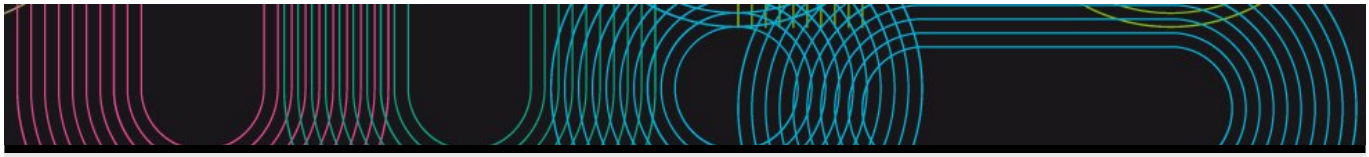

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Signal Conditioners** | | | | |
| Subject | Signal Conditioners | | | |
| Code | V05M145V01331 | | | |
| Study programme | Máster Universitario en Ingeniería de Telecomunicación | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 5 | Optional | 2nd | 1st |
| Teaching language | #EnglishFriendly<br>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.<br>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.<br>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.<br>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.<br>The key points of the laboratory work are:<br>-The followed methodology to measure physical variables to the calculation of uncertainties.<br>-Characterization of transducers.<br>-Topologies of conditioning circuits.<br>-The connection of the conditioned signals to a digital processor.<br>-Instrumentation software for digitally conditioning and user interfaces.<br><br>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 simulationing of analogic electronic systems by means of the hardware description language SPICE. | B1<br>B4<br>B8<br>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<br>C29 |
| To know the developing of complex electronic circuits for conditioning the sensors. | B1<br>B4<br>B8<br>C29 |
| To konw to analyse and to design circuits for interfaces between the sensors and digital processors. | B1<br>C29 |
| To know how to develop an instrumentation electronic systems. | B1<br>B4<br>B8<br>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.<br>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. |
| 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.<br>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:<br>- Monographic works, search of information in publications, databases, articles, books ... on a specific topic.<br>- Preparation of seminars, research, reports, essays, conferences, etc.<br>- Reviews on current scientific articles.<br>- Projects (design and develop projects).<br>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.<br>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.).<br>The learning outcomes that are developed are: B1, B4, B8 and C29.<br>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. 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 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 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<br>B4<br>B8 | C29 |
| Essay | It is a text prepared on a topic and should be written following established rules. | 10 | B1<br>B4<br>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<br>B4<br>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<br>B4<br>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<br>B4<br>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 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

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