

IDENTIFYING DATA				
Digital and Analog Mixed Circuits				
Subject	Digital and Analog Mixed Circuits			
Code	V05M145V01213			
Study programme	Telecommunication Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	Spanish English			
Department				
Coordinator	Quintáns Graña, Camilo			
Lecturers	Quintáns Graña, Camilo			
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General description	The majority of the electronic systems are a mixture of analogic and digital circuits. Due to this fact, besides studying them separately, it is necessary to consider them as a whole and to know their specific characteristics. From a point of view of the electrical signal, the mixed circuits can use both digital signals with analogic information and analogic signals with digital information. Combining the digital data domain with the analogic and temporal is of fundamental importance for designing complex systems. This subject introduces the students in the multidisciplinary study of the different kind of circuits which conform the electronic systems.			

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

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

To know how to design specific digital filters and modulators for sampling and reconstruction of signals.	C14
To know how to use the modulation techniques for conditioning of sensors and for generating electrical signals to actuators.	

Contents

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

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	13	26	39
Laboratory practises	13	26	39
Short answer tests	1	13	14
Practical tests, real task execution and / or simulated.	2	20	22
Multiple choice tests	1	10	11

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

Methodologies

	Description
Master Session	Exhibition of the contents of the subject; it includes exhibition of concepts; introduction of practices and exercises; and resolution of problems and/or exercises in ordinary classroom.
Laboratory practises	Application, at a practical level, of the knowledge and skills acquired in the lectures by mean of practices undertaken with test and measurement equipment, either in the laboratory or in other place.

Personalized attention

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

Assessment

	Description	Qualification	Training and Learning Results

Laboratory practises	It values the participation of the student in the practices of laboratory: preparation of previous tasks, fulfillment of the aims posed in each practice and back tasks in which the student analyses the results, compares them with the expected and presents the conclusions. They can apply to the tests of continuous or final assessment.	25		B8 C12 C14
Short answer tests	Tests that include direct questions about an specific topic. The student has to answer of direct form in virtue of the knowledge that has on the subject. The answer is brief. They can apply to the tests of continuous evaluation or to the final examination.	25	A1 B4	C11 C14
Practical tests, real task execution and / or simulated.	Tests that include activities of laboratory and/or TIC, problems or cases to resolve. The students have to give answer to the activity formulated by reflecting, in a practical way, the theoretical and practical knowledge that have been learnt in the subject, using, if it is necessary, the equipment or instrumentation of the practices carried out in the course. They can apply to the tests of continuous or final assessment.	25		B8 C11 C12 C14
Multiple choice tests	Tests that include direct questions about an specific topic with answers of multiple selection. They can apply to the tests of continuous or final assessment.	25	A1 B4	C14

Other comments on the Evaluation

1. Continuous evaluation

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

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

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

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

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

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

2. Final exam

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

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

3. Call for recovery

The call for recovery will be like the final exam.

Sources of information

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

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

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

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

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

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

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

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

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

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

Recommendations

Subjects that it is recommended to have taken before

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