

EE-429

Fundamentals of VLSI design

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Cursus	Sem.	Type
Electrical and Electronical Engineering	MA1, MA3	Opt.
Electrical and electronic engineering minor	H	Opt.
MNIS	MA3	Obl.

Language of teaching	English
Credits	6
Session	Winter
Semester	Fall
Exam	Written
Workload	180h
Weeks	14
Hours	6 weekly
Courses	3 weekly
Exercises	1 weekly
Project	2 weekly
Number of positions	

Summary

The course introduces the fundamentals of digital integrated circuits and the technology aspects from a designers perspective. It focuses mostly on transistor level, but discusses also the extension to large digital semicustom designs.

Content**Introduction:**

History/milestones, methodology, technology, design objectives & principles

Digital CMOS Fundamentals (Inverter):

DC characteristics, delay, rise/fall time, noise-margins, impact of sizing

Basic CMOS logic gates:

Constructing basic logic gates, transistor sizing, gate delay considerations

Custom digital logic:

Logical effort model, sizing of gates, inverter chains

Parasitic effects:

Routing capacitance, wire resistance, Elmore delay model

Technology considerations:

Technology scaling, impact on parasitics, variability

Low-power design:

Power consumption basics (leakage, dynamic), voltage-scaling, basic low-power design principles

Memories:

Embedded SRAM (6T bit-cell, organization, peripherals), SRAM stability (noise margins)

DRAM (briefly)

Fundamentals of Semicustom design:

Design flow, design abstraction, IP components, standard-cells (layout, characterization, lib, lef)

Semicustom design flow:

Logic synthesis, place & route, clock distribution, verification

Learning Prerequisites**Required courses**

EE-490(b) Lab in EDA based design (can be attended in parallel in same semester)

Recommended courses

EE-334 Digital system design (can be attended in parallel in same semester)

Learning Outcomes

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

- Construct digital logic gates
- Analyze the performance of digital gates
- Optimize digital logic
- Explain the operation of embedded memories
- Anticipate the impact of parasitics and technology scaling
- Implement a semicustom integrated circuit from a given RTL code to layout
- Link simplified abstract models to detailed computer simulations

Teaching methods

Ex-cathedra lectures with computer labs using industry-standard IC design tools

Resources

Notes/Handbook

Slides & course notes

Moodle Link

- <https://go.epfl.ch/EE-429>

Prerequisite for

EE-431 Advanced VLSI design (highly recommended)