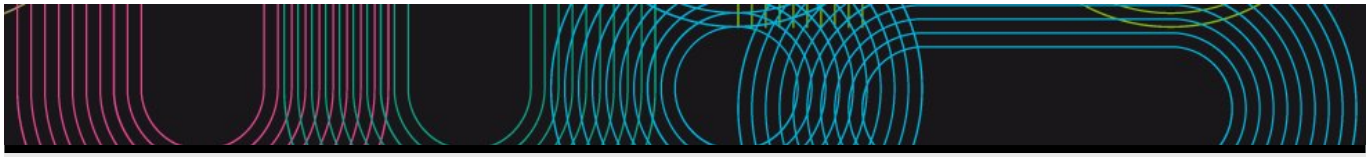

IDENTIFYING DATA				
Advanced electronic sensors				
Subject	Advanced electronic sensors			
Code	V05G300V01924			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish Galician			
Department	Electronics Technology			
Coordinator	Mariño Espiñeira, Perfecto			
Lecturers	Cao Paz, Ana María 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 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.
B9	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.
C63	(CE63/OP6) The ability to design and use optoelectronic sensors, micromechanical sensors (MEMS) and acoustic wave sensors.
D4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Knowledge of the modes of operation and applications of fiber optic sensors.	B3	C63	
Knowledge of the modes of operation and applications of microelectromechanical sensors.	B3	C63	
Knowledge of the modes of operation and applications of acoustic wave sensors.	B3	C63	
Ability to select and work with next generation electronic sensors.	B4	C63	
Ability to work in groups and to develop communications skills in order to elaborate and present technical reports related to the subject.	B9	C63	D4

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: 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 9: 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	1	2
Lecturing	17	8	25
Supervised work	3	12	15
Laboratory practices	12	58	70
Studies excursion	2	0	2
Project based learning	7	29	36
*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, CG9, CE63, and CT4 will be developed.
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, CG9, CE63, and CT4 will be developed.

Supervised 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. 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 sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.
Laboratory practices	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 lecturer's office. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.
Studies excursion	Large-group activities designed to apply, contrast and observe the knowledge within a particular context in an outdoor space. The student will acquire more knowledge about a specific type of sensors through a guided visit to a site where these sensors are being used. In these sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.
Project based learning	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 sessions, the skills CG3, CG4, CG9, CE63, and CT4 will be developed.

Personalized attention

Methodologies	Description
Lecturing	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 practices	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).
Supervised 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. In these sessions the lecturer will help students to deal with the monitored work.
Project based learning	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. 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.

Assessment

	Description	Qualification	Training and Learning Results
Supervised work	The lecturers will consider the quality of the results obtained, their analysis, the final report, and the classroom presentation. Marks will be assigned in a 10 points scale. In these works, the skills CG3, CG4, CG9, CE63, and CT4 will be evaluated.	50	B3 C63 D4 B4 B9
Laboratory practices	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, the attendance, and the quality of the work done. The mark for this part (FML: Final Mark of Laboratory) will be graded in a 10 points scale. In these practices, the skills CG3, CG4, CG9, CE63, and CT4 will be assessed.	30	B3 C63 D4 B4 B9
Project based learning	The lecturers will consider the quality of the results obtained, their analysis, and the classroom presentation. Marks will be (GPM: Group Project Mark) assigned in a 10 points scale. In these tasks, the skills CG3, CG4, CG9, CE63, and CT4 will be evaluated.	20	B3 C63 D4 B4 B9

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 B laboratory

session, or miss at most one C laboratory session, ***they will be assessed by continuous assessment.*** An attendance register shall be laid open for signature by students at each session.

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. The final grade for the students which have selected this option, may not be "no standing".

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 quality of the results obtained, their analysis, the final report, and the classroom presentation. 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)

It is compulsory to get a score of FMT >= 5 and to have attended a lectures regularly (less than 10% unjustified absence) to pass this part by continuous assessment.

1.b Laboratory

Six laboratory sessions and one outdoor study are scheduled. Each laboratory session lasts approximately 120 minutes and the students will work in pairs.

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 laboratory attendance, as well as the student work in the laboratory.

In the first session, the practice 1 will be performed. The mark of this session (P1M: Practice 1 Mark) will be assigned in a 10 points scale.

In the remaining sessions, a laboratory work related to process control modules available in laboratory will be carried out. In order to assess this work, the lecturer will consider the quality of the results obtained, their analysis, and the classroom presentation. The final mark of this part, (LWM: Laboratory Work Mark) , will be graded in a 10 points scale.

The outdoor study will be also assessed in a 10 points scale (OSM: Outdoor Study Mark).

The final mark of this part is calculated as the weighted sum of the three individual marks:

FML (Final Mark of Laboratory) = 0.15·P1M + 0.75·LWM + 0.10·OSM

Attendance at the laboratory classes is compulsory to pass this part by continuous assessment. 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 the laboratory part (FML=0).

1.c Group project

The classroom workload will be carried out in the C laboratory sessions. In the first session lecturers will present the objectives and the schedule of the project. They also assign a specific project to each group. In this sessions the lecturer will monitor the group work and the individual student work.

In order to assess the project, the lecturer will consider the quality of the results obtained, their classroom presentation and analysis, and the quality of the final report. The students will be duly informed of the report deadline by the lecturer. The final mark of this part, (GPM: Group Project Mark) , will be assessed in a 10 points scale.

In order to pass this part by continuous assessment, the student can not miss more than one project sessions and only if this absence is duly justified.

1.d Final mark of the subject

In order to past the subject by continuous assessment, 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

+ more than one missed group project session,

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

FM = min{ FMT, FML, GPM }

2. Single assessment

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.

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 = 0.15·P1M(Practice 1 Mark) + 0.75·LWM(Laboratory Work Mark) + 0.10·OSM(Outdoor Study Mark) when the student did no't miss more than one laboratory session,

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 quality of the results obtained, their analysis, and the classroom presentation. 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 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 *pass the 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 and extraordinary call

The assessment policy in these calls will follow the scheme described in the continuous assessment. 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 or single assessment 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.

4. Others

The subject will be taught in Galician and Spanish. It will be assessed in Spanish.

Sources of information
Basic Bibliography
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**, 1ª ed., Ediciones Paraninfo, S.A., 2014
Pallás Areny, R., **Sensores y Acondicionadores de Señal**, 4ª ed., Marcombo D.L., 2003
Norton, H.N., **Sensores y analizadores**, Gustavo Gili D.L., 1984
Fraile Mora, J., García Gutiérrez, P., y Fraile Ardanuy, J., **Instrumentación aplicada a la ingeniería**, 3ª ed., Editorial Garceta, 2013
Martín Fernández, A., **Instrumentación electrónica. Transductores y acondicionadores de señal y sistemas de adquisición de datos**, 2ª ed., Dpto. de publicaciones de la E.U.I.T.T. de Madrid,, 1990
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 it is recommended to have taken before

Digital Electronics/V05G300V01402
Electronic Technology/V05G300V01401
Programmable Electronic Circuits/V05G300V01502
Microelectronics Design/V05G300V01622
Analogue Electronics/V05G300V01624
Power Electronics/V05G300V01625
Engineering of Electronic Equipment/V05G300V01523
Electronic Instrumentation and Sensors/V05G300V01621
Data Acquisition Systems/V05G300V01521
Electronic Systems for Signal Processing/V05G300V01522
Electronic Systems for Digital Communications/V05G300V01623

Other comments

It recommends to have passed the following subjects:
+ Electronic Technology/V05G300V01401
+ Digital Electronics/V05G300V01402
+ Analogue Electronics/V05G300V01624
+ Data Acquisition Systems/V05G300V01521
+ Electronic Instrumentation and Sensors/V05G300V01621