جامـــعـة المـــسـتـقـبـل
AL MUSTAQBAL UNIVERSITY

قســـــــم الامـــــــــــن الــــــــــــــــــــــــــــسيبرانــــــــــــــــــــــــــــي

Department of Cyber Security

Subject:

COMPUTER ORGANIZATION & LOGIC DESIGN

Class:

First

Lecture: (2)

(Numbers System)

Lecturer:

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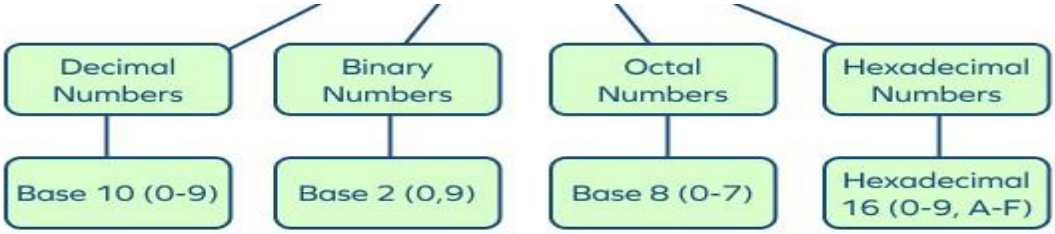
Number systems /أنظمة الأرقام



1. **The Binary Number System**: has the base 2 and uses only 2 symbols or digits (0, 1) to form other numbers. نظام الأرقام الثنائية
2. **The Octal Number System** has the base-8 and uses only 8 symbols or digits (0, 1, 2, 3, 4, 5, 6, 7) used to form other numbers.نظام الأرقام الثماني
3. **The Decimal Number System** : The most commonly used number, which has base 10 and uses only 10 symbols or digits (0, 1, 2, 3, 4, 5, 6, 7,8, 9) to form other numbers. نظام الأرقام العشري
4. **The Hexadecimal Number System**: has base 16 and uses only 16 symbols or digits (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F) to form other numbers. نظام الأرقام الست عشري

The main advantage of using the **Binary and octal** number system are that it uses fewer digits than the decimal and hexadecimal number system. So, it has fewer calculations and thereby less calculation errors.

الميزة الرئيسية لاستخدام نظام الأرقام الثنائي والثماني هي أنه يستخدم أرقامًا أقل من نظام الأرقام العشري والست عشري. لذا، فهي تحتوي على عدد أقل من الحسابات وبالتالي أخطاء حسابية أقل.

Table to compare number systems

10^3 10^2 10^1 10^0 Decimal	8^3 8^2 8^1 8^0 octal	2^9 2^8 2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0 Binary	16^2 16^1 16^0 hexadecimal
0000	0000	0 0 0 0 0 0 0 0 0 0	000
0001	0001	0 0 0 0 0 0 0 0 0 1	001
0002	0002	0 0 0 0 0 0 0 0 1 0	002
0003	0003	0 0 0 0 0 0 0 0 1 1	003
0004	0004	0 0 0 0 0 0 0 1 0 0	004
0005	0005	0 0 0 0 0 0 0 1 0 1	005
0006	0006	0 0 0 0 0 0 0 1 1 0	006
0007	0007	0 0 0 0 0 0 0 1 1 1	007
0008	0010	0 0 0 0 0 0 1 0 0 0	008
0009	0011	0 0 0 0 0 0 1 0 0 1	009
0010	0012	0 0 0 0 0 0 1 0 1 0	00A
0011	0013	0 0 0 0 0 0 1 0 1 1	00B
0012	0014	0 0 0 0 0 0 1 1 0 0	00C
0013	0015	0 0 0 0 0 0 1 1 0 1	00D
0014	0016	0 0 0 0 0 0 1 1 1 0	00E
0015	0017	0 0 0 0 0 0 1 1 1 1	00F
0016	0020	0 0 0 0 0 1 0 0 0 0	010
0017	0021	0 0 0 0 0 1 0 0 0 1	011
0018	0022	0 0 0 0 0 1 0 0 1 0	012
0019	0023	0 0 0 0 0 1 0 0 1 1	013
0020	0024	0 0 0 0 0 1 0 1 0 0	014
0021	0025	0 0 0 0 0 1 0 1 0 1	015
0022	0026	0 0 0 0 0 1 0 1 1 0	016
0023	0027	0 0 0 0 0 1 0 1 1 1	017
0024	0030	0 0 0 0 0 1 1 0 0 0	018
0025	0031	0 0 0 0 0 1 1 0 0 1	019
0026	0032	0 0 0 0 0 1 1 0 1 0	01A
0027	0033	0 0 0 0 0 1 1 0 1 1	01B
0028	0034	0 0 0 0 0 1 1 1 0 0	01C
0029	0035	0 0 0 0 0 1 1 1 0 1	01D
0030	0036	0 0 0 0 0 1 1 1 1 0	01E
0031	0037	0 0 0 0 0 1 1 1 1 1	01F
0032	0040	0 0 0 0 1 0 0 0 0 0	020
:	:	: : : : : : : : : :	:
0266	0412	0 1 0 0 0 0 1 0 1 0	10A
0267	0413	0 1 0 0 0 0 1 0 1 1	10B
:	:	: : : : : : : : : :	:
1022	1776	1 1 1 1 1 1 1 1 1 0	3FE
1023	1777	1 1 1 1 1 1 1 1 1 1	3FF

Frequently Asked Questions on Binary Number System ....

Q1) What is a binary number system?

A number system where a number is represented by using only two digits (0 and 1) with a base 2 is called a binary number system. For example, 1001_2 is a binary number.

Q2) What is a bit?

A bit is a single digit in the binary number. For example, 101 is three-bit binary numbers, where 1, 0 and 1 are the bits.

Q3) How to convert a decimal number into a binary number? Give an example.

To convert a decimal number into its equivalent binary number, we divide the decimal number by 2 each time, till we get 0 as a dividend. Let us take an example to convert 13_{10} into a binary number.

13	÷	2:	6	and	remainder 1
6	÷	2:	3	and	remainder 0
3	÷	2:	1	and	remainder 1
1	÷	2:	0	and	remainder 1

Now we take the bits from the last remainder to first remainder, i.e.(MSB to LSB). Hence, $13_{10} = 1101_2$

Q4) What is the use of binary numbers?

Binary numbers are commonly used in computer architecture. Since the computer understands only the language of two digits 0's and 1's, therefore the programming is done using a binary number system.

Q5) What is the value of 163 in binary?

The value of 163 in binary is 10100011.

Q6) How is 200 represented in binary?

200 is the decimal number. The binary form of 200 is 11001000_2.

Lec._2

Binary Arithmetic Operations

Like we perform the arithmetic operations in numerals, in the same way, we can perform addition, subtraction, multiplication and division operations on Binary numbers. Let us learn them one by one.

Binary Addition

Adding two binary numbers will give us a binary number itself. It is the simplest method. Addition of two single-digit binary number is given in the table below.

Binary Numbers		Addition
0	0	0
0	1	1
1	0	1
1	1	0; Carry $\rightarrow$1

Let us take an example of two binary numbers and add them.

For example: Add 1101_2 and 1001_2.
Solution:

$$\begin{array}{r} 1101 \\ +1001 \\ \hline 10110 \end{array}$$

Binary Subtraction

Subtracting two binary numbers will give us a binary number itself. It is also a straightforward method. Subtraction of two single-digit binary number is given in the table below.

Binary Numbers		Subtraction
0	0	0
0	1	1; Borrow 1
1	0	1
1	1	0

Let us take an **example** of two binary numbers and subtract them**:** Subtract $1101_{2,}$ and 1010_2.

Solution: $1101_2 - 1010_2 = 0011_2$

Binary Multiplication

The multiplication process is the same for the binary numbers as it is for numerals. Let us understand it with example.

Example: Multiply 1101_2 and 1010_2.

$$
\begin{array}{r}
1101 \\
\times\ 1010 \\
\hline
0000 \\
1101 \\
0000 \\
1101 \\
\hline
10000010 \\
\hline
\end{array}
$$

Binary Division

The binary division is similar to the decimal number division method. We will learn with an example here.

Example: Divide 1010_2 by 10_2

$$
\begin{array}{l}
10)1010(101 \\
\quad 10 \\
\hline
\quad 010 \\
\quad\ 10 \\
\hline
\quad\ 0 \\
\hline
\end{array}
$$

Uses of Binary Number System

Binary numbers are commonly used in computer applications. All the coding and languages in computers such as C, C++, Java, etc. use binary digits 0 and 1 to write a program or encode any digital data. The computer understands only the coded language. Therefore these 2-digit number system is used to represent a set of data or information in discrete bits of information.

Problems and Solutions

Let us practice some of the problems for better understanding:

Question 1: **What is binary number 1.1 in decimal?**

Solution:

Step 1: 1 on the left-hand side is on the one's position, so it's 1.

Step 2: The one on the right-hand side is in halves, so it's

$1 \times ½$

Step 3: so, 1.1 = 1.5 in decimal.

Question 2: Write 10.11_2 in Decimal?

Solution:

$10.11 = 1 \times (2)^1 + 0\ (2)^0 + 1\ (½)^1 + 1(½)^2$

$= 2 + 0 + ½ + ½$

$= 2.75$

So, 10.11 is 2.75 in Decimal.

Next >>> let us understand how the interconversions between these systems are done. **القادم>>> دعونا نفهم كيف**
تتم التحويلات البينية بين هذه الأنظمة