Universidad de Alcalá

TEACHING GUIDE

Real – time electronic systems

Master's Degree in Electronic Engineering

University of Alcalá

Academic Year 2023/2024

1st semester

Teaching guide

Name of the course:	**Real – time electronic systems**
Código:	202934
Degree:	**Master's Degree in Electronic Engineering**
Department & Area of Knowledge:	**Department:** Electronics **Area:** Electronic Technology
	Mandatory
ECTS credits:	**3**
Year & semester:	**1st year / 1st semester**
Teachers:	**View Website**
Office hours:	**View Website**
Modality:	**Blended (semi-attendance)**
Language Classes Offered:	**English Friendly**

1. COURSE SUMMARY

This course deals with the problem of the design of real-time electronic systems, first considering the model of tasks and the analysis of executability, to continue with the techniques for designing applications for embedded systems. Next, the study of hard real-time operating systems for embedded systems is addressed. Finally, the course is completed with the study of Linux as an operating system. The focus of the course will be practical, developing from the beginning an application that must run on a real-time operating system such as RTX, FreeRTOS or Embedded Linux.

2. COMPETENCES and LEARNING RESULTS

This course contributes to the acquisition of the Basic, General and Specific competences detailed below:

Basic competences	
CB6	Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB7	Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB9	Students must be able to communicate their findings and the ultimate knowledge and reasons behind them to specialist and non-specialist audiences in a clear and unambiguous manner.
CB10	Students must possess the learning skills that will enable them to continue studying in a largely self-directed or autonomous manner.

Generic competences	
CG1	Prepare concise, clear and reasoned documentation and specify the work to be done for the development, integration and application of complex and high value-added electronic systems.
CG2	Conceive, design, implement and maintain an electronic system in a specific application.
CG3	Acquire skills to understand new technologies for use in electronic systems and their appropriate use and integration to solve new problems or applications.
CG6	Adopt the scientific method as a fundamental working tool to be applied both in the professional and research fields.

Specific competences	
CE1	Ability to design electronic systems both at a conceptual level, starting from specific specifications, and at a system level, using modeling and simulation tools, and at a subsystem level using, among other hardware description languages.
CE3	Ability to handle advanced tools, techniques and methodologies for the design of electronic and photonic systems or subsystems.
CE4	Ability to design a device, system or application that meets given specifications, using a systemic and multidisciplinary approach and integrating the advanced modules and tools that are typical of the field of Electronic Engineering.
CE5	Ability to design, implement and manage a set of tests and experimental measures to assess the validity of innovative electronic proposals to partially defined problems.
CE7	Ability to experimentally verify in the laboratory the compliance of a new electronic and photonic system with the required specifications after its design.

CE10	Ability to apply optimization techniques for the development of electronic circuits and subsystems.
CE11	Ability to perform effective information searches and identify the state of the art of a technological problem in the field of electronic and photonic systems, as well as its possible application to the development of new systems.

On the other hand, the expected learning outcomes with this subject are as follows:

RAP1. To know advanced digital electronic systems based on processor.

RAP2. To understand the design problems of real-time electronic systems and embedded systems.

RAP3. To design electronic applications supported by real-time operating systems.

3. CONTENTS

The course includes the following contents:

Brief description of its contents

Content blocks	Hours
Block 1. Real-time system analysis: Introduction, classification, general characteristics, time requirements, fault tolerance, concurrent scheduling, planning, etc.	• **12 hours**
Block 2. Operating systems for hard real-time: Specific characteristics of RTOS, VxWorks, LynxOS, FreeRTOS. Linux as a real-time operating system.	• **6 hours**
Block 3. Advanced techniques of modeling real-time electronic systems: Introduction to modeling techniques, HTR-HOOD, UML.	• **4 hours**
Block 4. Designing a case study.	• **8 hours**
	30 hours

4. METHODOLOGY OF TEACHING AND LEARNING. TRAINING ACTIVITIES

4.1. Credit distribution

Number of hours of theoretical and practical classes:	30 h (13,7 h on-site or synchronous connected)
Time of student work on their own:	45 h
Total:	75 h

4.2. Methodological strategies, teaching materials and resources

In the teaching-learning process the following training activities will be held:

Theoretical classes and problem solving	11,25 h
Theoretical-practical classes and laboratory practices.	11,25 h
Tutorials	7,5 h
Other: student work, virtual classroom activity and tests.	45 h

Throughout the course the student will be offered activities and tasks so that they can experience and consolidate the concepts acquired.

In order to carry out the practices, the student will have a place in the laboratory with a computer and the necessary elements for the experimentation of design techniques of electronic control systems.

During the whole learning process of the subject, the student will have to make use of different sources and bibliographic or electronic resources, so that he gets familiar with the documentation environments that will be used in the research or professional field.

5. ASSESSMENT: Procedures, assessment and marking criteria

Preferably, students will be offered a system of continuous assessment that has formative evaluation characteristics, so that it serves as feedback in the teaching-learning process by the student. To this end, the following are established:

5.1 Assessment procedures

The proposed evaluation process is inspired by the continuous evaluation, although, respecting the rules of the University of Alcalá, the student will be able to benefit from the final evaluation[1].

5.2. Assessment criteria

The assessment criteria must take into account the degree of acquisition of the competencies by the student. To this end, the following are defined:

- C1: The student is able to correctly solve problems related to the design of real-time electronic systems.
- C2: The student integrates the knowledge explained in the different topics of theory to be able to solve in a creative and original way the problems that are presented to him.
- C3: The student implements in practice real time electronic systems that give solutions to the problems posed by integrating the knowledge acquired, making use of the bibliographic resources and computer tools at their disposal.
- C4: The student is able to generate correctly written, clear and precise documentation about the work carried out in the laboratory.
- C5: The student exposes and defends in a clear and reasoned way his proposals for the resolution of the problems posed.

5.3. Assessment tools

The assessment tools that will be applied are:

1. Laboratory practices (LP) of obligatory attendance that will consist of the design, simulation and implementation of practical applications of real-time electronic systems. From each practice, a simplified report will be presented per group.
2. Evaluation test of the theoretical part (PET) with questions or problems of analysis or design related to the concepts covered in the theory classes.

[1] Students will have a period of 15 days to request in writing to the Director of the EPS their intention to use the final assessment model, giving the reasons that they consider appropriate according to the regulations governing learning assessment processes (approved by the Governing Council on September 2021).

3. Resolution of a practical case (CP), not guided, from a real-time application, which will cover the knowledge acquired both in theory and in practice. Each group will have to deliver a detailed report of this practical case and make a public defense of its solution.

5.4. Marking criteria

5.4.1. Continuous assessment:

a) **Ordinary session.** Students will be assessed on an ongoing basis using the assessment instruments listed above, which will be distributed throughout the academic year. The weight percentages of such tests on the final grade, as well as the relationship between the criteria and assessment instruments of the subject are as follows:

Learning results	Assessment criteria	Assessment tool	Weight
RAP1, RAP2, RAP3	C1, C2, C5	PET	50%
	C2, C3	PL	20%
	C4, C5	CP	30%

A student will be considered to have participated in the teaching-learning process and therefore to **have taken part in the ordinary session** if he or she takes one of the programmed tests of the theoretical part (PET).

Students will be considered to **have passed the course** if they achieve an overall weighted mark of 5 or more (out of 10) among all the grading instruments, having obtained a minimum mark in each of the parts (PET and PL+CP) of at least 40% of the maximum mark.

b) **Extraordinary session**. Those students who do not pass the ordinary call will have the right to an extraordinary call. The theoretical part (PT) will be evaluated by means of an exercise with tests and questions, and the practical part (PP) by means of a practical laboratory exam. The percentages of weight of such tests on the final grade, as well as the relationship between the criteria, assessment instruments and the learning results of the subject are as follows:

Learning results	Assessment criteria	Assessment tool	Weight
RAP1, RAP2, RAP3	C1, C2, C5	PT	50%
	C2, C3, C4, C5	PP	50%

Students will be considered to have passed the course if they achieve an overall weighted grade of 5 or more (out of 10) among all the grading instruments, having obtained a minimum grade in each of the parts (PT and PP) of at least 40% of the maximum grade.

5.4.2. Final assessment:

Ordinary and Extraordinary sessions

Those students who choose the final evaluation model, both in the ordinary and extraordinary call, must pass: the theoretical part (PT) through an exercise with tests and questions, and the practical part (PP) through a practical laboratory exam. The percentages of weight of such tests on the final qualification, as well as the relation between the criteria, evaluation instruments and the learning results of the subject are as follows::

Learning results	Assessment criteria	Assessment tool	Weight
RAP1, RAP2, RAP3	C1, C2, C5	PT	50%
	C2, C3, C4, C5	PP	50%

Students will be considered to have passed the course if they achieve an overall weighted grade of 5 or more (out of 10) among all the grading instruments, having obtained a minimum grade in each of the parts (PT and PP) of at least 40% of the maximum grade.

6. BIBLIOGRAPHY

6.1 Basic bibliography

- Documentation elaborated by the teachers of the subject.
- Real-Time Systems and Programming Languages: Ada, Real-Time Java, And C/Real-Time POSIX (4th Edition). Alan Burns & Andy Welling. Addison-Wesley, 2009.
- The FreeRTOS™ Kernel (https://www.freertos.org/)

6.2 Auxiliary bibliography

- Real-time Operating Systems Book 1: The Theory (The engineering of real-time embedded systems). Jim Cooling. 2019.

- Real-Time Embedded Components and Systems with Linux and RTOS. Sam Siewert & John Pratt. Mercury Learning & Information, 2016.