

# CSE 241

## Introduction to Digital Systems

### Digital Systems

#### ● What is a digital system?

- ☞ A digital system is a system which is capable of manipulating discrete elements of information.
- ☞ Digital information is represented by a set consisting of a finite number of elements.
  - ↳ Example
    - ✓ 26 letters of the alphabet
    - ✓ 10 decimal digits
  - ↳ The use of digits as the discrete elements led to the term *digital computers*.

### Discrete Elements

#### ● How are *discrete* elements represented?

- ☞ Signals are the physical quantities used to represent discrete elements of information in a digital system.
- ☞ Electric signals used:
  - ↳ Voltage
  - ↳ Current

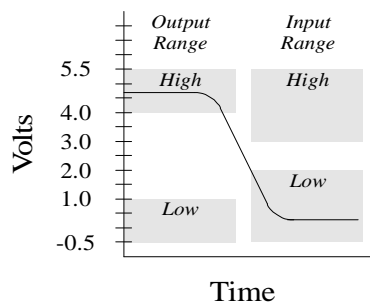
### The Binary System

#### ● Two discrete values are used in digital systems.

#### ● Binary Values

- ☞ High/Low
- ☞ True/False
- ☞ 1/0

#### ● Representation of Binary Values



- ☞ Why are the input ranges wider than the output ranges?
  - ↳ Variations in circuit behavior & noise

- Why use binary?

- ☞ Complex & costly circuits would be required for the circuits to operate properly

- ↳ Why?

- ✓ Noise

- ✓ Small variations in circuits due to manufacturing and the environment

- ☞ Counter example

- ↳ A system using 10 discrete values (one for each decimal digit).

## Bits

- Bit

- ☞ A binary digit

- ↳ 1,0

- Bits are grouped to represent both data and instructions in a digital system

- Coding Techniques

- ☞ Defines how bits are grouped together to represent information

- ☞ Types

- ↳ Numeric

- ↳ Character

- ↳ Error Detection/Correction

- ☞ Examples

- ↳ Numeric

- ✓ Fixed Point

- Signed integers & fractions

- ✓ Excess or Biased Representation

- Large positive or negative numbers

- ✓ Floating Point

- Scientific notation

- ↳ Character

- ✓ ASCII

- American Standard Code for Information Interchange

- ✓ BCD

- Binary Coded Decimal

- ✓ EBCDIC

- Extended Binary Coded Decimal Interchange Code

- ✓ Gray Code

- Cyclic code

- Any two (2) consecutive code words differ by only one (1) bit

- Circular shift produces another code word

- ↳ Error Detection/Correction

- ✓ Parity

- ✓ Hamming

- ✓  $m$  out of  $n$  codes

## Bits & Bytes

- Nibble
  - ☞ 4 bits
- Byte
  - ☞ 8 bits
- Word
  - ☞ Depends on specific hardware
  - ☞ 16, 32, 64, 128 bits
  - ☞ Words may also be extended to
    - ↳ Halfword
    - ↳ Doubleword

## The Digital Computer

- Organization
  - ☞ Input
  - ☞ Processor
    - ↳ Control
    - ↳ Arithmetic
  - ☞ Memory
    - ↳ Store instructions & data
    - ↳ *Addresses*
      - ✓ Indicate location of stored data
    - ↳ Note that processor contains a very limited amount of high speed memory called *registers*.
  - ☞ Output
- A digital computer can solve very complex problems, but it can only perform very simple operations
  - ☞ Instructions
    - ↳ Add, Subtract, Shift, Rotate, AND, OR, NOT, Compare, Jump, & Branch
  - ☞ Program
    - ↳ A collection of instructions which perform a designated task
- Data
  - ☞ Representation of information
  - ☞ Bits
- Operation
  - ☞ Instruction fetched from memory
    - ↳ Stored in *instruction register*
    - ↳ *Program counter* holds address of next instruction
  - ☞ Instruction decoded
  - ☞ Execution
    - ↳ Instruction performed
  - ☞ Write back
    - ↳ Results stored

## ● Overview

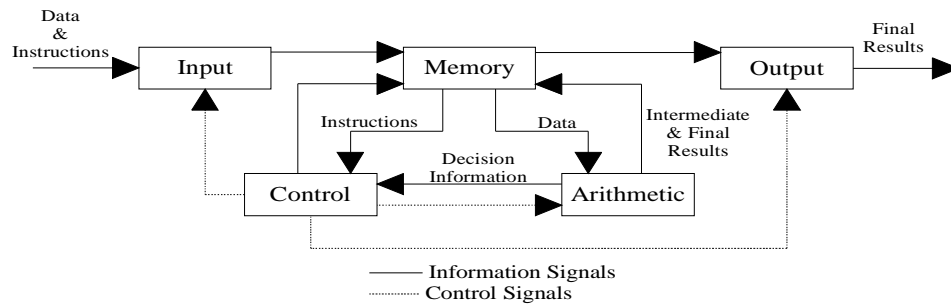


Figure 1.1, page 3, Donald D. Givone, *Digital Principles and Design*, McGraw-Hill, 2003

## References

- Donald D. Givone, *Digital Principles and Design*, McGraw-Hill, 2003
- M. Morris Mano and Charles R. Kime, *Logic and Computer Design Fundamentals*, Prentice Hall, Inc., 2000
- Victor P. Nelson, H. Troy Nagle, Bill D. Carroll, and J. David Irwin, *Digital Logic Circuit Analysis and Design*, Prentice Hall, Inc., 1995