UNICUSANO ROME

Code: ING-INF/01 **Credits:** 9
Matter: Fundamentals of Electronics Applications and Analysis
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
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Introduction

1. *Objective of the course :*

The course is intended to provide the students with the fundamentals of electronic systems design. Lessons are organized examining some electronics systems by either a top-down or a bottom-up approach. The former leads the learner to understand what can be required for an electronic system design. The latter, including circuit analysis, leading students to get a more insight of how a circuit operates, acquiring some competences of how circuits work and operate.

Objectives

2. *Course Structure:*

The course is focused on the following goals:

- To illustrate concepts related to some circuit topologies
- To provide the tools for the correct acquisition and conditioning of the electronic signals
- To illustrate the basic ideas related to fundamentals circuit topologies and solutions
- To present competencies about circuit design and analysis

Competencies:

As prerequisites, to attend the course the student must have passed the courses of **Microelectronics** (Microelettronica), **Electronics** (Elettronica), and **Electrical and Electronic measurements** (Misure Elettriche ed Elettroniche).
Notions and concepts of a Signal Theory course are extremely important, too.

At the end of the course the student will have the following competencies:

Knowledge and Understanding
to know and understand the terminology, properties and physical quantities involved in particular circuit solutions;
remember the peculiar characteristics of some circuit solutions, also taking inspiration from the designer's point of view;
recognize both elementary and advanced circuit solutions, based on standard analog devices and analyze them to understand their peculiar characteristics and their advantages and disadvantages;
remember some fundamental models of components and circuits;
memorize the analytical techniques necessary to understand an electronic system function.

Applying knowledge and understanding
use an appropriate terminology when describing an electronic system;
describe the principle of operation of some integrated components (chosen as examples of a particular technology or circuit solution);
interpreting the scheme of a circuit with a practical but rigorous approach.

Making judgments
choose a circuit solution according to specifications;
identify the circuit blocks needed to perform a desired function and the necessary blocks interconnections;
interpret the results both in terms of physical consistency and feasibility.

Communication skills
develop a correct and comprehensible technical-scientific language.

Syllabus

3. *Programme of the course:*

Introduction
This module illustrates the possible design of a front-end electronics for current sensors signal conditioning. The solution is based on a precision integrator, therefore indicated for the realization of an

accurate acquisition system, able to operate at low frequency. Offset voltage nulling, as well as bias or leakage currents zeroing, are illustrated, also including searching and studying phases of documentation.

Design of a low noise power supply
This module illustrates the flow of actions involved in the design process concerning: project requirements and specifications; study of documentation (datasheets and application notes); search for components and systems; drafting of the possible solution. As precision devices, bandgap voltage references theory is illustrated, describing some commercially available integrated solutions.

Amplifier Design Examples
This module illustrates two cases related to the design of an RF amplifier (with GBP > 1 GHz).
The argument includes the study of system stability, choosing the most suitable design criteria to solve the problem. Input and output coupling of the preamplifier are shown. System analysis is proposed using simulation tools available on the network.

Current-feedback amplifiers (CFA)
This module illustrates the limits that voltage-feedback op-amps (VFA) shown in terms of GBP. After a brief history of CFA, the architectures and equivalent model for modern CFA's, the diamond buffer, as well CFA/VFA performances comparison are shown. Practical application of the CFA are finally illustrated.

A-D conversion
General characteristics of the analog-to-digital converters and the basic definitions are shown.
As an example of an integrated converter in more complex systems, the architecture of the CMOS ADC-SAR devices is illustrated. A second part is dedicated to ΣΔ converters, as well as its basic concepts: oversampling; noise-shaping; ΣΔ modulator. Commercially available devices are discussed.

Microcontroller based embedded systems
This module shows a brief overview of embedded systems based on microcontrollers, microprocessors, DSPs, FPGAs, or single-board computers. The architecture of microprocessor systems is then presented and, in detail, the design of a minimum processor:

datapath-level design; RTL synthesis; decode and control circuitry design. As an example of RISC microprocessor, the ARM7 architecture is also presented. Hardware and software development tools characteristics are also discussed.

Evaluation system and criteria

The assessments of course is based on the following criteria:

4. Final exam (84 %)
5. Homework (16 %)

The final exam generally consists of three parts: two numerical exercises and one open question.
The homework consists in the writing of a technical report related to a circuit design or analysis.

Bibliography and resources

6. Materials to consult:

- Lecture notes
- Recorded and live lectures

7. Recommended bibliography:

- M. Thompson, *Intuitive Analog Circuit Design*, Newnes-Elsevier, 2006;
- R. A. Pease, *Troubleshooting Analog Circuits*, Newnes-Elsevier, 1999;
- *Analog-Digital Conversion*, W. Kester ed., Analog Devices, www.analog.com;
- S. Fuber, *ARM System-on-chip Architecture*, Pearson, 2001.