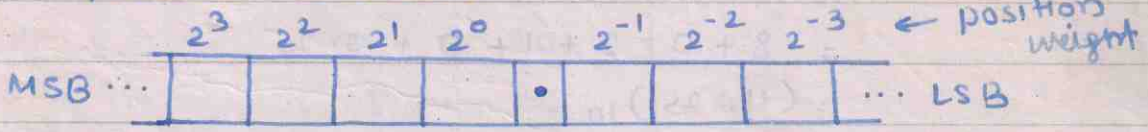
UNIT I

Introduction

- Number System
  - Number system defines set of values used to represent quantity
  - Number system in most common use today is the Arbic system
  - For decimal number system base is 10 i.e (0, 1, ... 9)
    Hence decimal number is represented like
    $(349.25)_{10}$
    i.e $3\times10^2 + 4\times10^1 + 9\times10^0 . 2\times10^{-1} + 5\times10^{-2}$
- 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 system
  - bit → 1 bit
  - Nibble → 4 bit
  - Byte → 8 bit
  - Word → 16 bit
  - Double Word → 32 bit
- the important drawback is, it requires large or very long string of 1's and 0's to represent decimal number
  ie $(128)_{10} \rightarrow (10000000)_2$

- Conversion
  - Conversion of binary to decimal

Ex. $(1011.01)_2$

$= 1\times2^3 + 0\times2^2 + 1\times2^1 + 1\times2^0 . 0\times2^{-1} + 1\times2^{-2}$

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

$= (11.25)_{10}$

  - Conversion of octal to decimal

Ex. ~~$(311)_8$~~ $(365.24)_8$

$= 3\times8^2 + 6\times8^1 + 5\times8^0 . + 2\times8^{-1} + 4\times8^{-2}$

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

$= (245.3125)_{10}$

  - Conversion of Hex to decimal

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

$= 4\times16^2 + C\times16^1 + 8\times16^0 + 2\times16^{-1}$

$= 1024 + 192 + 8 + 0.125$

$= (1224.125)_{10}$

- Conversion from decimal to other system
  - 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 ↑

$(259)_{10} = (\cancel{301})\ (103)_{16}$

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

~~47774~~

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

- 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

011 010 010

ie 3 2 2 = $(322)_8$

- Binary to Hex conversion

Ex $(1010\ 1111\ 1011\ 0010)_2$

- make group of four digit

1010 1111 1011 0010

ie A F B 2 = $(AFB2)_{16}$

- Octal to binary

Ex $(364.25)_8$

3 6 4 . 2 5

011 110 100 . 010 101 ie $(011110100.010101)_2$

- Conversion of Hex to binary

Ex. $(AFB2)_{16}$

A F B 2

$(1010\ 1111\ 1011\ 0010)_2$

- Octal to Hex conversion

Ex $(436)_8$

4 3 6

100 011 110 — Binary

$(1\ 1\ E)_{16}$ - Hex

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

- Hex to octal conversion

Ex $(4CA)_{16}$

4 C A

0100 1100 1010

2 3 1 2 ie $(2312)_8$

Fractional Hex to octal conversion

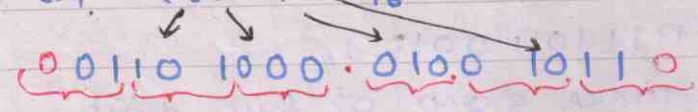
$(0.12E)_{16}$

$0.\underbrace{0001}\ \underbrace{0010}\ \underbrace{1110}$

$0.\ 0\ \ 4\ \ 5\ \ 6$ i.e. $(0.0456)_8$.

One more example

eg. $(68.4B)_{16}$



$0110\ 1000.0100\ 1011\ 0$

$1\ \ 5\ \ 0.\ 2\ \ 2\ \ 6$

i.e. $(150.226)_8$

- Signed Magnitude numbers.
  - MSB of binary number is used to represent the sign
  - 0 is used to represent + sign
    i.e. $0\,1011001 \rightarrow (+89)_{10}$
  - 1 is used to represent - sign
    i.e. $1\,1011001 \rightarrow (-89)_{10}$
  - Unsigned 8-bit number covers the decimal range of 255 number starting from 0
  - Signed 8 bit number covers the decimal range of $(-127)_{10}$ to $(+127)_{10}$

- 1's complement-
  - the 1's complement of 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 substract 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

e.g.
$$\begin{array}{r} 1\,0\,1\,1\,0\,0\,1\,0 \\ 0\,1\,0\,0\,1\,1\,0\,1 \leftarrow \text{1's complement} \\ +\quad\quad\quad\quad\quad 1 \\ \hline 0\,1\,0\,0\,1\,1\,1\,0 \leftarrow \text{2's complement} \end{array}$$

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