



Code: ING-INF/01

Credits: 6

Matter: Programmable Electronic Systems

Main language of instruction: Italian

Other language of instruction: English

Teaching Staff

Head instructor

Prof. Armando Piccardi - armando.piccardi@unicusano.it

Introduction

1. Objective of the course :

The teaching of the course aims to provide fundamentals about microprocessors and microcontroller systems, together with competencies to implement simple devices employing programmable development boards. Starting with digital electronic devices and systems, the course will introduce the microprocessor architecture, with reference to ARM microprocessors. Then, microcontroller systems architecture will be studied. After an introduction to C/C++ language, the fundamentals of microcontroller systems programming are introduced, ending with the implementation of some simple control systems.

Objectives

2. Course Structure:

The course is organized into 6 subjects.

The first is dedicated to recall the fundamentals of digital electronics, with the analysis of combinatorial and sequential logic devices, including logic gates, encoders, decoders, registers, counters and memories. The second and third subjects are devoted to the study of microprocessors. The architecture of microprocessors systems will be the subject of the former, through the study of hardware and instruction set, while the latter will deepen the study of ARM microprocessors, respectively. The fourth subject will focus on microcontroller hardware and architecture. In the fifth subject, C/C++ programming language will be introduced, while the sixth subject will regard the microcontroller systems programming and the implementation of simple digital control systems.

During the course, both analysis and design problems will be considered, also based on exercises and case of studies.

Competencies:

- To understand the difference between wired logic and programmable logic.
- To design and analyze simple examples of digital electronic circuits.
- To know the difference between microprocessor and microcontroller systems.
- To understand the fundamentals of microprocessor systems.
- To be able to examine a microprocessor block scheme and recognize the data path.
- To know the architecture of microcontroller systems.
- To be able to implement simple programs in C/C++.
- To know and examine the hardware of a microcontroller systems.
- To be able to program a microcontroller through a development tool.
- To be able to design simple devices controlled by the microcontroller.
- To be able to communicate in a proper technical language.
- To be able to approach new problems based on the course subjects.

Syllabus

3. Programme of the course:

Subject 1. Digital Electronics. From transistor to logic gates. Combinatory and sequential logic: logic gates, multiplexers, demultiplexers, encoders, decoders, latch and flip-flop, registers, counters, memories. Wired and programmable logic. Fundamentals about microprocessors and microcontroller systems. Architectures and abstraction levels.

Subject 2. Microprocessors: fundamentals and history. Classification: Von Newman and Harvard architectures, RISC and CISC architectures. Mu0 processor: components and architecture, instruction set, datapath and control logic, ALU, pipeline. RISC architecture, introduction to ARM microprocessors.

Subject 3. ARM microprocessor: fundamentals and history. Architecture and instruction set. Instruction format and execution. Registers, datapath, pipelines. Interrupt managing. Memory



hierarchy and address managing. Bus architecture. Thumb instruction set. Fundamentals of architectures for high level languages. Evolution of ARM microprocessors and state of the art.

Subject 4. Fundamentals of microcontrollers architecture. Memory system: PROM, EPROM, EEPROM, Flash. A/D and D/A converters. Peripherals and communication: UART, I2C, SPI. Timing: timer, watchdog, interrupt. Case of study: LCP2000 NXP microcontroller, architecture and features.

Subject 5. Programming in C/C++: fundamentals. Program structure and hierarchy. Identifiers: variable kinds and declaration. Operators. Conditional instructions. Functions. Object oriented languages: pointers and classes. C/C++ for embedded systems.

Subject 6. Development environment and tools, IDE. Mbed simulator. Fundamentals of coding: finite state machine, code structure. Instruments: macro, libraries, debug. Design of microcontroller-based systems and devices: interfaces, breadboarding, output ports, LED managing, devices connection.

Evaluation system and criteria

The assessment of course is based on the following criteria:

I) Final exam (75% of grade):

This exam will consist of the design of a microcontroller-based system and several multiple-choice questions (the number is slightly variable depending on the workload of the system design). The exam tries to verify the competencies acquired by the student. The evaluation will be based on the degree of knowledge and the correct language used.

II) Etivity (25% of grade):

During the course there will be a few interactive activities, about analysis or design problems on the course subjects, to be completed as a part of the evaluation.



Bibliography and resources

4. Materials to consult:

Provided video-lectures, slides and notes will cover the whole program and they contain the necessary material to assess the course.

5. Recommended bibliography:

- S. Furber, "ARM, System on Chip Architecture", Addison Wesley