EE-435

Analog circuit design II (for MNIS)

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Cursus	Sem.	Type
MNIS	MA3	Obl.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	1 weekly
Project	1 weekly
Number of positions	

Summary

The course provides a comprehensive treatment of analog IC design, emphasizing new solutions and paradigms used in today's low-power electronic systems. The analysis and design are first introduced from an intuitive perspective before the rigorous treatment and practical application in EDA-Lab.

Content

- Introduction: Low-Power AMS design and applications (IoT, Wearable, Sensors, Healthcare ect.)
- MOS Transistor: Modelling, Operation, and trade-offs
- Noise in analog circuits
- Voltage references and regulators
  - Supply and temperature-independent biasing
  - Low-Voltage solution

- Operational-Amplifiers:
  - Applications (Amplification, Filtering, and Regulation)
  - Frequency analysis and Stability
  - Noise, Offset, and Mismatch
  - Filly Differential and common mode feedback
  - LV solutions: Rail to Rail Amp.

- Mixed-signal design examples:
  - Digital calibration of analog circuits
  - Comparators
  - Practical aspects in MS-SOC

- EDA project (cadence-labs):
  - Technology parameters extraction
  - OTA and its biasing: Structural Design based on gm/ID Methodology
  - Folded cascode OTA and its CMFB

• Comparator

Keywords

• MOS transistor, Modelling, Analog Design, Current Mirrors, Voltage references, Regulators, Amplifiers, Stability, low-power, Low-noise, Low Voltage, digital calibration

Learning Prerequisites

Required courses

Students must be familiar with the fundamentals of microelectronics (Bachelor-level), including OpAmp application in linear and nonlinear circuits, Bipolar and/or MOS transistor physics, operation of basic circuits (inverter, simple amplifier, differential amplifier, current mirrors, basic OTA etc.).
Required courses: Electronics I, II, Analog IC Design 1

Recommended courses

• *Analog Design Essentials / Sansen*
• *CMOS Circuit Design, Layout, and Simulation / Baker*
• *Design of Analog CMOS Integrated Circuits / Razavi*

Learning Outcomes

By the end of the course, the student must be able to:

• Identify the different circuits used in analog processing
• Explain the functionality of the different circuits used in analog processing
• Choose an an appropriate design methodology for creating amplifiers based on a set of specifications and for a specific application.
• Quantify the effects of noise, process and temperature variations on the performances of analog circuits used for biasing, amplification and filtering
• Analyze the trade-offs between "linearity, noise, power consumption and speed" in analog design.
• Assess / Evaluate the strengths and weaknesses of different analog and mixed-signal circuit architectures with respect to these trade-offs
• Manipulate state-of-the-art industrial EDA tools (Cadence "Virtuoso, Assura, Spectre", and design kits (e.g. UMC 65 nm CMOS technology).
• Carry out basic analog design flows (Schematic and layout editing, circuit simulation "DC, transient, small-signal AC, Monte-Carlo," back-end verification (DRC/LVS), parasitics extraction, virtual testbench development).

Teaching methods

Ex-cathedra lectures
Exercice sessions
Computer labs using industry-standard IC design tools

Resources

Moodle Link

• https://go.epfl.ch/EE-435