Lecture 4

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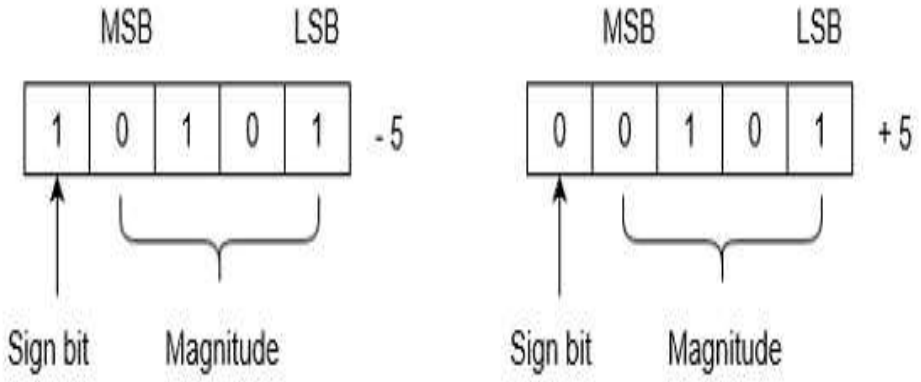
Negative Number Representation

Sign Magnitude
r's Compliment
(r-1)'s Compliment

Sign magnitude Representation: Number consist of magnitude (lower number) and sign bit (MSB)

MSB 0 Positive Number

MSB 1 Negative Number



$$Range\ of\ Number = -(2^{(n-1)} - 1)\ to\ +(2^{(n-1)} - 1)$$

So for example: if we have 4 bits to represent a signed binary number, (1-bit for the **Sign bit** and 3-bits for the **Magnitude bits**), then the actual range of numbers we can represent in sign-magnitude notation would be:

$-2^{(4-1)} - 1$ to $+2^{(4-1)} - 1$

$-2^{(3)} - 1$ to $+2^{(3)} - 1$

-7 to +7

- -15_{10} as a 6-bit number$\Rightarrow 101111_2$
- $+23_{10}$ as a 6-bit number$\Rightarrow 010111_2$
- -56_{10} as a 8-bit number$\Rightarrow 10111000_2$

$$(01010101)_2 = (\_\_\_\_\_)_{10}$$

$$(11010101)_2 = (\_\_\_\_\_)_{10}$$

$$(01111111)_2 = (\_\_\_\_\_)_{10}$$

$$(11111111)_2 = (\_\_\_\_\_)_{10}$$

$$(0000)_2 = (\_\_\_\_\_)_{10}$$

$$(1000)_2 = (\_\_\_\_\_)_{10}$$

Compliment

Sign magnitude negate a number by sign

Compliment system negate number by taking its compliment

	Radix Compliment	**Diminished Radix Compliment**
	r's compliment	(r-1)'s compliment
Binary	2's	1's
Octal	8's	7's
Decimal	10's	9's
Hexadecimal	16's	15's
Base 6	6's	5's

Radix (r) compliment

$$(r-1)\ compliment\ of\ N = (r^n - 1) - N$$

where r is base n is number of digit

R compliment of N $= r^n - N$

$= (r-1)$ compliment $+1$

$$Decimal(r = 10)$$

$$9's\ comp\lim ent\ of\ 456 = 999 - 456 = 543$$

$$10's\ comp\lim ent\ of\ 456 = 9's\ comp\lim ent + 1 = 544$$

$$Octal(r = 8)$$

$$7's\,comp\lim ent\,of\ 456 = 777 - 456 = 321$$

$$8's\,comp\lim ent\,of\ 456 = 7's\,comp\lim ent + 1 = 322$$

$$Hexadecimal(r = 16)$$

$$15's\,comp\lim ent\,of\ C7C = FFF - C7C = 383$$

$$16's\,comp\lim ent\,of\ 456 = 15's\,comp\lim ent + 1 = 384$$

Compliment Continue

Generally, there are two types of complement of Binary number: 1's complement and 2's complement. To get 1's complement of a binary number, simply invert the given number.

$$Binary(r = 2)$$

$$1's\,comp\lim ent\,of\ 11011 = 11111 - 11011 = 00100$$

$$2's\,comp\lim ent\,of\ 11011 = 1's\,comp\lim ent + 1 = 00101$$

- **Example-1** – Find 2's complement of binary number 10101110.
- Simply invert each bit of given binary number, which will be 01010001. Then add 1 to the LSB of this result, i.e., 01010001+1=01010010 which is answer.
- **Example-2** – Find 2's complement of binary number 10001.001.
- Simply invert each bit of given binary number, which will be 01110.110 Then add 1 to the LSB of this result, i.e., 01110.110+1=01110.111 which is answer.

Signed Number representation

Signed-Complement – a negative number is represented by its complement.

First represent the number with positive sign and then take complement of that number.

$$\underline{1's\ complement\ representation}$$

$$17_{10} = (00010001)_2$$

$$-17_{10} = 1's\ complement\ of\ (00010001)_2 = (11101110)_2$$

$$99_{10} = (01100011)_2$$

$$-99_{10} = 1's\ complement\ of\ (01100011)_2 = (10011100)_2$$

$$\underline{2's\ complement\ representation}$$

$$17_{10} = (00010001)_2$$

$$-17_{10} = 2's\ complement\ of\ (00010001)_2 = (11101111)_2$$

$$9_{10} = (1001)_2$$

$$-9_{10} = 2's\ complement\ of\ (1001)_2 = (0111)_2$$

The 2's complement representation of the decimal value -15 is

(a) 1111 (b) 11111 (c) 111111 (d) 10001

	sign	magnitude
-15 =	1	1111
2’s compliment	1	0001

2’s compliment representation of -17 in decimal is

+17= 10001

-17 in 2’s compliment 01111

Practice Question

9's *complement of* $(8151)_{10}$ =

10' *compliment of* $(7)_{10}$ =

2's *complement* $(10001.001)_2$ =

2's *complement* $(11100)_2$ =

1's *complement* $(1000)_2$ =

2's *complement* $(1000)_2$ =

16's *complement* $(1B06)_{16}$ =

10' *compliment of* $(0372)_{10}$ =