EE-424

Fundamentals of analog & mixed signal VLSI design

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Cursus	Sem.	Type
Data and Internet of Things minor	H	Opt.
Electrical and Electronical Engineering	MA1, MA3	Obl.
Microtechnics	MA1, MA3	Opt.

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

Summary

This course provides the stepping stone to becoming an advanced A/MS IC designer. It emphasizes conceptual learning spanning from implementation to structure/architecture. It expands basic concepts (e.g., KCL, gmro, S-domain) and introduces modeling, noise, mismatch, time variance, etc.

Content

Review of Core Circuit Design Concepts

- Transistor: Switch and a Current Source
- Basic transistor modeling: Square law model
- Frequency Analysis (S-Domain Analysis)
- Various Amplifiers and Their Behaviors

Understanding the Device and Design Methodology

- Modeling of the MOS Transistor: EKV model
- The Concept of Inversion Coefficient and Gm/ID Design Methodology
- Understanding Process Variations and Reliability

Deeper Dive into Continuous/Discrete-time Amplifiers

- Noise Analysis in Continuous-time Amplifier
- Noise Analysis in Discrete-time Amplifiers: example through a comparator

Applied Analog/Mixed-Signal Circuits

- Power Converter Circuits: LDO
- Filters Design
- Sensor Interface

Keywords

CMOS, Integrated Circuits, Analog Circuit, Mixed-Signal Circuit, Device Model, Noise, Amplifiers, Filters, Sensors

Learning Prerequisites

Required courses

"EE320 - IC Design I" or equivalent

Recommended courses

"EE490(b) - Lab in EDA based design" : recommended to take in the same semester. (This is where you will get to draw transistors like a pro.)

Important concepts to start the course

- Transistor operation (as a switch or a current source)
- Laplace-domain analysis of continuous-time domain circuits and their frequency reseponse
- Feedback

Learning Outcomes

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

- Choose appropriate design methodology for amplifier design
- Assess / Evaluate the impact of noise/variation/distortion in continuous/discrete-time circuits
- Critique on the pros/cons of various analog/mixed-signal circuit structures
- Contextualise circuit design with the characteristics of the device and the focus of the application
- Elaborate on energy-efficiency
- Elaborate on robustness

Transversal skills

- Demonstrate the capacity for critical thinking
- Access and evaluate appropriate sources of information.
- Use a work methodology appropriate to the task.

Teaching methods

Four hours per week:
altenating between weeks with two 2 hour lecture and with one 2 hour lecture and one 2 hour excercise

Expected student activities

In addition to following the lectures and the excercise, the students are expected to do some home work based on the excercises.

Assessment methods

Written exam

Resources

Bibliography

Device modeling:
[1] C. C. Enz and E. A. Vittoz, Charge-based MOS Transistor Modeling, Wiley, 2006.
[2] Y. Tsividis and C. Mc Andrew, Operation and Modeling of the MOS Transistor, 3rd ed., Oxford University Press, 2001.
CMOS IC design:
[3] T. C. Carusone, D. A. Johns, K. W. Martin, Analog Integrated Circuit Design, 2nd edition, Wiley, 2012.
[4] B. Razavi, Design of Analog CMOS Integrated Circuits, 2nd ed., Mc Graw Hill, 2017.
[5] W. Sansen, Analog Design Essentials, Springer, 2013.
[6] A. Sedra, K. Smith, Microelectronic Circuits, 7th edition, Oxford University Press, 2015.

[7] P. R. Gray, P. J. Hurst, S. H. Lewis and R. G. Meyer, Analysis and Design of Analog Integrated Circuits, 5th ed., Wiley, 2009.
Gm/ID design methodology:
[8] David Binkley, Tradeoffs and Optimization in Analog CMOS Design, Wiley, 2008.
[9] P. Jespers, B. Murmann, Systematic Design of Analog CMOS Circuits, Cambridge, 2017.
[10] P. Jespers, The Gm over ID Methodology, Springer, 2010.

Ressources en bibliothèque

- [4] B. Razavi, Design of Analog CMOS Integrated Circuits
- [1] C. C. Enz and E. A. Vittoz, Charge-based MOS Transistor Modeling
- [3] T. C. Carusone, D. A. Johns, K. W. Martin, Analog Integrated Circuit Design
- [2] Y. Tsividis and C. Mc Andrew, Operation and Modeling of the MOS Transistor
- [5] W. Sansen, Analog Design Essentials
- [6] A. Sedra, K. Smith, Microelectronic Circuits
- [8] David Binkley, Tradeoffs and Optimization in Analog CMOS Design
- [9] P. Jespers, B. Murmann, Systematic Design of Analog CMOS Circuits
- [10] P. Jespers, The Gm over ID Methodology
- [7] P. R. Gray, P. J. Hurst, S. H. Lewis and R. G. Meyer, Analysis and Design of Analog Integrated Circuits

Moodle Link

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