

# UNIT I

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## Introduction

### • Number System

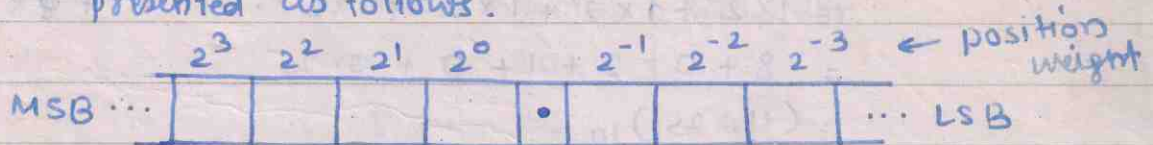
- Number system defines set of values used to represent quantity
  - Number system in most common use today is the Arabic system
  - For decimal number system base is 10 i.e. (0, 1, ..., 9)
- Hence decimal number is represented like

$$(349.25)_{10}$$

$$\text{i.e. } 3 \times 10^2 + 4 \times 10^1 + 9 \times 10^0 + 2 \times 10^{-1} + 5 \times 10^{-2}$$

### • Binary number system

- binary number system uses base 2 as it has two digits only
- binary number system uses only two digits namely 0 and 1
- Weighted value for different positions can be represented as follows.



MSB - Most significant bit → with the highest values

LSB - Least significant bit → with the smallest values

### • Octal number system

- the base used for octal system is 8
- Each digit in octal system will assume 8 different values (i.e. 0, 1, ..., 7)
- Weighted values can be represented as follows



### • Hexadecimal number system

- the base of Hexadecimal number system is 16
- Each digit in Hexadecimal number system will



- In binary number systems

bit  $\rightarrow$  1 bit

Nibble  $\rightarrow$  4 bit

Byte  $\rightarrow$  8 bit

word  $\rightarrow$  16 bit

Double word  $\rightarrow$  32 bit

- the important drawback is, it requires large or very long string of 1's and 0's to represent decimal number

$$i.e. (128)_{10} \rightarrow (100000000)_2$$

### • Conversion

• Conversion of binary to decimal

Ex.  $(1011.01)_2$

$$= 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 + 0 \times 2^{-1} + 1 \times 2^{-2}$$

$$= 8 + 0 + 2 + 1 + 0 + 0.25$$

$$= (11.25)_{10}$$

• Conversion of octal to decimal

Ex. ~~(314)~~  $(365.24)_8$

$$= 3 \times 8^2 + 6 \times 8^1 + 5 \times 8^0 + 2 \times 8^{-1} + 4 \times 8^{-2}$$

$$= 192 + 48 + 5 + 0.25 + 0.0625$$

$$= (245.3125)_{10}$$

• Conversion of Hex to decimal

Ex.  $(4C8.2)_{16}$

$$= 4 \times 16^2 + C \times 16^1 + 8 \times 16^0 + 2 \times 16^{-1}$$

$$= 1024 + 192 + 8 + 0.125$$

$$= (1224.125)_{10}$$

- Conversion from decimal to other systems
- Conversion of decimal to binary number system

Ex  $(105)_{10}$

division	number	Reminder
2	105	
2	52	1
2	26	0
2	13	0
2	6	1
2	3	0
2	1	1
	0	1

Answer is 1101001

$$\therefore (105)_{10} = (1101001)_2$$

- Conversion of decimal to octal number

Ex  $(204)_{10}$

divide	number	Reminder
8	204	
8	25	4
8	3	1
	0	3

Answer is 314

$$(204)_{10} = (314)_8$$

- Conversion of decimal to Hexadecimal number.

Ex  $(259)_{10}$

divide	number	Reminder
16	259	
16	16	3
16	1	0
		1

$$(259)_{10} = (103)_{16}$$

### Fractional part conversion

- conversion of decimal to binary

Ex -  $(0.42)_{10}$

Decimal fraction	Base	product	carry
0.42	2	0.84	0
0.84	2	1.68	1
0.68	2	1.36	1
0.36	2	0.72	0
0.72	2	1.44	1

$(01101)_2$

$(0.42)_{10} = (0.01101)_2$

- Conversion of decimal to octal

Ex -  $(0.6234)_{10}$

Decimal fraction	Base	product	carry
0.6234	8	4.9872	4
0.9872	8	7.8976	7
0.8976	8	7.1808	7
0.1808	8	1.4464	1
0.4464	8	3.5712	3

~~37774~~

$(0.6234)_{10} = (0.47713)_8$

- Conversion of decimal to Hexadecimal

Ex  $(0.122)_{10}$

Decimal fraction	base	product	carry	Hex
0.122	16	1.952	1	1
0.952	16	15.232	15	F
0.232	16	3.712	3	3
0.712	16	11.392	11	B
0.392	16	6.272	6	6
0.272	16	4.352	4	4

1F3B64

$(0.122)_{10} = (0.1F3B64)_{16}$

• Binary to octal conversion

Ex  $(11010010)_2$

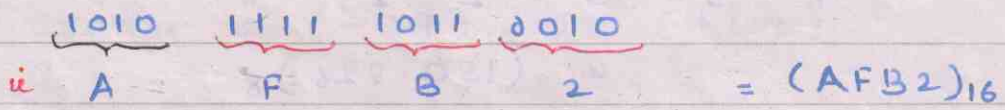
- make group of three digit



• Binary to Hex conversion

Ex  $(101011110110010)_2$

- make group of four digit



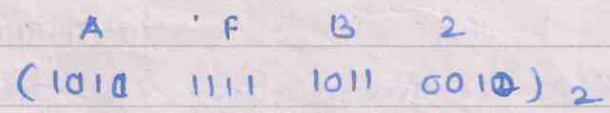
• Octal to binary

Ex  $(364.25)_8$



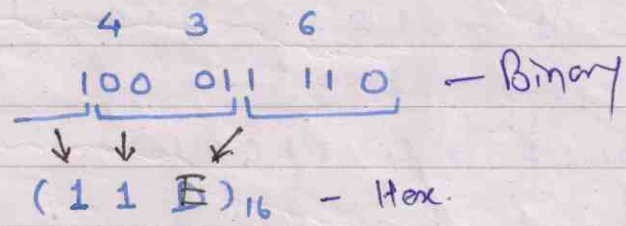
• Conversion of Hex to binary

Ex  $(AFB2)_{16}$



• Octal to Hex conversion

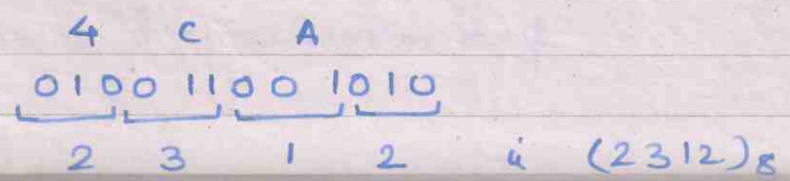
Ex  $(436)_8$



$(436)_8 \rightarrow (11E)_{16}$

• Hex to octal conversion

Ex  $(4CA)_{16}$



### Fractional Hex to octal conversion

$(0.12E)_{16}$

$0.\underline{0001}\underline{0010}\underline{1110}$   
 $0.0456 \quad (0.0456)_8$

one more example

eq.  $(68.4B)_{16}$   
 $\swarrow \quad \searrow \quad \searrow \quad \searrow$   
 $\underline{00110} \quad \underline{1000} \quad \underline{0100} \quad \underline{10110}$   
 $1 \quad 5 \quad 0 \quad . \quad 2 \quad 2 \quad 6$   
 $(150.226)_8$

- Signed magnitude numbers.
  - MSB of binary number is used to represent the sign
  - 0 is used to represent + sign
    - ↳ 01011001 → (+89)<sub>10</sub>
  - 1 is used to represent - sign
    - ↳ 11011001 → (-89)<sub>10</sub>
  - Unsigned 8-bit number covers the decimal range of 255 number starting from 0
  - Signed 8 bit number covers the decimal range of (-127)<sub>10</sub> to (+127)<sub>10</sub>

- 1's complement
  - the 1's complement of a number is found by changing all 1's to 0's and all 0's to 1's
  - eg.
 

1	0	0	1	0	1	0	0
↓	↓	↓	↓	↓	↓	↓	↓
0	1	1	0	1	0	1	1

 ← 1's complement
  - the result will be same when we subtract the above number from 1111 1111

- 2's complement
  - The 2's complement is obtained by adding 1 to the LSB of 1's complement of number
  - ∴ 2's complement = 1's complement + 1
  - eg.
 

1	0	1	1	0	0	1	0							
1	0	1	0	0	1	1	0							
							← 1's complement -							
							+ 1							
							0	1	0	0	1	1	1	0
														← 2's complement

- to convert negative number to a positive number and its 2's complement
- 2's complement of 2's complement of a number results in the original number itself.

