UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Electronic Experimentation

2425-3-E3001Q071

Aims

Basic knowledge of the use of microcontrollers to manage the link between the analog world and the digital world. Introduction to the analog manipulation of signals generated by particle detectors: amplification and signal shaping. Construction of a complete acquisition chain: the detector signal is amplified, suitably shaped, then transformed into a sequence of numbers by the microcontroller system, and finally transmitted to the PC for analysis and storage.

A more detailed description of the purposes and modalities of the course can be found described in the following publication (which can be accessed with campus credentials):
A laboratory course on detector readout for undergraduate students of experimental physics

Contents

The course aims to introduce the student to the world of physics experiments by introducing the main ingredients of a measurement chain with a particle detector: analog signal amplifiers and shapers, use of converters from the analog to the digital world, and use of microcontrollers to manage trigger and data trasmission. The MATLAB software will be used on the PC to receive and analyze the acquired data. A practical application will be the construction of a measurement chain for one of the most current detectors, the so called SiPM, or Silicon Photomultiplier. A detector capable of producing a measurable electrical signal in response even to a single incident photon. It will be studied the electrical signal generated in the detector to be converted into a sequence of numbers that will be analyzed mathematically with a chain completely built in the laboratory.

Detailed program

The course is for everyone and aims to be preparatory to any address the student wants to undertake later.

- First steps with ARM Cortex family microcontroller: GPIO, timers, interrupts.
- Communication between microcontroller and PC via serial protocol (UART): ASCII or binary data.
- Use of MATLAB software on PC.
- Acquisition with analog-to-digital converter (ADC).
- Advanced memory management: DMA, circular buffer.
- Signal acquisition and triggering.
- Operational amplifiers, inverting and non-inverting configuration.
- Diodes, LEDs, Silicon and SiPM detectors
- Peak detectors
- Observation of single photon signals with SiPM
- Construction and operation of the complete acquisition chain, from SiPM to microcontroller and then to PC.

More information will be available at the following web page: http://pessina.mib.infn.it

Prerequisites

Notions of classical Physics: Electricity and Magnetism.

Teaching form

**The course takes place in the first semester. **

24 laboratory sessions of 4 hours each, twice a week, to be confirmed with the semester schedule.

The sessions are conducted in interactive in-presence mode (lab activities).

In the first half of the course, each student works individually with his or her own microcontroller.
In the second half of the course, groups of 2-3 students are formed to work on amplifiers and SiPM.

When necessary to introduce the next topic, the first part of the session (about 1 hour) can be conducted in delivery mode (frontal lecture in the lab) and in English, if asked.

Textbook and teaching resource

- Slides that will be made available, on this web page (clicking on Enter, the green button on the right), in sync with the lectures;
- Project development software;
- Mathematical analysis tools;
- Development boards for the microcontrollers we will use;
- Detectors we will use;
- Laboratory instrumentation appropriate to the experiments: oscilloscopes, function generators, voltage generators.

Semester

First semester.

Assessment method

- A written report describing all the experiences covered (the report can be written in groups of up to 3 people);
- An interview (mandatory), which will be individual instead, where the content of the report and the topics covered in class will be discussed. As indicated above, the topics covered in class are available on this webpage (by clicking on enter). Next to each handout will be indicated any topics not required but only present for further study.

The final grade takes into account the work done in the laboratory during the course, the quality of the paper and the mastery of the topics demonstrated in the final interview.

The exam can be taken in English.

Office hours

Anytime, upon notice: claudio.gotti@mib.infn.it, pessina@mib.infn.it

Sustainable Development Goals

QUALITY EDUCATION