

EE-429

**Fundamentals of VLSI design**

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Cursus	Sem.	Type
Electrical and Electronical Engineering	MA1, MA3	Opt.
MNIS	MA3	Obl.

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

**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)