2's COMPLIMENT of

+18 = 00010010

1's Compliment;

-18 = 11101101

Retrieving a number:

2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0

1 1 1 0 1 1 0 1

$-128 + 64 + 32 + 8 + 4 + 1 = +109$

$-128 + 109 = -19$

$-19 + 1 = -18$

2's COMPLIMENT :>

$+18 = 00010010$

2's compliment ;

1's $\Rightarrow$ 11101101

$+1 \Rightarrow$ 11101110

$2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$

$-128 + 64 + 32 + 8 + 4 + 2$

$-128 + 110 = -18$

UNSIGNED NUMBERS :>

$0 \longrightarrow 2^n - 1$

e.g

$n = 2$

$0 \rightarrow 2^2 - 1$

$0 \rightarrow 3$

SIGNED NUMBERS :D

$$-2^{n-1} \longleftarrow 0 \longrightarrow 2^{n-1}-1$$

$n = 2$

$$-2^{1} \longleftarrow 0 \longrightarrow 2^{1}-1$$

$$-2 \longleftarrow 0 \longrightarrow 1$$

$n = 8$

$$-2^{7} \longleftarrow 0 \longrightarrow 2^{8-1}-1$$

$$-128 \longleftarrow 0 \longrightarrow 127$$

ADDITION & SUBTRACTION 8>

(i) Both numbers positive:- (no overflow)

7+4

```
+7    0000 0111
+4    0000 0100
      ---------
      0000 1011
```

1011

$2^3 2^2 2^1 2^0 \Rightarrow 8+2+1=11$

(ii) 15-6 (overflow, discard) Carry

```
+15 :-   0000 1111
+6 :-    0000 0110
-6 :-    1111 1010
```

```
+15+(-6) = 0000 1111
         + 1111 1010
         ------------
         1 0000 1001
```

↑ Discard

$0000\ 1001 \Rightarrow +9$

$2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0$

(iii) 16 - 24 (no overflow)

+16 :- 0001 0000
+24 :- 0001 1000

-24 :- 1110 1000

+16 + (24) :-

$$\begin{array}{r} 0001\ 0000 \\ +\ 1110\ 1000 \\ \hline 1111\ 1000 \end{array}$$

1111 1000
$-2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$

$$\left.\begin{array}{l} -128 \\ +\ 64 \\ +\ 32 \\ +\ 16 \\ +\ 8 \end{array}\right\} \begin{array}{l} -128 \\ +120 \end{array} \Bigg\} -8$$

(iv) Both numbers negative :-
(overflow, discard carry)

-5-9

+5 :- 0000 0101
-5 :- 1111 1011

+9 :- 0000 1001
-9 :- 1111 0111

$-5+(9)$:-

```
  1111  1011
+
  1111  0111
-------------
1 1111  0010
```

↑ Discard

```
 1111  0010
-2^7 2^6 2^5 2^4  2^3 2^2 2^1 2^0
```

$-128 + 64 + 32 + 16 + 2$ } $-128 + 114$ } -14

Second way:-

$-(5+9) \Rightarrow$

```
  0000 0101
+ 0000 1001
-----------
  0000 1110
```

Taking 2's Complement

1111 0010

-14