☆ Complemetary Number Representation:

→ $A - B = A + (-B)$

$A - B = A + (\text{Complement of } +B)$.

→ Base = 'r' system

→ $(r-1)$'s Complement $\Rightarrow r^n - r^{-m} - N$

→ r's Complement $\Rightarrow r^n - N$.

∴ N = Given Number.

n = no. of digits in Integer part of N.

m = no. of digits in Fractional part of N.

E.g.: Find 9's Complement of 835.27_{10} = ?

→ $r = 10$, $N = 835.27$, ← method-1

∴ $n = 3$, $m = 2$.

∴ $10^3 - 10^{-2} - 835.27$

$= 1000 - 0.01 - 835.27$

$= 164.72_{10}$

NOTE:

method:-2 ↙

$$\begin{array}{r} 999.99 \\ -\ 835.27 \\ \hline (164.72)_{10} \end{array}$$

Ex-2 10's Complement $(352)_{11} = ?$

Ans: $(352)_{11}$. $r = 11$.

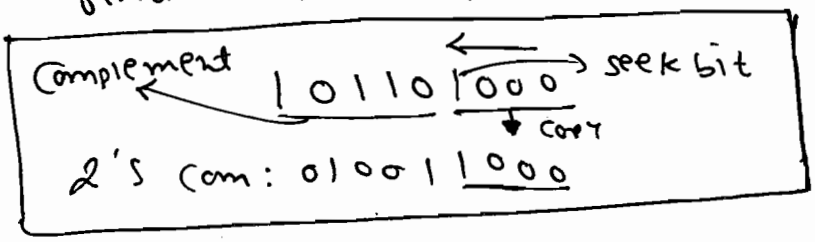
we have to find $(r-1)$'s Comp.

$\therefore$ $10 - 3 = 7$, $10 - 5 = 5$, $10 - 2 = 8$

Ans: $= (758)_{11}$.

Ex-3 find 2's Comp. of $x = 101101000$

Ans:



Ex-4 $0110_2 - 0001_2$

$6_{10} - 1_{10}$

Ans: 0110_2 + (Complement of 0001).

→ By 1's complement

$$\begin{array}{r} {\scriptstyle 1\ 1} \\ 0110_2 = 6_{10} \\ +\ 1110 \leftarrow \text{1's Complement of } 0001_2 \\ \hline 0100 \\ \text{EAC } (1) \quad +1 \\ \hline 0101 = 5_{10} \end{array}$$

→ By 2's Complement.

$$\begin{array}{r} {\scriptstyle 1\ 1} \\ 0110_2 \\ \text{EAC } +\ 1111 \leftarrow \text{2's Comp. of } 0001_2 \\ \hline \cancel{(1)} \quad 0101 = 5_{10} \end{array}$$

↓ EAC is discarded.

EAC = End Around Carry.

NOTE:

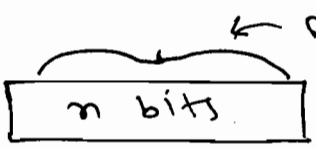
→ EAC doesn't occur when the result is -ve. i.e. Large value is subtracted from a small value.

(*)

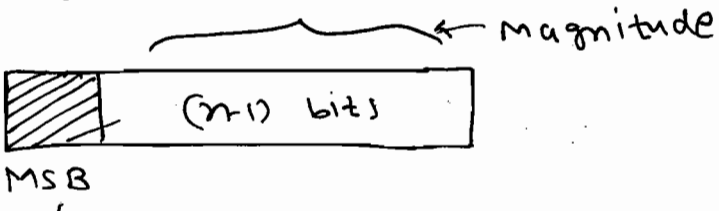
1's Comp. term	2's Comp. term.
→ +0 = 0000	→ +0 = 0000
-0 = 1's Comp. of +0	→ -0 = 2's comp. +0
= 1's Comp of 0000	= 2's Comp. 0000
→ -0 = 1111	→ -0 = 0000.

☆ Binary Numbers:

→ 1) Unsigned numbers. ⇒



2) Signed numbers. ⇒



sign bit

0 → +ve

1 → -ve

⇒ ⓐ signed magnitude form.

ⓑ 1's complement form.

ⓒ 2's complement form.

→ The Positive no. representation in all the above three forms is similar.

⇒ (a) sign magnitude form.

$+5_{10} = 0101$

$-5_{10} = 1101.$

(b) 1's Complement form.

$+5_{10} = 0101$

$-5_{10} =$ 1's comp. of $+5$

$-5_{10} = 1010$

(c) 2's Complement form.

$+5_{10} = 0101$

$-5_{10} =$ 2's Comp. of $+5$.

$-5_{10} = 1011.$

Ex-1 Represent the following no. in 2's complement form:

a) -17_{10} b) -83.375_{10}.

Ans: a) $+17_{10} =$ ~~XX~~010001 ← for the sign.

$-17_{10} =$ 2's comp. of $+17$.

$= 101111$ -- 128 64 32 16 8 4 2 1.
0.5 0.25, 0.125..

b) -83.375_{10}

→ $83.375 =$ ~~0110001~~ 01010001. 011

→ -83.375_{10} = 2's Comp. of $+83.375_{10}$

= 2's Comp. 01010011.011

= $(10101100.101)_2$

Ex-3

Determine the decimal value represented by the following signed no.s.

b) XXXX is ~~0101~~

1) Sign mag. no. 1101 is -5_{10}

$-5 = 1101 = 0101 = +5$

(1 → −, 101 → 5; 0 → +, 101 → 5)

2) (a) 2's Comp 01110 is +14

01110

+ve +14

b) 1's Comp no 01110 is +14

01110

+ve

3) 2's Comp no. 11001 is ⇒ ____ ?

11001

↓

−ve & 2's Comp.

So, 11001

↓

-sign 2's

→ 0 0111

= −7

-2^4	2^3	2^2	2^1	2^0
1	1	0	0	1

$= -16 + 8 + 1$

$= -7.$

4) 2's Comp. number 1000 is ⇒ ___ ?

→ 1000

$= -8 + 0 + 0 + 0$

$= -8.$

1000 → (2's comp) → 1000

$= -8.$

5) 1's Comp. no 10010 is ___ ?

Ans:

10010 → (1's comp) → -01101

$= -13$

$-(2^4 - 1) + 2^3 + 2^2 + 2^1 + 2^0$

1 0 0 1 0

$-15 + 0 + 0 + 2$

$= -13.$

GATE

(1) What is the equivalent 2's Comp. representation of a 2's comp. no. 1101 is ___ ?

→ 2's comp. no. → 1101. ⇒ -3

$= +3.$

(A) $101101 \longrightarrow -19_{10}$

(B) $001101 \rightarrow +13_{10}$

(C) $111101 \longrightarrow -3_{10}$

(D) $011101 \rightarrow +29_{10}$

111101 (2's)

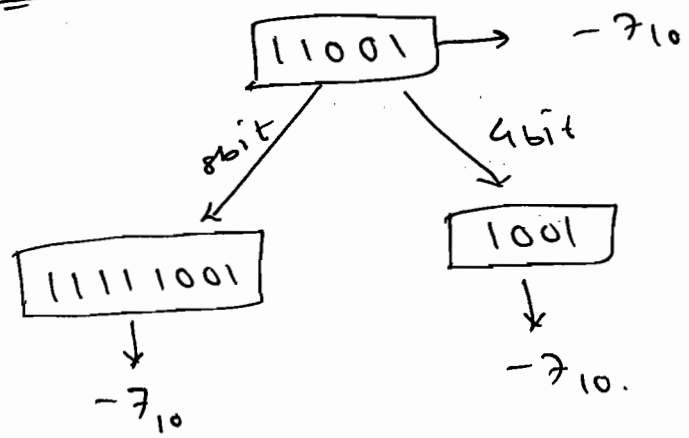
$= 000010$

$= -3.$

* Sign bit Extension:

→ In 1's & 2's complement form the Sign bit can be extended towards left any no. of times without changing its value.

Consider
E.g. 2's comp. no.



Ex-1 A 2's Comp. no. "$x_4\ x_3\ x_2\ x_1$" is copied into 6-bit register which of the following indicate the value of the register.

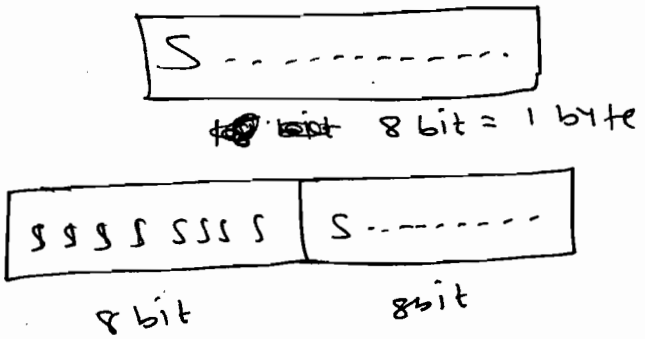
(a) $1\ 1\ x_4\ x_3\ x_2\ x_1$.

(b) $x_4\ x_4\ x_4\ x_3\ x_2\ x_1$.

(c) $0\ 0\ x_4\ x_3\ x_2\ x_1$.

(d) None.

* Convert Byte to word (CBW).



2) Convert Word to double word. => (CWD).

16 bit → 32 bit

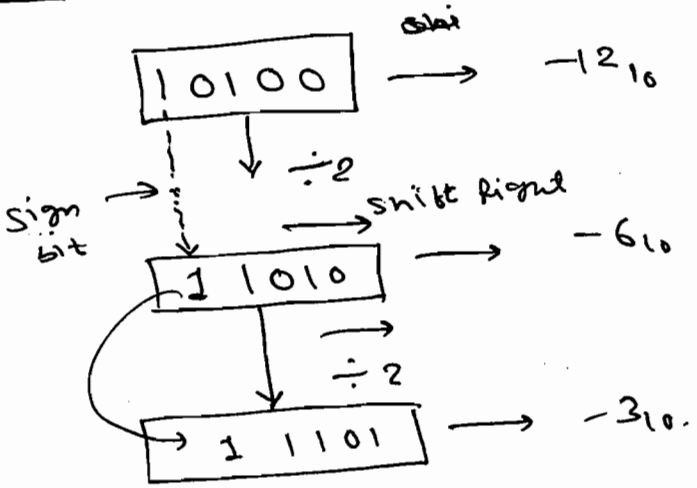
Ex. 2
⇒ A register contain a 2's comp. no. 10100. if it is divided by 2 find the value of the reg.

Ans:
$$10100$$
$$= -16 + 4 = -12.$$

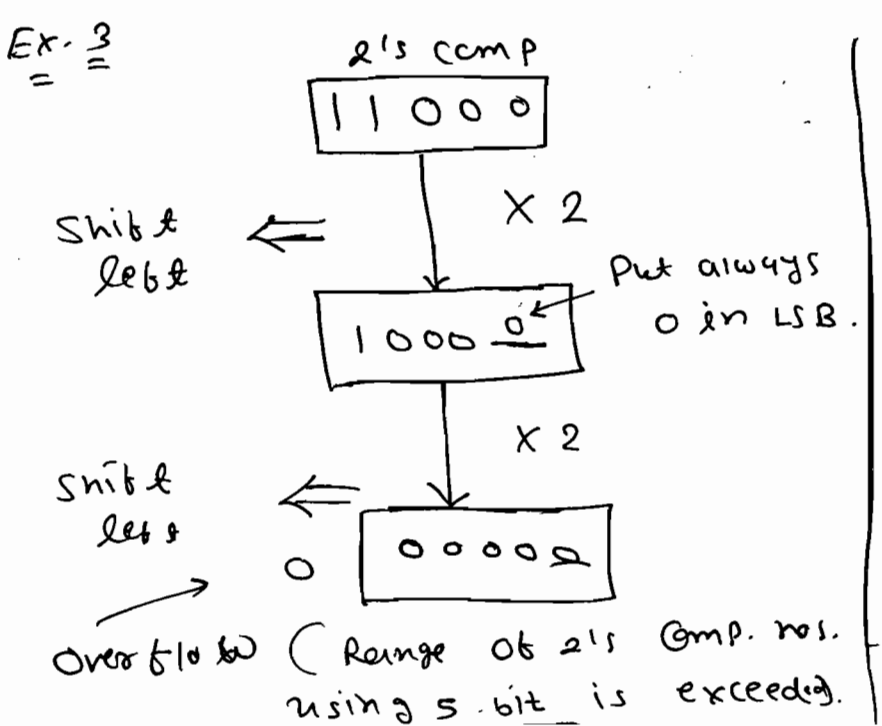
$$\therefore \frac{-12}{2} = -6.$$

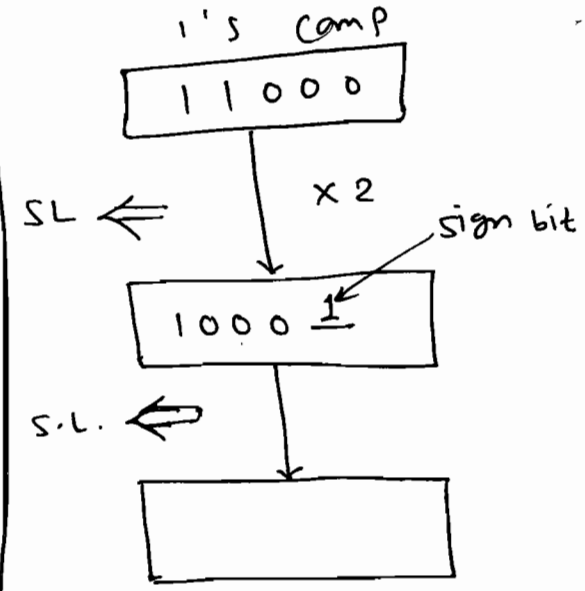
$$\therefore -6 = 2\text{'s Comp. of } +6$$
$$= 2\text{'s Comp. of } 00110$$
$$= 11010$$

→ method-2:



Ex. 3





	Range of number represents using 'n' bits.
1's Comp. form, sign mag. form	$+(2^{n-1}-1)$ to $-(2^{n-1}-1)$. e.g. $n=5 \rightarrow +15_{10}$ to -15_{10}
2's Comp form	$+(2^{n-1}-1)$ to -2^{n-1}. e.g. $n=5 \Rightarrow +15_{10}$ to -16_{10}

Note: Range of sign mag. form = Range of 1's Comp. form.