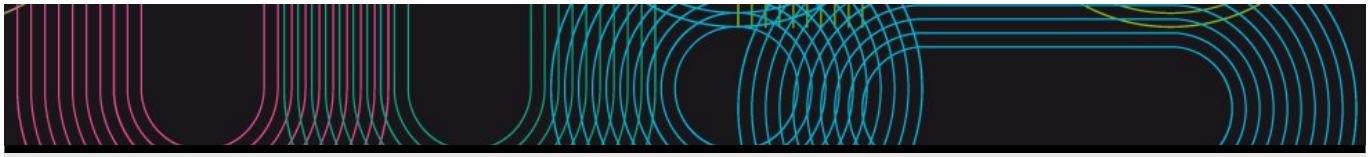

IDENTIFYING DATA				
Advanced Electronic Sensors				
Subject	Advanced Electronic Sensors			
Code	V05G300V01924			
Study programme	(*)Grao en Enxeñaría de Tecnoloxías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish			
Department				
Coordinator	Mariño Espiñeira, Perfecto			
Lecturers	Costas Pérez, Lucía Mariño Espiñeira, Perfecto Pastoriza Santos, Vicente			
E-mail	pmarino@uvigo.es			
Web	http://faitic.uvigo.es			
General description	The main purpose of this subject is to train students in order that they become well-qualified to understand the physical principles and current techniques employed in the most recent electronic sensors technology. Course outline: + Optical fiber sensors. + Laser sensors. + Microelectromechanical sensors (MEMS). + Image sensors. + Integrated sensors. + Intelligent sensors. + Acoustic wave sensors. + Biosensores. The main goal of the laboratory sessions (practical work) is to enable the students to acquire sufficient understanding and knowledge to: Analyze the parameters and main features of the sensors. Know the applications of each group of sensors. Manage specific software tools developed to design (virtual) instruments that allow store, display and analyze recorded data. The documentation of the course will be in English. It will be taught and assessed in Spanish.			

Competencies	
Code	
A3	CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations
A4	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.
A9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.
A72	(CE63/OP6) The ability to design and use optoelectronic sensors, micromechanical sensors (MEMS) and acoustic wave sensors.

Learning aims	
Expected results from this subject	Training and Learning Results

Knowledge of the modes of operation and applications of fiber optic sensors.	A3 A72
Knowledge of the modes of operation and applications of microelectromechanical sensors.	A3 A72
Knowledge of the modes of operation and applications of acoustic wave sensors.	A3 A72
Ability to select and work with next generation electronic sensors.	A4 A72
Ability to work in groups and to develop communications skills in order to elaborate and present technical reports related to the subject.	A9 A72

Contents

Topic	
Unit 1: Fiber Optic Sensors I.	Introduction. Classification. FOS types. Basic structure. Extrinsic, intrinsic and evanescent wave sensors. Applications. Interferometric FOS. Applications.
Unit 2: Fiber Optic Sensors II.	Multisensory FOS systems. Distributed and multiplexed FOS. OTDR reflectometry. OFDR reflectrometry. Fiber Bragg grating. Applications. Intelligent systems. Laser vibrometry and interferometry. Applications.
Unit 3: Integrated Optical Sensors.	Introduction. Classification of optical integrated waveguides. Materials. Devices. Interferometry in IO. Active integrated optic devices; detectors and sources. Sensors. Biosensors. OF-IO Coupling. Applications.
Unit 4: Microelectromechanical Sensors (MEMS).	Microelectronic technologies. MEMS fabrication processes. MEMS materials. MEMS Sensors. Micromachined free space integrated micro optics. CMOS Microsensors. Applications.
Unit 5: Image Sensors and Displays I.	Introduction. Display specifications. Display classification. Illumination technologies. Image capture technology: CCD and CMOS. Night vision technology: PMTs y IR cameras.
Unit 6: Image Sensors and Displays II.	Introduction to pyrometry. Operating principle General features. Disappearing filament pyrometer. Conditioning. Bolometric detector. Quantum detectors. Radiometers. IR cameras. Applications.
Unit 7: Acoustic Wave Sensors (AWS).	Classification. Materials features. Comparative study of AWS sensors. Applications. FPW microsensor. FPW integrated systems. Coatings for AWS. Pattern recognition in electronic nose.
Unit 8: Intelligent Sensors.	Definition. Classification. Architectures. Multisensorial systems. International standars. Applications.
Unit 9: Virtual Reality Sensors.	Introduction. Tactile response systems. RV features. Architectures. Neuronal processes. Mechanoreceptors. Projective field. Visual tactile synesthesia. Visual immersion systems. UAV (Unmanned Aerial Vehicle) systems.
Unit 10: Sensor Technology in Particle Physics.	Introduction. Specific instrumentation standars: CAMAC, FASTBUS and SCI. The standard model. Features of the standard model. Beta decay. Evolution of particle accelerators. Particle Detectors in accelerators. Nuclear medicine applications.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	2	3
Master Session	17	17	34
Tutored works	3	26	29
Laboratory practises	12	30	42
Integrated methodologies	7	25	32
Practical tests, real task execution and / or simulated.	2	8	10

*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 sesions, the skills A3, A4, A72, and A9 will be worked.
Master Session	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 sesions, the skills A3, A4, A72, and A9 will be worked.

Tutored works	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. The lecturer will propose in the classroom the topic of this individual task and monitor the student□s work in personalized attention sessions. In these sesions, the skills A3, A4, A72, and A9 will be worked.
Laboratory practises	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. In these sesions, the skills A3, A4, A72, and A9 will be worked.
Integrated methodologies	Project-based learning: students have to develop a group activity that 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 assessment will be based on the quality of the proposed solution, the depth of content understanding demonstrated and the final presentation. The sessions will be performed in the laboratory. In these sesions, the skills A3, A4, A72, and A9 will be worked.

Personalized attention

Methodologies	Description
Master Session	Master session: The students can go to the lecturer□s office (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 practises: The students can go to the lecturer□s office (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). Tutored works: The students can go to the lecturer□s office (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. Integrated methodologies: The lecturers will be available to help students in order to deal with the contents of the subject, the laboratory practices as well as the monitored work. The students can go to the lecturer□s office (individually or in a group). The timetable will be available on the subject website at the beginning of the term.
Laboratory practises	Master session: The students can go to the lecturer□s office (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 practises: The students can go to the lecturer□s office (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). Tutored works: The students can go to the lecturer□s office (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. Integrated methodologies: The lecturers will be available to help students in order to deal with the contents of the subject, the laboratory practices as well as the monitored work. The students can go to the lecturer□s office (individually or in a group). The timetable will be available on the subject website at the beginning of the term.
Tutored works	Master session: The students can go to the lecturer□s office (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 practises: The students can go to the lecturer□s office (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). Tutored works: The students can go to the lecturer□s office (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. Integrated methodologies: The lecturers will be available to help students in order to deal with the contents of the subject, the laboratory practices as well as the monitored work. The students can go to the lecturer□s office (individually or in a group). The timetable will be available on the subject website at the beginning of the term.

Integrated methodologies	Master session: The students can go to the lecturer□s office (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 practises: The students can go to the lecturer□s office (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). Tutored works: The students can go to the lecturer□s office (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. Integrated methodologies: The lecturers will be available to help students in order to deal with the contents of the subject, the laboratory practices as well as the monitored work. The students can go to the lecturer□s office (individually or in a group). The timetable will be available on the subject website at the beginning of the term.

Assessment

	Description	Qualification
Tutored works	The lecturers will consider the results, the presentation, the analysis and the quality of the final report. Marks will be assigned in a 10 points scale. In these works, the skills A3, A4, A72, and A9 will be evaluated.	50
Laboratory practises	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 laboratory session to prepare the proposed tasks and the work in the laboratory. Marks for each session (LSM: Laboratory Session Mark) will be assigned in a 10 points scale. In these practices, the skills A3, A4, A72, and A9 will be assessed.	30
Practical tests, real task execution and / or simulated.	The lecturers will consider the results and the quality of their analysis. Marks will be (GPM: Group Project Mark) assigned in a 10 points scale. In these tasks, the skills A3, A4, A72, and A9 will be evaluated.	20

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 go to the lectures regularly (less than 10% unjustified absence) or miss at most one laboratory session, they will be assessed by continuous assessment.

The subject comprises three different parts: theory (50 %), laboratory (30%) and group project (20%). Once a task has been assessed, the students cannot do/repeat the task at a later date. The marks are valid only for the current academic course.

1.a Theory

In the first weeks of the course each student will be asked to carry out a task individually with the help of the lecturer about a topic related to the subject. In order to assess the task, the lecturer will consider the results, the presentation, the analysis and the quality of the final report. The students will be informed of the deadline by the lecturer. Marks will be (TWM: Tutored Work Mark) assigned in a 10 points scale. If the students present their works after the deadline the WM will be 0.

The final mark of this part will be:

FMT (Final Mark of Theory) = TWM (Tutored Work Mark)

The minimum mark required to pass this part is of 5 (FMT>=5).

1.b Laboratory

Six 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.

Each session will be only evaluated according to the developed work at the schedule date. The lecturers will consider the work of the students carried out before the laboratory session to prepare the proposed tasks, the work in the laboratory to deal with them as well as the student□s behavior. Marks for each session will be (LSM: Laboratory Session Mark) assigned in a 10 points scale. A mark of 0 will be obtained for missing sessions.

The final mark of this part is calculated as the arithmetic mean of the six individual marks:

FML (Final Mark of Laboratory) = Sum(LSMi)/6; i = 1, 2, □, 6

Attendance at the laboratory classes is compulsory. If the student miss more than one laboratory session without a valid documented reason (medical, bereavement or other) he/she will be assigned a grade of 0 for that laboratory class.

1.c Group project

In the first session lecturers will present the objectives and the schedule of the project. They also assign a specific project to each group. After that, the most important part of the workload will be developed in the laboratory. Two hours of B laboratory sessions and six hours of C laboratory sessions.

In order to assess the project, the lecturer will consider the results and the quality of their analysis. Marks will be (GPM: Group Project Mark) assigned in a 10 points scale.

The students are only allowed to miss one project session without a valid documented reason.

1.d Final mark of the subject

In order to past the subject, students will be required:

+ to obtain FMT >=5, and

+ no more than one missed laboratory session, and

+ no more than one missed group project session.

The weighted *points* from all assessed parts are added together to calculate the final *mark (FM)*. The following weightings will be applied: 50% theory, 30% laboratory and 20% group project.

FM = 0,50·FMT + 0,30·FML + 0,20·GPM

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

However, when:

+ FMT < 5, or

+ more than one missed laboratory session, or

+ or more than one missed group project session,

the final mark (FM) will be the minimum value among them.

FM = min{ FMT, FML, GPM }

2. Final Exam

If a student prefers a different educational policy he/she can take an exam on a scheduled *date*. The date will be specified in the academic calendar. This exam will comprise four parts (similar to the activities completed by the continuously assessed students):

+ an **exam** if they didn□t go to the lectures regularly (more than 10% unjustified absence).

+ a **task monitored by a tutor**, (tutored work)

+ a **practical exam carried out in the laboratory** if they have missed more than one laboratory session.

+ a previously assigned **project**.

The tutored work and the project will be assigned following the procedure described in advance by the lecturer. The student will prepare a writing report to be handed in just before the exam.

2.a Theory

2.a.1 Theory Exam

In order to pass the theory, the student cannot miss more than 10 % of the lectures without a valid documented reason (medical, bereavement or other). Otherwise, he/she will have to attend to an exam (with short or long answer questions). Marks will be (EM: Exam Mark) assigned in a 10 points scale.

2.a.2 Tutored Work

To evaluate the tutored work the lecturer will consider the results, the presentation, the analysis and the quality of the final report. Marks will be (TWM: Tutored Work Mark) assigned in a 10 points scale.

2.a.3 Theory Final Mark

The final mark of theory (FMT) will be:

FMT = TWM (Tutored Work Mark) if the student don□t miss more than 10 % of the lectures**.**

FMT = EM (Exam Mark) if the student miss more than 10 % of the lectures and MTM >= 5.

FMT = 0 in any other case.

2.b Laboratory

In order to pass the laboratory part, the student cannot miss more than one laboratory session lectures without a valid documented reason (medical, bereavement or other**). Otherwise,**he/she will have to attend to a practical exam carried out in the laboratory. In this exam the student will be asked to deal with some of the electronic circuits developed in the laboratory sessions as well as some short answer questions related to these sessions. Marks will be (LEM: Laboratory Exam Mark) assigned in a 10 points scale.

The final mark of laboratory (FML) will be:

FML = the arithmetic mean of the laboratory session marks (LSM) when the student didn□t miss more than one laboratory session, that is:

FML = Sum(LSMi)/6 i = 1, 2, □, 6

FML = LEM (Laboratory Exam Mark) when the student missed more than one laboratory session.

LFM = 0 in any other case.

2.c Project

In order to assess the project, the lecturer will consider the results and the quality of their analysis. Marks will be (GPM: Group Project Mark) assigned in a 10 points scale.

2.d Final mark

In order to pass the subject, it is mandatory:

+ FMT >= 5, and

+ no more than one missed laboratory session or FML >= 5, and

+ no more than one missed group project session or GPM >= 5.

The final mark will be the weighted average of the marks obtained by the student in the different parts. The final mark (FM) will apply a weight of 50% to the final theory mark (FMT), a 30% to the laboratory final mark (FML) and a 20 % to the group project mark (GPM).

FM = 0,50·FMT + 0,30·FML + 0,20·GPM

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

However, when:

+ FMT < 5, or

+ FML < 5 and the student missed more than one laboratory session, or

+ GPM < 5 and the student missed more than one group project session,

the final mark will be the minimum value among them.

FM = min{ FMT, FML, GPM }

3. Second opportunity to pass the subject.

The assessment policy in this call will follow the scheme described in the previous section. 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.

Marks obtained in the previous continuous assessment or final exam are kept if the student have got a pass in some parts. Moreover, students cannot take an exam, develop a project or a tutored work task if they have got a pass previously.

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

Sources of information

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

Pallás Areny, R., **Sensores y Acondicionadores de Señal**, 4ª,

Norton, H.N., **Sensores y analizadores**,

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

Martín Fernández, A., **Instrumentación electrónica. Transductores y acondicionadores de señal y sistemas de adquisición de datos**,

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

Recommendations

Subjects that it is recommended to have taken before

Analogue Electronics/V05G300V01624
Electronic Instrumentation and Sensors/V05G300V01621
Data Acquisition Systems/V05G300V01521