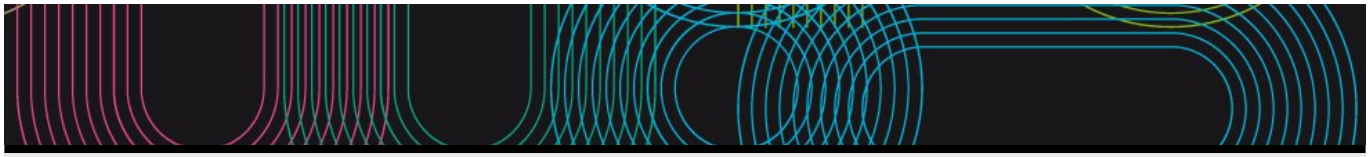

IDENTIFYING DATA				
Analog Electronic Circuits Design				
Subject	Analog Electronic Circuits Design			
Code	V05M145V01106			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Mandatory	1st	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Pastoriza Santos, Vicente			
Lecturers	Costas Pérez, Lucía Pastoriza Santos, Vicente			
E-mail	vpastoriza@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The main purpose of this subject is that the student acquires the knowledge and the skills to be able to analyze and design analogue electronic circuits of low frequency, which are most frequently used in data acquisition systems and electronic instrumentation systems. Course outline: +Introduction to electronic systems for signal acquisition: functional block diagrams and architectures. +Feedback: definition and topologies. +Introduction to sensors: definition and classification. +Introduction to signal conditioning circuits. Auxiliary circuits: linearization circuits. Level-shifting circuits. Precision rectifiers. Voltage references. Voltage-to-current conversion. Analog switches and multiplexers. +Amplification in electronic measurement systems: instrumentation amplifiers, programmable amplifiers, and isolation amplifiers. +Active filters. +Sample-and-hold circuits, digital-to-analog and analog-to-digital converters. The main goal of the laboratory sessions (practical work) is to enable the students to acquire sufficient understanding and knowledge to: + Assemble electronics circuits. + Use of laboratory instrumentation to measure of physical variables on circuits. + Detect and correct assembly errors. + Manage specific software tools developed to design, simulation and analysis of analogue electronic system.			

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
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.
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
Know analyse and design analogue electronic circuits of low frequency.	A4 B4 B8 C12 C14
Know the parts that constitute an electronic measurement system.	A5 B4 C12 C14
Know the principle of operation of sensors and their conditioners.	A5 B4 C12 C14
Know model an analogue electronic system by means of hardware description languages.	A4 B4 B8 C12 C14

Contents	
Topic	
Unit 1: Introduction	Analog systems for signal acquisition: Architectures. Functional block diagrams. Feedback: Definition. Topologies. Series-Parallel feedback. Through this unit the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Unit 2: Auxiliary circuits	Sensors and signal conditioners: Sensors: Definition and classification. Signal conditioners for resistive sensors: The voltage divider. Wheatstone bridge. Other conditioning circuits. Linearization circuits. Level-shifting circuits: DC level shifter and gain calibration. Precision rectifiers: Half-wave rectifiers and full-wave rectifiers. Voltage references and current sources: Voltage references: Introduction. Performance specifications. Basic circuit. Self-regulated circuit. Thermal stabilization. Voltage-to-current converter circuits: Introduction. Floating-load converters. Grounded-load converters. Analog Switches and Multiplexers Switches: Definition. Types. Applications. Commercial devices. Multiplexers: Definition. Types. Specifications. Through this unit the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Unit 3: Amplification in signal acquisition systems	Instrumentation amplifiers: Introduction. Definition and ideal characteristics. Real model. Basic configurations. Specifications. Functional block diagram. Applications. Commercial amplifiers and their data sheets. Programmable amplifiers: Introduction. Types. Pin Programmable Gain Amplifier. PGA: Programmable Gain Amplifier. Commercial amplifiers and their data sheets. Isolation amplifiers: Introduction. Classification criteria. Types: capacitive coupled, transformer coupled, and optically coupled. Basic structure. Specifications. Applications and limitations. Examples. Commercial amplifiers and their data sheets. Through this unit the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.

Unit 4: Active filters	Introduction: Fundamentals. Basic filter types. Real parameters. Description by transfer function: Introduction. Transfer function: poles and zeros, stability analysis and frequency response. First order and second order filters. Approximation of filter transfer function: Steps in the realization of active filters. Filter specifications. Mathematical approximation of the characteristic function. Transfer function normalization. Transfer function normalization. Transformation from one type of filter into another. Polynomial approximations. Synthesis: Introduction. Methods. Direct design. Basic topologies of direct synthesis. Cascade design. Comparison of methods. Scaling. Through this unit the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Unit 5. Sample-and-hold circuits. Digital-to-analog and analog-to-digital converters	Sample-and-hold circuits: Background. Specifications. Architectures. Commercial devices. Analog-to-digital converters: Introduction. Fabrication parameters. Errors. Architectures. Commercial devices. Digital-to-analog converters: Introduction. Fabrication parameters. Errors. Architectures. Commercial devices. Through this unit the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Practice 1: Auxiliary circuits.	Implementation and testing of certain of the auxiliary circuits developed in the theoretical part. Through this practice the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Practice 2: Instrumentation amplifier.	Implementation, testing and analysis of an commercial instrumentation amplifier with adjustable gain. Through this practice the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Practice 3: Active filters.	Implementation of an active filter. Identification of the topology, the order, and the filter type. Theoretical calculation of its cut-off frequency. Frequency response measurement using the waveform generator and the oscilloscope. Plot the magnitude of the frequency response of the filter (Bode magnitude plot). Through this practice the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Practice 4: Measurement system of a physical variable using commercial sensors.	Implementation and testing of the signal conditioning circuit of a measurement system based on commercial sensors. Through this practice the competencies CB4, CB5, CG4, CG8, CE12 and CE14 are developed.
Practice 5: Electronic circuit simulation	Simulation of electronic circuits described in the theoretical and/or previous practical part. In this practice will work the competencies CB4, CB5, CG4, CG8, CE12 and CE14.
Tutored project	Realization of one or several laboratory practices (in groups or individually). The theme will be centered on two themes of theoretical-practical planning of the subject. The students will have to present a report of critical results (assessment and comparison with reference data, if applicable). In this practice will work the competencies CB4, CB5, CG4, CG8, CE12 and CE14.

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	2	3
Lecturing	13	19	32
Problem solving	8	12	20
Project based learning	5	12	17
Laboratory practical	10	10	20
Objective questions exam	1.5	15	16.5
Objective questions exam	1.5	15	16.5
*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	Subject presentation. Presentation of laboratory sessions, instrumentation and software resources to be used. In these sessions, the skills A4, A5, B4, B8, C12 and C14 will be worked.
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 A4, A5, B4, B8, C12 and C14 will be worked.
Problem solving	Complementary activity to the master sessions. The students will perform exercises and troubleshooting related with the subject. The student should find right solutions to the classroom exercises and other exercises from bibliography. The lecturer will identify issues and resolve students questions in the classroom or at the office. In these sessions, the skills A4, A5, B4, B8, C12 and C14 will be worked.
Project based learning	Complementary activity to the master sessions. Students have to develop a group activity that projects 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 lecturers will guide and monitor the student work in the C hour sessions. In these sessions, the skills A4, A5, B4, B8, C12 and C14 will be worked.
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. Software to be used: National Instruments (NI) LabVIEW and NI Multisim. In these practices, the skills A4, A5, B4, B8, C12 and C14 will be worked.

Personalized assistance	
Methodologies	**Description**
Lecturing	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject's website on Moovi teleteaching portal (https://moovi.uvigo.gal/) at the beginning of the academic semester. In these sessions the lecturer will answer the students questions and also give instructions to guide the studying and learning process.
Problem solving	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject's website on Moovi teleteaching portal (https://moovi.uvigo.gal/) at the beginning of the academic semester. In these sessions, the lecturer will answer the students questions about the problems and/or exercises proposed and/or resolved in the classroom as well as other issues that can appear along the study of the subject.
Laboratory practical	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject's website on Moovi teleteaching portal (https://moovi.uvigo.gal/) at the beginning of the academic semester. In these sessions the lecturer will help students understand the work to be developed in the laboratory (components, circuits, instrumentation and tools).
Project based learning	The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject's website on Moovi teleteaching portal (https://moovi.uvigo.gal/) at the beginning of the academic semester. In these sessions the lecturer will help students to deal with issues and questions related with the theoretical and practical project.

Assessment			
	Description	Qualification	Training and Learning Results

Project based learning	The student have to perform a theoretical practical project. In order to assess the project, the lecturer will consider the developed work, the obtained results, their classroom presentation and analysis, and the quality of the final written report if required. The final mark of tutored project (TPM), will be assessed in a 10 points scale. For the evaluation of the project, the lecturer will assess the group work, if this is done in a group (the same mark for each member), the individual student work and the individual oral presentation, if this were to take place. In these practices, the skills A4, A5, B4, B8, C12 and C14 will be assessed.	15	A4 B4 C12 A5 B8 C14
Laboratory practical	The lecturers will check the compliance level of the objectives related to the laboratory skills. Final mark of laboratory, FLM, 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), the individual preliminary tasks and the answers to personalised questions for each session. In these practices, the skills A4, A5, B4, B8, C12 and C14 will be assessed.	25	A4 B4 C12 A5 B8 C14
Objective questions exam	The lecturers will check the compliance level of the objectives related to the theoretical skills. Marks for each objective test (OT) will be assessed in a 10 points scale. In this exam, the skills A4, A5, B4, B8, C12 and C14 will be assessed.	30	A4 B4 C12 A5 B8 C14
Objective questions exam	The lecturers will check the compliance level of the objectives related to the theoretical skills. Marks for each objective test (OT) will be assessed in a 10 points scale. In this exam, the skills A4, A5, B4, B8, C12 and C14 will be assessed.	30	A4 B4 C12 A5 B8 C14

Other comments on the Evaluation

1. Continuous assessment

According to the guidelines of the degree and the agreements of the academic commission, a continuous assessment learning system will be offered.

Students who have taken 1 objective testing (theoretical test) or 1 laboratory session or 1 session of C hours after a month has elapsed since the beginning of classes, **they will be assessed by continuous assessment.**

The subject is divided into the following parts: objective tests (60 %) and practical tests (40%). The marks are valid only for the current academic year. The final grade for the students which have selected this option, may not be "no standing".

The schedule of the different assessment tests will be available at the beginning of each academic semester.

1.a Objective tests (multiple choice questionsor short-answer questions)

Two partial testings (OT: objective tests) will be scheduled throughout the academic semester.

Each objective test will be comprised multiple choice questions and/or short-answer questions and/or problem-solving exercises. Marks for each objective test (OT) will be assessed in a 10 points scale. The student who miss a test will be assessed with a mark of 0 for that test. The minimum mark required to pass the theoretical part is of 5 for each objective test (OT1 >= 5 and OT2 >= 5).

If OT1 >= 5 and OT2 >= 5 the the final mark of objective tests (OTM), will be the arithmetic mean of the two tests:

OTM = (OT1 + OT2)/2

otherwise, the final mark of this part will be:

OTM = 5 -Sum(Ai)/2 where Ai = max({0; 5-OTi}) for i = 1, 2.

1.b Practical tests

1.b.1 Laboratory

Five laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in pairs.This part also will be assessed by continuous assessment.

The lecturers will assess the individual student work. They will consider the individual work carried out before the laboratory session to prepare the proposed tasks, the participation, as well as the student work in the session. Marks for each laboratory session (LSM) will be assessed in a 10 points scale. A mark of 0 will be obtained for missing sessions. The final mark of laboratory (FLM) is calculated as the arithmetic mean of the individual laboratory session marks.

The minimum mark required to pass this part is of 5 (FLM >= 5). Furthermore, the student alone may miss 1 session (where LSM = 0); otherwise FLM = 0.

1.b.2 Tutored project

In the first session of C hours, lecturers will present the objectives and the schedule of the project. They also assign a specific project to each group. The lecturers will monitor the work in the following sessions of C hours.

In order to assess the project, the lecturer will consider the developed work, the quality of the obtained results, their classroom presentation and analysis, and the quality of the final written report if required. The final mark of this part, tutored project mark (TPM), will be assessed in a 10 points scale.

The minimum mark required to pass this part is of 5 (TPM>=5). Furthermore, the student alone may miss 1 session; otherwise TPM = 0.

1.c 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: 60% objective tests (OTM) and 40% practical tests (25% laboratory (FLM) and 15% tutored project (TPM). In order to pass the subject, students will be required to pass the three parts:

- objective tests: OT1>=5 and OT2>=5.
- laboratory: FLM>=5.
- tutored project: TPM>=5.

In this case, the final mark will be the weighted average of the marks obtained by the student in the different parts:

FM = 0.60·OTM + 0.25·FLM + 0.15·TPM

However, when the students do not pass all parts, the final mark will be calculated using the following expression:

FM = min({ 4.9; (0.60·AM + 0.25·BM + 0.15·CM) }), where:

AM = 5 -Sum(Ai)/2 where Ai = max({0; 5-OTi}) for i = 1, 2.

BM = min({5; FLM})

CM = min({5; TPM})

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

2. Global assessment

The students who prefer a different educational policy can attend an exam on a scheduled date. This exam will comprise three parts (similar to the activities completed by the continuous assessment): two objective test, laboratory exam and tutored project. Dates will be specified in the academic calendar. In order to attend the laboratory exam and to assign the tutored project, the students have to contact to the lecturer according to an established procedure.

The two objective test will be comprised multiple choice questions and/or short-answer questions and/or problem-solving exercises. Marks for each objective test (OT1 and OT2) will be assessed in a 10 points scale.

The laboratory exam will involved a practical test.The laboratory exam will be assessed in a 10 points scale and this mark will be the final mark of laboratory (FLM).

In order to assess the tutored project, the lecturer will consider the developed work, the quality of the the obtained results, their presentation and analysis, and the quality of the final written report if required. This work will be assessed in a 10 points scale and this mark will be the final mark of this part (TPM).

In order to pass the subject, students will be required to pass the three parts:

- objective tests: OT1>=5 and OT2>=5,
- laboratory: FLM>=5.
- tutored project: TPM>=5.

In this case, the final mark (FM) will be:

FM = 0.60·OTM + 0.25·FLM + 0.15·TPM, where:

OTM will be the arithmetic mean of the two objective tests:

OTM = (OT1 + OT2)/2

However, when the students do not pass all parts, the final mark will be calculated using the following expression:

FM = min({ 4.9; (0.60·AM + 0.25·BM + 0.15·CM) }), where:

AM = 5 -Sum(Ai)/2 where Ai = max({0; 5-OTi}) for i = 1, 2.

BM = min({5; FLM})

CM = min({5; TPM})

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

3. Extraordinary exam and end-of-program exam

The evaluation policy in this call will follow the scheme described in the previous sections. Dates will be specified in the academic calendar. The lecturer will assign the tutored work and the project to the student. The student has to contact to the lecturer according to an established procedure. The procedure will be published in advance.

In the extraordinary exam, the marks of the parts to which the student does not appear will be those obtained in the ordinary opportunity (continuous or global assessment) of the current academic year. Moreover, students cannot take an exam, develop a project or a tutored work task if they have got a pass previously in the ordinary opportunity.

The final mark will be the weighted average of the marks obtained by the student as it has described in section 2.

4. About ethical behaviour of students

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

Pérez García, M.A., **Instrumentación Electrónica**, 1ª ed., Ediciones Paraninfo, S.A., 2014

Franco, S., **Diseño con amplificadores operacionales y circuítos integrados analógicos**, 3ª ed., McGraw-Hill, 2004

Fraile Mora, J., García Gutiérrez, P., y Fraile Ardanuy, J., **Instrumentación aplicada a la ingeniería**, 3ª ed., Editorial Garceta, 2013

Pallás Areny, R., **Sensores y Acondicionadores de Señal**, 4ª ed., Marcombo D.L., 2003

Pallás Areny, R., Casas, O., y Bragó, R., **Sensores y Acondicionadores de Señal. Problemas resueltos**, Marcombo D.L., 2008

Pérez García, M.A., Álvarez Antón, J.C., Campo Rodríguez, J.C., Ferrero Martín F.C., y Grillo Ortega, **Instrumentación Electrónica**, 2ª ed., Thomson, 2004

Pérez García, M.A., **Instrumentación Electrónica: 230 problemas resueltos**, 1ª ed., Editorial Garceta, 2012

Complementary Bibliography

Recommendations

Subjects that continue the syllabus

Digital and Analog Mixed Circuits/V05M145V01213