جامعة الملك فهد للبترول والمعادن
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EE 200- Digital Logic Circuit Design
1.2 Binary Numbers
1.3 Number-Base Conversion
1.5 Complements

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Objectives

- Basic concepts of numbering systems.
- Binary numbers.
- Decimal to binary conversion.
- Binary to decimal conversion.

- **Basic Concepts**
  - What is 5123?
    - TH | H | T | O
    - 5 | 1 | 2 | 3
    - the number 5123 is

$$\{(5\times10^{3})+(1\times10^{2})+(2\times10^{1})+(3\times10^{0})\}$$

    - Each digit (bit) carries an arithmetic *weight*, based on its position in the string.

حسابي

- **Decimal Numbering**
  - In Latin, ***dec**em* means ten or related to ***ten***.
  - Number of possible characters = 10.
  - Using the digits 0-9.
  - Base (***radix***) of 10.

- **Binary Numbering**
  - Something that has only ***two*** status.
  - Number of possible characters = 2.
  - Using the digits 0 & 1.
  - Base (***radix***) of 2.

- **Positional Notation**
  - The weight depends on the *radix* and the position relative to the *radix* point.
  - $a_n \cdot r^n + a_{n-1} \cdot r^{n-1} + \cdots + a_2 \cdot r^2 + a_1 \cdot r^1 + a_0 \cdot r^0 + a_{-1} \cdot r^{-1} + a_{-2} \cdot r^2 + \cdots + a_{-m} \cdot r^{-m}$
  - $(110101)_2 = (X)_{10}$
  - $(4021.2)_5 = (X)_{10}$
  - How we convert from decimal to binary?

- **Convert 59 to binary**

  59/2 = 29 rem 1 (lsb)

  29/2 = 14 rem 1

  14/2 = 7 rem 0

  7/2 = 3 rem 1

  3/2 = 1 rem 1

  1/2 = 0 rem 1 (msb)

  1 + 2 + 8 + 16 + 32 = 59 59 = 111011

Basic addtion operations

- 0 + 0 = 0
- 1 + 0 = 1
- 1 + 1 = 10

$$\begin{array}{r} 1010 \\ +\ 1111 \\ \hline \end{array}$$

Basic Multiplication operations

- 1 X 1 = 1
- 1 X 0 = 0
- 0 X 1 = 0

$$\begin{array}{r} 101 \\ \times\ 11 \\ \hline \end{array}$$

Signed Magnitude:

The leading digit set it, "0" is positive and "1" is negatave.

One's Complement:

flip bits for -*ve* numbers

Two's Complement:

one's complement + 1

OR toggle bits after the *1st* 1 from the *LSB*

Signed Magnitude:

12 = 00001100

-12 = 10001100

One's Complement:

12 = 00001100

-12 = 11110011

Two's Complement:

12 = 00001100

-12 = 11110100

Summary

- Basic concepts of numbering systems.
- Binary numbers.
- Decimal ↔ binary conversion.

- **Next Lecture**
  - General number-base conversion.
  - Decimal ↔ Octal conversion.
  - Binary ↔ Octal ↔ Hex Shortcut.