imposible to follow the system recommended.

CONTINUOUS ASSESSMENT:

In order to be qualiffied following the continuous assessment proccess, the student will have to attend at least to the 80% of the programmed activities. The continuous assessment will be based in the evaluation of practical task, projects and two tests. Once a student has signed a document of agreement with the process of continuous assessment, the final degree will be obtained by the application of the criteria described bellow, even though a student could miss some of the tasks or tests envolved in the process.

The final grade with be obtained from the weighted sum of the grade obtained in the following tasks with the given weights:

1. Tutored works: The students will deliver three reports on tutored works during the weeks 5th, 9th and 14th. The total weight of tutored works on the final grade is 35 %.
2. Reports of practical tasks (Weight: 15 %).
3. Short answer tests : A short answer tests is scheduled around the 6th week. (25 % of the final grade)
4. A second examination, containing problems and exercises is scheduled on the official scheduled date at the end of the semester.(25 % of the final grade)

Tutored works are developed in groups. The final grade will be weighted taking into account the results of a cross assesment survey. To consider as "satiscactory" the contribution of each student to the group a minimum grade of 2 over 5 points is stablished.

The studenst have to show good skills in all the learning outcomes, therefore, four points over a ten points scale must be obtained in all the learning outcomes evaluated during the continuous evaluation process. The final grade will be obtained through the addition of the grades obtained during the process with the weights given before. At least five over ten points should be obtained to pass the subject. It could happen that the minimum grade required for all the learning outcomes (4 points) is not fullfilled and the weighted average calculated if greater than 5 points. In this case, the final grade resulting form the continuous assesment process will be 4 over 10 points.

FINAL EXAMINATION
A final examination in the officeal date scheduled and officially published is available for all the students.

1. Students following the continuous evaluation process, will have the chance to improve their grade. Those students that did not reach the minumum grade required for the practical tasks, should deliver those jobes required for the teachers on the official scheduled date for the final examination.
2. The final examination is also available for those students that for some reason could not follow the continuous evaluation assessment process. In this case the final examination will consist in two short answer tests, and some additional questions related with the practical tasks and projects.

The subject is assessed in a 0 to 10 points scale and it is considered "passed" if the final grade obtained is equal or greater than 5.

SECOND CALL:

There is scheduled date in july for a final examination retake, for those students that either dropped out during the semester or failed. Prior the examination, a student can choose to follow the continuous assessment or the final examination. In the former selection, the grades obtained in the projects and practical tasks will be taken into account and the student will only answer to the short answer tests. If the later, (final examination), the student will have also to answer a full examination as described before. The conditions former described for the Continuous Evaluation asessment are kept in this second call.

Sources of information

Basic Bibliography

Higini Arau, ABC de la acústica arquitectónica, Barcelona : CEAC, D.L. 1999

Heinrich Kuttruff, Room Acoustics, 5, Spon Press

Manuel A. Sobreira, Acústica Arquitectónica (Apuntes de la Asignatura),

Complementary Bibliography

Phillip R. Newell, Recording Studio Design, 3, Focal Press

Lothar Cremer, Principles and applications of room acoustics, London ; New York : Applied Science, cop. 1982

Recommendations

Subjects that continue the syllabus

Advanced acoustics/V05G300V01933
Legislation and noise measurement techniques/V05G300V01934

Subjects that it is recommended to have taken before

Fundamentals of Sound and Image/V05G300V01405
Fundamentals of Acoustics Engineering/V05G300V01531

IDENTIFYING DATA				
Distributed and Concurrent Programming				
Subject	Distributed and Concurrent Programming			
Code	V05G300V01641			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	García Duque, Jorge			
Lecturers	García Duque, Jorge			
E-mail	jgd@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main goal of this subject is to provide the foundations of the synchronisation and communication among processes in centralised and distributed systems.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How - Know be
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CE33	CE33/TEL7 The ability to program network and distributed applications and services.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences
The ability to program network and distributed applications and services.	CG4 CG9 CE33
The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations	CG3 CT2 CT3 CT4
The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	CG4 CG9 CE33

Contents
Topic

Introduction to Concurrent Programming	Concepts of concurrence, parallelism and multitasking. Interleaving of atomic instructions. Precedence graphs.
The critical section problem	The definition of the problem. Busy waiting. Starvation Deadlock. Dekker´s algorithm. Peterson´s algorithm
Concurrent Programming Constructs	Semaphores. The problem of the producer-consumer. The problem of the philosophers. Monitors. Variables of Condition. The problem of the readers-writers.
Deadlock	Introduction and definition of deadlock. Necessary conditions. Deadlock prevention. Deadlock avoidance. Detection and Recovery
Communication among processes	Message Passing. Remote Procedure Call (RPC).
Distributed Programming	Introduction to Distributed Systems. Distributed mutual exclusion Ricart-Agrawala Algorithm. Token ring Algorithms. Consensus: Crash Failures. Byzantine Failures.

Planning

	Class hours	Hours outside the classroom	Total hours
Workshops	5	30	35
Practice in computer rooms	13	26	39
Master Session	20	46	66
Multiple choice tests	1	0	1
Practical tests, real task execution and / or simulated.	1	0	1
Jobs and projects	2	6	8

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

Methodologies

	Description
Workshops	Each group of students will tackle the design and implementation of a software project with half complexity. This task will be realised in successive steps, that will be discussed and validated in the face-to-face sessions. The aim of this methodology is to provide a suitable feedback to improve the proposed solutions. This methodology deals with skills CG4 and CG9
Practice in computer rooms	The students will resolve practical problems under supervision of teachers This methodology deals with skill CE33/TEL7
Master Session	Presentation of the ideas, concepts, technics and algorithms of each lesson. This methodology deals with skill CG3

Personalized attention

Methodologies	Description
Master Session	By means of tutoring
Workshops	Part of the sessions devote to resolve individual questions with each student by means of individual questions so much by part of the professor as of the student

Practice in computer rooms	Of complete way for the students that do the practices of individual way, and by means of the resolution of individual questions with each student by means of questions *individualizadas so much by part of the professor as of the student

Assessment

	Description	Qualification	Evaluated Competencess
Multiple choice tests	Proof of theoretical contents exposed in the master classes.	50	CG3 CG4 CE33 CT2
Practical tests, real task execution and / or simulated.	Evaluation of the work realised in each one of the sessions of laboratory For the individual evaluation of each student will realise personalised questions in each one of the sessions.	20	CG3 CG4 CE33 CT2 CT3
Jobs and projects	In the last face-to-face session of workshop, students will deliver and will expose to their mates the design and the proposed solution for their project. This solution will be exposed to debate for students and professors For the individual evaluation of each student will realise personalised questions in each one of the sessions.	30	CG9 CE33 CT3 CT4

Other comments and July evaluation

The matter can surpass by means of Continuous Evaluation second the criteria that indicate more advance, having opened the possibility to opt by the No Continuous Evaluation anytime until the beginning of the final examination to celebrate the day fixed to such effect in the official calendar of the *EET.

All those students that opt by the continuous evaluation will consider presented evaluate of the part of the work in Workshops.

Continuous evaluation:

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

1. Four proofs of type Test to evaluate the contents given in the masterclasses. Each proof will take place in one of the sessions *magistrales, except the last that will realise in one of the sessions of the Workshop.

Punctuation: Until 1,25 points each proof.

2. Six Practical Proofs that will realise when finalising each one of the sessions of laboratory and that will consist in the **validation of the results obtained during the said session.

Punctuation: Until 1/3 points. Each proof.

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

Punctuation: Until 3 points.

To approve the matter by Continuous Evaluation will have to give the three following conditions:

(*i) Obtain an equal or upper qualification to 2 points in the group of the tests.;
(*ii) Upper qualification to 0 points in, at least, four of the six practical proofs; and
(*iii) Assist to all the face-to-face sessions of workshop and obtain more than 0 points in the presentation of the project.

In case of not fulfilling any of said condition, the final note of the student will be limited to a maximum of 4 points.

Evaluation No Continuous:

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

Announcement of End of Course:

It will govern by the indicated for the No Continuous evaluation .

Sources of information
Basic Bibliography
M. Ben-Ari, Principles of Concurrent And Distributed Programming, Second Edition, Addison Wesley 2006
Complementary Bibliography
George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, Distributed Systems Concepts and Design, Fifth Edition, Addison Wesley 2011
William Stallings, Operating Systems: Internals and Design Principles, 6/E, Eight Edition, Prentice Hall 2014
Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating system concepts, Ninth Edition, Wiley, cop. 2014
Lea, Douglas, Programación concurrente en Java : principios y patrones de diseño, Second Edition, Addison Wesley, 2001

Recommendations

Subjects that are recommended to be taken simultaneously

Architectures and Services/V05G300V01645
Information Systems/V05G300V01644

Subjects that it is recommended to have taken before

Informatics: Computer Architecture/V05G300V01103
Programming I/V05G300V01205
Programming II/V05G300V01302
Operating Systems/V05G300V01541

IDENTIFYING DATA				
Network and Switching Theory				
Subject	Network and Switching Theory			
Code	V05G300V01642			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Suárez González, Andrés			
Lecturers	López García, Cándido Antonio Suárez González, Andrés			
E-mail	asuarez@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The objective pursued with this course is that students acquire mastery of the basic methods of analysis for predicting the performance of networks, services and telecommunication systems, in terms of the amount of traffic they carry, the physical structure of the system and the way it is interconnected, the capacity of its constituent network elements and the algorithms used in them.			

Competencies		
Code		Typology
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.	- know
CE28	CE28/TEL2 The ability to apply the techniques that are basis of computer networks, services and applications, such as management, signaling and switching, routing and securing systems (cryptographic protocols, tunneling, firewalls, charging mechanisms, authentication and content protection) traffic engineering (graph theory, queuing theory and teletraffic) rating, reliability and quality of service in both fixed, mobile, personal, local or long distance environments with different bandwidths, including telephony and data.	- know - Know How
CE31	CE31/TEL5 The ability to follow the technological progress of transmission, switching and processing to improve computer networks and services.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Ability to apply mathematical methods of queueing theory to the analysis and design of telecommunication networks and systems.	CG5 CE28 CE31
Ability to understand the basic compromises in designing telecommunication networks and systems in function of the parameters of traffic.	CG5 CE28 CE31
Ability to use methods of discrete mathematics to resolve problems of routing and interconnection of networks, reliability, quality of service and distribution of contents in wired and wireless networks, fixed and mobile networks, access and transport networks.	CG5 CE28 CE31
Mastery of the necessary basic concepts to resolve problems of resource optimization in networks.	CG5 CE28 CE31

Contents
Topic

Queuing Theory	One-server systems. Finite queue systems. Systems with congestion: models of Erlang and Engset. Reversibility. Networks of queues with product solution. Applications: design of link capacity; design of buffer size; congestion in cellular networks; analysis of systems with priorities; provision of ARQ; provision of multiaccess networks.
Graph theory	Graph traversal and connectivity. Minimum cut, maximum flow. Tree coverage and expansion. Minimum cost trees. Graph coloring. Results and uses. Regular and irregular random graphs: small world networks, scale-free networks. Applications: Network topology design, the web graph, message broadcasting in wired networks and ad hoc networks.
Network Optimization	Utility Maximization. NUM decomposition problems. Applications.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	21	42	63
Practice in computer rooms	4	6	10
Troubleshooting and / or exercises	8	12	20
Projects	7	35	42
Long answer tests and development	2	6	8
Troubleshooting and / or exercises	0	7	7

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

Methodologies

	Description
Master Session	It will present a systematic theoretical approach to the subject, highlighting the objectives, key concepts and relationships between different topics. Students should assimilate knowledge to enable them in the CG5, CE28/TEL2 and CE31/TEL5 competencies.
Practice in computer rooms	Guided practice where it is intended to study problems by both by applying analytical techniques and by using software tools, providing a training in the use of the latter. So students should acquire practical training in the CE28/TEL2 competency.
Troubleshooting and / or exercises	Resolution in detail of a series of selected problems and/or exercises, focused on both the theoretical concepts involved and the methodology to be employed.
Projects	Group work focused on studying and solving a real problem using the techniques studied in theory and the software tool seen in practice. So students should gain practical experience that will enable them on the CE31/TEL5 competency.

Personalized attention

Methodologies	Description
Master Session	The student may consult individually in the tutoring hours all doubts that arise in the study of the theoretical content.
Practice in computer rooms	The student may consult individually both in the practice time and in the tutoring hours all doubts that arise in the use of the software tools of the practices.
Projects	The student may consult individually in the tutoring hours all doubts that arise both in applying the theoretical concepts and in the use of the software tools used in the projects.

Assessment

	Description	Qualification	Evaluated Competencess

Projects	Group work, presentation and defense of the resolution of a typical real-world problem by applying both theoretical knowledge as using, where appropriate, the software tools used in practical classes.	20	CE28 CE31
Long answer tests and development	Partial test developed over the first two themes, around the eighth week of class.	60	CG5 CE28 CE31
Troubleshooting and / or exercises	The student will have to resolve individually two bulletins of problems, corresponding to the first two lessons.	20	CE28

Other comments and July evaluation

It is left to the discretion of the students two alternative evaluation methods in the subject: continuous assessment and one-time evaluation.

Selection of continuous assessment involves conduct of a no-scoring short test (15 minutes) of basic knowledge. It will take place during the first two weeks of class. In addition to this short test, the continuous assessment will consist of the group development of two projects, the individual resolution of two groups of problems on the two first lessons, and the completion of a written exam about the full subject at the end of the quarter. Projects will be presented during the last class C. During these expositions there will be also personal interviews with each one of the group members. The personal qualification of the project will depend on both this interview and the project exposition and report. The rating of the projects and of the exercises is effective only in the course they are proposed, including the second opportunity at the end of the academic year. In any case, the score on the continuous assessment evaluation (once the requirement at the beginning of this paragraph is met) is given by: score = 0.2 x projects + 0.8 x maximum (exam, 0.2 x exercises + 0.6 x exam).

The one-time assessment will consist of a written examination on the contents of the subject. The final grade will be the score obtained in this exam. This exam will include (one-time assessment) one or several questions about the computer tools presented in the laboratory, evaluating a minimum on the CE28/TEL2 competency.

All students who have attended the final exam will be subjected to a final qualification. Continuous evaluation is selected for when delivering the two projects. Those who fail the course at the first opportunity at the quarter end have a second at the end of the academic year, similar to the first call.

Sources of information

Basic Bibliography

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

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

Complementary Bibliography

Villy B. Iversen, TELETRAFFIC ENGINEERING and NETWORK PLANNING, 2011, web

Boyd, S., Vandenberghe, L., Convex Optimization, 2009, web

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Probability and Statistics/V05G300V01204
Data Communication/V05G300V01301
Computer Networks/V05G300V01403

IDENTIFYING DATA				
Multimedia Networks				
Subject	Multimedia Networks			
Code	V05G300V01643			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Herrería Alonso, Sergio			
Lecturers	Herrería Alonso, Sergio López García, Cándido Antonio			
E-mail	sha@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject presents the main specific technological solutions for distributing multimedia contents over telecommunication networks.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- Know How
CE30	CE30/TEL4 The ability to describe, program, assess and optimize communication protocols and interfaces at different network architecture layers .	- know - Know How
CE33	CE33/TEL7 The ability to program network and distributed applications and services.	- Know How
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be

Learning outcomes	
Learning outcomes	Competences
The comprehension of basic concepts in digital encoding of audio and video.	CG3
The knowledge of the main standards in the field of digital encoding of audio and video.	CG6
The knowledge and comprehension of the main problems raised in the transmission of multimedia contents.	CG3 CE30 CT3
The knowledge of the main protocols used for the transmission of multimedia contents.	CE30
The knowledge and comprehension of the main techniques used to provide quality of service in Internet.	CG3 CE30 CT3
The ability to analyze and develop VoIP networks.	CE30 CE33

Contents	
Topic	
Encoding of digital audio and video	a) Digital audio (PCM). Audio compression b) Digital video. Intraframe and interframe compression
Multimedia applications	a) Classes. Quality of service (QoS) requirements b) Impact of delay and packet losses c) Content distribution. Multicast. CDN d) IP telephony: architecture, codecs, softphones, softswitches...
Multimedia protocols	a) Transport protocols: TCP/UDP, RTP, HTTP b) Adaptive streaming. MPEG-DASH c) Session protocols: SIP, H.323, RTSP

Quality of service in the Internet	a) Monitoring and policing techniques b) Scheduling and resource allocation c) Differentiated Services (DiffServ) d) Integrated Services (IntServ). RSVP

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	20	40	60
Practice in computer rooms	12	18	30
Tutored works	6	24	30
Troubleshooting and / or exercises	1	5	6
Jobs and projects	1	5	6
Troubleshooting and / or exercises	2	16	18

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

Methodologies

	Description
Master Session	Exhibition of the ideas, concepts and techniques of each topic of the course. In these sessions, students must acquire competences CG3, CG6, CE30 and CT3.
Practice in computer rooms	Practical learning of basic tools for the distribution of multimedia contents on computer networks. In these sessions, students must acquire competences CE30 and CE33.
Tutored works	Configuration, with the teacher's guidance, of a basic IP PBX. This work should help students to acquire competence CE33.

Personalized attention

Methodologies	Description
Master Session	It will be dispensed personalized attention during the office hours that will be announced at the beginning of the course. There is no appointment necessary.
Practice in computer rooms	It will be dispensed personalized attention during the office hours that will be announced at the beginning of the course. There is no appointment necessary.
Tutored works	It will be dispensed personalized attention during the office hours that will be announced at the beginning of the course. There is no appointment necessary.

Assessment

	Description	Qualification	Evaluated Competencess
Troubleshooting and / or exercises	Midterm exam covering some of the contents of the subject. Questions and problems of conceptual, logical, analytical or applied character. One hour long written exercise.	20	CG3 CG6 CE30
Jobs and projects	Evaluation of the features and performance of the IP PBX configured by the student during the course.	20	CE33
Troubleshooting and / or exercises	Final exam covering all the contents of the subject. Questions and problems of conceptual, logical, analytical or applied character. Two hour long written exercise.	60	CG3 CG6 CE30

Other comments and July evaluation

Two different methods of evaluation will be offered to the students: continuous evaluation and evaluation at the end of the course.

Students opting for the continuous evaluation method must take two intermediate tasks: a midterm exam around week 8 of the course (20% of the final grade) and a project involving the configuration of a basic IP PBX around week 14 of the course (20% of the final grade), together with a final exam at the end of the course (60% of the final grade). If the score of the final exam is less than 3.5/10, then the final grade of the subject will be the score obtained in this final exam. The score of the project will take into account both the features and performance of the IP PBX configured (75%) and the responses to a practical exam that must be solved individually (25%). Both intermediate tasks are not recoverable and will be only valid for the current course.

Students can also opt for being evaluated by means of just a final exam at the end of the course. The final grade of the subject will be, in this case, just the score obtained in this exam.

It will be considered that a student opts for the continuous evaluation method if he takes the midterm exam or the project proposed. The final exam will contain some additional questions for those students that have opted by the evaluation at the end of the course.

If plagiarism is detected in any of the tasks proposed (exams or project), the involved students will be failed with a final grade of 0.

Those students that have not passed the subject in first call will have to take an extra written exam in July. Those students that opted for the continuous evaluation method will be able to choose between evaluation by means of just the final exam or to keep continuous evaluation. In the latter case they would keep the scores obtained in the intermediate tasks (midterm exam and project) and would only have to take the final exam as the last task. Students must indicate which method they choose at the final exam.

Sources of information
Basic Bibliography
J. F. Kurose, K. W. Ross, Computer networking: a top-down approach, 7ª ed., Pearson, 2016,
Kun I. Park, QoS in packet networks, 1ª ed., Springer, 2005,
R. Bryant, L. Madsen, J. Van Meggelen, Asterisk: the definitive guide, 4ª ed., O'Reilly Media, 2013,
Complementary Bibliography
H. W. Barz, G. A. Bassett, Multimedia networks: protocols, design, and applications, 1ª ed., Wiley, 2016,
M. Barreiros, P. Lundqvist, QoS-enabled networks: tools and foundations, 2ª ed., Wiley, 2016,
Bruce Hartpence, Packet Guide to Voice over IP, 1ª ed., O'Reilly Media, 2013,
S. Wintermeyer, S. Bosch, Practical Asterisk 1.4 and 1.6, 1ª ed., Addison-Wesley, 2010,
Alan B. Johnston, SIP: Understanding the Session Initiation Protocol, 4ª ed., Artech House Publishers, 2015,

Recommendations
Subjects that continue the syllabus
Multimedia services/V05G300V01941

Subjects that it is recommended to have taken before
Fundamentals of Sound and Image/V05G300V01405 Computer Networks/V05G300V01403

IDENTIFYING DATA				
Information Systems				
Subject	Information Systems			
Code	V05G300V01644			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Ramos Cabrer, Manuel			
Lecturers	Pazos Arias, José Juan Ramos Cabrer, Manuel			
E-mail	mramos@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The aim of this subject is to introduce to the student in the main technologies to process and store the information, like central element of the telematic services			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How - Know be
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CE27	CE27/TEL1The ability to construct, operate and manage telecommunication networks, services, processes and applications considered as systems to receive, transport, represent, process, store, manage and present multimedia information from the computer services point of view.	- know - Know How
CE29	CE29/TEL3 The ability to build, operate and manage computer services using planning, sizing and analytical tools	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know How - Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know - Know How - Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Know the main mechanisms of organisation of the information for their storage and process.	CE27
Know the main mechanisms of research, recovery and presentation of the information.	CE27
Comprise the concept of metainformatión and its main applications in the new telematic services.	CE27
Capacity to design and implement a database using current models.	CE29
Comprise the importance of information management like a basic support element for telematic services.	CG3 CE29 CT3
Skill to select the mechanisms of information management more suitable for a problem.	CG4 CG6 CE27 CT2

Capacity to build telematic services based in stored information.	CG4 CG6 CG9 CE29 CT2 CT4

Contents

Topic	
Introduction and general perspective of the Systems of Information.	- Concepts of system of information and database. - Types of systems of information. - Concept of Managing System of Databases. - Models of databases. - The process of design of a database.
Design of Relational Databases: Conceptual Model.	- Aims of the conceptual design. - Conceptual models of databases. - The E-A model.
Design of Relational Databases: Logical Model.	- Concept of the logical design. - Logical models of databases. - The relational model. - Relational algebra. - Normalisation of databases.
Database Management Systems.	- Physical storage of the data. - Organisation of data in files. - Indexes and associations. - Management of the integrity of the data. - Consistency. - Concepts related with the security. - Optimisation of queries.
Other information systems.	- No relational databases. - Semistructured information Processing. - No-structured information Processing. - Semantic information processing.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	20	46	66
Practice in computer rooms	13	26	39
Workshops	5	30	35
Short answer tests	1	0	1
Practical tests, real task execution and / or simulated.	1	0	1
Jobs and projects	2	6	8

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

Methodologies

	Description
Master Session	Presentation of the ideas, concepts, technics and algorithms of each lesson. This activity develops CG3, CG4, CG6, CT2 and CT3 competencies.
Practice in computer rooms	The students will resolve practical problems under supervision of teachers. This activity develops CG4, CT2, CE29 and CE27 competencies.
Workshops	Each group of students will tackle the design and implementation of a software project with half complexity. This task will be realised in successive steps, that will be discussed and validated in the face-to-face sessions. The aim of this methodology is to provide a suitable feedback to improve the proposed solutions. This activity develops CG4, CG9, CT2, CT4 and CE27 competencies.

Personalized attention

Methodologies	Description

Workshops	The professor will be present during the realisation of the workshops, answering all the doubts that can arise to the students.
Practice in computer rooms	The professor will be present during the realisation of the practices, answering all the doubts that can arise to the students.
Master Session	In the development of the master sessions, the students will be able to interrupt and formulate all the questions or doubts that can arise them.

Assessment

	Description	Qualification	Evaluated Competencess
Short answer tests	Proof of theoretical contents exposed in the master classes.	60	CG3 CG4 CG6 CT2 CT3
Practical tests, real task execution and / or simulated.	Evaluation of the work realised in the sessions of laboratory.	20	CG4 CE27 CE29 CT2
Jobs and projects	In the last face-to-face session of workshop, students will deliver and will expose to their mates the design and the proposed solution for their project. This solution will be exposed to debate for students and professors. The professor will do questions for each member of the group, what will allow his individual evaluation.	20	CG4 CG9 CE27 CT2 CT4

Other comments and July evaluation

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

Continuous evaluation:

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

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

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

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

Punctuation: Up to 2 points. (L)

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

Punctuation: Up to 2 points. (P)

To pass the subject by Continuous Evaluation will have to give the three following conditions: (i) obtain an equal or upper qualification to 2 points in the group of the tests.; (ii) Upper qualification to 0.75 points in the practical proof; and (iii) to attend all the face-to-face sessions and obtain more than 0 points in the presentation of the project. In the case to fulfil the three previous conditions, the final mark of the continuous evaluation will be the sum of the three components (Mark=T+L+P). If the student does not fulfil any of the three conditions, the mark of the continuous evaluation will be the minimum of the marks obtained in each one of the three components (Mark=min(T,L,P))

No Continuous Evaluation:

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

Final Call:

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

Sources of information

Basic Bibliography

Abraham Silberschatz, Henry Korth y S. Sudarshan, Database System Concepts, 6, McGraw-Hill, 2010, .

Anthony Molinaro, SQL Cookbook, 1, O'Reilly Media, 2005, .

Complementary Bibliography

Ramez Elmasri y Shamkant Navathe, Fundamentals of Database Systems”, 6, Addison Wesley, 2010, .

Hector Garcia-Molina, Jeffrey D. Ullman y Jennifer Widom, Database Systems: The Complete Book”, 2, Prentice Hall, 2008, .

Jeffrey D. Ullman y Jennifer Widom, A First Course in Database Systems, 3, Prentice Hall, 2007, .

Chris J. Date, An Introduction to Database Systems, 8, Addison Wesley, 2003, .

Chris J. Date, Database Design and Relational Theory: Normal Forms and All That Jazz, 1, O'Reilly Media, 2012, .

Clare Churcher, Beginning Database Design: From Novice to Professional, 1, Apress, 2007, .

Rick A Morelan, Beginning SQL Joes 2 Pros: The SQL Hands-On Guide for Beginners, 1, BookSurge Publishing., 2009, .

Recommendations

Subjects that are recommended to be taken simultaneously

Architectures and Services/V05G300V01645

Distributed and Concurrent Programming/V05G300V01641

Subjects that it is recommended to have taken before

Programming II/V05G300V01302

Internet Services/V05G300V01501

Operating Systems/V05G300V01541

IDENTIFYING DATA				
Architectures and Services				
Subject	Architectures and Services			
Code	V05G300V01645			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Fernández Vilas, Ana			
Lecturers	Castro Jul, Fátima Fernández Vilas, Ana			
E-mail	avilas@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course focuses on the architectonic solutions for the design of distributed systems. More specifically, the course is oriented to sscenarios based on services (service-oriented architectures) and the deploymen SOA solutions by means of Web Services Technologies (WS-*). Taking the WS-* stack as our techonologcal layout, the course lokks through the description, discovery and invocation of services in an SOA. Finally, The course introduces models for services composition in SOA (again using Web Services as deployment technology).			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- Know be
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know be
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	
CE29	CE29/TEL3 The ability to build, operate and manage computer services using planning, sizing and analytical tools	- Know be
CE32	CE32/TEL6 The ability to design networks and service architectures.	- Know be
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be

Learning outcomes	
Learning outcomes	Competences
To know the main architectures for telematic services of medium & high complexity.	CG3 CG6 CE29 CE32 CT2 CT3
To Understand the concept of middleware as a supporting element for services, and to know the main models used today.	CG3 CE29 CE32
To understand the importance and utility of web services for the development of telematic services.	CG6 CE29 CE32
To know the main technologies to build complex services by combining other services.	CG6 CE29 CE32

To master the basic concepts and technologies associated with the management of services and their security.	CG3 CE29 CE32
To Acquire skills to build complex telematic services.	CG4 CT2 CT3

Contents	
Topic	
Introduction	• Distributed Systems. • Client-server Model: RPC. • Message Middlewares. • Web Services and SaaS. • SOA : Roles, operations, layers.
Web Services	• Simple SOA with REST. • API Styles for Web Services. • RPC, messages and resources APIs. • Stack of Web Services technologies.
Technological Basis	• Review of XML. • SOAP Protocol & Messages. • WSDL: Description of Services. • Services Discovery.
Designing Services	• Design of Web Services. • Web Service LifeCycle. • Implementation Axis2.
Composing Services	• Model of composition • Orchestration and choreography • Orchestration with WS-BPEL • Description of choreography: WS-CDL
Addressing services	• Introduction to WS-Addressing. • Routing SOAP messages • Notification services.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	19	38	57
Practice in computer rooms	10	20	30
Troubleshooting and / or exercises	3	6	9
Projects	2	22	24
Presentations / exhibitions	2	8	10
Practical tests, real task execution and / or simulated.	4	8	12
Long answer tests and development	2	6	8

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

Methodologies	
	Description
Master Session	Classes that will combine the exhibition of the concepts and small exercises. These will be resolved by the teachervor by the students individually and/or in groups. The aim is to boost the debate in the class and reinforce the acquisition of skills. COMPETENCES: CG3, CE29, CE32
Practice in computer rooms	During all the course, the lab sessions will be devoted to the development of small prototypes that allow to materialise the fundamental concepts of the course. COMPETENCES: CG4, CG6
Troubleshooting and / or exercises	In the laboratory or in the classroom, the professor will pose small challenges that will be resolved collectively so that the students can discuss abouth the underlying concepts and the different options. COMPETENCES: CG3, CG4.

Projects	The students, in groups, will develop a software system whose requirements will be established in the 9th week of the teaching period. The follow-up of the project will be carried out during the workshops. COMPETENCES: CE29, CE32, CT2, CT3
Presentations / exhibitions	Each workhroup will justify in a oral presentation the adopted solution for the course project. The presentation will take place the last week of the teaching period. COMPETENCES: CG4, CT2, CT3

Personalized attention

Methodologies	Description
Projects	The students, organized in groups, develop a project that addresses the design and implementation of a distributed service-oriented architecture. Personalized attention related to these projects will take place in the sessions type C in the course. In each session of personalized attention, groups would discuss with the teacher the following questions concerning the progress of the project: what work has been addressed since the previous meeting? What problems have been found? What problems have not been solved? and what is the planning of future work?

Assessment

	Description	Qualification	Evaluated Competencess
Presentations / exhibitions	Each workgroup will justify in an oral presentation the solution adopted in his project. The presentation will take place the last week of the teaching period with the professors of the course.	10	CG4 CT2 CT3
Projects	Each workgroup will deliver a preliminary design (week 9) and the implementation of the course project during the penultimate week of the teaching period. The delivery will consist of the design, implementation and documentation. After delivering the project, a practical test will be performed (last week of the course) on the project implemented by each of the groups .	20	CG4 CG6 CE32 CT2 CT3
Practical tests, real task execution and / or simulated.	One individual practical tests will be made in Week 5 of the teaching period. Each student will carry out an exercise to demonstrate competence in the use of course technologies in a practical setting .	10	CG6 CE29
Long answer tests and development	Individual writing test will take place in the date indicated in the official calendar of exams. Books, class notes and other matrial will not be allowed during the exam.	60	CG3 CE29 CE32

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 5th week. Once a student selects “continuous evaluation” (having done the first intermediate practical assignment) his/her mark will never be “not taken”.

Final mark will be calculated using the weighted geometric mean formula with two partial results: (i) written exam (60%) and (ii) practical assignments (40%).

- The written exam will take place when and where the official calendar specifies.
- Practical assignments:
  1. **Continuous assessment:** 1 intermediate assignment on 5th week (10%) and the course project: design (week 9, 5%) and implementation (week 13, 25%).
  2. **Final assessment:** Project Design and implementation on week 13

Extraordinary assessment scheme is exactly the same as the final assessment.

Sources of information

Basic Bibliography

Michael Papazoglou, Web Services & SOA: Principles and Technology, 1, Pearson Education, 2012,

Deepal Jayasinghe, Arkham Azeez, Apache Axis2 Web Services, 2, Packt Publishing, 2011,

Complementary Bibliography

Steve Graham, Doug Davis, Simeon Simeonov, Glen Daniels, Peter Brittenham, Yuichi Nakamura, Paul Fre, Building Web Services with Java: Making Sense of XML, SOAP, WSDL, and UDDI, 1, Sams, 2004,

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

Eric Newcomer, Understanding Web Services: XML, WSDL, SOAP, and UDDI, 1, Addison-Wesley Professional, 2002,

Mark D. Hansen, SOA Using Java Web Services, 1, Prentice Hall, 2007,

George F. Coulouris, Distributed Systems: Concepts and Design, 5, Addison Wesley, 2011,

Harvey M. Deitel, Paul J. Deitel, B. DuWaldt, L. K. Trees, Web Services: A Technical Introduction, 1, Prentice Hall, 2002,

Robert Daigneau, Service Design Patterns: Fundamental Design Solutions for SOAP/WSDL and RESTful Web Services, 1, Addison-Wesley Professional, 2011,

Nicolai M. Josuttis, SOA in Practice: The Art of Distributed System Design (Theory in Practice), 1, O'Reilly Half, 2007,

Binildas To. Christudas, Service Oriented Architecture with Java: Using SOA and Web Services to build powerful Java applications, 1, Packt Publishing, 2008,

Michael Rosen, Applied SOA: Service-Oriented Architecture and Design Strategies, 1, Wiley, 2008,

Thomas Erl, SOA Principles of Service Design, 1, Prentice Hall, 2007,

Thomas Erl, Service-Oriented Architecture (SOA): Concepts, Technology, and Design, 1, Prentice Hall, 2005,

Recommendations

Subjects that are recommended to be taken simultaneously

Distributed and Concurrent Programming/V05G300V01641

Information Systems/V05G300V01644

Subjects that it is recommended to have taken before

Internet Services/V05G300V01501

IDENTIFYING DATA				
Technology Management				
Subject	Technology Management			
Code	V05G300V01801			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Mandatory	4th	2nd
Teaching language	Spanish English			
Department				
Coordinator	González Castaño, Francisco Javier			
Lecturers	Docio Fernández, Laura Fernández Vilas, Ana González Castaño, Francisco Javier López Ardao, José Carlos Ramos Merino, Mateo			
E-mail	javier@det.uvigo.es			
Web	http://http://faitic.uvigo.es			
General description	This course provides skills in design, management and leadership of technological projects. This includes detection of needs, technological surveys, team creativity techniques, project management, property definition and protection, and business models. The course is taught in Spanish and English.			

Competencies		
Code		Typology
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.	- know
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.	- know
CE54	(CE54/PY1) The ability to elaborate the proposal of technical projects according to the specified requirements in a public competitive bidding.	- know
CE55	(CE55/PY2) The ability for technical direction of telecommunication project.	- know - Know How
CE56	(CE56/PY3) The ability to manage telecommunication project human resources and economic.	- know - Know How
CE57	(CE57/PY4) The ability to elaborate technical reports and for the follow up of a telecommunication project.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
- To analyze the technical and economic feasibility of a project. Project budgets.	CG7 CG8 CE55 CE56
- Learn how to find statistical information and indicators - Learn how to perform technological surveys and consulting	CE57
- Learn how to apply the main certification regulations	CG8
- Project reporting	CE54 CE55 CE56 CE57
- Project planning and management	CG8 CE54 CE55 CE56
- Sociological and human aspects of projects.	CE55 CE56

- Telecommunciations, safety and environmental regulations	CG7 CE54
- To develop models for the creation of entreprises, products and services - To propose business models in telecommunications	CG8 CE55 CE56

Contents	
Topic	
Project design and management	- Definition of technical goals - Translating goals into tasks - Planning the project - Project resources - Human team. R&D profiles - Budget - Tracking project evolution
Identifying and interpreting needs	- Gathering requisites - Translating needs into technical objectives - Technological perspective. Hype cycles - Sources and methods for technical surveys
Creativity techniques	- Research, development and innovation - Team methods to boost creativity - Is my idea original? Formulating and evaluating it
Collaborative Tools	- Purpose - Tools - Tool-assisted collaborative techniques
Legal aspects	- Types of property: Intellectual and industrial - Technological actives vs. legal property. Models, patents. Licenses - Spanish case/international case. Europe and the US. Internationalization hints - CIN/352/2009 regulation
Business models. Entrepeneurship.	- Product proposal - Risk analysis - Customer survey - From the idea to the business plan - First steps towards the creation of an enterprise
(*)-	(*)-

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	24	38	62
Projects	4	20	24
Practice in computer rooms	28	36	64

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

Methodologies	
	Description
Master Session	Oral presentation of the main concepts of the course by the professors, supported by multimedia. Lectures by experts. Through this methodology the competencies CG7, CG8, CE54, CE55, CE56 and CE57 are developed.
Projects	Group project to be presented during class hours A of the last week. Through this methodology the competencies CE54, CE55, CE56 and CE57 are developed.
Practice in computer rooms	Practice on aspects of specification of requisites, creativity and project design and tracking using computer tools. Through this methodology the competencies CE54, CE55, CE56 and CE57 are developed.

Personalized attention

Methodologies	Description
Master Session	The professors will be available during tutoring hours to clarify any doubts on master session contents. Tutoring hours will be published at the beginning of the course.
Projects	All techniques in the course will be applied to the creation and planning of a project. The project will be performed in groups. At the beginning of the course, the professors will notify a working field for the course (ex. medical applications, intelligent furniture). Projects will focus on product proposals in that specific working field. Nevertheless, the professors will track individual performance, and at the final defence there may be individual questions. Personalized individual attention on these aspects will take place during official tutoring times or via e-mail at any time.

Assessment

	Description	Qualification	Evaluated Competencess
Master Session	Exam	40	CG7 CG8 CE54 CE55 CE56 CE57
Practice in computer rooms	Evaluation of partial results+exam	20	CE55 CE56 CE57
Projects	Individual defense (commitee)	40	CE55 CE56 CE57

Other comments and July evaluation

Continuous evaluation consists of:

· Individual exam (Maximum 4 points). Official calendar.

· Intermediate practical test (Maximum 2 points).

· Final project (Maximum 4 points).

To pass the course, the final student score (as the sum of the previous activities) must be 5 points or more. Maximum score is 10 points.

The project will be performed in groups. Individual scores will be assigned according to student interaction in B hours and the part corresponding to each student in the public project defence.

FINAL EVALUATION:

It will consist in an exam with theoretical and practical parts in the official date. The practical part will cover the same content as the continuous evaluation along the course.

Sources of information

Basic Bibliography

Carl Chatfield,Timothy Johnson, Microsoft Project 2013 Step by Step, 1, Microsoft Press, 2013,

Complementary Bibliography

Michael Michalko, Thinkertoys: A Handbook of Creative Thinking Techniques, 2, Ten Speed Press, 2006,

Alexander Osterwalder, Yves Pigneur, Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, 1, John Wiley and Sons, 2010,

Edward de Bono, Six Thinking Hats, 2, Back Bay Books, 1999,

Recommendations

IDENTIFYING DATA				
Projects Lab				
Subject	Projects Lab			
Code	V05G300V01802			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	12	Mandatory	4th	2nd
Teaching language	Spanish Galician English			
Department				
Coordinator	Caeiro Rodríguez, Manuel			
Lecturers	Álvarez Sabucedo, Luis Modesto Caeiro Rodríguez, Manuel Cardenal López, Antonio José Costa Montenegro, Enrique Eguizábal Gándara, Luis Eduardo González Valdés, Borja López Nores, Martín Lorenzo Rodríguez, María Edita de Machado Domínguez, Fernando Martín Herrero, Julio Mikic Fonte, Fernando Ariel Pérez Estévez, Diego Poza González, Francisco Prol Rodríguez, Miguel Raña García, Herminio José Rodríguez Rodríguez, José Luis Sánchez Real, Francisco Javier Santos Gago, Juan Manuel Torres Guijarro, María Soledad Valdés Peña, María Dolores			
E-mail	manuel.caeiro@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Interdisiciplinary projects must be addressed by a team of students who must represent at least two of the four technologies of the Telecommunication Technologies Engineering Degree. The teams are supervised by two faculty members from different Departments to enrich and facilitate the cross-fertilization between different areas of work. The work developed by the different teams will be defended at the end of the course as part of the evaluation process. The teaching language is Spanish, Galician or English.			

Competencies		
Code		Typology
CG1	CG1: The ability to write, develop and sign projects in the field of Telecommunication Engineering, according to the knowledge acquired as considered in section 5 of this Law, the conception and development or operation of networks, services and applications of Telecommunication and Electronics.	- Know How
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- Know How
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.	- know
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.	- know
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know be

CG11	CG11 To approach a new problem considering first the essential and then the secondary aspects	- Know How
CG12	CG12 The development of discussion ability about technical subjects	- Know be
CE54	(CE54/PY1) The ability to elaborate the proposal of technical projects according to the specified requirements in a public competitive bidding.	- know
CE55	(CE55/PY2) The ability for technical direction of telecommunication project.	- Know be
CE56	(CE56/PY3) The ability to manage telecommunication project human resources and economic.	- Know be
CE57	(CE57/PY4) The ability to elaborate technical reports and for the follow up of a telecommunication project.	- Know How
CT1	CT1 Development of sufficient autonomy to carry out works within the area of Telecommunications in interdisciplinary contexts.	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How

Learning outcomes

Learning outcomes	Competences
Learn to work in group in a medium term project	CG1 CG4 CG6 CG8 CG9 CG11 CG12 CE54 CE56 CE57 CT4
Plan the development of a team project	CG9 CG11 CE55 CE56 CE57 CT4
Integrate the required skills in a multidisciplinary team	CG4 CG9 CG12 CE56 CT1 CT4
Keep a dynamic attitude and foster an on-going improvement effort	CG1 CG4 CG7 CG9 CT1 CT2

Contents

Topic	
Team work	The contents for each team will be specific of the project developed. In any case, they will be multidisciplinary contents. As an example, in the school web page is available the list of projects developed in previous years. See at http://teleco.uvigo.es/index.php/es/estudios/gett/planificacion-academica/lpro
Technical edition	Executive report Stages in report development
Project development	Introduction to project development methodologies such as, Design Thinking, Lean and Agile, where key principles are introduced: focus on the final user, rapid prototyping, to provide value to the client from the beginning, communication, etc.

Public presentations	Key elements in a presentation. Hints to perform an effective presentation. How to prepare a good presentation: - Strategy - Structure - Examples - Issues to take into account

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	0	2
Classroom work	4	4	8
Projects	14	244	258
Presentations / exhibitions	8	24	32

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

Methodologies

	Description
Introductory activities	Some practical hints on skills such as oral and written presentation, and team working. Competences CT1, CT2 and CT4 are developed here.
Classroom work	Partial review of the different projects evolution, with short presentations and discussions. Competences CG9, CG11 and CG12 are developed here.
Projects	This is the core of the course: the team of students must address a project, either proposed by them or by two faculty members. During the duration of the course the team members must work in close cooperation to achieve the objectives of the project; the supervision is such that a weekly one hour meeting willl take place with one or both advisors. It is recommended the creation of a web site, such as a wiki, blog or similar, for each team to document and show the works developed during the term. All members of the team must be able to defend its project at the end of the course in both oral and two public poster sessions. Competences CG1, CG4, CG6, CG7, CG8, CG9, CG11, CG12, CE54, CE55, CE56 and CE57 are developed here.
Presentations / exhibitions	Every team must defend its project in a final oral presentation and in two poster sessions, known as LPRO DAYS. The oral presentation can be made by one or more members of the team, and must include evidences to show proof of the work developed and achieved results. At the end of the presentation all members must be available for Q&A. The poster sessions require the presence of all members of the team. A summary of the work must be submitted to the evaluation committee three days in advance. Competences CG9 and CG12 are developed here.

Personalized attention

Methodologies	Description
Introductory activities	Subject teachers will be available during tutoring hours to solve any doubts and issues about theses activities. Teachers will establish timetables for this purpose at the beginning of the term.
Projects	Each team will have the support of their tutors for the development of the project and to solve any doubts and issues about it in tutoring hours. Teachers will establish timetables for this purpose at the beginning of the term.
Classroom work	Subject teachers will be available to solve any doubts and issues about the development of these tasks during tutoring hours. Teachers will establish timetables for this purpose at the beginning of the term.

Assessment

	Description	Qualification	Evaluated Competencess

Presentations / exhibitions	A portion of the final grade will be based on the committee evaluation during the LPRO DAYS. The attendance to these days will be mandatory for all students. They must submit an executive summary of the project at least three days in advance to help assess their work. This part of the assessment will be made taking into account the summary of the project, the presentation, the poster and the work performed during the LPRO DAYS. The members of the evaluation committee will be the instructors of the Type-A ECTS, as long as they are not involved in the supervision of any project. Otherwise, additional assistance for the evaluation of those conflicting projects will be requested from other instructors from the course. Although the grade is expected to be similar for the entire group as a general principle, exceptions might apply. Thus, especially underperforming students not contributing to the team effort can get a different grade. Similarly, students contributing well above the average of the group can get a higher grade.	35	CG1 CG7 CG9 CG12 CT2
Projects	A portion of the final grade will be based on: 1. Advisors recommendations. For an adequate tracking of the project development, advisors will request different pieces of evidence, both oral and/or written, including partial and/or final reports. Each pair of advisors must submit a justified recommendation to the committee as to the team work methodology and the performance of the team members in the accomplishment of the project goals. Competences CG1, CG4, CG6, CG7, CG8, CG11, CG12, CE54, CE55, CE56, CE57 will be evaluated here. 2. Group mates. A peer review among the team members will be also requested as additional evidence for competences CG9, CT1, CT4.	65	CG1 CG4 CG6 CG7 CG8 CG9 CG11 CG12 CE54 CE55 CE56 CE57 CT1 CT4

Other comments and July evaluation

It is mandatory the attendance to the 80% of the face to face sessions during the term, both in type-A and Type-C academic activities.

Final presentations are allowed in Galician, Spanish or English. In any case, those students that decide to take the course in English should participate always in the English activities.

Those teams not getting the minimum grade to pass the course will have some additional weeks till the allocated date in the second call to present their work again. If the performance of a given student is graded differently from his/her team-mates, and this leads to failing the course, then he/she will need to show a comprehensive domain of the project developed by his/her team in the second call, together with sufficient additional contributions of his/her own.

Sources of information

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Complementary Bibliography

Jim Highsmith e Ken schwaber, Lean Software Development. An Agile Toolkit, 1, Addison Wesley, 2003, Indiana

Recommendations

Subjects that are recommended to be taken simultaneously

Technology Management/V05G300V01801

Other comments

This subject involves a high workload for the students outside of the classrooms related to the development of the projects: 244 hours. This effort is not just required individually, but also for the team as a joint group. In addition, it is important to have time availability to maintain meetings and perform group activities. Therefore, it is highly recommended to take this subject just with the subjects included in the second semester of the fourth year (DTEC and TFG) or equivalent. It is recommended to inform about subjects of other courses taken simultaneously with LPRO.

The work teams of this subject are multidisciplinary taking into account the 4 specializations of the degree. As a generic rule, if possible, teams cannot involve more than 3 students of the same specialization and students of 3 different specializations will be involved.

IDENTIFYING DATA				
Remote sensing				
Subject	Remote sensing			
Code	V05G300V01911			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Cuiñas Gómez, Íñigo			
Lecturers	Cuiñas Gómez, Íñigo Díaz Otero, Francisco Javier Martín Rodríguez, Fernando Torío Gómez, Pablo			
E-mail	inhigo@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Remote Sensing is the topic devoted to all systems that allow the collection of data about object or surface characteristics without physical contact. This topic presents the basic principles of Remote Sensing, both in visible and infrared spectrum, and in microwaves. Special care will be put on active and passive sensors, with a deep explanation of RADAR and optic-electronic systems. The topic involves technological elements and signal processing, with a focus on the applications. The topic is going to be taught in English.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.	- know - Know be
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CE65	(CE65/OP8)Applying conceptual, theoretical and practical tools of telecommunications in the development and applications of radar and remote sensing systems.	- Know How
CE66	(CE66/OP9) The ability for selection of circuits, subsystems and systems of remote sensing.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- know - Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Identify and analyse problems that can be solved with Remote Sensing techniques	CG3 CG4 CG9 CE65 CT4

Propose solutions based on RADAR, microwaves, infrared, LIDAR or visible spectrum observation	CG3 CG4 CG9 CE66 CT3 CT4
Specify sensors and Remote Sensing systems more adequate for each application	CG3 CG7 CE65 CE66 CT2
Interpret and analyse images taken from satellites	CG3 CG4 CG7 CE65 CT2

Contents	
Topic	
Introduction to Remote Sensing	The aim of this topic is to provide the students with a panoramic of the meaning and application of remote sensing of earth, sea and air. Special attention is given to different points of view between our usual perception of the Earth and its appearance when it is observed from a satellite or another airlifted platform. Besides, the subject shows the historical evolution of Remote Sensing and its implication in the human life, standing out the hits of the space exploration and the different programs that have been designed. The contents given in group A have an autonomous activity associated, called "The Earth from the air/space".
Fundamental concepts	The three fundamental concepts of Remote Sensing are the core of this topic: the spectral signature, the classification and the compositions of color. All these are explained after an introduction to the multispectral sensors.
Sensors	Explanation of the concept of sensor, introduction to the distinct types of sensors, the concept of resolution and calibration. Then, there is at least a session of two hours devoted to the passive sensors (optical-electronic, thermal and radiometers of microwaves) and another session to the active sensors (RADAR and LIDAR). This explanation includes the foundations and operation, its characteristics, advantages and inconvenient and applications. The contents given in group A have several associated practices of laboratory (group B), those called "Sensors calibration", "Passive Sensors: infrared", and "RADAR Fundamentals".
Processing, interpretation and formation of images	This section is a summary of the distinct techniques of processing applied for interpreting and classifying images taken from satellites. It employs an image example to which all different processing techniques are explained. The subject also takes care of the formation of images of big regions of the surface of the Earth from images of areas more reduced, by means of the use of mosaics. It shows the process of the mosaic both from satellite and airborne images. All the contents are given in laboratory (group B), for four sessions of 2 hour each. Besides, the works developed in group C will support the contents of this chapter.
Geographic Information Systems (GIS)	It treats to introduce the foundations and applications of the GIS, orienting all the exhibition to the support in the decisions process related with geographic locations. The second part of the session devotes to deepen in the knowledge of applications of GIS by means of the study of practical cases.

Terrestrial exploration	This section devotes to some examples of applications of the Remote Sensing in diverse fields: studies of the ground, agriculture, mining, geology. The own actuality at teaching time can determine the applications in which more upsetting is done. The contents given in group A could have associated some of the works developed by students in groups C, depending on the focus of each group challenge.
Meteorology and Oceanography	In this section, the applications that more satellites have used along the history of Remote Sensing are presented: the meteorology and the oceanography. In Meteorology, it indicates which types of sensors employ, analyses the different parameters of interest, the characteristics regarding resolution and the results of climatic studies along the planet. Regarding Oceanography, the subject focuses on the observed parameters, the sensors, and it also presents images that show the results of the observations both directly and after the application of distinct processed. The contents given in group A could have associated some of the works developed by students in groups C, depending on the focus of each group challenge.
Space exploration	The aim of the subject is to present a panoramic of the space exploration. Beginning with the sensors employed along the years of history of the humanity in the space, the subject shows the main knowledges that we have obtained from the distinct bodies of the solar system and it explains how they arrived to this knowledge (missions, peculiarities of the ships and sensors employed, etc.).

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	17.2	25.8	43
Laboratory practises	4	8	12
Practice in computer rooms	10	15	25
Tutored works	5	45	50
Presentations / exhibitions	2	4	6
Autonomous practices through ICT	0	2	2
Introductory activities	1	1.2	2.2
Short answer tests	2.8	0	2.8
Systematic observation	0	2	2
Jobs and projects	0	5	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	The course topics are presented and developed by the lecturer: foundations, theoretical bases, applications, etc. Group A sessions. 1 session/week. 2 hours/session Through this methodology the competencies CE65, CE66, CT2, and CG3 are developed.
Laboratory practises	Experimental work on sensor calibration and infrared termography. Group B sessions. 2 sessions/semester. 2 hours/session. Through this methodology the competencies CE65, CE66, CT4, and CG4 are developed.
Practice in computer rooms	Computer-based work on radar fundamentals and satellite imagery processing and interpretation. Group B sessions. 5 sessions/semester. 2 hours/session Through this methodology the competencies CG4, CG7, CG9, CT4, and CT3 are developed.

Tutored works	The students will be assigned a simulation project. They will developed the project working in groups of 5-7 students. Project class sessions will be devoted to discussion and follow-up of the project. Group C sessions. 6 sessions/semester. 1 hour/session. Additional tutorial sessions will be scheduled if required. Through this methodology the competencies CG4, CG7, CG9, CT4, and CT3 are developed.
Presentations / exhibitions	The students will present, in an open session, their project results. Previously, the students must e-mail to their group C teacher the code developed and a report summarizing the results. Group C sessions. 1 session/semester. 1 hour/session. Through this methodology the competency CG9 is developed.
Autonomous practices through ICT	Activities to be autonomously developed, with software provided by means of FaiTIC platform: "Earth from air/space", to learn about points of view. This methodology works on competences CE65 and CE66
Introductory activities	Activities directed to take contact and gather information on the students, as well as to present the topic. For this activity reserves one face-to-face hour of group A, in which the professor presents the topic, explain the practices of laboratory and computer, and what expects of the works in group C. This methodology works on competences CE65, CE66, and CG4

Personalized attention

Methodologies	Description
Introductory activities	Time that each professor has reserved to attend and resolve doubts of the students
Master Session	Time that the lecturer of group A has reserved to attend and resolve doubts of the students
Laboratory practises	Time that the lecturer of groups B can use to help the students understand the lab practices and to resolve doubts.
Practice in computer rooms	Time that the lecturer of groups B can use to help the students understand the lab practices and to resolve doubts.
Tutored works	Time that the lecturer of groups C can use to provide support to the tutored groups, additional to the scheduled meetings.
Presentations / exhibitions	Time that the lecturer of groups C can use to help the students in preparing their results presentations.
Autonomous practices through ICT	Time that the lecturer of group A will use to attend the students that need some support in doing their autonomous work.

Assessment

	Description	Qualification	Evaluated Competencess
Master Session	Proofs of short answer: there will be four proofs, at dates informed to the students at the beginning of the academic year, of 10 minutes length, that allows the student to pass part of the matters. In these short proofs the skils CE65, CE66, CG3 and CG7 will be evaluated.	40	CG3 CG7 CE65 CE66

Laboratory practises	Systematic observation: During laboratory practices, the results and the demonstration of having understood the procedure to arrive to them will be evaluated: 1. "Sensors calibration": 5% 2. "Infrared thermography": 10% In these practices the skils CE66, CT3, CG4 and CG9 will be evaluated.	15	CG4 CG9 CE66 CT3
Practice in computer rooms	Systematic observation: During the computer practices , the results and the demonstration of having understood the procedure to arrive to them will be evaluated: 1. "Foundations of RADAR": 7% 2. "Image Processing": 13% In these practices the skils CE65, CT2 and CG4 will be evaluated.	20	CG4 CE65 CT2
Tutored works	The works developed in C groups will be evaluated in two parts: the own dynamics of the works and the presentations. The work itself will receive 15% of the final mark of the subject. Each of the members of the work would receive the same mark, as each of them is co-responsible of the development. In these works the skils CE66, CG7 and CG9 will be evaluated.	15	CG7 CG9 CE66
Presentations / exhibitions	Presentations of the works developed by the groups C. After the presentation, the lecturers will ask questions, individually, to the members of the group. The mark of this part will be given individually, depending on the demonstrated knowledge of each member of the group, and will represent 7% of the total subject mark. In the presentation of the works the skils CG9 and CT4 will be evaluated.	7	CG9 CT4
Autonomous practices through ICT	Students will give the lecturer their autonomous work results: "The Earth from the air/space": 3% In these practices the skils CE65 and CG4 will be evaluated.	3	CG4 CE65
Short answer tests	The final examination, in case to have to do it, will consist of 10 questions of short answer, with questions related with the classes of theory, of laboratory and the presentations of the works, and will cost by 100% of the note of the topic.	0	CG3 CG4 CG7 CG9 CE65 CE66 CT2 CT3 CT4

Other comments and July evaluation

The course language is English. **Tests, reports and exams should be written in English.**

Evaluation and grading.

The students can chose any of the following assessment systems:

1.-**Continuous assessment.** This consist of the following activities

1.1. Four quizzes. They account for 40%of the final grade.

1.2. Performance at lab classes. It accounts for a 35% of the final grade.

1.3. Simulation project results andreport. 15% of the grade.

1.4. Project presentation. 7% of thegrade.

1.5. Homework. 3% of the final grade.

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

Students attending to two of the 4 quizzes will be considered in the continuous assessment system. A student in continuos assessment is considered to be presented to the exam, independently of having taken all assessment events.

Students that want to improve their grademay attend the final exam. Their final grade will be the average between thefinal exam and the continuous assessment grade.

2.- **Final exam.** It consists of a 10 questions exam. The exam can be taken up to two timesper course. Time and place are published in the School web page. All material given in the lectures, lab classes and project presentations is subject toquestioning.

Ethical code

Final exams and quizzes must be worked out on everyone’s own. Any infraction will beconsidered a serious breach of ethics and reported to the academic authorities.

Lecturers may decide to fail a student if he has committed a serious ethical breach.

Sources of information
Basic Bibliography
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Complementary Bibliography
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Iñigo Cuiñas, Verónica Santalla, Pablo Torío, Aprender jugando: fundamentos de Termografía en asignaturas de Teledetección, Jornada de Innovación Educativa 2012, 2012, Spain

Recommendations

Subjects that are recommended to be taken simultaneously

Navigation systems and satellite communications/V05G300V01912

Subjects that it is recommended to have taken before

Fundamentals of Sound and Image/V05G300V01405
Signal Transmission and Reception Techniques/V05G300V01404
Electromagnetic Transmission/V05G300V01303
Microwave Circuits/V05G300V01611
Radio Frequency Circuits/V05G300V01511
Optical Telecommunication Infrastructures/V05G300V01614
Principles of Digital Communications/V05G300V01613
Wireless Systems and Networks/V05G300V01615
Radio Communication Systems/V05G300V01512
Multimedia Signal Processing/V05G300V01513

Other comments

The topic is going to be taught in English.
All the documents will be in English.

IDENTIFYING DATA				
Navigation systems and satellite communications				
Subject	Navigation systems and satellite communications			
Code	V05G300V01912			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Mosquera Nartallo, Carlos			
Lecturers	Aguado Agelet, Fernando Antonio Mosquera Nartallo, Carlos Pérez Fontán, Fernando			
E-mail	mosquera@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The contents of this course cover the basics of satellite navigation and satellite communication systems: GPS and Galileo, the different segments of satellite communication systems, and an introduction to the planning and development standards. The course will be entirely conducted in English; the use of Spanish or Galego will be optionally allowed in the last exam.			

Competencies		
Code		Typology
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.	- know
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CE67	(CE67/OP10) Applying conceptual, theoretical and practical tools of telecommunications in the development and applications of navigation and satellite communications systems.	- Know How
CE68	(CE68/OP11) The ability for selection of navigation and satellite communications systems and subsystems.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know How
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know

Learning outcomes	
Learning outcomes	Competences
To know the planning and development standards of satellite systems.	CG2 CG3 CE67 CE68 CT3
To know the different alternatives of communication and navigation satellite systems, their different segments (space, ground and user) and the type of orbits.	CG3 CG4 CE67 CE68 CT2 CT3

To know the more usual systems and services for satellite communications, including their technological capabilities and limitations.	CG3 CE67 CE68 CT3
To know and apply satellite navigation systems: GPS, Galileo, and other systems.	CG2 CG3 CG4 CE67 CE68 CT2 CT3

Contents

Topic	
Introduction	- System definition - Standards - Regulations - Allocated frequency bands
Elements of a System	- Ground Segment - Space Segment - Launch Segment - User Segment
Architecture of the Communication Subsystems	Subsystems: - Antennas - Payload: transponders
Introduction to Satellite Communications	- Main elements in a communications payload - Signal propagation impairments - Link budget - Multibeam satellites
Satellite Communication Services	- Fixed Satellite Services (FSS) - Broadcast Satellite Services (BSS) - Mobile Satellite Services (MSS)
Introduction to Navigation Systems (GNSS)	- GPS, Galileo, Glonass, and other systems.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	21	42	63
Practice in computer rooms	13	39	52
Laboratory practises	4	8	12
Tutored works	3	9	12
Short answer 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	We describe the different aspects of the subject providing all the necessary educational material. Through this methodology the competencies CG2, CG3, CG67, CG68, CT2 and CT3 are developed.
Practice in computer rooms	Every student will apply the theoretical knowledge to different practical tasks covering the main part of the contents of the subject with the help of the software suites. Through this methodology the competencies CG3, CG4, CG67, CG68 and CT3 are developed.
Laboratory practises	Every student will apply in a practical way the different theoretical knowledge in a specific context. Through this methodology the competencies CG3, CG4, CG67, CG68 and CT3 are developed.
Tutored works	The student will work in groups, with the support of the university lecturers, to apply, extend and personalize the contents covered in the theoretical and laboratory hours. Through this methodology the competencies CG4, CG67, CG68, CT2 and CT3 are developed.

Personalized attention

Methodologies	Description
Tutored works	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
Practice in computer rooms	The students will perform laboratory practice where they will work with concepts studied in the theoretical classes. The practices will be carried out in groups of 2 people. The final grade will be individual, including the assessment of the student's participation during the sessions as well as the individual final report and, in some practices an individual test.	40	CG3 CG4 CE67 CE68 CT3
Tutored works	The evaluation of the group work will be taken into account as well as the understanding, maturity, importance and originality of the work and interaction between the group. The tutored works will be carried out in groups of 2 people. The final grade will be individual, including the assessment of the student's participation during the sessions as well as the individual final report.	5	CG3 CG4 CE67 CE68 CT2 CT3
Laboratory practises	Each student will perform field practices. The evaluation will be performed by means of a report for a total weight of 10% of the final mark. The practices will be carried out in groups of 2 people. The final grade will be individual, including the assessment of the student's participation during the sessions as well as the individual final report and, in some practices an individual test.	10	CG3 CG4 CE67 CE68 CT3
Short answer tests	A final test to evaluate the contents presented in the master sessions. The test will be individual with time limit.	45	CG2 CG3 CG4 CE67 CE68 CT2 CT3

Other comments and July evaluation

At the beginning of the term, the student will choose the assessment methodology: final exam or continuous evaluation.

The teaching language will be English.

Both, documentation and presentations of this subject will be exclusively in English.

English shall be used for writing the reports to evaluate the laboratory practices and the tutored works.

The students can use English, Spanish or Galego to respond the final test.

The subject will be evaluated through one of the following mechanisms:

Final exam:

- The exam will include questions and/or numerical problems related with the contents presented in master sessions, laboratory practices and tutored works. It will be necessary to obtain 5 points over 10 to pass the exam.

***Continuous* evaluation.** The subject will be assessed throughout the entire term:

- **Laboratory practices**: each student will have to perform different tasks with a total weight of 40% of the final mark.
- **Tutored works:** each student will participate in different tutored works proposed during the lecture period. This part will be evaluated by written reports. These reports will have a total weight of 5% of the final mark.
- **Outdoor study/field practices:** each student will perform field practices. A report must be turned in to get a maximum

score of 10% of the final grade.
- **Final test**: This exam will be the final assessment of the continuous evaluation, and it will have a total weight of 45% of the final mark.

Make-up exam (second exam): the student will have to take an exam which will include questions and/or numerical problems related with the contents presented in the master sessions, the laboratory practices and the tutored works (100% of the final mark). Those students following the continuous evaluation can optionally take this exam for the 45% of the final grade.

All the different grades are only valid for the current course, and will expire after the second call in case someone needs to take the course again.

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Recommendations

Subjects that are recommended to be taken simultaneously

Remote sensing/V05G300V01911

Subjects that it is recommended to have taken before

Signal Transmission and Reception Techniques/V05G300V01404
Electromagnetic Transmission/V05G300V01303
Radio Communication Systems/V05G300V01512

IDENTIFYING DATA				
Digital processing in real time				
Subject	Digital processing in real time			
Code	V05G300V01913			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Cardenal López, Antonio José			
Lecturers	Cardenal López, Antonio José			
E-mail	cardenal@gts.uvigo.es			
Web				
General description	This course is designed to provide the student with basic knowledge about the design and implementation of real-time digital signal processing (DSP) algorithms. The main objective for the student is to obtain knowledge about the different platforms available for this purpose in scenarios with real-time restrictions, and to learn the practical issues related with the implementation of DSP algorithms in such platforms. Knowledge acquired on lectures will be reinforced by laboratory practices. For this purpose a Digital Signal Processor development board, will be employed. The course will be taught in Spanish, but all teaching materials will be in English.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How - Know be
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How - Know be
CE69	(CE69/OP12) The ability to implement digital signals processing schemes in programming devices.	- know - Know How
CE70	(CE70/OP13) The ability to interact digitally with radio signals.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know - Know How - Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know - Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Know the architectures for applications in real time.	CG3 CE69 CT2
Develop applications in real time on selected architectures.	CG3 CG4 CE69 CT2
Adapt the knowledges of digital signal processing to real time tasks.	CG3 CG4 CE69 CE70 CT3

Propose digital solutions for its integration in radio transceptors.	CG4 CE70 CT3

Contents

Topic	
Topic 1 Elementary concepts	Definition of real-time processing. Real-time restrictions for digital signal processing. Overview of hardware platforms for real time digital signal processing.
Topic 2 Time-domain algorithms.	Signal generation. Advanced structures for IIR filters. Finite-precision effects.
Topic 3 Frequency-domain Algorithms	Fast Fourier Transform (FFT). Discrete Cosine Transform. Goertzel algorithm
Topic 4 Introduction to Digital Signal Processors.	DSP architecture. Arithmetic-logic unit. Address-Generation Unit. Program flow control. Performance measures.
Topic 5 High level programming for DSP	Development systems structure. Fixed point programming techniques. Optimising high level code.
Practice 1: Introduction to the development system	Compiling, runing and debugging programs on the DSP development system.
Practice 2: Signal generator	Generation of a sinusoidal signal using several approaches.
Practice 3: IIR filters (I)	IIR filters implementation using transposed and cascade structures.
Practice 4: IIR filters (II)	IIR filter programming using fixed-point arithmetic.
Practice 5: Frequency domain processing.	Using the DSP libraries for FFT computation. Frequency domain filtering.
Practice 6: Software defined radio.	Programming of basic algorithms for programmable transmiters and receptors.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	21	42	63
Tutored works	7	35	42
Laboratory practises	12	24	36
Long answer tests and development	2	7	9

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

Methodologies

	Description
Master Session	Presentation of main topics in class. Multimedia material will be made available in faitic before classes take place. Personal study. Support from the instructors through tutorial help. Through this methodology the competencies CG3, CE69, CT2 and CT3 are developed.
Tutored works	Group work on a project centered in a practical application using the DSP development board employed in the laboratory. Through this methodology the competencies CG3, CG4, CE69, CE70, CT2 and CT3 are developed.
Laboratory practises	Practical exercises on a DSP development board. Matlab will be used for designing filters, and for simulation purpose if necessary. Through this methodology the competencies CG4, CE69, CE70, CT2 and CT3 are developed.

Personalized attention

Methodologies	Description
Laboratory practises	In practical sessions, each student must solve his/her own tasks. The teacher will be available during the session to solve any problem/question or doubt the student may have.
Master Session	Lectures are develop within a continuous interaction framework, where students can answer questions delivered by the teacher. They could also solve their particular doubts during the sessions.
Tutored works	Tutored works are developed in small working groups. The works are followed during meetings between the groups and the teacher. In those meetings the students can interact and ask their questions to the teacher.

Assessment

	Description	Qualification	Evaluated Competencess

Laboratory practises	Evaluation of practical exercices using the DSP development board.	50	CG3 CG4 CE69 CE70 CT2
Tutored works	Group work centred in a practical application of real-time signal processing, using the DSP development board.	30	CG3 CG4 CE69 CT3
Long answer tests and development	Written exam encompassing all the material exposed in the classroom and laboratory.	20	CG3 CG4 CE69 CT3

Other comments and July evaluation

The course will be taught in Spanish, but all teaching materials will be in English.

Evaluation

Following the own guidelines of the degree students shall be offered two evaluation systems: continuous evaluation or evaluation at the end of the semester.

CONTINUOUS EVALUATION

The continuous evaluation of the course will consist in:

- 5 practices developed on the DSP development board.These practices will account for 50% of the final grade.
- 1 project to be carried out in group, that will account for 30% of the final grade.
- A written exam encompassing all the material exposed in the classroom and in the laboratory. It will take place in the dates scheduled by the school. It will account for 20% of the final grade.

The final qualification of the student will be computed as a weighted sum (50%, 30% and 20%, respectively) of the qualifications of laboratory, group project and final exam.

The contents and the weight of each continuous evaluation exercise are the following:

- Signal generation (10%)
- IIR filter programming (10%)
- Programming IIR filters with fixed point arithmetic. (10%)
- Frequency domain processing (10%)
- Software defined radio (10%)
- Project: (30%)

The individual note for the group work, will be the common note wheighted using the results of a cross evaluation test between the members of the group.

EVALUATION AT THE END OF THE SEMESTER

Should a student decide not to be graded through continuous evaluation, he will have a written examination opportunity that will take place the same day of the final exam for all the students. The exam will cover all the material mastered in the classroom and the laboratory. Students should communicate their intention to renounce to be graded through continuous evaluation at least a week before the date of the final exam.

Students who do not pass the course at the end of the semester have an oportunity to retest on the end of the academic year. Previously to the exam, students will be asked to choose to be evaluated by continuous evaluation system or only by the final exam. In the former case, they will have the opportunity to improve the continous evaluation grade by means of redoing and improving selected practices.

Sources of information

Basic Bibliography

Sen M. Kuo, Bob H. Lee, Real-Time Digital Signal Processing,: Implementations, Application and Experiments with the TMS320C55X, John Wiley & Sons, 2001

Complementary Bibliography

Sanjit K. Mitra, Digital Signal Processing: A Computer Based Approach, McGraw-Hill, 2001

Alan V. Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing, Prentice Hall, 1999

Recommendations

Subjects that it is recommended to have taken before

Digital Signal Processing/V05G300V01304
Multimedia Signal Processing/V05G300V01513

IDENTIFYING DATA				
Digital Communications				
Subject	Digital Communications			
Code	V05G300V01914			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Pérez González, Fernando			
Lecturers	Mosquera Nartallo, Carlos Pérez González, Fernando			
E-mail	fperez@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course covers the fundamentals of modulations that are used in practically all modern communication standards, including digital terrestrial television, WiFi, fourth-generation mobile communications (LTE), digital radio, visible light communications (LiFi). Contents, teaching and exams are in English. Students may participate in classes and answer to exams preferably in English, but Spanish and Galician are also accepted.			

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How - Know be
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- know - Know How
CG12	CG12 The development of discussion ability about technical subjects	- Know How
CE71	(CE71/OP14) The ability to analyze the physical layer in modern digital communications systems.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know - Know How - Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Acquire the intuition and needed math skills to understand the role played by diversity in improving the provision of communication systems.	CG4 CG9 CG12 CE71 CT2
Develop the capability of analyzing the physical layer of current telecommunication systems.	CG4 CG9 CG12 CE71 CT2
Handle the necessary tools to understand the different aspects of the physical layer of communications system a system and put them to practice when it comes to simulating, designing or dimensioning.	CG4 CG9 CG12 CE71 CT2

Strengthen the capacity to follow a technical class in English.	CG9 CG12 CE71 CT4

Contents

Topic	
Subject 1: Multicarrier modulations	1.Introduction. 2 Analog and digital OFDM modulations 3 Diagram of an OFDM transmitter. 4 Effect of the channel on the received signal. 5 Diagram of an OFDM receiver. 6 OFDM seen as a block process.
Subject 2: Equalization, coding and synchronization in multicarrier modulations.	1. Pilot carriers. 2 ZF and MMSE equalization. 3 Zero-padding methods. 4 Coded OFDM (COFDM). 5 Carrier synchronization algorithms. 6 Timing recovery algorithms. 7 Channel state information estimation.
Subject 3: Applications	1 Digital Radio/TV standards. 2 OFDM wireless communications standards. 3 OFDM wire communications standards.
Subject 4: Advanced digital communications.	1 MIMO ystems. 2 Advanced coding: turbo and LDPC codes. 3 Spread-spectrum systems. 4 Generalized multicarrier systems.

Planning

	Class hours	Hours outside the classroom	Total hours
Troubleshooting and / or exercises	6	6	12
Laboratory practises	12	24	36
Master Session	21	40	61
Short answer tests	2	10	12
Reports / memories of practice	0	14	14
Jobs and projects	1	14	15

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

Methodologies

	Description
Troubleshooting and / or exercises	Each subject will be complemented with exercises. Previous work by the students on the exercises will be required. Competences: CG4, CG9, CG12, CE71, CT2, CT4
Laboratory practises	Lab practices will consist in the demodulation of Digital Radio Mondiale (DRM) signals. This will allow students to practically implement some of the concepts seen in the lectures: OFDM, demodulations, synch recovery,... Competences: CG4, CG9, CG12, CE71, CT2, CT4
Master Session	The course is structured in four main subjects that revolve around the concept of multicarrier modulations. Each subject will be taught through lectures in the classroom. Competences: CG4, CG9, CG12, CE71, CT2, CT4

Personalized attention

Methodologies	Description
Master Session	The teachers will provide individualized and personalized attention to students during the course, soving their doubts and questions. Doubts will be answered in presential form (during the master session, or during the office hours). Office hours will be given at the beginning of the course and published in the subject's webpage.

Troubleshooting and / or exercises	The teachers will provide individualized and personalized attention to students during the course, soving their doubts and questions. Doubts will be answered in presential form (during the work sessions or during the office hours).
Tests	Description
Reports / memories of practice	The teachers will provide individualized and personalized attention to students during the course, soving their doubts and questions. Doubts will be answered in presential form (during the office hours). Office hours will be given at the beginning of the course and published in the subject's webpage.
Jobs and projects	The teachers will provide individualized and personalized attention to students during the course, soving their doubts and questions. Doubts will be answered in presential form (during the office hours). Office hours will be given at the beginning of the course and published in the subject's webpage.

Assessment

	Description	Qualification	Evaluated Competencess
Short answer tests	Final exam with short questions on the contents of the subject, that will include also some questions on the projects. Evaluated competences: CG4, CG9, CG12, CE71, CT2.	20	CG4 CG9 CG12 CE71 CT2
Reports / memories of practice	Deliverables for the lab project. 50% of the final grade corresponds to tasks associated to a lab project. Along the course there will be six milestones, corresponding to each of the stages for the Matlab implementation of a simplified OFDM receiver. The weight given to each of these tasks is the following: Task 1 (Demodulation to baseband): 5% Task 2 (Mode detection and temporal allignment): 5% Task 3 (Frequency error correction): 10% Task 4 (Frame synchronization): 10% Task 5 (Channel estimation and equalization - I): 10% Task 6 (Channel estimation and equalization - II): 10% Evaluated competences: CG4, CG9, CG12, CE71, CT2, CT4.	50	CG4 CG9 CG12 CE71 CT2 CT4
Jobs and projects	Projects on any of the digital communication standards that employ the techniques presented in the classroom. Possible topics include: - Digital radio (DAB, DAB+, DRM) - Digital terrestrial television (DVB-T, DVB-H, DVB-T2) - LAN and MAN wireless networks. - ADSL and VDSL - Comunicaciones over PLC and multimedia over coax (MoCA) - LTE - LiFi The project must focus on those aspects of the standards that are related to the subjects covered by the lectures and should consider the following issues: - Historical aspects: previous standards solving similar problems. - Technical aspects: details about the employed modulation, bandwidth, channel coding, etc. - Applications of the standard. - Deployment degree at national and international levels. Evaluated competences: CG4, CG9, CE71, CT2.	30	CG4 CG9 CE71 CT2

Other comments and July evaluation

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

In case of collective reports, the respective contribution of each student must be clearly stated, and the final score will be personalized as a function of such contribution. An interview with the lecturer may be required in order to assess the individual contributions.

Once the student turns in any of the deliverables, he/she will be considered to be following the continuous evaluation track. Any student that chooses the continuous evaluation track will get a final score, regardless of he/she takes the final exam.

Continuous evaluation tasks cannot be redone after their corresponding deadlines, and are only valid for the current year.

Sources of information
Basic Bibliography
Complementary Bibliography
Ye Li, G.L. Stuber, Orthogonal Frequency Division Multiplexing for Wireless Communications, Springer-Verlag, 2006
J.R. Barry, E.A. Lee, D.G. Messerschmitt, Digital Communication, Kluwer, 2004
M. Engels, Ed, Wireless OFDM Systems. How to make them work?, Springer-Verlag, 2002
Antonio Artés, Fernando Pérez González, Carlos Mosquera et al., Comunicaciones Digitales, Pearson, 2007

Recommendations

Subjects that it is recommended to have taken before
Principles of Digital Communications/V05G300V01613

IDENTIFYING DATA				
Basics of bioengineering				
Subject	Basics of bioengineering			
Code	V05G300V01915			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Hermida Domínguez, Ramón Carmelo			
Lecturers	Hermida Domínguez, Ramón Carmelo			
E-mail	rhermida@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course provides an introduction to several aspects of biomedical engineering, including basic concepts of human physiology, description of most common systems and biomedical signals, and a brief introduction to several electromedical systems. This course will be tough and evaluated in English. All the documentation for this course will be in English.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- know - Know be
CG10	CG10 The ability for critical reading of scientific papers and docs.	- know
CE72	(CE72/OP15) The knowledge of biomedical engineering elements and techniques and their application in solving therapy, monitoring and diagnostic problems.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- know

Learning outcomes	
Learning outcomes	Competences
Know the systemic structure of the human physiology.	CG3 CG10 CE72 CT3
Identify biomedical signals and learn their utility in the clinical environment.	CG3 CG4 CG9 CG10 CE72 CT2 CT3 CT4

Adapt the adquired knowledge to propose solutions for the design of systems for diagnosis, monitorization and therapy.	CG3 CG4 CG9 CG10 CE72 CT2 CT3 CT4
Strengthen the capacity to follow a technical class in English.	CG9 CG10 CT4

Contents

Topic	
1. Introduction to biomedical engineering.	Physiology and anatomy of the circulatory system. Measurements in the cardiovascular system. Nervous and endocrine systems. Introduction to chronobiology.
2. Biomedical signals and systems.	Linear least-square estimation. Model comparison and analysis of variance. Techniques for model construction. Introduction to rhythmometry.
3. Diagnosis, monitorization, and therapy.	Criteria for the diagnosis of vascular risk. Ambulatory blood pressure monitoring. Treatment of hypertension: Current approaches. Chronotherapy for cardiovascular risk reduction. Early identification and prevention of complications in pregnancy.
4. Electromedical systems.	Diagnosis by X rays. Nuclear medicine. Ultrasounds. Nuclear magnetic resonance. Biotelemetry. Telemedicine.

Planning

	Class hours	Hours outside the classroom	Total hours
Tutored works	2	35	37
Presentations / exhibitions	7	9	16
Troubleshooting and / or exercises	10	15	25
Master Session	21	42	63
Short answer tests	2	7	9

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

Methodologies

	Description
Tutored works	The student, in groups, prepares a document on an application of Biomedical Engineering. Through this methodology the students will develop the competencies CG3, CG4, CG9, and CE72.
Presentations / exhibitions	Exhibition by the students in front of the professor and the rest of students of the work realized in small groups. Through this methodology the students will develop the competencies CG9 and CG72.
Troubleshooting and / or exercises	Some topics will be complemented with problem resolution. Through this methodology the students will develop the competencies CG3, CG4, CG9, and CE72.
Master Session	Exposition by the professor of the main concepts of each topic. This will be complemented by the student´s own work with recommended readings to extend the concepts explained in the classroom. Through this methodology the students will develop the competencies CG3, CG4, CG9, CG10, CE72, CT2, CT3, and CT4.

Personalized attention

Methodologies	Description
Master Session	These will be complemented by questions/answers encouraging the participation of every student.

Tutored works	Details pertaining to each assigned work will be discussed with each student.
Troubleshooting and / or exercises	Resolution of every exercise will be discussed with each student, as needed.

Assessment

	Description	Qualification	Evaluated Competencess
Tutored works	Composition, in small groups, of a monographic document related to one of the electromedical systems in bioengineering (nuclear medicine, ultrasounds, magnetic resonance, biotelemetry, telemedicine).	30	CG9 CG10 CE72 CT4
Presentations / exhibitions	Exhibition by the students of the tutored work, and discussion of the findings with the professor and other students.	10	CG9 CG10 CE72 CT4
Troubleshooting and / or exercises	Short questions on the problems solved in the practices in relation to the contents of the master sessions.	30	CG3 CG4 CE72 CT2 CT3
Short answer tests	The final exam will consist on small questions and problems in relation to the master sessions, laboratory practices, and presentation of the tutored works.	30	CG3 CG4 CE72 CT2 CT3

Other comments and July evaluation

Following the guidelines of the studies, two evaluation systems will be offered to the students inscribed on this course: continuous evaluation and evaluation at the end of the semester. Students should communicate their intention to renounce to be graded through continuous evaluation before the third week of class. The continuous evaluation will be based on the grades obtained in the tutored works and their exposition, the laboratory practices and the final test. The tutored work will be evaluated in terms of composition, accuracy and style and the grade will be the same for all members of the group. Individualized evaluation will be based on the exposition of the work (timing, clarity, accuracy) and the answers to specific questions by other students. The grades obtained throughout the continuous evaluation will only be valid for the current academic year. The possibility of a final examination, with theory and problems, will be provided to students who do not opt for the continuous evaluation. This exam will be rated between 0 and 10, and this will be the final grade obtained. The second chance of examination at the end of the academic year will have a similar structure to the final examination of those students who do not choose the continuous evaluation. All tests will be performed in English.

Sources of information

Basic Bibliography

Guyton & Hall, Textbook of Medical Physiology, 13th edition, W.B. Saunders Company, 2015,

Weisberg S, Applied Linear Regression, 4ª Ed., J Wiley & Sons,, 2013, New York

Hermida RC, Smolensky MH, Ayala DE, et al., 2013 ambulatory blood pressure monitoring recommendations for the diagnosis of adult hypertension, assessment of cardiovascular and other hypertension-associated risk, and attainment of therapeutic go, 30, Chronobiol Int, 2013,

Complementary Bibliography

Webster JG, Medical Instrumentation. Application and Design, 4th edition, Wiley, 2009,

Cook RD, Weisberg S, Residuals and Influence in Regression, Chapman Hall, 1982, London

Enderle J, Blanchard S, Bronzino J., Introduction to Biomedical Engineering., 3rd edition., Academic Press, 2012, San Diego

Recommendations

Subjects that it is recommended to have taken before
Mathematics: Probability and Statistics/V05G300V01204

IDENTIFYING DATA				
Application Design with micro-controllers				
Subject	Application Design with micro-controllers			
Code	V05G300V01921			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Costas Pérez, Lucía			
Lecturers	Costas Pérez, Lucía Valdés Peña, María Dolores			
E-mail	lcostas@uvigo.es			
Web	http://cursos.faitic.uvigo.es/tema1415/claroline/course/index.php			
General description	Design and development of microcontroller-based applications, including design methodologies to develop real time applications, peripheral components configuration and connectivity. The scope of these contents will be adapted to the academic level reached by the students. Teachers will speak in spanish or galician language. Exams will be written in spanish.			

Competencies		
Code		Typology
CE58	(CE58/OP1) The ability to design hardware and software systems based on microcontrollers.	
CE59	(CE59/OP2) The ability to use software tools for microcontrollers simulation.	

Learning outcomes	
Learning outcomes	Competences
Ability to know in deep the configuration methodologies of real time microcontrollers.	CE58
Ability to know in deep the hardware design of the microcontroller-based electronic systems.	CE58
Ability to know in deep the software design of the microcontroller-based electronic systems.	CE58 CE59
Ability to go deeper into the development of microcontroller-based electronic systems.	CE58 CE59

Contents	
Topic	
Introduction. Previous topics review.	Introduction. Previous topics review. PIC18F45K20. Internal Structure. Arithmetic and Logic Unit. Control Unit. Program memory. Data memory. Peripherals. Watch Dog Timer (WDT).
Instruction set. Addressing modes.	Introduction: Instruction Set. Transfer Instructions. Arithmetic Instructions. Logic Instructions. Jumps. Addressing Modes.
Timers.	Introduction. Timers/Counters: TMR0/TMR1/TMR2/TMR3.
Excepctions and interrupts.	Introduction. Excepctions. Interrupts. Interrupt Response. Registers.
Analog interface.	Introduction. ADC. ADC Operation. Analog Comparator Module.
Compare Mode.	Introduction. Capture Mode. Compare Mode. PWM. ECCP1: Enhanced Mode.
MSSP: Master Synchronous Serial Port SPI. I2C	Introduction. Registers. SPI Mode. I2C Mode.
Power-Managed modes.	Introduction. Different Modes. Switching between modes.
Input/Output.	Introduction. I/O Structure. Ports (A B C D E). Configuration Registers. Parallel Slave Port. Signal Coupling.

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practises	12	38	50
Master Session	12	33	45
Troubleshooting and / or exercises	5	15	20
Tutored works	7	22	29
Short answer tests	2	0	2
Short answer tests	2	0	2
Practical tests, real task execution and / or simulated.	2	0	2

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

Methodologies

	Description
Laboratory practises	The students will perform simulations and electronic circuits. The student develops the competencies CE58 and CE59.
Master Session	The lecturer will explain in the classroom the subject contens. The student develops the competency CE58.
Troubleshooting and / or exercises	The lecturer will solve exercices related to the subject contebts. The student develops the competencies CE58 and E59.
Tutored works	The students have to develop a project in groups. The lecturers will help and monitor them. The student develops the competencies CE58 and CE59.

Personalized attention

Methodologies	Description
Tutored works	The Laboratory teacher will resolve the doubts of students in his office at the schedule established and published on the school website.
Laboratory practises	The Laboratory teacher will resolve the doubts of students in his office at the schedule established and published on the school website.
Master Session	The teacher will resolve the doubts of students at the schedule established and published on the school website.
Troubleshooting and / or exercises	The teacher will resolve the doubts of students at the schedule established and published on the school website.

Assessment

	Description	Qualification	Evaluated Competencess
Tutored works	The group of students will be asked to elaborate a report related to the project they have to carry out. The lecturer will also assess individually the student's work developed during the laboratory sessions. Competencies CE58 and CE59 are assessed.	20	CE58 CE59
Short answer tests	Exam to evaluate the knowledge acquired by the student after the first part of the subject. It is carried out in a classroom session. Competency CE58 is assessed.	25	CE58
Practical tests, real task execution and / or simulated.	Laboratory exam. It is related to the lab sessions and carried out in the laboratory. The student has to deal with some real and/or simulated tasks and answer several questions. Competencies C58 and CE59 are assessed.	30	CE58 CE59
Short answer tests	Exam to evaluate the knowledge acquired by the student related to the second part of the subject. Competency CE58 is assessed.	25	CE58

Other comments and July evaluation

CONTINUOUS ASSESSMENT: A continuous assessment learning scheme will be offered to the students: - Two partial exams will be held related to the theory (A sessions). - The laboratory work will be assessed by means of an exam (B sessions). - The student has to elaborate a report describing the monitored project (C sessions). The first partial exam will take place in the classroom after the first six sessions approximately. It will last ninety minutes. If the student passes this part, he/she is not required to retake it. In this case, after finishing the term, he/she has to take only the second partial exam. The date will be specified in the academic calendar. Teachers will speak in spanish or galician language. Exams will be written in spanish. In partial exams, a minimum score (5 out of 10) is required in order to get a pass. The laboratory exam will take place at the laboratory during the last session. In order to assess the monitored project, the lecturer will consider the quality of the final report (60%), the work in the laboratory and the student's behavior (40%). To pass the subject, it is necessary that the mark of each one of the exams or the monitored project are equal or greater than 5 over 10. The final mark (FM) is calculated as the weighted average of the three individual marks. The formula will apply a weight of 50% to the theory mark (TM), a 30% to the laboratory mark (LM) and a 20 % to the project mark (PM): FM = 0,5*TM + 0,3*LM + 0,2*PM (1) The mínimum passing score required in order to get a pass in the subject is 5. In case the students do not pass any of the tasks of the subject, the final mark (FM2) will be: FM2= Minimum{4.5, FM}

Being FM the mark applying (1). When a student takes the first partial exam, it is considered that he/she choose the continuous assessment scheme and he/she will be assessed in June. FINAL EXAM: Students who refuse the continuous assessment scheme will be assessed by means of a final exam to evaluate the theory. The exam will be the same for them as for the students who fail the first partial exam. The assessment of the laboratory for these students will be carried out by means of a laboratory exam. The date will be fixed within the examination period. In this case, the final mark (FM) is calculated as the weighted average of the two individual marks. The formula will apply a weight of 50% to the theory mark (TM) and a 50% to the laboratory mark (LM): FM = 0,5*TM + 0,5*LM (2) To pass the subject, it is necessary that the mark of each one of the exams are equal or greater than 5 over 10. The minimum passing score required in order to get a pass in the subject is 5.

In case the students do not pass any of the tasks of the subject, the final mark (FM2) will be: FM2= Minimum{4.5, FM} Being FM the mark applying (2). IMPORTANT REMARK: Students who refuse the continuous assessment scheme have to contact the lecturer at least two weeks before the exam date. It is necessary to organize the laboratory exams. SECOND OPORTUNTY: The assessment policy in this call follows the scheme described in the previous section (FINAL EXAM).

Sources of information

Basic Bibliography

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Complementary Bibliography

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http://ww1.microchip.com/downloads/en/DeviceDoc/52116A.pdf, PICkit™ 3 In-Circuit Debugger/Programmer User's Guide,

http://ww1.microchip.com/downloads/en/DeviceDoc/41370C.pdf, PICkit™ 3 Debug Express PIC18F45K20 – MPLAB® C Lessons,

Recommendations

Subjects that it is recommended to have taken before

Programmable Electronic Circuits/V05G300V01502
Electronic Instrumentation and Sensors/V05G300V01621

IDENTIFYING DATA				
Optoelectronic devices				
Subject	Optoelectronic devices			
Code	V05G300V01922			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Moure Rodríguez, María José			
Lecturers	Cao Paz, Ana María Moure Rodríguez, María José			
E-mail	mjmoure@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject deals with the optoelectronic properties of semiconductors and their application in electronic devices for detection, emission, amplification and conversion of optical/electrical signals. Devices include light-emitting diodes, lasers diodes, photodiodes, phototransistors and solar cells. The contents of the course and the laboratory activities coverage the basic operating principles, design considerations, driving circuits and applications of optoelectronic devices. The subject will enable students to apply the physics of optoelectronic devices in optical sensors design and fiber optic communications. Emphasis will also be place on understanding the data sheets of optoelectronic components and their applications to different technologies. Finally integrated optoelectronics, display and image sensor technologies are introduced. The subject is given in Spanish but all the documentation provided by the teachers is written in English.			

Competencies		
Code		Typology
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CG12	CG12 The development of discussion ability about technical subjects	- Know How - Know be
CG14	CG14 The ability to use software tools to search for information or bibliographical resources.	- Know How
CE60	(CE60/OP3) The ability to design circuits based on optoelectronics devices used in telecommunication systems.	- know - Know How
CE61	(CE61/OP4) The ability to acquire, condition and process the information obtained from optoelectronic sensors.	- know - Know How
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences
To know the fundamentals of different optoelectronic devices.	CE61
The capability to analyze the data sheets and to compare different optoelectronic devices.	CG12 CG14 CE61
To know of the applications of electronic devices.	CE60
The capability to design basic circuits for driving photoemitter devices.	CE60
The capability to design basic circuits for photodetection.	CE60 CE61
To know different optoelectronic sensors.	CE61
To know the architecture and the operating modes of displays.	CE60
To know of the architecture and characteristics of image sensors.	CE60 CE61

The ability to select the more suitable devices according to each application.	CG12 CG14 CE60 CE61
To know in depth the applications related to Telecommunications.	CG9 CE60 CT4

Contents

Topic	
Unit 1: Introduction	Fundamentals and classification of optoelectronic devices. Radiometric and photometric units and their relationships.
Unit 2: Light Emitting Diodes	Principles of LED operation. Types of LEDs and properties. Parameters and characteristics. Driving circuits. Basic applications.
Unit 3: Optoelectronic Detectors	Light Dependent Resistors: principles of LDR operation, properties, parameters, driving circuits and applications. Photodiodes: principles of photoconductive detectors, types, parameters, driving circuits and applications. Phototransistor: principles of phototransistor operation, types, parameters, driving circuits and applications. Photodetector comparison.
Unit 4: Solar Cells	Photovoltaic detectors: principles and properties. Manufacture and performance of solar cells, parameters and characteristics. Applications.
Unit 5: Laser Diodes	Principles of Laser operation. Types of lasers. Laser diode operation. Driving circuits and applications.
Unit 6: Image Sensors	Principles of CCD and CMOS operation. Parameters and characteristics. Color detection. Applications.
Unit 7: Optical Sensors	Principles of optical sensing. Internal design, types, parameters and applications of: optocouplers, optical encoders, object sensors, code-bar readers, humidity sensors, color detection, distance sensors, anemometers, temperature sensors and biomedical sensors.
Unit 8: Display Technologies	Principles of Liquid Crytal Display operation. Principles of LED and Organic LED displays. Introduction to plasma, electroluminescence and digital light processor technologies.
Unit 9: Introduction to Fiber Optics	Fiber Optic fundamentals. Classification of fibers. Fiber optic emitters and detectors. Principles of fiber optic communications. Principles of fiber optic sensors.
Laboratory Practices	1. Basic optoelectronic circuits. LEDs and LDRs. Laboratory measurements. 2. Optical detectors. Circuits based on photodiodes. 3. Analog optical modulation. Optical detectors based on photodiodes and phototransistors. 4. Digital communications based on fiber optic. 5. Optoelectronic sensors for object sensing. 6. Optical circuits for color measurement. 7. Basic drive circuit for laser diodes.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	15	30	45
Case studies / analysis of situations	4	8	12
Projects	6	30	36
Presentations / exhibitions	1	3	4
Laboratory practises	14	9	23
Short answer tests	2	24	26
Reports / memories of practice	0	4	4

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

Methodologies

	Description

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. In the master sessions the competencies CE60 and CE61 are developed.
Case studies / analysis of situations	The study and analysis of actual technological solutions completes the theoretical presentations. This activity includes the study of different alternatives, commercial devices or systems, cost and power estimation, environmental impact and performance analysis. Through the case studies the competencies CE60, CE61 and CG12 are developed.
Projects	This activity focuses on applying the techniques described in the lecture classes and the skills developed at laboratory to a project implementation. These sessions are developed in a laboratory with skilled equipment. Students should obtain well founded solutions, choosing appropriate methods and devices. These projects are planned and tutored in small size groups. In the projects the competencies CG9, CG12, CG14 and CT4 are mainly developed.
Presentations / exhibitions	The project developed by the students must be oral presented by the authors. Through the oral presentations the competencies CG9 and CG12 are developed.
Laboratory practises	During laboratory sessions the student learns the design, hardware implementation, verification and measurement of basic optoelectronics circuits. All the sessions are guided and supervised by the professor. Through the the competencies CE60, CE61 and CG14 are mainly developed.

Personalized attention

Methodologies	Description
Master Session	Students have the opportunity to solve doubts in personalized attention sessions. The appointment with the corresponding professor should be required and agreed by e-mail, preferably in the hours which are published in the faculty website.
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 hours which are published in the faculty website.
Projects	Each group of students developing a project will attend periodic follow-up meetings.

Assessment

	Description	Qualification	Evaluated Competencess
Projects	The students should present a tutored project which deserves the 40% of the final qualification. The progress of this job will be supervised from continuous assessment but the final work should be oral presented by the authors.	40	CG9 CG12 CG14 CE60 CE61 CT4
Reports / memories of practice	The assistance to the laboratory practices is mandatory: at least the student should complete 6 of the 7 sessions. The implementation of the circuits described in the practice guidelines and the reports submitted at the end on each session will deserve the 30% of the final qualification.	30	CG9 CG12 CG14 CE60 CE61 CT4
Short answer tests	The student must pass a short answer test which covers all of the contents taught in the theoretical classes or laboratory practices. This test will deserve the 30% of the final qualification.	30	CE60 CE61

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. If the students assist to more than 2 laboratory sessions means that they follow the continuous assessment.

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

1.1 Test (NTest):

- It consists on a short answer questionnaire carried out preferably using the FaiTic platform.
- It covers all of the contents taught in the theoretical classes or laboratory practices.
- The estimated date will be the 11th week of the course.
- The student pass this part if he/she gets a mark greater than or equal to 5.

1.2 Laboratory practices (NPrac):

- The student should complete 6 of the 7 sessions in order to pass this part.
- The student should correctly implement the circuits described in the guidelines of the practice and submit a report corresponding to each laboratory session. The qualification of each practice depends on these achievements.
- It can be developed individually or by groups of 2 students. In this last case and if both attend the practice, the qualification is the same for the 2 students.
- The student will pass this part if he/she gets an average greater than or equal to 5. The weighting of each practice is the same to obtain the NPrac mark.

1.3 Project (NPro):

- It should be oral presented by the authors.
- It can be developed individually or by groups of 2 students. In this last case, the 85% of the qualification is common for both members of the group meanwhile the 15% represents the individual qualification obtained from the oral presentation of each student.
- The student will pass this part if he/she gets a mark greater than or equal to 5.

1.4 Final qualification of continuous assessment (Final_ca)

The final qualification of continuous assessment is obtained as follows:

Final_ca: = (NTest*0.3 + NPrac*0.3 + NPro*0.4) if NTest is greater than or equal to 5 and NPrac is greater than or equal to 5 and NPro is greater than or equal to 5;

Final_ca = min [(NTest*0.3 + NPrac*0.3 + NPro*0.4), 4] in other case;

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

- He/she can make a written long answer exam and this mark replaces NTest.
- He/she student can improve his/her laboratory mark (NPrac) by means of an exam. This exam consists of several problems related to the contents of laboratory practices.
- He/she can complete and present his/her project (NPro) before the date of the final exam.

2. Final assessment and second call

In those cases in which the student decides not to carry out the continuous evaluation tasks, the final qualification is based on:

- A final exam comprising all the topics of the subject. It usually consists of several questions and problems and lasts about 2.5 hours. The pass mark for this exam is 5 out of 10 and deserves 60% of the final qualification (NEx).
- The students should also present a project with the same objectives and complexity of the project developed in continuous assessment. This project deserves 40% of the final qualification (NPro) and should be presented before the date of the final exam.

The final qualification (Final_ex) is obtained as follows:

Final_ex = (NEx*0.6 + NPro*0.4) if NEx is greater than or equal to 5 and NPro is greater than or equal to 5;

Final_ex = min [(NEx*0.6 + NPro*0.4) , 4] in other case.

This assessment system applies as well to the second call.

3. Other comments

- The exams will be written in Spanish. The student can use the Spanish, English or Galician for the reports, works or presentations.

- The grades obtained from the continuous assessment and final exams are only valid for the current academic year.
- The use of books, notes or electronic devices such as phones or computers is not permitted in any test or exam. Mobile phones must be turned off and out of reach of the student.
- In the case that plagiarism is detected in any of the tasks/exams done/taken, the final score for the subject will be 'fail' (0) and the teachers will inform the School authorities so that they take the actions that they consider appropiate.

Sources of information

Basic Bibliography

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Complementary Bibliography

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Yu F.T.S., Yang X., Introduction to Optical Engineering, Cambribge University Press, 1997,

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Goetzberger A., Knobloch J., Voss B., Crystalline Silicon Solar Cells, Wiley, 1998,

Watson J., Optoelectrónica, Limusa, 1993,

Smith S.D., Optoelectronic Devices, Prentice Hall, 1995,

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Wood D., Optoelectronic Semiconductors Devices, Prentice Hall, 1995,

Goff D.R., Fiber Optic Reference Guide. A Practical Guide to Communications Technology, Focal Press, 2002,

Marston R.M., Circuitos de optoelectrónica, CEAC, 2000,

Moure M.J., Apuntes de DOE, 2017, FaiTIC (http://faitic.uvigo.es)

Cao A.M., Prácticas de DOE, 2017, FaiTIC (http://faitic.uvigo.es)

Recommendations

Subjects that it is recommended to have taken before

Physics: Fundamentals of Electronics/V05G300V01305
Electronic Technology/V05G300V01401

IDENTIFYING DATA				
Design and synthesis of digital systems				
Subject	Design and synthesis of digital systems			
Code	V05G300V01923			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Álvarez Ruiz de Ojeda, Luís Jacobo			
Lecturers	Álvarez Ruiz de Ojeda, Luís Jacobo			
E-mail	jalvarez@uvigo.es			
Web	http://www.faitic.uvigo.es			
General description	This course will be taught and assessed in English. The course documentation is in English. The main learning goals of this course are: • Introduction to VHDL for synthesis. • Design and synthesis of synchronous digital systems. • Development, synthesis and verification of programmable digital circuits, using VHDL for its application in the field of the Telecommunications.			

Competencies		
Code		Typology
CG1	CG1: The ability to write, develop and sign projects in the field of Telecommunication Engineering, according to the knowledge acquired as considered in section 5 of this Law, the conception and development or operation of networks, services and applications of Telecommunication and Electronics.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How
CG13	CG13 The ability to use software tools that support problem solving in engineering.	- Know How
CE62	(CE62/OP5) The ability to design and synthesize complex digital systems by hardware description language.	- Know How
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know be

Learning outcomes	
Learning outcomes	Competences
To be able to distinguish the differences between the use of Hardware Description Languages for simulation and for synthesis.	CG13 CE62
To deepen the understanding of synchronous digital design techniques using VHDL for synthesis.	CG13 CE62
To acquire skills at designing complex synchronous digital systems using VHDL.	CG1 CG9 CG13 CE62 CT4

Contents
Topic

LESSON 1 THEORY (2 h.). INTRODUCTION TO COMPLEX DIGITAL SYSTEM DESIGN AND SYNTHESIS.	1.1.- Introduction. 1.2.- Types of digital integrated circuits. Microprocessors. DSPs. ASICs. FPGAs. 1.2.1.- Comparative analysis. 1.3.- Field Programmable Gate Arrays (FPGAs). 1.4.- Complex application specific digital system design by means of FPGAs. 1.4.1.- Sequential processing systems. Operational unit. Control Unit. 1.4.2.- Continuous processing systems.
LESSON 2 THEORY (2 h.). ADVANCED DIGITAL SYSTEM DESIGN.	2.1.- Introduction. 2.2.- General rules for the design of digital systems. 2.2.1.- Hierarchical design. 2.2.2.- Technology independent design. 2.2.3.- Design timing. 2.2.4.- Design for reuse. 2.2.5.- Design for verificability. 2.2.6.- Design documentation. 2.3.- Intellectual Property (IP) cores.
LESSON 3 THEORY (2 h.). INTRODUCTION TO SYNTHESIS OF DIGITAL SYSTEMS DESCRIBED IN VHDL.	3.1.- Introduction. 3.2.- Definition of synthesis. Basic concepts on synthesis. 3.3.- Conversion of a VHDL description to real hardware. Differences between the original VHDL model and the result of the synthesis / implementation. Timing simulation model. 3.4.- Recommendations for the description in VHDL synthesisable of distinct types of circuits. 3.5.- Examples of synthesisable models of commonly used circuits.
LESSON 4 THEORY (6 h.). VHDL FOR SYNTHESIS. RESTRICTIONS.	4.1.- Introduction. 4.2.- IEEE standard for synthesis. 4.3.- Time sentences (“After”, “Wait”). 4.4.- Loops (“Loop”). Loops “generate”. 4.5.- ‘Real’ data type. Type conversion. 4.6.- Complex arithmetical operations. Division (“/”). 4.7.- Complex mathematical functions. (“Without”, “Cos”, “Log”). 4.8.- Two-dimensional matrices. (“Array”). 4.9.- Exercises of non- synthesisable models and equivalent synthesisable circuits.
LESSON 5 THEORY (2 h.). ARITHMETICAL CIRCUITS DESIGN IN VHDL.	5.1.- Introduction. 5.2.- Representation of binary numbers with decimal part. Fixed point. Floating point. 5.3.- Design of fixed point applications. 5.4.- Design of floating point applications. 5.5.- Implementation of arithmetical circuits in FPGAs.
LESSON 6 THEORY (4 h.). VHDL ADVANCED SENTENCES.	6.1.- Introduction. 6.2.- Libraries and packages. 6.3.- Access to files. 6.3.1.- Memory initialisation. 6.3.2.- Testbench stimuli. 6.4.- ‘Generic’ data type. Parameterisable circuits. 6.5.- Subprograms. 6.5.1.- Functions. 6.5.2.- Procedures. 6.6.- Conditional compilation.
LESSON 7 THEORY (1 h.). VERIFICATION OF COMPLEX DIGITAL SYSTEMS.	7.1.- Introduction. 7.2.- Verification through simulation. 7.2.1.- Signals. Delay models. Definition of ‘driver’. 7.2.2.- Design analysis and simulation. Simulation cycle. Delta delay. 7.2.3.- Recommendations for VHDL simulation. Examples. Testbench design. 7.2.4.- Differences between functional and timing simulation. 7.3.- Verification through timing analysis. 7.4.- Verification through test in a development board. 7.5.- Exercises.
LESSON 1 LABORATORY (4 h. TYPE B). PRACTICAL TUTORIAL OF DIGITAL SYSTEM DESIGN AND SYNTHESIS.	1.1.- Introduction. 1.2.- Basic digital system design in synthesisable VHDL. 1.3.- Testbench design in VHDL. 1.4.- Implementation of digital systems in FPGAs. 1.5.- Testing digital systems.

LESSON 2 LABORATORY (2 h. TYPE B). DIGITAL SYSTEM DEBUGGING. VIRTUAL LOGICAL ANALYSERS.	2.1.- Introduction. 2.2.- Xilinx virtual logical analyser. ‘Chipscope core’. 2.3.- Parameters of the Xilinx virtual logical analyser. 2.4.- Implementation of the Xilinx virtual logical analyser. 2.5.- Analysis of a digital system by means of the Xilinx virtual logical analyser.
LESSON 3 LABORATORY. (15 h. = 8 H. TYPE B + 7 h. TYPE C). DESIGN OF A MEDIUM-COMPLEXITY DIGITAL SYSTEM IN SYNTHESISABLE VHDL.	3.1.- Introduction. Task explanation. (2 h. TYPE B) 3.2.- Project based learning. Discussions on the most suitable approach. (6 h. TYPE C) 3.2.- Design of a medium-complexity digital system in synthesisable VHDL. (6 h. TYPE B) 3.3.- Oral presentation. (1 h. TYPE C)

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	4	8	12
Integrated methodologies	15	31.5	46.5
Laboratory practises	6	7.5	13.5
Integrated methodologies	14	51	65
Presentations / exhibitions	1	8	9
Introductory activities	2	2	4

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

Methodologies

	Description
Master Session	Conventional lectures. Through this methodology the outcome CE62/OP5 is developed.
Integrated methodologies	Problem based learning (PBL): Problem solving. Design of non- synthesisable models and synthesisable circuits in VHDL. To solve them, the student has to previously develop certain outcomes. Through this methodology the outcomes CG9, CG13 and CE62/OP5 are developed.
Laboratory practises	VHDL design of digital circuits and circuit implementation in FPGAs. Through this methodology the outcomes CG9, CG13 and CE62/OP5 are developed.
Integrated methodologies	Project based learning. The students must design a digital system in VHDL to solve a problem. In order to that, the students must plan, design and implement the necessary steps. The project development will be implemented in laboratory hours (type B). Besides, in type C hours there will be discussions and one-to-one interaction with the teacher. Activities to develop in the groups C: Analysis and debate about the project approach and different alternatives. Analysis and follow-up of the proposed solution. Design implementation. Analysis and debate of results. Oral presentations of the project results. Through this methodology the outcomes CG1, CG9, CG13 and CE62/OP5 are developed.
Presentations / exhibitions	Presentations/exhibitions: Exhibition of the results of the project developed. Through this methodology the outcomes CG1 and CG9 are developed.
Introductory activities	Introduction to the subject key topics both theoretical and practical. Through this methodology the outcomes CG13 and CE62/OP5 are developed.

Personalized attention

Methodologies	Description
Integrated methodologies	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.
Integrated methodologies	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
Integrated methodologies	Resolution of theoretical problems and exercises. The majority of them will be focused on the design of non-synthesisable models and synthesisable circuits in VHDL. The problems will be based on the theoretical topcis. It will be necessary to teach to the professor the operation of each one of the models and circuits. The correct application of the theoretical concepts to the problems will be assessed, based on the published criteria. It will be necessary to deliver the documentation requested by the professor for each one of the exercises. Through this methodology the outcomes CG9, CG13 and CE62/OP5 are assessed.	50	CG13 CE62
Integrated methodologies	Laboratory Project. Design of a medium-complexity synthesisable digital system in VHDL. It will be necessary to deliver the design source files. The assessment will be based on the operation of the digital system and the correct application of the theoretical concepts, according to the published criteria. Through this methodology the outcomes CG1, CG9, CG13 and CE62/OP5 are assessed.	40	CG1 CG9 CG13 CE62 CT4
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. Through this methodology the outcomes CG1 and CG9 are assessed.	10	CG1 CG9 CT4

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 at the end of the year (second opportunity), 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 at the end of the year.

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 and the laboratory practices individually.

The laboratory projects will be developed in groups of two students during the continuous assessment but the students will be assessed individually. To achieve this, the students will be required to explain during the oral presentation which parts of the project each of them has developed.

The students who want to be assessed in the continuous assessment can only miss two sessions as a maximum. If they miss more than 2 sessions, it will be compulsory to do an additional individual task or an examination.

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) and the Laboratory Project (LP), that is, the mark of each part >= 5,

the final mark (FM) will be the weighted sum of the marks of each part of the subject:

FM = 0'50 * TE + 0'40 * LP + 0'10 * OP

In case the students do not pass any of the two main parts of the subject, the theoretical exercises (TE) or the Laboratory Project (LP), that is, the mark of any task < 5, the final mark (FM) will be:

FM = Minimum [4'5; (FM = 0'50 * TE + 0'40 * LP + 0'10 * OP)]

Where:

TE = Global mark of the theoretical exercises and problems.

LP = Laboratory Project.

OP = Oral presentation.

ASSESSMENT CRITERIA.

1) 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.

There will be eight reports of exercises.

The majority of the exercises will consist in the design of non-synthesisable models and synthesisable circuits in VHDL.

The assessment criteria are the following:

1. Correct design (CORR).

a. Behavioural model adequate to the project specifications.

b. Synchronous design.

c. Reusable design.

2. Functionality (FUNC). For each one of the exercises, the behavioural circuit model has to work perfectly to obtain the maximum mark. If the circuit is synthesisable, the temporary simulation of the resultant circuit also has to work perfectly.

a. Behavioural simulation.

b. Synthesis.

c. Timing simulation.

3. Project documentation (DOC).

a. Design source files.

b.Enough comments in the VHDL 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 = (Report 1 + … + Report 8) / 8

2) Laboratory Project.

This project consists in the design of a synthesisable digital system of medium complexity in VHDL.

The assessment criteria are the following:

1. Correct design (CORR).

a. System entirely synthesisable.

b. Suitable hierarchy arrangement.

c. Design totally synchronous.

d. Technology independent design.

e. Reusable design.

2. Analysis of the design and the implementation in FPGAs (ANA).

a. Analysis of the FPGA logical resources used and their justification.

b. Analysis of the internal system delays.

c. Analysis of the chosen implementation options.

d. Optimal utilisation of the FPGA logical resources.

e. Achievement of an optimal processing speed.

f. 'Chipscope' Verification.

3. Functionality (FUNC). For each circuit, the behavioral simulation, the timing simulation and the board test should work perfectly to obtain the maximum mark.

a. Individual circuits.

b. Complete system.

4. Documentation (DOC).

a. Design source files.

b. Enough comments in the VHDL files to explain the sentences used.

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

3) Oral Presentation.

The assessment criteria are the following:

1. Clear structure and presentation order.

2. Clear explanations.

3. Enough explanations to understand the project.

4. Suitable figures.

Sources of information

Basic Bibliography

CHU, PONG P., RTL Hardware Design Using VHDL: Coding for Efficiency,Portability, and Scalability, John Wiley & Sons Inc, 2006,

ÁLVAREZ RUIZ DE OJEDA, L.J., Diseño Digital con FPGAs, Visión libros, 2013, Madrid

Complementary Bibliography

ASHENDEN, PETER J., The Designer's Guide to VHDL, 3, MorganKaufmann Publishers, 2008,

Standard IEEE VHDL Language Reference Manual (IEEE Srd 1076-2001), IEEE, 2001,

CHU, PONG P., FPGA Prototyping by VHDLExamples, John Wiley & Sons Inc, 2008,

Recommendations

Subjects that it is recommended to have taken before

Digital Electronics/V05G300V01402
Programmable Electronic Circuits/V05G300V01502

Other comments

The students will have previously followed the subjects Digital Electronics and Programmable Electronic Circuits. They give the necessary knowledge to understand the topics of this course.
It is not necessary to have passed them.
The students of the specialisation “Electronic Systems”, should have previously followed the subject Electronic Systems of Processed of Signal, but is not indispensable.

IDENTIFYING DATA				
Advanced electronic sensors				
Subject	Advanced electronic sensors			
Code	V05G300V01924			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Mariño Espiñeira, Perfecto			
Lecturers	Costas Pérez, Lucía Mariño Espiñeira, Perfecto Pastoriza Santos, Vicente			
E-mail	pmarino@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main purpose of this subject is to train students in order that they become well-qualified to understand the physical principles and current techniques employed in the most recent electronic sensors technology. Course outline: + Optical fiber sensors. + Laser sensors. + Microelectromechanical sensors (MEMS). + Image sensors. + Integrated sensors. + Intelligent sensors. + Acoustic wave sensors. + Biosensores. The main goal of the laboratory sessions (practical work) is to enable the students to acquire sufficient understanding and knowledge to: + Analyze the parameters and main features of the sensors. + Know the applications of each group of sensors. + Manage specific software tools developed to design (virtual) instruments that allow store, display and analyze recorded data. The documentation of the course will be in English. It will be taught in Galician and Spanish. It will be assessed in Spanish.				

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CE63	(CE63/OP6) The ability to design and use optoelectronic sensors, micromechanical sensors (MEMS) and acoustic wave sensors.	- know - Know How
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Knowledge of the modes of operation and applications of fiber optic sensors.	CG3 CE63

Knowledge of the modes of operation and applications of microelectromechanical sensors.	CG3 CE63
Knowledge of the modes of operation and applications of acoustic wave sensors.	CG3 CE63
Ability to select and work with next generation electronic sensors.	CG4 CE63
Ability to work in groups and to develop communications skills in order to elaborate and present technical reports related to the subject.	CG9 CE63 CT4

Contents

Topic	
Unit 1: Fiber Optic Sensors I.	Introduction. Classification. FOS types. Basic structure. Extrinsic, intrinsic and evanescent wave sensors. Applications. Interferometric FOS. Applications.
Unit 2: Fiber Optic Sensors II.	Multisensory FOS systems. Distributed and multiplexed FOS. OTDR reflectometry. OFDR reflectrometry. Fiber Bragg grating. Applications. Intelligent systems. Laser vibrometry and interferometry. Applications.
Unit 3: Integrated Optical Sensors.	Introduction. Classification of optical integrated waveguides. Materials. Devices. Interferometry in IO. Active integrated optic devices; detectors and sources. Sensors. Biosensors. OF-IO Coupling. Applications.
Unit 4: Microelectromechanical Sensors (MEMS).	Microelectronic technologies. MEMS fabrication processes. MEMS materials. MEMS Sensors. Micromachined free space integrated micro optics. CMOS Microsensors. Applications.
Unit 5: Image Sensors and Displays I.	Introduction. Display specifications. Display classification. Illumination technologies. Image capture technology: CCD and CMOS. Night vision technology: PMTs y IR cameras.
Unit 6: Image Sensors and Displays II.	Introduction to pyrometry. Operating principle General features. Disappearing filament pyrometer. Conditioning. Bolometric detector. Quantum detectors. Radiometers. IR cameras. Applications.
Unit 7: Acoustic Wave Sensors (AWS).	Classification. Materials features. Comparative study of AWS sensors. Applications. FPW microsensor. FPW integrated systems. Coatings for AWS. Pattern recognition in “electronic nose”.
Unit 8: Virtual Reality Sensors.	Introduction. Tactile response systems. RV features. Architectures. Neuronal processes. Mechanoreceptors. Projective field. Visual tactile synesthesia. Visual immersion systems. UAV (Unmanned Aerial Vehicle) systems.
Unit 9: Sensor Technology in Particle Physics.	Introduction. Specific instrumentation standars: CAMAC, FASTBUS and SCI. The standard model. Features of the standard model. Beta decay. Evolution of particle accelerators. Particle Detectors in accelerators. Nuclear medicine applications.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	2	3
Master Session	17	17	34
Tutored works	3	26	29
Laboratory practises	12	30	42
Integrated methodologies	7	25	32
Practical tests, real task execution and / or simulated.	2	8	10

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

Methodologies

	Description
Introductory activities	Subject presentation. Presentation of laboratory sessions, instrumentation and software resources to be used. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.

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 CG3, CG4, CG9, CE63, and CT4 will be developed.
Tutored works	The students have to manage basic concepts to search and select information in order to get a deeper understanding in some specific fields related to the subject. The lecturer will propose in the classroom the topic of this individual task and monitor the student's work in personalized attention sessions. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.
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 sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.
Integrated methodologies	Project-based learning: students have to develop a group activity that goes on over a period of time and address a specific problem. They have to design, schedule and carry out a set of tasks to achieve a solution. The assessment will be based on the quality of the proposed solution, the depth of content understanding demonstrated and the final presentation. The sessions will be performed in the laboratory. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.

Personalized attention

Methodologies	Description
Master Session	The students can go to the lecturer's office (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will answer the students' questions and also give instructions to guide the studying and learning process.
Laboratory practises	The students can go to the lecturer's office (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will help students understand the work to be developed in the laboratory (components, circuits, instrumentation and tools).
Tutored works	The students can go to the lecturer's office (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will help students to deal with the monitored work.
Integrated methodologies	The students can go to the lecturer's office (individually or in a group). The timetable will be available on the subject website at the beginning of the term. The lecturers will be available to help students in order to deal with the contents of the subject, the laboratory practices as well as the monitored work.

Assessment

	Description	Qualification	Evaluated Competencess
Laboratory practises	The lecturers will check the level of compliance of the students with the goals related to the laboratory skills. They will consider the work of the students carried out before the laboratory session to prepare the proposed tasks and the work in the laboratory. Marks for each session (LSM: Laboratory Session Mark) will be assigned in a 10 points scale. In these practices, the skills CG3, CG4, CG9, CE63, and CT4 will be assessed.	30	CG3 CG4 CG9 CE63 CT4
Tutored works	The lecturers will consider the quality of the results obtained, their analysis, the final report, and the classroom presentation. Marks will be assigned in a 10 points scale. In these works, the skills CG3, CG4, CG9, CE63, and CT4 will be evaluated.	50	CG3 CG4 CG9 CE63 CT4
Practical tests, real task execution and / or simulated.	The lecturers will consider the quality of the results obtained, their analysis, and the classroom presentation. Marks will be (GPM: Group Project Mark) assigned in a 10 points scale. In these tasks, the skills CG3, CG4, CG9, CE63, and CT4 will be evaluated.	20	CG3 CG4 CG9 CE63 CT4

Other comments and July evaluation

1. Continuous assessment

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

When the students go to the lectures regularly (less than 10% unjustified absence) or miss at most one laboratory session, ***they will be assessed by continuous assessment.*** An attendance register shall be laid open for signature by students at each session.

The subject comprises three different parts: theory (50 %), laboratory (30%) and group project (20%). Once a task has been assessed, the students cannot do/repeat the task at a later date. The marks are valid only for the current academic course.

1.a Theory

In the first weeks of the course each student will be asked to carry out a task individually with the help of the lecturer about a topic related to the subject. In order to assess the task, the lecturer will consider the quality of the results obtained, their analysis, the final report, and the classroom presentation. The students will be informed of the deadline by the lecturer. Marks will be (TWM: Tutored Work Mark) assigned in a 10 points scale. If the students present their works after the deadline the WM will be 0.

The final mark of this part will be:

FMT (Final Mark of Theory) = TWM (Tutored Work Mark)

The minimum mark required to pass this part is of 5 (FMT >= 5).

1.b Laboratory

Six laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in pairs. This part also will be assessed by continuous assessment. Each session will be only evaluated according to the developed work at the schedule date.

The lecturers will assess the individual student work. They will consider the individual work carried out before the laboratory session to prepare the proposed tasks, the laboratory attendance, as well as the student work in the laboratory. Marks for each session will be (LSM: Laboratory Session Mark) assigned in a 10 points scale. A mark of 0 will be obtained for missing sessions.

The final mark of this part is calculated as the arithmetic mean of the six individual marks:

FML (Final Mark of Laboratory) = Sum(LSMi)/6; i = 1, 2, ..., 6

Attendance at the laboratory classes is compulsory. If the student miss more than one laboratory session without a valid documented reason (medical, bereavement or other) he/she will be assigned a grade of 0 for the laboratory part (FML=0).

1.c Group project

The classroom workload will be carried out in two hours of B laboratory sessions and all hours of C laboratory sessions. In the first session lecturers will present the objectives and the schedule of the project. They also assign a specific project to each group. In this sessions the lecturer will monitor the group work and the individual student work.

In order to assess the project, the lecturer will consider the quality of the results obtained, their classroom presentation and analysis, and the quality of the final report. The students will be duly informed of the report deadline by the lecturer. The final mark of this part, (GPM: Group Project Mark) , will be assessed in a 10 points scale.

In order to pass this part the student can not miss more than one project sessions and only if this absence is duly justified.

1.d Final mark of the subject

In order to past the subject, students will be required:

+ to obtain FMT >= 5, and

+ no more than one missed laboratory session, and

+ no more than one missed group project session.

The weighted *points* from all assessed parts are added together to calculate the final *mark(FM)*. The following weightings will be applied: 50% theory, 30% laboratory and 20% group project.

FM = 0,50·FMT + 0,30·FML + 0,20·GPM

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

However, when:

+ FMT < 5, or

+ more than one missed laboratory session, or

+ more than one missed group project session,

the final mark (FM) will be the minimum value among them.

FM = min{ FMT, FML, GPM }

2. Final Exam

If a student prefers a different educational policy he/she can take an exam on a scheduled *date*. The date will be specified in the academic calendar. This exam will comprise four parts (similar to the activities completed by the continuously assessed students):

+ an **exam** if they didn't go to the lectures regularly (more than 10% unjustified absence).

+ a task monitored by a tutor, (**tutored work**)

+ a **practical exam carried out in the laboratory** if they have missed more than one laboratory session.

+ a previously assigned **project**.

The tutored work and the project will be assigned following the procedure described in advance by the lecturer.

2.a Theory

2.a.1 Theory Exam

In order to pass the theory, the student cannot miss more than 10 % of the lectures without a valid documented reason (medical, bereavement or other). Otherwise, he/she will have to attend to an exam (with short or long answer questions). Marks will be (EM: Exam Mark) assigned in a 10 points scale.

2.a.2 Tutored Work

To evaluate the tutored work the lecturer will consider the results, the presentation, the analysis and the quality of the final report. Marks will be (TWM: Tutored Work Mark) assigned in a 10 points scale.

2.a.3 Theory Final Mark

The final mark of theory (FMT) will be:

FMT = TWM (Tutored Work Mark) if the student don't miss more than 10 % of the lectures.

FMT = EM (Exam Mark) if the student miss more than 10 % of the lectures and MTM >= 5.

FMT = 0 in any other case.

2.b Laboratory

In order to pass the laboratory part, the student cannot miss more than one laboratory session lectures without a valid documented reason (medical, bereavement or other). **Otherwise**, he/she will have to attend to a practical exam carried out in the laboratory. In this exam the student will be asked to deal with some of the electronic circuits developed in the laboratory sessions as well as some short answer questions related to these sessions. Marks will be (LEM: Laboratory Exam Mark) assigned in a 10 points scale.

The final mark of laboratory (FML) will be:

FML = the arithmetic mean of the laboratory session marks (LSM) when the student didn't miss more than one laboratory session, that is:

FML = Sum(LSMi)/6; i = 1, 2,..., 6

FML = LEM (Laboratory Exam Mark) when the student missed more than one laboratory session.

LFM = 0 in any other case.

2.c Project

In order to assess the project, the lecturer will consider the quality of the results obtained, their analysis, and the classroom presentation. Marks will be (GPM: Group Project Mark) assigned in a 10 points scale.

2.d Final mark

In order to pass the subject, it is mandatory:

+ FMT >= 5, and

+ no more than one missed laboratory session or FML >= 5, and

+ no more than one missed group project session or GPM >= 5.

The final mark will be the weighted average of the marks obtained by the student in the different parts. The final mark (FM) will apply a weight of 50% to the final theory mark (FMT), a 30% to the laboratory final mark (FML) and a 20 % to the group project mark (GPM).

FM = 0,50·FMT + 0,30·FML + 0,20·GPM

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

However, when:

+ FMT < 5, or

+ FML < 5 and the student missed more than one laboratory session, or

+ GPM < 5 and the student missed more than one group project session,

the final mark will be the minimum value among them.

FM = min{ FMT, FML, GPM }

3. Second opportunity to pass the subject.

The assessment policy in this call will follow the scheme described in the previous section. Dates will be specified in the academic calendar. The lecturer will assign the tutored work and the project to the student. The student has to contact to the lecturer according to an established procedure. The procedure will be published in advance.

Marks obtained in the previous continuous assessment or final exam are kept if the student have got a pass in some parts. Moreover, students cannot take an exam, develop a project or a tutored work task if they have got a pass previously.

The final mark will be the weighted average of the marks obtained by the student as it has described in section 2.

4. Others

The subject will be taught in Galician and Spanish. It will be assessed in Spanish.

Sources of information
Basic Bibliography
Pérez García, M.A., Álvarez Antón, J.C., Campo Rodríguez, J.C., Ferrero Martín F.C., y Grillo Ortega, Instrumentación Electrónica, 2ª ed., Thomson, 2004, Madrid
Pérez García, M.A., Instrumentación Electrónica, 1ª ed., Ediciones Paraninfo, S.A., 2014, Madrid
Pallás Areny, R., Sensores y Acondicionadores de Señal, 4ª ed., Marcombo D.L., 2003, Barcelona
Norton, H.N., Sensores y analizadores, Gustavo Gili D.L., 1984, Barcelona
Fraile Mora, J., García Gutiérrez, P., y Fraile Ardanuy, J., Instrumentación aplicada a la ingeniería, 3ª ed., Editorial Garceta, 2013, Madrid
Martín Fernández, A., Instrumentación electrónica. Transductores y acondicionadores de señal y sistemas de adquisición de datos, 2ª ed., Dpto. de publicaciones de la E.U.I.T.T. de Madrid,, 1990, Madrid
Complementary Bibliography
del Río Fernández, J., Shariat-Panahi, S., Sarriá Gandul, S., y Lázaro, A.M., LabVIEW: Programación para Sistemas de Instrumentación, 1ª ed., Editorial Garceta, 2011, Madrid

Recommendations

Subjects that it is recommended to have taken before

Digital Electronics/V05G300V01402
Electronic Technology/V05G300V01401
Programmable Electronic Circuits/V05G300V01502
Microelectronics Design/V05G300V01622
Analogue Electronics/V05G300V01624
Power Electronics/V05G300V01625
Engineering of Electronic Equipment/V05G300V01523
Electronic Instrumentation and Sensors/V05G300V01621
Data Acquisition Systems/V05G300V01521
Electronic Systems for Signal Processing/V05G300V01522
Electronic Systems for Digital Communications/V05G300V01623

Other comments

It recommends to have passed the following subjects:
+ Electronic Technology/V05G300V01401
+ Digital Electronics/V05G300V01402
+ Analogue Electronics/V05G300V01624
+ Data Acquisition Systems/V05G300V01521
+ Electronic Instrumentation and Sensors/V05G300V01621

IDENTIFYING DATA				
Industrial Communications				
Subject	Industrial Communications			
Code	V05G300V01925			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Domínguez Gómez, Miguel Ángel			
Lecturers	Domínguez Gómez, Miguel Ángel Poza González, Francisco			
E-mail	mdgomez@uvigo.es			
Web	http://faitic.uvigo.es			
General description	There are more electronic units of control in the systems used in diverse areas of the engineering (industrial control, automotion, domotic, aircrafts, ships, etc.). These units must be connected between them of an efficient way and in real time to transmit all the necessary information. The use of industrial communications networks has had a very big peak in the last years and the knowledge of the different fieldbus protocols existing in the market is of big interest for the engineering. This subject intends that the student know the different protocols of communications that exist in various areas of application and acquires the capacity to choose the most adapted solution for a determinate problem. In accordance with the exposed, will treat the following contents: * Introduction to industrial communications systems * Introduction to fieldbuses * Standards * General Characteristics * Applications * Study of the most used protocols * Tools of design and analysis			

Competencies		
Code		Typology
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- know - Know How
CG14	CG14 The ability to use software tools to search for information or bibliographical resources.	- Know How
CE64	(CE64/OP7) Comprehension and command of basic concepts of industrial communication networks of field buses.	- know

Learning outcomes	
Learning outcomes	Competences
Understanding and control of the industrial communications systems.	CE64
Understanding and control of the basic concepts of industrial communications networks (fieldbuses).	CE64
Understanding and control of fieldbuses applications and the most important protocols.	CE64
Capacity to choose the better solution for a determinate problem of communication.	CG6 CE64
Capacity to design simple industrial communication systems.	CG6 CG14
Basic knowledges of software tools for analysis and design.	CG6 CG14
Capacity of use and configurate communication hardware modules.	CG6 CG14

Contents
Topic

Theme 1: Communication networks	OSI and TCP/IP models. Local Area Networks (LAN). Wide Area Networks (WAN). Wireless and mobile communication systems. Interconnection resources. Hierarchy.
Theme 2: Fieldbuses	Origin. Main characteristic. standardization. Applications.
Theme 3: CAN/LIN	History. Applications. Main characteristic. Physical layer. Data link layer. Media access control. Frames format. Coding of frames. Errors management.
Theme 4: CAN controller MCP2515	Features. Device overview. Message transmission and reception. Timing configuration. Error detection. Interrupts. Modes of operation.
Theme 5: Domotic fieldbuses: KNX	Basic concepts (domotic, inmotic, digital home). Physical levels of transmission. Main protocols used in domotic. KNX (Generalities, main characteristic, topology, telegram).
Theme 6: PROFIBUS	Physical layer. Topology. Data link layer. Media access control. Transmission methods. Timers. Structure of the frames.
Theme 7: WorldFIP	Physical layer. Data link layer. Variables and messages. Media access control. Frames format. Timers. Bus arbitrator. Producers/Consumers entities.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	4	8	12
Master Session	12	36	48
Tutored works	9	40	49
Laboratory practises	12	24	36
Short answer tests	5	0	5

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

Methodologies

	Description
Introductory activities	Presentation of the course. Presentation of the laboratory practices and the instrumentation and software to use. Through this methodology the competencies CG6, CG14 and CE64 are developed.
Master Session	Exhibition by professor of the contents. Personal homework of the student reviewing the concepts seen in the classroom and preparing the topics using the proposed bibliography. Identification of doubts that require to be resolved in personalised attention. Through this methodology the competencies CG6, CG14 and CE64 are developed.
Tutored works	A work about a specific protocol will be assigned to the students, individually or in group. This work will have to be exposed and argued in class. Through this methodology the competency CG14 is developed.
Laboratory practises	Activities of application of the theoretical knowledges purchased. It will learn to handle specific software of design, simulation and analysis of industrial communication networks. They will program simple hardware modules of some protocol studied in theory. Personal work of the student preparing the practices using the available documentation and reviewing the related theoretical concepts. Preparation and analysis of results. Identification of doubts that require to be resolved in personalised attention. Through this methodology the competency CG6 is developed.

Personalized attention

Methodologies	Description
Master Session	The students will be able to attend to personalised tutorials in the professor´s office in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts about the contents given in the Master Sessions and will be oriented about how to deal with them.
Tutored works	The students will be able to attend to personalised tutorials in the professor´s office in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts and will be oriented about the work that they have to do and present in the last weeks of classes.
Laboratory practises	The students will be able to attend to personalised tutorials in the professor´s office in the schedule that the professors will establish and will publish in the web page of the subject. Here, they will be able to resolve their doubts about the development of the laboratory practices, the handle of the software of design, simulation and analysis and the specifications and operation of the modules and kits that they use.

Assessment			
	Description	Qualification	Evaluated Competencess
Tutored works	Work that have to do the students and present in class. It will evaluate the work and the quality of the implementation and presentation.	50	CG6 CG14
Laboratory practises	The work of the student in the laboratory will be evaluated, as well as the memories that should be deliver of the practices.	20	CG6 CG14 CE64
Short answer tests	Exams that will be realised in the classroom after a set of exposed subjects to evaluate the knowledges acquired by the student.	30	CE64

Other comments and July evaluation

1. Continuous evaluation

Following the own guidelines of the degree and the agreements of the academic commission, a system of continuous evaluation will be offered to the students. Evaluation will be in Spanish.

1.a Proofs of short answer

There will be 3 proofs of short answer (type test and/or questions) properly programmed along the course. These proofs will be valued from 0 up to 10 and the final mark will be the average (NPRC):

NPRC = (NPRC1 + NPRC2 + NPRC3)/3

The proofs are not recoverable,that is to say, that if a student cannot attend the day in that they are programmed, the professor has no obligation to repeat them. The mark of the proofs that were missed will be of 0.

1.b Personalized works

A work will be assigned to the students, individually or by groups (depending of the number of students) in the first weeks of the course. This work should be delivered and presented in the last weeks of the course. The presentation of the works will be properly programmed by the professors. The implemented work and its presentation will be valued with a final mark (NT) from 0 up to 10.If the work is done in group, every student of the group will be valued with the same mark which will be the mark of the work (NT).

The student that does not deliver the work or does not present it in the indicated day will have a mark of 0.

1.c Laboratory practices

Each practice will be valued from 0 up to 10 taking into account the work made in the laboratory. The final mark of laboratory (NPL) will be the average of the qualifications obtained in the practices:

NPL = (NPL1 + NPL2 + … + NPLn)/n

The practices are not recoverable, that is to say, that if a student cannot attend the day in that they are programmed, the professor has no obligation to repeat them. The mark of the practices that were missed will be of 0.

1.d Final mark

The final mark (NF) will be:

NF = 0,3*NPRC + 0,5*NT + 0,2*NPL

2. Final exam

The students that do not pass by continuous evaluation (final qualification less than 5), will be able to present to a final exam.

The final exam will be in the dates provided for the School and will consist in a proof of short answer (type test and/or questions) (NPRC), the delivery and presentation of a work that the professors will have assigned to the student and the delivery of a laboratory work (NPL) previously assigned to the student by the professors. Each one of these parts will be valued from 0 up to 10. The students will be able to present to all these parts or which they consider appropriate. They will conserve the mark of the continuous evaluation in the parts that do not present.

The calculation of the final mark will be as it was explained in the section 1.d.

3. On the announcement of recovery

The announcement of recovery will have the same format that the final exam and will be in the dates provided for the School.

The students that present to this announcement can do it to all the parts or only which they consider appropriate. They will conserve the mark of the ordinary announcement (continuous evaluation or final exam) in the parts that do not present .

The calculation of the final mark will be as it was explained in the section 1.d. The final mark will be the best of the obtained by the student in the ordinary announcement and the recovery one.

4. Validity of the qualifications

The qualifications of the student will be valid only for the academic course in which they were obtained.

Sources of information
Basic Bibliography
Oliva N. y otros, Redes de comunicaciones industriales, 1ª, UNED, 2013, España
Complementary Bibliography
Castro M.A. y otros, Comunicaciones industriales: principios básicos, 1ª, UNED, 2007, España
Castro, M.A. y otros, Comunicaciones industriales: sistemas distribuidos y aplicaciones, 1ª, UNED, 2007, España

Recommendations

Other comments
It is recommended to have passed or be taking all the subjects of the Electronic Systems module

IDENTIFYING DATA				
Image processing and analysis				
Subject	Image processing and analysis			
Code	V05G300V01931			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Alba Castro, José Luis			
Lecturers	Alba Castro, José Luis			
E-mail	jalba@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	This course follows "Fundamentals of Image Processing" (3rd year). The student will acquire knowledge and skills on high-level techniques to analyze and extract relevant information from images of different application field in computer vision, medical imaging and multimedia resources. The course is lectured and assessed in english. The documentation is also in english.			

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CG10	CG10 The ability for critical reading of scientific papers and docs.	- Know How - Know be
CG12	CG12 The development of discussion ability about technical subjects	- Know be
CE73	(CE73/OP16) The ability to construct, exploit and manage artificial vision, medical imaging, and multimedia data base systems.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Understand the foundations of standard techniques to analyze images	CG10 CG12 CT2
Apply image analysis techniques in computers	CG9 CG12 CE73 CT4
Understand the foundations of image description techniques in advanced standards	CG10 CG12 CT2
Identify different analysis necessities for different imaging systems	CG9 CG12 CE73 CT4

Design an image analysis and description system	CG4 CG9 CE73 CT4

Contents	
Topic	
Analysis of image.	Segmentation based in colour, textures, shapes and models. Extraction of descriptive and invariant characteristics. Examples in actual problems.
Description and classification of objects.	Clustering. Image descriptors. Classical and probabilistic decisors. Classification. Examples in actual problems.
Aplications	RGB image processing. Medical image processing. Real-time video processing

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	10	10	20
Tutored works	24	82	106
Presentations / exhibitions	3	6	9
Introductory activities	3	0	3
Multiple choice tests	2	0	2
Reports / memories of practice	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	Each 3-hour class will include one hour of explanation of subject contents, encouraging critical discussion and assimilation through computer programming and visualization.
Tutored works	Each 3-hour session will include 2 hours of "hands-on" working to assimilate the explained concepts through problem-based learning (PBL). Every Problem/Task will take 4 or 5 weeks of the subject during which the student will have to discover, alone or with the professor guidance, what he needs to solve the problem effectively.
Presentations / exhibitions	The third and last task will be presented in front of the class mates. The students from the same group will have to split the presentation, so both of them explain one part of the work.
Introductory activities	In the first class of the course, concepts learned in FPI and the programming tools for the course will be reviewed: C/C++, QT, OpenCV

Personalized attention	
Methodologies	Description
Introductory activities	The introductory activities are related to motivation for learning how to to develop projects in real-life.
Master Session	During the master sessions, the teacher asks questions to the class and/or specific student to grab their attention about the current topic.
Tutored works	This methodology gives a lot of room for personalized attention. The teacher sits with each of the groups and guides every student through the step-by-step process of building a solution.
Presentations / exhibitions	Every time a student has to deliver a presentation (in the last guided task and also when challenged to beat another group in a specific subtask), the teacher explains him/them how to improve the impact of their presentation.

Assessment		
Description	Qualification	Evaluated Competencess

Multiple choice tests	Each part of the subject has theoretical concepts that are explained in class. The concepts are assessed through these tests, that are also formally linked to the delivery of each guided task. They are meant to grade each student individually. They help to assess general competence A82. The concepts are discussed in class and also individually through the e-learning platform and/or counseling hours.	15	CG10 CG12 CE73
Reports / memories of practice	Each part of the subject is learnt through a hands-on guided task. Most of the teacher's time is devoted to discuss, both in group and individually, how to go step by step through the process of building a solution. The score of the guided task includes: the follow-up of each student, the techniques used, the results achieved, the quality of the report and the oral presentation of the last one. The guided tasks help to assess general competences A4, A82, B1 and B3.	85	CG4 CG9 CE73 CT2 CT4

Other comments and July evaluation

Teaching and assessment is in english.

Attendance is compulsory in continuous assessment, unless special circumstances are alleged. Continuous assessment will be based on the student lab work and guided tasks related to contents of the subject.

There will be an official final exam scheduled by the "Junta de Escuela" that the students that didn't pass the continuous assessment will have to take if they want to pass the course. This final exam will be scored from 0 to 10 points and includes all the topics explained during the course and also concepts and techniques explained for the guided tasks. To pass this exam the student has to score, at least, 5 points. The students that are eager to improve their continuous assessment score can also take the final exam. In this case the final score of the course will be the maximum score of the final exam and continuous assessment.

Throughout the semester, the students will be receiving feedback about his performance on the continuous assessment, along with the scores obtained in the tests and guided tasks. Delivering any of the guided tasks or sitting any test will automatically mean that the student is following the course in the continuous assessment mode. That means that he will appear as "presented" in the records of the subject even if the final exam is not taken.

The continuous assessment contains the next milestones:

Guided task 1: linked to the image analysis topic (25%). 20% for the computer work and 5% for the test.

Guided task 2: linked both to the image analysis and classification topics (25%). 10% for the computer work and 5% for the test.

Guided task 3: linked to all topics (35%). 30% for the computer work an 5% for the test.

Report and public presentation of the 3rd guided task (15%).

The extraordinary final exam will only be held for students who failed the course both in continuous assesment mode or final exam. The score of the subject will be the score of this exam. The exam will be scored between 0 and 10. To pass the subject, at least 5 points are needed.

Sources of information

Basic Bibliography

Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 3ª (2008), Prentice Hall

Robert Laganière, OpenCV 2 Computer Vision Application Programming Cookbook, 2011, Packt Publishing

Complementary Bibliography

Jasmin Blanchette, Mark Summerfield, C++ GUI Programming with Qt 4, 2008, Prentice Hall

Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, 2ª (2001), John Wiley & sons

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Probability and Statistics/V05G300V01204
Programming I/V05G300V01205
Fundamentals of Sound and Image/V05G300V01405

Digital Signal Processing/V05G300V01304
Fundamentals of Image Processing/V05G300V01632
Imaging Systems/V05G300V01633

IDENTIFYING DATA				
Multimedia technology and computer graphics				
Subject	Multimedia technology and computer graphics			
Code	V05G300V01932			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Pena Giménez, Antonio			
Lecturers	Pena Giménez, Antonio			
E-mail	apena@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Topics related to Virtual Environments (video games, augmented reality, virtual reality). A videogame is developed in a multidisciplinary group, with students from other degrees. The development engine is Unity and programming language is C #.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know - Know How - Know be
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- know - Know How - Know be
CG12	CG12 The development of discussion ability about technical subjects	- know - Know How - Know be
CE74	(CE74/OP17) The ability to construct, exploit and manage image and synthetic video generation systems and interactive multimedia applications.	- know - Know How
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How - Know be

Learning outcomes	
Learning outcomes	Competences
Understand the foundations of the synthesis of image by computer.	CG3 CG12 CE74 CT3
Apply methods of synthesis of image by computer.	CG3 CG12 CE74 CT3
Apply methods of synthesis of effects of audio by computer.	CG3 CG12 CE74 CT3

Develop multimedia applications.	CG3 CG9 CE74 CT3 CT4

Contents

Topic	
Computer image synthesis	Approach to the associated electronics with the graphic processing boards on computers.
3D Modeling	Understanding the differences between different applications and what it implies on design compatibility issues. File formats for virtual environments and games.
3D Animation	Programming of simple animations of rigid objects (rotation, translation, scale). Illumination of scenes and video rendering from these scenes. Integration of animations in a virtual environment.
Audio 3D	Programming the soundscapes in a three-dimensional virtual environment. Mixing of different sound sources (environment, dialogues, effects, ...).
Virtual Reality, Enhanced Reality	Description of the mathematics underlying the creation of a Virtual Environment. Description and issues of virtual reality and augmented reality applications.
Video games	Multidisciplinarity in the construction of a video game. Notions of video game design. Pipeline in the development of a video game. Management and programming of a virtual environment engine (Unity).

Planning

	Class hours	Hours outside the classroom	Total hours
Projects	7	59.5	66.5
Practice in computer rooms	16	8.5	24.5
Master Session	17	26	43
Autonomous practices through ICT	0	14	14
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
Projects	Collaborative work in a small multidisciplinary group, with students from other Degrees of the University of Vigo, for the elaboration of a video game, following the professional production process of the related industry, from an initial concept to a final product. Group work, role assignments, working in common, planning, technical reports and oral presentation are considered. Through this methodology, competencies CG3, CG9, CE74, CT3, CT4 are developed.
Practice in computer rooms	Management and adjustment of the engine of a Virtual Environment. Programming of components in virtual objects. Through this methodology, competencies CG3, CG12, CE74, CT3 are developed.
Master Session	Exposition by the teacher of the contents of the subject, encouraging the critical discussion of the concepts. The theoretical bases of algorithms and procedures used to solve problems are laid down. Through this methodology, competencies CG3, CG12, CE74, CT3 are developed.
Autonomous practices through ICT	Written and / or audiovisual material is provided to study and prepare an online test. This activity is prior to the master class or computer room sessions where doubts will be solved and challenges will arise. Through this methodology, competencies CG3, CE74 are developed.

Personalized attention

Methodologies	Description
Master Session	Tutoring to solve issues related to master sessions or lab practice is implemented either individually or in reduced groups (no more than 2-3 students). E-mail confirmation to match the date of the appointment is needed.

Practice in computer rooms	Tutoring to solve issues related to master sessions or lab practice is implemented either individually or in reduced groups (no more than 2-3 students). E-mail confirmation to match the date of the appointment is needed.
Projects	During group projects an individualized tracking of the student is developed. Cross-evaluation within the group and autoevaluation may be used.

Assessment

	Description	Qualification	Evaluated Competencess
Practice in computer rooms	Work assessment in the computer room.	20	CG3 CG12 CE74 CT3
Projects	Assessment of a collaborative work, developed along the semester, including a written report and oral presentation.	55	CG3 CG9 CE74 CT3 CT4
Autonomous practices through ICT	Automatic corrected online test.	5	CG3 CE74
Short answer tests	Written test with short questions and problems to solve.	20	CG3 CG12 CE74 CT3

Other comments and July evaluation

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

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

Some tasks are evaluated:

* Collaborative work in a group C (weight: 55%): during approx. 12 weeks each group develops a project. Some evidences are picked during this period (cross evaluation, written test, etc.) and a final report must be delivered at the end. An oral presentation ends this activity. Individual assessment mark in group work is obtained from cross evaluation by the other members of the group, oral questions during presentations and/or written questions about the content of the work. Group work, role assignments, working in common, planning, technical reports and oral presentation are considered.

* Written exam (weight: 20%): short questions related to computer room and master classes activities, plus additional material. At the end of the semester, the same day when the final exam is planned.

* Automatic corrected online test. (Weight : 5%): prior to the sessions.

* Laboratory tests (Weight: 20%): at the end of the laboratory session.

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

CONDITIONS TO PASS THE SUBJECT

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

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

2) and a score equal to or greater than 4 (on the same scale) in each of the partial marks (written exam and collaborative group, respectively).

If some of these conditions are not fulfilled, then the final grade (on a ten-points scale) will be the minimum between the final mark and the value "4".

*** "Students who choose for evaluation at the end of the semester" conditions:**

The possibility of a final examination will be provided to students who do not opt for the continuous evaluation.

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

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

2) and a score equal to or greater than 4 (on the same scale) in each of the sections of the exam. These sections, respectively, correspond with:

* contents included in all activities

* project developed in group, including group internals, management, writing of technical reports and oral presentations.

If some of these conditions are not fulfilled, then the final grade (on a ten-points scale) will be the minimum between the final mark and the value "4".

--- RETAKE

Two different situations:

<u>=> Students that are evaluated using continuous evaluation:</u>

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

* repeat the written exam included in the continuous evaluation planning an be evaluated under the "Students who choose continuous evaluation" conditions, described above.

* be evaluated with the same final exam of students who choose for evaluation at the end of the semester, under the "Students who choose for evaluation at the end of the semester" evaluation conditions, described above. No other activities are considered.

<u>=> Students who choose for evaluation at the end of the semester:</u>

A final examination will be provided to students who do not opt for the continuous evaluation, and are evaluated under the "Students who choose for evaluation at the end of the semester" conditions, described above. No other activities are considered.

Sources of information
Basic Bibliography
Jeremy Gibson, Introduction to Game Design, Prototyping, and Development (Game Design and Development), Ed. 1, Addison Wesley, 2014,
Fletcher Dunn, Ian Parberry, 3D Math Primer for Graphics and Game Development, Ed. 2, A K Peters/CRC Press, 2011,
Unity, Unity web: API description, tutorials and more. (https://unity3d.com),
Complementary Bibliography
Jason Gregory (Editor), Game Engine Architecture, Ed. 2, A K Peters/CRC Press, 2014,
Durant R. Begault, 3-D sound for virtual reality and multimedia (https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20010044352.pdf), Ed. 1, 1994, (free download)
Eric Lengyel, Mathematics for 3D Game Programming and Computer Graphics, Ed. 2, Course Technology, 2011,
Guy Somberg, Game Audio Programming: Principles and Practices, Ed. 1, CRC Press, 2016,
Steven M. LaValle, Virtual Reality (http://vr.cs.uiuc.edu/vrbooka4.pdf), Ed. 1, University of Illinois, 2017, (free download)
Robert Nystrom, Game Programming Patterns (http://gameprogrammingpatterns.com/contents.html), Ed. 1, 2014, (available online)
Dieter Schmalstieg, Tobias Hollerer, Augmented Reality: Principles and Practice (Usability), Ed. 1, Addison-Wesley Professional, 2016,

Recommendations

Subjects that are recommended to be taken simultaneously

Image processing and analysis/V05G300V01931

Subjects that it is recommended to have taken before

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

Other comments

There will be group work sessions on Wednesday mornings, alternating between the Campus of Vigo and Pontevedra. The University will provide free round trip transportation from the Escola de Enxeñaría de Telecomunicación or the Facultad de Ciencias Sociais e a Comunicación, respectively.

In 2017/18, multidisciplinary groups will be formed by students of the following three subjects: (1) Video Games: design and development, 4th year, Degree in Audiovisual Communication. (2) Multimedia Technology and Computer graphics, 4th year, Degree in Telecommunication Engineering Technologies, Sound and Image module. (3) Intelligent systems programming, 4th year, Degree in Telecommunication Engineering Technologies, Telematics module. The activity is coordinated by teachers of the Teaching Innovation Group: ComTecArt (Communication, Technology and Art in Virtual Environments).

IDENTIFYING DATA				
Advanced acoustics				
Subject	Advanced acoustics			
Code	V05G300V01933			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish English			
Department				
Coordinator	Sobreira Seoane, Manuel Ángel			
Lecturers	García Lomba, Guillermo Sobreira Seoane, Manuel Ángel			
E-mail	msobre@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this subject, the use of advanced calculation methods in Acoustics are introduced. The Finite Element Method (FEM) and the Boundary Element Method (BEM) are applied to study problems of acoustic radiation, diffraction and modal analysis (calculation of mode shapes and resonance frequencies). Statistical Analysis Methods (SEA) are also introduced and applied to the calculation of flanking transmission in buildings. The language of the subject is mostly English, although the first lessons on Finite Element Methods could be explained in Spanish.			

Competencies		
Code		Typology
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.	- know
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.	- know
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.	- know
CE75	(CE75/OP18) The ability to elaborate noise maps and their geographical information display.	- know - Know How
CE76	(CE76/OP19) The ability to apply numerical methods in acoustical problem solving.	- know - Know How
CE77	(CE77/OP20) The ability to indentify industrial noise problems and to design appropriate control solutions.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Knowledge on the application of numerical methods in acoustics. Knowledge on the application of calculation models of sound transmission in structures. Knowledge on design techniques of mufflers. Capacity for understanding the results of complex acoustic measures and relate them with the calculations obtained by means of simulations. Knowledge of noise control measures in industrial environments.	CG2 CG5 CG7 CE75 CE76 CE77

Contents	
Topic	
Introduction.	Review of acoustic concepts: impedance, boundary conditions, Helmholtz and Euler equations.
The Finite Elements Method in Acoustics (FEM)	Theoretical introduction to the Finite Element Method. Radiation Problems with FEM. Diffraction Problems. Modal analysis with FEM: resonance frequencies and modes

The Boundary Element Method in Acoustics (BEM)	Introduction to the Boundary Element Method in Acoustics. Integral equation of Kirchhoff Helmholtz. Application to radiation and diffraction problems. The calculation of resonances in BEM.
Calculation methods based in S.E.A. Calculation of sound transmission in buildings.	Building Acoustics: acoustic insulation in buildings and determination of the flanking transmission. Calculation method of the international standard ISO 12354.
Other calculation methods.	Ray tracing and application to evaluation of sound propagation outdoors. Prediction of noise levels in industrial plants. Noise control.

Planning

	Class hours	Hours outside the classroom	Total hours
Tutored works	6	24	30
Practice in computer rooms	12	9	21
Previous studies / activities	0	15	15
Master Session	19	38	57
Short answer tests	2	8	10
Jobs and projects	2	10	12
Reports / memories of practice	1	4	5

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

Methodologies

	Description
Tutored works	Practical projects that the students have to develop: 1. Design of a diffuser to optimise the radiation pattern of a loudspeaker. 2. Design and calculation of the acoustic insulation of a building. Through this methodology the general competencies CG2, CG5, CG7 and the specific competency CE77 are developed. Transversal competencies as CT3 and CT4 are also developed.
Practice in computer rooms	The student will work with different software packages to apply the different calculation methods presented un the subject. 1. CAD and mesh generation: FreeCAD and Gmsh. 2. Finite Element calculations : COMSOL. 3. Boundary Element calculations: OpenBEM. 4. Calculations in building acoustics. Through this methodology the specific competencies CE 75, CE67 and CE77 are developed
Previous studies / activities	The students must study and prepare with the sources of information given before the lectures and the practical sessions. Through this methodology the general competencies CG2, CG5, CG7 and the specific competencies CE75, CE76 and CE77 are developed.
Master Session	Lectures will be given, developing the main theoretical concepts of the subject. Through this methodology the general competencies CG2, CG5, CG7 and the specific competencies CE75, CE76 and CE77 are developed.

Personalized attention

Methodologies	Description
Master Session	Lectures are develop within a continuous interaction framework, where students can answer questions delivered by the teacher. They could also solve their particular doubts during the sessions.
Tutored works	Tutored works are developed in small working groups. The works are followed during meetings between the groups and the teacher. In those meetings the students can interact and ask their questions to the teacher.
Practice in computer rooms	In practical sessions, each student must solve his/her own tasks. The teacher will be available during the session to solve any problem/question or doubt the student may have.

Assessment

Description	Qualification	Evaluated Competencess

Tutored works	Tutored practical project, with the delivery of a final report. The learning aims related to the ability to elaborate projects and application of calculation methods (numerical methods) are assesed. Learning aims related to the identification of problems are also assessed (through the application of numerical calculations).	25	CG2 CG5 CG7 CE75 CE77
Short answer tests	Written test, with short questions on the theory of the subject. Evaluation of learning aims involving knowledge of legislation and how to perform measurements.	25	CG2 CG5
Jobs and projects	Questions and report of the practical tasks. Evaluation of those learning aims related to noise measurement and analysis of acoustic problems using numerical calculations.	50	CG5 CG7 CE76 CE77

Other comments and July evaluation

Following the guidelines of the degree, two systems of evaluation are offered: continuous assessment (recommended) and a final examination. Evaluation with only a final examination will be only allowed in situations in which it is imposible to follow the system recommended.

LANGUAGE: Any student can choose which language will use during the assessment process (English, Spanish).

CONTINUOUS ASSESSMENT:

In order to be qualiffied following the continuous assessment proccess, the student will have to assist at least to the 80% of the programmed activities. The continuous assessment will be based in the evaluation of practical task, projects and two tests. Once a student has signed a document of agreement with the process of continuous assessment, the final degree will be obtained by the application of the criteria described bellow, even though a student could miss some of the tasks or tests envolved in the process.

Once the student has shown good skills in all the assesed learning aims (at least 4 over 10 points in each learning aim assesed), the final grade with be obtained from the weighted sum of the grade obtained in the following tasks with the weights given.

1. Reports/memories of practical exersices involving calculations with finite elements (FEM), that should be delivered around the week 11 (25% of the final grade).
2. Tutored works focused on the application of numerical methods to basic problems in acoustics. (50% of the final grade)
3. Short answer tests, around the week 9 (10 % of the final grade)
4. Individual test containing problems and practical exercises (15 % of the final note)

Tutored works are developed in groups. The final grade will be weighted taking into account the results of a cross assesment survey. To consider as "satiscactory" the contribution of each student to the group a minimum grade of 2 over 5 points is stablished.

The studenst have to show good skills in all the learning outcomes, therefore, four points over a ten points scale must be obtained in all the learning outcomes evaluated during the continuous evaluation process. The final grade will be obtaining through the addition of the grades obtained during the process with the weights given before. At least five over ten points should be obtained to pass the subject.
If it happens that the minimum requirement (4 over 10 points in all the learming outcomes) is not fullfilled and the weighted average is greater than 5 points, the final grade will be 4 over 10 points.

FINAL EXAMINATION (Continous Assesment)
The final examination consists in two tests (tasks 3 and 4 described before). Those students having less than four points in some of the practical tasks (1 and 2) should deliver those aditional jobs required by the teachers of the subjetc on the date of the final examination.

NON CONTINUOUS ASSESMENT:

A final examination is available for those students that for some reason could not follow the continuous evaluation assessment process. In this case there is date scheduled and officially published for final examination. The final examination will consist in two short answer tests, and some additional questions related with the practical tasks and projects.

The subject is assessed in a 0 to 10 points scale and it is considered "passed" if the final grade obtained if equal or greater than 5.

RETAKE:

There is scheduled date at the end of the semester for a final examination retake, for those students that either dropped out during the semester or failed. Prior the examination, a student can choose to follow the continuous assessment or the final examination. In the former selection, the grades obtained in the projects and practical tasks will be taken into account and the student will only answer to the short answer tests. If the later, (final examination), the student will have also to answer a full examination as described before.

Sources of information
Basic Bibliography
Ciskowski R.D. and Brebbia C.A., Boundary Element Methods in Acoustics, Elsevier
CEN European Standards, EN 12354-1:2000. Building Acoustics - Estimation of acoustic performance of buildings from the performance of elements - Part 1: Airborne sound insulation between rooms, CEN
Reddy, J.N., An introduction to the Finite Element Method,, 2ª y 3ª ed, Mc Graw Hill
Complementary Bibliography
Johnson C., Numerical solution of PDE by the finite element method., Dover
Quarteroni A, Valli A., Numerical approximation of partial differential equations, Springer Verlag
Juhl, P.M., The Boundary Element Method for Sound Field Calculations, www.openbem.dk

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Linear algebra/V05G300V01104
Mathematics: Calculus 1/V05G300V01105
Mathematics: Calculus 2/V05G300V01203
Fundamentals of Sound and Image/V05G300V01405
Room Acoustics/V05G300V01635
Fundamentals of Acoustics Engineering/V05G300V01531

IDENTIFYING DATA				
Legislation and noise measurement techniques				
Subject	Legislation and noise measurement techniques			
Code	V05G300V01934			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Torres Guijarro, María Soledad			
Lecturers	Torres Guijarro, María Soledad			
E-mail	marisol@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this subject, the main methods of measurement of environmental noise are discussed. The European an national regulations on noise and acoustic insulation are also presented. As part of the measurement process, a guide for the evaluation of the measurement uncertainty in acoustics is also presented. The teaching will be in English.			

Competencies		
Code		Typology
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.	- know
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.	- know
CG7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.	- know
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.	- know
CE78	(CE78/OP21) The ability to write essays on environmental, construction and automation acoustics.	- know - Know How
CE79	(CE79/OP22) The ability to elaborate specific acoustic essay procedures.	- know - Know How

Learning outcomes	
Learning outcomes	Competences
Knowledge of the regulations on the field of acoustic engineering.	CG2
Knowledge of the usual international standards on acoustic measurements.	CG2
Ability to write technical and reports, measurement reports on fields related to acoustic engineering.	CG5 CG7 CG8
Ability to design measurement procedures matching the regulations and standard specifications.	CE78 CE79

Contents	
Topic	
Introduction: noise, its description and annoyance.	Classification of noise and descriptors. The assessment of noise. General overview of measurements in acoustics. Nose levels, vehicle noise: pass by measurements, sound power determination.
Description and measurement of environmental noise	Characterization of the noise sources. Influence of the propagation conditions. Noise measurements.

Environmental noise regulations in Europe.	The EU Environmental Noise Directive. Directive 2002/49/EC of the European Parliament and of the Council of 25th June 2002 relating to the assessment and management of environmental noise. National noise regulations.
Acoustic Insulation, description and regulations in Europe.	Acoustic insulation, descriptors. National Code Buildings in Europe, and the regulations on acoustic insulation.
Measurement uncertainty.	The need to assess the measurement uncertainty: quality management in laboratories. The guide for expression of uncertainty in measurement- GUM. Measurement Uncertainty in Acoustics.

Planning

	Class hours	Hours outside the classroom	Total hours
Tutored works	6	24	30
Laboratory practises	12	9	21
Previous studies / activities	0	15	15
Master Session	19	38	57
Short answer tests	2	8	10
Reports / memories of practice	2	10	12
Jobs and projects	1	4	5

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

Methodologies

	Description
Tutored works	The student has to develop in group and write a report on two projects: 1. Procedure to describe and assess environmental noise un a real scenario. 2. Project of acoustic insulation according to the simplified method described in the CTE-DB HR (Spanish Building Code, document for protection against noise). Through this methodology the competencies CG2, CG5, CG7, CG8, CE78, CE79 are developed.
Laboratory practises	Laboratory practises on: 1. Characterisation and assessment of noise annoyance. 2. Noise measurements in closed spaces. 3. Measurement of pass-by noise. 4. Measurement of acoustic insulation in buildings. Detailed uncertainty budget for some of the measurements carried out. Through this methodology the competencies CG2, CG5, CG7, CG8, CE78, CE79 are developed.
Previous studies / activities	The students must study and prepare with the sources of information given before the lectures and the practical sessions. Through this methodology the competencies CG2, CG5, CG8, CE78, CE79 are developed.
Master Session	Lectures will be given, developing the main concepts of the subject. Through this methodology the competencies CG2, CG5, CG7, CG8, CE78, CE79 are developed.

Personalized attention

Methodologies	Description
Master Session	The doubts, questions and discussions on topics related to the subject can be carried out in tutoring sessions which can be attended either individually or in small groups (maximum 3 students) Previous appointment with the professor is needed. The appointment will be requested and agreed by email, preferably in the hours and places previously scheduled and officially published.
Tutored works	The doubts, questions and discussions on topics related to the subject can be carried out in tutoring sessions which can be attended either individually or in small groups (maximum 3 students) Previous appointment with the professor is needed. The appointment will be requested and agreed by email, preferably in the hours and places previously scheduled and officially published.
Laboratory practises	The doubts, questions and discussions on topics related to the subject can be carried out in tutoring sessions which can be attended either individually or in small groups (maximum 3 students) Previous appointment with the professor is needed. The appointment will be requested and agreed by email, preferably in the hours and places previously scheduled and officially published.
Tests	Description

Short answer tests	The doubts, questions and discussions on topics related to the subject can be carried out in tutoring sessions which can be attended either individually or in small groups (maximum 3 students) Previous appointment with the professor is needed. The appointment will be requested and agreed by email, preferably in the hours and places previously scheduled and officially published.
Reports / memories of practice	The doubts, questions and discussions on topics related to the subject can be carried out in tutoring sessions which can be attended either individually or in small groups (maximum 3 students) Previous appointment with the professor is needed. The appointment will be requested and agreed by email, preferably in the hours and places previously scheduled and officially published.
Jobs and projects	The doubts, questions and discussions on topics related to the subject can be carried out in tutoring sessions which can be attended either individually or in small groups (maximum 3 students) Previous appointment with the professor is needed. The appointment will be requested and agreed by email, preferably in the hours and places previously scheduled and officially published.

Assessment

	Description	Qualification	Evaluated Competencess
Tutored works	Tutored practical project, with the delivery of a final report and oral presentation of results. The individual grade of group work is obtained as the weighted sum of: 1) the common grade of the group (60%); 2) The individual grade (40%), obtained from one or more of the following assessment methods: peer assessment by the other members of the group, oral questions during presentations of the work, written questions about the content of the work.	30	CG2 CG5 CG7 CG8 CE78 CE79
Short answer tests	Written test, with short questions on the theory of the subject.	40	CG2 CG5 CG7 CE78 CE79
Reports / memories of practice	Questions and report of the practical tasks.	30	CG2 CG5 CG7 CE78 CE79

Other comments and July evaluation

TEACHING LANGUAGE:English

ASSESSMENTLANGUAGE: The student can choose to do the writtem test in English or Spanish.

Following the guidelines of the degree, two systems of evaluation are offered: continuous assessment (recommended) and a final examination. Evaluation with only a final examination will be only allowed in situations in which it is imposible to follow the recommended system.

CONTINUOUS ASSESSMENT:

The continuous assessment will be based in the evaluation of practical task, projects and two tests. Once a student has signed a document of agreement with the process of continuous assessment, the final degree will be obtained by the application of the criteria described bellow.

The subject is assessed in a 0 to 10 points scale and it is considered "passed" if each activity is graded equal or greater than 4, and the final grade obtained is equal or greater than 5. The final grade with be obtained from the weighted sum of the grade obtained in the following tasks with the given weights. If in any of the activities the grade does not reach 4 but the average exceeds 5, the final grade will be 4.

1. Tutored works: 30 % of the final grade. Two reports will be delivered: the first during the 6th week and the second during the 11th week. The individualized part of the assessment will be done through cross-evaluation, oral questions during presentations, and written exam questions.
2. Reports of practical tasks(Weight: 40 %).
3. Short answer tests : A short answer test is included in the process of continuous assesment, at the end of the tern, with a weight of 40% on the final grade.

FINAL EXAMINATION:

A final examination is available for those students that for some reason could not follow the continuous evaluation assessment process. In this case there is date scheduled and officially published for final examination. The final examination will consist in a short answer test, and some additional questions related with the practical tasks and projects.

The subject is assessed in a 0 to 10 points scale and it is considered "passed" if the final grade obtained is equal or greater than 5.

RETAKE IN JULY:

There is scheduled date in july for a final examination retake, for those students that either dropped out during the semester or failed. Prior the examination, a student can choose to follow the continuous assessment or the final examination. In the former selection, the grades obtained in the projects and practical tasks will be taken into account and the student will only answer to the short answer test. If the later, (final examination), the student will have also to answer a full examination as described before.

Sources of information

Basic Bibliography

ISO Standard, ISO 1996-1. Acoustics -- Description, measurement and assessment of environmental noise -- Part 1: Basic quantities and assessment procedures, ISO Standard

ISO Standard, ISO 1996-2. Acoustics -- Description, measurement and assessment of environmental noise -- Part 2: Determination of environmental noise levels, ISO Standard

ISO Standard., ISO 140-4:1998 Acoustics -- Measurement of sound insulation in buildings and of building elements -- Part 4: Field measurements of airborne sound insulation between rooms., ISO Standard.

Complementary Bibliography

DIRECTIVE 2002/49/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 June 2002 relating to the assessment and management of environmental noise, Official Journal of the European Communities, 18.0

Birgit Rasmussen, J. H. Rindel, Sound insulation between dwellings – Descriptors applied in building regulations in Europe, Applied Acoustics 71 (2010) 171–180

Birgit Rasmussen, Sound insulation between dwellings – Requirements in building regulations in Europe, Applied Acoustics 71 (2010) 373–385

RODRIGO AVILÉS LÓPEZ, ROCÍO PERERA MARTÍN, Manual de acústica ambiental y arquitectónica, Paraninfo, 2017, Madrid, Spain

Recommendations

Subjects that it is recommended to have taken before

Fundamentals of Sound and Image/V05G300V01405
Room Acoustics/V05G300V01635
Fundamentals of Acoustics Engineering/V05G300V01531
Sound Processing/V05G300V01634
Audio Systems/V05G300V01532
Audiovisual Technology/V05G300V01631

IDENTIFYING DATA				
Audiovisual production				
Subject	Audiovisual production			
Code	V05G300V01935			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Fernández Santiago, Luís Emilio			
Lecturers	Fernández Santiago, Luís Emilio			
E-mail	faraon@uvigo.es			
Web	http://faitic.uvigo.es			
General description	General knowledge of the processes and language of AudioVisual production and direction, compression oriented them to get the ability to integrate into production / direction team, after organization charts, technical positions. Also, achieve general skills on cameras, Sets and NLE Editing Systems. Documentation in english.			

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know - Know be
CG8	CG8: To know and apply basic elements of economics and human resources management, project organization and planning, as well as the legislation, regulation and standarization in Telecommunications.	- know - Know How
CG12	CG12 The development of discussion ability about technical subjects	- know - Know be
CE80	(CE80/OP23) The ability to conceptually and technically manage the phases in an audiovisual production.	- know - Know How
CE81	(CE81/OP24) The ability to creatively and skillfully use the technical equipment for production development.	- know - Know How
CE82	(CE82/OP25) The ability to use specific software applications in audiovisual production.	- know - Know How
CE83	(CE83/OP26) The ability to organize an audiovisual production.	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be

Learning outcomes	
Learning outcomes	Competences
Know the stages and the techniques of an Audiovisual production.	CG4 CG8 CG12 CE80
Identify the various audiovisual structures.	CE80
Know use the necessary technologies to develop an audiovisual production.	CG4 CG12 CE80 CE81 CE82 CT2
Know use of the postproduction software tools.	CE81 CE82

Know how to manage an audiovisual project.	CG8 CE80 CE81 CE83 CT2

Contents	
Topic	
Audiovisual Concepts:	Basic audiovisual language. Polysemy audiovisual, formats and genres. Production development, From Script to Broadcast: -script, revision, screenplay, development. shooting script, Storyboard. -Production Breakdown script, blocking shoots,shooting schedule, call sheets. Generic Organization of a studio. Generic Organization of production.
Definition of technical positions:	Preproduction: -Advisor (foresight other stages) -Technical Direction. -IT system Administration. (Networks, databases-nomenclatures-, adaptation ...) Production: -Electrical (lighting, rush ...) -Physical effects (mechanical, electronic, computer ...) -Sound. (Record, registration) -Signal Control. -Camera Control. Postproduction: -Transfer of information. (workflow&pipeline) -Quality control, compression. -Postprodcution operator (editing, Grading) -Computer effects. Broadcast: -Recoding, compressing and reformatting. -Replication. -Streaming.
Audiovisual Genres	Specific studio / production genre based: -Fiction -Advertising -Industrial -News -Magazines -Visual Effects -Animation TV as a set
Theoretical information linked to practices	NEWS -news, scipting, call sheets, recording. -Capture, editing and export. -Playlist, headers, bursts, direction, broadcast. REPORT: -Types, definition, development, DOCUMENTARY: -Documentation, rhythm, graphics. FICTION: -single camera, multi camera.

PRÁCTICAS	Camera: -Installation. -Specific and common elements. -Settings. -Analysis of the signal. -Variables involved in filming. NEWS -News, scipting, call sheets, recording. -News scripting and Recording. Edition: -Setting projects -Footage capture. -online/offline - linear / nonlinear -Three points editing -Triming -Audio setting. (Levels) -Export. NEWS -Capture, editing and export. -Editing news. Set -Set's camera. -Camera control -Lighting -Chroma lighting -Set's Resources -Direction NEWS -Playlist, headers, bursts, direction, broadcast. REPORT: -Types, definition, development, -Developing, recording and editing a story. DOCUMENTARY: -Documentation, rhythm, graphics. FICTION: -Single camera, multi camera. -Development, directión, production design, conducting a fictional Gag in single camera and set. POSTPRODUCTION (the basics): quality lost in compression / quality comparison. chroma key. wire removal. track. 3D track. integration.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	16	40	56
Laboratory practises	7	11	18
Classroom work	10	45	55
Outdoor study / field practices	5.84	0	5.84
Practical tests, real task execution and / or simulated.	0.16	0	0.16
Multiple choice tests	1	0	1
Reports / memories of practice	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	Theoretical sessions on concepts of visual language, formats, sets and use, workflow and integration of technical human resources in the production's team.
Laboratory practises	practise on images and sound gathering and their postproduction to develop audiovisual products.
Classroom work	Realization of Audiovisual contents to suitable for differect formats, apliying the knowledge learnt in the laboratory practices.
Outdoor study / field practices	Practices in the TV Set of CC.SS. Aimed to the understanding of direction workflow for news and fictional programs.

Personalized attention	
Methodologies	Description
Laboratory practises	Use of systems and software for Audiovisual production, turn of questions during the practices, access to office and solution of questions via email or message. Individual test about the contents seen on practises.
Classroom work	Application of methods seen in workshops and classes for distinct types of audiovisual production, advice about developing each project, as human team or individual. Access to office and solution of questions via email or message. Individual test about the contents seen on practises.
Tests	Description
Reports / memories of practice	Report about the personal participation in group works. Development on the knowledge of all the process independently of the role played.

Assessment			
	Description	Qualification	Evaluated Competencess
Classroom work	Group products developed in the classroom and in the self time: News, Report, Documentary, Fiction. In collaborative tasks, each group member get the same mark, as long as each one is responsible of the results.	40	CG4 CG8 CG12 CE80 CE82
Practical tests, real task execution and / or simulated.	Individual Editing of the report and set's individual test.	25	CG4 CE81 CE82 CT2
Multiple choice tests	Test, theoretical contents and practical concepts of the subject.	20	CG8 CE80 CE81 CE82 CE83
Reports / memories of practice	Report of the differences between multicamera and singlecamera productions over the various studied formats. Study of a project.	15	CG8 CG12 CE83 CT2

Other comments and July evaluation

In second call will be necessary pass an Test (30%-theoretical contents and practical concepts of the subject) and questions to develop(30%-knowledge of the process of production formats) and a practical exercise of efficience in the handle of camera and NLE edition (40%).

Sources of information

Basic Bibliography

MMILLERSON, GERALD. OWENS, JIM, Television production, Taylor & Francis

Complementary Bibliography

ALTEN, STANLEY, Audio in media, Wadsworth

TRIBALDOS, CLEMENTE, Sonido profesional, Paraninfo

RUMSEY, FRANCIS. MCCORMICK, TIM, Sonido y grabación; Introducción a las técnicas sonoras, 2ª edición, IORTV

ONDAATJE, MICHEL, The Conversations: Walter Murch and the Art of Editing Film, Bloomsbury Publishing Plc

BRINKMANN, R., The art and science of digital compositing, 2nd ed, Elsevier

HERRERO, JULIO CESAR, Manual de teoria de la información y telecomunicación, 2009, Universitas

Dunlop, Renee, Production Pipeline Fundamentals for Film and Games, 1st Edition, Focal Press, 2014,

Glor, Flax & Sardella, Andrea, Filmmaking Simplified: Practical Techniques for Getting More out of Any Production, Edition: 1, kindle,

Recommendations

Subjects that are recommended to be taken simultaneously

Image processing and analysis/V05G300V01931
Multimedia technology and computer graphics/V05G300V01932

Subjects that it is recommended to have taken before

Fundamentals of Sound and Image/V05G300V01405
Fundamentals of Image Processing/V05G300V01632
Sound Processing/V05G300V01634
Imaging Systems/V05G300V01633
Audiovisual Technology/V05G300V01631
Video and Television/V05G300V01533

IDENTIFYING DATA				
Multimedia services				
Subject	Multimedia services			
Code	V05G300V01941			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	López Nores, Martín			
Lecturers	López Nores, Martín Mikic Fonte, Fernando Ariel Ramos Merino, Mateo			
E-mail	mlnores@det.uvigo.es			
Web	http://www.faitic.es			
General description	The aim of this subject is to provide the students with the theoretical foundations and the practical skills that allow them to understand the basic principles of the digital treatment of the multimedia information. To this aim, the main standards in the field of the audiovisual content processing are presented, as well as the mechanisms available for the transmission of data through different types of networks and the different types of services that can be offered to the end user, with special attention to digital terrestrial TV broadcasting (DTTV) and transmission over IP networks (IPTV). The practical part of the subject will allow the students to experiment with the design and development of telematic services based on the transmission of multimedia streams, along with the programming of interactive services about digital television broadcasting and video-on-demand. The documentation of the subject will be available in English.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG6	CG6: The aptitude to manage mandatory specifications, procedures and laws.	- know
CE84	(CE84/OP27) The ability to apply the techniques based on computer, networks and distributed applications and services, in the broadcasting and interchange of audiovisual information.	- know - Know How
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be

Learning outcomes	
Learning outcomes	Competences
Understand the basic foundations of the digital treatment of the multimedia information.	CG3 CE84
Know the main standards in the field of the processing of the multimedia information.	CG6
Understand the foundations and the main mediums adopted in digital TV broadcasting.	CG6 CE84
Know the basic foundations of the transmission of audiovisual information through telematic networks.	CG3 CE84 CT3
Acquire skills in the design and development of telematic services based on exchanging audiovisual contents.	CG3 CE84 CT3
Acquire skills for the programming of telematic services in the scope of interactive digital television.	CE84

Contents
Topic

1. Multimedia systems: Foundations and basic concepts	a. Digitalization of audio and video signals. b. Format for storage of audio and video signals. c. Conditional access and digital rights management.
2. Terrestrial Digital TV broadcasting	a. Architecture b. Transport of bitstreams c. Signaling d. Middlewares e. Mobile Digital Television
3. IP Television and video-on-demand	a. Architecture b. Data distribution. VoD and nVoD. c. Broadcasting, multicasting and P2P d. Systems and protocols e. Signaling

Planning

	Class hours	Hours outside the classroom	Total hours
Presentations / exhibitions	2	3	5
Projects	7	33	40
Practice in computer rooms	4	7	11
Practice in computer rooms	8	22	30
Seminars	3	0	3
Master Session	18	32	50
Multiple choice tests	2	9	11

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

Methodologies

	Description
Presentations / exhibitions	The students, organized into groups of 2-3 people (as per professor's criteria), will expose to their mates in the computer room the main design decision and implementation details of the Project planned for group classes, besides showing how it works. The aim is to argue the advantages and problems of each model, promoting the debate around the proposal of each group. These methodologies will assess the skills CG3, CG6 and CT3.
Projects	The students, organized in groups of 2-3 people (as per professor's criteria), will implement the project planned for group classes. The goal is to boost a collective discussion to identify the key points when it comes to developing the functionalities of each project. The students will combine face-to-face work in the computer room with the individual work. These methodologies will assess the skills CG3, CG6 and CT3.
Practice in computer rooms	The professor will propose practices in which the students will deal with the main concepts explained in the subject, putting the focus on the coding formats adopted in the transmission of multimedia information. The doubts arisen during the autonomous work of the students in the computer room will allow to promote the debate of the group to agree the best solution for each problem. These methodologies will assess the skills CE84 and CG3.
Practice in computer rooms	The professor will propose practices in which the students will deal with the main concepts explained in the subject, putting the focus on possible applications in the realm of Terrestrial Digital TV and transmission of television over IP. The doubts arisen during the autonomous work of the students in the computer room will allow to promote the debate of the group to agree the best solution for each problem. These methodologies will assess the skills CE84, CG3 and CG6.
Seminars	Invited presentations will be delivered by representatives of companies whose activities relate directly to any of the subjects treated in the course, fostering a debate with the professor and the students. This methodology will assess the skills CT3 and CE84.

Master Session	Classes where the main theoretical concepts of the subject will be explained, by proposing examples and possible application scenarios in the context of the transmission of multimedia streams. These methodologies will assess the skills CG3 and CG6.

Personalized attention

Methodologies	Description
Master Session	The professor will address the doubts raised by each student during the public presentation of the contents that will be explained in master sessions.
Presentations / exhibitions	After the public exhibition made by each student about the main design decisions, implementation details and demo of the functioning of the developed project, the professor will provide personalized feedback in order to highlight the potential and possible limitations identified in each part of the development.
Projects	In the computer room, the professor will carry out a personalized follow-up of the member of each group, with the goal of fixing possible deficiencies and guiding right decisions when facing design and implementation of the project.
Practice in computer rooms	The personalized attention will be based on following-up the work of each student, by tracking the solutions proposed for each problem proposed in the practices in the computer room.
Practice in computer rooms	The personalized attention will be based on following-up the work of each student, by tracking the solutions proposed for each problem proposed in the practices in the computer room.
Seminars	The professor will complement the explanations provided by the invited speakers in reply to the questions posed by the students, in order to integrate the points of view of business, academy and science.

Assessment

	Description	Qualification	Evaluated Competencess
Presentations / exhibitions	The students, organised in groups of 2-3 people (according to the criterion of the professor), will make a public presentation describing the main decisions of design and details of implementation of the project proposed for groups C. Each member of the group must identify which part of the project has developed, showing its real-time functioning during the public exhibition. These presentations will take place during week 17. The mark of each member (up to 1,5 points) will depend on the following criteria: (i) the particular level of knowledge about his/her contribution, (ii) its complexity, and (iii) his/her personal performance during the exhibition.	15	CG3 CG6 CT3
Projects	The students, organized in groups of 2-3 people (according to the criterion of the professor), will develop a project about Digital TV broadcast or video streaming over IP. This project, that must be delivered during week 17, must include the code and the necessary documentation to justify the main design decisions and implementation details. The mark of each member of the group (up to 2,5 points) will depend on the following criteria: (i) the quality of the documentation related to the part of the project this student has made, and (ii) the relevance and usefulness of the developed functionalities.	25	CG3 CG6 CT3
Practice in computer rooms	The students will deliver individually a report in which they will describe the solution proposed for a first practice in the laboratory, which will be about the main formats of coding adopted in the transmission of the multimedia information over telematic networks. In case to be necessary, the submission will include the software used in the development of the solution proposed. This first practice will be delivered during 6th week of the course.	10	CG3 CE84
Practice in computer rooms	Each student will deliver individually a report that describes properly the solution proposed for the second of the practical proposals in the laboratory, which will be about Digital TV broadcast. The proposed solutions must include the coding adopted in the development of the practice, as well as a rigorous discussion about design decisions and implementation details. The practice will be delivered during 10th week of the course.	20	CG3 CG6 CE84

Multiple choice tests	Each student will take --individually and without material of support-- an exam including multiple-choice tests and short-answer questions, which is aimed at assessing his level of understanding on the theoretical concepts explained in the subject. This exam will be held on the official date approved by the Board of School. Any type of support material is not allowed in this exam.	30	CG3 CG6

Other comments and July evaluation

Lessons will be explained in Spanish, although the material about the subject will be available in English.

There exist two mechanisms for the assessment of students in this subject: continuous assessment (CA) and traditional assessment (TA). Regardless of the considered assessment mechanism, the pass mark for the subject is 5 out of 10.

The students must choose one of the possible mechanisms by bearing in mind the following conditions:

- CA includes the 5 tests described above.
- Students who sit CA must submit during the 6th week of the course their solution for the first practice proposed in the computer room (3rd test in the previous section). By the submission of this practice the student makes a commitment to be assessed via CA, thus renouncing the TA mechanism. In virtue of this commitment, the final remark of these students cannot be "Not taken".
- Students who do not submit the first practice during the 6th week of the course renounce to the CA, thus being assessed through the TA mechanism. Note that it will not be possible to join the CA in the next tests.
- CA tests will be carried out only in the dates defined by the professors. These CA tests cannot be repeated later.
- The grades obtained in the CA and other exams and practical projects are only valid for the current academic year.
- CA will be just considered in the first opportunity to pass the subject. In the second one only TA will be valid.

Students who sit CA in the first opportunity to pass the subject will be assessed as follows:

- CA tests will be 100% of the final remark of the student. This assessment mechanism consists of five CA tests that have been previously described (a multiple-choice test, two practices in the computer room, delivery of code and documentation of the practical project proposed for group classes, and the public presentation of its main design and implementation decisions, including a real-time demo of its functioning). Note that the student makes a commitment to follow-up CA by submitting the first practice during the 6th week of the course, thus renouncing the TA mechanism.

Students who sit TA in the first opportunity to pass the subject will be assessed as follows:

- A final exam that these students will take in the official date published at http://www.teleco.uvigo.es. This test will include short-answer questions and/or multiple-choice tests, along with problems and practical use cases to be analyzed and resolved. The weight of this exam in the final remark is 50%. Note that support materials are not allowed.
- Submission of a practical project that will include software and documentation to justify design decisions and describe implementation details. The weight of this project in the final remark is 50%. Note that that each student must submit this project individually in week 17.

Students who did not pass the subject in the first opportunity, will have **a second opportunity** where they cannot be assessed via CA, so that **only TA is valid**. Therefore, these students must (i) take the final exam (in the official date published at http://www.teleco.uvigo.es) and (ii) submit individually the practical project (in the date published by professors at www.faitic.uvigo.es), as described above for the TA mechanism. The weight of each part in the final remark will be 50%.

Sources of information

Basic Bibliography

Wes Simpson, Video over IP IPTV, Internet video, H.264, P2P, Web TV, and streaming: a complete guide to understanding the technology, Elsevier, 2008,

Frantisek Korbel, FFmpeg Basics: Multimedia handling with a fast audio and video encoder, CreateSpace, 2012,

Complementary Bibliography

Jan Lee Ozer, Video Encoding by the Numbers: Eliminate the Guesswork from your Streaming Video, Doceo Publishing, 2016,

José J. Pazos Arias, Carlos Delgado Kloos, Martín López Nores, Personalization of Interactive Multimedia Services: a research and development perspective, Nova Science Publishers, 2008, George Lekakos, Konstantinos Chorianopoulos, Georgios Doukidis, Interactive Digital Television: technologies and applications, IGI Publishing, 2007,

Liliana Ardissono, Alfred Kobsa, Mark Maybury, Personalized Digital Television: targeting programs to individual viewers, Kluwer Academic Publishers, 2004,

Digital Video Broadcasting Consortium, DVB Standards, http://www.dvb.org/technology/standards/

Recommendations

Other comments

It is recommended to have taken or to be taking the following subjects of the Telematics-related module:

+ Operating systems
+ Architecture and Technology of Networks
+ Security
+ Concurrent and Distributed Programming
+ Networks and Switching Theory
+ Multimedia Networks
+ Systems of Information
+ Architectures and Telematic Services

IDENTIFYING DATA				
Wireless and mobile networks				
Subject	Wireless and mobile networks			
Code	V05G300V01942			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish Galician			
Department				
Coordinator	López Bravo, Cristina			
Lecturers	López Bravo, Cristina			
E-mail	clbravo@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The subject "Wireless and Mobile Networks" (redes sen fíos e móbiles) examines the area of wireless and mobile networks, one of the technological basis of the present society, studying the existing challenges for the communications protocols, and looks at the opportunities that provides continuous connectivity even in movement. The focus of this subject will be on network protocols above physical layer (nevertheless, it will touch the most important physical layer properties). The documentation will be available in english.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How
CE85	(CE85/OP28) The ability to analyze, plan and deploy wireless communication networks for different coverage ranges: metropolitan, local and short range.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know - Know How
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know - Know How - Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How

Learning outcomes	
Learning outcomes	Competences
Understand the main concepts of wireless communications.	CG3 CE85 CT2 CT3
Understand the main concepts of mobile communications.	CG3 CE85 CT2 CT3

Know the main protocols used in wireless communication networks.	CG3 CE85 CT2 CT3
Know the architectures used in wireless communication networks.	CG3 CE85 CT2 CT3
Ability to design mobile wireless networks.	CG4 CG9 CE85 CT2 CT3 CT4

Contents

Topic	
Introduction to wireless communications	Channel characteristics Multiple access Modulation
Principles of operation of wireless networks	Mobility management Introduction to ubiquitous computing Ad hoc networks, routing Security Network topologies
Wide area networks	Architecture Mobile networks Network topologies Practical case
Local networks	Architecture: ad hoc and infrastructure based networks User authentication approaches Security Quality of services Practical case
Low range networks	Architecture Bandwidth/power consumption balance Personal communication Industrial communication

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	19	38	57
Integrated methodologies	6	28	34
Laboratory practises	13	39	52
Reports / memories of practice	0	3	3
Systematic observation	1	0	1
Jobs and projects	1	0	1
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
Master Session	Professors present the main theoretical contents related to wireless and mobile networks. Through this methodology the competencies CG3 and CE85 are developed.
Integrated methodologies	Team development of the design, implementation and validation of a protocol, system, application or service. Through this methodology the competencies CG3, CG4, CG9, CE85, CT2, CT3 and CT4 are developed.
Laboratory practises	Students will complete guided and supervised practices in the laboratory. Through this methodology the competencies CG3, CG4 and CE85 are developed.

Personalized attention

Methodologies	Description
Master Session	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered during the master sessions or during tutorial sessions. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.
Integrated methodologies	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered during the supervising sessions or during tutorial sessions. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.
Laboratory practises	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered during the lab sessions or during tutorial sessions. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.

Assessment

	Description	Qualification	Evaluated Competencess
Master Session	Students will be evaluated to asses what they have learned in master sessions.	30	CG3 CE85
Integrated methodologies	Students will be divided in groups to complete the design, implementation and validation of a protocol, a system, an application or service. The result will be evaluated after the delivery, having into account key aspects such as the correction, the quality, the performance and the functionalities. In addition, during the implementation of the project, the design and the evolution of the development will be evaluated. The evaluation will be by group and by person: each one of the members of a team must document his/her tasks and answer the questions related to them.	50	CG3 CG4 CG9 CE85 CT2 CT3 CT4
Laboratory practises	Students will fill lab reports, individually, to asses the correct realization and understanding of the laboratory tasks.	20	CG3 CG4 CE85

Other comments and July evaluation

In order to pass the course it is necessary to complete the different parts of the course (master sessions, practices in labs, and tutored works - integrated methodologies). The final grade will be the **weighted geometric mean** of the grades of the different parts (i.e. it is not possible to pass the subject with a zero in one part). If "x" is the grade obtained for the master sessions, "y" for the practices in labs, and "z" for the tutored works - integrated methodologies, the final grade will be: FG = x^0.3*y^0.2*z^0.5.

During the first month, students must declare if they opt for continuous or final assessment. Students who select continuous assessment and submit the first task or lab report may not be listed as "Not Present".

Students that opt by the final assessment procedure, must submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the tutored work. In addition, during the first month of the course, professors will notify students if they have to do the tutored work individually, in the case they opt for final assessment.

Second opportunity to pass the course

The course final exam will only be held for students who failed the course in the first oportunity (semester final exam).

In order to pass the course it is necessary to complete the different parts of the subject, which will be evaluated as is indicated in the tests description section. Besides, it will be necessary to submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the tutored work.

Students that have opted by the continuous assessment procedure, can decide to maintain the grades of the parts they have already passed in the first opportunity or discard them.

Other comments

The documentation will be in English. The course will be tough in Spanish and Galician (including examns). Hower students will be able to ansewr in English, Spanish or Galician, as they prefer.

The grades obtained are only valid for the current academic year.

Although the tutored work will be completed (if possible) in groups, the performance of each student in his or her group will be analyzed continuously

Although the tutored work will be completed (if possible) in groups, the performance of each student in his or her group will be monitored continuously. In the case in which the performance of a member of the group wouldn't be adequate compared with the performance of his or her team mates, he or she could be excluded from the group and/or qualified individually.

The use of any material during the tests will have to be explicitly authorized.

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
Basic Bibliography
Coty Beard, William Stallings, Wireless communication networks and systems, 1, Pearson Education, 2013,
Viajy Garg, Wireless Communications and Networking, 1, Morgan Kaufmann-Elsevier, 2007, Londres
Pei Zheng, Larry L. Peterson, Bruce S. Davie, Adrian Farre, Wireless Networking Complete, 1, Morgan Kaufmann-Elsevier, 2010, Amsterdam
Kaveh Pahlavan, Prashant Krishnamurthy, Networking Fundamentals: Wide, Local and Personal Area Communications, 1, Wiley and Sons, 2009, Chichester
Kevin Townsend, Carles Cufí, Akiba, Robert Davidson, Getting started with Bluetooth Low Energy, 1, O'Reilly, 2014, Sebastopol, CA
Complementary Bibliography
James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 7, Pearson Education, 2017, Boston

Recommendations

Subjects that it is recommended to have taken before

Computer Networks/V05G300V01403
Data Networks: Technology and Architecture/V05G300V01542

IDENTIFYING DATA				
Intelligent systems programming				
Subject	Intelligent systems programming			
Code	V05G300V01943			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Burguillo Rial, Juan Carlos			
Lecturers	Burguillo Rial, Juan Carlos Costa Montenegro, Enrique			
E-mail	jrial@uvigo.es			
Web				
General description	This course will begin providing the notion of agent, to comprise what is, how build it and how can, the agents interact for modeling and solving complex problems. Later we will study the design, implementation and application of intelligent agents and multiagent systems in current communications technologies and relate them with other current paradigms such as: object oriented programming, mobile agents, the management distributed of networks, the adaptive user interfaces and the electronic commerce. The students will learn to program multiagent systems in suitable platforms and mobile terminals (Android). Besides, they will perform a work in group, where they will extend the concepts studied in the subject to other topics of their own interest. This subject will be taught and evaluated in English, but students have the possibility to interact in Spanish with the teachers at the classroom or at the lab. The documentation of the subject will be provided in English.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How
CE86	(CE86/OP29) The ability to program computer applications and services based on artificial intelligence.	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- know
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How

Learning outcomes	
Learning outcomes	Competences
To understand the basic concepts of intelligent systems: search, reasoning and learning.	CG3 CG4 CG9 CT2 CT3 CT4

To know the main concepts related with intelligent agents and multiagent systems.	CG3 CE86 CT2 CT3
To understand the basic concepts of software engineering in intelligent systems.	CG3 CE86
To achieve a suitable level of expertise in the use of IDEs for programming intelligent systems.	CE86 CT2
To acquire skills in the design and development of intelligent services applied to electronic devices.	CE86 CT2 CT3 CT4
To acquire skills for the application of intelligent systems in complex telematic services.	CE86 CT2 CT3 CT4

Contents	
Topic	
Introduction to intelligent systems	a) Searching b) Reasoning c) Learning
Intelligent agents	a) Definition of intelligent agent b) Architectures for intelligent agents c) Learning and adaptability
Multiagent systems	a) Distributed Artificial Intelligence and multiagent systems b) Communication between agents: KQML, FIPA-ACL c) Coordination and protocols of interaction d) Learning in multiagent systems e) Self-organised multiagent-systems
Software engineering of oriented to agents	a) Programming and methodologies oriented to agents b) Agents vs. Objects c) Agents vs. Expert Systems d) The JADE development platform
Multiagent systems and Game Theory	a) Cooperation vs. Competition b) Negotiation c) Auctions d) electronic Commerce
Mobile agents	a) Concept of mobile agent b) Security problems c) Possible applications

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	3	6	9
Master Session	9	36	45
Laboratory practises	14	28	42
Proceedings	9	0	9
Forum Index	0	4	4
Tutored works	6	30	36
Multiple choice tests	1	4	5

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

Methodologies	
	Description
Introductory activities	We start doing a generic introduction to the aims, and the global contents of the subject together with the results expected at the end of the course.
Master Session	We describe the different topics of the subject providing the necessary educational material. Through this methodology the competencies CG3, CG4, CT2, CT3 and CT4 are developed.

Laboratory practises	Every student must do a practical task in the laboratory with the JADE development platform. Through this methodology the competencies CG3, CG4, CG9, CE86, CT2 and CT3 are developed.
Proceedings	In the classes there will be open discussion, among groups of students, in order to focus on a topic of subject content, the analysis of a case, the outcome of a project, exercise or problem previously developed a keynote address. Through this methodology the competencies CG3, CG4, CG9, CE86, CT2, CT3 and CT4 are developed.
Forum Index	The students must perform some activities within the TEMA platform at FAITIC in order to discuss topics related to the subject. Through this methodology the competencies CG3, CE86, CT2, CT3 and CT4 are developed.
Tutored works	The students must perform a project in group, with the support of the professor, to extend and personalize the topics seen along the theoretical and practical classes. At the same time, we will try that the students perform such project demos using Android terminals. Through this methodology the competencies CG3, CG4, CG9, CE86, CT2, CT3 and CT4 are developed.

Personalized attention

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

Assessment

	Description	Qualification	Evaluated Competencess
Tutored works	Evaluation of the works developed: understanding, maturity, importance and originality of the work and interaction between the group.	25	CG3 CG4 CG9 CE86 CT2 CT3 CT4

Laboratory practises	The students will perform a practical task in the laboratory with the JADE development platform where they will work with the concepts studied in the theoretical classes.	35	CG3 CG4 CG9 CE86 CT2 CT3
Proceedings	Discussions done along classes related with expositions done or read previously.	5	CG3 CG4 CG9 CE86 CT2 CT3 CT4
Forum Index	Short answers and interaction done individually by students within the TEMA platform to discuss topics related with the subject.	5	CG3 CE86 CT2 CT3 CT4
Multiple choice tests	Three successive tests (weeks 4, 7 and 10) to evaluate the contents given up to that time in the course. The tests will be individual and with time limit.	30	CG3 CG4 CE86

Other comments and July evaluation

The elements that are part of the evaluation of the subject are the following:

- **Questionnaires**: along the course the student will fill 3 questionnaires that will contribute 10% to the final mark (each one).

- **Laboratory practice**: each student will have to perform a practical task in the laboratory that will contribute 35% to the final mark.

- **Group tutored work**: each student will have to do a work in group, about one among several possible topics, that will contribute 25% (20% work done + 5% presentation) to the final mark shared by all group members. Nevertheless, the teachers will follow the work done by every group member, and they will also perform a peer review of the work done. In the case that a student would perform clearly lower than his/her mates, he/she will be rated individually (see note*).

- **Class participation**: students will discuss in class about expositions done by the professor, and this contributes up to a 5% to the final mark.
- **Forum participation**: students should interact individually in the forum of the subject to achieve up to a 5% to the final mark. To achieve such percentage the student should provide at least two relevant contributions.

Therefore, we have: Final Mark = Questionnaires (3*x10% = 30%) + Lab. practice (35%) + Tutored work (25%) + Class participation (5%) + Forum (5%) = 100%.

The students need to pass the questionnaires, the practical task and the tutored work with at least 4 points over 10 to calculate the average final mark. If any of the marks is below 4, then the final mark will never be higher than 4 points over 10.

Following the degree guidelines, the students that will follow this subject can choose between two possibilities: continuous evaluation and evaluation at the end of the semester.

Continuous evaluation: the student follows the continuous evaluation since the moment he/she fulfills two questionnaires. From that moment we assume that he/she will participate in the subject, independently of the assistance to the final exam.

Evaluation at the end of the semester: the student will have to perform a final exam that substitutes the questionnaires done along the course, in addition to providing the practical task and the equivalent work to be done as part of the continuous evaluation.

Evaluation at the end of the second semester: the student will have to perform the part that has not passed previously.

This subject will be evaluated in English, but students have the possibility to interact in Spanish with the teachers at any time.

The questionnaires and tasks, proposed and performed along the module, are only valid for the current course.

***NOTE: Multidisciplinar Group Tutored Work (optional)**
This course 2017/18, and as an innovation project, some students will have the possibility to join a multidisciplinary group (MDG) with other three subjects: (1) Video Games: design and development, 4th year, Degree in Audiovisual Communication. (2) Multimedia Technology and Computer graphics, 4th year, Degree in Telecommunication Engineering Technologies, Sound and Image module. (3) Intelligent systems programming, 4th year, Degree in Telecommunication Engineering Technologies, Telematics module. The activity is coordinated by teachers of the Teaching Innovation Group: ComTecArt (Communication, Technology and Art in Virtual Environments).

The activities and tasks to be performed by the students of this subject in the MDG will be related with using artificial intelligent techniques in videogames. The students that would join this multidisciplinary tutored work will not participate in the ordinary groups C. Besides, each MDG will only join one student from this subject, so he/she will be rated individually in such case.

The participation in the MDG is optional, and if there are more request than available positions; then those students will be ranked and selected according to the global grade mark, provided by the Escola de Enxeñaría de Telecomunicación Secretary.

There will be group work sessions on Wednesday mornings, alternating between the Campus of Vigo and Pontevedra. The University will provide free round trip transportation from the Escola de Enxeñaría de Telecomunicación or the Facultad de Ciencias Sociais e a Comunicación, respectively.

Sources of information
Basic Bibliography
Michael Wooldridge,, An Introduction to Multiagent Systems, Addison-Wesley, 2a, 2009
Complementary Bibliography
Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach,, Prentice Hall, 3a, 2014
Jacques Ferber, Multi-Agent Systems: an Introduction to Distributed Artificial Intelligence, Addison-Wesley, 1a, 1999
Alison Cawsey, The Essence of Artificial Intelligence, Prentice Hall Europe, 1a, 1998

Recommendations

Subjects that it is recommended to have taken before

Programming II/V05G300V01302

Other comments

The only requirement for the students, in order to follow this subject, is to have a basic understanding of Java programming.

IDENTIFYING DATA				
Integrated systems design				
Subject	Integrated systems design			
Code	V05G300V01944			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Gil Castiñeira, Felipe José			
Lecturers	Gil Castiñeira, Felipe José Rodríguez Hernández, Pedro Salvador			
E-mail	xil@gti.uvigo.es			
Web	http://faitic.uvigo.es			
General description	Embedded systems are part of almost all the diary activities that involve an electronic device (the alarm clock, the mobile phone, the car...). This course introduces the main concepts behind modern embedded systems that include an operating system, and puts them in practice through a series of exercises and projects. The documentation will be provided in English.			

Competencies		
Code		Typology
CG3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations	- know
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How - Know be
CE87	(CE87/OP30) The ability to understand the specific requirements for integrated circuits with strict real time restrictions.	- know
CE88	(CE88/OP31) The ability to formulate and solve problems of design and development of integrated systems.	- know - Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be
CT3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.	- Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know be

Learning outcomes	
Learning outcomes	Competences
Know the technological base which supports the most recent investigations in the study and design of integrated systems.	CG3 CE87
Understand the basic aspects of the special requirements inherent to embedded systems with hard real time restrictions	CG3 CE87 CT3
Adopt a global view of the problem of programming environments with real-time restrictions, and know the proper tools for dealing with them, so that embedded systems can be addressed with a system level approach.	CG3 CG4 CG9 CE88 CT2 CT4

Understand the basic elements of fault prevention and fault tolerance	CG3 CE88
Master the concepts related to the organisation of this kind of systems software	CG3 CG4 CG9 CE88 CT4
Handle the tasks scheduling and resources sharing techniques in embedded systems	CG3 CG4 CE88
Become familiar with the use of abstraction platforms for developing embedded systems	CG4 CG9 CE88

Contents

Topic	
Concept of embedded system	Definition of embedded system Real-time systems Characteristics
Operating systems for embedded systems	Operating systems with real-time restrictions Multitasking: threads and processes Synchronization
Architectures of embedded systems	ARM, MIPS Microprocessors
Process scheduling	Cyclic executives Priority-driven scheduling: DMS, EDF Access synchronization
Reliability and fault tolerance	Fault prevention and fault tolerance Static and dynamic redundancy Security, reliability and dependability
Distributed embedded systems	Communication mechanisms Field buses
Abstraction platforms for the development of embedded systems	Android OSGI Linux (as a platform)
Communication with sensors and actuators	I/O Hardware Coping with concurrency The Analog/Digital interface

Planning

	Class hours	Hours outside the classroom	Total hours
Presentations / exhibitions	1	5	6
Laboratory practises	14	0	14
Group tutoring	6	10	16
Integrated methodologies	0	53	53
Master Session	20	40	60
Short answer 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
Presentations / exhibitions	Presentation by the students of the developed projects results. Through this methodology the competencies CT2, CT4, CG4, CG9, CE87 and CE88 are developed.
Laboratory practises	Development by the students of guided and supervised assignments in the laboratory. Through this methodology the competencies CT2, CT3, CG3, CG4, CE87 and CE88 are developed.
Group tutoring	Meetings of the professors with the students for tracking the current status and further planning the project activities. Through this methodology the competencies CT2, CT4, CG4, CG9, CE87 and CE88 are developed.

Integrated methodologies	We use learning projects based training: the students carry out a project along the semester to resolve a complex problem by means of planning, design and implementation of a series of activities. Through this methodology the competencies CT2, CT3, CT4, CG3, CG4, CG9, CE87 and CE88 are developed.
Master Session	Professors present the main theoretical contents related to embedded systems with real-time restrictions. Through this methodology the competencies CT3, CG3, CE87 and CE88 are developed.

Personalized attention

Methodologies	Description
Master Session	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered during the master sessions or during tutorial sessions. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.
Laboratory practises	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Te professors will guide and help the students to complete the assigned laboratory practises. Questions will be answered during the lab sessions or during tutorial sessions. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.
Group tutoring	In addition to the attention to the group, the professors of the subject will provide individual attention adadpted to the students during the group supervision sessions, or during tutorial sessions. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.
Integrated methodologies	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. The professors will guide and help the students to complete the assigned project. Questions will be answered during the supervising sessions, group supervising sessions, or during tutorial sessions. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.

Assessment

	Description	Qualification	Evaluated Competencess
Presentations / exhibitions	Once their project is implemented, the students will perform a public presentation of its design, development and results. Each member of the group must present the tasks that he or she completed, and provide satisfactory answers to the questions made by the professors.	5	CG4 CG9 CE87
Laboratory practises	The students will fill individual questionnaires to asses the correct realization and understanding of the laboratory tasks.	10	CG3 CG4 CE87 CE88
Group tutoring	A continuous tracking of the design and evolution of the implementation will be held during the realization of the project. Each student must collect and show evidences of her/his individual work. Periodically, the students will present the state and results of their projects, as well as the scheduled tasks. If these results are not satisfactory, a penalization of the 20% of the grade could be applied.	5	CG4 CG9 CE87 CE88
Integrated methodologies	The students will be divided in groups for accomplishing the design, implementation and proof of an embedded system. The result will be evaluated after the his delivery, assessing aspects such as correction, quality, performance and functionalities. In addition, during the implementation of the project, the design and the evolution of the development will be evaluated. If the intermediate results are not satisfactory, a penalization of the 20% of the grade could be applied. The evaluation will be by group and by person: each one of the members of a team must document his/her tasks and answer the questions related to them.	40	CG3 CG4 CG9 CE87 CE88
Short answer tests	Students will be evaluated to asses what they have learned in master sessions.	40	CG3 CE87 CE88

Other comments and July evaluation

In order to pass the course it is necessary to complete the different parts of the subject (master sessions, practices in labs, and projects). The final grade will be the **weighted geometric mean** of the grades of the different parts (i.e. it is not possible to pass the subject with a zero in one part). If "x" is the grade obtained for the master sessions, "y" for the practices in labs, and "z" for the project, the final grade will be: grade = x^0.4*y^0.1*z^0.5

During the first month, students must provide a written declaration to opt for final assessment. In other case, it will be considered that they opt for continuous assessment. Students who select continuous assessment and submit the first task or questionnaire may not be listed as "Absent".

Students who opt for the final assessment procedure must pass the short answer test (40%), submit a project (50%) and submit the laboratory practises (10%). These parts will be evaluated as indicated in the tests description section. The final grade will be the **weighted geometric mean** of the grades of the different parts. Besides, they must submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the project. In addition, during the first month of the course, professors will notify students who opted for final assessment if they have to do the tutored work individually.

Although the project will be developed in groups, the ongoing activities of each student in a group will be monitored individually. In case a student's performance is below his or her groupmates, he or she could be expelled from the group or graded on a individual basis.

Intermediate milestones could be required for the project. In case they are not satisfied, a penalization of the 20% of the grade could be applied.

Second opportunity to pass the course

The end of course exam will only be held by students who failed the end of semester exams.

In order to pass the course it is necessary to complete the different parts of the subject: pass the short answer test (40%), submit a project (50%) and submit the laboratory practises (10%). These parts will be evaluated as indicated in the tests description section. The final grade will be the **weighted geometric mean** of the grades of the different parts. Besides, it will be necessary to submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the project.

Students that have opted by the continuous assessment procedure, can decide to maintain the grades of the parts they have already passed in the first opportunity or discard them.

Other comments

The grades obtained are only valid for the current academic year.

Although the tutored work will be completed (if possible) in groups, each student should keep a record of his or her activities. In the case in which the performance of a member of the group wouldn't be adequate compared with the performance of his or her team mates, he or she could be excluded from the group and/or qualified individually.

The use of any material during the tests will have to be explicitly authorized.

The assessment will be performed in any of the official languages in Galicia. If a student wishes to be tested in English, it must give written notice to teachers with 15 days in advance.

In case of detection of plagiarism or unethical behavior in any of the tasks/tests done, the final grade will be "failed (0)" and the professors will communicate the incident to the academic authorities to take the appropriate measures.

Sources of information

Basic Bibliography

A. Burns & A. Wellings, istemas de Tiempo Real y Lenguajes de Programación, 3, 2003

E.A. Lee & S.A. Seshia, Introduction to Embedded Systems, 1, 2012

Complementary Bibliography

P. Marwedel, Embedded System Design, 2, 2012

P. Barry & P. Crowley, Modern Embedded Computing, 1, 2012

S. Barrett & J. Kridner, Bad to the Bone: Crafting Electronics Systems with Beaglebone and BeagleBone Black, 1, 2013

Recommendations

Subjects that it is recommended to have taken before

Informatics: Computer Architecture/V05G300V01103
Distributed and Concurrent Programming/V05G300V01641
Operating Systems/V05G300V01541

IDENTIFYING DATA				
New computerised services				
Subject	New computerised services			
Code	V05G300V01945			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Álvarez Sabucedo, Luis Modesto			
Lecturers	Álvarez Sabucedo, Luis Modesto Santos Gago, Juan Manuel			
E-mail	lsabucedo@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The global aim of the course is to provide the students with a global outlook of the new technologies in the area of the telematic services. Therefore, the contents of this course will be open and in line with the technological evolution in the most active fields of the new technologies. The subject will be taught in Spanish and the contents will be available in English.			

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know How
CE89	(CE89/OP32) The ability to design and construct new computer services.	- Know How
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know How

Learning outcomes	
Learning outcomes	Competences
To identify new applications of telematic services.	CG4 CE89 CT4
Knowledge of the main tools and environments for the development of new telematics services.	CG4 CG9
To acquire skills to develop new telematic services.	CE89

Contents	
Topic	
Introduction	Supporting technologies Representation models General concepts for eTechnologies (The contents and slides of the subject will be in English but lectures will be delivered in Spanish)
Services in the Web	Concepts about applied security Services for authentication in the net Services for payment Searchers Recommenders

Introduction to the semantic web.	Metadata, RDF. Metadata examples: LOM and Dublin Core. Use of the lightweight semantics in the Web. Introduction to SPARQL.
*eServizos	eLearning eGovernment eCommerce Modalities of Payment in the web. Cryptocoins.
New paradigms	IoT Cloud computing Others

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	16	40	56
Laboratory practises	14	28	42
Case studies / analysis of situations	5	25	30
Introductory activities	3	6	9
Jobs and projects	1	3	4
Jobs and projects	1	4	5
Long answer tests and development	2	2	4

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

Methodologies

	Description
Master Session	Theoretical contents and their practical application will be presented during the lectures. Student are expected to play an active role during lectures. This methodology will impact in all the competences addressed in the subject.
Laboratory practises	During practical sessions, it will be developed a semantic project with the support of adhoc software tools. This methodology will impact in all the competences addressed in the subject.
Case studies / analysis of situations	Use cases will presented to the students. Thus, they will be able to analyze and to study them in depth in order to prepeare their academic projects. This methodology will impact in all the competences addressed in the subject.
Introductory activities	Program of the subject will be presented along with the methodologies used, the classroom, practical contents, final project, final and continuous evaluation criteria, and, in general, all aspects of the subject. This methodology will impact in all the competences addressed in the subject.

Personalized attention

Methodologies	Description
Master Session	During these sessions, any questions that may arise will be addresseed. Also during the tutoring sesions, questions that may arise will be resolved.
Laboratory practises	In the practical sessions, a closer attention will be paid to the tasks assigned to the students. Also, any questions that may arise will be addressed. Also during the tutoring sesions, questions that may arise will be resolved.
Case studies / analysis of situations	In these sessions, any questions that may arise will be addressed. Also during the tutoring sesions, questions that may arise will be resolved.
Tests	Description
Jobs and projects	In these sessions, any questions that may arise will be addressed. Also during the tutoring sesions, questions that may arise will be resolved.
Jobs and projects	In these sessions, any questions that may arise will be addressed. Also during the tutoring sesions, questions that may arise will be resolved.
Long answer tests and development	In these sessions, any questions that may arise will be addressed.

Assessment

	Description	Qualification	Evaluated Competencess

Jobs and projects	It will consist of the presentation of two practical-projects using the concepts presented in the subject. It will take place during the development of the course. Marks of each work will be the same for all the members in the group.	25	CG4 CG9 CE89
Jobs and projects	It will consist of the presentation of a project that carries out a telematic-based solution. It will take place at the end of the course. Marks of each work will be the same for all the members in the group.	25	CG4 CG9 CE89
Long answer tests and development	It will involve all the contents of the course. It will take place at the end of the course	50	CG4 CG9 CE89

Other comments and July evaluation

1. Continuous assessment

The subject will be taught in Spanish and the contents will be available in English.

The course can be passed with full marks from continuous assessment, with no need to sit the final exam.

Students who sit any of the assessment tests may not be listed as "Not Present".

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

Assessment 1 (50%):

· All contents presented along the course.

· It will take place at the end of the course.

Assessment 2 (25%):

· It will consist of the presentation of a practical-projects (specified in due course).

Assessment 3 (25%):

· It will consist of a presentation of a holistic project involving telematic based services

· At the end of the course.

It is mandatory to pass each part of the continuous assessment (that is, the minimum score of each part must be 5 out of 10). In case of not passing any part of the continuous evaluation, the remaining grades will be adjusted by a factor of 0.5.

All students presenting a project will get the same marks.

The course may be passed only with continuous assessment.

2. Final exam

· There is a final exam at the end of the semester and another at the end of the course. All content presented along the course is included in this exam.

· Students sitting this final exam will be asked to submit in advance some works to be done according to specific instructions on each call. These works must be original and will involve task related to assessments 2 and 3. Should the work not be original, the student will be banned from the subject. The pass mark for this test is 5 out of 10. It is mandatory to pass the project presentation also.

Sources of information

Basic Bibliography

Professors of the subject, Slides for classes, http://faitic.uvigo.es,

Complementary Bibliography

R. Baeza-Yates y B. Ribeiro-Neto., R. Baeza-Yates y B. Ribeiro-Neto. "Modern Information Retrieval"., R. Baeza-Yates y B. Ribeiro-Neto. "Modern Information Retrieval". Addison Wesley.,

Gómez-Pérez, A.; Fernández-López, M.; Corcho, O, Ontological Engineering, Springer-Verlag, November 2003

Arasu, A., Cho, J., García-Molina, H., Paepcke, A., y Raghavan, S., Searching the web, ACM Transactions on Internet Technology, Vol. 1, N, Agosto 2001.

S. Chakrabarti, B. Dom, D. Gibson, J. Kleinberg, P. Raghavan, and S. Rajagopalan., Automatic resource compilation by analyzing hyperlink structure and associated text., In Proceedings of the 7th World-wide web conferenc, 1998

S. Brin y L. Page, The anatomy of a large-scale hypertextual Web search engine., 7th International World Wide Web Conference, Brisb, 1998

Lassila, O., y Swick,R.R., Resource Description Framework (RDF) Model and Syntax Specification, World Wide Web Consortium Recommendation. Accesib,

Deborah L. McGuinness, Ontologies Come of Age, http://www.ksl.stanford.edu/people/dlm/papers/onto,

Grigoris Antoniou and Frank van Harmelen, Web Ontology Language: OWL, http://www.cs.vu.nl/~frankh/postscript/OntoHandboo,

Resource Description Framework (RDF) Model and Syntax Specification, http://w3c.org/RDF,

DCMI Home, http://dublincore.org,

IEEE Learning Technology Standards Committee (LTSC), http://ltsc.ieee.org/wg12. Standard accesible en,

W3C Semantic Web Activity, http://www.w3.org/2001/sw/,

Recommendations

IDENTIFYING DATA				
Mobility I				
Subject	Mobility I			
Code	V05G300V01951			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Mobility II				
Subject	Mobility II			
Code	V05G300V01952			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Mobility III				
Subject	Mobility III			
Code	V05G300V01953			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Mobility IV				
Subject	Mobility IV			
Code	V05G300V01954			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Mobility V				
Subject	Mobility V			
Code	V05G300V01955			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Externships: Internships I				
Subject	Externships: Internships I			
Code	V05G300V01981			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Marcos Acevedo, Jorge			
Lecturers	Marcos Acevedo, Jorge			
E-mail	acevedo@uvigo.es			
Web	http://faitic.uvigo.es			
General description	(*)Estancia nunha empresa desenvolvendo funcións propias dun/a Enxeñeiro/a Técnico/a de Telecomunicación relacionadas co perfil profesional cursado polo alumno (Sistemas de Telecomunicación, Telemática, Sistemas Electrónicos ou Son e Imaxe) e supervisado por profesorado do Centro e persoal da empresa.			

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.	- know
CG12	CG12 The development of discussion ability about technical subjects	- Know How
CG13	CG13 The ability to use software tools that support problem solving in engineering.	- Know How
CE21	CE21/ST1 The ability to construct, exploit and manage telecommunication networks, services, process and applications, considered as systems of receiving, transporting, representation, processing, storage, management and presentation of multimedia information from the point of view of transmission systems.	- Know How
CE22	CE22/ST2 The ability of applying the basic techniques of telecommunication networks, services and applications for mobile and fixed environments, personal, local or long distance, with different bandwidth, including telephony, radio broadcasting, TV and data, from the point of view of transmission systems.	- Know How
CE23	CE23/ST3 The ability to analyze the components and their specifications for guided and non-guided communications systems	- Know How
CE24	CE24/ST4 The ability to select circuits, subsystems and systems of radiofrequency, microwaves, broadcasting, radio link and radio determination.	- Know How
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.	- Know How
CE26	CE26/ST6 The ability to analyze, codify, process and transmit multimedia information using analogical and digital signal processing techniques.	- Know How
CE27	CE27/TEL1The ability to construct, operate and manage telecommunication networks, services, processes and applications considered as systems to receive, transport, represent, process, store, manage and present multimedia information from the computer services point of view.	- Know How
CE28	CE28/TEL2 The ability to apply the techniques that are basis of computer networks, services and applications, such as management, signaling and switching, routing and securing systems (cryptographic protocols, tunneling, firewalls, charging mechanisms, authentication and content protection) traffic engineering (graph theory, queuing theory and teletraffic) rating, reliability and quality of service in both fixed, mobile, personal, local or long distance environments with different bandwidths, including telephony and data.	- Know How
CE29	CE29/TEL3 The ability to build, operate and manage computer services using planning, sizing and analytical tools	- Know How
CE30	CE30/TEL4 The ability to describe, program, assess and optimize communication protocols and interfaces at different network architecture layers .	- Know How

CE31	CE31/TEL5 The ability to follow the technological progress of transmission, switching and processing to improve computer networks and services.	- Know How
CE32	CE32/TEL6 The ability to design networks and service architectures.	- Know How
CE33	CE33/TEL7 The ability to program network and distributed applications and services.	- Know How
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.	- Know How
CE35	CE35/SI2 The ability to analyze, specify, carry out and maintain systems, equipments, heads and installations of TV, audio and video for mobile and fixed environments.	- Know How
CE36	CE36/SI3 The capacity to implement projects at places and installations for the production and recording of audio and video signals.	- Know How
CE37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.	- Know How
CE38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.	- Know How
CE39	(CE39/SE1): The ability to construct, exploit and manage the receiving, transporting, representation, processing, storage, manage and presentation multimedia information from the electronic systems point of view.	- Know How
CE40	(CE40/SE2): The ability to select electronic circuits and devices specialized in transmission, forwarding or routing, and terminals for fixed and mobile environments.	- Know How
CE41	(CE41/SE3):The ability to make the specification, implementation, documenting and tuning of electronic systems and equipment (both instrumentation and control oriented), considering the corresponding technical aspects and the regulations.	- Know How
CE42	(CE42/SE4): The ability to apply electronics as support technology in other fields and activities and not only in information and communication technologies.	- Know How
CE43	(CE43/SE5): The ability to design analogical and digital electronics circuits of analogical to digital conversion and vice versa, of radiofrequency, of feeding and electrical energy conversion for computing and telecommunication engineering.	- Know How
CE45	(CE45/SE7): The ability to design interface, data capturing and storage devices, and terminals for services and telecommunication systems.	- Know How
CE46	(CE46/SE8): The ability to specify and use electronic instrumentation and measurement systems.	- Know How
CE47	(CE47/SE9): The ability to analyze and solve interference and electromagnetic compatibility problems .	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know

Learning outcomes	
Learning outcomes	Competences

Experience in the exert of the profession of Technical Engineer of Telecommunication and of his more usual functions (according to the programme of the student) in some real surroundings of company.	CG4 CG5 CG12 CG13 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE45 CE46 CE47 CT2

Contents	
Topic	
Item	To define by the company advisor and the academic advisor.

Planning			
	Class hours	Hours outside the classroom	Total hours
External practises	147	0	147
Reports / memories of internships or practicum	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
External practises	The student develops own functions in a company as an Telecommunication Engineer with determinate profile by the technology that the student have studied (Systems of Telecommunication, Electronic Systems, Telematic or Sound and Image)

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

Assessment			
	Description	Qualification	Evaluated Competencess

External practises	It will value so much the aptitude like the attitude of the student in the development of the activities entrusted.	90	CG4 CG5 CG12 CG13 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE45 CE46 CE47 CT2

Reports / memories of internships or practicum	The memory presented by the student will have to adjust to the indications collected in the rules of practices in valid company (University of Vigo and intern of the degree in Engineering of Technologies of Telecommunication).	10	CG4 CG5 CG12 CG13 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE45 CE46 CE47

Other comments and July evaluation

The tutor of the company will deliver a report valuing appearances related with the practices realised by the student:punctuality, assistance, responsibility, capacity of work in team and integration in the company, quality of the workrealised, etc.
The student/to will have to deliver an explanatory memory of the activities realised during the practices, specifying hislength, the units or departments of the company in that they realised , the training received (courses, computerprograms, etc.), the level of integration inside the company and the relations with the personnel.
The memory has to include also a section of conclusions, that will contain a reflection on the suitability of theeducations received during the career for the exert of the practice (positive and negative appearances more significantrelated with the development of the practices). It will value , besides, the inclusion of information on the professionaland personal experience obtained with the practices (personal assessment of the learning achieved along the practices,and suggestions or own contributions on the structure and operation of the company visited).
If the memory presented by the student does not reach the quality and minimum requirements, the student will have opportunity torectify it for his *re-evaluation in the extraordinary announcement of July.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

It recommends have studied the three first courses of the degree.

IDENTIFYING DATA				
Externships: Internships II				
Subject	Externships: Internships II			
Code	V05G300V01982			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Marcos Acevedo, Jorge			
Lecturers	Marcos Acevedo, Jorge			
E-mail	acevedo@uvigo.es			
Web	http://faitic.uvigo.es			
General description	(*)Estancia nunha empresa desenvolvendo funcións propias dun/a Enxeñeiro/a Técnico/a de Telecomunicación relacionadas co perfil profesional cursado polo alumno (Sistemas de Telecomunicación, Telemática, Sistemas Electrónicos ou Son e Imaxe) e supervisado por profesorado do Centro e persoal da empresa.			

Competencies		
Code		Typology
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- know
CG5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.	- know
CG12	CG12 The development of discussion ability about technical subjects	- Know How
CG13	CG13 The ability to use software tools that support problem solving in engineering.	- Know How
CE21	CE21/ST1 The ability to construct, exploit and manage telecommunication networks, services, process and applications, considered as systems of receiving, transporting, representation, processing, storage, management and presentation of multimedia information from the point of view of transmission systems.	- Know How
CE22	CE22/ST2 The ability of applying the basic techniques of telecommunication networks, services and applications for mobile and fixed environments, personal, local or long distance, with different bandwidth, including telephony, radio broadcasting, TV and data, from the point of view of transmission systems.	- Know How
CE23	CE23/ST3 The ability to analyze the components and their specifications for guided and non-guided communications systems	- Know How
CE24	CE24/ST4 The ability to select circuits, subsystems and systems of radiofrequency, microwaves, broadcasting, radio link and radio determination.	- Know How
CE25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.	- Know How
CE26	CE26/ST6 The ability to analyze, codify, process and transmit multimedia information using analogical and digital signal processing techniques.	- Know How
CE27	CE27/TEL1The ability to construct, operate and manage telecommunication networks, services, processes and applications considered as systems to receive, transport, represent, process, store, manage and present multimedia information from the computer services point of view.	- Know How
CE28	CE28/TEL2 The ability to apply the techniques that are basis of computer networks, services and applications, such as management, signaling and switching, routing and securing systems (cryptographic protocols, tunneling, firewalls, charging mechanisms, authentication and content protection) traffic engineering (graph theory, queuing theory and teletraffic) rating, reliability and quality of service in both fixed, mobile, personal, local or long distance environments with different bandwidths, including telephony and data.	- Know How
CE29	CE29/TEL3 The ability to build, operate and manage computer services using planning, sizing and analytical tools	- Know How
CE30	CE30/TEL4 The ability to describe, program, assess and optimize communication protocols and interfaces at different network architecture layers .	- Know How

CE31	CE31/TEL5 The ability to follow the technological progress of transmission, switching and processing to improve computer networks and services.	- Know How
CE32	CE32/TEL6 The ability to design networks and service architectures.	- Know How
CE33	CE33/TEL7 The ability to program network and distributed applications and services.	- Know How
CE34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.	- Know How
CE35	CE35/SI2 The ability to analyze, specify, carry out and maintain systems, equipments, heads and installations of TV, audio and video for mobile and fixed environments.	- Know How
CE36	CE36/SI3 The capacity to implement projects at places and installations for the production and recording of audio and video signals.	- Know How
CE37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.	- Know How
CE38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.	- Know How
CE39	(CE39/SE1): The ability to construct, exploit and manage the receiving, transporting, representation, processing, storage, manage and presentation multimedia information from the electronic systems point of view.	- Know How
CE40	(CE40/SE2): The ability to select electronic circuits and devices specialized in transmission, forwarding or routing, and terminals for fixed and mobile environments.	- Know How
CE41	(CE41/SE3):The ability to make the specification, implementation, documenting and tuning of electronic systems and equipment (both instrumentation and control oriented), considering the corresponding technical aspects and the regulations.	- Know How
CE42	(CE42/SE4): The ability to apply electronics as support technology in other fields and activities and not only in information and communication technologies.	- Know How
CE43	(CE43/SE5): The ability to design analogical and digital electronics circuits of analogical to digital conversion and vice versa, of radiofrequency, of feeding and electrical energy conversion for computing and telecommunication engineering.	- Know How
CE44	(CE44/SE6): The ability to understand and use feedback theory and electronic control systems.	- Know How
CE45	(CE45/SE7): The ability to design interface, data capturing and storage devices, and terminals for services and telecommunication systems.	- Know How
CE46	(CE46/SE8): The ability to specify and use electronic instrumentation and measurement systems.	- Know How
CE47	(CE47/SE9): The ability to analyze and solve interference and electromagnetic compatibility problems .	- Know How
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- know

Learning outcomes	
Learning outcomes	Competences

Experience in the exert of the profession of Technical Engineer of Telecommunication and of his more usual functions (according to the programme of the student) in some real surroundings of company.	CG4 CG5 CG12 CG13 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE44 CE45 CE46 CE47 CT2

Contents

Topic	
Item	To define by the company advisor and the academic advisor.

Planning

	Class hours	Hours outside the classroom	Total hours
External practises	147	0	147
Reports / memories of internships or practicum	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
External practises	The student develops own functions in a company as an Telecommunication Engineer with determinate profile by the technology that the student have studied (Systems of Telecommunication, Electronic Systems, Telematic or Sound and Image)

Personalized attention

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

Assessment

	Description	Qualification	Evaluated Competencess

External practises	It will value so much the aptitude like the attitude of the student in the development of the activities entrusted.	90	CG4 CG5 CG12 CG13 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE45 CE46 CE47 CT2

Reports / memories of internships or practicum	The memory presented by the student will have to adjust to the indications collected in the rules of practices in valid company (University of Vigo and intern of the degree in Engineering of Technologies of Telecommunication).	10	CG4 CG5 CG12 CG13 CE21 CE22 CE23 CE24 CE25 CE26 CE27 CE28 CE29 CE30 CE31 CE32 CE33 CE34 CE35 CE36 CE37 CE38 CE39 CE40 CE41 CE42 CE43 CE45 CE46 CE47

Other comments and July evaluation

The tutor of the company will deliver a report valuing appearances related with the practices realised by the student: punctuality, assistance, responsibility, capacity of work in team and integration in the company, quality of the workrealised, etc.
The student/to will have to deliver an explanatory memory of the activities realised during the practices, specifying hislength, the units or departments of the company in that they realised , the training received (courses, compute programs, etc.), the level of integration inside the company and the relations with the personnel.
The memory has to include also a section of conclusions, that will contain a reflection on the suitability of the educations received during the career for the exert of the practice (positive and negative appearances more significant related with the development of the practices). It will value , besides, the inclusion of information on the professional and personal experience obtained with the practices (personal assessment of the learning achieved along the practices,and suggestions or own contributions on the structure and operation of the company visited).
If the memory presented by the student does not reach the quality and minimum requirements, the student will have opportunity to rectify it for his re-evaluation in the extraordinary announcement of July.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

It recommends have studied the three first courses of the degree.

IDENTIFYING DATA				
Final Year Dissertation				
Subject	Final Year Dissertation			
Code	V05G300V01991			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Type	Year	Quadmester
	12	Mandatory	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Fernández Veiga, Manuel			
Lecturers	Fernández Veiga, Manuel			
E-mail	mveiga@det.uvigo.es			
Web	http://faitic.uvigo.es			
General description	The Bachelor Thesis (TFG) is a constituent part, as a unit module, of the curriculum of Degree in Engineering of Technologies of Telecommunication. It is an original and personal work that each student will realise autonomously under educational supervision, and has to allow him to show in a comprehensive form the acquisition of the formative contents and the competences associated to the title. Its definition and contents are explained in detail in the regulation for the realisation of the Bachelor's thesis approved by the Academic Commission of Degree, in session celebrated the 3/4/2013, whose content appears in the web of the School of Engineering of Telecommunication.			

Competencies		
Code		Typology
CB1	Students have demonstrated knowledge acquisition and understanding in the field of study. This knowledge begins based on general secondary education, and it is typically at a level that, although advanced textbooks would support it, includes some aspects at the forefront of their field of study.	- Know be
CB2	Students can apply their knowledge to their jobs in a professional way and they have competences that are typically demonstrated through devising and sustaining arguments and solving problems within their field of study.	- Know How
CB4	Students can communicate information, ideas, problems and solutions to both general and specialized public.	- Know How
CG1	CG1: The ability to write, develop and sign projects in the field of Telecommunication Engineering, according to the knowledge acquired as considered in section 5 of this Law, the conception and development or operation of networks, services and applications of Telecommunication and Electronics.	- Know How
CG2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.	- Know How
CG4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.	- Know How
CG9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.	- Know be
CG10	CG10 The ability for critical reading of scientific papers and docs.	- Know How
CG14	CG14 The ability to use software tools to search for information or bibliographical resources.	- Know How
CE90	(CE90/TFG)Original and individual exercise to be defended before an examining board consisting of a project in a specific technology of Telecommunication Engineering and of a professional nature, where the abilities acquired from the teachings are integrated and synthesized.	- Know How
CT1	CT1 Development of sufficient autonomy to carry out works within the area of Telecommunications in interdisciplinary contexts.	- Know be
CT2	CT2 Understanding Engineering within a framework of sustainable development.	- Know be
CT4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.	- Know be

Learning outcomes	
Learning outcomes	Competences
Search, management and structuring of information on any topic	CB2 CG2 CG10 CG14 CT1
Development and writing of a project document which are collected: history, state of the art or problematic, objectives, project phases, project development, conclusions and future lines.	CB2 CG1 CG10 CT1 CT2 CT4
Prototyping, programming simulation software, etc., according to specifications.	CB4 CG1 CG2 CG4 CG9 CE90
CG1: The ability to write, develop and sign projects in the field of Telecommunication Engineering, according to the knowledge acquired as considered in section 5 of this Law, the conception and development or operation of networks, services and applications of Telecommunication and Electronics.	CB1 CG1 CE90 CT1 CT2 CT4

Contents	
Topic	
The contents of each TFG will be defined in individual proposals offered by tutors and approved by the Academic Degree Commission under the rules for carrying out the Final Project Work, which content is available on the website of the School of Telecommunication Engineering.	Each TFG will have different contents

Planning			
	Class hours	Hours outside the classroom	Total hours
Previous studies / activities	0	20	20
Integrated methodologies	0	20	20
Presentations / exhibitions	0	8	8
Tutored works	30	210	240
Jobs and projects	2	10	12

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

Methodologies	
	Description
Previous studies / activities	Search, read and work documentation, troubleshooting suggestions and / or exercises to be performed in the classroom and / or laboratory ... independently by students.
Integrated methodologies	The student presents the results obtained in the preparation of a document on the subject matter. It will be carried out individually, and both in writing (memory) and orally.
Presentations / exhibitions	Students must prepare and defend the work in front of a jury.
Tutored works	The student, individually, produces a paper on the subject matter, or he/she prepares seminars, research, memoirs, essays, summaries, etc.

Personalized attention	
Methodologies	Description
Tutored works	Each student receives academic advice by his/her supervisor concerning the specific topic of the Bachelor's thesis. Students will meet regularly with their supervisors for tracking of their progress.

Assessment

	Description	Qualification	Evaluated Competencess
Jobs and projects	A panel of three teachers for each of the mentions of the Degree shall be appointed. The evaluation was carried out according to the rules for carrying out the Final Year Work and assessment rubric approved by the Academic Degree Committee, whose contents are available on the website of the school of Telecommunication Engineering.	100	

Other comments and July evaluation

All information related to the TFG is available on the website of the School of Telecommunication Engineering at the following link:

http://www.teleco.uvigo.es/index.php/es/estudios/gett/planificacion-academica/tfg

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

Having passed all necessary subjects to obtain the Bachelor degree except the TFG, or enroll simultaneously in all subjects.