Abdelhafid Boussouf University
Center of Mila

Structure of Computers and Applications
1st year ST – ENG & LMD

Part 1: Introduction to Computer Science

Lecture 01_02: Definition of Computer Science
Evolution of computing and computers
Computer Coding System

By

Dr. Farouk KECITA

Academic year : 2025/2026

1- Definition of Computer Science

what is Computer Science?

- Computer Science is the study of **computers** and **computational systems**.
- It encompasses the theory, development, and application of **software** and **hardware**, and involves algorithms, data structures, artificial intelligence, programming languages, and the design of computer systems and networks.
- Computer science focuses on the **automatic processing** of **information** by **computer**.
- With its interdisciplinary nature, computer science has driven innovation in healthcare, finance, transportation, and entertainment.

1- Definition of Computer Science

What are the main tasks of a computer?

The main tasks performed by a computer:

- **Data Processing**: Performing calculations and manipulating information.
- **Data Storage**: Storing data and programs for later use.
- **Data Retrieval**: Accessing and retrieving stored information.
- **Data Transmission**: Sending and receiving data over networks.
- **Control**: Managing and controlling external devices and systems.
- **User Interaction**: Providing interfaces for users to interact with the computer.
- **Automation**: Performing repetitive tasks automatically.
- **Analysis**: Analyzing data to extract insights and support decision-making.

These tasks enable computers to handle a wide range of functions across various fields.

2- Evolution of computing and computers

- The evolution of computing has happened over centuries thanks to numerous mathematician and physicist researchers. The evolution is marked by several key stages and breakthroughs:

Generation of Computers	Time Period	Evolved Hardware	Key Characteristics
First Generation	1940-1959	Vacuum tubes	Large size, high power consumption, limited memory
Second Generation	1950-1960	Transistors	Smaller size, increased reliability, reduced heat generation
Third Generation	1964-1971	Integrated circuits	Further size reduction, increased speed, improved efficiency
Fourth Generation	1972-present	Microprocessors	Personal computers, increased processing power, user-friendly interfaces
Fifth Generation	Present and beyond	AI hardware, neural networks	Machine learning capabilities, natural language processing
Sixth Generation	Emerging	Quantum processors, molecular computing	Massive parallel processing, potential for solving complex problems

3- Computer Coding System

Itroduction

- Computer processes different nature of Information (number, text, image, sound, video, …etc.)
- This information is always represented in a binary form (sequence of two digits 0 and 1) such as: 01001011, 11000011…..etc,
- The two digits (0 and 1) are referred to as **bit** (**bi**nary digi**t**).
- **Binary States:** In electronic systems, a bit is represented by two distinct electrical states:
  - **1 (High State):** Often represented by the presence of an electrical pulse or a high voltage level.
  - **0 (Low State):** Represented by the absence of an electrical pulse or a low voltage level.
- The process that allows to move from the initial representation of information (number, text, etc.) to a binary representation is called **information coding**.

3- Computer Coding System

Itroduction

- Information coding goes through the following stages:

1. **Representation of Information by a Sequence of Numbers:**

   Data Conversion: Initially, information (text, images, audio…) is converted into a numerical format. This is a crucial step because computers operate using numeric data.

2. **Encoding Each Number in Binary Form:**

   Binary Conversion: Once the information is represented numerically, each number is then encoded into binary format. Binary encoding is the process of converting decimal numbers (or other numeric bases) into binary, which is the fundamental language of computers.

- A number can be represented by different symbols depending on the used **number system**

3- Computer Coding System

What is Number System?

- A **number system** is indeed a system of writing used to express numbers, involving a **set of symbols** and **rules** to represent numerical values.
- The total number of symbols that are used in a number system is called the **base** of the number system.
- In the context of computers, the different number systems are used depending on the **context** and **application**.
- There are mainly **four types** of the number system in computer:

a. **Decimal Number System (Base-10)**

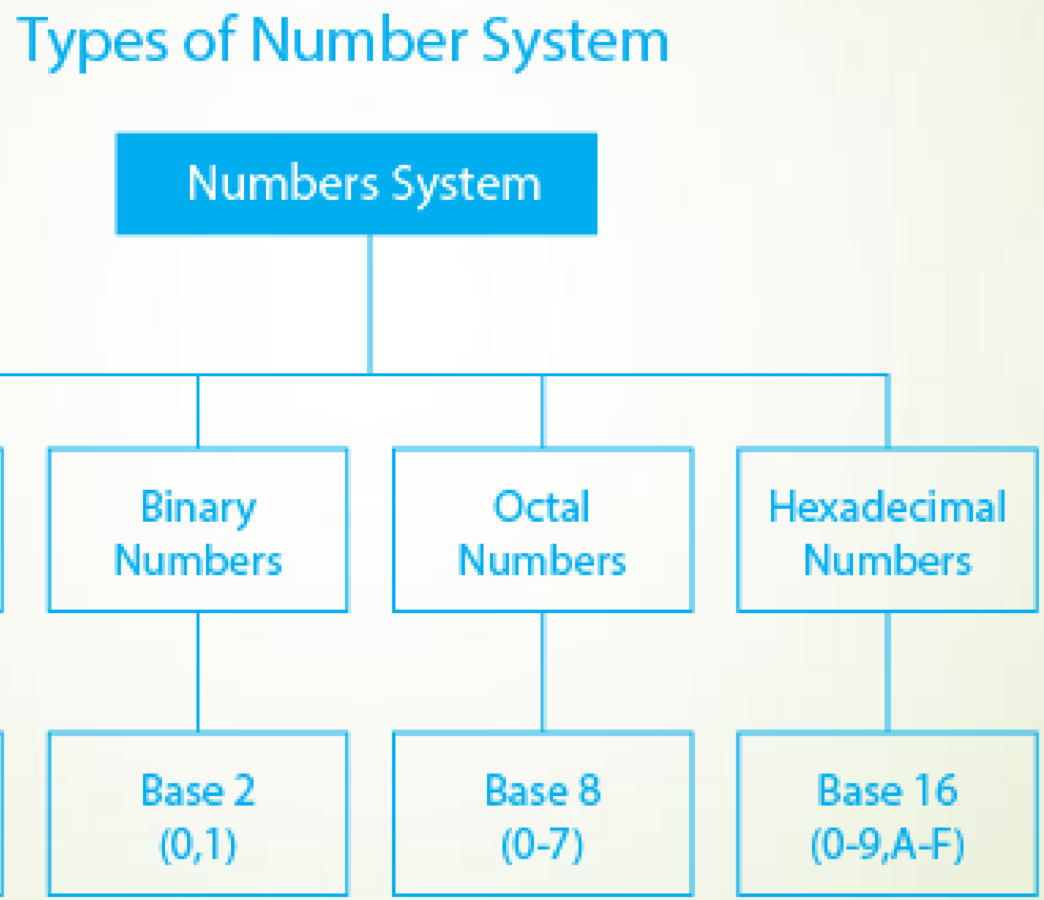
b. **Binary Number System (Base-2)**

c. **Octal Number System (Base-8)**

d. **Hexadecimal Number System (Base-16)**

3- Computer Coding System

What is Number System?



3- Computer Coding System

- **a. Decimal Number System:**

- Decimal number system has only ten (10) digits {0,1,2,3,4,5,6,7,8,9} → **base 10**
- In this number system, every number (value) **represents** with unique symbols {0,1,2,3,4,5,6,7,8,9}.
- It is the weighted (**positional**) number representation,

where value of each digit is determined by its position in a number.

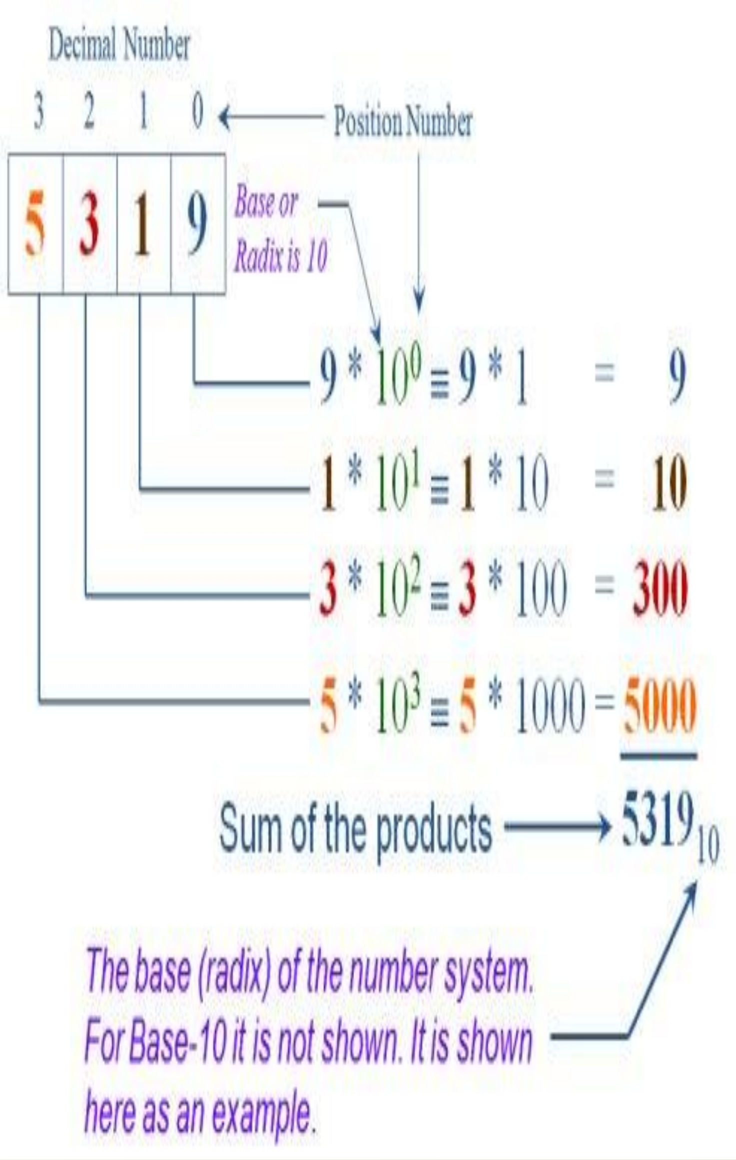
For example:

$$(5319)_{10} = (9 + 10 + 300 + 5000)_{10}$$
$$=(9\times10^0 + 1\times10^1 + 3\times10^2 + 5\times10^3)_{10}$$

- **Advantages:** easy readability, used by humans, and easy

to manipulate.

- **Disadvantages:** wastage of space and time.



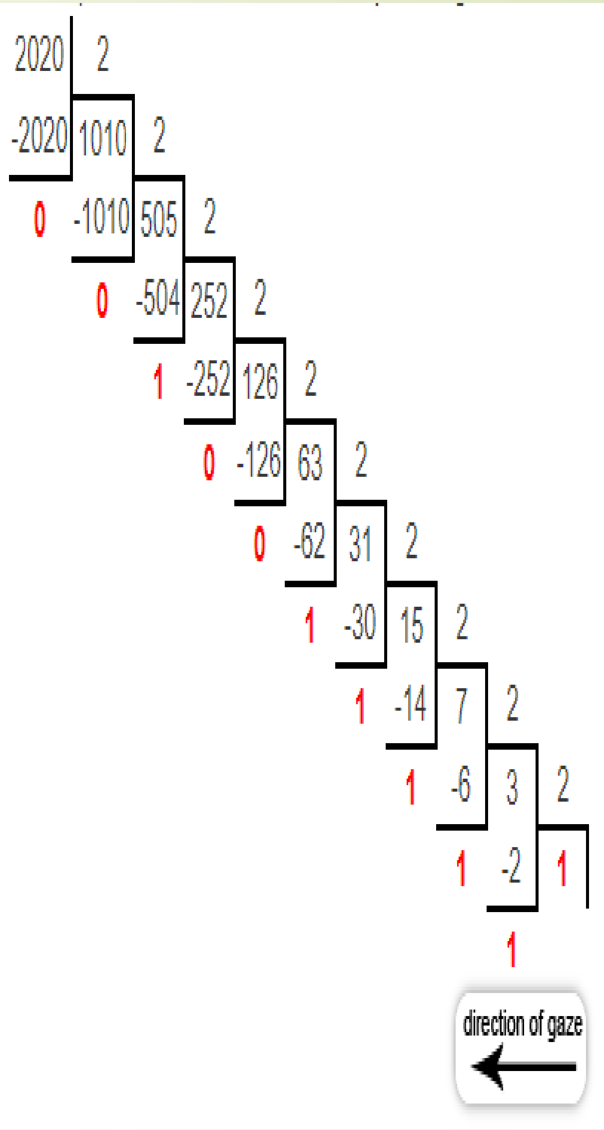
3- Computer Coding System

❑ b. Binary Number System

- Binary number system has only two symbols (**digits**) that are **0 and 1** ⟶ **base 2**.
- In this number system, every number (value) represents with {**0**,**1**}.
- Each digit in the binary number system is called a "**bit**".

For example:

$$(2020)_{10} = (2^{10}x1+2^{9}x1+2^{8}x1+2^{7}x1+2^{6}x1+2^{5}x1+2^{4}x0+2^{3}x0+2^{2}x1+2^{1}x0+2^{0}x0)_{10} = (11111100100)_2$$



❑ Decimal vs Binary

Here are some equivalent values:

Decimal:	0	1	2	3	4	5	6	7	8	9	10	11	12
Binary:	0	1	10	11	100	101	110	111	1000	1001	1010	1011	1100

3- Computer Coding System

c. Octal Number System

- Octal number system has only 8 symbols (digits) **{**0,1,2,3,4,5,6,7**}** ⇨ **base 8**.
- In this number system, every number (value) represents with 0,1,2,3,4,5,6,7.

For example: $123_8 = 1 \times 8^2 + 2 \times 8^1 + 3 \times 8^0 \Rightarrow 123_8 = 1 \times 64 + 2 \times 8 + 3 \times 1 = 83_{10}$

Hence 83_{10} is decimal representation of 123_8.

d. Hexadecimal Number System

- A Hexadecimal number system has sixteen (16) alphanumeric values from **0 to 9** and **A to F** ⇨ **base 16**.
- In this number system, every number (value) represents with {0,…,9,A,B, C,D,E,F}.

For example: $(A7B)_{16} = A \times 16^2 + 7 \times 16^1 + B \times 16^0 \Rightarrow\ 2560 + 112 + 11 = 2683$

Remark: (convert symbols A and B to their decimal equivalents; A = 10, B = 11)

Therefore, the decimal equivalent of $(A7B)_{16}$ is $(2683)_{10}$.

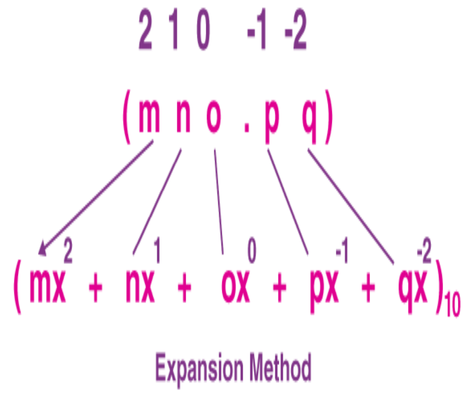
3- Computer Coding System

❑ Number System Conversion

- **Conversion from base ‘b’ to base 10**

➢ Use polynomial representation (**expansion method**)

$$X = (a_{n..}a_2a_1a_0)_b \quad = b^0a_0 + b^1a_{1+...}b^na_n = (\sum a_i b^i)_{10}$$



➢ If we have a number mno.pq in base x, its value in **base 10** can be represented as follows:

$$\mathbf{(mno.pq)_x = (mx^2 + nx^1 + ox^0 + px^{-1} + qx^{-2})_{10}}$$

For example:

Convert the number $(11001)_2$ to base 10

Answer:

$$(11001)_2 = (1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0)_{10}$$

$$= (16 + 8 + 0 + 0 + 1)_{10} = (25)_{10}$$

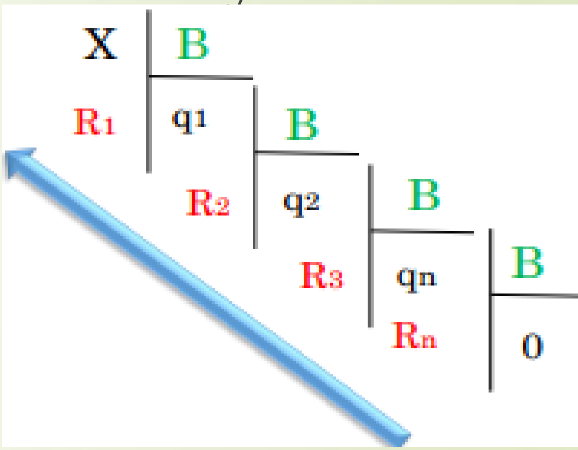
3- Computer Coding System

Number System Conversion

- **Conversion from base 10 to another base B**

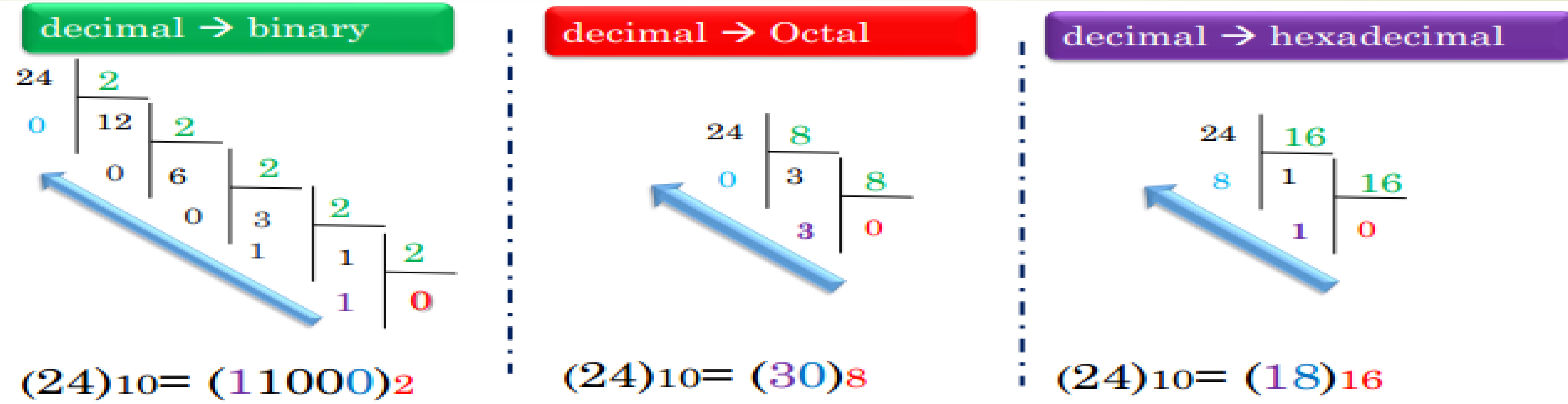
The decimal number **“X”** can be converted to a number on base **“B”** by:

- ✓ Repeatedly dividing **inputNum** by base **B**
- ✓ Store the remainder
- ✓ Finally, reverse the obtained string to get the desired result.



Therefore, $(X)_{10} = (R_n..R_3R_2R_1)_B$

Examples:



3- Computer Coding System

Number System Conversion

- **Conversion from base 16 to base 2**

To convert from Hexadecimal to Binary:

- Each hexadecimal digit (0-9 and A-F) is represented by a 4-bit binary number
- For each digit in the hexadecimal number, find its corresponding 4-bit binary equivalent and write them down sequentially.

Examples: $(3A)_{16}$

$(3)_{16} = (0011)_2$

$(A)_{16} = (1010)_2$

Thus, $(3A)_{16} = (00111010)_2$

Binary equivalent	Hexadecimal
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

3- Computer Coding System

Number System Conversion

- **Conversion from base 8 to base 2**

- To convert from octal to binary:
- Each octal digit (0-7) corresponds to a 3-bit binary number.
- For each octal digit, replace it with its corresponding 3-bit binary equivalent.

DECIMAL	OCTAL	BINARY
0	0	000
1	1	001
2	2	010
3	3	011
4	4	100
5	5	101
6	6	110
7	7	111

Example: $(153)_8$

Break the octal number into digits: 1, 5, 3

Convert each digit to binary:

1 in octal = 001 in binary

5 in octal = 101 in binary

3 in octal = 011 in binary

Thus, $(153)_8 = (001101011)_2$

Base Conversions for Number System

Base 2	Base 10	Base 16	Base 8
0000	0	0	0
0001	1	1	1
0010	2	2	2
0011	3	3	3
0100	4	4	4
0101	5	5	5
0110	6	6	6
0111	7	7	7
1000	8	8	10
1001	9	9	11
1010	10	A	12
1011	11	B	13
1100	12	C	14
1101	13	D	15
1110	14	E	16
1111	15	F	17

4_ Data Representation

What are three popular coding systems to represent data ?

- **ASCII**—American Standard Code for Information Interchange
- **EBCDIC**—Extended Binary Coded Decimal Interchange Code
- **Unicode**—coding scheme capable of representing all world's languages

4_ Data Representation

❑ Examples of coding system

DATA	CODING SYSTEM		
	ASCII	EBCDIC	UNICODE
1	0000001	00000001	0000000000000001
4	0000100	00000100	0000000000000100
9	0001001	00001001	0000000000001001
13	0001101	00001101	0000000000001101