**EPFL**

| EE-429 | **Fundamentals of VLSI design** |
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Burg Andreas Peter

| Cursus | Sem. | Type |
|---|---|---|
| Cyber security minor | H | Opt. |
| Cybersecurity | MA1, MA3 | Opt. |
| Electrical and Electronical Engineering | MA1, MA3 | Opt. |
| MNIS | MA3 | Obl. |

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| Language of teaching | English |
| Credits | 4 |
| Session | Winter |
| Semester | Fall |
| Exam | During the semester |
| Workload | 120h |
| Weeks | 14 |
| **Hours** | **4 weekly** |
| Courses | 3 weekly |
| Exercises | 1 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, variabiity
**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

**Prerequisite for**

EE-431 Advanced VLSI design (highly recommended)