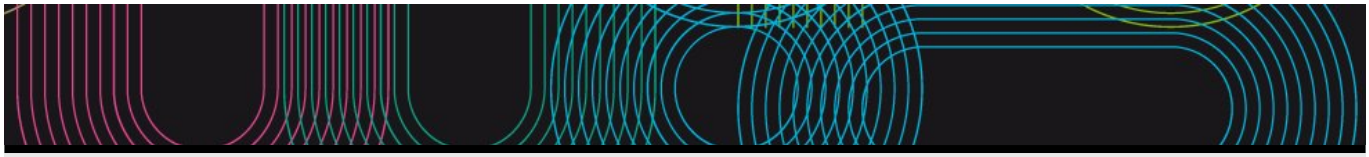

IDENTIFYING DATA				
Intelligent Sensors				
Subject	Intelligent Sensors			
Code	V05M145V01319			
Study programme	Telecommunication Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Mariño Espiñeira, Perfecto			
Lecturers	Machado Domínguez, Fernando Mariño Espiñeira, Perfecto Pastoriza Santos, Vicente			
E-mail	pmarino@uvigo.es			
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General description	The main purpose of this subject is to form to the student in the design and characterisation of the electronic instrumentation systems based on smart sensors in wired or wireless topologies. The main contents are ordered as follows: + Analysis of the main architectures of smart multi-sensor networks, with the aim of covering different fields of application. + Review of the standards applied by the microelectronic manufacturers to the design of advanced smart sensors. + Analysis and design of energy harvesting smart sensors systems. + Software tools and hardware platforms for designing smart sensor systems. + Wired interconnection standards in different fields application areas: home automation, building automation, vehicular technologies, industrial plants, robotics, and autonomous vehicles of land, sea, air and space. + Wireless networks standards in the different application areas: home automation, building automation, vehicular technologies, industrial plants, robotics, and autonomous vehicles of land, sea, air and space. The main objective of the practical part of the subject is that the student acquire the fundamentals for a correct handling of the software tools and the hardware platforms for designing smart sensor systems. The student, at the end of the course, must be able to distinguish and characterize the different components of the smart sensor systems (wired or wireless), and to have practical skills in assembling and measurement.			

Competencies	
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
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C36	CE43/OP13 Ability to characterize intelligent sensors and their specific characteristics in networks

Learning outcomes	
Expected results from this subject	Training and Learning Results
Know the different structures of the intelligent sensors.	A5 B8 C36
Know the topologies and architectures of the sensor networks.	A5 B8 C36

Know analyse and design systems of efficient sensors in consumption.	A4 B8 C36
Know software tools and hardware platforms for the design of sensor systems.	A5 B8 C36
Design applications based on data fusion of different sensors.	A4 B8 C36

Contents	
Topic	
Unit 1: Smart Sensors.	Definition. Classification. Architectures. Multisensorial systems. International standards. Applications.
Unit 2: Wired topologies.	General features. Classification. Practical examples: PROFIBUS and CAN. Intelligent Transportation Systems (ITS). Embedded buses for automotive applications: LIN, MOST, FLEXRAY, JSAE 1939 and others. Standard IEEE 1451 for smart sensors. Development tools.
Unit 3: Wireless topologies.	The ISM bands. Basic features of wireless networks. Multiplexing and modulation. The SDR concept. Standards for WLAN and WPAN. IEEE standards 802.15.1/4/3. Wireless sensor networks (WSNs). Other commercial networks.
Laboratory	
Unit 1. Wired smart sensors systems.	Analysis and test of smart sensors.
Unit 2. Wireless smart sensors systems.	Design, implementation and test of a wireless sensor network.
Unit 3. Project: Design and implementation of an electronic instrumentation system with smart sensors.	Design, implementation and test of an electronic instrumentation system with smart sensors, applying theoretical and practical concepts.

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	5	10	15
Laboratory practises	6	12	18
Integrated methodologies	13	65	78
Jobs and projects	1	13	14
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
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 sessions, the skills CB4, CB5, CG8, and CE43 will be developed.
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 sessions, the skills CB4, CB5, CG8, and CE43 will be developed.
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 sessions, the skills CB4, CB5, CG8, and CE43 will be developed.

Personalized attention	
Methodologies	**Description**
Master Session	The students can go to the lecturer s office (individually or in a group). The timetable will be available on the school 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 school 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).
Integrated methodologies	The students can go to the lecturer's office (individually or in a group). The timetable will be available on the school 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
Laboratory practises	The lecturers will check the level of compliance of the students with the goals related to the laboratory skills. The final mark of laboratory (FML) 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 personalized questions for each session. In these practices, the skills CB4, CB5, CG8 and CE43 will be assessed.	40	A4 B8 C36 A5
Jobs and projects	The lecturers will consider the quality of the results obtained, their presentation and analysis, and the written final report. The final mark of the project (FMP) will be assessed in a 10 points scale. For the evaluation of the project, the lecturer will assess the group work (the same mark for each member) and the individual oral presentation of the developed project. The skills CB4, CB5, CG8 and CE43 will be evaluated in these projects.	60	A4 B8 C36 A5

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 attend at least one session of theory, laboratory or project, they will be assessed by continuous assessment.

The subject comprises three different parts: theory (0% but compulsory attendance), laboratory (40%), and project (60%). Once a task has been assessed, the students can not do/repeat the task at a later date. The marks are valid only for the current academic course.

1.a Theory

Attendance at the theory classes is compulsory. In order to pass the theory part, the student cannot miss more than one theory session lectures and only if this absence is duly justified.

1.b Laboratory

Three laboratory sessions are scheduled. Each session lasts approximately 120 minutes and the students will work in pairs (whenever possible). 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 lecturer 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 behaviour.

Marks for each laboratory session (LSM) will be assessed in a 10 points scale. A mark of 0 will be obtained for missing sessions. In order to pass the laboratory part the students can not miss more than one laboratory sessions and only if this absence is duly justified. The final mark of laboratory (FML) is calculated as the arithmetic mean of the individual laboratory session marks:

FML = (LSM1 + LSM2 + LSM3)/31.c Project

In the first session lecturer will present the objectives and the schedule of the project. They also assign a specific project to each group (two students per project whenever possible). After that, the most important part of the workload will be developed in the laboratory: two laboratory sessions (B hours) and the project sessions (C hours).

In order to assess the project, the lecturer will consider the results, their analysis and presentation, and the quality of the written report. The final mark of project (FMP) will be assessed in a 10 points scale. The

minimum mark required to pass this part is of 5 (FMP>=5). The students are only allowed to miss one project session and only if this absence is duly justified.

1.d 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: 40% laboratory (FML) and 60% project (FMP).

In order to pass the subject, students will be required to pass the theory, laboratory and project parts. In this case the final mark (FM) will be:

$$FM = 0.4 \cdot FML + 0.6\ FMP$$

However, when the students do not pass both parts (FML < 5 or FMP < 5), or miss more than 1 theory sessions, or more than 1 laboratory sessions, or miss more than 1 project sessions, the final mark will be:

$$FM = 0.4 \cdot NB + 0.6 \cdot NC \text{ , where:}$$

$$NB = \min(\{4.5; FML\})$$

$$NC = \min(\{4.5; FMP\})$$

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

2. Final Exam

The students who prefer a different educational policy can attend an exam on a scheduled date. The date will be specified in the academic calendar. This exam will comprise three parts: theory exam, laboratory exam and project. The project will be assigned following the procedure described in advance by the lecturer. The student will prepare a written report to be handed in just before the exam. The final project must be presented within one week of delivery of reports.

In order to pass the theory, the student will have to attend to an exam with test questions and/or sort answer questions. The theory exam will be assessed in a 10 points scale and and the final mark of theory (FMT) will be the obtained mark.

In the laboratory 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. The laboratory exam will be assessed in a 10 points scale and the final mark of laboratory (FML) will be the obtained mark.

In order to assess the project, the lecturer will consider the results, their analysis and presentation, and the quality of the written report. The project will be assessed in a 10 points scale and the the final mark of project (FMP) will be the obtained mark.

In order to pass the subject, students will be required to pass each part (FMT>=5, FML>=5 and FMP>=5). In this case the final mark (FM) will be:

$$FM = 0.2 \cdot FMT + 0.2 \cdot FML + 0.6\ FMP$$

However, when the students do not pass all parts (FMT < 5 or FML < 5 orFMP < 5), the final mark will be:

$$FM = 0.2 \cdot NA + 0.4 \cdot NB + 0.6 \cdot NC \text{ , where:}$$

$$NA = \min(\{5; FMT\})$$

$$NB = \min(\{5; FML\})$$

$$NC = \min(\{5; FMP\})$$

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

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. This exam consist on a theory exam, a laboratory exam and a project. In order to attend the laboratory exam and to assign the project, the students have to contact to the lecturer according to an established procedure. The procedure will be published in advance.

The marks obtained in the previous continuous assessment or final exam are kept for those parts in which the student has not attended. The final mark will be calculated as it has described in:

- section 1 to students with the theory part passed in continuous assessment.
- section 2 for all other case.

Sources of information
Faludi, R., **Building wireless sensor networks.**, 2011,
Fraden, J., **Handbook of modern sensors**, 4º, 2010,
Gómez, C., Paradells, J. y Caballero, J.E., **Sensores en todas partes; tecnologías y soluciones de redes inalámbricas**, 2010,
Mariño-Espiñeira, P., **Las comunicaciones en la empresa; normas, redes y servicios**, 2º, 2003,
Misra, S., Woungang, I. & Chandra, S., **Guide to Wireless sensor networks**, 2009,
Oliva-Alonso, N (coordinadora), **Redes de comunicaciones industriales**, 2013,
Parallax Inc., **Sensores inteligentes y sus aplicaciones; guía del estudiante**, 2006,
Pérez-Fontán, F. y Mariño-Espiñeira, P., **Modeling the wireless propagation channel. a simulation approach with Matlab**, 2008,
Ripka, P. & Tipek, A., **Modern sensors handbook**, 2007,
Wilson, J (editor), **Sensor technology handbook**, 2005,

Recommendations