



# **UNIT 1**

## **TOPIC 2: COMPLEMENTS**

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# Complements

There are two types of complements for each base- $r$  system:

- The radix complement –  $r$  complement
- The diminished radix complement -  $(r-1)$  complement

## Binary :

- $r$  complement – 2's complement
- $(r-1)$  complement - 1's complement

## Decimal

- $r$  complement – 10's complement
- $(r-1)$  complement - 9's complement

## Octal :

- $r$  complement – 8's complement
- $(r-1)$  complement - 7's complement

## Hexadecimal

- $r$  complement – 16's complement
- $(r-1)$  complement - 15's complement

Given a number  $N$  in base  $r$  having  $n$  digits, the  $(r-1)$ 's complement of  $N$  is defined as:  
$$(r^n - 1) - N$$



# Complements cont..

Given a number  $N$  in base  $r$  having  $n$  digits,

- the  $(r-1)$ 's complement of  $N$  is defined as:  $(r^n - 1) - N$
- the  $r$ 's complement of  $N$  is defined as:  $r^n - N = [(r^n - 1) - N] + 1$ .

OR

- the  $(r-1)$ 's complement is obtained by Complementing each digit. ie) subtracting each digit from (base-1) of the number
- the  $r$ 's complement obtained by adding 1 with  $(r-1)$ 's complement



# Complements Examples

For Binary : 11010110

$$\begin{array}{r} 11111111- \\ 11010110 \\ \hline \end{array}$$

1's complement - 00101001 +

1

2's complement - 00101010

For Decimal : 72039651

$$\begin{array}{r} 99999999- \\ 72039651 \\ \hline \end{array}$$

9's complement - 27960348 +

1

10's complement - 27960349

For Octal : 523621

$$\begin{array}{r} 777777- \\ 523621 \\ \hline \end{array}$$

7's complement - 254156 +

1

8's complement - 254157

For Hexadecimal : 97 B 5 8 4 2 1 F C

$$\begin{array}{r} FFFFFFFF- \\ 97B58421FC \\ \hline \end{array}$$

15's complement - 684A7BDE03 +

1

16's complement - 684A7BDE04



# Signed Binary Numbers

<b>Decimal</b>	<b>Signed Magnitude</b>	<b>Signed-1's Complement</b>	<b>Signed-2's Complement</b>
+7	0111	0111	0111
+6	0110	0110	0110
+5	0101	0101	0101
+4	0100	0100	0100
+3	0011	0011	0011
+2	0010	0010	0010
+1	0001	0001	0001
+0	0000	0000	0000
-0	1000	1111	—
-1	1001	1110	1111
-2	1010	1101	1110
-3	1011	1100	1101
-4	1100	1011	1100
-5	1101	1010	1011
-6	1110	1001	1010
-7	1111	1000	1001
-8	—	—	1000



# Subtraction of Binary Numbers using Complement Addition

Let the given Number is  $X - Y$

## Using 1's complement

- Find the 1's complement of  $Y$
- Add with  $X$
- If carry = 1, then remove the carry and add with the LSB of the result ( This is called end around carry)

if carry = 0, find the 1's complement of result and assign negative sign

## Using 2's complement

- Find the 2's complement of  $Y$
- Add with  $X$
- If carry = 1, then remove the carry ( This is called discard carry)

if carry = 0, find the 2's complement of result and assign negative sign



Given two numbers  $A = 1010100$  and  $B = 1000011$ , Perform subtraction (a)  $A - B$  (b)  $B - A$  using 1's complement method

**No. of digits in A and B must be equal**

Using 1's complement

(a)  $A - B$

$$B = 1000011$$

$$1's \text{ complement of } B = 0111100 +$$

$$A = 1010100$$

$$\text{Sum} = 10010000 +$$

$$\text{End around carry} = \xrightarrow{\quad\quad\quad} 1$$

$$\text{Ans. (A-B)} = 0010001$$

(b)  $B - A$

$$A = 1010100$$

$$1's \text{ complement of } A = 0101011 +$$

$$B = 1000011$$

$$\text{Sum} = 1101110$$

$$\text{carry} = 0;$$

$\xrightarrow{\quad\quad\quad} 1's \text{ of (B-A)}$

$$1's \text{ complement of sum} = 0010001$$

$$\text{Ans. (B-A)} = -0010001$$



Given two numbers  $A = 1010100$  and  $B = 1000011$ , Perform subtraction (a)  $A - B$  (b)  $B - A$  using 2's complement method

Using 2's complement

(a)  $A - B$

$$B = 1\ 0\ 0\ 0\ 0\ 1\ 1$$

$$1's\ complement\ of\ B = 0\ 1\ 1\ 1\ 1\ 0\ 0$$

$$2's\ complement\ of\ B = 0\ 1\ 1\ 1\ 1\ 0\ 1 +$$

$$A = 1\ 0\ 1\ 0\ 1\ 0\ 0$$

$$Sum = 1\ 0\ 0\ 1\ 0\ 0\ 0\ 1 +$$

Discard carry

$$Ans.\ (A - B) = 0\ 0\ 1\ 0\ 0\ 0\ 1$$

(b)  $B - A$

$$A = 1\ 0\ 1\ 0\ 1\ 0\ 0$$

$$1's\ complement\ of\ A = 0\ 1\ 0\ 1\ 0\ 1\ 1$$

$$2's\ complement\ of\ A = 0\ 1\ 0\ 1\ 1\ 0\ 0 +$$

$$B = 1\ 0\ 0\ 0\ 0\ 1\ 1$$

$$Sum = 1\ 1\ 0\ 1\ 1\ 1\ 1$$

carry=0;

2's of (B-A)

$$1's\ complement\ of\ sum = 0\ 0\ 1\ 0\ 0\ 0\ 0$$

$$2's\ complement\ of\ sum = 0\ 0\ 1\ 0\ 0\ 0\ 1$$

$$Ans.\ (B - A) = -\ 0\ 0\ 1\ 0\ 0\ 0\ 1$$





# Home work

- 1. Given two numbers  $X = 111010$  and  $Y = 10011$ ,  
Perform subtraction (a)  $X - Y$  (b)  $Y - X$  using 1's and 2's  
complement method**
- 2. Given two numbers  $X = 11010.01$  and  $Y = 10001.11$ ,  
Perform subtraction (a)  $X - Y$  (b)  $Y - X$  using 1's and 2's  
complement method**

**Note :No.of digits in A and B must be equal**