Numbering system 😊

Number system is used to Represent information
in Quantative Form.

1) Binary Number system
2) Decimal "   "
3) Octal   "   "
4) Hexadecimal "   "

① Binary system (النظام الثنائي)

- Two Digits $<^0_1$

- Base $2^\square$

Ex → $(101010)_2$

② Decimal system (النظام العشري)

- 10 Digits $0 \longrightarrow 9$
- $2^0 \longrightarrow 2^8 = \underline{256}$

$0 \rightarrow 0000$		$6 \rightarrow 0110$
$1 \rightarrow 0001$		$7 \rightarrow 0111$
$2 \rightarrow 0010$		$8 \rightarrow 1000$
$3 \rightarrow 0011$		$9 \rightarrow 1001$
$4 \rightarrow 0100$		
$5 \rightarrow 0101$		

③ Octal system ‎(النظام الثماني)
  - 8 Digits ‎(0 → 7)
  - Base 8 → ( )$_8$

Ex: 3 → 011 .

④ Hexadecimal system. ‎(النظام السادس عشر)
  - 16 Digits
  - (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F)
  - Base 16 → ( )$_{16}$

❋ Binary To Decimal Conversion.   1

① $(11001)_2$ → (25)

$$1\ 1\ 0\ 0\ 1$$
$$2^4 + 2^3 + 2^2 + 2^1 + 2^0$$
$$16 + 8 + 0 + 0 + 1 = \underline{25}$$

② $(0010101)_2$ → (21)

$$0\ 0\ 1\ 0\ 1\ 0\ 1$$
$$2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$$
$$16 + 4 + 1 = 21$$

(2) Decimal To Binary:

- $(160)_{10} \longrightarrow (1010000)_2$

160	2	
80	2	0
40	2	0
20	2	0
10	2	0
5	2	1
2	2	0
1	2	1

$(169)_{10}$

169	2	1
84	2	0
42	2	0
21	2	1
10	2	0
5	2	1
2	2	0
1	2	1
0		

$(10101001)_2$

(5) Decimal To octal. ÷ 8

- $(670)_{10} \longrightarrow (1236)_8$

$$
\begin{array}{c|c|c}
670 & 8 & 6 \\
83 & 8 & 3 \\
10 & 8 & 2 \\
1 & 8 & 1 \\
\end{array}
$$

$(1236)_8$

(6) Decimal To Hexadecimal.

- ① $(4735)_{10} = (127F)_{16}$

$$
\begin{array}{c|c|c}
4735 & 16 & \text{⑮} \longrightarrow F \\
295 & 18 & 7 \\
18 & 16 & 2 \\
1 & 16 & 1 \\
\end{array}
$$

② $(3479)_{10} = (D97)_{16}$

$$
\begin{array}{c|c|c}
3479 & 16 & 7 \\
217 & 16 & 9 \\
13 & 16 & 13 \rightarrow D \\
\end{array}
$$

(4)

* Binary To Hexadecimal

① $(\underset{A}{1010}/\underset{C}{1100})_2 \longrightarrow (AC)_{16}$

② $(100100)_2 \longrightarrow (24)_{16}$

$\underbrace{(00)10}_{2}/\underbrace{0100}_{4}$

③ $(110 1011)_2 \longrightarrow (6B)_{16}$

$\underbrace{(0)110}_{6}/\underbrace{1011}_{B}$

* Hexadecimal To Binary

① $(5A4)_{16} \longrightarrow (0101\ 1010\ 0100)_2$

$\underset{0101}{5} \quad \underset{1010}{A} \quad \underset{0100}{4}$

② $(123)_{10} \longrightarrow (0001\ 0010\ 0011)_2$

$\underset{0001}{} \quad \underset{0010}{} \quad 0011$

③ **Binary To octal**

① $(101100)_2 \longrightarrow (54)_8$

$\quad\quad$ 101/100
$\quad\quad$ 5 $\quad$ 4

● ② $(0110011)_8 \longrightarrow (147)_8$

$\quad\quad$ 0̲01 100 111
$\quad\quad$ 1 $\quad$ 4 $\quad$ 7

③ $(100011)_2 \longrightarrow (43)_8$

$\quad\quad$ 100/011
$\quad\quad$ 4 $\quad$ 3

★ **Octal To Binary**

① $(25)_8 \longrightarrow (010101)_2$

$\quad\quad\quad$ 25
$\quad\quad$ 010 ↙ $\quad\longrightarrow\quad$ 101

● ② $(123)_2 \longrightarrow (001\,010\,011)_2$

$\quad$ 001 $\quad$ 010 $\quad$ 011

⑦ Octal To Hexadecimal.

• $(175)_8 = (07D)_{16}$

$$\begin{array}{ccc} 1 & 7 & 5 \\ \swarrow\downarrow\searrow & & \\ 001 & 111 & 101 \end{array} = 0/01 11/1 101$$

0000 0111 1101   13 = D

$\underset{0}{\downarrow}$ $\underset{7}{\downarrow}$ $\underset{D}{\downarrow}$

⑧ Hexadecimal To Octal.

$(5A)_{16} = (132)_8$

$$\begin{array}{cc} 5 & A \\ \swarrow & \searrow \\ 0101 & 1010 \end{array} = 01/01 1/010$$

001 011. 010

$\underset{1}{\downarrow}$ $\underset{3}{\downarrow}$ $\underset{2}{\downarrow}$

* Binary Addition:

⟹ (Add Two Binary Numbers).

```
    1 1      1 1
    0 1 1 0 0 1 1 0 0 1        Carry         409
    0 0 1 0 0 1 1 1 1 0    +                + 158
   ─────────────────────                   ──────
  1 0 0 0 1 1 0 1 1 ①    → Sum:            567
```

* Binary Subtraction:

A = 1 0 1 0 1 0 1 0 ⟶ 170 −
B = 1 0 0 1 1 1 0 0 ⟶ 156
                          ↳ = 14

```
  1 0 1 0 1 0 1 0
- 1 0 0 1 1 1 0 0
```

1) 1's Complement
   of 1 0 0 1 1 1 0 0
            ↓
        0 1 1 0 0 0 1 1

```
     ③
   1 0 1 0 1 0 1 0
 + 0 1 1 0 0 0 0 0
 ─────────────────
① 0 0 0 0 0 1 1 ⑩
        ↳ 14
```

2) 2's Complement
   0 1 1 0 0 0 1 1
            1 +
   ──────────────
   0 1 1 0 0 1 0 0

* Binary Multiplication:

(Multiply Two Binary Numbers)

Examples:

(1)
```
  0110 1101          0110 110
+ 1001 0100        0911 1011  +
----------         ----------
```

(2)
```
  100 1101          111 1100
- 100 1010        - 101 0101
---------         ----------
```

(3)
```
   1 0111
 *  1 101
---------
```

(4)
```
   1 1011
 *   101
---------
```

Examples:

1. $(110011)_2 = (51)_{10}$

2. $(10110101)_2 = (265)_8$

3. $(1010101101)_2 = (1DE)_{16}$

4. $(51)_{10} = (110011)_2$

5. $(177)_{10} = (261)_8$

6. $(77)_{10} = (4D)_{16}$

7. $(632)_8 = (410)_{10}$

8. $(741)_8 = (111100001)_2$

9. $(F4C)_{16} = (3916)_{10}$

10. $(A1D)_{16} = (101000011101)_2$

$$\begin{array}{r} \overset{3}{0}\ \overset{2}{1}\ \overset{1}{0}\ \overset{0}{0} \quad \to 4 \\ 0\ 0\ 1\ 1 \quad * \quad 3 \\ \hline 0\ 1\ 0\ 0 \\ 0\ 1\ 0\ 0 \quad + \\ 0\ 0\ 0\ 0 \quad + \\ 0\ 0\ 0\ 0 \quad + \\ \hline 0\ 0\ 0\ 1\ 1\ 0\ 0 = \boxed{12} \end{array}$$

$$\begin{array}{r} 1\ 0\ 1 \quad \to \quad 5 \\ 1\ 1 \quad *\ *\ 3 \\ \hline 1\ 0\ 1 \\ 1\ 0\ 1 \quad + \\ \hline 1\ 1\ 1\ 1 \quad \boxed{15} \end{array}$$

* **Binary Division**

I⟩

$$\begin{array}{r} 1\ 0\ 1\ 0\ 1 \\ 1\ 0\ 0\ 1\ \overline{)\ 1\ 0\ 1\ 1\ 0\ 0\ 0} \\ 1\ 0\ 0\ 1 \\ \hline 0\ 1\ 0\ 1 \\ 0\ 0\ 0 \\ \hline 1\ 0\ 1\ 0 \\ 1\ 0\ 0\ 1 \\ \hline 0\ 1\ 1\ 0 \\ 0\ 0\ 0\ 0 \\ \hline 1\ 1\ 0\ 0 \\ 1\ 0\ 0\ 1 \\ \hline 1\ 0\ 1 \end{array}$$

xor call

2⟩ $\to 1 \quad \boxed{9}$

$$\begin{array}{r} 3 \quad 1\ 0\ 0\ 1 \\ 1\ 1\ \overline{)\ 1\ 1\ 0\ 1\ 1} \quad \to \boxed{27} \\ 1\ 1 \\ \hline 0\ 0 \\ 0\ 0 \\ \hline 0\ 1 \\ 0\ 0 \\ \hline 1\ 1 \\ 1\ 1 \\ \hline 0\ 0 \end{array}$$

xor

$$\begin{array}{r} 9 \\ 3\ \overline{)\ 27} \end{array}$$

Remider

$$1\ 0\ 0\ 1\ 1\ \overline{)\ 1\ 0\ 1\ 1\ 1\ 0\ 1} \quad = \quad \boxed{1\ 0\ 1\ 0\ 1}$$
$$9 \quad\quad 189 \quad\quad\quad\quad 21$$

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