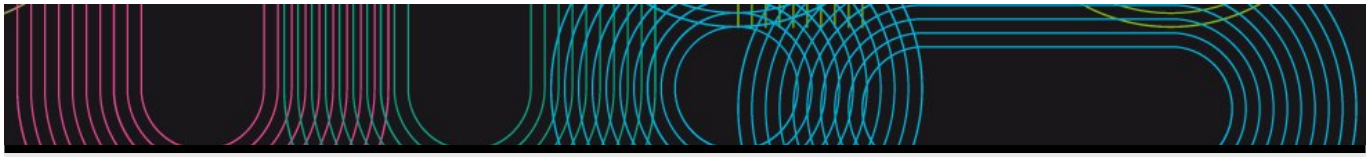

IDENTIFYING DATA				
Integrated systems design				
Subject	Integrated systems design			
Code	V05G301V01404			
Study programme	Grado en Ingeniería de Tecnologías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Gil Castiñeira, Felipe José			
Lecturers	Gil Castiñeira, Felipe José Rodríguez Hernández, Pedro Salvador			
E-mail	xil@gti.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	Embedded systems are part of almost all the diary activities that involve an electronic device (the alarm clock, the mobile phone, the car...). This course introduces the main concepts behind modern embedded systems that include an operating system, and puts them in practice through a series of exercises and projects. The documentation will be provided in English. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
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.
C87	(CE87/OP30) The ability to understand the specific requirements for integrated circuits with strict real time restrictions.
C88	(CE88/OP31) The ability to formulate and solve problems of design and development of integrated systems.
D2	CT2 Understanding Engineering within a framework of sustainable development.
D3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
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.

Expected results from this subject	Training and Learning Results		
Know the technological base which supports the most recent investigations in the study and design of integrated systems	B3	C87	
Understand the basic aspects of the special requirements inherent to embedded systems with hard real time restrictions	B3 B4 B9	C87	D3

Adopt a global view of the problem of programming environments with real-time restrictions, and know the proper tools for dealing with them, so that embedded systems can be addressed with a system level approach	B3 B4 B9	C88	D2 D4
Understand the basic elements of fault prevention and fault tolerance	B3	C88	D4
Master the concepts related to the organisation of this kind of systems software	B3 B4 B9	C88	D4
Handle the tasks scheduling and resources sharing techniques in embedded systems	B3 B4	C88	
Become familiar with the use of abstraction platforms for developing embedded systems	B4 B9	C88	

Contents

Topic	
Concept of embedded system	Definition of embedded system Real-time systems Characteristics
Operating systems for embedded systems	Operating systems with real-time restrictions Multitasking: threads and processes Synchronization
Arquitecturas de sistemas integrados	Microprocessor architecture. Peripherals. Buses.
Process scheduling	Cyclic executives Priority-driven scheduling: DMS, EDF Access synchronization
Reliability and fault tolerance	Fault prevention and fault tolerance Static and dynamic redundancy Security, reliability and dependability
Distributed embedded systems	Communication mechanisms Field buses
Abstraction platforms for the development of embedded systems	Android Linux (as a platform)
Communication with sensors and actuators	I/O Hardware Coping with concurrency The Analog/Digital interface

Planning

	Class hours	Hours outside the classroom	Total hours
Presentation	1	5	6
Laboratory practical	14	0	14
Seminars	6	10	16
Project based learning	0	53	53
Lecturing	20	40	60
Problem and/or exercise solving	1	0	1

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Presentation	Presentation by the students of the developed projects results. Through this methodology the competencies CT2, CT4, CG4, CG9, CE87 and CE88 are developed.
Laboratory practical	Development of guided and supervised assignments. Through this methodology the competencies CT2, CT3, CG3, CG4, CE87 and CE88 are developed. The following software will be used: - Linux system with terminal and a development environment for C. - Web browser. - Virtualización environment with VirtualBox and VMware. - Vrtual machines with a cross compiling environment for ARM and QtCreator will be provided. - Android Studio With NDK. - PSoC Creator
Seminars	Meetings of the professors with the students for tracking the current status and further planning the project activities. Through this methodology the competencies CT2, CT4, CG4, CG9, CE87 and CE88 are developed.

Project based learning	We use learning projects based training: students carry out a project along the semester to resolve a complex problem by means of planning, design and implementation of a series of activities. Through this methodology the competencies CT2, CT3, CT4, CG3, CG4, CG9, CE87 and CE88 are developed.
Lecturing	Professors present the main theoretical contents related to embedded systems with real-time restrictions. Through this methodology the competencies CT3, CG3, CE87 and CE88 are developed.

Personalized assistance

Methodologies	Description
Lecturing	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Questions will be answered during the master sessions or during tutorial sessions (https://moovi.uvigo.gal).
Laboratory practical	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. Te professors will guide and help the students to complete the assigned laboratory practises. Questions will be answered during the lab sessions or during tutorial sessions (https://moovi.uvigo.gal).
Seminars	In addition to the attention to the group, the professors of the subject will provide individual attention adadpted to the students during the group supervision sessions, or during tutorial sessions (https://moovi.uvigo.gal).
Project based learning	The professors of the course will provide individual attention to the students during the course, solving their doubts and questions. The professors will guide and help the students to complete the assigned project. Questions will be answered during the supervising sessions, group supervising sessions, or during tutorial sessions (https://moovi.uvigo.gal).

Assessment

	Description	Qualification	Training and Learning Results
Presentation	Once their project is implemented, the students will perform a public presentation of its design, development and results. Each member of the group must present the tasks that he or she completed, and provide satisfactory answers to the questions made by the professors.	5	B4 C87 B9
Laboratory practical	The students will deliver the five practices and complete individual questionnaires where they show the correct completion and understanding of the practices. It is necessary to pass the practicals as a whole in order to pass the subject.	10	B3 C87 B4 C88
Seminars	A continuous tracking of the design and evolution of the implementation will be held during the realization of the project. Each student must collect and show evidences of her/his individual work. Periodically, the students will present the state and results of their projects, as well as the scheduled tasks. If these results are not satisfactory, a penalization of the 20% of the grade could be applied.	5	B4 C87 B9 C88
Project based learning	The students will be divided in groups for accomplishing the design, implementation and proof of an embedded system. The result will be evaluated after the his delivery, assessing aspects such as correction, quality, performance and functionalities. In addition, during the implementation of the project, the design and the evolution of the development will be evaluated. If the intermediate results are not satisfactory, a penalization of the 20% of the grade could be applied. The evaluation will be by group and by person: each one of the members of a team must document his/her tasks and answer the questions related to them.	40	B3 C87 D2 B4 C88 D3 B9 D4
Problem and/or exercise solving	Students will be evaluated to asses what they have learned in master sessions.	40	B3 C87 C88

Other comments on the Evaluation

In order to pass the course it is necessary to complete the different parts of the subject (master sessions, practices in labs, and projects). The final grade will be the **weighted geometric mean** of the grades of the different parts (i.e. it is not possible to pass the subject with a zero in one part). If "x" is the grade obtained for the master sessions, "y" for the practices in labs, and "z" for the project (project, seminars and presentation), the final grade will be:

grade = x^0.4*y^0.1*z^0.5

During the first month, students must provide a written declaration to opt for global assessment. In other case, it will be considered that they opt for continuous assessment. Students who select continuous assessment and submit the first task or questionnaire may not be listed as "Absent".

Students who opt for the global assessment procedure must pass the short answer test (40%), submit a project (50%) and submit the laboratory practises (10%). These parts will be evaluated as indicated in the tests' description section. The final grade will be the **weighted geometric mean** of the grades of the different parts. Besides, they must submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the project. In addition, during the first month of the course, professors will notify students who opted for final assessment if they have to do the tutored work individually.

Students who opt for continuous assessment must submit each laboratory report before the deadlines that will be notified at the beginning of the course.

Although the project will be developed in groups, the ongoing activities of each student in a group will be monitored individually. In case a student's performance is below his or her group mates, he or she could be expelled from the group or graded on an individual basis.

Intermediate milestones may be required for the project. Those intermediate milestones will be notified at the beginning of the course.

Extraordinary opportunity to pass the course

The extraordinary exam will only be held by students who did not pass the ordinary exams (end of semester).

In order to pass the course, it is necessary to complete the different parts of the subject: pass the short answer test (40%), submit a project (50%) and submit the laboratory practises (10%). These parts will be evaluated as indicated in the tests description section. The final grade will be the **weighted geometric mean** of the grades of the different parts. Besides, it will be necessary to submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the project.

Students that have opted by the continuous assessment procedure, can decide to maintain the grades of the parts they have already passed in the first opportunity or discard them.

"End of career" opportunity to pass the course

In order to pass the course, it is necessary to complete the different parts of the subject: pass the short answer test (40%), submit a project (50%) and submit the laboratory practises (10%). These parts will be evaluated as indicated in the tests description section. The final grade will be the **weighted geometric mean** of the grades of the different parts. Besides, it will be necessary to submit an additional dossier with detailed information about the events and issues that arose during the execution of the different tasks, and especially the project.

Other comments

The grades obtained are only valid for the current academic year.

Although the tutored work will be completed (if possible) in groups, each student should keep a record of his or her activities. In the case in which the performance of a member of the group wouldn't be adequate compared with the performance of his or her teammates, he or she could be excluded from the group and/or qualified individually.

The use of any material during the tests will have to be explicitly authorized.

The assessment will be performed in any of the official languages in Galicia. If a student wishes to be tested in English, it must give written notice to teachers with 15 days in advance.

In case of detection of plagiarism or unethical behavior in any of the tasks/tests done, the final grade will be "failed (0)" and the professors will communicate the incident to the academic authorities to take the appropriate measures.

In carrying out the academic activities of this course, the use of generative artificial intelligence (GAI) is permitted. Its use must be ethical, critical, and responsible. When using GAI, it is essential to critically evaluate any results it provides and carefully verify any citations or references generated. Additionally, it is recommended to disclose the use of the tools employed.

Sources of information
Basic Bibliography
A. Burns & A. Wellings, **Sistemas de Tiempo Real y Lenguajes de Programación**, 3, ADDISON-WESLEY, 2003
E.A. Lee, S.A. Seshia, **Introduction to Embedded Systems**, 2, MIT PRESS, 2017
Complementary Bibliography
P. Marwedel, **Embedded System Design**, 4, Springer, 2021

P. Barry, P. Crowley, **Modern Embedded Computing**, 1, Morgan Kaufmann, 2012
S. Barrett, J. Kridner, **Bad to the Bone: Crafting Electronics Systems with Beaglebone and BeagleBone Black**, 1627051376, 2, New Publisher, 2021
Lawrence J. Henschen, Julia C. Lee, **Embedded System Design**, 9780443184710, 1, Elsevier, 2023
Elecia White, **Making Embedded Systems: Design Patterns for Great Software**, 1098151542, 2, O□Reilly Media, 2024

Recommendations

Subjects that it is recommended to have taken before

Distributed and Concurrent Programming/V05G301V01306
Operating Systems/V05G301V01303