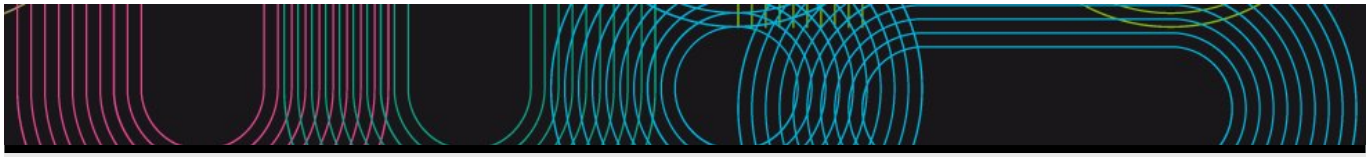

IDENTIFYING DATA				
Signal Conditioners				
Subject	Signal Conditioners			
Code	V05M145V01331			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Quintáns Graña, Camilo			
Lecturers	Quintáns Graña, Camilo			
E-mail	quintans@uvigo.es			
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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.			

Skills	
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

Learning outcomes	
Expected results from this subject	Training and Learning Results
To know the modeling and simulationing of analogic electronic systems by means of the hardware description language SPICE.	B1 B4 B8 C29
To know the evaluationing 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 konw to analyse and to design circuits for interfaces between the sensors and digital processors.	B1 C29
To know how to develop an instrumentation electronic systems.	B1 B4 B8 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 measureing 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.

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: CG1, CG4 and CE29.
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: CG1, CG4, CG8 and CE29.

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: CG1, CG4, CG8 and CE29.
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: CG1, CG4, CG8 and CE29. Software to be used: OrCAD PSpice, Excel, Matlab, C compiler.

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. 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 practical	The professor will attend personally doubts and queries of the students on the preparation of 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.
Mentored work	The professor will attend personally doubts and queries of the students on the upervised works. 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.
Problem solving	The professor will attend personally doubts and queries of the students on the resolution of the problems. 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.
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. 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 practice	Execution practices of real or simulated tasks. These are tests in which the performance of the students will be evaluated on the basis of the knowledge shown, the behavior, organization and planning during the practice, 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 extensive 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. First call: Continuous assessment

The continuous evaluation consists of the following four parts:

1.-Laboratory (35%), which is divided into:

Development of laboratory practices: Monitoring (10%) plus the practical test (10%).

Report of laboratory practices (15%).

2.-Theory exams (45%), which is divided in an orientation way in:

Development questions (20%).

Problems (25%).

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

4.-Systematic observation (10%). In addition to the aspects mentioned in the description, the participation of the student in carrying out the activities proposed for their autonomous work and the use of personalized attention in the office hours of the teacher will be taken into account.

The final grade, which is scored on a maximum of 10 points, is the sum of the mark of each part if the following conditions are met:

1.-Have carried out a minimum of the 80% of the laboratory practices.

2.-Obtain a minimum mark of the 40% in each part of the assessment.

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). Students who do not reach a minimum score of 40% in the laboratory evaluation, exams and supervised work in the continuous assessment may recover them in the second opportunity tests while maintaining the percentages of the continuous assessment.

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

The practical test will take place near of the last session of laboratory classes. The development questions and problems will can be divided in two sessions spread along the period of teaching.

2. First call: Final exam

Students who fail the course in continuous assessment (have not performed, at least, 80% of the practices) can 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.

The students of continuous evaluation that have pending to surpass the minimum of some part will be able to do it in the final examination. If they did not reach the minimum in the supervised work, they will have a deadline to present the proposed improvements until the final exam.

3. Second call and extraordinary

In the second call the assessment will be like the final exam of the first call.

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