Logical Design

Lecture 1: Number System

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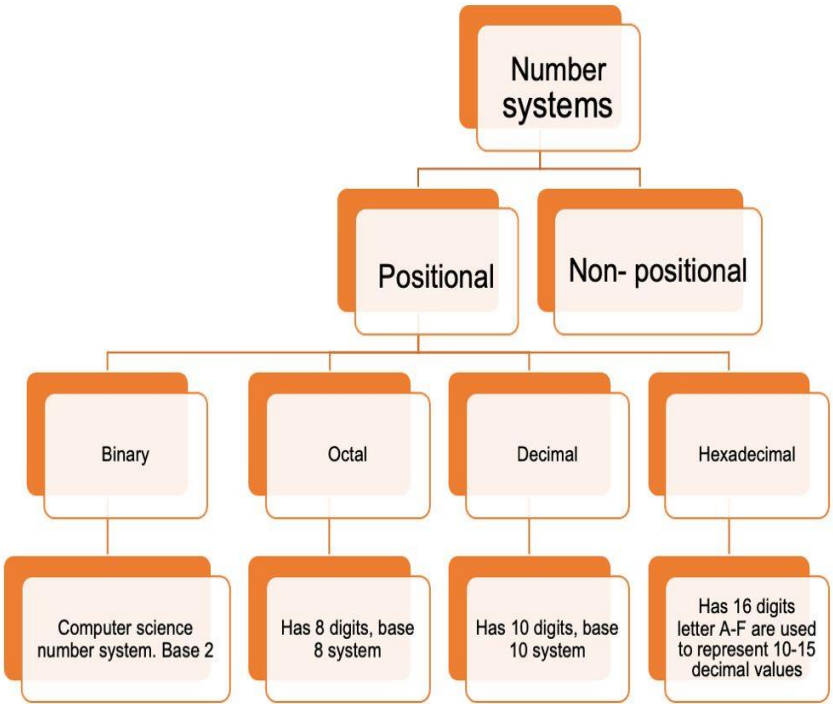
Logic Design Definition

The basic organization of the circuitry of a computer. All digital computers are based on a two-valued logic system—1/0, on/off. Computers perform calculations using components called logic gates (or logic circuits), which are made up of integrated circuits that receive an input signal, process it, and change it into an output signal.

What is a Number System?

A number system is defined as a system of writing to express numbers. It is the mathematical notation for representing numbers of a given set by consistently using digits or other symbols. It provides a unique representation of every number and allows us to operate arithmetic operations like addition, subtraction, multiplication, and division. In general, number systems are divided into two types as shown in the following figure.



• ***Non-positional number systems***: Each symbol represents the same value regardless of its position in the number.

1	I	6	𝍸 I
2	II	7	𝍸 II
3	III	8	𝍸 III
4	IIII	9	𝍸 IIII
5	𝍸	10	𝍸 𝍸

• ***Positional number systems***: Use only a few symbols called digits, these symbols represent different values depending on the position they occupy in the number. The value of any digit in a number can be determined by:

1- The digit
2- Its position in the number
3- The base of the number system

In a number system, these numbers are used as digits. 0 and 1 are the most common digits in the number system, that are used to represent binary numbers. On the other hand, 0 to 9 digits are also used for other number systems. Let us learn here the types of positional number systems.

Types of Positional Number Systems

There are various types of positional number systems. The four most common number system types are:

1. Decimal number system (Base- 10)
2. Binary number system (Base- 2)
3. Octal number system (Base-8)
4. Hexadecimal number system (Base- 16)

1- Decimal Number System (Base 10 Number System)

The decimal number system has a base of **10** ***because it uses ten digits from 0 to 9***. In the decimal number system, the positions successive to the left of the decimal point represent units, tens, hundreds, thousands, and so on. This system is expressed in decimal numbers. Every position shows a particular power of the base (10).

Example of Decimal Number System:

The decimal number 1457 consists of the digit 7 in the units position, 5 in the tens place, 4 in the hundreds position, and 1 in the thousands place whose value can be written as:

$(1\times10^3) + (4\times10^2) + (5\times10^1) + (7\times10^0)$

$(1\times1000) + (4\times100) + (5\times10) + (7\times1)$

$1000 + 400 + 50 + 7$

1457

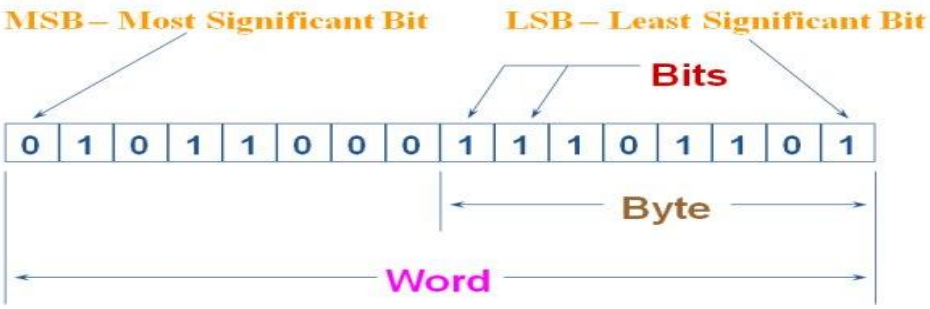
2- Binary Number System (Base 2 Number System)

Since a computer is a machine that can only work in two states: "ON" or "OFF" or two electrical pulse states "High" or "Low", or two logical states "True" or "False". Base ***2 because it uses 2 symbols o & 1***.

Because of its direct application in electronic circuits utilizing logic gates, the binary system is used internally by all modern computers and computer-based devices. Every digit is referred to as a ***bit***. where each digit has a value expressed in powers of 2, as displayed here.

2^5	2^4	2^3	2^2	2^1	2^0

MSB stands for the **Most Significant Bit**, while **LSB** is the **Least Significant Bit**. In binary terms, the MSB is the bit that has the greatest effect on the number, and it is the left-most bit.



Computer Memory Measurement

Computer memory is measured in terms of how many bits it can store. Here is a chart for memory capacity conversion:

1 byte (B) = 8 bits

1 Kilobytes (KB) = 1024 bytes

1 Megabyte (MB) = 1024 KB

1 Gigabyte (GB) = 1024 MB

1 Terabyte (TB) = 1024 GB

1 Exabyte (EB) = 1024 TB

1 Zettabyte = 1024 EB

1 Yottabyte (YB) = 1024 ZB

3- Octal Number System (Base 8 Number System)

In the octal number system, the base is **8** and it uses numbers from 0 to 7 to represent numbers. Octal number system is also a positional value system with where each digit has its value expressed in powers of 8, as shown.

8^5	8^4	8^3	8^2	8^1	8^0

4- Hexadecimal Number System (Base 16 Number System)

In the hexadecimal system, numbers are written or represented with base **16**. In the hexadecimal system, the numbers are first represented just like in the decimal system, i.e. from 0 to 9. Then, the numbers are represented using the alphabet from A to F. The below-given table shows the representation of numbers in the hexadecimal number system.

Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15