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, 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

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

Assessment methods

Written exam.

Resources

Notes/Handbook

Slides & course notes

Moodle Link

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

Prerequisite for

EE-490(b) Labs on Advanced VLSI design (highly recommended)