Universida_{de}Vigo

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
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General description	The overall objective of this course is to provide the theoretical and practical skills for the design and characterization of the electronic instrumentation systems based on smart sensors in wired or wireless topologies. To achieve this, the main intelligent sensors structures, the sensor networks architectures and topologies, the energy harvesting smart sensors systems and the software tools and hardware platforms for designing smart multi-sensor systems will be studied.

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 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. Standard IEEE 1451 for smart sensors. Applications: Internet of Things, Industry 4.0, Machine Learning.
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. 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	4	4	8
Tutored works	1	18.5	19.5
Laboratory practises	7.5	15	22.5
Integrated methodologies	12.5	62.5	75

*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.
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 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. 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 project as well as the monitored work.

	Tutored works	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 to deal with the monitored work.

Assessment

	Description	Qualification	Training and Learning Results
Tutored works	The lecturers will consider the quality of the results obtained, their analysis, the final report, and the classroom presentation. The tutored work mark (TWM) will be assessed in a 10 points scale. In these works, the skills CB4, CB5, CG8 and CE43 will be evaluated.	20	A4 B8 C36 A5
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.	20	A4 B8 C36 A5
Integrated methodologies	The lecturers will consider the quality of the results obtained, their presentation and analysis, and the final oral presentation. 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 master and the agreements of the academic commission, a continuous assessment learning scheme will be offered to the students.

In order to **be assessed by continuous assessment**, the student cannot miss more than one theory session, more than one laboratory session and more than one project session; and only if this absence is duly justified.

The subject comprises three different parts: theory (20%), laboratory (20%) 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 and only if this absence is duly justified.

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 work, the lecturer will consider the results, their analysis and presentation, and the quality of the written report. The students will be informed of the deadline by the lecturer. The tutored work mark (TWM) will be assessed in a 10 points scale. If the students present their works after the deadline the TWM will be 0.

The final mark of theory (FMT) will be: FMT = TWM.

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

1.b Laboratory

Three laboratory sessions are scheduled. Each session lasts approximately 150 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 behavior.

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)/3

1.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: one laboratory session (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 final oral presentation. 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: 20% theory (FMT), 20% 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:

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

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

$$FM = \min\{4 \ ; \ (0.2 \cdot FMT + 0.2 \cdot FML + 0.6 \ FMP)\}.$$

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 student will prepare a written project 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 assign the project, the student has to contact to the lecturer at least four weeks before the exam.

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:

$$FM = \min\{4 \ ; \ (0.2 \cdot FMT + 0.2 \cdot FML + 0.6 \ FMP)\}.$$

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. The student will prepare a written project 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 assign the project, the student has to contact to the lecturer at least four weeks before the exam.

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

Basic Bibliography

Fraden, J., **Handbook of modern sensors**, 5th, Springer, 2016

Gómez, C., Paradells, J. y Caballero, J.E., **Sensors Everywhere: Wireless Network Technologies and Solutions**, Fundación Vodafone España, 2010

Misra, S., Woungang, I. & Chandra, S., **Guide to Wireless sensor networks**, Springer, 2009

Slama, D., Puhlmann, F., Morrish, J. and Bhatnagar R.M, **Enterprise IoT: Strategies and Best Practices for Connected Products and Services**, O'Reilly, 2016

Rogers, L. a& Stanford-Clark, A, **Wiring the IoT: Connecting Hardware with Raspberry Pi, Node-Red, and MQTT**, O'Reilly, Upcomming

Complementary Bibliography

Mariño-Espiñeira, P., **Las comunicaciones en la empresa; normas, redes y servicios**, 2ª, RAMA, 2006

Faludi, R., **Building wireless sensor networks.**, O´Reilly, 2011

Parallax Inc., **Smart Sensors and Applications**, 3rd, Parallax Inc., 2006

Recommendations