| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Electronic Instrumentation and Sensors** | | | | |
| Subject | Electronic Instrumentation and Sensors | | | |
| Code | V05G300V01621 | | | |
| Study programme | Degree in Telecommunications Technologies Engineering - In extinction | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Optional | 3rd | 2nd |
| Teaching language | Spanish<br>Galician | | | |
| Department | | | | |
| Coordinator | Mariño Espiñeira, Perfecto | | | |
| Lecturers | Mariño Espiñeira, Perfecto<br>Pastoriza Santos, Vicente | | | |
| E-mail | pmarino@uvigo.es | | | |
| Web | http://faitic.uvigo.es | | | |
| General description | The main purpose of the subject is to provide the theoretical and practical skills for the design and characterization of electronic instrumentation systems, and the range of sensors which provide analogical and digital signal in the input stage of said instrumentation systems.<br>Course outline:<br>+ Analysis of sensor parameters.<br>+ Basic concepts about the physical principles of the sensors.<br>+ The most important application of sensors in electronic instrumentation.<br>+ Electronic instrumentation architectures, from the simplest point to point systems to the most complex distributed systems. International standards for electronic instrumentation are presented.<br>+ Design of programmable instrumentation: GPIB, VXI and PXI buses.<br>+ Classification of architectures for electronic instrumentation. Introduction of wired and wireless field buses.<br>The main goal of the laboratory sessions (practical work) is to enable the students to acquire sufficient understanding and knowledge to:<br>+Analyse the parameters and main features of the sensors integrated in the electronic instrumentation systems.<br>+ Know the applications of each group of sensors.<br>+ Manage specific software tools to design (virtual) instruments that allow store, display and analyse recorded data.<br>+ Use specific software tools to work with buses of instrumentation programmable.<br><br>The documentation of the course will be in Spanish. It will be taught in Galician and Spanish. It will be assessed in Spanish. | | | |

| Competencies | |
|---|---|
| Code | |
| B3 | CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations |
| B4 | CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity. |
| B5 | CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area. |
| C42 | (CE42/SE4): The ability to apply electronics as support technology in other fields and activities and not only in information and communication technologies. |
| C46 | (CE46/SE8): The ability to specify and use electronic instrumentation and measurement systems. |
| D2 | CT2 Understanding Engineering within a framework of sustainable development. |

| | |
|---|---|
| D3 | CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc. |

**Learning outcomes**

| Expected results from this subject | Training and Learning Results | | |
|---|---|---|---|
| Knowledge of the distinct types of sensors and his applications. | B3 | C42<br>C46 | D2<br>D3 |
| Capacity for the development of electronic circuits of conditioning of signal. | B4<br>B5 | C42<br>C46 | D2<br>D3 |
| Knowledge and utilisation of computer tools for treatment of data and representation of the information. | B4<br>B5 | C42<br>C46 | |
| Knowledge of the basic principles of the programmable instrumentation and his utilisation. | B3 | C42<br>C46 | D2<br>D3 |

**Contents**

| Topic | |
|---|---|
| Unit 1: Introduction to sensors. | Energy conversions. Concepts of sensor, transducer and actuator. Dynamic and static features. Other features. Selection of sensors. |
| Unit 2: Temperature resistive sensors. Strain gauges. | Temperature resistive sensors:<br>General features. Types. Conditioning . Application examples.<br><br>Strain gauges:<br>Basic principles. General features. Types of using. Conditioning . Application examples. |
| Unit 3: Photoresistive and Optoelectronic. Other resistive sensors. | Photoresistive and Optoelectronic:<br>Basic principles. General features. Encoders. Conditioning. Application examples.<br><br>Other resistive sensors:<br>Gas sensors. Magnetoresistors. Potentiometers. Basic principles. General features. Conditioning . Application examples. |
| Unit 4: Capacitive sensors. Inductive and magnetic sensors. | Capacitive sensors:<br>Introduction. Measurements principles. Features. Conditioning. Proximity sensors. Application examples.<br><br>Inductive and magnetic sensors:<br>Introduction. Basic principles. Variable transformer types. Features. Conditioning. Hall effect sensors. Application examples. |
| Unit 5: Thermocouples. Other sensors. | Thermocouples:<br>Basic principles. General features. Calibration scales. Conditioning. Application examples.<br><br>Other sensors:<br>Pyroelectric. Ultrasounds. Magnetostrictive. |
| Unit 6: Programmable instrumentation. | Programmable instrumentation. Switched instrumentation. Hybrid systems on instrumentation.<br><br>GPIB bus: General features. Configurations and equipment. Standards IEEE 488.1/488.2. Transference procedures. Standard HS488.<br><br>GPIB command groups. Basic functions. Integrated circuits. Controllers on cards. SCPI Standard. Design environments for ATE systems. |
| Unit 7: Standard multiprocessor buses. | Systems on cards. Applications of standard buses. Classification. Types of connectors and cards. Multiprocessor systems. Common memory multiprocessor systems. Multiplexing. Bus arbiters. Arbiter techniques.<br><br>Asynchronous bus concept. Addressing. Data transfer. Interrupts. Electrical design of high speed buses. ECL and TTL signals. Backplane features. |
| Unit 8: The VME bus. | Introduction . Functional modules. Subbuses and signals. Data transfer. Types of arbitration. System controller. The interrupt chain. Commercial products. |
| Unit 9: Standards on programmable instrumentation. | Introduction to VXI and PXI buses. Subbuses and signals. Configurations. Types of devices. Products and systems of development. PCI Express and the switched instrumentation. Ethernet and its LXI version for instrumentation. The AXIEe for high features. |

| | |
|---|---|
| Practice 1: Introduction to the LabVIEW Application Development Environment | Introduction to LabVIEW environment by means of basic examples of programming. |
| Practice 2: Temperature sensors. NTC thermistor. | Signal conditioning and virtual instrument development for measurement |
| Practice 3: Optoelectronic sensors. PIN photodiode. | Spectral response analysis. |
| Practice 4: Capacitive sensors. Accelerometer. | Signal analysis and post-processing, and virtual instrument developing for tilt measurement. |
| Practice 5: Programmable Instrumentation I. | Frequency response test of two RC circuits via the programmable control of the laboratory instrumentation. The programmable control will realise through a USB connection from the PC to each instrument. |
| Practice 6: Programmable Instrumentation II. | To develop an application that verify the frequency response of a RC circuit by means of the programmable control of some of the instruments situated in a VXI chassis. The programmable control of each instrument from the PC will realise through a LAN connection and using a GPIB - Ethernet gateway . |

**Planning**

| | Class hours | Hours outside the classroom | Total hours |
|---|---|---|---|
| Introductory activities | 2 | 1 | 3 |
| Lecturing | 16 | 16 | 32 |
| Laboratory practical | 14 | 28 | 42 |
| Mentored work | 7 | 29 | 36 |
| Objective questions exam | 3 | 34 | 37 |

*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. Individual task. In these sessions, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be worked. |
| Lecturing | The lecturer will explain in the classroom the main contents of the subject. The students, individually, 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 CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be worked. |
| Laboratory practical | Small-group 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 lecturers office. In these practises, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be worked. |
| Mentored work | The students have to manage basic concepts to search and select information in order to get a deeper understanding in some specific fields related to the subject. This is a group activity. The lecturer will propose in the classroom the topic of this group task and monitor the students work in personalized attention sessions. In these sessions, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 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 website at the beginning of the term. In these sessions the lecturer will answer the students questions and also give instructions to guide the studying and learning process. |
| Laboratory practical | The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will help students understand the work to be developed in the laboratory (components, circuits, instrumentation and tools). |
| Mentored work | The students can attend tutoring sessions (individually or in a group). The timetable will be available on the subject website at the beginning of the term. In these sessions the lecturer will help students to deal with the monitored work. |

**Assessment**

| | Description | Qualification | Training and Learning Results |
|---|---|---|---|
| Laboratory practical | The lecturers will check the level of compliance of the students with the goals related to the laboratory skills. They will consider the work of the students carried out before the practical session to prepare the proposed tasks, the attendance, and the quality of the work done. Marks for each session (LSM: Laboratory Session Mark) will be assigned in a 10 points scale. Final mark of laboratory, FML, will be assessed in a 10 points scale. For the evaluation of these 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 CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be assessed. | 35 | B3 C42 D2 B4 C46 D3 B5 |
| Mentored work | The lecturers will consider the quality of results obtained, their presentation and analysis, and the quality of the final report. The tutored work mark, TWM, will be graded in a 10 points scale. For the evaluation of the project, the lecturer will assess the group work (the same mark for each member). In these works, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be evaluated. | 15 | B3 C42 D2 B4 C46 D3 B5 |
| Objective questions exam | The lecturers will check the level of compliance of the students with the goals related to the theory skills. Marks for each test will be assessed in a 10 points scale. Final mark of theory, FMT, will be assessed in a 10 points scale. In these tests, the skills CG3, CG4, CG5, CE42, CE46, CT2 and CT3 will be evaluated. | 50 | B3 C42 D2 B4 C46 D3 B5 |

## 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 scheme will be offered to the students.

When the students perform a short answer test or attend at least two laboratory sessions, **they will be assessed by continuous assessment.**

The subject comprises three different parts: theory (50 %), laboratory practical (35%) and tutored work (15%). The marks are valid only for the current academic course. The final grade for the students which have selected this option, may not be "no standing".

***1.a Theory***

Two partial testing (PT) are scheduled. The first exam will be performed after unit 5, in the usual weekly scheduling of the theoretical classes. The second exam will be performed during the examination period in the date specified in the academic calendar.The students cannot do the exams at a later date.

Each theory exam will be comprised short answer tests and long answer development. Marks for each theory exam (TEM) will be assessed in a 10 points scale. The classroom attendance (CA) during the academic course will be graded in a 1 point scale.

The final mark of each partial testing will be calculated by the expression:

$PT_i = \min( \{ 10; (1+0.1\cdot CA)\cdot TEM_i \} )$ i=1,2.

The final mark of theory (FMT), will be the arithmetic mean of the two parts:

FMT = (PT1 + PT2)/2

The minimum mark required to pass the theory is of 5 for each test (PTi>=5). If the minimum mark in the first test is not achieved (PT1 less than 5), the students can repeat this part in the same date of the second exam.

***1.b Laboratory***

Seven laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in small groups. This part also will be assessed by continuous assessment. Marks for each laboratory session (LSM) will be assessed in a 10 points scale.

The final mark of laboratory (FML) is calculated as the arithmetic mean of the individual laboratory session marks.

In order to pass the laboratory part the students can not miss more than one practical sessions and the minimum mark required is of 5 (FML>=5). These absences must be excused with a valid documented reason (medical, bereavement or other), otherwise FML=0.

***1.c Tutored work***

In the first session of C hours, lecturers will present the objectives and the schedule of the work. They also assign a specific work to each group. After that, the most important part of the workload will be developed outside the classroom hours. The lecturers will monitor the group work and the individual student work in the following sessions of C hours. The students will be duly informed by the lecturer about the deadline for the report submission.

The minimum mark required to pass this part is of 5, TWM (Tutored Work Mark) >=5, and the students are only allowed to miss one tutored work session. This absence must be excused with a valid documented reason (medical, bereavement or other), otherwise TWM=0.

**2. Single 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 continuously assessed students): theory exam, practical exam and tutored work. Dates will be specified in the academic calendar. In order to attend the practical exam and to assign the tutored work, the students have to contact to the lecturer according to an established procedure. The procedure will be published in advance.

The theory exam will be comprised two exams (PT) each one with short answer tests and long answer development. Marks for each test will be assessed in a 10 points scale. The final mark of theory (FMT) is calculated as the arithmetic mean of the individual marks:

FMT = (PT1 + PT2)/2

The practical exam will include the implementation of electronic circuits developed in the laboratory sessions as well as some short answer questions related to these sessions. The practical exam will be assessed in a 10 points scale and this mark will be the final mark of laboratory (FML).

The student will also do a tutored work and prepare a written report to be handed in just before the exam.

**3. Final mark of the subject**

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

- theory: FMT>=5 with PT1>=5 and PT2>=5
- and laboratory: FML>=5
- and tutored work: TWM>=5

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

FM = 0.5·FMT + 0.3·FML + 0.15·TWM

However, when the students do not pass all parts, the final mark will be:

FM = min( { 4.5; 0.5·FMT + 0.3·FML + 0.15·TWM } )

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

**4. Second opportunity and extraordinary call**

The assessment policy in these calls will follow the scheme described in the single assessment: a theory exam, a practical exam and a tutored work. Dates will be specified in the academic calendar. In order to attend the practical exam and to assign the tutored work, the students have to contact to the lecturer according to an established procedure. The procedure will be published in advance.

The marks obtained during the current academic year in the first opportunity are kept in the second one for those parts in which the student has not attended. Moreover, in the second opportunity, the students can not take an exam or a tutored work task if they have got a pass previously in the first opportunity.

The final mark will be calculated as it has described in section 3.

---

**Sources of information**

**Basic Bibliography**

Black, J. (editor), **The system engineering handbook: a guide to building VME bus and VXI bus Systems**, Academic Press, 1992

Mariño, P., **Las comunicaciones en la empresa: normas, redes y servicios**, 2ª ed., RAMA, 2002

Norton, H., **Sensores y analizadores**, Gustavo Gili D.L., 1984

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

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

**Complementary Bibliography**

del Río Fernández, J., Shariat-Panahi, S., Sarriá Gandul, S., y Lázaro, A.M., **LabVIEW: Programación para Sistemas de Instrumentación**, 1ª ed., Editorial Garceta, 2011

## Recommendations

### Subjects that are recommended to be taken simultaneously

Programmable Electronic Circuits/V05G301V01302

Analogue Electronics/V05G301V01311

Data Acquisition Systems/V05G301V01314

## Contingency plan

### Description

In case of exclusively online teaching, then the planning will be as follows:

*The teaching in groups A, B and C will be taught through classrooms on the Remote Campus.

*In A sessions, the same content described in the guide will be developed. The tasks in B sessions will try to adapt, as far as possible, to be able to be carried out with simulators; and in C sessions, the students will carry out a work assigned by the teacher.

In case of exclusively online teaching, the evaluation will be as follows:

*The objective tests will be carried out synchronously in classrooms of the Remote Campus.