Computer-Aided Design

Introduction

Mahdi Aminian

The University Of Guilan
Rasht - Iran

Computer-Aided Design

- Course: 3 hours/week

- Textbooks:

  - طراحی کامپیوتری سیستم‌های دیجیتال، دکتر صاحب الزمانی

  - Any Notes about VHDL, FPGA, and Digital Design Automation

  [1] S. Palnitkar, *Verilog HDL: A Guide to Digital Design and Synthesis*. SunSoft Press, 2nd ed. 2003.
  [2] V. A. Pedroni, *Circuit Design with VHDL*. MIT Press, 2011.
  [3] C. Maxfield, *The Design Warrior's Guide to FPGAs: Devices, Tools and Flows*. Elsevier Pub., 2004.

  - http://esd.cs.ucr.edu/labs/tutorial/

  - P.P. Chu, RTL Hardware Design Using VHDL: Coding for Efficiency, Portability, and Scalability, Wiley-Interscience, 2006.

  - A. Rushton, *VHDL for Logic Synthesis*, 3rd ed.: Wiley, 2011.

  - Ulrich Heinkel, et al, "The VHDL Reference: A Practical Guide to Computer-Aided Integrated Circuit Design including VHDL-AMS," Wiley, 2000.

  - Z. Salcic, A. Smailagic, "Digital Systems Design and Prototyping Using Field-Programmable Logic and Hardware Description Languages", 2nd Edition, 2000

Computer-Aided Design

- Grading policy
  - Homework 20%
    - Delay (<1 week) → -50%, >1 week → "0"
  - Project 25%
  - Midterm 25%
  - Final exam: 30%

- **توجه مهم**: کسب حداقل 40% امتحان پایان ترم و پروژه پایانی الزامی است.

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  - Mrs. Asma Naseri Rad: asmanaserirad24@gmail.com

Computer-Aided Design

- Slides Address:

  https://www.dropbox.com/sh/renz9eljm8x1crt/AAB52LOzVYujT1SzXN45kg9ia?dl=0

- Assignments Upload Address:

  https://www.dropbox.com/request/3knDRN3iOOxdTWABo7Nh

  Note: name starts with "**CAD**"+…

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Syllabus

١- مقدمات و مفاهیم اولیه
- تاریخچه‌ی سیستم‌های دیجیتال
- بررسی روند رشد صنعت طراحی سیستم‌های دیجیتال
- ابزارها و زبان‌های طراحی خودکار سخت‌افزار
- چرخه‌های طراحی ASIC و FPGA و مقایسه‌ی آنها
- سبک‌های طراحی سخت‌افزار
- سطوح انتزاعی طراحی سخت‌افزار

٢- زبان‌های توصیف سخت‌افزار

٣- آموزش زبان توصیف VHDL/Verilog

۴- سنتز سخت‌افزار
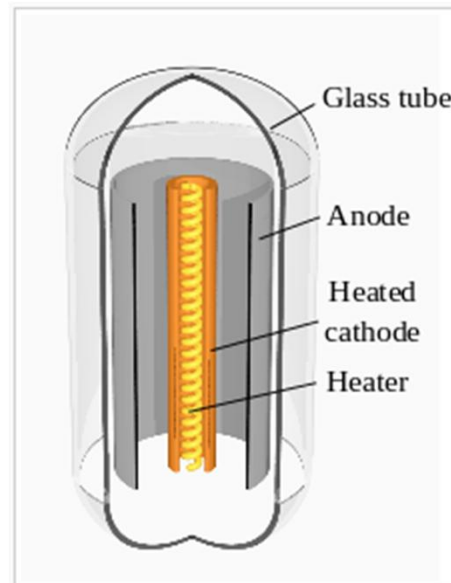
۵- طراحی سیستم‌های دیجیتال با PLD

ابزارهای ISE، Quartus، Leonardo و Modelsim که برای سنتز و شبیه‌سازی تراشه‌های ASIC و FPGA	نرم‌افزارهای مورد نیاز

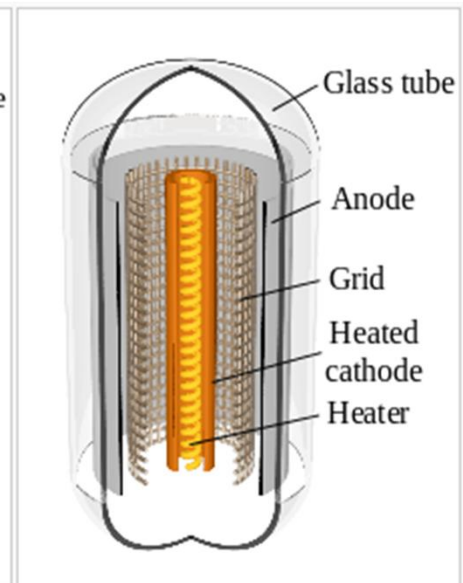CAD   Mahdi Aminian

INTRODUCTION

Vacuum Tube

The 1946 ENIAC computer used 17,468 vacuum tubes and consumed 150 kW of power

Diode: electrons from the hot cathode flow towards the positive anode, but not vice versa

Triode: voltage applied to the grid controls plate (anode) current.

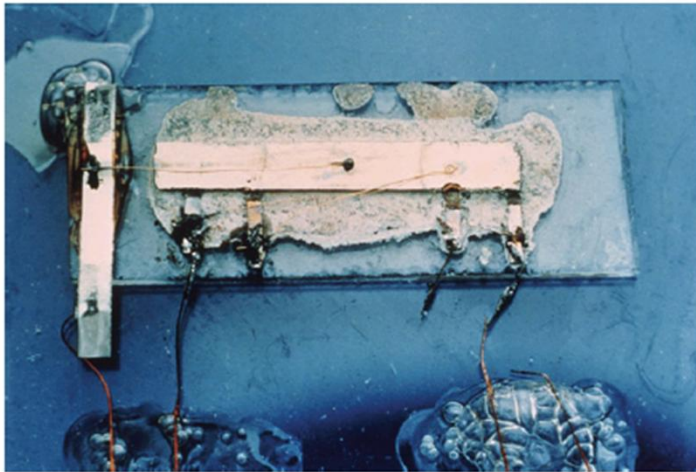CAD   Mahdi Aminian

First Transistors - 1947

John Bardeen, William Shockley
and Walter Brattain at Bell Labs, 1948.

A replica of the first working
transistor.

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First IC - 1958

Jack Kilby
Texas Instruments
Invented IC during his first year at TI

(Nobel Prize 2000)
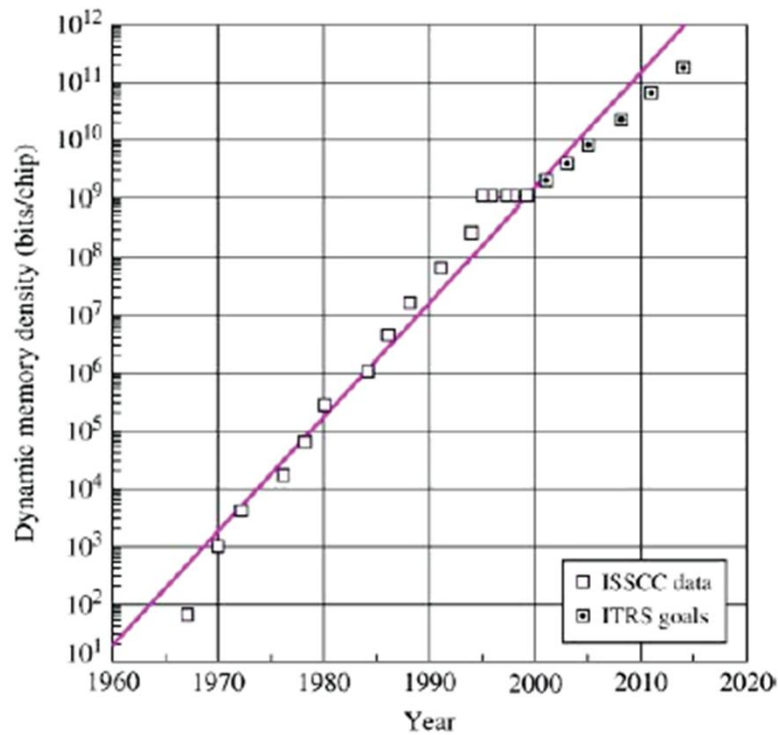
"Solid Circuit" made of Ge
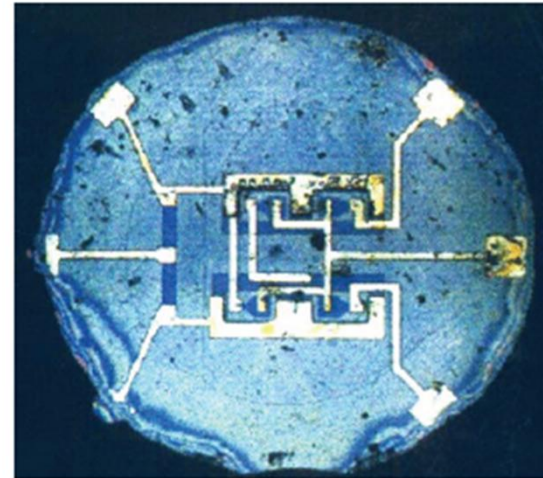
R. N. Noyce
Fairchild Semiconductor
Co-Founder of both
Fairchild and Intel
(deceased 1990)

"Unitary Circuit" made of Si

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Moore's Law

Memory chip density versus time

Microprocessor complexity versus time

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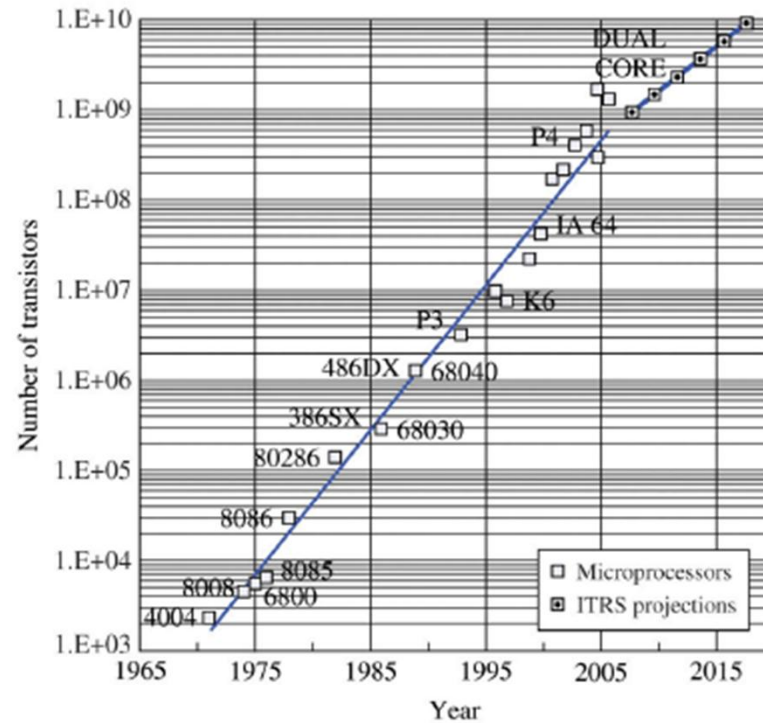
Intel Core i7-980X (6 cores)
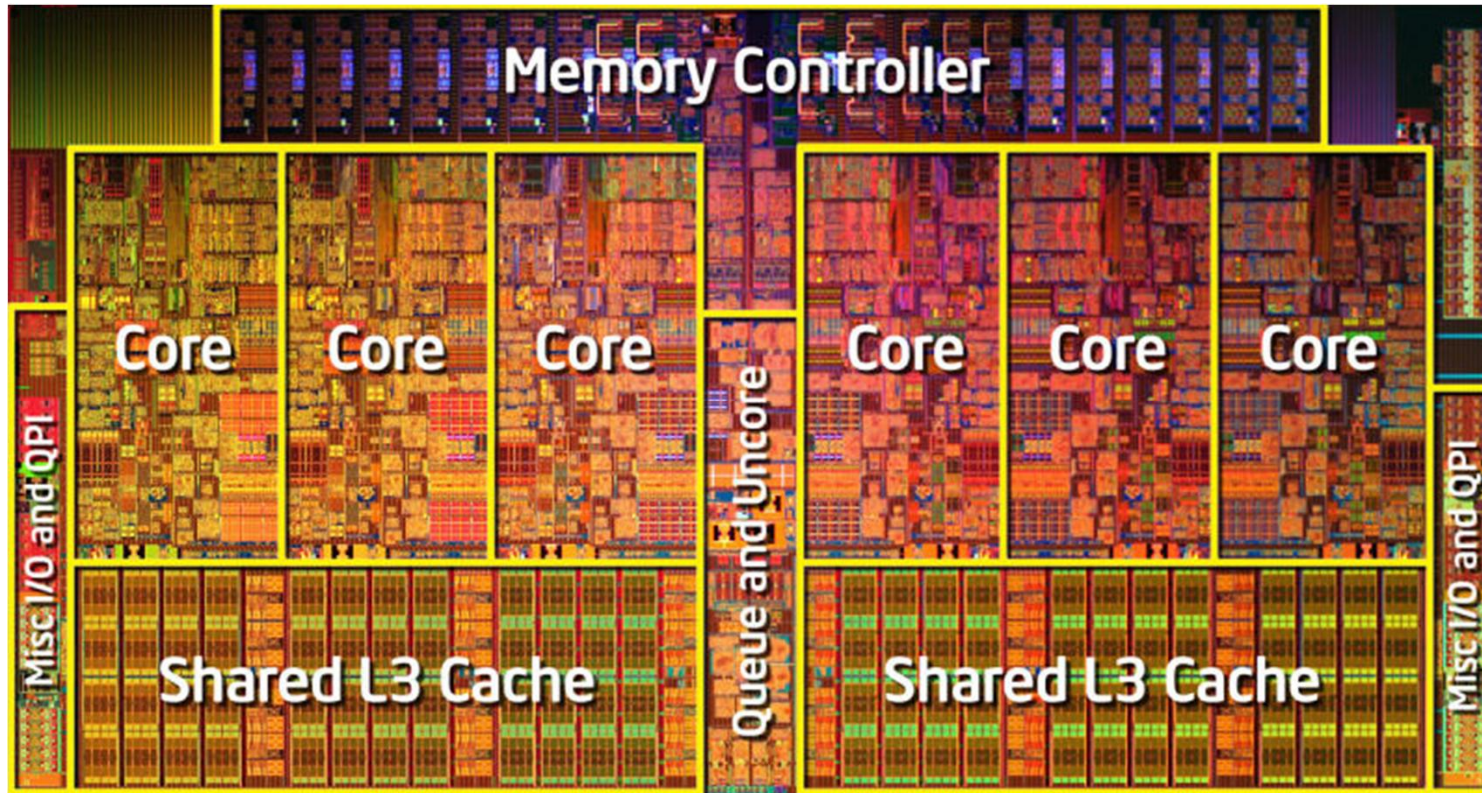
Intel i7-980X, (12MB Cache, 3.33 GHz)
6 cores, 32 nm, 240 mm^2, 1.17 billion transistors

Most powerful processor has about 10B transistors today.
Most powerful FPGA has 20B+ transistors.

CAD   http://en.wikipedia.org/wiki/Transistor_count

Digital Circuits

```
                              ┌─────────┐
                              │  Logic  │
                              └────┬────┘
              ┌────────────────────┴────────────────────┐
        ┌───────────┐                              ┌─────────┐
        │ Standard  │                              │  ASIC   │
        │  Logic    │                              └────┬────┘
        └───────────┘         ┌──────────┬──────────────┼──────────────┐
                       ┌───────────┐  ┌────────┐   ┌──────────┐   ┌────────────┐
                       │Programmable│ │ Gate   │   │Cell-Based│   │Full Custom │
                       │Logic Dev.  │ │ Arrays │   │   ICs    │   │    ICs     │
                       │ (FPLDs)    │ └────────┘   └──────────┘   └─────┬──────┘
                       └─────┬──────┘                                   │
              ┌──────────────┼──────────────┐                   ┌──────────────┐
        ┌──────────┐   ┌──────────┐   ┌──────────┐              │Microprocessor│
        │  SPLDs   │   │  CPLDs   │   │  FPGAs   │              │   & RAM      │
        │(e.g.,PALs)│  └──────────┘   └──────────┘              └──────────────┘
        └──────────┘
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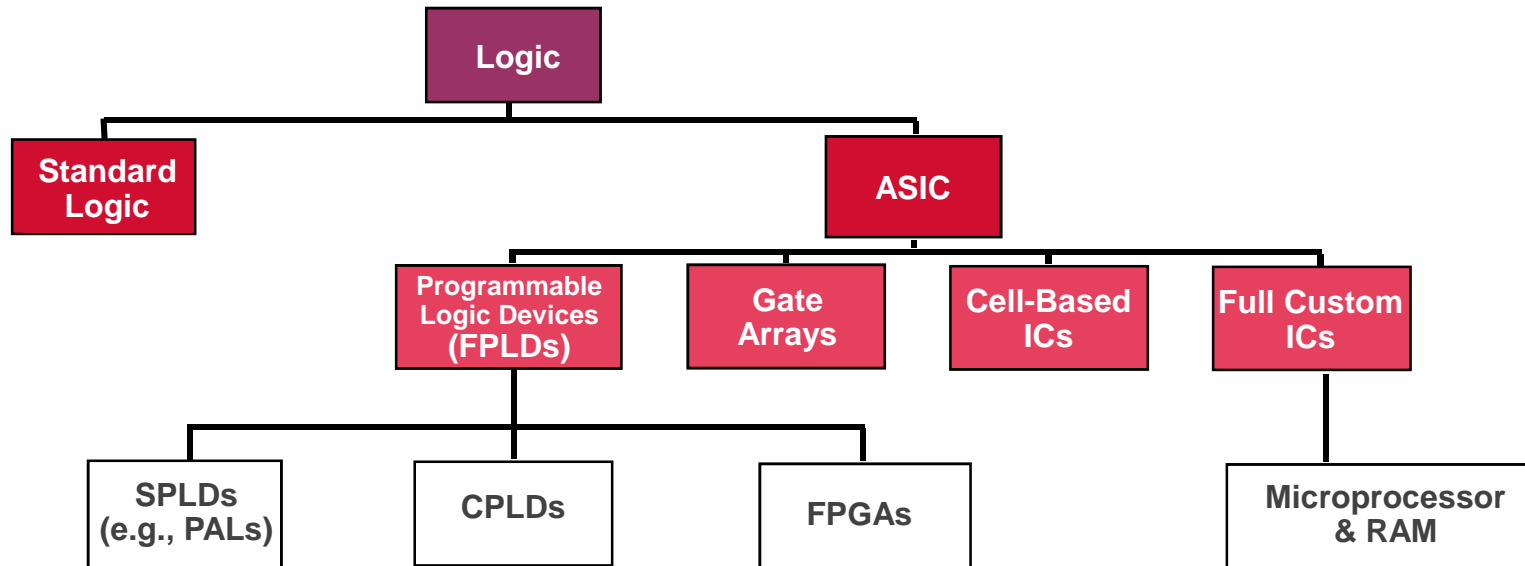
Acronyms

SPLD = Simple Programmable Logic Device
PAL = Programmable Array Logic
CPLD = Complex PLD
FPGA = Field Programmable Gate Array
ASIC = Application Specific IC

Common Resources

Configurable Logic Blocks (CLB)
– Memory Look-Up Table (LUT)
– AND-OR planes
– Simple gates
Input / Output Blocks (IOB)
– Bidirectional, latches, inverters, pullup/pulldowns
Interconnect or Routing
– Local, internal feedback, and global

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