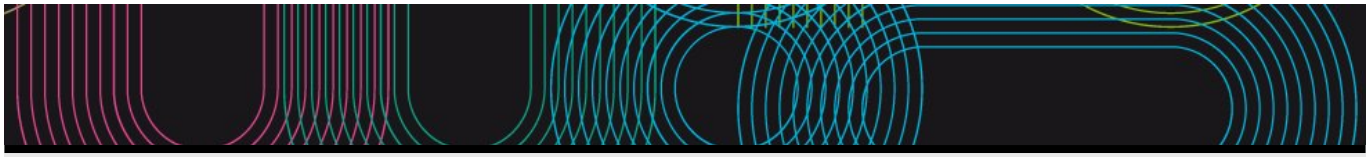

IDENTIFYING DATA				
Design of Industrial Electronic Systems				
Subject	Design of Industrial Electronic Systems			
Code	V04M141V01218			
Study programme	(*)Máster Universitario en Enxeñaría Industrial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	4.5	Optional	1st	2nd
Teaching language	#EnglishFriendly Spanish Galician English			
Department				
Coordinator	Nogueiras Meléndez, Andres Augusto			
Lecturers	Nogueiras Meléndez, Andres Augusto Pérez Estévez, Diego Soto Campos, Enrique			
E-mail	aaugusto@uvigo.gal			
Web	http://moovi.uvigo.gal/			
General description	The objective of this course is to provide the theoretical and practical fundamental knowledge needed to design, select and implement industrial electronic systems. English Friendly subject: International students may request from the professors: a) materials and bibliographic references in English, b) tutoring sessions in English, and c) exams and assessments in English. In case of any discrepancy between this translation of the guide and the Spanish version, the valid one is the Spanish version.			

Training and Learning Results	
Code	
C1	CET1. Project, calculate and design products, processes, facilities and plants.
C5	CET5. Technically and economically manage projects, installations, plants, companies and technology centers.
C18	CTI7. Ability to design electronic and industrial instrumentation systems.
D1	ABET-a. An ability to apply knowledge of mathematics, science, and engineering.
D3	ABET-c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
D9	ABET-i. A recognition of the need for, and an ability to engage in life-long learning.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
An ability to specify power electronic systems	C1 C18 D1
An ability to specify digital electronic systems based on microcontrollers for industrial control and instrumentation	C1 C18 D1
An ability to specify electronic communication systems for industrial control applications	C1 C18 D1
An ability to specify the analysis, design and deployment of electronic equipment	C5 D3 D9

An ability to apply RAMS technologies to electronic systems	C5 D3 D9

Contents	
Topic	
Topic 1: Introduction to Microcontrollers	Introduction. Components of a Microcontroller. Memory Architectures. Instruction Set Architectures. Selection Criteria.
Topic 2: Characteristics of Microcontrollers	Introduction. Overview of the Internal Structure. Arithmetic and Logic Unit. Program Memory. Data Memory. Peripherals. ESP32 Microcontrollers.
Topic 3: Programming a Microcontroller. Instruction Set.	Concept of a Computer Program. Abstraction Level. Structure of Instructions. Classification of Instructions. C language.
Topic 4: Microcontroller peripherals	Introduction. Basics of Parallel Input/Output. Information Transfer Control. Input/Output Structures. Basic Structure of a Timer. Timers/Counters in a ESP32. Interruptions. Interruptions in a ESP32.
Topic 5: Industrial Communications	Elements of a Communications System. Selection and Design Parameters: Electromagnetic Spectrum, Time Domain and Frequency. Noise.
Topic 6: Linear and Switch-Mode Power Sources	Introduction to Linear Power Sources. Rectifiers. Rectified Voltage Filtering. Types of Regulators. Parts of a Lineal Regulator. Integrated Lineal Regulators. Introduction to Switch-Mode Power Sources.
Topic 7: AC-to-DC Converters (Rectifiers)	Introduction. Classification. Non-Controlled Rectifiers. Associative Configuration of Rectifiers. Three-Phase Rectifiers. Losses Evaluation.
Topic 8: AC-to-AC Converters	Introduction. Classification. Monophasic AC Regulators. Three-Phase AC Regulators. Control of AC Regulators.
Topic 9: DC-to-AC Converters (Inverters)	Introduction. Classification. Single-Phase Inverters. Three-Phase Inverters. Output Voltage Control. Output Filtering.
Topic 10: DC-to-DC Converters	Introduction. Classification. Step-Down Converter (Buck). Step-Up Converter (Boost). Step-Up-and-Down Converter (Buck-Boost). Control of DC-to-DC Converters.
Topic 11: Uninterrupted Power Sources (UPS)	Introduction. Electric Power Variations. Types of UPS. UPS Selection.
Topic 12: Reliabitily of Electronic Components, Circuits, Systems and Facilities	Introduction and Definitions. Reliability. Unreliability. Other Parameters. Failure Mechanisms of Electronic Components. Reliability of Assembled Components and Connectors. Failure Rate Estimation for Electronic Components. Series and Parallel Systems. Redundant Systems: Types, Calculations of Parameters and Optimization.
Topic 13: Availability, Maintainability and Safety	Introduction and Definitions. Availability of Series and Parallel Systems. Definition and Types of Maintainability. Maintainability Parameters. Maintainability Parameters Determination. Applications and Critical Variables in Circuits, Systems and Facilities. Definitions Related to Safety. Electronic Systems for Safety Related Applications. Safety Standards.
Laboratory Session 1: Programming and Debugging Environment for Microcontrollers	Introduction to the software and hardware tools for the design, simulation and test of applications for the ESP32 microcontroller family.
Laboratory Session 2: Parallel Communications	ESP32 Parallel communications peripheral programming and testing
Laboratory Session 3: Uncontrolled Rectifiers	Half-Wave Mono-Phase Rectifier with R-L Load. Half-Wave Mono-Phase Rectifier with R-L Load and Free-Wheeling Diode. Mono-Phase Rectifier with R-L Load and Free-Wheeling Diode.
Laboratory Session 4: Inverters	Mono-Phase Full-Bridge Inverter Analisis. PWM Modulation.
Laboratory Session 5: DC-to-DC Converter	Step-Down (Buck) Converter Analysis. Continuous and Non-Continuous Operating Mode. Load Regulation.
Laboratory Session 6: Reliability	Analysis of the reliabilty of an electronic circuit according to the MIL-HDBK-217F. Analysis and optimization of reduncant parallel and series systems.

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	0	48	48
Lecturing	16	0	16
Problem solving	10	0	10
Laboratory practical	12	0	12
Autonomous problem solving	0	19.5	19.5
Report of practices, practicum and external practices	3	0	3
Self-assessment	4	0	4

*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	Previous preparation of the theoretical sessions: Prior to the start of the theoretical sessions, the students will have available a series of materials that have to prepare, as the sessions will rely on them. Previous preparation of the laboratory sessions: It is mandatory that the students make all the assigned previous tasks prior to access the laboratory. These tasks are intended to greatly improve the laboratory knowledge acquisition. The fulfillment of all the tasks will be taken in consideration in the laboratory session evaluation.
Lecturing	These sessions will be held in the rooms and dates mandated by the head office of the school. They will consist in an oral explanation by the professor of the most important parts of the course, all related with the materials that the student had to work previously. This is intended to favor the active participation of the students, that will have occasion to rise doubts and questions during the sessions. Active participation is desired during all the sessions.
Problem solving	During these sessions, in the classroom, interleaved with the lectures, the professors will proceed to solve examples and/or exercises that properly illustrate the problems. As long as the number of participants in the classroom allows, active participation will be promoted.
Laboratory practical	Laboratory sessions will be held in the time schedule established by the school's head office. Students will work in groups of two students each. The sessions will be supervised by a professor, who will control the assistance and will also evaluate the harnessing of it. At the end of each laboratory session each group will deliver the corresponding score sheets.
Autonomous problem solving	Self study and review of the theoretical sessions for knowledge consolidation: The student must study, in a systematic time schedule, after each lecture session, in order to dissipate any doubts. Any doubts or unsolved questions will have to be exposed to the professor as soon as possible in order to enhance the feedback of the learning process.

Personalized assistance	
Methodologies	**Description**
Laboratory practical	During the tutoring hours, students will be able to consult with the professors to receive academic guidance and support. This orientation and support may also be requested by email, although this mode of care is advisable for prompt indications and short questions.
Autonomous problem solving	During the tutoring hours, students will be able to consult with the professors to receive academic guidance and support. This orientation and support may also be requested by email, although this mode of care is advisable for prompt indications and short questions.

Assessment				
	Description	Qualification	Training and Learning Results	
Report of practices, practicum and external practices	The laboratory sessions will be evaluated in a continuous way, on each session. The applied criteria are: - A minimum attendance of 80% of the sessions - Punctuality - Previous task preparation of the sessions - Make the most of the session The practical sessions will be held in groups of two students. The documents of the practices will be available prior to the sessions. The students will fill a report, that will be delivered when the session ends. This report serves to justify both the attendance and how they have done the work asked for.	30	C18	D1

Self-assessment	It will consist in the individual realisation of 3 test related to the thematic blocks. The tests can be done by telematic means in lecture hours throughout the semester, and if it is this case, its correction will be automatic and immediate. The tests may consist of multiple choice questions, closed answer questions and analysis problems with numerical answer. Each test will have a maximum score of 10 points and the final grade of this evaluation [NT] will be the average of the three tests. To be able to make this average it is necessary to obtain, in each of the tests, a minimum score of 2 points out of 10. If any of the tests does not reach 2 points out of 10, the mark of this test will be the final grade [NT].	70	C1 C18	D1 D3

Other comments on the Evaluation

Ordinary exam for continuous assessment

The final mark [NAEC] that will be on the record, is taken from the weighted sum of the practical and assessment marks.

NAEC = 0.3 * NP + 0.7 * NT

Ordinary exam for global assessment

It will be necessary to sit a theoretical exam [NTEG], on the date established by the center for the ordinary exam, and a practical laboratory exam [NPEG], on a date to be agreed depending on the availability of laboratories and non-coincidence with other exams of the same course.

Each of these exams will be evaluated on a score of 10 points. If the theoretical exam is taken, and the student does not show for the practical, the [NPEG] grade will be zero (0,0).

The final mark that will go to the record [NAEG] will be the average of both exams. That is to say:

NAEG = (NTEG + NPEG) / 2

Extraordinary exam for continuous assessment

In this exam, the practical note from the ordinary exam will be kept, and it will be necessary to sit the parts of the self-assessment blocks that have not passed the 5-point mark.

The theory mark [NTE] in the extraordinary exam will be the average of the parts previously approved, and of the parts to which it has been sit.

The grade that will go to the records [NAEEC] will be the weighted sum of the practical and self-assessment grades.

NAEEC = 0.3 * NP + 0.7 * NTE

Extraordinary exam for global assessment

It will be necessary to sit a theoretical exam [NTEEG], on the date established by the center for the ordinary call, and a practical laboratory exam [NPEEG], on a date to be agreed depending on the availability of laboratories and non-coincidence with other exams of the same course.

Each of these exams will be evaluated on a score of 10 points. If the theoretical exam is taken, and the student does not show up for the practical, the grade [NPEEG] will be zero (0,0).

The grade that will go to the record [NAEEG] will be the average of both exams. That is to say:

NAEEG = (NTEEG + NPEEG) / 2

End-of-program exam

It will be necessary to sit a theoretical exam [NTFDC], on the date established by the center for the ordinary call, and a practical laboratory exam [NPFDC], on a date to be agreed depending on the availability of laboratories and non-coincidence with other exams of the same course.

Each of these exams will be evaluated on a score of 10 points. If the theoretical exam is taken, and the student does not show up for the practical, the grade [NPFDC] will be zerp (0,0).

The note that will go to the [NAFDC] record will be the average of both exams. That is to say:

NAFDC = (NTFDC + NPFDC) / 2

Ethical commitment

Whoever takes the subject is expected to have a correct ethical behavior. In the case of detecting unethical behavior (copying, plagiarism, use of unauthorized electronic devices, and others) it will be considered that it does not meet the necessary requirements to pass the subject. In this case, the overall grade for this academic year will be fail (0.0) and the school authorities will be notified for the appropriate purposes.

Sources of information

Basic Bibliography

Massimo Banzi, Michael Shiloh, **Introducción a Arduino**, Anaya, 2015

Blake, R., **Electronic Communication Systems**, Delmar Thomson Learning, 2001

Rashid, M. H., **Electrónica de Potencia**, Pearson-Prentice Hall, 2015

Complementary Bibliography

Ballester, E. y Piqué, R., **Electrónica de Potencia: Principios Fundamentales y Estructuras Básicas**, Marcombo, 2011

Barrado Bautista, A. y Lázaro Blanco, A., **Problemas de Electrónica de Potencia**, Pearson-Prentice Hall, 2012

Creus Solé, A., **Fiabilidad y Seguridad: Su aplicación en procesos industriales, 2ª Ed.**, Marcombo, 2005

MIL-HDBK-338B: Electronic Reliability Design Handbook, 1998

Kales, P., **Reliability: for technology, engineering, and management**, Pearson-Prentice Hall, 1998

Rashid, M. H., **Power Electronics. Circuits, Devices, and Applications**, Pearson, 2014

Recommendations

Other comments

It is very important that the students keep updated the profile in the Moovi platform. All communications related with this course will be made through this platform. All individual communications will be made through the email listed in this platform.

The students can solve doubts related with the laboratory previous activities in the personal attention hours (tutoring time), or by any other contact procedure available in Moovi.

The students must meet the deadlines for all the activities.

The translations to Galician and English are for informative purposes. In case of discrepancies, the Spanish version of this guide will prevail.

All the achieved results must be justified, in any of the exams or activities. No result will be considered valid unless an appropriate explanation of how it was found is provided. The selected method for solving a problem is considered when grading the solution.

When writing the solutions and answers in reports and tests, avoid spelling mistakes and unreadable symbols.

Exams lacking some of the sheets will not be graded.

Use of any electronic device, notes or books is forbidden during exams. Exception is made to electronic calculators.

The translations to Galician and English are for informative purposes. In case of discrepancies, the Spanish version of this guide will prevail.