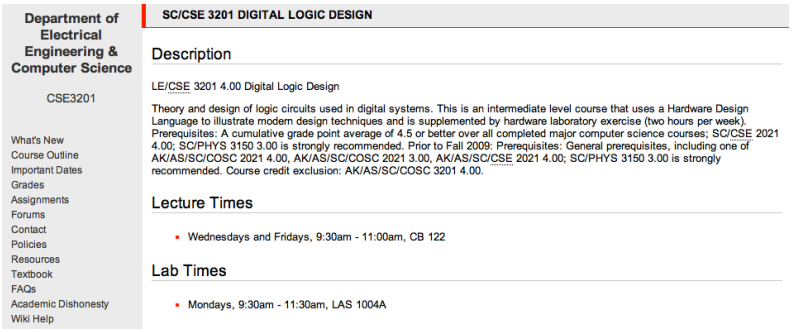
LE/CSE 3201 Fall 2013

L1: Introduction to Digital Systems

Sebastian Magierowski
York University

Web Stuff

- Course Wiki
  - https://wiki.cse.yorku.ca/course_archive/2013-14/F/3201/



Department of Electrical Engineering & Computer Science

CSE3201

What's New
Course Outline
Important Dates
Grades
Assignments
Forums
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Policies
Resources
Textbook
FAQs
Academic Dishonesty
Wiki Help

SC/CSE 3201 DIGITAL LOGIC DESIGN

Description

LE/CSE 3201 4.00 Digital Logic Design

Theory and design of logic circuits used in digital systems. This is an intermediate level course that uses a Hardware Design Language to illustrate modern design techniques and is supplemented by hardware laboratory exercise (two hours per week). Prerequisites: A cumulative grade point average of 4.5 or better over all completed major computer science courses; SC/CSE 2021 4.00; SC/PHYS 3150 3.00 is strongly recommended. Prior to Fall 2009: Prerequisites: General prerequisites, including one of AK/AS/SC/COSC 2021 4.00, AK/AS/SC/COSC 2021 3.00, AK/AS/SC/CSE 2021 4.00; SC/PHYS 3150 3.00 is strongly recommended. Course credit exclusion: AK/AS/SC/COSC 3201 4.00.

Lecture Times

- Wednesdays and Fridays, 9:30am - 11:00am, CB 122

Lab Times

- Mondays, 9:30am - 11:30am, LAS 1004A

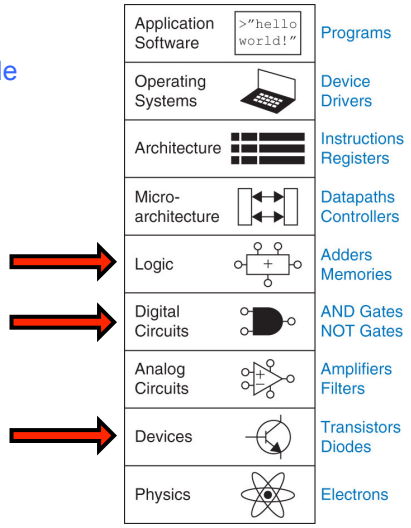
- Marks on Moodle

Mark Breakdown

Component	Percentage
Assignments (4, 1st one due Wed. Sept. 25)	10
Labs (9, 1st one on Sept. 23)	15
Midterm (tentatively on Wed. Oct. 23)	25
Final	50

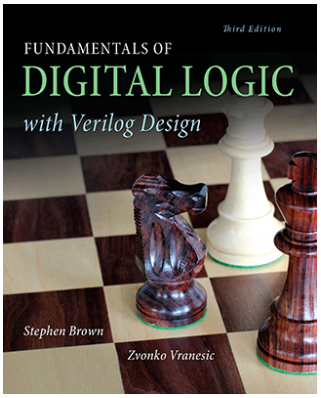
Digital Logic Design

- We'll be studying logic circuits
  - stuff from which computers are made
  - treat signals as 1's and 0's
- Not just the desktop
  - embedded computers
  - everything is a computation
    - scientific calculations
    - spreadsheets
    - financial data
    - images
    - biometrics



Textbook & Topics

- Textbook: Fundamentals of Digital Logic with Verilog Design
- Ch. 1 – 6 + B
  1. General Introduction
  2. Intro. to Logic Circuits
  3. Numbers and Arithmetic Circuits
  4. Combinational Circuits
  5. Flip-Flops, Registers, and Counters
  6. Synchronous Sequential Circuits
  B. Implementation Technology



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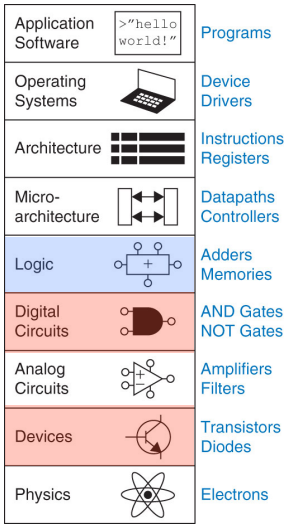
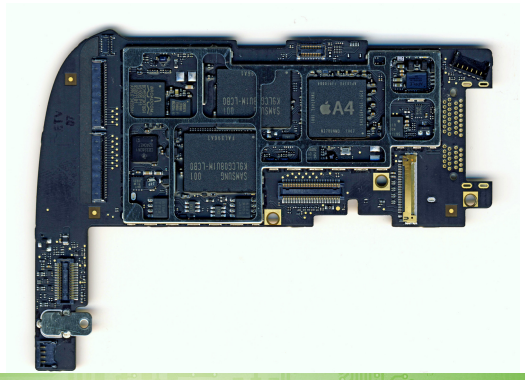
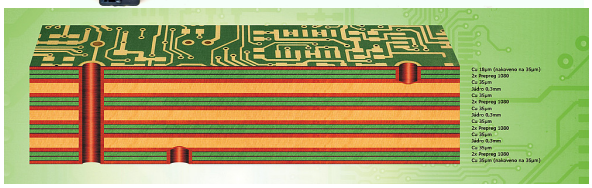


Digital Hardware: Boards

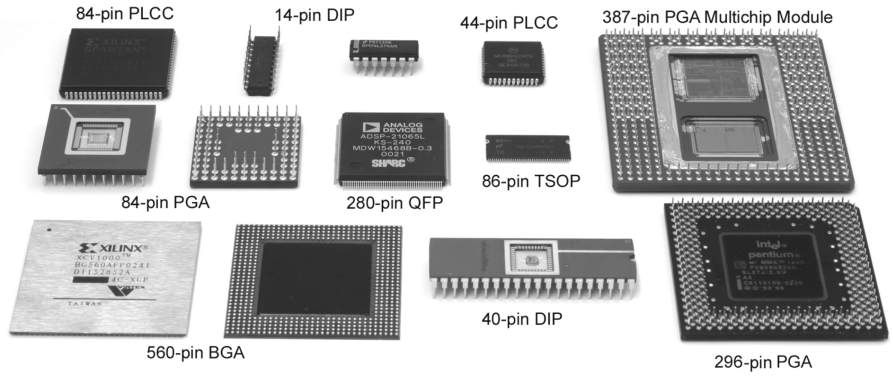
- Board
  - layers of conductors & insulators
    - copper
    - fiberglass, Teflon, etc.
    - core
  - pattern each layer
  - interspersed with a glue
    - dielectric with epoxy resin mixed in
    - prepreg
  - then press and heat





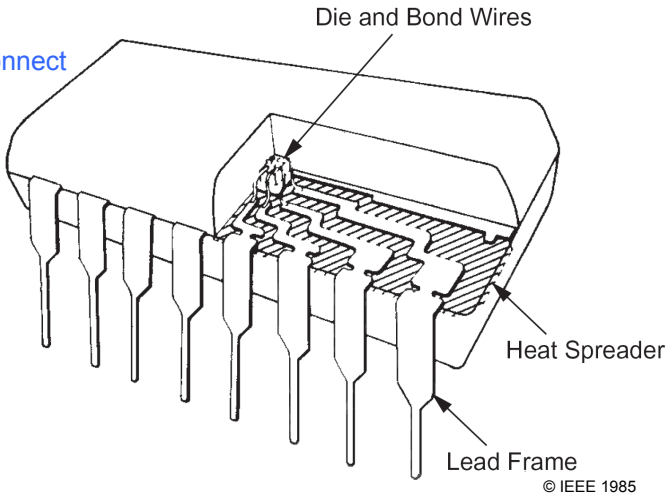
Digital Hardware: Packages

- The rectangular stuff all over the board
  - plastic, ceramics
  - 10-1000 pins/bumps (I/O a big issue in digital systems today)



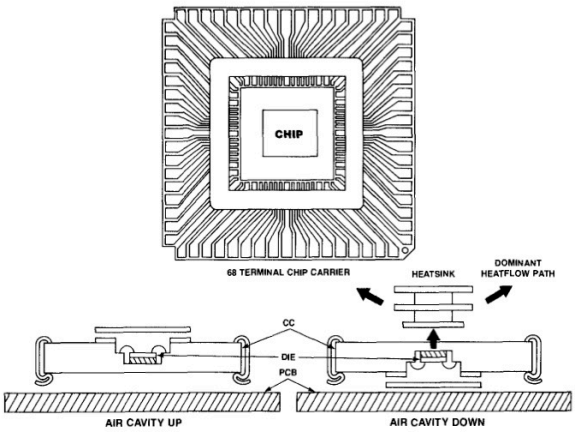
Digital Hardware: Intra-Packages

- Basic DIP stuff
  - re-flow plastic
  - simple interconnect



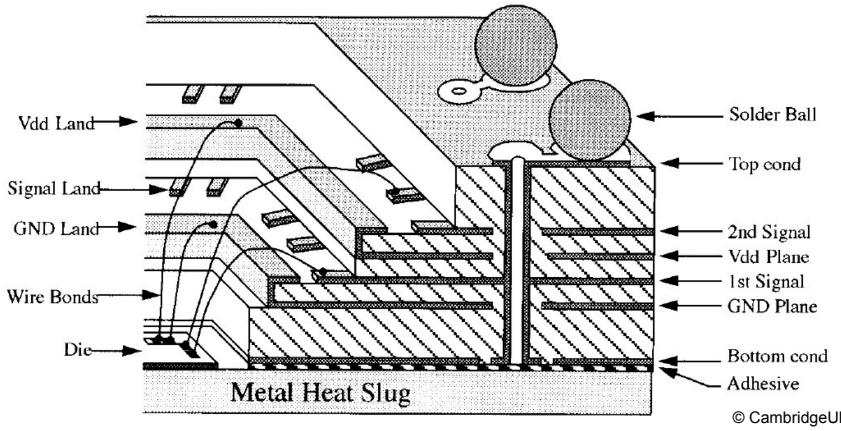
Digital Hardware: Intra-Packages

- Advanced packages
  - chips placed on ceramic substrate and sealed in air cavity (up or down)



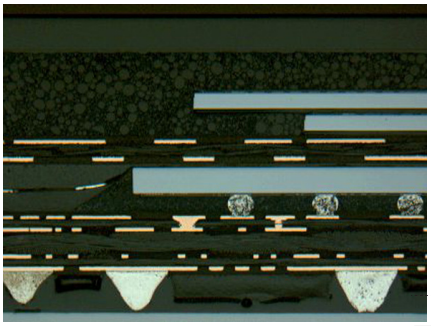
Digital Hardware: Intra-Packages

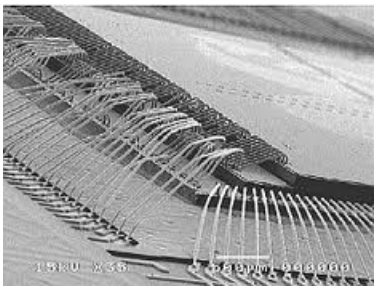
- Advanced packages
  - like mini boards

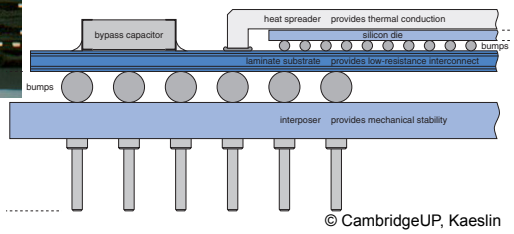


Digital Hardware: Intra-Packages

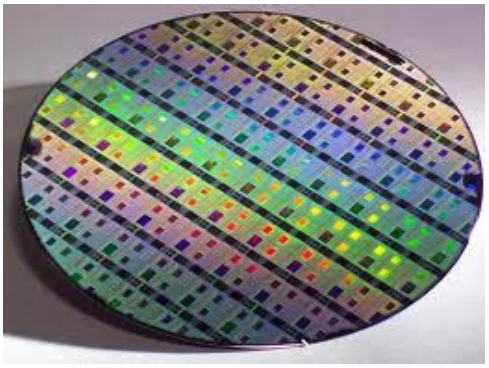
- Advanced packages
  - flip-chip and 3D stacking





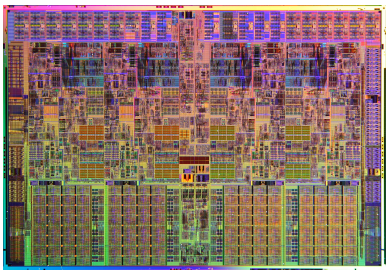


Digital Hardware: Wafers

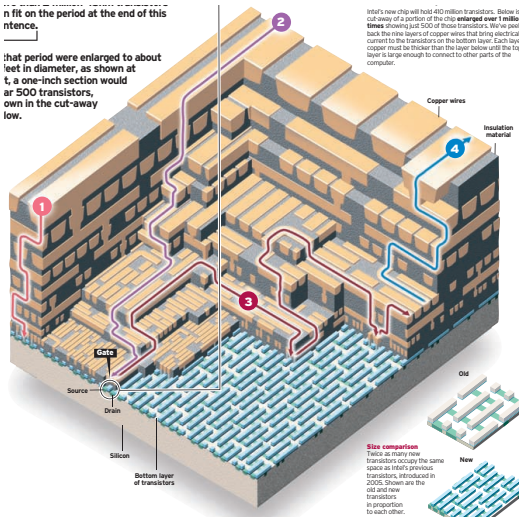


30 cm diameter wafer

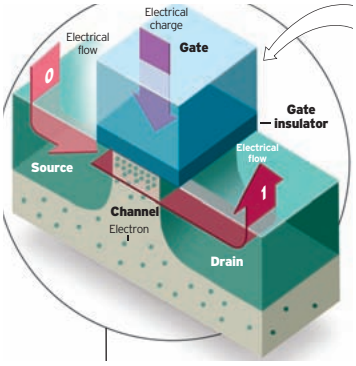
- chips ~ 25 mm on a side
- ~ 100 per wafer
- ~ 15 operational in new tech



Digital Hardware: Chips

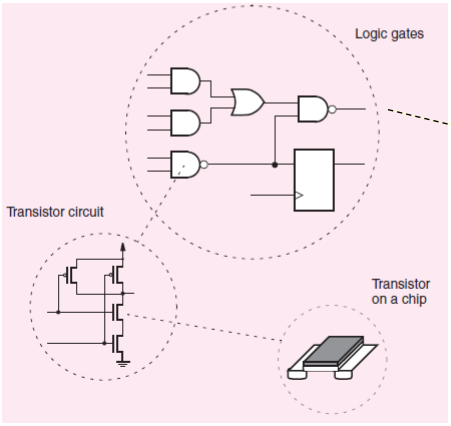


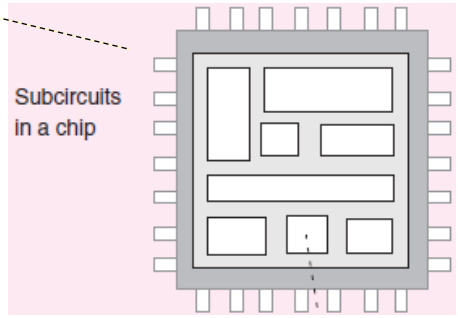
source: Steve Cowden
THE OREGONIAN



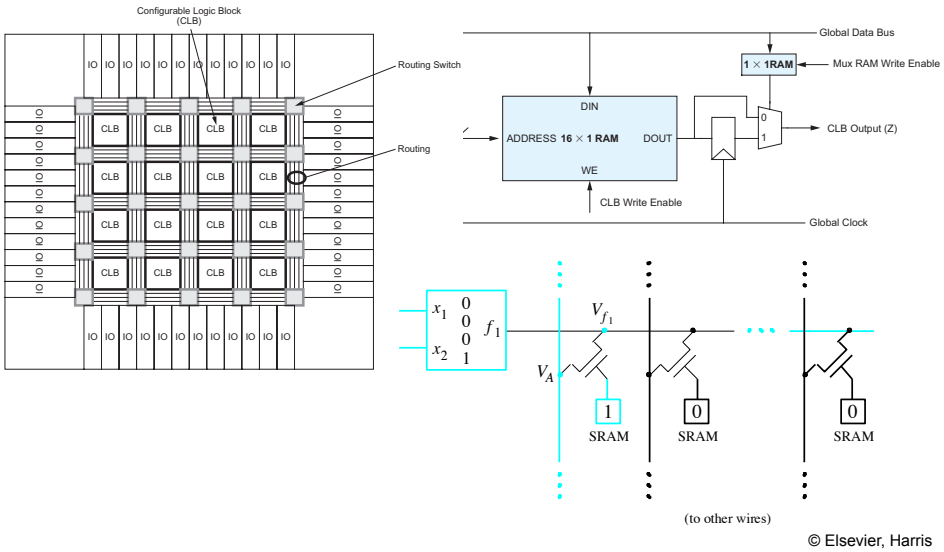
On Chip

- From transistors to…
- …circuits
- …gates
- …sub-systems, etc.

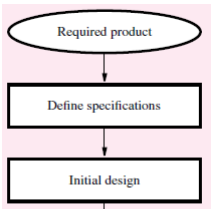


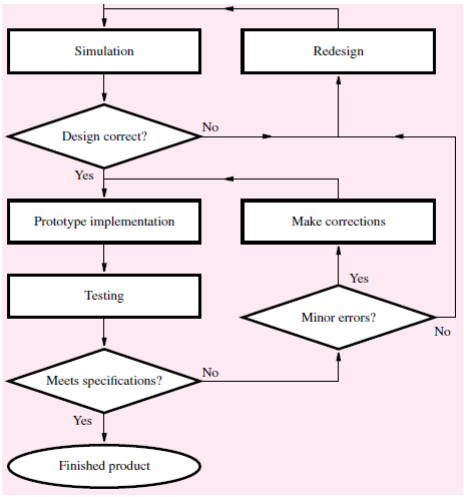


FPGAs



Design Process





The Three-Y's

- **Hierarchy**
  - A system divided into modules and submodules
- **Modularity**
  - Having well-defined functions and interfaces
- **Regularity**
  - Encouraging uniformity, so modules can be easily reused

Abstraction & Discipline

- Complex systems are possible because of simplifications
- Digital Abstraction
  - physical world values are (seemingly) continuous
  - digital abstracts this to only a discrete subset
- Digital Discipline
  - limiting of design choices
  - Two discrete values: much simpler to design, easy to combine into sophisticated components
    - 1's and 0's
    - 1, TRUE, HIGH
    - 0, FALSE, LOW
  - Digital circuits use voltage to represent 1 and 0
  - Bit: Binary digit

Number Systems: Positional Notation

- Decimal numbers

1000's column 100's column 10's column 1's column

5374_{10} =

- Binary numbers

8's column 4's column 2's column 1's column

1101_2 =

Powers of Two

- 2^0 =
- 2^1 =
- 2^2 =
- 2^3 =
- 2^4 =
- 2^5 =
- 2^6 =
- 2^7 =
- 2^8 =
- 2^9 =
- 2^{10} =
- 2^{11} =
- 2^{12} =
- 2^{13} =
- 2^{14} =
- 2^{15} =

- Handy to memorize up to 2^9

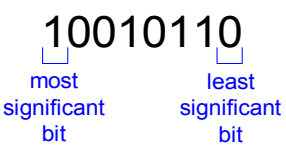
Number Conversion

- Binary to decimal conversion:
  - Convert 10011_2 to decimal

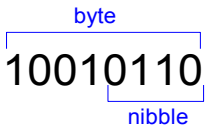
- Decimal to binary conversion:
  - Convert 47_{10} to binary

Bits, Bytes, Nibbles…

- Bits



- Bytes & Nibbles



- Bytes

Binary Values and Range

- *N*-digit decimal number
  - How many values?
  - Range?
  - Example: 3-digit decimal number:

- *N*-bit binary number
  - How many values?
  - Range:
  - Example: 3-digit binary number:

Large Powers of Two

- 2^{10} = 1 kilo ≈ 1000 (1024)
- 2^{20} = 1 mega ≈ 1 million (1,048,576)
- 2^{30} = 1 giga ≈ 1 billion (1,073,741,824)

Estimating Powers of Two

- What is the value of 2^{24}?
- How many values can a 32-bit variable represent?