UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Laboratory of Electronics II

2526-1-F1703Q015

Aims

The Laboratory of Electronics II course is divided into two sections:

- study and simulation of analog circuits using Computer-Aided-Design (CAD) software;
- electrical characterization of simple analog circuits in the laboratory (using specific instrumentation (power supply, signal generator, oscilloscope, spectrum analyzer, etc)).

More specifically, the objectives of the course are focused on acquiring skills in:

- Integrated Analog Circuit Design (Operational Amplifiers, Analog Filters, Charge-Sensitive Amplifiers, Low Noise Amplifiers for Sensors) in deeply scaled down CMOS Technology;
- Learning of Computer-Aided-Design (CAD) tools for the characterization of integrated circuits (simulations under nominal conditions and varying temperatures, including physical and electrical deviations of the CMOS process);
- Characterization of Analog Circuits in both static (operating point) and dynamic (time and frequency) domain;
- Study and characterization of the Noise Power Spectral Density (input and output) of the Amplifiers;
- Electrical characterization in the laboratory of simple analog circuits.

Contents

- Introduction to Analog Circuits Design by Computer-Aided-Design (CAD)
- CMOS Design of Operational Transconductance Amplifiers (OTA)
- Operational Transconductance Amplifiers Design Procedure
- Nominal Conditions Simulations (operating point, frequency, time, noise in both time and frequency domain, closed-loop stability)
- Noise Power Spectral Density in Closed-Loop Circuits

- Process-Voltage-Temperature Simulations
- Montecarlo Simulations
- Circuital exercises in the laboratory

Detailed program

Lesson 1: Miller-Compensated Operational Transconductance Amplifiers (OTA)

- Introduction
- Class-A OTA Basic Scheme
- OTA Operating Point
- Small-Signal
- Large-Signal
- Noise: Class-A OTA Input Referred Noise
- Common-Mode Feedback Circuit

Lesson 2: Miller OTA Design Procedure

- Introduction
- Opamp Specifications
- Input Differential Stage
- Miller Capacitance
- Class-A Output Stage
- Class-AB Output Stage
- Common ModeFeedback Circuit

Lesson 3: CAD Tools

- Creating a schematic and symbol.
- Simulating simple analog circuits using Analog Design Environment.
- Running process/voltage/temperature simulations.
- Running Montecarlo simulations.

Prerequisites

Bachelor in physics or equivalent.

Teaching form

LECTURES in which the fundamental concepts of analogue design in CMOS technology will be presented.

Classroom EXERCISES with presentation and discussion of examples of analog circuits at the transistor level.
EXERCISES in the electronics laboratory where students will be divided into groups (2 students per group).
Students will follow guided exercises, preceded by a classroom presentation.

GROUP WORK for development and simulation of analogue stages.

Attendance is strongly recommended and is essential for all activities.

The course will be delivered in Italian.

Textbook and teaching resource

- Lecture notes provided by the instructor
- Johns, David A., and Ken Martin. *Analog integrated circuit design*. John Wiley & Sons, 2008.
- Sansen, Willy M. *Analog design essentials*. Vol. 859. Springer Science & Business Media, 2007.
- Kularatna, Nihal. *Digital and analogue instrumentation: testing and measurement*. No. 11. IET, 2003.
- M. Norgia, R. Ottoboni, A. Pesatori, C. Svelto. *Misure - Dai fondamenti alla strumentazione*. Ed. Esculapio.

Semester

second semester

Assessment method

The exam consists of an ORAL EXAM.

During the oral exam, the student will present two Laboratory Reports:

1. RelazioneCAD: Design and simulation at transistor level of an analog circuit (whose general scheme will be provided by the course teachers during the lessons);
2. Meas Report: Electrical and electronic measurements on simple circuit configurations.
   The exam will consist of:

- Interview on Laboratory Reports;
- Interview on topics covered in class.

The SKILLS and knowledge required are based on:

- analysis and synthesis of analog stages with transconductance amplifier operation (active amplifiers and filters);
- CAD simulations of the analogue stages covered by the CAD Report;
- in-depth knowledge of the measurement setup issues covered by the CAD Report.

The evaluation CRITERIA are:

- level of knowledge of the circuits covered by the two laboratory reports, both at an architectural and transistor level;
- level of originality and in-depth analysis of the circuit solutions adopted relating to the RelazioneCAD and the RelazioneMeas.

Office hours

Monday 10-12

Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE