UNIVERSITÀ DI PAVIA

Anno Accademico 2021/2022

VLSI ANALOG-DIGITAL INTERFACE ICS

Enrollment year	2020/2021
Academic year	2021/2022
Regulations	DM270
Academic discipline	ING-INF/01 (ELECTRONICS)
Department	DEPARTMENT OF ELECTRICAL,COMPUTER AND BIOMEDICAL ENGINEERING
Course	ELECTRONIC ENGINEERING
Curriculum	Photonics
Year of study	2°
Period	1st semester (27/09/2021 - 21/01/2022)
ECTS	6
Lesson hours	51 lesson hours
Language	English
Activity type	WRITTEN AND ORAL TEST
Teacher	MANSTRETTA DANILO (titolare) - 6 ECTS
Prerequisites	The course assumes good knowledge of the basic electronic circuits (bachelor electrical-engineering courses).
Learning outcomes	The main aim of the course is to provide an introduction to the design of a vast area of analog/digital interface circuits and systems: sensors, trasducers, wireless and wireline front-ends, electro-optical front-ends, etc... At the end of the course the students will be able to identify the main type and architectures of filters (including equalizers) and analog/digital, digital/analog converters used in these systems. They will be able to provide the general guidelines for the selection and design of the appropriate type and architecture of filters and analog/digital converter architectures based on the specifications of the analog/digital interface to be implemented. They will also have the tools to study and develop new architectures using the most advanced CAD

tools and techniques.

Course contents

The course is structured in two parts: the first part is dedicated to the design of the main types of analog integrated filters, the second part provides an introduction to the design of the main architectures of D / A and A / D converters.
Lectures are complemented by the laboratories, which address the analysis and design issues, at the architectural and circuit-level, with the help of CAD tools. The various projects carried out in laboratories cover the area of A / D and D / A converters and different types of integrated filters, such as SC, and RC active gm-C.

Analog Filters

This part of the course deals with the design of various types of switched-capacitors and continuous-time analog filter architectures. The emphasis is on the architecture and on the key performances limitations/trade-offs. Specific circuit design examples will be discussed that are compatible with scaled CMOS VLSI implementations.

• Types of filters.
• Normalizing and and de-normalizing: scaling in frequency and impedance.
• Frequency transformation.
• Transfer function approximations: Butterworth, Chebyshev and elliptic.
• Passive networks synthesis: single-terminated and double-terminated networks.
• Active-RC type filters: biquadratic cells and ladder type filters.
• Transconductance-based Filters (gm-C)
• Switched-Capacitor Filters

A/D and D/A converters

This part of the course deals with the design of A/D and D/A converters. The emphasis is on the analysis and design of the different converter architectures and on the related performance limitations/trade-offs.

• ADC Introduction: performance metrics
• Basic building blocks: amplifiers, comparators, S / H circuits
• Flash and two-step flash architectures
• Pipeline structures
• Folding and interpolating structures
• Successive approximation converters (SAR)
• Interleaved converters
• Sigma-delta converters
• DAC Introduction: performance metrics
• D/A converters design: operating principles (scale of resistors, current division and charge division), circuit examples, yield estimation

Teaching methods

Lectures (hours/year in lecture theatre): 42
Practical class (hours/year in lecture theatre): 0
Practicals / Workshops (hours/year in Lab): 9

	Lectures are carried out using overhead projector. The slides are made available to the students e prior to the lecture. The slides from previous years are available on KIRO. Practical activities consists in circuit simulations and are carried out with CAD software.
Reccomended or required readings	During the course the instructor will provide students with the lectures notes. For further reference: Kendall Su, Analog Filters, Second Edition, Kluwer Academic Publisher Group, The Netherland B. Razavi, Principles of Data Conversion System Design, IEEE Press R. van de Plassche, Integrated Analog-to-Digital and Digital-to-analog Converters, Kluwer Academic Publisher
Assessment methods	The final evaluation consists of a written test followed by oral discussion. The test consists of one circuit analysis exercise which provides an evaluation of the design skills and 10 multiple-choice questions that covers all the major subject areas of the course. The final score is based 50% on the exercise and 50% on the questions. There is no threshold to be admitted to the oral exam.
Further information	Information on course contents are available on the new KIRO platform: https://elearning.unipv.it/course/view.php?id=57
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile