10's complement. 9's complement.

9's complement.

470 → 470 → 470
−231 → +(−231) → 768

$\boxed{1}$238 → extra step → 238 + 1 = 239

10's complement

470 → 470
−231 → 769
$\boxed{1}$239

9 − each digit
↓
add 001 at the end.

→ Signed magnitude
→ 1's complement
→ 2's complement

Representation steps.

−6
↓
0110
↓
1001
↓
1010

---

n = 4

Addition.

0010 +2
0011 +3
0101

5 − 2
↳ 5 + (−2)

7 − 3

Using 2's complement.

−8 4 2 1
0100 +4
1010 −6
1110 → −2

0001
+ 1
0010

+6 +3
−7 +1

Overflow

range
[−8 to +7]

Adding

+5 0101
+6 0110
+11 1011 → −5

1011
↓
0100
↓
0101 5

1 0 1

$$\begin{array}{rr} -5 & 1011 \\ -6 & 1010 \\ \hline -11 & (1)\ 0101 \end{array}$$

$\rightarrow$ +5

Sign position (-8)

1 0 1 0 1

$\boxed{\text{if signs are different} \rightarrow \text{no overflow.}}$

An overflow occurs if and only if the carry out of the sign position is **NOT** equal to the carry into the sign position.

Adding two positives gives a negative.
Adding two negative gives a positive.

0

## Exercise :

10's complement

## Sign Extension method.

$n = 4 \rightarrow n = 8$

4 bit: 0101 +5

8 bit: $\boxed{0000\ 0101}$

1011 -5

$\boxed{1111\ 1011}$

$x = 5$ | 0 0 0 0 0 1 0 1 | +5

$x \cdot 2$ | 0 0 0 0 1 0 1 0 | +10.

$x \cdot 4$ | 0 0 0 1 0 1 0 0 | +20.

$x \cdot 8$ | 0 0 1 0 1 0 0 0 | +40.

$$\boxed{x \cdot 2^i \rightarrow \text{shift left by } i \text{ bits}}$$

$x = -5.$ | 1111 1011 | −5.

$x \cdot 2$ | 1111 0110 | −10

$x \cdot 4$ | | −20

−40.

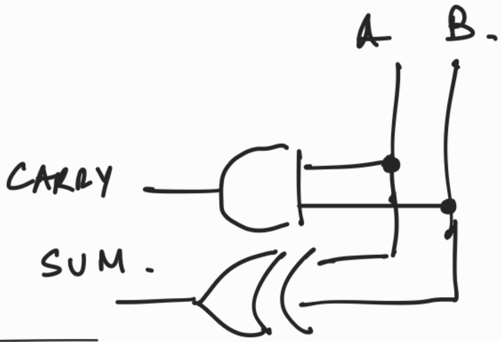
decimal

Half-adder

SUM = $A \oplus B$.

CARRY = $A \cdot B$.

| A | B | CARRY | SUM |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 |




not very useful.

Full adder

full adder

# Full Adder

| $x_i$ | $y_i$ | $c_i$ | $C_{i+1}$ | $S_i$ |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 |

$C_{i+1} = \sum m(3,5,6,7)$

$S_i = \sum m(1,2,4,7)$

$C_{i+1}$

| $x_i \backslash y_iC_i$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | | | 3 1 | |
| 1 | | 5 1 | 7 1 | 6 1 |

$$\boxed{C_{i+1} = x_i y_i + x_i C_i + y_i C_i}$$

$S_i$

| $x_i \backslash y_iC_i$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | | 1 | | 1 |
| 1 | 1 | | 1 | |

$$\boxed{S_i = x_i \oplus y_i \oplus C_i}$$