



Escola de Enxeñaría de Telecomunicación

(*)Páxina web

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www.teleco.uvigo.es

(*)Presentación

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

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

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

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

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

Master in Telecommunication Engineering

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

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

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

Interuniversity Masters

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

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

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

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

(*)Equipo directivo

MANAGEMENT TEAM

Directora: Rebeca Pilar Díaz Redondo (teleco.direccion@uvigo.gal)

Secretaría e Subdirección de Novas Titulacións: Pedro Rodríguez Hernández

(teleco.subdir.secretaria@uvigo.gal;teleco.subdir.novastitulacions@uvigo.gal)

Subdirección de Organización Académica: Pedro Comesaña Alfaro (teleco.subdir.academica@uvigo.gal)

Subdirección de Relaciones Internacionais e Subdirección de Infraestructuras: María Verónica Santalla del Río (teleco.subdir.internacional@uvigo.gal; teleco.subdir.infraestructuras@uvigo.gal)

Subdirección Difusión e Captación: Laura Docio Fernández (teleco.subdir.captacion@uvigo.gal)

Subdirección de Calidade: Ana María Cao Paz(teleco.subdir.calidade@uvigo.gal)

BACHELOR'S DEGREE IN TELECOMMUNICATION TECHNOLOGIES ENGINEERING

Generalcoordinator: Lucía Costas Pérez (teleco.grao@uvigo.gal)

<https://teleco.uvigo.es/es/documentos/acordos-es/comisions-academicas-es/miembros-de-la-comision-academica-del-gett/>

MASTER IN TELECOMMUNICATION ENGINEERING

Generalcoordinator: Manuel García Sánchez (teleco.master@uvigo.gal)

<https://teleco.uvigo.es/es/documentos/acordos-es/comisions-academicas-es/miembros-de-la-comision-academica-del-met/>

MASTER IN CYBERSECURITY

General coordinator: Ana Fernández Vilas (teleco.munics@uvigo.gal)

<https://teleco.uvigo.es/es/documentos/acordos-es/comisions-academicas-es/miembros-de-la-comision-academica-del-munics/>

MASTER IN INDUSTRIAL MATHEMATICS

Generalcoordinator: Elena Vázquez Cendón (USC)

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

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

INTERNATIONAL MASTER IN COMPUTER VISION

General coordinator: Xose Manuel Pardo López (USC)

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

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

MASTER'S DEGREE IN QUANTUM INFORMATION SCIENCE AND TECHNOLOGIES (MQIST)

General coordinator: Javier Mas (USC)

Coordinador UVIGO: Manuel Fernández Veiga(teleco.mqist@uvigo.es)

<https://quantummastergalicia.es/info>

Máster Universitario en Ingeniería de Telecomunicación

Subjects

Year 2nd

Code	Name	Quadmester	Total Cr.
V05M145V01301	Real-Time Signal Processing	1st	5
V05M145V01302	Communication Advanced Systems	1st	5
V05M145V01303	Statistical Signal Processing	1st	5
V05M145V01304	Numerical Optimisation in Telecommunications	1st	5

V05M145V01305	Mathematical Modelling and Numerical Simulation	1st	5
V05M145V01306	Data Protection Cryptographic Techniques	1st	5
V05M145V01307	Machine Learning	1st	5
V05M145V01308	Administration of Networks and Systems	1st	5
V05M145V01309	Web Development Technologies	1st	5
V05M145V01310	Mobile Applications Development	1st	5
V05M145V01311	Satellites	1st	5
V05M145V01312	Wideband Radio Systems	1st	5
V05M145V01313	Wireless and Mobile Communications	1st	5
V05M145V01314	Radio Navigation	1st	5
V05M145V01315	Optical Networks	1st	5
V05M145V01316	Radar	1st	5
V05M145V01317	Microwave and Millimetre Wave Circuit Design and CAD	1st	5
V05M145V01318	Multimedia Security	1st	5
V05M145V01319	Intelligent Sensors	1st	5
V05M145V01320	Practicals in Digital Electronics for Communications	1st	5
V05M145V01321	Distributed Computing	1st	5
V05M145V01322	Data analysis	1st	5
V05M145V01323	Economical and Social Networks	1st	5
V05M145V01324	Internship in Companies I	1st	5
V05M145V01325	Internship in Companies II	1st	5
V05M145V01326	Internship in Companies III	1st	5
V05M145V01327	Network Information Theory	1st	5
V05M145V01328	Learning in Networks and Collaborative Work	1st	5
V05M145V01329	Human-Computer Interaction	1st	5
V05M145V01330	Photovoltaic Power Electronics	1st	5
V05M145V01331	Signal Conditioners	1st	5
V05M145V01332	Electronic Equipments Implementation and Exploitation	1st	5
V05M145V01333	Electronic Equipment Practicals	1st	5
V05M145V01334	Telecommunications Seminar	1st	5
V05M145V01335	Piezoelectric Transducers and Applications	1st	5
V05M145V01336	Numerical Linear Algebra in Telecommunications Engineering	1st	5
V05M145V01401	Master Thesis	2nd	30

IDENTIFYING DATA				
Real-Time Signal Processing				
Subject	Real-Time Signal Processing			
Code	V05M145V01301			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	English			
Department				
Coordinator	Martín Rodríguez, Fernando			
Lecturers	Martín Rodríguez, Fernando			
E-mail	fmartin@uvigo.es			
Web	http://https://moovi.uvigo.gal/			
General description	In this subject we deal with several architectures and techniques for real-time signal and video processing. Our main focus will be on hands-on, practical work and the capability to adapt to new, emerging, constantly evolving technologies and tools.			

Training and Learning Results

Code	
B1	CG1 Ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C21	CE21/PS1 Manage implementation of signal processing systems options to accelerate computationally complex algorithms.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Understanding the basic principles of real time signal and video processing.	B1 B8 C21
Handling advanced programming tools for real-time signal and video and applications.	B1 B8 C21
Understanding the design and implementation of computationally complex models generated from data (machine learning) and their use in real applications.	B1 B8 C21
Knowing how to design the suitable software-hardware solution for a problem of signal processing with real-time restrictions.	B1 B8 C21

Contents

Topic	
Fundamentals of real-time signal and video processing	Real-time definitions Real-time processing platforms Software methods and algorithm simplifications
Design and implementation of real-time signal and video processing applications	Real-time constraints: from research to implementation. Practical examples for signal processing Practical examples for video processing
Highly demanding computational models learned from data	Machine learning principles Artificial neural networks and deep learning Typical DNN models and implementation Examples of highly demanding signal and video processing applications.
Practical content.	Work on three practical cases related to theory units.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	12	0	12
Practices through ICT	8	25	33

Case studies	5	70	75
Report of practices, practicum and external practices 1	1	0	1
Report of practices, practicum and external practices 1	1	0	1
Report of practices, practicum and external practices 1	1	0	1
Presentation	1	0	1
Objective questions exam	1	0	1

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

Methodologies	
	Description
Lecturing	Description of the fundamental concepts and practical considerations for signal and video processing applications with real-time constraints. CG1
Practices through ICT	Individual practice work using computing platforms and/or simulators to implement and compare software solutions. CG1, CG8, CE21. Software: Matlab, Simulink, Python/OpenCV.
Case studies	Individual or group practice work using computing platforms and/or simulators to study and implement specific applications. CG1, CG8, CE21

Personalized assistance

Methodologies	Description
Practices through ICT	The instructor will propose practical exercises to grasp the concepts explained in class and related to the case studies. The professor will review with the student the design and the code of the student in each session. https://www.uvigo.gal/es/universidad/administracion-personal/pdi/fernando-martin-rodriguez
Case studies	The instructor will propose a couple of case studies and the students will need to study them and implement different solutions. The students will need to make a written report and present the results to their classmates. The professor will guide the students but the work is mainly done by them. https://www.uvigo.gal/es/universidad/administracion-personal/pdi/fernando-martin-rodriguez

Assessment				
	Description	Qualification	Training and Learning Results	
Report of practices, practicum and external practices	CASE 1, REAL TIME PROGRAMMING. Report on the study of the practical case and solution adopted.	25	B1 B8	C21
Report of practices, practicum and external practices	CASE 2, REAL TIME PROGRAMMING AND MACHINE LEARNING. Report on the study of the practical case and solution adopted.	25	B1 B8	C21
Report of practices, practicum and external practices	CASE 3, ADVANCED MACHINE LEARNING, DEEP LEARNING. Report on the study of the practical case and solution adopted.	25	B1 B8	C21
Presentation	The students will present, individually, their work related to the case studies	10	B8	C21
Objective questions exam	Multiple choice test about course theory.	15	B1 B8	

Other comments on the Evaluation

Teaching and assessment is in english.

Attendance is compulsory in continuous assessment, unless special circumstances are alleged. Continuous assessment will be based on short answer tests, case study reports and presentations.

There will be an ordinary call exam in the official date scheduled by the "Xunta de Escola" that the students that didn't pass the continuous assessment will have to take to pass the course (global assessment). This final exam will be scored from 0 to 10 points and covers all the topics explained during the course and also concepts and techniques explained for the case studies. To pass this exam the student has to score, at least, 5 points.

Delivering any of the reports or sitting at any test will automatically mean that the student is following the course in the continuous assessment mode. That means that he/she will appear as "presented" in the records of the subject even if assessment is not completed.

There will be a extraordinary exam at the end of the course for students who failed both in the continuous assesment mode

and/or at ordinary 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

Nasser Kehtarnavaz and Mark Gamadia,, **Real-Time Image and Video Processing: From Research to Reality**, 1, Morgan & Claypool publishers, 2006

Gerassimos Barlas, **Multicore and GPU Programming: An Integrated Approach**, 1, Elsevier, 2015

Complementary Bibliography

Nasser Kehtarnavaz, Shane Parris,Abhishek Sehgal, **Smartphone-Based Real-Time Digital Signal Processing**, 1, Morgan & Claypool publishers, 2015

Nasser Kehtarnavaz, Fatemeh Saki, **Anywhere-Anytime Signals and Systems Laboratory: From MATLAB to Smartphones**, 1, Morgan & Claypool publishers, 2016

Recommendations

Subjects that it is recommended to have taken before

Signal Processing in Audiovisual Systems/V05M145V01205

Signal Processing in Communications/V05M145V01102

IDENTIFYING DATA				
Communication Advanced Systems				
Subject	Communication Advanced Systems			
Code	V05M145V01302			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	English			
Department				
Coordinator	Mosquera Nartallo, Carlos			
Lecturers	Gómez Cuba, Felipe Mosquera Nartallo, Carlos			
E-mail	mosquera@gts.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This course covers the application of advanced mathematical tools to address some challenges in new and emerging satellite and terrestrial communication systems, with special emphasis on lower layers and multiuser systems.			

Training and Learning Results	
Code	
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
C22	CE22/PS2 Ability to understand the impact of the requirements of the telecommunications systems design services, with special emphasis in the lower layers, while maintaining a global vision of the solutions employed in modern commercial systems of communications.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
Understand the impact of telecommunication services requirements on system design, with special emphasis on lower layers.	B4 C22
Acquire a global view of the solutions developed for modern commercial communication systems.	B4 C22

Contents	
Topic	
1. Convex optimization	1.1 Basic concepts of convex sets 1.2 Introduction to convex functions 1.3 Quasiconvex functions 1.4 Convex optimization problems 1.5 Duality 1.6 Introduction to non-convex problems 1.7 Practical examples in communications
2. Multi-user fundamentals	2.1 Fundamentals of information theory for multi-user systems, regions of capacity. 2.2 Multiple access channel: rate region, orthogonal and non-orthogonal allocations. Multi-user detection. 2.3 Broadcast channel: rate region, orthogonal assignments, linear precoding and Dirty Paper Coding techniques. 2.4 Network modeling: Interfering Channel and Relay Channel. Interference management and performance. 2.5 Networks and multiple access: planned systems and contention systems. Limitations of IoT systems. Hybrid retransmission. 2.6 Spectrum and interference management. Spectral sensing, cognitive radio, and virtualization. 2.7 Applications in current standards

Planning

	Class hours	Hours outside the classroom	Total hours
Seminars	6	15	21
Lecturing	24	53	77
Problem solving	0	12	12
Problem solving	0	13	13
Problem and/or exercise solving	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
Seminars	Different communication systems will be presented with special emphasis on those challenges which are at the core of modern solutions and require advanced mathematical tools. Skills CG4 and CE22 are developed here.
Lecturing	Advanced mathematical tools will be introduced as background material to address practical solutions in modern communication systems. Skills CG4 and CE22 are developed here.
Problem solving	1. Convex optimization. Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis, Matlab-based software tools or both. Skills CG4 and CE22 are developed here.
Problem solving	2. Multi-user fundamentals. Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis, Matlab-based software tools or both. Skills CG4 and CE22 are developed here.

Personalized assistance

Methodologies Description

Lecturing	Student support will be provided during office hours and by e-mail. For contact information, see https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo .
Seminars	Student support will be provided during office hours and by e-mail. For contact information, see https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo
Problem solving	Student support will be provided during office hours and by e-mail. For contact information, see https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo
Problem solving	Student support will be provided during office hours and by e-mail. For contact information, see https://www.uvigo.gal/es/universidad/administracion-personal/pdi/carlos-mosquera-nartallo

Assessment

	Description	Qualification	Training and Learning Results
Problem solving	1. Convex optimization. Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis, software tools or both. If the solution is not turned in within the allocated deadline, the corresponding assignment will not be graded.	30	B4 C22
Problem solving	2. Multi-user fundamentals. Every week a homework challenge will be proposed to be solved with the aid of mathematical analysis, software tools or both. If the solution is not turned in within the allocated deadline, the corresponding assignment will not be graded.	30	B4 C22
Problem and/or exercise solving	Final exam with short questions and exercises.	40	B4 C22

Other comments on the Evaluation

The students need to obtain 50 out of 100 points to pass the course. In addition, a minimum grade of 30% is required in the final exam; if this grade is not achieved, his/her global score will be obtained using the formula: $\min(0.6 \cdot \text{REP} + 0.4 \cdot \text{TEST}, 4.9)$, where REP is the score achieved in the reports and TEST is the score achieved in the final exam. This applies also to the extra call.

The grades obtained from the weekly assignments are only valid for the current academic year, and cannot be redone after the corresponding deadline. A student can decide to opt out the evaluation of the weekly assignments; in such a case, his/her final score will be fully based on the final exam. This applies also to the extra call. Once the student turns in any of the deliverables, he/she will be considered to be following the continuous evaluation track if he/she does not say otherwise within one month from the beginning of the course.

Any student that chooses the continuous evaluation track will get a final score, regardless of her/his taking the final exam.

All the homeworks and exam will be given in English.

Sources of information

Basic Bibliography

Stephen Boyd, Lieven Vandenberghe, **Convex Optimization**, Cambridge University Press, 2004

Carlos Mosquera, **Class notes**, 2020

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

Complementary Bibliography

Dimitri P. Bertsekas, **Convex Optimization Theory**, Athena Scientific, 2009

David G. Luenberger, Yinyu Ye, **Linear and Nonlinear Programming**, Fourth, Springer, 2016

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

Recommendations

Subjects that it is recommended to have taken before

Data Communication/V05M145V01204

Signal Processing in Communications/V05M145V01102

Other comments

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

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

Training and Learning Results

Code	
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C23	CE23/PS3 Ability to apply methods of statistical processing of signal communications systems and audiovisual.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Ability to apply statistical estimation techniques in communications and multimedia systems	C23
Ability to apply statistical detection techniques in communications and multimedia systems	C23
Ability to determine and interpret fundamental limits in estimation and detection problems	B4 C23
Ability to evaluate the performance of estimation and detection techniques, by analytical as well as by Monte Carlo simulation methods	B8 C23

Contents

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

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	21	23	44
Practices through ICT	7	7	14
Autonomous problem solving	0	14	14
Autonomous problem solving	0	14	14

Simulation	0	25	25
Objective questions exam	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
Lecturing	Presentation of main topics, possibly with audiovisual aids. Skills involved: CG4, CG8
Practices through ICT	Computer-based simulation in the lab, under the MATLAB programming environment, of statistical signal processing applications to communications and multimedia, via Monte Carlo methods. Performance analysis. Skills involved: CG8, CE23
Autonomous problem solving	Students will be given a series of short homework assignments throughout the course that they should turn in by the set deadline. Skills involved: CG4, CG8, CE23
Autonomous problem solving	
Simulation	Computer-based simulation of statistical signal processing applications to communications and multimedia, via Monte Carlo methods. Performance analysis. Skills involved: CG8, CE23

Personalized assistance

Methodologies	Description
Lecturing	Student aid will be provided during office hours by appointment, as well as on-line (email). See https://moovi.uvigo.gal/user/profile.php?id=11637
Practices through ICT	Student aid will be provided during lab hours and office hours by appointment, as well as on-line (email). See https://moovi.uvigo.gal/user/profile.php?id=11637

Assessment

	Description	Qualification	Training and Learning Results
Autonomous problem solving	Students will be given a series of short homework assignments throughout the course that they should turn in by the set deadline.	30	B4 C23 B8
Autonomous problem solving	(*)Assignarase unha serie de exercicios ao longo do curso que os estudantes deberán resolver e entregar no prazo fixado	30	B4 C23 B8
Objective questions exam	Comprehensive test in which students must solve a number of exercises or problems.	40	B4 C23 B8

Other comments on the Evaluation

Students may choose one of the following two assessment options:

1) Continuous assessment: Final grade will consist of:

- comprehensive test (up to 4 points)
- homework assignments (up to 6 points)

A minimum grade of 35% in the comprehensive test is required in order to pass the course. Otherwise, the overall grade will be:

- a) 4 points, if the overall grade without considering the 35% requirement in the test is no less than 5.
- b) Directly that of the comprehensive test, otherwise.

Homework grades from the ordinary call will be kept for the extraordinary call, in which the student will be allowed to retake the comprehensive test. Students assume continuous assessment with the submission of any homework assignment.

2) Global assessment: The final grade is the one achieved in the comprehensive test, for both the ordinary and extraordinary calls.

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

Sources of information

Basic Bibliography

- S. M. Kay, **Fundamentals of Statistical Signal Processing, vol. I: Estimation Theory**, 1, Prentice Hall, 1993
- S. M. Kay, **Fundamentals of Statistical Signal Processing, vol. II: Detection Theory**, 1, Prentice Hall, 1998

Complementary Bibliography

L. L. Scharf, **Statistical signal processing: detection, estimation and time series analysis**, 1, Pearson, 1991

T. K. Moon, W. C. Stirling, **Mathematical Methods and Algorithms for Signal Processing**, 1, Pearson, 1999

IEEE, <http://ieeexplore.ieee.org/>,

Recommendations

Subjects that are recommended to be taken simultaneously

Communication Advanced Systems/V05M145V01302

Subjects that it is recommended to have taken before

Data Communication/V05M145V01204

Signal Processing in Communications/V05M145V01102

IDENTIFYING DATA				
Numerical Optimisation in Telecommunications				
Subject	Numerical Optimisation in Telecommunications			
Code	V05M145V01304			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA**Mathematical Modelling and Numerical Simulation**

Subject	Mathematical Modelling and Numerical Simulation			
Code	V05M145V01305			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Data Protection Cryptographic Techniques				
Subject	Data Protection Cryptographic Techniques			
Code	V05M145V01306			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Machine Learning				
Subject	Machine Learning			
Code	V05M145V01307			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA**Administration of Networks and Systems**

Subject	Administration of Networks and Systems			
Code	V05M145V01308			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Web Development Technologies				
Subject	Web Development Technologies			
Code	V05M145V01309			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	Spanish			
Department				
Coordinator				
Lecturers				
E-mail				
Web	http://fatic.uvigo.es			
General description	Description of the most current techniques applications for the development of Web applications. The course will teach the students to develop multiplatform applications based on the HTML5 foundation.			

Training and Learning Results	
Code	
A1	CB1 Knowledge and understanding needed to provide a basis or opportunity for being original in developing and/or applying ideas, often within a research context.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B12	CG12 Skills for lifelong, self-directed and autonomous learning.
C35	CE50/OP20 Ability to deploy and manage server software application logic of a web service managers, to design and manage non-relational data bases , and understand the functional division of an existing Web application between the client and the server itself

Expected results from this subject	
Expected results from this subject	Training and Learning Results
The students will be able to design, develop and manage the whole infrastructure of a web application. Besides, they will be able to develop the application logic and to create responsive user interfaces using web technologies.	A1 A5 B12 C35

Contents	
Topic	
The current ecosystem of web development	Introduction to HTML5, CSS3 and Javascript. Architectures of web and mobile applications. Concepts and frameworks of multi-platform development.
Markup with HTML5 and Angular	Structural elements of an application. Semantic markup. Forms. Programming interfaces.
Presentation with CSS3 and SaaS	Data binding and structural directives. The box model. Adaptable design. Selectors. Extensions of the SaaS metalanguage.

Application logic with Javascript and TypeScript Evolution of scripting languages for the web.

CRUD applications and REST interfaces.

Objects and arrays in Javascript.

Processing of JSON and XML content.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	9	18	27
Problem solving	5	14	19
Project based learning	11	66	77
Essay questions exam	2	0	2

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

Methodologies

	Description
Lecturing	Presentation of the main concepts and technologies, predominantly through practical examples of use. It will work mainly the competency CE35.
Problem solving	Practices of the concepts presented in the lectures. It will work the CB5 and CE35 competencies.
Project based learning	Development in group of a practical project, consisting in a functional version of a web service that incorporates the main mechanisms presented in the course. It will work the CB5 and CE35 competencies.

Personalized assistance

Methodologies Description

Lecturing	During the tutoring hours, the professors will deliver personalised attention, to guide the student in the understanding of the theoretical concepts explained in the lecturing sessions or in the practical ones. In these hours, the professors will also follow up on the work linked to the practical project. In the group tutoring hours, the professors will conduct the debate on the solutions proposed by the members of the working groups, and also check the uniform participation of the members in the final development.
Problem solving	During the tutoring hours, the professors will deliver personalised attention, to guide the student in the understanding of the theoretical concepts explained in the lecturing sessions or in the practical ones. In these hours, the professors will also follow up on the work linked to the practical project. In the group tutoring hours, the professors will conduct the debate on the solutions proposed by the members of the working groups, and also check the uniform participation of the members in the final development.

Assessment

	Description	Qualification	Training and Learning Results
Project based learning	Practical project.	70 A1 A5	C35
Essay questions exam	Final exam.	30 A5 B12	C35

Other comments on the Evaluation

Continuous Assessment:

To opt to continuous assessment, it is necessary to attend 80% of the practical lab sessions and make the corresponding deliveries, and also to make the partial deliveries requested for the group development project.

Each one of the deliveries will be evaluated separately. The final practical mark will be the result of averaging the mark obtained in the last delivery of the development project (70%) and the arithmetical average of the previous deliveries (30%). All the marks associated to the work done in group will be shared by all of its members.

The final mark will be the obtained by averaging the practical mark (70%) and the mark obtained in the exam (30%).

One-step Assessment:

The student who prefers one-step assessment must tell the professor before the date of the first partial delivery of the development project. In this case, his/her partial deliveries will not be taken into account for his/her mark, but they will for the marks of the other group members who opt to continuous assessment. The final mark will be calculated by averaging the mark obtained in the final delivery of the project (70%) and that of the final examination (30%).

Second Opportunity:

In the second opportunity, the students have to deliver (individually) a set of modifications to the project developed during the course. In the case of the students of one-step assessment, this delivery will account for 70% of the final mark, and the remaining 30% will correspond to the final exam.

For the students who chose continuous assessment, the practical note will be the maximum between (i) the weighted average of the marks of new delivery (70%) and the marks of the partial deliveries (30%) and (ii) the mark corresponding only to the new delivery.

Sources of information

Basic Bibliography

Mark Pilgrim, **HTML5: Up and Running**, 1ª, O'Reilly, 2010

Wesley Hales, **HTML5 and JavaScript Web Apps**, 1ª, O'Reilly, 2012

Chris Griffith, **Mobile App Development with Ionic, Revised Edition**, 1ª, revisada, O'Reilly, 2017

<https://developer.mozilla.org/en/docs/Web>, **Web technology for developers**,

Complementary Bibliography

Peter Gasston, **The book of CSS3**, 2ª, No Starch Press, 2014

Recommendations

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

Training and Learning Results	
Code	
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C33	CE46/OP16 Ability to understand the current development of mobile and ubiquitous services and market developments
C34	CE47/OP17 Ability to design, create, integrate sources of context, and working group on the development of a mobile application

Expected results from this subject	
Expected results from this subject	Training and Learning Results
Acquire an overview of the ubiquitous panorama, in particular of the mobile applications and of the different operating systems in which they run.	C33
Learn how to build mobile applications including different elements (interaction with the user, context integration, interconnection with other devices, notifications, ...)	A2 A5 B8 C34
Work in group to propose, build and defend a mobile application.	A2 A5 B8 C33 C34

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

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	4	4	8
Laboratory practical	12	36	48
Mentored work	4.5	49.5	54
Presentation	0.5	0.5	1
Objective questions exam	1	1	2
Laboratory practice	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
Lecturing	The professors of the course present the main theoretical contents related to the development of applications for mobile devices. Through this methodology the competency CE33 (CE46/OP16) is developed.
Laboratory practical	Students will complete guided and supervised practices about the basic aspects of Android mobile applications. Through this methodology the competencies CB2, CG8, CE33 (CE46/OP16) and CE34 (CE7/OP17) are developed.
Mentored work	In groups, design, development and test of a mobile application. Students and professors will have regular meetings to check the correct evolution of the tutored works. Through this methodology the competencies CB2, CB5, CG8, CE33 (CE46/OP16) and CE34(CE7/OP17) are developed.
Presentation	Presentation and defense of the mobile application that has been developed throughout the course. Through this methodology the competencies CG8, CE33 (CE46/OP16) and CE34 (CE7/OP17) are developed.

Personalized assistance

Methodologies	Description
Lecturing	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered face-to-face or online (during the master session itself or during the tutoring hours). The tutoring hours will be agreed with the students by appointment. The tutoring sessions may be carried out by telematic means (email, videoconference, Moovi forums, ...) under the modality of prior agreement.
Laboratory practical	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered face-to-face or online (during the lab session itself or during the tutoring hours). The tutoring hours will be agreed with the students by appointment. The tutoring sessions may be carried out by telematic means (email, videoconference, Moovi forums, ...) under the modality of prior agreement.

Mentored work	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered face-to-face or online (during the supervising session itself or during the tutoring hours). The tutoring hours will be agreed with the students by appointment. The tutoring sessions may be carried out by telematic means (email, videoconference, Moovi forums, ...) under the modality of prior agreement.
Presentation	The professors of the course will guide the students during the preparation of the presentation of the results of the guided work, mostly during the last sessions of the supervising sessions or during tutorial sessions.

Assessment				
	Description	Qualification	Training and Learning Results	
Mentored work	Whenever possible, the students will be divided in groups, to design, build and test an application for mobile devices. The result will be evaluated after the delivery, taking into account key aspects such as correction, quality, performance and functionalities of the developed application. Likewise, during the development of the project, professors will make a continuous follow-up of the design and the evolution of the implementation, which may include intermediate assessment tests.	40	A2 B8 C33 A5 C34	
Presentation	At the end of the course, each group of students has to present and defend in English the developed application for mobile devices. The defence has to include a practical demonstration of the use of the application.	10	B8 C33 C34	
Objective questions exam	After each master session, students will make a multiple choice test (in English) to evaluate the understanding of the presented topics.	20	C33	
Laboratory practice	In each practice session students will demonstrate the proper functioning of the developments carried out during the session.	30	A2 B8 C33 C34	

Other comments on the Evaluation

ORDINARY CALL

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

Continuous evaluation system

Those students who opt for continuous evaluation system must:

- Take a set of tests with multiple choice questions. These partial tests will be done at the end of each master session. These tests will account for 20 % of the overall grade of the course.
- Take a set of practical tests in the laboratory. These tests will be performed at the end of each practice session. These tests will account for 30 % of the overall grade of the course.
- Design, build and defend a mobile application (tutored work). This task will account for 50 % of the overall grade of the course. A 10 % is reserved for the presentation and defence of the developed mobile application. Though this task will be developed in groups (whenever possible), professors will make a continuous follow-up of the activities performed by each student of a group. If the performance of a student is not in line with the rest of his/her teammates, his/her expulsion of the group might be considered, or he or she might be assessed individually.

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

Global evaluation system

Those students who opt for the global evaluation system must:

- Take a final test with short answer or multiple choice questions (a 20 % of the overall grade of the course).
- Make and demonstrate the proper functioning of the practices in the laboratory (a 30 % of the overall grade of the course).
- Design, build and defend a mobile application (tutored work), individually or if it is possible in groups (a 50 % of the overall grade of the course, with a 10 % reserved for the presentation and defence of the developed mobile application).
- Deliver a *dossier* that includes all the details about the development of the practices in the laboratory and, especially,

about the tutored work.

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

EXTRAORDINARY CALL

The course final exam will only be held for students who failed the course in the ordinary call.

The assessment will consist in doing one, two or three of the following tasks, depending on the marks achieved in the equivalent tasks during the first opportunity:

- Make a final test with short answers or multiple choice questions (a 20 % of the overall grade of the course).
- Make and demonstrate the proper functioning of the practices in the laboratory (a 30 % of the overall grade of the course).
- Design, build and defend a mobile application (tutored work), individually or if it is possible in groups (a 50 % of the overall grade of the course, with a 10 % reserved for the presentation and defence of the developed mobile application).
- In addition, those who opt for the final assessment system should deliver a *dossier* that includes all the details about the development of the practices in the laboratory and, especially, about the tutored work.

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

OTHER COMMENTS

- The obtained grades 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 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. This criteria will be also apply to the presententaion of the developd application.
- The use of any material during the tests will have to be explicitly authorized.
- Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the tests or exams, the final grade will be FAIL (0), and the incident will be reported to the corresponding academic authorities for prosecution.

Sources of information

Basic Bibliography

Joshua J. Drake, **Android hackers's handbook**, 1ª,

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

Jesús Tomás Gironés, **El gran libro de Android**, 8ª,

Jerome DiMarzio, **Beginning Android Programming With Android Studio**, 2ª,

Complementary Bibliography

Recommendations

Other comments

It is recommended to have Java programming skills

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

Training and Learning Results	
Code	
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
B3	CG3 Ability to lead, plan and monitor multidisciplinary teams.
B7	CG7 Capacity for implementation and management of manufacturing processes of electronic and telecommunications equipment; guaranteeing safety for persons and property, the final quality of the products, and their homologation.
C18	CE18/RAD1 Capacity of elaborating, strategic planning, direction, coordination and technical and economic management of spatial projects applying spatial systems engineering standards, with knowledge of the processes a satellite operation.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
To know and apply ECSS management space project standards.	C18
To know the basics of the system engineering applied to space projects.	A2 B3 C18
To know the mission life cycle of a space mission.	A2 C18
To know the documentation generated in each engineering phase in a space mission	A2 B3 C18
To know and elaborate the main technical studies and budgets in a space mission.	B3 B7 C18
To know applicable methodologies and standards to product assurance (PA) and Assembly, Integration and Verification (AIV) procedures in a space project.	A2 B3 C18
To know the basics of satellite operation procedures and standards	C18

Contents	
Topic	
International space project standards (Theoretical ECSS, NASA, INCOSE and Practical).	
Space project life cycle (Theoretical and Practical).	Documentation and reviews.
Segments of a satellite project (Theoretical).	- Space Segment. - Ground Segment. - User Segment. - Launchers.

Satellite subsystems (Theoretical).	- Communication. - Mechanical & Thermal. - Power. - ADCS. - Propulsion. - On-board computer.
Product Assurance and Assembly, Integration and Verification Procedures in a space project (Theoretical and Practical).	- Product Assurance (PA) in space projects. - Assembly, Integration and Verifications (AIV) plans and procedures in space projects.
Introduction to satellite operations (Theoretical).	- Telemetry and Telecommand definition. - Operation procedures.
Analysis and simulation of two polarization effects, antenna pointing, and tropospheric propagation in satellite communications (Practical)	- Simulation of the pointing and polarization effects. - Effects of the troposphere.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	13	39	52
Mentored work	2	6	8
Mentored work	2	6	8
Mentored work	2	6	8
Seminars	10	20	30
Problem and/or exercise solving	1	18	19
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	The different aspects of the subject are described, including the possibility of using the flipped learning methodology
	With this methodology A2, B3 and C18 competencies are covered.
Mentored work	Each student will apply the theoretical knowledge to evaluate the technical feasibility of a small satellite project proposed by the student. Phase 0.
	With this methodology A2, B3 and C18 competences are covered.
Mentored work	Each student will apply the theoretical knowledge to evaluate the technical feasibility of a small satellite project proposed by the student. Phase A.
	With this methodology A2, B3 and C18 competences are covered.
Mentored work	Each student will apply the theoretical knowledge to evaluate the technical feasibility of a small satellite project proposed by the student. Phase B1.
	With this methodology A2, B3 and C18 competences are covered.
Seminars	Each student will apply the theoretical knowledge to different practical tasks that cover the main part of the contents of the subject with the help of specific software.
	With this methodology A2, B7 and C18 competences are worked.

Personalized assistance	
Methodologies	Description
Lecturing	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 (https://moovi.uvigo.gal/user/profile.php?id=11661). They may also send their queries by email.
Seminars	The students will have the opportunity to attend tutorial hours with the university lecturers in the schedule that will be established and published in the subject web-page (https://moovi.uvigo.gal/user/profile.php?id=11661). They may also send their queries by email.
Mentored work	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 (https://moovi.uvigo.gal/user/profile.php?id=11661). They may also send their queries by email.
Mentored work	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 (https://moovi.uvigo.gal/user/profile.php?id=11661). They may also send their queries by email.

Mentored work 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 (<https://moovi.uvigo.gal/user/profile.php?id=11661>). They may also send their queries by email.

Assessment				
	Description	Qualification	Training and Learning Results	
Mentored work	The students will write a report of Phase 0 including the results obtained to justify the technical feasibility of the proposed small satellite mission. The evaluation will be based on the students' assistance to the master lessons, his or her participation on the seminars as well as the presented reports and oral presentations showing the obtained results.	15	A2	B3 C18 B7
Mentored work	The students will write a report of Phase A including the results obtained to justify the technical feasibility of the proposed small satellite mission. The evaluation will be based on the students' assistance to the master lessons, his or her participation on the seminars as well as the presented reports and oral presentations showing the obtained results.	15	A2	B3 C18 B7
Mentored work	The students will write a report of Phase B1 including the results obtained to justify the technical feasibility of the proposed small satellite mission. The evaluation will be based on the students' assistance to the master lessons, his or her participation on the seminars as well as the presented reports and oral presentations showing the obtained results.	15	A2	B3 C18 B7
Seminars	The students will perform simulations using specific software. The evaluation will be based on the students' assistance to the seminars, his or her participation on the seminars and a final report.	35	A2	C18
Problem and/or exercise solving	A final test to complement the evaluation of the contents presented in the master sessions. The test will be individual with time limit.	20		C18

Other comments on the Evaluation

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

Within a maximum period of one month from the start of the course, the student must choose the method of evaluation for the ordinary opportunity: global assessment or continuous assessment. In case of having chosen continuous assessment, the grade cannot be 'not presented'. However, students can switch to global assessment one week before the final test. The extraordinary opportunity will always be assessed by global assessment, although, optionally, part of the continuous assessment grades can be taken into account.

Language of instruction: English.

All course documentation will be done in English, as well as the presentations.

The assessment of reports and practices will also be conducted in English.

The last exam can be answered in English, Galician, or Spanish.

1.- Ordinary opportunity

Global assessment:

The exam will include questions, problems, and practices related to the contents that are explained both in the master sessions, seminars, and supervised works. It will be necessary to get a 5 out of 10 to pass the exam.

Continuous assessment:

The subject will be evaluated throughout the course:

□ **Practice seminars:** students will carry out 3 practices. Their evaluation will have a weight of 35% in the final grade.

□ **Tutored works:** 3 works will be proposed throughout the course and the evaluation will be carried out through the correction of the corresponding reports, as well as their oral presentation. Each work will have a weight of 15% in the final grade.

□ **Short answer final test:** this exam will be the final test of the continuous assessment and will have a weight of 20% of the final grade.

2.- Extraordinary opportunity:

The students will carry out a global assessment that will include topics and/or problems related to the content taught both in master sessions, seminars, and in supervised works (100% of the final grade). Students who chose continuous assessment for the first opportunity can optionally take this unique assessment for 65% of the final grade.

3.- End-of-program call:

The students will carry out a global assessment that will include topics and/or problems related to the content taught both in master sessions, seminars, and in supervised works (100% of the final grade). Students who chose continuous assessment for the first opportunity can optionally take this unique assessment for 65% of the final grade.

The practical tasks carried out in the course are not recoverable and are only valid for the current course.

Sources of information

Basic Bibliography

Course documentation and slides,

James R. Wertz, David F. Everett and Jeffery J. Puschell, **Space Mission Engineering: The New SMAD**, 4,
<http://www.ecss.nl>,

Complementary Bibliography

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

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

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

Recommendations

Subjects that it is recommended to have taken before

Analog Electronic Circuits Design/V05M145V01106

Wireless and Mobile Communications/V05M145V01313

IDENTIFYING DATA				
Wideband Radio Systems				
Subject	Wideband Radio Systems			
Code	V05M145V01312			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	English			
Department				
Coordinator	García Sánchez, Manuel			
Lecturers	García Sánchez, Manuel Santalla del Río, María Verónica			
E-mail	manuel.garciasanchez@uvigo.es			
Web	http://moovi.uvigo.es			
General description	Wideband radio systems.			

Training and Learning Results

Code	
C19	CE19/RAD2 Ability to perform theoretical design, experimental band systems measurement and practical implementation broadband for current applications

Expected results from this subject

Expected results from this subject	Training and Learning Results
Theoretical and experimental knowledge of wideband systems	C19
Knowledge of designs of wideband active and passive elements	C19
Fundamentals of wideband signal generation and reception	C19
Fundamentals of wideband signal measurement	C19

Contents

Topic	
Introduction	Definitions and basic concepts Communication systems Radio systems. Antennas. Radioelectric spectrum. Modulation. Radio channel. Propagation channel.
Description of the radio channel	Free space Undistorted transmission Attenuation. Multipath Fading. Doppler spread. Delay spread. Frequency selective channels. Precursors.
Mathematical characterization	Narrowband Statistical amplitude distributions Doppler spectrum Wideband Bello formulation
Channel sounders	Narrowband Doppler. Nyquist limit. Wideband. Frequency domain sounders: VNA Time domain sounders. RF pulse. Sliding correlation sounders. Sounder design and performance assesment. Narrowband sounder with spectrum analyzer 0 span. VNA based sounder. Sliding correlation sounder.
Channel sounders lab	Building a wideband sounder to measure the radio channel.

Wideband modulations	Delay spread. Inter symbol interference. Irreducible BER. Frequency hopping: GSM OFDM. Guard interval. Pilot tones. Equalization. PAPR. Amplifiers. DVB-T. 4G. CDMA. Processing gain. Noise. Acquisition and tracking. RAKE receiver. 3G. Power control. Cellular breathing.
UWB systems	1. Definition. Specificities. Regulation 2. Channel characteristics. 3. Impulse radio UWB. 4. Multiband OFDM approach to UWB. 5. Applications
Wideband and UWB antenna design	1. Wideband antennas. Definition and requirements. 2. Characterization of wideband antennas 3. Examples and applications. 4. UWB antennas. Definition and requirements. 5. Characterization of UWB antennas 6. Examples and applications.
UWB applications	Radar Ground penetrating radar Positioning and location Medical imaging Emerging applications

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	10	28	38
Flipped Learning	9	40	49
Lecturing	10	20	30
Laboratory practice	0	2	2
Objective questions exam	1	2	3
Objective questions exam	1	2	3

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

Methodologies

	Description
Laboratory practical	Building and testing wideband radio channel sounders
Flipped Learning	Theoretical foundations of wideband systems
Lecturing	Presentation by the lecturer

Personalized assistance

Methodologies	Description
Laboratory practical	The students could ask questions during classes, during sheduled hours for the professors to atend the students or by email. (www.teleco.uvigo.es)
Flipped Learning	The students could ask questions during classes, during sheduled hours for the professors to atend the students or by email. (www.teleco.uvigo.es)
Lecturing	The students could ask questions during classes, during sheduled hours for the professors to atend the students or by email. (www.teleco.uvigo.es)

Tests	Description
Laboratory practice	The students could ask questions during classes, during sheduled hours for the professors to atend the students or by email. (www.teleco.uvigo.es)
Objective questions exam	The students could ask questions during classes, during sheduled hours for the professors to atend the students or by email. (www.teleco.uvigo.es)
Objective questions exam	The students could ask questions during classes, during sheduled hours for the professors to atend the students or by email. (www.teleco.uvigo.es)

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practice	Practice written and oral reports.	30	C19
Objective questions exam	Exam during last class	30	C19
Objective questions exam	Exam in the official date fixed by the school	40	C19

Other comments on the Evaluation

Regular call: We offer the students two schemes of assessment: continuous assessment and global assessment. The students will have to opt by one of the two schemes before a given date.

Special call: just global exam.

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

Sources of information

Basic Bibliography

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

Complementary Bibliography

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

M. Ghavami L.B Michael R. Kohno, **Ultra Wideband signals and systems in communication engineering**, Wiley, 2007

W. Pam Siriwongpairat K.J. Ray Liu, **Ultra-Wideband Communications systems. Multiband OFDM approach**, Wiley, 2008

W. Wiesbeck, G. Adamiuk, C. Sturm, **Basic Properties and Design Principles of UWB Antennas**, 2009

P. Bello, **Theory and applications of OFDM and CDMA**, 1963

J.D. Parsons, D.A. Demery and A.M.D. Turkmani, **Sounding techniques for wideband mobile radio channels: a review**, 1991

David D. Wentzloff,, **System Design Considerations for Ultra-Wideband Communication**, 2005

Recommendations

IDENTIFYING DATA				
Wireless and Mobile Communications				
Subject	Wireless and Mobile Communications			
Code	V05M145V01313			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	English			
Department				
Coordinator	Vazquez Alejos, Ana			
Lecturers	Pérez Fontán, Fernando Vazquez Alejos, Ana			
E-mail	analejos@uvigo.es			
Web	http://http://fatic.uvigo.es			
General description	This subject introduces the student in the technology of the main present mobile and wireless communication systems, with training in analysis of coverage and quality planning at radio interface level.			

Training and Learning Results	
Code	
C20	CE20/RAD3 Ability to analyse and specify the basic parameters of a mobile or wireless radio network, as well as of quality of service.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
Ability to compute the coverage and capacity of a mobile communications site and estimate the cellular radius.	C20
Dimensioning and capacity planning of mobile and wireless systems.	C20
Ability to carry out a mobile network deployment planning.	C20
Ability to select the radio technology most appropriate to a given application.	C20

Contents	
Topic	
Unit 1. Overview of mobile wireless radio communication systems.	1.1. Introduction to mobile and wireless systems. 1.2. Mobile and wireless radio propagation channel modeling.
Unit 2. Dimensioning and quality of service planning in mobile and wireless radio systems.	2.1. Dimensioning of a mobile radio system. 2.2. Quality of service. 2.3. Enabling technologies.
Unit 3. Cellular systems.	3.1. 1G and 2G mobile systems. 3.2. 3G mobile systems: CDMA, UMTS. 3.3. 4G mobile systems: LTE. 3.4. Next Generation mobile systems: 5G and B5G.
Unit 4. Wireless local and wide area networks.	4.1. Local area wireless systems and services: WLAN, and LPWAN. 4.2. Internet of Things (IoT). 4.3. Vehicular communications. 4.4. Design fundamentals: radio propagation channel modeling, dimensioning and quality of service. 4.5. Other wireless systems: WiMAX and WPAN.
(*)Prácticas de laboratorio	(*)1. Simulación conductual dun enlace de transmisión baixo condicións de desvanecimento tipo Rayleigh. 2. Canle radio Rayleigh con espectro Doppler tipo Jakes. 3. Balance de enlace e estimacións preliminares de erros. 4. Simulación de diferentes configuracións do sistema: sen codificación de canle vs codificación de canle e intercalado.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	12	30	42

Case studies	6	5	11
Problem solving	7.5	10	17.5
Practices through ICT	7.5	10	17.5
Mentored work	4	10	14
Laboratory practice	0	10	10
Essay questions exam	1.5	2	3.5
Presentation	1.5	0	1.5
Essay questions exam	1.5	2	3.5
Objective questions exam	1.5	3	4.5

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

Methodologies

	Description
Lecturing	Presentation of the theoretical contents of the subject by teachers.
Case studies	Conducting case studies in laboratory with delivery of a memory/report to be assessed.
Problem solving	Theoretical contents taught in the master lessons will be complemented with the resolution of problems and/or exercises during class time.
Practices through ICT	Practical cases will be realized with delivery of evaluable memory.
Mentored work	The development in group of two works will be proposed that covers any of the subjects considered in master lessons and practices.

Personalized assistance

Methodologies	Description
Lecturing	The students will be able to consult any doubt during this time of classes. If necessary, an appointment for tutoring with the faculty must be scheduled through the contact information provided in Moovi and the following link: Ana Vázquez Alejos @ https://www.uvigo.gal/universidade/administracion-persoal/pdi/ana-vazquez-alejos
Case studies	The case study is carried out during face-to-face hours and the students will be able to consult any doubt during this time of classes. If necessary, an appointment for tutoring with the faculty must be scheduled through the contact information provided in Moovi and the following link: Ana Vázquez Alejos @ https://www.uvigo.gal/universidade/administracion-persoal/pdi/ana-vazquez-alejos
Problem solving	The resolution of problems and exercises is carried out during face-to-face hours and the students will be able to consult any doubt during this time of classes. If necessary, an appointment for tutoring with the faculty must be scheduled through the contact information provided in Moovi and the following link: Ana Vázquez Alejos @ https://www.uvigo.gal/universidade/administracion-persoal/pdi/ana-vazquez-alejos
Practices through ICT	The lecturer will be available during the completion of the proposed practices to attend and resolve doubts. If necessary, an appointment for tutoring with the faculty must be scheduled through the contact information provided in Moovi and the following link: Fernando Pérez Fontán @ https://www.uvigo.gal/universidade/administracion-persoal/pdi/fernando-perez-fontan
Mentored work	The students will be able to consult any doubt during this time of classes. If necessary, an appointment for tutoring with the faculty must be scheduled through the contact information provided in Moovi and the following link: Ana Vázquez Alejos @ https://www.uvigo.gal/universidade/administracion-persoal/pdi/ana-vazquez-alejos
Tests	Description
Laboratory practice	For the delivery and assessment of the memory of the practices an appointment for tutoring with the faculty must be scheduled through the contact information provided in Moovi and the following link: Fernando Pérez Fontán @ https://www.uvigo.gal/universidade/administracion-persoal/pdi/fernando-perez-fontan
Essay questions exam	To resolve doubts related to this test, an appointment for tutoring with the faculty must be scheduled through the contact information provided in Moovi and the following link: Ana Vázquez Alejos @ https://www.uvigo.gal/universidade/administracion-persoal/pdi/ana-vazquez-alejos
Presentation	To resolve doubts related to the presentation of mentored work, an appointment for tutoring with the faculty must be scheduled through the contact information provided in Moovi and the following link: Ana Vázquez Alejos @ https://www.uvigo.gal/universidade/administracion-persoal/pdi/ana-vazquez-alejos
Essay questions exam	To resolve doubts related to this test, an appointment for tutoring with the faculty must be scheduled through the contact information provided in Moovi and the following link: Ana Vázquez Alejos @ https://www.uvigo.gal/universidade/administracion-persoal/pdi/ana-vazquez-alejos
Objective questions exam	To resolve doubts related to this test, an appointment for tutoring with the faculty must be scheduled through the contact information provided in Moovi and the following link: Ana Vázquez Alejos @ https://www.uvigo.gal/universidade/administracion-persoal/pdi/ana-vazquez-alejos

Assessment				
	Description	Qualification	Training and Learning Results	
Laboratory practice	For each lab practice an individual report of results must be presented for assessment.	30	C20	
Essay questions exam	Short exercise resolution exam oriented to contents of Units 1 and 2.	20	C20	
Presentation	Oral presentation in a group of the tutored work. The evaluation of each member of the group will be carried out by personalized follow-up.	10	C20	
Essay questions exam	Short exercise resolution exam oriented to contents of Units 3 and 4.	20	C20	
Objective questions exam	Single-answer question test on the total content of the subject	20	C20	

Other comments on the Evaluation

Students enrolled in the subject can choose one of the two proposed assessment systems: continuous assessment or exam-only assessment. Each student must notify the coordinating professor by email of the selected assessment system one month after the start of classes.

Continuous assessment (ordinary exam)

Continuous assessment involves performing throughout the semester of the paragraphs disaggregated in the above table. Each of the blocks is of mandatory fulfillment in the form of continuous and individual assessment, and to pass the subject a minimum of 25% of the note assigned to each of the sections and the total mark accumulated within the five sections to be achieved must overcome at least 50% of the final grade.

The short answer test is multiple choice and is done the day indicated in the official exam schedule. Regarding the block of laboratory practices, one report is required per practice and per student, made in a individual way. Evidences of report copying or cloning will drive to fail the related task.

Continuous assessment involves making 100% of all proposed tasks. Failure to take any of these tests implies the loss of continuous assessment and the final grade will be "SUSPENSO".

These tasks are not recoverable, that is, if a student does not satisfy the scheduled tasks, the teacher has no obligation to repeat any of them, and also they will be only valid for the academic year in which they are completed.

The schedule of the midterm/intermediate exams will be approved in the Comisión Académica de Máster (CAM) and will be available at the beginning of each academic semester.

It is considered that the subject is passed if the total grade is equal to or greater than 5. In case of leaving the modality of continuous assessment, the final grade will be "SUSPENSO".

Exam-only assessment (ordinary exam)

A student who does not opt for continuous assessment should be eligible for the highest grade by a final exam, which will consist of three parts:

- Part 1: realization of laboratory practices and delivery of reports due (30% of the final grade). One report is required per practice and per student, made in a individual way. Evidences of report copying or cloning will drive to grade as zero the related practice.
- Part 2: test exam (50% of the final grade).
- Part 3: troubleshooting (20% of the final grade).

It is considered that the subject is passed by eventual assessment if the total grade is equal to or greater than 5.

Extraordinary exam

For students who chose the exam-only assessment, the grade will be given by a final exam that will consist of three parts: a practical examination (pass /non-pass) (20%), a standard test exam (40%) and an examination of problems (40%) .

It is considered that the subject is approved in second call if the total grade is equal to or greater than 5.

End-of-program exam

It will consist of an exam with three parts: a practical examination (pass /non-pass)(20%), a standard test exam (40%) and an examination of problems (40%). It is considered that the subject is approved if the total grade is equal to or greater than 5.

Ethical code and plagiarism

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

Sources of information

Basic Bibliography

Ana Vazquez Alejos, **Lecture Notes and Powerpoint Slides**, 2017,

Oriol Sallent, **Fundamentos de diseño y gestión de sistemas de comunicaciones móviles celulares**, 2014,

Andreas F. Molisch, **Wireless Communications: From Fundamentals to Beyond 5G, 3rd Edition**, 978-1-119-11720-9, 3, Wiley, 2022

William Stallings, **5G Wireless: A Comprehensive Introduction**, 978-0136767145, 1, Addison-Wesley Professional, 2021

Complementary Bibliography

Jose María Hernando Rábanos, **Comunicaciones Móviles**, 2004,

M^a Teresa Jiménez Moya, Juan Reig Pascual, Lorenzo Rubio Arjona, **Problemas de comunicaciones móviles**, 2006,

José Manuel Huidobro Moya, **Comunicaciones móviles : sistemas GSM, UMTS Y LTE**, 2012,

Martin Sauter, **From GSM to LTE: An Introduction to Mobile Networks and Mobile Broadband**, 2011,

Maciej Stasiak et al., **Modelling and Dimensioning of Mobile Wireless Networks: From GSM to LTE**, 2010,

W. Dargie, C. Poellabauer, **Fundamentals of Wireless Sensor Networks: Theory and Practice**, 2010,

Recommendations

Subjects that continue the syllabus

Antennas/V05M145V01208

Wireless Networks and Ubiquitous Computation/V05M145V01211

Satellites/V05M145V01311

Communication Advanced Systems/V05M145V01302

Subjects that are recommended to be taken simultaneously

Wideband Radio Systems/V05M145V01312

Subjects that it is recommended to have taken before

Radio Laboratory/V05M145V01209

Radiocommunication/V05M145V01103

IDENTIFYING DATA				
Radio Navigation				
Subject	Radio Navigation			
Code	V05M145V01314			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Optical Networks				
Subject	Optical Networks			
Code	V05M145V01315			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Radar				
Subject	Radar			
Code	V05M145V01316			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

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

Training and Learning Results

Code	
B1	CG1 Ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C32	CE38/OP8 Ability to design, manufacture (in hybrid technology) and characterize the analog components of transceivers of communications in microwave and millimeter-wave bands

Expected results from this subject

Expected results from this subject	Training and Learning Results
Learn to design analogue advanced active circuits (linear and nonlinear) for emitters and receivers for communications in the microwave and millimeter wave frequency bands.	B1 B4 C32
Learn to design high frequency circuits for the optoelectronic interface in optical communications systems.	B1 B4 C32
Learn the fabrication techniques of integrated circuits (hybrid and monolithic) for communications in the high frequency bands. Learn how to apply one of these techniques in circuit prototype fabrication.	B1 B4 B8 C32
Learn to characterize and asses the performance of microwave circuits for communication transceivers.	B1 C32

Contents

Topic

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

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	5	5	10
Practices through ICT	15	0	15
Laboratory practical	4	0	4
Mentored work	0	35	35
Mentored work	0	50	50
Mentored work	1	10	11

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

Methodologies

	Description
Lecturing	It will be given in a classroom with the aid of a slate board and a video projector. It will be described the main concepts in the most relevant Topics in the Subject. Students will have available support documentation in Moovi. Note: the last Topic is an application work (case study) to be performed by the student, as part of a tutored work. Besides, some of the Topics/sub-topics in the Subject will be individually worked and presented by the student, as part of another tutored work.
Practices through ICT	These lessons are oriented to the acquisition of the competencies: CG1,4,8 and CE38/OP8. During these classes, with the aid of a commercial microwave circuits simulator, the student will design a circuit prototype, among those described in the subject. This work will also continue at home hours through tutorized personal work. The student will have available in Moovi support documentation and files. He/she will be able to obtain a circuit simulator student license for his/her PC, thanks to an agreement between UVIGO and the simulator provider company.
Laboratory practical	These classes are designed to aid in acquiring competencies: CG1,4,8 and CE38/OP8. The previously designed prototype by the student, during the practices with the circuit simulator and his/her personal work, will be fabricated in hybrid MIC technology and characterized using adequate instrumentation.
Mentored work	These classes are designed to help in acquiring competencies: CG1,4,8 and CE38/OP8. With the aid of the hours of practices through ICT, and through his/her personal work, the student will be guided to design - working individually- a circuit prototype using ideal models of the passive components. Then, he/she will implement this design in microstrip hybrid technology, in another mentored work, and evaluate its performance. The student will write a report of the work. These classes are designed to help in acquiring competencies: CG1,4,8 and CE38/OP8.

Mentored work	Each student will prepare - working individually- a short written report about one of the topics covered in the subject. This work will also be assessed by an oral presentation in which he/she will answer questions about the topic. These classes are designed to aid in acquiring competencies: CG1,4,8 y CE38/OP8.
Mentored work	With the aid of the hours of practices through ICT, and through his/her personal work, the student will be guided to design - working individually- a circuit prototype in microstrip hybrid technology. Then, he/she will fabricate this prototype and evaluate its performance during the laboratory practices. The student will write a report of the work. These classes are designed to aid in acquiring competencies: CG1,4,8 y CE38/OP8.

Personalized assistance

Methodologies	Description
Lecturing	The student will be able to consult his doubts, about the different topics described in the master lessons, during the lecturer office hours. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321
Practices through ICT	During these classes, students -individually- will perform the assigned tasks related to CAD design with the aid and personalized guidance of the lecturer. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321
Laboratory practical	During these classes, students -individually- will perform the assigned tasks related to prototyping and measurements with the aid and personalized guidance of the lecturer. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321
Mentored work	The student will be able to consult his/her technical questions and request suggestions, in the realization of his/her work related to the design of an ideal circuit prototype, by using the lecturer office hours. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321
Mentored work	The student will be able to consult his/her technical questions and request suggestions, to prepare the presentation of a topic related with the Subject, during the lecturer office hours. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321
Mentored work	The student will be able to consult his/her technical questions and request suggestions, in the realization of his/her work related to the design of an hybrid microstrip circuit prototype, by using the lecturer office hours. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321

Assessment

Description		Qualification	Training and Learning Results
Laboratory practical	The student will -individually- fabricate (in Hybrid Technology) and measure the RF performance of a microwave circuit prototype. The assessment will take into account: the assembly of the fabricated prototype, the final measured RF performance and the written report. In this work, it will be evaluated competencies CG1, CG4, CG8 and CE32.	20	B1 B4 B8 C32
Mentored work	The student will -individually- design, with ideal passive components, and simulate the performance of a microwave circuit prototype. The assessment will take into account: the circuit design, the simulated performance and the written report. In this work, it will be evaluated competencies CG1, CG4, CG8 and CE32.	30	B1 B4 B8 C32
Mentored work	The student will -individually- write a report and perform an oral presentation about a topic related to the Subject. The assessment will be performed by taking into account: the quality of the report, the presentation and the discussion (answers to questions) after the presentation. In this work, it will be evaluated competencies CG1, CG4, CG8 and CE32.	10	B1 B4 B8 C32
Mentored work	The student will -individually- design in Hybrid Microstrip Technology and simulate/evaluate the RF performance of a microwave circuit prototype. The assessment will take into account: the circuit layout, the simulated RF performance and the written report. In this work, it will be evaluated competencies CG1, CG4, CG8 and CE32.	40	B1 B4 B8 C32

Other comments on the Evaluation

The subject will be taught and evaluated fully in English. Technical documents, reports, presentations and interactions with the students will be performed in English.

A) First Call: The student work in the subject will be evaluated through the development of the mentored works and laboratory practice:

1. The microwave circuit prototype: design (ideal and microstrip), fabrication in hybrid integrated technology, RF performance evaluation (simulated/ experimental) and written report. In total, up to 90% of the total Subject qualification.

2. The topic written report and its oral presentation (with discussion). In total, up to 10% of the total subject qualification.

Those students who did opt for Global Evaluation (this decision is always open until 1 month before the date of the global examination), will have four weeks to design, fabricate (mandatory to opt to a grade above 80% of the maximum subject qualification), evaluate performance and write a report of a new circuit prototype, chosen by the lecturer. The assessment of this work will be up to 100% of the subject qualification.

B) Second Call:

Those students who attended at least in 80% of the face-to-face class hours will have the opportunity to re-design his/her previous prototype and also improve the topic written report. Each of these tasks will be assigned the same qualification percentage as in the First Call

Those students who have not been present in at least 80% of the face-to-face class hours, or did not opt for improving their previous works, will have four weeks to design, fabricate (mandatory to opt to a grade above 80% of the maximum subject qualification), evaluate performance and write a report of a new circuit prototype, chosen by the lecturer. The assessment of this work will be up to 100% of the subject qualification.

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

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

Sources of information

Basic Bibliography

Guillermo Gonzalez, **Microwave Transistor Amplifiers: Analysis and Design**, 2,

Complementary Bibliography

Technical papers (journals, application notes, data sheets,...),

Instrumentation and simulator manuals,

Steve C. Cripps, **Advanced Techniques in RF Power Amplifier Design**, 1,

Guillermo Gonzalez, **Foundations of Oscillator Circuit Design**,

D. Root, **X-Parameters: Characterization, Modeling, and Design of Nonlinear RF and Microwave Components**, 1,

Recommendations

Subjects that it is recommended to have taken before

Electronics and Photonics for Communications/V05M145V01202

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

Training and Learning Results	
Code	
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C31	CE37/OP7 Ability to model, operate, manage, and deal with the full cycle and bagging of networks, services and applications considering the quality of service, direct and costs of operation, the plan of implementation, monitoring, security, scaling and maintenance, managing and ensuring the quality of the development process

Expected results from this subject	
Expected results from this subject	Training and Learning Results
Understand the potential and limitations of the different methods.	B4 B8 C31
Handle the use of different algorithms in current multimedia communications environments.	B4 B8 C31
Understand technical material in an autonomous way.	B4 B8 C31

Contents	
Topic	
Introduction to cryptography.	Application to multimedia systems. Integration with source and channel coding. Block and stream ciphers. Hashing and MAC codes. Specific algorithms.
Conditional access systems.	Requirements. History and state of the art. Design of a conditional access system.
Secret sharing.	Simple secret sharing systems. Visual cryptography.

Data hiding and watermarking.	Basic concepts. Watermarking versus data hiding. Spread-spectrum watermarking. Quantization-based watermarking. Application to images and video. Application to copyright protection of deep learning models.
Forensic signal processing.	Quantization detection and estimation. Filtering detection and identification. Resampling detection and estimation. Camera attribution.
Signal Processing in the Encrypted Domain.	Privacy metrics and notions. Homomorphic encryption. Garbled circuits. Signal representation and cipher blowup. Applications.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	14	28	42
Laboratory practical	9	42	51
Report of practices, practicum and external practices	0	15	15
Report of practices, practicum and external practices (Repetida non usar)	0	15	15
Essay questions exam	2	0	2

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

Methodologies

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

Personalized assistance

Methodologies	Description
Lecturing	The teachers will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered during the master session, or during the office hours. Office hours will be given at the beginning of the course and published in the subject's webpage. Contact: https://www.uvigo.gal/es/universidad/administracion-personal/pdi/fernando-perez-gonzalez
Tests	Description
Report of practices, practicum and external practices	The teachers will provide individualized and personalized attention to students during the course, solving their doubts and questions. Doubts will be answered during the work review sessions or during the office hours. Contact: https://www.uvigo.gal/es/universidad/administracion-personal/pdi/fernando-perez-gonzalez
Report of practices, practicum and external practices (Repetida non usar)	

Assessment

Description	Qualification Training and Learning Results

Report of practices, practicum and external practices	Reports of the practices and additional personal work that employ the techniques seen in the classroom:	35	B4 B8	C31
	Practice 1: Watermarking/data hiding (35%)			
	Quality of the reports and correctness of the results will be evaluated. Reports will be individual or collective, depending on the size of the unit that carried out the practices.			
Report of practices, practicum and external practices(Repetida non usar)	Reports of the practices and additional personal work that employ the techniques seen in the classroom:	35	B4 B8	C31
	Practice 2: Forensics (35%)			
	Quality of the reports and correctness of the results will be evaluated. Reports will be individual or collective, depending on the size of the unit that carried out the practices.			
Essay questions exam	Final exam with short questions on the contents of the subject.	30	B4 B8	C31

Other comments on the Evaluation

A minimum score of 30% with respect to the maximum possible score in the final exam is required to pass the course.

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

In case the student does not achieve the minimum score in the final written exam, his/her global score will be obtained using the formula: $0.35 \cdot \text{REP} + 0.15 \cdot \text{TEST}$, where REP is the score achieved in the reports and TEST is the score achieved in the final exam.

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.

In the case that plagiarism is detected in any of the reports/exams done/taken, the final score for the subject will be 'fail' (0) and the teachers will inform the School authorities of the affaire so that they take the appropriate measures. Besides, the teachers will inform the School authorities of any conduct against ethics by the students, the possibility existing that the School authorities take the appropriate measures.

Sources of information

Basic Bibliography

A.J. Menezes, **Handbook of Applied Cryptography**, 1996,

Complementary Bibliography

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

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

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

Recommendations

IDENTIFYING DATA				
Intelligent Sensors				
Subject	Intelligent Sensors			
Code	V05M145V01319			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	Galician			
Department				
Coordinator	Machado Domínguez, Fernando			
Lecturers	Machado Domínguez, Fernando			
E-mail	fmachado@uvigo.es			
Web	http://moovi.uvigo.es			
General description	The overall objective of this course is to provide the theoretical and practical skills for the design and characterization of the electronic instrumentation systems based on smart sensors in wired or wireless topologies. To achieve this, the main intelligent sensors structures, the sensor networks architectures and topologies, the energy harvesting smart sensors systems and the software tools and hardware platforms for designing smart multi-sensor systems will be studied.			

Training and Learning Results	
Code	
A4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C36	CE43/OP13 Ability to characterize intelligent sensors and their specific characteristics in networks

Expected results from this subject	
Expected results from this subject	Training and Learning Results
Know the different structures of the intelligent sensors.	A5 C36
Know the topologies and architectures of the sensor networks.	A5 C36
Know analyse and design systems of efficient sensors in consumption.	A4 B8 C36
Know software tools and hardware platforms for the design of sensor systems.	A5 C36
Design applications based on data fusion of different sensors.	A4 B8 C36

Contents	
Topic	
Unit 1: Smart Sensors.	Definition. Classification. Architectures. Multisensorial systems. Standard IEEE 1451 for smart sensors. Applications: Internet of Things, Industry 4.0, Machine Learning.
Unit 2: Wired topologies.	General features. Classification. Practical examples. Intelligent Transportation Systems (ITS). Embedded buses for automotive applications. Development tools.
Unit 3: Wireless topologies.	The ISM bands. Basic features of wireless networks. Multiplexing and modulation. The SDR concept. Standards for WLAN and WPAN. IEEE standards 802.15.1/4/3. Wireless sensor networks (WSNs). Other commercial networks.
Laboratory	Laboratory sessions and project.
Unit 1. Wired sensors systems.	Sensor conditioning and data acquisition.
Unit 2. Wireless sensors systems.	Design, implementation and test of a wireless sensor network.

Unit 3. Project: Design and implementation of an electronic instrumentation system with smart sensors. Design, implementation and test of an electronic instrumentation system with smart sensors, applying theoretical and practical concepts.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	4	4	8
Mentored work	1	18.5	19.5
Laboratory practical	7.5	15	22.5
Project based learning	12.5	47.5	60
Report of practices, practicum and external practices	0	15	15

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

Methodologies	
	Description
Lecturing	The lecturer will explain in the classroom the main contents of the subject. The students have to manage the proposed bibliography to carry out a self-study process in a way that leads to acquire the knowledge and the skills related to the subject. The lecturer will answer the students' questions in the classroom or at the office. In these sessions, the skills A5 and C36 will be developed.
Mentored work	The students have to manage basic concepts to search and select information in order to get a deeper understanding in some specific fields related to the subject. The lecturer will propose in the classroom the topic of this individual task and monitor the student's work in personalized attention sessions. In these sessions, the skills A4, A5, B8 and C36 will be developed.
Laboratory practical	Activities designed to apply the main concepts and definitions of the subject. The student will be asked to acquire the basic skills to manage the laboratory instrumentation, software tools and components in order to construct and test electronic circuits. The student has to develop and demonstrate autonomous learning and collaborative skills. 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 A5 and C36 will be developed.
Project based learning	Students have to develop a group activity that goes on over a period of time and address a specific problem. They have to design, schedule and carry out a set of tasks to achieve a solution. The assessment will be based on the quality of the proposed solution, the depth of content understanding demonstrated and the final presentation. In these sessions, the skills A4, A5, B8, and C36 will be developed.

Personalized assistance	
Methodologies	Description
Lecturing	The lecturer will answer the students' questions and also give instructions to guide the studying and learning process. The students can go to the lecturer's office (individually or in a group). The timetable will be available on the school website at the beginning of the term. The timetable and/or the mechanism to request tutoring sessions will be available on the subject's website on the Moovi online-teaching portal (https://moovi.uvigo.gal/).
Laboratory practical	The lecturer will help students understand the work to be developed in the laboratory (components, circuits, instrumentation and tools). The students can go to the lecturer's office (individually or in a group). The timetable will be available on the school website at the beginning of the term. The timetable and/or the mechanism to request tutoring sessions will be available on the subject's website on the Moovi online-teaching portal (https://moovi.uvigo.gal/).
Mentored work	The lecturer will help students to deal with the mentored work. The students can go to the lecturer's office (individually or in a group). The timetable will be available on the school website at the beginning of the term. The timetable and/or the mechanism to request tutoring sessions will be available on the subject's website on the Moovi online-teaching portal (https://moovi.uvigo.gal/).
Project based learning	The lecturer will be available to help students in order to deal with the project. The timetable will be available on the school website at the beginning of the term. The timetable and/or the mechanism to request tutoring sessions will be available on the subject's website on the Moovi online-teaching portal (https://moovi.uvigo.gal/).

Assessment			
	Description	Qualification	Training and Learning Results

Mentored work	The lecturers will consider the quality of the results obtained, their analysis, the final report, and the classroom presentation. The tutored work mark (TWM) will be assessed in a 10 points scale.	20	A4 B8 C36 A5
Laboratory practical	The lecturers will check the level of compliance of the students with the goals related to the laboratory skills. The final mark of laboratory (FML) will be assessed in a 10 points scale. For the evaluation of the laboratory sessions, the lecturer will assess the group work (the same mark for each member), as long as it was possible to form groups, the individual preliminary tasks and the answers to personalized questions for each session.	30	A5 C36
Project based learning	The lecturers will consider the work done during the laboratory sessions, the presentation of results and functionality. This mark (FUN) will be assessed in a 10 points scale and will represent 80% of the final mark project (FMP) and 40% of the final mark of the subject (FM). For the evaluation of the project, the lecturer will assess the group work (the same mark for each member) and the individual work during the laboratory sessions and the presentation of the developed project.	40	A4 B8 C36 A5
Report of practices, practicum and external practices	The lecturers will consider the quality of the project report and the presentation and analysis of the results. This mark (REP) will be assessed in a 10 points scale and will represent 20% of the final mark project (FMP) and 10% of the final mark of the subject (FM). For the evaluation of this part, the lecturer will assess the group work (the same mark for each member) and the individual presentation of the developed project. The skills CB4, CB5, CG8 and CE43 will be evaluated in these projects.	10	

Other comments on the Evaluation

1. Continuous assessment (ordinary call)

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

In order to **be assessed by continuous evaluation**, the student cannot miss more than one theory session, more than one laboratory session and more than one project session; and only if this absence is duly justified. The final grade of students who have chosen this path cannot be "not presented".

The subject comprises three different parts: theory (20%), laboratory (30%) and project (50%). The marks of the assessed tasks are valid only for the current academic course.

The planning for the different sessions will be available at the beginning of the semester. Students who are occasionally unable to attend any of the assessment tasks could repeat it, whenever it was possible within the subject academic schedule and only if the absence is duly justified.

1.a Theory

Attendance at the theory classes is compulsory. In order to pass the theory part, the student cannot miss more than one theory session and only if this absence is duly justified.

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 work, the lecturer will consider the results, their analysis and presentation, and the quality of the written report. The students will be informed of the deadline by the lecturer. The 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 final mark of theory (FMT) will be: $FMT = TWM$.

The minimum mark required to pass this part is of 5 ($FMT \geq 5$).

1.b Laboratory

Each laboratory session lasts approximately 150 minutes and the students will work in pairs (whenever possible). 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 and only if this absence is duly justified. The final mark of laboratory (FML) is calculated as the arithmetic mean of the individual laboratory session marks.

1.c 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 (two students per project whenever possible). After that, the most important part of the workload will be developed in the laboratory: one laboratory session (B hours) and the project sessions (C hours).

In order to assess the project, the lecturer will consider: the work done during the laboratory sessions, functionality and presentation of results (FUN), and the quality of the project report (REP). Each of these parts will be scored on a 10 points scale. The final mark of project (FMP) will be the weighted sum of the marks for each part:

$$FMP = 0.8 \cdot FUN + 0.2 \cdot REP$$

The project will be assessed in a 10 points scale. The minimum mark required to pass this part is of 5 ($FMP \geq 5$). The students are only allowed to miss one project session and only if this absence is duly justified.

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: 20% theory (FMT), 30% laboratory (FML) and 50% project (FMP).

In order to pass the subject, students will be required to pass the theory, laboratory and project parts. In this case the final mark (FM) will be:

$$FM = 0.2 \cdot FMT + 0.3 \cdot FML + 0.5 \cdot FMP.$$

However, when the students do not pass both parts ($FML < 5$ or $FMP < 5$), or miss more than 1 theory session, or more than 1 laboratory session, or miss more than 1 project session, the final mark grade can never be higher than 4.9:

$$FM = \min\{4.9 ; (0.2 \cdot FMT + 0.3 \cdot FML + 0.5 \cdot FMP)\}.$$

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

2. Global assessment (ordinary call)

The students who prefer a different educational policy can attend an exam on a scheduled date. The date will be specified in the academic calendar. This exam will comprise three parts: theory exam, laboratory exam and project. The student will prepare a written project report to be handed in just before the exam. The final project must be presented within one week of delivery of reports. In order to assign the project, the student has to contact to the lecturer at least four weeks before the exam.

In order to pass the theory, the student will have to attend to an exam with test questions and/or sort answer questions. The theory exam will be assessed in a 10 points scale and the final mark of theory (FMT) will be the obtained mark.

In the laboratory 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. The laboratory exam will be assessed in a 10 points scale and the final mark of laboratory (FML) will be the obtained mark.

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

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

$$FM = 0.2 \cdot FMT + 0.3 \cdot FML + 0.5 \cdot FMP.$$

However, when the students do not pass all parts ($FMT < 5$ or $FML < 5$ or $FMP < 5$), the final mark can never be higher than 4.9:

$$FM = \min\{4.9 ; (0.2 \cdot FMT + 0.3 \cdot FML + 0.5 \cdot FMP)\}.$$

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

3. Extraordinary call and advance of call

The assessment policy in extraordinary call and advance of 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 assign the project, the student has to contact to the lecturer at least four weeks before the exam.

The final mark will be calculated as it has described in:

- section 1 to students with the theory part passed in continuous evaluation, and
- section 2 for all other case.

In extraordinary call, the marks obtained in the previous continuous or global assessment are kept for those parts in which the student has not attended.

Sources of information

Basic Bibliography

Fraden, J., **Handbook of modern sensors**, 5th, Springer, 2016

Gómez, C., Paradells, J. y Caballero, J.E., **Sensors Everywhere: Wireless Network Technologies and Solutions**, Fundación Vodafone España, 2010

Misra, S., Woungang, I. & Chandra, S., **Guide to Wireless sensor networks**, Springer, 2009

Slama, D., Puhlmann, F., Morrish, J. and Bhatnagar R.M, **Enterprise IoT: Strategies and Best Practices for Connected Products and Services**, O'Reilly, 2016

Rogers, L. a& Stanford-Clark, A, **Wiring the IoT: Connecting Hardware with Raspberry Pi, Node-Red, and MQTT**, O'Reilly, 2017

Complementary Bibliography

Mariño-Espiñeira, P., **Las comunicaciones en la empresa; normas, redes y servicios**, 2ª, RAMA, 2006

Faludi, R., **Building wireless sensor networks.**, O'Reilly, 2011

Parallax Inc., **Smart Sensors and Applications**, 3rd, Parallax Inc., 2006

Recommendations

IDENTIFYING DATA				
Practicals in Digital Electronics for Communications				
Subject	Practicals in Digital Electronics for Communications			
Code	V05M145V01320			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Distributed Computing				
Subject	Distributed Computing			
Code	V05M145V01321			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Mikic Fonte, Fernando Ariel			
Lecturers	Burguillo Rial, Juan Carlos Mikic Fonte, Fernando Ariel Rodríguez Hernández, Pedro Salvador			
E-mail	mikic@det.uvigo.es			
Web	http://moovi.uvigo.es			
General description	This course will provide a vision of group of the most usual technologies inside the distributed computing. They will tackle subjects such as the distributed transactions and the replication; the distributed artificial intelligence; and the parallel and evolutionary computing.			
	We will use Spanish and Galician languages in classroom, and English language for the instructional materials.			

Training and Learning Results	
Code	
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
A4	CB4 Students must communicate their conclusions, and the knowledge and reasons stating them-, to specialists and non-specialists in a clear and unambiguous way.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C24	CE24/TE1 Ability to understand the fundamentals of distributed systems and distributed computing paradigms, and its application in the design, development and management in grid, ubiquitous computing scenarios and cloud systems.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
To earn skills in the design, development and management of distributed systems.	A2 B8 C24
To understand the functional bases of the distributed systems.	A4 A5 C24
To know the distinct concepts related with the distributed computing.	A5 B8 C24
To earn skills for the application of intelligent systems in the distributed computing.	A2 A5 B8 C24
To learn how to distribute the execution of tasks for the resolution of problems and optimisation by means of evolutionary and parallel computing.	A2 A4 B8 C24

Contents
Topic

Theory 1. Distributed artificial intelligence	1. Intelligent agents and multiagent systems 2. Theory of games applied to multiagent systems: coordination, competition, negotiation, auctions, electronic trade 3. Complex distributed systems and auto-organised ones
Theory 2. Parallel and evolutionary computation	1. Distributed Computing and parallelization 2. Algorithms and evolutionary programming: genetics, memetics, differential evolution, intelligence of swarm. 3. Optimisation by means of evolutionary technics and parallelization
Theory 3. Transactions	1. Concurrency problems 2. Recoverability problems 3. Deadlocks 4. Optimistic concurrency control 5. Timestamps
Theory 4. Replication	1. Introduction to replication 2. Case studies of high available services (Bayou and Coda) 3. Transactions with replicated data
Theory 5. Design of distributed systems	1. Google case study
Practice 1. Multi-node cluster with Hadoop Distributed File System.	Part 1: Installation. Part 2: Developing a program analyzing Big Data using distributed Hadoop.
Practice 2: Introducing the basics for using evolutionary algorithms in optimization processes by means of parallel computing on Spark	Part 1: Evolutionary algorithms. Part 2: Decentralized evolutionary algorithms.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	17	47	64
Project based learning	10	45	55
Report of practices, practicum and external practices	0	3	3
Objective questions exam	1	0	1
Objective questions exam	2	0	2

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

Methodologies	
	Description
Lecturing	Theoretical classes with practical cases. Besides, problems will be proposed for solving them in autonomous way (A5 and C24).
Project based learning	The students, in groups, will develop a software system with specific requirements. The follow-up of the project will be carried out during the B sessions (A2, A4, A5, B8).

Personalized assistance	
Methodologies	Description
Lecturing	Tutorships: Fernando A. Mikic Fonte: https://moovi.uvigo.gal/user/profile.php?id=11299 Pedro S. Rodríguez Hernández: https://moovi.uvigo.gal/user/profile.php?id=11584 Juan Carlos Burguillo Rial: https://moovi.uvigo.gal/user/profile.php?id=11297
Project based learning	The students, organized in groups, develop a project that addresses the design and implementation of a service-oriented architecture. Personalized attention related to these projects will take place in the sessions type B 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	Training and Learning Results	
Project based learning	The students, organized in groups, will develop a solution to a software system with specific requirements.	35	A2 A4 A5	B8
Report of practices, practicum and external practices	Detailed report of the tasks during the practices of laboratory carried out in group.	5	A4	
Objective questions exam	Series of short answer questions and/or multiple choice.	20	A5	C24
Objective questions exam	Series of short answer questions and/or multiple choice.	40	A5	C24

Other comments on the Evaluation

Students can, at ordinary exam, decide to be assessed according to a continuous assessment model or by global assessment. During the first week of the course, students must notify the subject coordinator about their choice. In case of choosing continuous assessment, a period of 1 month is offered to be able to renounce it. Once the students choose the continuous assessment model, their grade can never be "Not Submitted". For extraordinary exam the students will be evaluated using the modality of "global assessment" (some modifications over the original practices can be required). The scores obtained in ordinary exam are not preserved for extraordinary exam.

Plagiarism and copying are not allowed. In the event of detection of plagiarism or copying in any of the tests, the final grade will be FAIL (0) and the fact will be communicated to the Center's management for appropriate purposes.

1- CONTINUOUS ASSESSMENT

To pass the course requires a minimum score of 5 points. The score will be the result to add the scores received in each one of the following parts:

- Exam 1:
 - Dates: Approved in the Comisión Académica de Grado (CAG), they will be available at the beginning of the academic semester.
 - Individually
 - Contents: Theoretical content given until this moment
 - Type: Series of short answer questions and/or test type ones
 - Maximum score = 2 points
- Exam 2:
 - Dates: Official calendar (coinciding with the global assessment for those that opted by this modality)
 - Individually
 - Contents: Theoretical content given until this moment excepting those that already were assessed in the Exam 1.
 - Type: Series of short answer questions and/or test type ones
 - Maximum score = 4 points
- Practice:
 - Dates: Throughout the semester (not being compulsory practices).
 - In group:
 - Reports / memories of practice and Laboratory practice: A personalized score is assigned to each member of the group according to the following:
 - Final score of practices = (Memory + Practice) * Weighting factor
 - Memory maximum score = 0.5 points
 - Practice maximum score = 3.5 points (verification of the correct operation of the practice and of possible changes to be made in it, in group or individually).
 - Weighting factor = (Follow-up by the teacher + Peers assessment) / 20
 - Follow-up by the teacher: About the work carried out by each student observed by the teacher (0-10)
 - Peers assessment: Within each group. Each student assesses his/her partners about the work they did (0-10). Then, an arithmetic average is calculated for each student.
 - Maximum score= 4 points

2- GLOBAL ASSESSMENT AND END-OF-PROGRAM EXAM

To pass the course requires a minimum score of 5 points.

- Theoretical exam:
 - Dates: Official calendar
 - Individually

- Contents: Given in the whole theoretical part of the course.
 - Type: Series of short answer questions and/or test type ones
 - Maximum score= 6 points
- Practice exam and delivery of practice:
 - Dates of the exam: Official calendar
 - Dates of the delivery of practice: Before the exam.
 - Individually.
 - Type: Verification of the correct operation of the practice and of possible changes to be made in it.
 - Maximum score= 4 points

Sources of information

Basic Bibliography

George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, **Distributed systems. Concepts and design**, 5, Addison Wesley, 2011

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

A.E. Eiben, J.E. Smith, **Introduction to Evolutionary Computing (Natural Computing Series)**, 2, Springer, 2015

Tom White, **Hadoop: The Definitive Guide**, 3, O'Reilly Media, 2012

Complementary Bibliography

Thomas Rauber, Gudula Rúniger, **Parallel Programming for Multicore and Cluster Systems**, 2, Springer, 2013

Recommendations

Subjects that it is recommended to have taken before

Application Technologies/V05M145V01105

IDENTIFYING DATA				
Data analysis				
Subject	Data analysis			
Code	V05M145V01322			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	González Castaño, Francisco Javier			
Lecturers	García Méndez, Silvia González Castaño, Francisco Javier			
E-mail	javier@det.uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	Data analysis with a practical approach: data extraction and cleansing, data characterization with techniques such as statistical regression, clustering or outlier analysis, and knowledge generation with techniques such as intuitive visualization or automatic classification. The course is taught in Spanish.			
English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.				

Training and Learning Results

Code	
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
A3	CB3 Students must integrate knowledge and handle complexity of formulating judgments based on information that was incomplete or limited, including reflections on social and ethical responsibilities linked to the application of their knowledge and judgments.
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C25	CE25/TE2 Ability to manage the acquisition, structuring, analysis and visualization of data, extracting information and underlying knowledge, critically assessing the results, and applying it to strategic decision-making and innovation in different areas.

Expected results from this subject

Expected results from this subject	Training and Learning Results
- Knowledge of the different stages of knowledge extraction and the areas of application of data mining.	A2 A3 B4 B8 C25
- Knowledge of the importance of the preparation of the data and how to apply the main pre-processing techniques.	A2 B4 B8 C25
- Knowledge of the main techniques of data mining as well as the necessary premises for its application to a particular stage.	A2 A3 B4 B8
- Knowledge of the different types of data mining results evaluation and how to apply them.	C25
- Knowledge of statistical software and how to apply it to on-line and off-line data mining.	B4 C25
-Ability to to schedule, develop and evaluate a data analysis process.	B4 B8 C25

Contents

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

Planning

	Class hours	Hours outside the classroom	Total hours
Project based learning	2	36	38
Laboratory practical	5	19	24
Lecturing	20	40	60
Problem and/or exercise solving	2	0	2
Essay	1	0	1
Essay	1	0	1

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

Methodologies

	Description
Project based learning	The students will solve a practical case of data analysis in an application scenario. A2 A3 B4 B8 C25.
Laboratory practical	During the course, students will develop solutions in laboratory sessions to grasp the course content. Software to be used: R (https://www.r-project.org/). A2 A3 B4 B8 C25.
Lecturing	Lectures that will illustrate the course content with small exercises. These will be solved by the lecturer of the students themselves, alone or in groups. The goal is to foster discussion and knowledge of course competencies. A2 A3 B4 B8.

Personalized assistance

Methodologies	Description
Lecturing	Individual attention will take place during official tutoring times published at https://atlanttictic.uvigo.es/es/equipo/staff/francisco-javier-gonzalez-castano/ or via e-mail at any time.
Project based learning	Individual attention will take place during official tutoring times published at https://atlanttictic.uvigo.es/es/equipo/staff/francisco-javier-gonzalez-castano/ or via e-mail at any time.
Laboratory practical	Individual attention will take place during official tutoring times published at https://atlanttictic.uvigo.es/es/equipo/staff/francisco-javier-gonzalez-castano/ or via e-mail at any time.

Assessment

	Description	Qualification	Training and Learning Results
Problem and/or exercise solving	Short-answer written exam.	40	C25
Essay	Deliverable reporting work on a dataset that will be handed at the beginning on the course.	30	A2 A3 B4 B8 C25
Essay	Deliverable reporting work on a dataset that will be handed at the beginning on the course.	30	A2 A3 B4 B8 C25

Other comments on the Evaluation

ORDINARY OPPORTUNITY

At the beginning of the course the student will have to choose between continuous and global evaluation. No change of decision will be allowed.

Continuous evaluation will consist in the following::

1. Short answer test (4 points maximum).
2. Two deliverables of the work on a common dataset (6 points maximum, 3 points each)

To pass the course, the student must obtain 1,5/4 points at least in the short answer test and an overall score (across all

possible activities) above 5 points. Failure to reach the minimum grade in the short answer test limits the maximum achievable grade to 4. The maximum score is 10 points.

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

Global evaluation will consist on a single exam covering the whole theoretical and practical course content (the maximum score of this exam will be 5 points. A minimum score of 2 is necessary to pass the course) and a deliverable based on a dataset selected by the professor (maximum score of 5 points). The minimum score to pass the course is 5 points overall. Failure to reach the minimum grade in the exam limits the maximum achievable grade to 4. The maximum score is 10 points.

EXTRAORDINARY OPPORTUNITY

The only possibility will be global evaluation, as previously described.

Sources of information

Basic Bibliography

Complementary Bibliography

Zumel, N., Mount, J., **Practical Data Science with R**, ISBN 9781617291562, Manning Publications,

James, G., Witten, D., Hastie, T., Tibshirani, R., **An Introduction to Statistical Learning with Applications in R**, ISBN 9781461471387, Springer,

Recommendations

IDENTIFYING DATA				
Economical and Social Networks				
Subject	Economical and Social Networks			
Code	V05M145V01323			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Sousa Vieira, Estrella			
Lecturers	Sousa Vieira, Estrella			
E-mail	estela@det.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Social and Economic networks tackles the dynamic and structural study of networks of relationship between agents that arise in the fields of telecommunications, economy and sociology. We study, in particular, dynamic models of diffusion of information, of contagion, of strategic balance and of training of coalitions. The theoretical contents are applied to a practical study case.			

Training and Learning Results	
Code	
A1	CB1 Knowledge and understanding needed to provide a basis or opportunity for being original in developing and/or applying ideas, often within a research context.
A3	CB3 Students must integrate knowledge and handle complexity of formulating judgments based on information that was incomplete or limited, including reflections on social and ethical responsibilities linked to the application of their knowledge and judgments.
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C26	CE26/TE3 Ability to understand and know to exploit the processes of training and dissemination of information in social networks, applying them to the improvement of Internet
C27	CE27/TE4 Ability to design and manage distributed systems based on learning and incentive

Expected results from this subject	
Expected results from this subject	Training and Learning Results
Understand the static and dynamic phenomena that explain the structure of the social networks	B4 C26
Know how to analyse the mechanisms of training of networks in strategic terms	B4 B8 C26 C27
Know how to model and apply to real data the processes of diffusion of information in social networks	A1 A3 C26 C27
Know how apply the procedures of structural and dynamic analysis of the networks to analyse complex systems in the technological fields, biological, economic and social.	A1 A3 B4 B8 C26 C27
Know how to use the dynamics of learning in networks to characterise phenomena	A1 A3 B4 C27

Contents	
Topic	

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

Planning

	Class hours	Hours outside the classroom	Total hours
Project based learning	4.5	36.5	41
Autonomous problem solving	4.5	22.5	27
Lecturing	18	36	54
Essay questions exam	2	0	2
Objective questions exam	1	0	1

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

Methodologies

	Description
Project based learning	Development of a practical project of analysis and modeling of a technological, social or economic network. It will consist in the structural and dynamic explanation of the observable phenomena in the data that describe the network. Through this methodology, competencies CB1, CB3, CG4, CG8, CE26 and CE27 are developed.
Autonomous problem solving	Autonomous resolution of problems and exercises related to the contents taught in the lectures. Through this methodology, competencies CB1, CB3, CG4, CG8, CE26 and CE27 are developed.
Lecturing	Synthetic exposition of the basic concepts that support the subject. Through this methodology, competencies CB1, CB3, CG4, CG8, CE26 and CE27 are developed.

Personalized assistance

Methodologies	Description
Lecturing	Individual attention to students to solve the doubts that may arise in the study of the material of the lectures. Tutoring sessions can be seen and/or requested in Moovi (https://moovi.uvigo.ga/user/profile.php?id=11585)
Project based learning	Individual attention to students to solve the doubts that may arise in the development of the project. Tutoring sessions can be seen and/or requested in Moovi (https://moovi.uvigo.ga/user/profile.php?id=11585)
Autonomous problem solving	Individual attention to students to solve the doubts that may arise in the autonomous resolution of the problems. Tutoring sessions can be seen and/or requested in Moovi (https://moovi.uvigo.ga/user/profile.php?id=11585)

Assessment

	Description	Qualification	Training and Learning Results
Project based learning	Functional test of the project and quality of the conclusions.	30	A1 B4 C26 A3 B8 C27
Autonomous problem solving	Correction of the proposed exercises.	30	A1 B4 C26 A3 B8 C27
Essay questions exam	Written exam of essay questions about the contents of the subject.	30	A1 B4 C26 A3 B8 C27
Objective questions exam	Written exam of objective questions about the contents of the subject.	10	A1 B4 C26 A3 B8 C27

Other comments on the Evaluation

We leave to discretion of the students two methods of alternative assessment in the subject: continuous assessment (by default) and global assessment.

The continuous assessment will consist in the realisation of a written final exam (40% of the qualification), the development of a practical project (30% of the qualification) and the written resolution of problems and exercises in three deliveries along the course (30% of the qualification). The global assessment will consist in the realisation of a written final exam (60% of the qualification) and in the development of a practical project (40% of the qualification).

It is necessary to reach 3.5 points out of 10 in the written final exam to pass the subject. In case of not reaching this minimum but reaching or exceeding 5 points in the total qualification, the received qualification will be 4.5.

The students will be able to renounce the continuous assessment before the third delivery of problems and exercises, informing the teachers about it.

All those students who attend the written final exam and/or deliver the project will be considered as presented.

Those students who do not pass the subject at the ordinary call have a extraordinary call in which his/her knowledge will be re-evaluated with a written exam and/or his/her project will be re-evaluated if it had been improved or modified. The weights of each one of the tests (exam and project) will be the same that in the ordinary period of exams according to the modality that had been chosen.

The qualifications of the tests have only effects in the academic course in that they were awarded, with independence of the itinerary of evaluation chosen.

Sources of information

Basic Bibliography

M. O. Jackson, **Social and economic networks**, Princeton University Press, 2010

M. Newman, **Networks**, OUP Oxford, 2018

A.-L. Barabasi, **Network science**, Cambridge University Press, 2016

Complementary Bibliography

R. van der Hofstad, **Random graphs and complex networks**, Cambridge University Press, 2016

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

B. Bollobas, **Random Graphs**, Cambridge University Press, 2001

Recommendations

IDENTIFYING DATA				
Internship in Companies I				
Subject	Internship in Companies I			
Code	V05M145V01324			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Marcos Acevedo, Jorge			
Lecturers	Marcos Acevedo, Jorge			
E-mail	acevedo@uvigo.es			
Web	http://fatic.uvigo.es			
General description	The student develops own functions in a company as an Telecommunication Engineer with determinate profile by the technology that the student have studied (Electronics, Processed of signal for communications, Radiocommunication and Telematic) and supervised by the University adviser and the company adviser.			

Training and Learning Results

Code	
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
B9	CG9 Ability to understand the responsibility and professional ethics in the activity of the profession of Telecommunications Engineering.
B10	CG10 Ability to apply principles of economics and human resources and projects management, as well as legislation, regulation and standardization of telecommunications.
B12	CG12 Skills for lifelong, self-directed and autonomous learning.
B13	CG13 Knowledge, understanding and ability to implement the necessary legislation in the exercise of the profession of Telecommunication Engineering.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Experience in the practice of the profession of engineering of Telecommunication and his/her usual functions in some real company environment.	A2 A5 B8 B9 B10 B12 B13

Contents

Topic	
General content	To define by the tutor in the company and the academic tutor
Integration in the company and in his surroundings of work	During his stay the student will be integrated into the organization of the company and must coordinate with the rest of members of the work team to he was assigned.
Development of his professional activity	The student will make the tasks entrusted, in accordance with his knowledges and competences.

Planning

	Class hours	Hours outside the classroom	Total hours
Practicum, External practices and clinical practices	120	5	125

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

Methodologies

	Description
Practicum, External practices and clinical practices	Stay in a company developing functions of a Telecommunications Technical Engineer so that they can put into practice the knowledge and skills acquired, to complete their academic training.

Personalized assistance

Methodologies	Description
Practicum, External practices and clinical practices	The student will have a tutor inside the company that will guide him and will supervise in the specific tasks that it will have to develop inside the same; and an academic tutor - professor of the E.E.T. of the University of Vigo- that will define together with the tutor of the company, the general frame of the activity of the student, checking that it adjusts to the profile studied by the student.

Assessment

	Description	Qualification	Training and Learning Results	
Practicum, External practices and clinical practices	The evaluation will realise in function of: 1) The memory of activities 2) The evaluation of the company tutor	100	A2 A5	B8 B9 B10 B12 B13

Other comments on the Evaluation

REPORT OF ACTIVITIES: The student must submit a report explaining the activities undertaken during practices, specifying its duration, departments of the company that were conducted, training received (courses, software, etc.), the level of integration within the company and personal relationships.

The report must also include a section of conclusions, containing a reflection on the adequacy of the lessons learned during the university studies to performance practice (negative and positive aspects significant related to the development of practices). It also assessed the inclusion of information on the professional and personal experience with the practices (personal assessment of learning achieved over practices or own contributions and suggestions on the structure and operation of the company visited).

The assessment of memory will be 60% of the final qualification.

COMPANY TUTOR EVALUATION: The company tutor will submit a report assessing aspects with the practices carried out by students: punctuality, attendance, responsibility, teamwork ability and integration in the enterprise, quality of work done, etc.

The assessment of the tutor in the company will be 40% of the final qualification.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

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

IDENTIFYING DATA				
Internship in Companies II				
Subject	Internship in Companies II			
Code	V05M145V01325			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Marcos Acevedo, Jorge			
Lecturers	Marcos Acevedo, Jorge			
E-mail	acevedo@uvigo.es			
Web	http://fatic.uvigo.es			
General description	The student develops own functions in a company as an Telecommunication Engineer with determinate profile by the technology that the student have studied (Electronics, Processed of signal for communications, Radiocommunication and Telematic) and supervised by the University adviser and the company adviser.			

Training and Learning Results

Code	
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
B9	CG9 Ability to understand the responsibility and professional ethics in the activity of the profession of Telecommunications Engineering.
B10	CG10 Ability to apply principles of economics and human resources and projects management, as well as legislation, regulation and standardization of telecommunications.
B12	CG12 Skills for lifelong, self-directed and autonomous learning.
B13	CG13 Knowledge, understanding and ability to implement the necessary legislation in the exercise of the profession of Telecommunication Engineering.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Experience in the practice of the profession of engineering of Telecommunication and his usual functions in some real company environment.	A2 A5 B8 B9 B10 B12 B13

Contents

Topic	
General content	To define by the tutor in the company and the academic tutor.
Integration in the company and in his surroundings of work	During his stay the student will be integrated into the organization of the company and must coordinate with the rest of members of the work team to he was assigned.
Development of his professional activity	The student will make the tasks entrusted, in accordance with his knowledges and competences.

Planning

	Class hours	Hours outside the classroom	Total hours
Practicum, External practices and clinical practices	120	5	125

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

Methodologies

	Description
Practicum, External practices and clinical practices	Stay in a company developing functions of a Telecommunications Engineer so that they can put into practice the knowledge and skills acquired, to complete their academic training.

Personalized assistance

Methodologies	Description
Practicum, External practices and clinical practices	The student will have a tutor inside the company that will guide him and will supervise in the specific tasks that it will have to develop inside the same; and an academic tutor - professor of the E.E.T. of the University of Vigo- that will define together with the tutor of the company, the general frame of the activity of the student, checking that it adjusts to the profile studied by the student.

Assessment

	Description	Qualification	Training and Learning Results	
Practicum, External practices and clinical practices	The evaluation will realise in function of: 1) The memory of activities 2) The evaluation of the tutor in the company	100	A2 A5	B8 B9 B10 B12 B13

Other comments on the Evaluation

REPORT OF ACTIVITIES: The student must submit a report explaining the activities undertaken during practices, specifying its duration, departments of the company that were conducted, training received (courses, software, etc.), the level of integration within the company and personal relationships.

The report must also include a section of conclusions, containing a reflection on the adequacy of the lessons learned during the university studies to performance practice (negative and positive aspects significant related to the development of practices). It also assessed the inclusion of information on the professional and personal experience with the practices (personal assessment of learning achieved over practices or own contributions and suggestions on the structure and operation of the company visited).

The assessment of memory will be 60% of the final qualification.

COMPANY TUTOR EVALUATION: The company tutor will submit a report assessing aspects with the practices carried out by students: punctuality, attendance, responsibility, teamwork ability and integration in the enterprise, quality of work done, etc.

The assessment of the tutor in the company will be 40% of the final qualification.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

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

IDENTIFYING DATA				
Internship in Companies III				
Subject	Internship in Companies III			
Code	V05M145V01326			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	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	The student develops own functions in a company as an Telecommunication Engineer with determinate profile by the technology that the student have studied (Electronics, Processed of signal for communications, Radiocommunication and Telematic) and supervised by the University adviser and the company adviser.			

Training and Learning Results

Code	
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
A5	CB5 Students must have learning skills to allow themselves to continue studying in largely self-directed or autonomous way
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
B9	CG9 Ability to understand the responsibility and professional ethics in the activity of the profession of Telecommunications Engineering.
B10	CG10 Ability to apply principles of economics and human resources and projects management, as well as legislation, regulation and standardization of telecommunications.
B12	CG12 Skills for lifelong, self-directed and autonomous learning.
B13	CG13 Knowledge, understanding and ability to implement the necessary legislation in the exercise of the profession of Telecommunication Engineering.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Experience in the practice of the profession of engineering of Telecommunication and his usual functions in some real company environment.	A2 A5 B8 B9 B10 B12 B13

Contents

Topic	
General content	To define by the tutor in the company and the academic tutor.
Integration in the company and in his surroundings of work	During his stay the student will be integrated into the organization of the company and must coordinate with the rest of members of the work team to he was assigned.
Development of his professional activity	The student will make the tasks entrusted, in accordance with his knowledges and competences.

Planning

	Class hours	Hours outside the classroom	Total hours
Practicum, External practices and clinical practices	120	5	125

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

Methodologies

	Description
Practicum, External practices and clinical practices	Stay in a company developing functions of a Telecommunications Engineer so that they can put into practice the knowledge and skills acquired, to complete their academic training.

Personalized assistance

Methodologies	Description
Practicum, External practices and clinical practices	The student will have a tutor inside the company that will guide him and will supervise in the specific tasks that it will have to develop inside the same; and an academic tutor - professor of the E.E.T. of the University of Vigo- that will define together with the tutor of the company, the general frame of the activity of the student, checking that it adjusts to the profile studied by the student.

Assessment

	Description	Qualification	Training and Learning Results	
Practicum, External practices and clinical practices	The evaluation will realise in function of: 1) The memory of activities 2) The evaluation of the tutor in the company	100	A2 A5	B8 B9 B10 B12 B13

Other comments on the Evaluation

REPORT OF ACTIVITIES: The student must submit a report explaining the activities undertaken during practices, specifying its duration, departments of the company that were conducted, training received (courses, software, etc.), the level of integration within the company and personal relationships.

The report must also include a section of conclusions, containing a reflection on the adequacy of the lessons learned during the university studies to performance practice (negative and positive aspects significant related to the development of practices). It also assessed the inclusion of information on the professional and personal experience with the practices (personal assessment of learning achieved over practices or own contributions and suggestions on the structure and operation of the company visited).

The assessment of memory will be 60% of the final qualification.

COMPANY TUTOR EVALUATION: The company tutor will submit a report assessing aspects with the practices carried out by students: punctuality, attendance, responsibility, teamwork ability and integration in the enterprise, quality of work done, etc.

The assessment of the tutor in the company will be 40% of the final qualification.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

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

IDENTIFYING DATA				
Network Information Theory				
Subject	Network Information Theory			
Code	V05M145V01327			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Learning in Networks and Collaborative Work				
Subject	Learning in Networks and Collaborative Work			
Code	V05M145V01328			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Human-Computer Interaction				
Subject	Human-Computer Interaction			
Code	V05M145V01329			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Photovoltaic Power Electronics				
Subject	Photovoltaic Power Electronics			
Code	V05M145V01330			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Doval Gandoy, Jesús			
Lecturers	Doval Gandoy, Jesús			
E-mail	jdoval@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The subject describes the basic concepts of control and power electronic converters used in photovoltaic systems.			

Training and Learning Results

Code	
A2	CB2 Students must apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C28	CE28/SE1 Capacity of technology integration of photovoltaic conversion for power systems of Telecommunication Engineering.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Knowledge of power conversion technologies used in photovoltaic systems.	A2 B4 B8 C28
Knowledge of control techniques of electronic power converters used in photovoltaic systems.	A2 B4 B8 C28

Contents

Topic	
Chapter 1: Introduction to photovoltaic systems	Photovoltaic effect. Electrical characteristics of photovoltaic cells. Temperature dependence. Irradiation dependence. Electrical connection. Shadow effect.
Chapter 2: Topologies of power electronics converters in photovoltaics.	Electrical configuration photovoltaic cells. Topologies of power electronics converters.
Chapter 3: Control of photovoltaic inverters.	Control of stand-alone photovoltaic inverters. Control of grid-connected photovoltaic inverters. Synchronisation. Maximum power point tracking.
Chapter 4: Regulations and Standards in power electronics photovoltaics systems.	International regulations: IEEE, IEC, VDE, EN. Power quality, ride-through, anti-islanding.

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	10	31	41
Problem solving	5	16	21
Lecturing	15	48	63

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

Methodologies	
	Description
Laboratory practical	Application of the knowledge to particular situations and acquisition of basic skills related with the topic. Competencies: A2, B4, B8, C28.
Problem solving	Formulation of problems and/or exercises related with the topic. The student has to develop the correct solutions by means of applying routines, the application of formulas or algorithms, the application of procedures of transformation of the available information and the interpretation of the results. Competencies: A2, B4, B8, C28.
Lecturing	The professor presents the contents on the subject: theoretical basis and/or guidelines of the work to be developed by the students. Competencies: A2, B4, B8, C28.

Personalized assistance

Methodologies	Description
Lecturing	The professor will attend personally doubts and queries of the students, on the study of theoretical concepts, on exercises or on practices of laboratory. The students will have occasion to attend personal tutorials at the professor office. The tutorial hours will be published at the beginning of the semester in the website of the subject. (www.moovi.uvigo.gal)
Laboratory practical	The professor will attend personally doubts and queries of the students, on the study of theoretical concepts, on exercises or on practices of laboratory. The students will have occasion to attend personal tutorials at the professor office. The tutorial hours will be published at the beginning of the semester in the website of the subject. (www.moovi.uvigo.gal)
Problem solving	The professor will attend personally doubts and queries of the students, on the study of theoretical concepts, on exercises or on practices of laboratory. The students will have occasion to attend personal tutorials at the professor office. The tutorial hours will be published at the beginning of the semester in the website of the subject. (www.moovi.uvigo.gal)

Assessment

	Description	Qualification		Training and Learning Results	
Laboratory practical	Development of the practices of laboratory.	33	A2	B4 B8	C28
Problem solving	Resolution of exercises proposed	33	A2	B4 B8	C28
Lecturing	Theoretical concepts.	34	A2	B4 B8	C28

Other comments on the Evaluation

For the ordinary and extraordinary exam, it will be possible to choose between continuous assessment and global assessment. Students that select global assessment should notify this to the teachers during the first month of classes of the subject.

1. Continuous evaluation

The continuous evaluation consists in the evaluation of the tasks proposed by the professor along the course. The students will execute the tasks and will deliver a report of each one of the tasks. The professor may ask students questions about the tasks carried out in order to assess the knowledge acquired.

The professor will score the students from their work in the developed tasks and from the reports.

The marks will be valid only for the current academic course. It is understood that the student chooses the continuous evaluation when he/she presents at least one task. His/her qualification will be the one of continuous evaluation.

2. Global assessment

The final examination is for students that do not participate in the continuous evaluation. It consists of theoretical questions, problems and exercises that will evaluate the knowledge of the student in the topic. The examination date will be established by the head of the Faculty.

3. Extraordinary exam

There is an extraordinary exam to pass the subject. The student will have to pass an exam with questions, problems and exercises that will evaluate the knowledge of the student in the topic. The examination date will be established by the head of the Faculty. This examination is the same for all the students, have followed or no the continuous evaluation.

Sources of information

Basic Bibliography

Remus Teodorescu, Marco Liserre, Pedro Rodríguez, **Grid Converters for Photovoltaic and Wind Power Systems**, John Wiley & Sons, Ltd.,

Complementary Bibliography

Ned Mohan, Tore M. Undeland, William P. Robbins, **Power Electronics: Converters, Applications, and Design**, John Wiley & Sons, Ltd.,

Andrés Barrado Bautista, Antonio Lázaro Blanco, **Problemas de electrónica de potencia**, Pearson Educación,

Recommendations

IDENTIFYING DATA				
Signal Conditioners				
Subject	Signal Conditioners			
Code	V05M145V01331			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Quintáns Graña, Camilo			
Lecturers	Quintáns Graña, Camilo			
E-mail	quintans@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	In this subject the electronic circuits that condition the signals generated by sensors to be efficiently coupled to a data acquisition system or to a digital processor are studied. It is a subject that follows the Design of Analog Electronic Circuits, which is coursed in the first course of the master. Thus, in this new subject the basic conditioning circuits are expanded by including measuring active bridges, alternating current conditioning circuits, etc. Another important aspect that is included in the study is the evaluation of the measurement uncertainty. Student learns to characterize a measure provided by a sensor through the calibration curve and the uncertainty. The theory is complemented by laboratory practices that focus on providing students with the skills needed to address the realization of a complete measurement system, from the physical system up to the user interface. The key points of the laboratory work are: -The followed methodology to measure physical variables to the calculation of uncertainties. -Characterization of transducers. -Topologies of conditioning circuits. -The connection of the conditioned signals to a digital processor. -Instrumentation software for digitally conditioning and user interfaces. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
B1	CG1 Ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C29	CE29/SE2 Ability to build a system of a physical variable measured from the transducer to the user interface, including knowledge of methodology, basic topologies of conditioning signal and instrumentation software

Expected results from this subject

Expected results from this subject	Training and Learning Results
To know the modeling and simulation of analogic electronic systems by means of the hardware description language SPICE.	B1 B4 B8 C29
To know the evaluation of the uncertainties in the measuring processes following the standards.	B4
To know how to handle and to program data acquisition systems.	B1 C29
To know the developing of complex electronic circuits for conditioning the sensors.	B1 B4 B8 C29
To know to analyse and to design circuits for interfaces between the sensors and digital processors.	B1 C29

Contents

Topic	
Unit 1: Introduction to the measuring systems of physical variables.	Functional and working characteristics of sensors. Evaluation of measurement data. Sensor calibration. Measurement uncertainties. Parts of a conditioning circuit. Types of conditioners.
Unit 2: Introduction to the metrology. Evaluation of measurement uncertainty.	Methodology to measure and to calibrate sensors. Terminology. Statistical method.
Unit 3: Circuits to conditioning signal from measured sensors.	Active measuring bridges in direct and alternating current. Ac/dc converters. Selection and design of filtering stages. Frequency to voltage converters. Conditioners for output stages.
Unit 4: Interfaces between on-off sensors and digital processors.	Basic concepts of local interfaces of on-off sensors. Interfaces with and without galvanic isolation. Coupling in alternating and continuous current.
Unit 5: Conditioning circuits for inductive and magnetic measure sensors.	Study of the conditioners for several inductive and magnetic sensors according to his application.
Unit 6: Conditioning circuits for capacitive measuring sensors.	Study of the conditioners for capacitive sensors.
Unit 7: Conditioning circuits for generators sensors.	Study of the conditioning circuits for generators sensors according to his physical working principle.
Unit 8: Practical cases of conditioning circuits for measuring sensors.	Study of real cases with commercial sensors and circuits.
Laboratory sessions.	Two projects will be carried out, each one corresponding to a complete measurement system, from the sensor to the user interface, including conditioning and programming a data acquisition system. The evaluation of uncertainties will be included.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	0.5	1	1.5
Lecturing	7	14	21
Mentored work	4.5	9	13.5
Problem solving	6	12	18
Laboratory practical	7	14	21
Laboratory practice	1	12	13
Essay	0.5	1	1.5
Essay questions exam	1	15	16
Problem and/or exercise solving	1	15	16
Report of practices, practicum and external practices	0.5	2	2.5
Systematic observation	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
Introductory activities	Activities aimed at making contact and gathering information about the students, as well as presenting the subject.
Lecturing	Exhibition by the teacher of the reports on the subject matter of study, theoretical bases and / or guidelines of a work, exercise that the student has to develop. The learning outcomes that are developed are: B1, B4 and C29.
Mentored work	The student, individually or as a group, carries out activities, which can be: - Monographic works, search of information in publications, databases, articles, books ... on a specific topic. - Preparation of seminars, research, reports, essays, conferences, etc. - Reviews on current scientific articles. - Projects (design and develop projects). The learning outcomes that are developed are: B1, B4, B8 and C29.
Problem solving	Activity in which problems and / or exercises related to the subject are formulated. The student must develop the correct solutions through the exercise of routines, and application of formulas or algorithms, the application of procedures of transformation of the available information and the interpretation of the results. The learning outcomes that are developed are: B1, B4, B8 and C29.

Laboratory practical	Activities of application of knowledge and concrete situations, and acquisition of basic and procedural skills, related to the object of study. They are developed in special spaces with specialized equipment (laboratories, computer rooms, etc.). The learning outcomes that are developed are: B1, B4, B8 and C29. Software to be used: OrCAD PSpice, Excel, Matlab, C compiler.
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Personalized assistance

Methodologies	Description
Lecturing	The professor will attend personally doubts and queries of the students on the study of the theoretical concepts and the exercises. Office hours will take place in the teacher's office at the time established at the beginning of the course and published on the personal profile accessible on Moovi (https://moovi.uvigo.gal/user/profile.php?id=11317).
Laboratory practical	The professor will attend personally doubts and queries of the students on the preparation of the practices of laboratory. Office hours will take place in the teacher's office at the time established at the beginning of the course and published on the personal profile accessible on Moovi (https://moovi.uvigo.gal/user/profile.php?id=11317).
Mentored work	The professor will attend personally doubts and queries of the students on the supervised works. Office hours will take place in the teacher's office at the time established at the beginning of the course and published on the personal profile accessible on Moovi (https://moovi.uvigo.gal/user/profile.php?id=11317).
Problem solving	The professor will attend personally doubts and queries of the students on the resolution of the problems. Office hours will take place in the teacher's office at the time established at the beginning of the course and published on the personal profile accessible on Moovi (https://moovi.uvigo.gal/user/profile.php?id=11317).
Tests	Description
Report of practices, practicum and external practices	The professor will attend personally doubts and queries of the students on the preparation and presentation of the memories of the results of the laboratory practices. Office hours will take place in the teacher's office at the time established at the beginning of the course and published on the personal profile accessible on Moovi (https://moovi.uvigo.gal/user/profile.php?id=11317).

Assessment

	Description		Qualification Training and Learning Results		
Laboratory practice	Completion of real or simulated practical tasks. These are tests in which the performance of the students will be evaluated on the basis of their ability to demonstrate their knowledge of the material, their ability to organize and plan during the practice sessions, as well as their reflection on the results obtained, etc.	20	B1 B4 B8	C29	
Essay	It is a text prepared on a topic and should be written following established rules.	10	B1 B4 B8	C29	
Essay questions exam	Tests that include open questions about a topic. Students must develop, relate, organize and present the knowledge they have about the subject in an comprehensive response.	20	B1 B4 B8	C29	
Problem and/or exercise solving	Test in which the student must solve a series of problems and / or exercises in a time / conditions established by the teacher. In this way, students must apply the knowledge acquired.	25	B1 B4 B8	C29	
Report of practices, practicum and external practices	Preparation of a report by the student in which the characteristics of the work carried out are reflected.	15	B1 B4 B8	C29	
Systematic observation	Attentive, rational, planned and systematic perception to describe and record the manifestations of student behavior.	10	B8		

Other comments on the Evaluation

1. Ordinary exam

1.1. Continuous assessment

The continuous assessment consists of the following four parts (with their respective grading policy):

Part 1.- The laboratory work (35%) will be evaluated based on the quality of experimental techniques and results analysis (10%), the writing of laboratory reports (15%) and the Laboratory exam (10%).

Part 2.- The exams will cover material from lectures and additional resources provided (45%). The format of the exams may include essay questions (20%) and problem solving questions (25%).

Part 3.- Supervised work (10%), in which the results will be presented in a group C work report.

Part 4.-Systematic observation (10%). In addition to the aspects mentioned in the methodologies/tests description, active participation in the activities proposed for their autonomous work as well as in office hours will be taken into account.

The final grade, which ranges from 0 to 10 points, will be the sum of those from all parts, if the following requirements are met:

Requirement 1.- Attend and participate actively in a minimum of 80% of the laboratory sessions.

Requirement 2.- Obtain a minimum of 40% of the grade in the laboratory work (part 1), in the exams (part 2) and in the supervised work (part 3).

If any of the previous requirements are not met, the final grade will be the sum of all grades or 4,9 points, if that sum is equal to or greater than 5 points.

Students who opt for continuous assessment and who have not reached the minimum mark in any part can recover it in the final exam of the ordinary or extraordinary calls. In the case of the ordinary call, the weight of the parts to be recovered must not exceed 40% of the total grade. In the case of supervised work, if the minimum grade was not reached, the deadline to present the improvements proposed by the teaching team is the date of the final exam of the ordinary or extraordinary calls.

To pass, students have to obtain a mark equal to or greater than 50% of the maximum grade (5 points).

The laboratory exam will be held during one of the final sessions. The part with essay and problem solving questions will be divided in two exams throughout the semester.

If after the first month of academic activity and after taking the first partial exam the students do not expressly waive continuous assessment, it will be considered to be the assessment method they have chosen.

1.2. Global assessment

Students who do not opt for continuous assessment or who do not carry out at least 80% of the laboratory work can take a comprehensive final exam.

The format of the final exam will consist of a laboratory part with practical tasks and a writing part that may include essay and problem solving questions. Each part accounts for 50% of the final grade. To pass, students have to obtain at least the 40% in each part and get a sum of both parts equal or greater than 5 points. If the minimum grade of any part is not achieved, the final grade will be the sum of both grades or 4.9 points, if that sum is equal to or greater than 5 points.

Students who do not opt for continuous assessment and do not attend the final exam will receive a grade of "No show".

2. Extraordinary exam

In the extraordinary exam the assessment will be like the final exam of the global assessment.

3.- Academic Integrity

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

Sources of information

Basic Bibliography

Pallás Areny, Ramón, **Sensors and signal conditioning**, Second Edition, John Wiley & Sons, inc., 2001

European co-operation for Accreditation, **Expression of the Uncertainty of Measurement in Calibration**, September 2013 rev 02, EA-4/02 M, 2013

C. Quintáns, **Simulación de Circuitos Electrónicos con OrCAD PSpice**, 2, Marcombo, 2021

Complementary Bibliography

Philip R. Bevington and D. Keith Robinson, **Data Reduction and Error Analysis for the Physical Sciences**, McGraw Hill, 2003

Grupo de Trabajo 1 del Comité Conjunto de Guías en Metrología (JCGM / WG 1), **Guía para la Expresión de la Incertidumbre de Medida**, 2008

Recommendations

Subjects that it is recommended to have taken before

Digital and Analog Mixed Circuits/V05M145V01213

Analog Electronic Circuits Design/V05M145V01106

Advanced Digital Electronic Systems/V05M145V01203

IDENTIFYING DATA**Electronic Equipments Implementation and Exploitation**

Subject	Electronic Equipments Implementation and Exploitation			
Code	V05M145V01332			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	López Sánchez, Óscar			
Lecturers	López Sánchez, Óscar Nogueiras Meléndez, Andres Augusto			
E-mail	olopez@uvigo.es			
Web	http://moovi.uvigo.gal/			

General description This subject provides the main concepts related with the analysis of reliability of complex electronic systems, as well the modelling of these, from the point of view of the reliability. It includes methodologies of design of electronic systems for applications of safety, and also the EMC analysis. Also provides insight of the relation with the management of the equipment inventory and the human capital.

English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.

This is a translation of the subject. In case of any discrepancy, the only valid guide is the one written in Spanish.

Training and Learning Results

Code	
B1	CG1 Ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B3	CG3 Ability to lead, plan and monitor multidisciplinary teams.
B7	CG7 Capacity for implementation and management of manufacturing processes of electronic and telecommunications equipment; guaranteeing safety for persons and property, the final quality of the products, and their homologation.
C15	CE15/GT1 Ability to integrate technologies and systems of Telecommunication Engineering, with general character, and at broader and multidisciplinary contexts such as bioengineering, photovoltaic conversion, nanotechnology, telemedicine.
C30	CE30/SE3 Capacity planning, evaluation and decision-making in new environments relating to the packaging of networks, services and applications in the electromagnetic field, with knowledge of reliability and life cycle costing
D3	CT3 Understanding Engineering in a framework for sustainable development.
D5	CT5 Encourage cooperative work, communication skills, management, planning and acceptance of responsibilities in an environment of multilingual and multidisciplinary work, which promotes education for equality, peace and respect for fundamental rights.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Ability to make an analysis of electromagnetic compatibility of an electronic system according the standards	B1 B3 B7
Ability to design electronic equipment that includes specifications of maintainability and availability	B7 C15 C30 D3
Ability to specify the stocks level required for a given equipment maintainability	B7 C30
Ability to determine the life cycle cost of a product	C30 D3
Capacity to implement and manage the operation of electronic equipment	B7 C30
Ability to the assets management of an organization, related to the subject	B3 D5

Contents

Topic	
Electromagnetic Interferences	Noise and interference. Design for electromagnetic compatibility (ECM). Path of electromagnetic noise. Coupling methods.
Design techniques for EMC	Analysis of conducted emissions. Analysis of radiated emissions. Common impedance coupling. Cabling. Ground system. Shielding.
EMC standards for telecommunications equipment	EMC directive 2014/30/UE. EMC basic publications. EMC generic standards. Product family standards. Emission and immunity standards, conducted and radiated. Harmonic currents standards. Grid disturbances standards. Pre-compliance EMC tests.
Introduction to the reliability of electronic systems	Definitions and basic concepts. RAMS Technologies. Parameters of the reliability of electronic components. Prediction of the reliability. Applicable technical standards. Systems in series, parallel and redundant.
Design and optimization of electronic systems	Optimization of redundancies. Analysis for mantenibilidad and availability.
Analysis of failures	Modelling by Markov and by Petri networks. Failure modes of electronic components. Determination of mechanism and ways of failures.
Fail-safe systems	Specifications for safe systems against failures. Design methodologies for fail-safe systems.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	12	24	36
Problem solving	2	6	8
Laboratory practical	10	25	35
Essay questions exam	1	0	1
Objective questions exam	1	0	1
Essay	4	40	44

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

Methodologies

	Description
Lecturing	It will 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. Competences B1, B3, B3, C15, C30, D3 and D5.
Problem solving	In this educational activity we will propose problems and/or exercises subject related. They are also used to highlight the doubts and also for feedback to teachers on this aspect. Competences B1, B3, B3, C15, C30, D3 and D5.
Laboratory practical	Simulation exercises and measurements will be carried out in the laboratory. The results will be reported. Competences B1, B3, B3, C15, C30, D3 and D5.

Personalized assistance

Methodologies Description

Lecturing	Teachers will personally address doubts and queries of the students about theoretical and practical issues. Students can appoint for tutorial at the website of the University of Vigo: https://www.uvigo.gal/es/universidad/administracion-personal/pdi/oscar-lopez-sanchez , https://www.uvigo.gal/es/universidad/administracion-personal/pdi/andres-augusto-nogueiras-melendez .
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Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	Students will carry out various practical simulations and Measurements in the laboratory. They will be done in groups. The correct execution of the practical exercises in the laboratory and the memory of the results will be assessed. Nonattendance or non-delivery of the report of results will be qualified as suspended (0). They cannot be retaken.	15	C15 D5 C30

Essay questions exam	First partial test. Written test with theoretical questions on part of the content of the subject. It will be held on the date and place set by the center. It can be retaken in the extraordinary assessment call.	35	B7 C15 D3 C30
Objective questions exam	The examination can consist of tes type questions, of short questions to develop, and/or of numerical problems.	10	B1 C15 B7 C30
Essay	Second partial test. Written test with theoretical questions, problems and exercises on the contents of the subject not included in the first partial test. It will be held on the date and place set by the center. It can be retaken in the extraordinary assessment call.	40	B1 C15 D3 B3 C30 D5 B7

Other comments on the Evaluation

Choosing of global assessment must be communicated in writing to the coordinator within one month of the start of the semester.

The end-of-program exam will be by global assessment.

The global assessment will consist of an individual written test with theoretical questions, problems and exercises that will evaluate all the content of the subject (85%) and a practical exam that will be carried out in the laboratory (15%).

In case of detection of copying or any form of plagiarism is detected in any of the tests or exams, the final grade will be fail (0), and the incident will be reported to the corresponding academic authorities for prosecution.

Sources of information

Basic Bibliography

Henry W. Ott, **Electromagnetic Compatibility Engineering**, 1ª, Wiley, 2011

López Veraguas, Joan Pere, **Compatibilidad electromagnética y seguridad funcional en sistemas electrónicos**, Marcombo, 2010

David J. Smith, **Reliability, Maintainability and Risk**, 8ª, Butterworth Heinemann, 2011

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

M. Goble, H. Cheddie, **Safety Instrumented Systems Verification**, ISA, 2005

M. Goble, **Control Systems Safety Evaluation and Reliability**, 3ª, ISA, 2010

Michael D. Medoff Rainer and I. Faller, **Functional Safety: An IEC 61508 SIL 3 Compliant Development Process**, 3ª, Exida, 2014

Complementary Bibliography

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

P. Kales, **Reliability**, Prentice-Hall, 1998

B. R. Mehta Y. J. Reddy, **Industrial Process Automation Systems Design and Implementation**, Elsevier, 2015

ISO, **UNE-ISO 55000:2015: Gestión de activos. Aspectos generales, principios y terminología**, AENOR, 2015

Milton Ohring, **Reliability and Failure of Electronic Materials and Devices**, 2ª, Elsevier, 2015

Chris J. O'Brien, **Final Elements in Safety Instrumented Systems**, 1ª, Exida, 2018

Shahriyar Kaboli, **Reliability in Power Electronics and Electrical Machines: Industrial Applications and Performance Models**, 1ª, IGI Global, 2016

Francesco Flammini, **Railway Safety, Reliability, and Security: Technologies and Systems Engineering**, 1ª, 2012

Recommendations

Subjects that are recommended to be taken simultaneously

Signal Conditioners/V05M145V01331

Photovoltaic Power Electronics/V05M145V01330

Subjects that it is recommended to have taken before

Digital and Analog Mixed Circuits/V05M145V01213

Hardware/Software Design of Embedded Systems/V05M145V01214

Integrated Circuits Design and Manufacturing/V05M145V01215

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				
Electronic Equipment Practicals				
Subject	Electronic Equipment Practicals			
Code	V05M145V01333			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Telecommunications Seminar				
Subject	Telecommunications Seminar			
Code	V05M145V01334			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA				
Piezoelectric Transducers and Applications				
Subject	Piezoelectric Transducers and Applications			
Code	V05M145V01335			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

IDENTIFYING DATA**Numerical Linear Algebra in Telecommunications Engineering**

Subject	Numerical Linear Algebra in Telecommunications Engineering			
Code	V05M145V01336			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language				
Department				
Coordinator				
Lecturers				
E-mail				

----- UNPUBLISHED TEACHING GUIDE -----

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

Training and Learning Results	
Code	
A1	CB1 Knowledge and understanding needed to provide a basis or opportunity for being original in developing and/or applying ideas, often within a research context.
B1	CG1 Ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B5	CG5 Capacity for development, strategic planning, direction, coordination and technical and financial management of projects in all fields of Telecommunication Engineering following quality and environmental criteria.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
B11	CG11 Ability to communicate (oral and written) conclusions, and the knowledge and reasons supporting them, to specialists and non-specialists in a clear and unambiguous way.
B12	CG12 Skills for lifelong, self-directed and autonomous learning.
C17	CE17/TFM Embodiment, presentation and defense, once all credits of the curriculum are passed, of an original exercise performed individually in front of a university jury, consisting of a comprehensive project of Telecommunication Engineering with professional nature, in which skills acquired in the teachings are synthesized.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
Research, classification and structuring of information on some topic relevant to Telecommunications engineering.	A1 B8 B12
Dissertation containing the fundamentals, the solution and an analysis of results about the problem addressed. It should include a review of the state of the art, an explanation of the methodology or approach, and a discussion of results.	B1 B8 B11 C17
Design of prototypes, computer programs, circuits, procedures, algorithms, designs, methods, etc, complying to specifications	A1 B1 B5 B8 B12

Contents	
Topic	
The contents of the Master's Thesis are established in the individual proposals offered by the advisors, according to the rules issued by the Academic Commission of the Master Programme.	
The subject of each work is specific, given the individual character of the work.	

Planning

	Class hours	Hours outside the classroom	Total hours
Previous studies	0	60	60
Case studies	0	20	20
Project based learning	0	630	630
Problem solving	0	30	30

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

Methodologies

	Description
Previous studies	Research, reading and work of documentation, proposals of resolution of problems and/or exercises that will realise in the classroom or the laboratory of autonomous form by the students.
Case studies	It carries out a critical analysis of similar problems to the posed in the thesis, with the goal of extracting ideas, analogies, methods or partial results that help in the resolution of the problem posed in the thesis.
Project based learning	The student, individually, solves a scientific problem, originally and independently, within the thematic area of his/her interest, and is able to write a dissertation with the hypotheses, the solution and the conclusions of his work.
Problem solving	The student analyzes the possible solutions to a scientific problem proposed for the thesis, and elaborates a synthesis solution (analytical, meteorological, experimental or combined) that allow him to fulfill the stated goals.

Personalized assistance

Methodologies	Description
Project based learning	Each student will meet his/her advisors to receive guidance, orientation or academic assistance on the objectives, the methodology, the analysis of results and the presentation of the thesis. The TFM coordinator will establish tutoring hours at the beginning of the term. These hours could be checked at the subject web page https://moovi.uvigo.gal/ .

Assessment

	Description	Qualification	Training and Learning Results		
Project based learning	The assessment is done after an oral presentation and defence in front of an examining committee. In the evaluation, the Committee might take into account the opinions or the report issued by the advisor, as well as questions like the quality of the presentation, the review of the state of the art, the quality of the technical proposal, the novelty and importance of the results, the capacity of initiative of the student, etc. System of qualifications: it will express by means of numerical final qualification of 0 to 10 according to the valid legislation.	100	A1	B1 B5 B8 B11 B12	C17

Other comments on the Evaluation

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations