Digital Integrated Circuit (IC) Layout and Design

□ EE 134 – Winter 05

- Lecture Tu & Thurs. 9:40 11am ENGR2 142
- 2 Lab sections
 - M 2:10pm 5pm ENGR2 128
 - -F 11:10am 2pm ENGR2 128
- NO LAB THIS WEEK
- FIRST LAB Friday Jan. 20

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People

Lecturer - Roger Lake

- Office ENGR2 Rm. 437
- Office hours MW 4-5pm
- rlake@ee.ucr.edu

TA – Faruk Yilmaz

- Office ENGR2 Rm. 222
- Office Hours TBD
- faruk@ee.ucr.edu

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EE134 Web-site

http://www.ee.ucr.edu/~rlake/EE134.html

- Class lecture notes
- Assignments and solutions
- Lab and project information
- Exams and solutions
- Other useful links

Class Organization

Homework assignments (10%)

- □ Labs (20%)
 - Tutorials to learn the Cadence design software

□ Final Project (50%)

- Design a digital circuit (eg. 4 bit adder)
- Work in teams of 3

□ Midterm (20%)

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Text Book



Digital Integrated Circuits: A Design Perspective, 2nd Ed.

Jan M. Rabaey Anantha Chandrakasan Borivoje Nikolic

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Software

□ Cadence software

- Online documentation and tutorials
- Sun4 UNIX Workstations

What is this book all about?

□ Introduction to digital integrated circuits.

- CMOS devices and manufacturing technology.
- CMOS inverters and gates.
- Propagation delay,
- noise margins, and
- power dissipation.
- Sequential circuits. Arithmetic, interconnect, and memories.
- □ What will you learn?
 - Understanding, designing, and optimizing digital circuits with respect to different quality metrics: cost, speed, power dissipation, and reliability

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Digital Integrated Circuits

- Introduction: Issues in digital design
- CMOS devices and manufacturing
- **D** The CMOS inverter
- Combinational logic structures
- □ Propagation delay, noise margins, power
- □ Sequential logic gates; timing
- □ Interconnect: R, L and C
- Arithmetic building blocks
- Memories and array structures
- Design methods

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The First Computer (1832)



The Babbage Difference Engine (1832)

25,000 parts cost: £17,470

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ENIAC - The first electronic computer (1946)



The Transistor Revolution



First transistor Bell Labs, 1948

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The First Integrated Circuits



Bipolar logic 1960's

ECL 3-input Gate Motorola 1966

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Intel 4004 Micro-Processor (1971)



1971 2,300 transistors 108 KHz operation

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Intel Pentium 4 microprocessor (2000)



42 M transistors (217 mm²)

1.5 GHz

0.18 μm

180 nm technology node

What Happened over 30 Years?



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Die Size Growth







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Productivity Trends



Courtesy, ITRS Roadmap



