

Basic numbers systems

Objectives

At the end of the lecture students may learn :

- 1- Decimal numbers system
- 2- Binary numbers system
- 3- Conversion of binary numbers to decimal numbers
- 4- Conversion of decimal numbers to binary numbers
- 5- Examples

1-Basic numbers systems

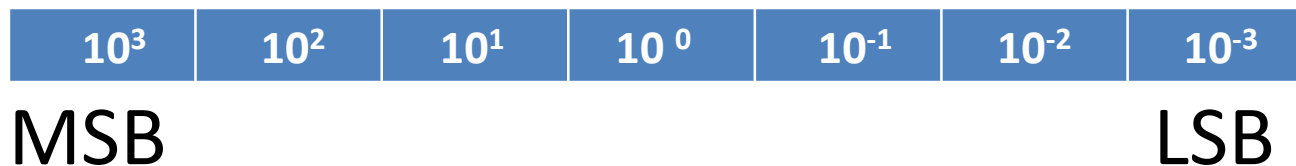
The feature which distinguishes one system from another is the number of digits which are used, and this called the base of the system.

The numbering system used in digitals systems are

Name of the system	Base	digitals used
Binary	2	0, 1
Octal	8	0,1,2,3,4,5,6,7
Decimal	10	0,1,,9
Hexadecimal	16	0,1,.....,9,A,B,C,D,E,F

2-Decimal numbers system

The base of decimal system numbers is 10 because it uses 10 digits and the coefficients are multiplied by the power of 10



Most significant bit (MSB)

Least significant bit (LSB)

Example-1

$$(56.73)_{10} = 5 * 10^1 + 6 * 10^0 + 7 * 10^{-1} + 3 * 10^{-2}$$

Example-2

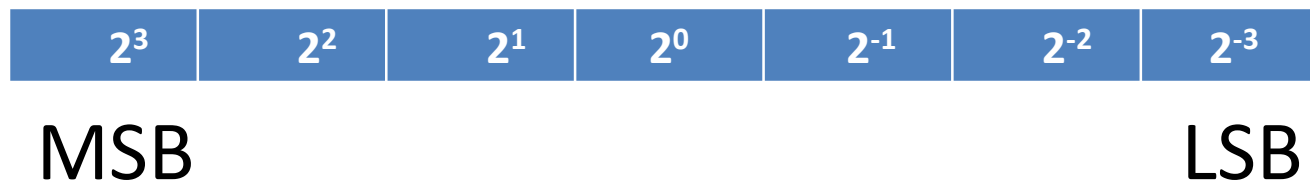
$$(509.28)_{10} = 5 * 10^2 + 0 * 10^1 + 9 * 10^0 + 2 * 10^{-1} + 8 * 10^{-2}$$

Example-3

$$(313)_{10} = 3 * 10^2 + 1 * 10^1 + 3 * 10^0$$

3- Binary numbers

It is said to be of base 2 (0,1) i.e the coefficients of the binary numbers system have only two possible values: 0 or 1.



Most significant bit (MSB)

Least significant bit (LSB)

A binary digit is called a **bit**

Example-4

$$101010_2 = 1*2^5 + 0*2^4 + 1*2^3 + 0*2^2 + 1*2^1 + 0*2^0 = 42_{10}$$

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

$$101.01_2 = 1*2^2 + 0*2^1 + 1*2^0 + 0*2^{-1} + 1*2^{-2} = 5.25_{10}$$

1 0 1 0 1


2^2	2^1	2^0	2^{-1}	2^{-2}
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4-conversion from binary to decimal

Example-5: $(1011)_2$  $(\quad)_{10}$

solution:

$$\begin{aligned} 1011 &= 1*2^0 + 1*2^1 + 0*2^2 + 1*2^3 \\ &= 1+2+0+8=(11)_{10} \end{aligned}$$

Example-6: $(110.1)_2$  $(\quad)_{10}$

$$\begin{aligned} 110.1_2 &= 0*2^0 + 1*2^1 + 1*2^2 + 1*2^{-1} \\ &= 0+2+4+0.5= (6.5)_{10} \end{aligned}$$

Example-7 $(1100.101)_2 \rightarrow (\quad)_{10}$

Solution:

$$1100.101 = 0 * 2^0 + 0 * 2^1 + 1 * 2^2 + 1 * 2^3 + 1 * 2^{-1} + 0 * 2^{-2} + 1 * 2^{-3}$$

$$= 0 + 0 + 4 + 8 + 0.5 + 0 + 0.125$$

$$= (12.625)_{10}$$

5- conversion from decimal to binary

Example -8: $(59)_{10}$  $(\quad)_2$

solution:

$(\text{Integer})_{10} \div 2$	Result	Remainder	
$59 \div 2$	29	1	LSB
$29 \div 2$	14	1	
$14/2$	7	0	
$7/2$	3	1	
$3/2$	1	1	
$1/2$	0	1	MSB


$$(59)_{10} = (111011)_2$$

Example -9: $(0.78125)_{10} = (\quad)_2$

solution:

$(\text{Fraction})_{10} * 2$	Result(Fraction)	Carry	
$0.78125 * 2$	0.5625	1	MSB
$0.5625 * 2$	0.125	1	
$0.125 * 2$	0.25	0	
$0.25 * 2$	0.5	0	
$0.5 * 2$	0	1	LSB


$(0.78125)_{10} = (0.11001)_2$



<https://www.rapidtables.com/convert/number/decimal-to-binary.html>


Example-10: $(35.375)_{10} = (\quad)_2$

solution

$(\text{Integer})_{10} / 2$	Result	Remainder		
35/2	17	1	 LSB	
17/2	8	1		
8/2	4	0		
4/2	2	0		(100011)
2/2	1	0		
1/2	0	1		MSB

(Fraction)₁₀ * 2 Result(fraction)

0.375*2	Carry 0.75	0	MSB
0.75*2	0.5	1	
0.5*2	0	1	LSB



$$(35.375)_{10} = (100011.011)_2$$

Home work

$$(169.456)_{10} = (\quad)_2$$

$$(11001101)_2 = (\quad)_{10}$$

$$(101100.1011)_2 = (\quad)_{10}$$

Reference

Digital Fundamentals, Thomas L. Floyd,
Eleventh Edition, Chapter two, 2015, Pearson

Thank you
with best wishes