UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Applied Electronics

2526-1-F1703Q003

Learning objectives

This course is particularly suitable for experimental physicists who wish to understand how a detector readout chain works. The objectives of the course are to provide knowledge of design criteria based on the use of feedback amplifiers (stability and noise). The teaching criteria are particularly suitable for Physics students (1). Filtering criteria to optimize signal-to-noise ratio. Applications to reading signals from particle detectors. Introduction to the use of transistors in low-noise circuits. Operation of solid-state devices at very low (cryogenic) temperatures and in high-radiation environments.

The concepts learned in the course are also crucial in the industrial field; examples include IoT, Internet of Things, Domtotics, Home Automation, Robotics, Automotive, etc.

(1) See: Reference

Contents

The student is given the basic instruments to be able to design analog amplifiers, also for low noise applications. An introduction is given to the transistor operation in low noise circuits. Filtering for optimization of signal to noise ratio. Understanding of signal acquisition criteria from particle detectors for astro-particle physics and with accelerators.
The lecturers are for students in physic that are particularly interested in the experimental field.

Detailed program

The concept of amplifier, the Operational amplifier. The concept of feedback of an amplifier. The mathematical

approach t to the determination of all the aspects that concern a fed backed amplifier. The frequency domain analysis of the signals with Fourier and Laplace Transforms. The stability of a feed backed network and the compensation criteria. The noise in the electronic systems and the analysis of the noise in linear networks. The concept of the signal t to noise ratio. The charge sensitive preamplifier and the shaping of the signals coming from a nuclear detector of particles. Study of temporal fluctuation of signals in high-speed applications.

A short introduction to the physic of semiconductors applied to Bipolar, JFET and MOS transistors. The mathematical modelling and the noise sources in transistors. Transistors in low noise circuits. Circuit solutions for charge sensitive preamplifiers. A study is given on the basic blocks of Operational Amplifiers: input stage, intermediate stage, output stage and the more common electrical protections.

Investigation of the behaviour of electronics devices at extremely low temperatures, cryogenic temperatures, and in radioactive environments in the contest of experiments about neutrino physics and dark matter and the physics with accelerators.

Prerequisites

Notions on classical Physics: Electricity and Magnetism

Teaching methods

- Lectures, tutorials, circuit simulation examples using MATLAB Symbolic, MATLAB Simscape-Electronics and PSPICE, 6 cfu, 42 hrs.
- The teaching approach was specially developed Physics students (See Reference)
- Lecture recordings will also be available for use on this web platform, subject to course registration and classroom attendance.
- Lectures will be given in English.

Assessment methods

The examination will be conducted with a single final interview on all topics covered.

NOTE: Next to each lecture notes you will find indications of any topics left for further study that will not be discussed. The lectur notes are intended to be considered the basis of the required topics.

The exam will be taken mainly in English.

Textbooks and Reading Materials

- The projected slides of the course will be available at the same time as the lectures on this web page by clicking on enter in the upper right corner, in the form of handouts.
  The handouts are explanatory and sufficient for exam preparation.
- Details of the reference texts will be given in the handouts and also on the course web page.

- Here are some of the background texts:

Paolo Carniti et all, Feedback Amplifier Analysis: Extending the Rosenstark Method for Impedance and Noise Evaluation, Electronics 2025, 14(8), 1558; https://doi.org/10.3390/electronics14081558.

Sergio Franco, Amplificatori operazionali e circuiti integrati analogici : tecniche di progetto, applicazioni, U. Hoepli, c1992.

P.R.Gray, R.G.Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley & Sons;

E.Gatti, P.F.Manfredi, Processing the signals from solid-state detectors in elementary-particle physics, La Rivista del Nuovo Cimento, V.9, serie 3, p.1-146, 1986.

S.M.Sze Semiconductor Devices II Ed., John Wiley & Sons, 2001

R.S.Muller, T.I.Kamins, Device Electronics for Integrated Circuits, II Edition., John Wiley & Sons, New York.

M.Shur Physics of Semiconductors Devices, Prentice Hall 1990

Semester

First Semester

Teaching language

English

Sustainable Development Goals

QUALITY EDUCATION