1 0 1 0

$(4)_{10} \rightarrow (0100)_2$

Decimal → 0 – 9

Binary → 1 or 0

Hex → 0 – F

3 2 1 0

0 1 0 0

$0 \cdot 2^0 + 0 \cdot 2^1 + 1 \cdot 2^2 + 0 \cdot 2^3 = 4$

0 0 4 0

$(6)_{10} = (0110)_2$

8 4 2 1

0 1 1 0 → 4 + 2 = 6

Decimal → binary

$(75)_{10} = (01001011)_2$

128 64 32 16 8 4 2 1

0 1 0 0 1 0 1 1

75 – 64 = 11

11 – 8 = 3

3 – 2 = 1

1 – 1 = 0

64 + 8 + 2 + 1 = 75

$(75)_{10} = (01001011)_2$

75 : 2 = 37 R 1
37 : 2 = 18 R 1
18 : 2 = 9 R 0
9 : 2 = 4 R 1
4 : 2 = 2 R 0
2 : 2 = 1 R 0
1 : 2 = 0 R 1

AND &

```
  01110110
& 00011010
----------
  00010010
```

7 6 5 4 3 2 1 0
01101001

{0, 3, 5, 6}

$(60)_{10} \rightarrow (00111100)_2$

$(13)_{10} \rightarrow (0000\ 1101)_2$

```
  00111100
& 00001101
----------
  00001100
```

$\rightarrow (12)_{10}$

8 4 2 1

8 + 4 = 12

$(0x41)_{16} \rightarrow (65)_{10}$

64 32 16 8 4 2 1
0 1 0 0 0 0 1

64+1=65

Shift operations

0x10 0010 <<3 ⟶ 00010000

Logical right shift

10100010>>2 ⟶ 00101000

Arithmetic right shift

10100010>>2 ⟶ 11101000

1110	-6
1101	-5
1100	-4
1011	-3
1010	-2
1001	-1
1000	-0
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7

1111 -7

$\overline{[5 + (-5)]}$

$$\begin{array}{r} {\scriptstyle 1\ \ 1} \\ 1101 \\ +\ 0101 \\ \hline 10010 \end{array} \neq 0$$

One's complement

1000	-7
1001	-6
1010	-5
1011	-4
1100	-3
1101	-2
1110	-1
1111	-0
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7

$5 + (-5)$

$$\begin{array}{r} 1010 \\ +\ 0101 \\ \hline 1111 \end{array} \longrightarrow -0 + 1 = 0$$

$5 + (-3)$ "add one"

$$\begin{array}{r} 0101 \\ +\ 1100 \\ \hline 10001 \end{array} \longrightarrow 1 + 1 = 2$$

-8	4	2	1	
1	0	0	0	-8
1	0	0	1	-7
1	0	1	0	-6
1	0	1	1	-5
1	1	0	0	-4
1	1	0	1	-3
1	1	1	0	-2
1	1	1	1	-1
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7

$5 + (-5)$

$$\begin{array}{r} {\scriptstyle 1\,1\,1} \\ 0101 \\ +\,1011 \\ \hline \cancel{1}0000 \end{array} \rightarrow 0$$

$5 + (-3)$

$$\begin{array}{r} {\scriptstyle 1\,1} \\ 0101 \\ +\,1101 \\ \hline \cancel{1}0010 \end{array} \rightarrow 2$$

$$(\overset{-8}{1}\,4\,2\,1\;\; 1010)_{10} \rightarrow (-6)_{10}$$

$$-8 + 0 + 2 + 0 = -6$$