EMBEDDED AND REAL-TIME SYSTEMS

Mestrado em Engenharia Eletrónica e de Computadores

Code: 20300

Main Scientific Area: Intelligent Systems and Control

Lecturer: António Herculano de Jesus Moreira

Language of Instruction: Portuguese

Regime: S1

Contact Hours: 30h Total Workload: 138h

ECTS: 6,0

Objectives

This curricular unit aims to familiarize with embedded and real-time systems focusing fundamentally on the characteristics that distinguish them from Desktop applications.

Students are expected to obtain capabilities that enable the specification, development and testing of embedded systems in Arduino and ARM architecture through the development of bare-metal applications and a real-time operating system (RTOS).

Whenever possible, the study will be based on practical cases of real application.

Learning Outcomes

Students who successfully complete this course should be able to:

Understand the fundamental concepts and laws of electrical circuit analysis and key electronic components.
Familiarize themselves with and utilize major measuring instruments such as a multimeter and oscilloscope.
Identify fundamental concepts related to embedded systems with real-time characteristics.
Understand the operation of real-time operating systems, particularly in terms of scheduling, and multitasking applications within embedded systems.
Comprehend multitasking processes, such as synchronization and communication between tasks.
Gain knowledge of both processor and embedded system architectures and their impact on system performance and energy consumption.
Be familiar with the development process and configuration of the development environment for embedded systems.
Have the ability to define the specification, develop, and test embedded systems while considering imposed requirements.

Course Contents

Introduction to Electronics
Laws and analysis of electrical circuits: Ohm’s law, Kirchhoff’s laws.
Capacitors, Inductors and RLC Circuits
Measuring instruments, e.g. Multimeter and Oscilloscope
Analysis of circuits with diodes, bipolar junction transistors and MOS

Introduction to embedded and real-time systems
Real-time systems: soft and hard.
Development process for embedded systems.
Computer architecture.
Embedded systems architecture.
Real-time operating systems (RTOS).
Competition, communication and synchronization of tasks.
Real-time scheduling algorithms.
Treatment of events and interaction with peripheral devices.
Interface with common buses and networks for embedded systems.
Development of an embedded system
Arduino Development Board
Bare-Metal Libraries and Programming
FreeRTOS (Real-Time Operating System)

Recommended Bibliography

Wolf, W. (2016). Computers as Components: Principles of Embedded Computing Systems Design. 4th edition: Morgan Kaufman

Tammy Noergaard, (2012). Embedded Systems Architecture, 2nd Editions, Newnes.Margolis, M. (2012) Arduino Cookbook. O'Reilly.

Learning and Teaching Methods

The development process for embedded systems allows students to gain the ability to set up a remote development environment for any hardware platform.

Learning processor architecture and embedded systems provides the student with tools to select the hardware platform according to the requirements imposed by the application.

The study of multitasking applications in the context of real-time operating systems, as well as knowledge of real-time scheduling algorithms, enables the student to specify and configure an RTOS while considering the imposed requirements

Assessment Methods

The approval in this curricular unit is achieved with a grade equal to or higher than 10 (ten) points on a scale of 0 to 20, resulting from the evaluation of the theoretical component through a mandatory written assessment (40%) and the practical component through various practical assignments conducted during the semester (Practical exercise sheets + Final Practical Project 60%).

The minimum grade for the written assessment is 8 (eight) values. The TP is mandatory and will have a minimum score of 9 (nine) values.

If the student does not obtain the minimum grade in any of the situations mentioned above, they may always make an appeal exam, with the final grade being determined by the weighting of the evaluation elements. The submission of Final Practical Projects (TPs) outside the continuous assessment period is not allowed; only the theoretical component can be evaluated during appeal or special assessment periods