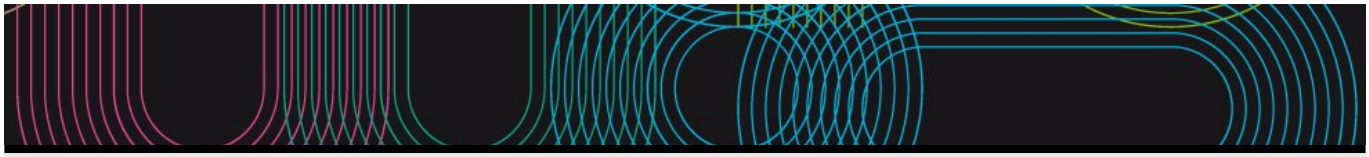

IDENTIFYING DATA				
Digital and Analog Mixed Circuits				
Subject	Digital and Analog Mixed Circuits			
Code	V05M145V01213			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Quintáns Graña, Camilo			
Lecturers	Quintáns Graña, Camilo			
E-mail	quintans@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The majority of the electronic systems are a mixture of analogic and digital circuits. Due to this fact, besides studying them separately, it is necessary to consider them as a whole and to know their specific characteristics. From a point of view of the electrical signal, the mixed circuits can use both digital signals with analogic information and analogic signals with digital information. Combining the digital data domain with the analogic and temporal is of fundamental importance for designing complex systems. This subject introduces the students in the multidisciplinary study of the different kind of circuits which conform the electronic systems. 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	
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.
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.
C11	CE11 Knowledge of hardware description languages for high complexity circuits.
C12	CE12 Ability to use programmable logic devices, as well as to design advanced electronic systems, both analog and digital. The ability to design communications components such as routers, switches, hubs, transmitters and receivers in different bands.
C14	CE14 Ability to develop electronic instrumentation, as well as transducers, actuators and sensors.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
To know and to understand the basics of mixed circuits in order to obtain new applications that combine different methods and resources for the design of complex systems	A1
To know the modeling of mixed electronic systems by using the mathematical basis of the continuous analog systems and discrete systems.	B4
The ability to combine different methods and resources for the design of complex systems that include analog and digital circuits.	B8
The knowledge of the characteristics of the description languages modeling the analog and digital mixed electronic circuits. To be able of modeling mixed electronic systems using hardware description languages.	C11

Knowing how to combine different methods and resources for the design of complex systems that include analog and digital circuits. To design matching circuits from analog to digital signal processors efficiently. Besides of the output signals from analog systems to digital processors.	C12
To know how to design specific digital filters and modulators for sampling and reconstruction of signals. To know how to use the modulation techniques for conditioning of sensors and for generating electrical signals to actuators.	C14

Contents

Topic	
Unit 1: Introduction to mixed analog and digital electronic circuits.	Mixed circuits characteristics. Modeling, simulation and applications of mixed circuits. Introduction to hardware description languages for analog / digital mixed circuits.
Unit 2: Introduction to direct signal coupling techniques from analog to digital processors.	Introduction. Coupling technology in base band and by modulation. Measurement of time constants. PWM modulation. Sigma-Delta Modulation. Phase modulation. Frequency Modulation. Resources for coupling analog signals to digital processors.
Unit 3: Oversampling Techniques for digital processing of analog signals.	Oversampling techniques. Resolution gain. Reshaping of the quantization noise spectrum. First-order modulator. Modeling, simulation and test of sigma-delta modulators.
Unit 4: Sigma-delta modulators circuits.	Design of sigma-delta modulators with different topologies. Operating parameters. Low-pass and band-pass modulators.
Unit 5: Introduction to multistage A/D converters.	Pipelined A/D converters. Basic steps, timing and alignment. Test methods.
Unit 6: Digital filter circuits for signal sampling and reconstruction applications.	VHDL synthesis of digital filters. Decimation filters. Equalizer filters. Data format. Optimization.
Unit 7: Digital synthesis of signals to feed analog systems.	Methods of digital synthesis of analog signals. Direct synthesis. IIR filters. Modeling of digital synthesizers of analog signals with hardware description languages.
Laboratory sessions.	1.- Simulation of a Sigma-Delta ADC modulator. 2.- Assembly of a Sigma-Delta ADC modulator. 3.- Configuration of an FPGA to implement a Sigma-Delta DAC modulator. 4.- Configuration of an FPGA to implement a comb pass-2 filter. 5.- Configuration of an FPGA to implement a DDS circuit. 6.- Configuration of an FPGA to implement a synthesizer circuit based on IIR filter.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	0.5	1	1.5
Lecturing	10.5	21	31.5
Mentored work	4.5	9	13.5
Problem solving	2	4	6
Laboratory practical	7.5	15	22.5
Laboratory practice	1	11	12
Essay	0.5	1	1.5
Essay questions exam	1	15	16
Problem and/or exercise solving	1	15	16
Systematic observation	1	1	2
Report of practices, practicum and external practices	0.5	2	2.5

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

Methodologies

	Description
Introductory activities	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: A1, B4, C11, C12 and C14.

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: A1, B4, B8, C11, C12 and C14.
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: A1, B4, B8, C11, C12 and C14.
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: A1, B4, B8, C11, C12 and C14. Software to be used: OrCAD PSpice, Excel, Matlab, Vivado or ISE de Xilinx, PARTQUEST.

Personalized assistance

Methodologies	Description
Lecturing	The professor will attend personally doubts and queries of the students on the study of the theoretical concepts and 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 to prepare 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 upervised 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 of the report of 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		B8	C11 C12 C14
Essay	It is a text prepared on a topic and should be written following established rules.	10	A1	B4 B8	
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		B4 B8	C11 C12 C14
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	A1	B4 B8	C11 C12 C14
Systematic observation	Attentive, rational, planned and systematic perception to describe and record the manifestations of student behavior.	10		B8	

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	B8	C11 C12

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 recieve 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

Shanthi Pavan; Richard Schreier; Gabor C. Temes, **Understanding Delta-Sigma Data Converters**, 2, Wiley-IEEE Press, 2017

U. Meyer-Base, **Digital Signal Processing with Fiel Programmable Gate Arrays**, 4, Springer, 2014

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

Complementary Bibliography

Charles H. Roth, Lizy Kurian John, **Digital Systems Design using VHDL**, 3, Cengage Learning, 2017

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

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

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

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

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

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

Recommendations

Subjects that continue the syllabus

Signal Conditioners/V05M145V01331

Subjects that it is recommended to have taken before

Analog Electronic Circuits Design/V05M145V01106
Advanced Digital Electronic Systems/V05M145V01203