UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Applied Electronics

2425-1-F1701Q116

Learning objectives

The Course is particularly suitable for the Experimental Physicist who wants to understand the mode of operation of a detector readout chain. The course objectives are to provide knowledge on design criteria based on the use of amplifiers with feedback (stability and noise). Filtering criteria for optimizing 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 components at ultra-low (cryogenic) temperatures and in high-radiation environments.

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 transistors operation in low noise circuits. Filtering for optimization of signal to noise ratio. Understanding of signal acquisition criteria from particle detectors for astroparticle 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.

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.
- Lecture recordings will also be available for use on this web platform , subject to course registration and classroom attendance.
- If requested, lectures can 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 can be taken 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:

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

Italian / English

Sustainable Development Goals

QUALITY EDUCATION