

In The Name Of
Allah

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DIGITAL LOGIC CIRCUITS

Ali Shahhoseini

**Department of Electrical
Engineering**

**Islamic Azad University
Qazvin Branch**

DIGITAL LOGIC CIRCUITS

- *Instructor:* Ali Shahhoseini
- *Email:* shahhoseini@qazviniau.ac.ir
Shahhoseini@yahoo.com
- *Class Hours:* Thursday: 16:30_19:30
- *References:*
 1. Digital logic circuits analysis and design ,V.P. Nelson et. Al. , Printice_Hall,1995.
 2. Digital Design,M. Mano , Printice_Hall,2000.
- *Grading:*
 - Homework: 10%
 - Midterm: 30%
 - Final: 60%

Topic covered

- Introduction
- 1. Number systems and codes
- 2. Algebraic Methods for the Analysis and Synthesis of Logic Circuits
- 3. Simplification of Switching Function
- 4. Modular Combinational logic
- 6. Introduction to Sequential Devices
- 8. Analysis and Synthesis of Synchronous Sequential Circuits
- 7. Modular Sequential Logic

Chapter 0 Introduction

0.1 History of Computing

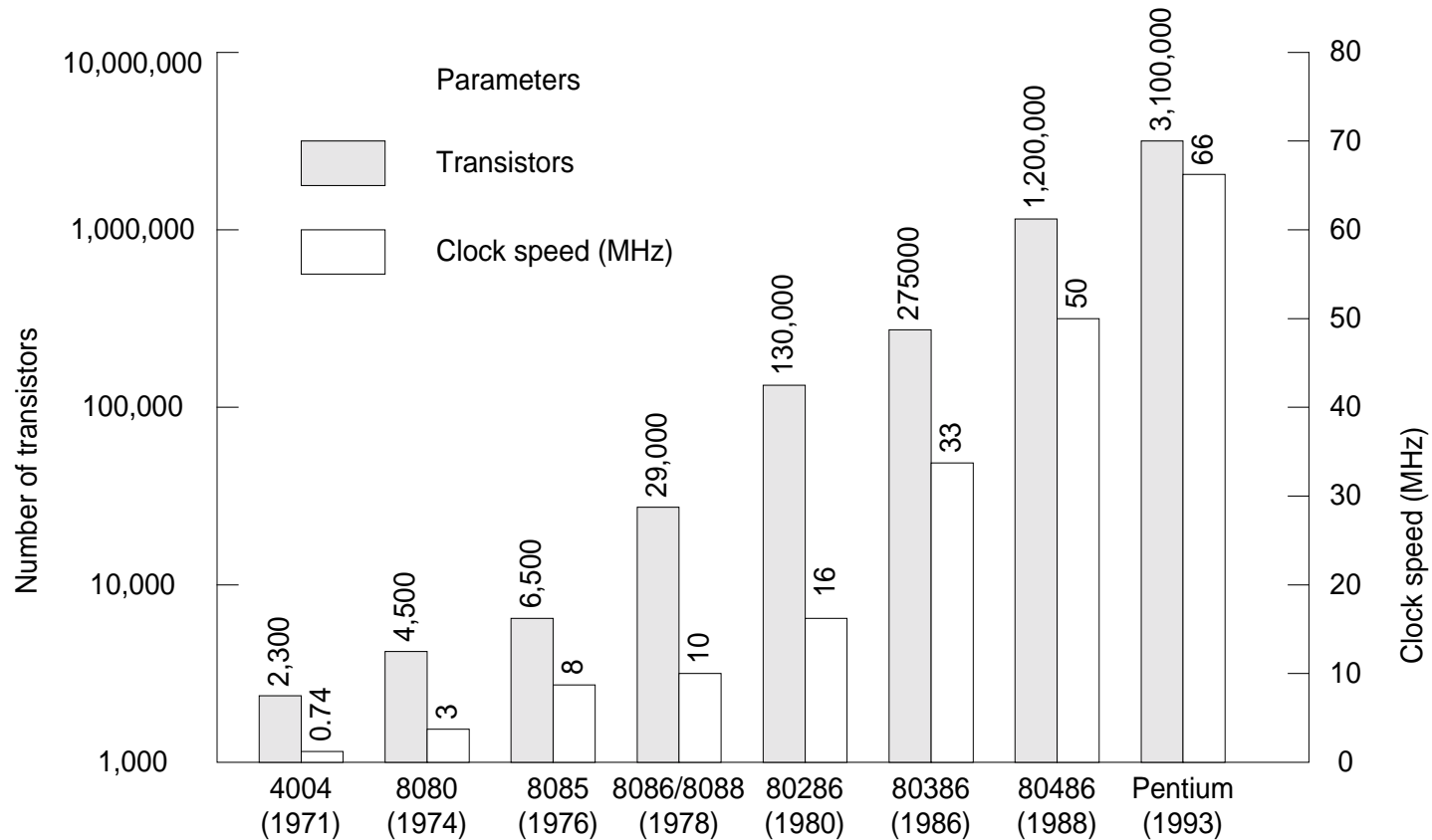
- Abacus (ancient orient, still in use).
- Slide rule (17C, John Napier).
- Adding machine with geared wheels (17C, B. Pascal).
- Difference Engine (19C, C. Babbage): First device using the principles of modern computer.
- ENIAC (1945, John Mauchly and J. Presper Eckert, Jr.).
 - ✓ Vacuum tube computer (18,000 electron tubes).
- Three important inventions.
 - ✓ Stored program concept (John von Neumann).
 - ✓ Transistor (J. Bardeen, W.H. Brattain, W. Shockley).
 - ✓ Magnetic core memory (J.W. Forrester and colleagues in MIT).

0.1 History Of Computing

- First generation: Vacuum tube computers (1940s - 1950s)
- Second generation (1950s): Transistors
- Third generation (1960s and 1970s): Integrated circuits
- Fourth generation (late 1970s through present): LSI and VLSI
 - Personal computers, computer networks, WWW, etc.
- Next generation:
 - New user interfaces (voice activation, etc.)
 - New computational paradigm (parallel processing, neural network, etc.)
 - Parallel processing, artificial intelligence, optical processing, visual programming, gigabit networks, etc.

0.1 History of Computing

➤ Evolution of Intel Microprocessor



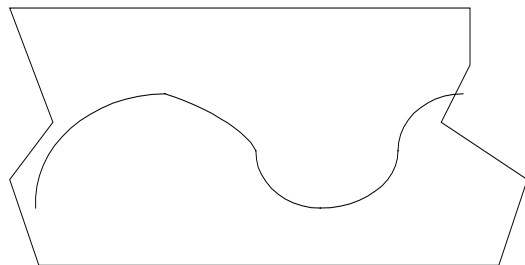
Evolution of the Intel microprocessors.

0.2 Digital Systems

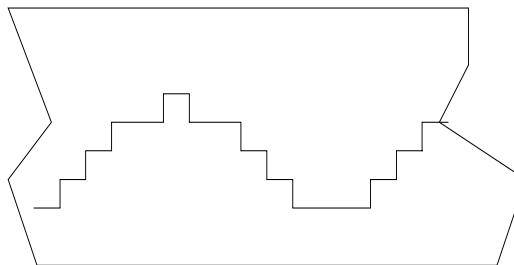
➤ Analog vs. Digital: Continuous vs. discrete.

Digital computers replaced analog computers:

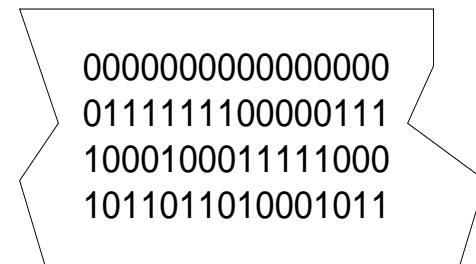
- More flexible (easy to program), faster, more precise.
- Storage devices are easier to implement.
- Built-in error detection and correction.
- Easier to minimize.



(a) Analog form



(b) Sampled analog form

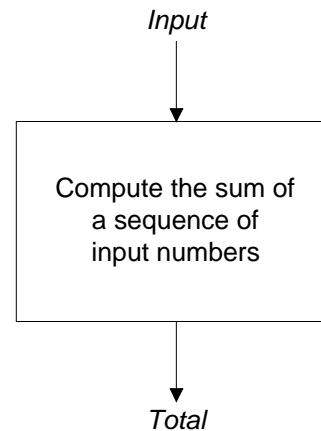


(c) Digital form

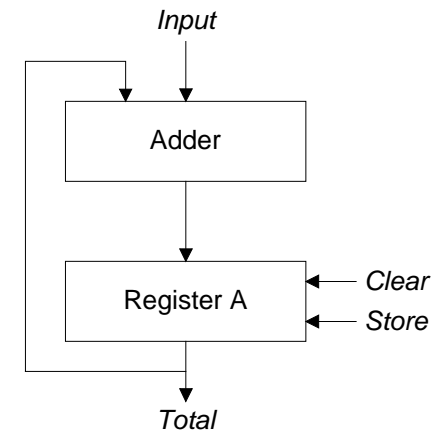
Magnetic tape containing analog and digital forms of a signal.

0.2 Digital Systems

- *Design Hierarchy(1)*
- System level -
Register level - Gate
level - Transistor and
physical design level
- System level: Black
box specification.
- Register level:
Collection of registers.



(a) System Level

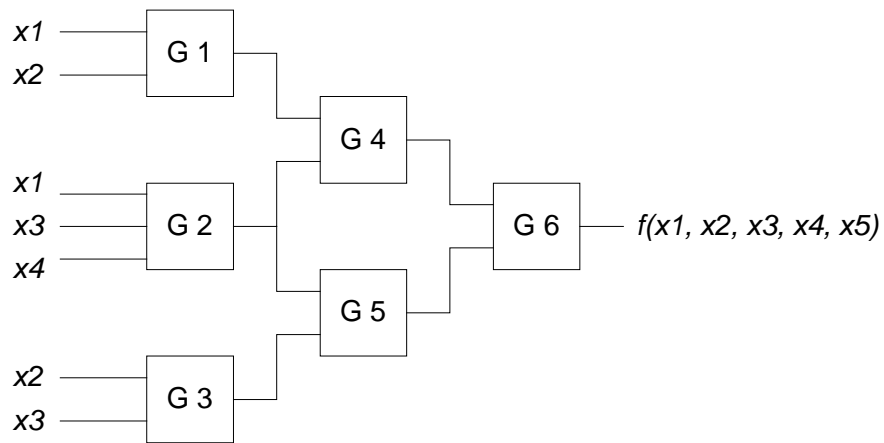


(b) Register Level

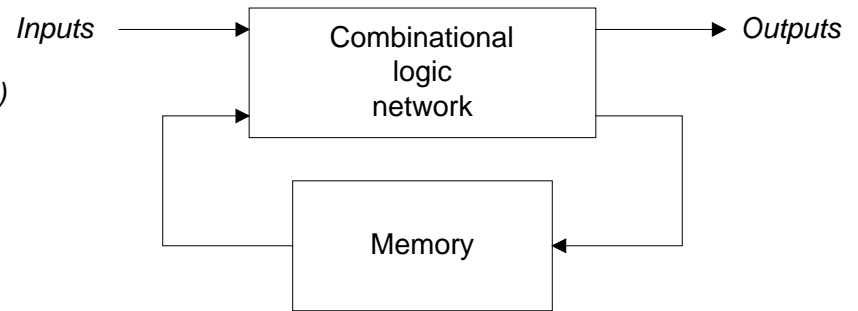
Models of a digital system that adds lists of numbers.

0.2 Digital Systems

- *Design Hierarchy (2)*
- Gate level: Collection of logic gates.



A combinational logic circuit with six gates.



Sequential logic circuit.

0.2 Digital Systems

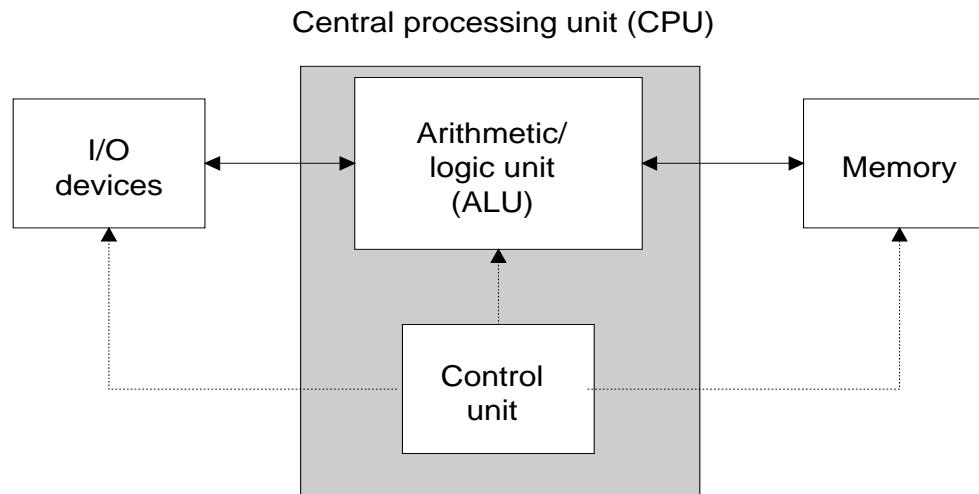
- *Design Hierarchy (3)*
- Transistor and physical design level: Each logic gate is implemented by a lower-level transistor circuit.
- Electronic Technologies:

Technology (Device Type)	Power Consumption	Speed	Packaging
RTL (Bipolar junction)	High	Low	Discrete
DTL (Bipolar junction)	High	Low	Discrete, SSI
TTL (Bipolar junction)	Medium	Medium	SSI, MSI
ECL (Bipolar junction)	High	High	SSI, MSI, LSI
pMOS (MOSFET)	Medium	Low	MSI, LSI
nMOS (MOSFET)	Medium	Medium	MSI, LSI, VLSI
CMOS (MOSFET)	Low	Medium	SSI, MSI, LSI, VLSI
GaAs (MOSFET)	High	High	SSI, MSI, LSI

0.3 Organization of a Digital Computer

Four Major Components

- Control unit: Follows the stored list of instructions and supervises the flow of information among other components.
- Arithmetic/logic unit (ALU): Performs various operations.
- Memory unit: Stores programs, input, output, and intermediate data.
- I/O devices: Printers, monitors, keyboard, etc.



High-level organization of a digital computer.

0.3 Organization of a Digital Computer

Instruction Cycle

- Fetch the next instruction into the control unit.
- Decode the instruction.
- Fetch the operands from memory or input devices.
- Perform the operation.
- Store the results in the memory (or send the results to an output device).



Instruction cycle of a stored program computer.

0.3 Organization of a Digital Computer

Computer Instructions

- Arithmetic instructions.
- Test and compare instructions.
- Branch or skip instructions.
- Input and output commands.
- Logical and shift operations.

0.3 Organization of a Digital Computer

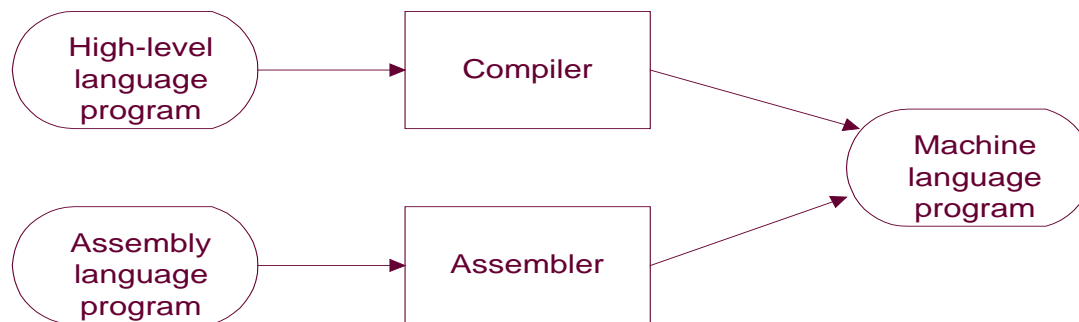
Information Representation

- Numeric data: Binary number system.
- Numeric (Input/Output) codes: ASCII.
- Instruction codes: Operation code and memory addresses of operands and result.

0.3 Organization of a Digital Computer

Software

- Programming: The process of designing a list of instructions.
- Application programs: Word processor, spreadsheet, drawing programs, inventory management programs, accounting programs, etc.
- System programs: Operating systems, language translation programs, utility programs, performance monitoring programs, etc.



Translation of computer programs into machine language