## * Number System Conversion

⇒ Used to convert numbers from one base to another.

1. Decimal to other Base System.
2. other Base System to Decimal.
3. other Base System to Non-Decimal.
4. Shortcut Method → Octal to Binary
5. Shortcut Method → Binary to Octal.
6. Shortcut Method → Binary to Hexadecimal.
7. Shortcut Method → Hexadecimal to Binary.

### ① Decimal to other Base System

Steps

① ⇒ Divide the decimal number to be converted by the value of the new base.

② ⇒ Get the remainder from step ① as the rightmost digit (Least Significant digit) of new base number.

③ ⇒ Divide the quotient of the previous divide the new base by

④ ⇒ Record the remainder from Step 3 as the next digit (to the left) of the new base number.

⇒ Repeat Steps 3 & 4, getting remainder from Right to left, until the quotient becomes Zero. in step ③.

⇒ last Remainder thus obtained will be the MSB ( Most significant bit) of the new base

exa. $X(29.)_{10} = (\quad)_2$.

*) $(29.25)_{10} = (\quad)_2$.

| | | |
|---|---|---|
| 2 | 29 | |
| 2 | 14 | 1 ← LSB |
| 2 | 7 | 0 |
| 2 | 3 | 1 |
| 2 | 1 | 1 |
| | | 1 ← MSB |

$0.25 \times 2 = 0.5 = 0$
$0.5 \times 2 = 1.0 = 1$

→ $\boxed{(29.25)_{10} = (.11101.01)_2}$

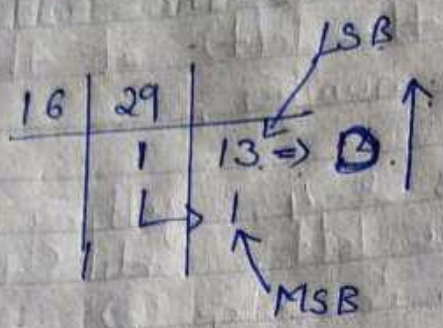
*) $(29.25)_{10} = (\quad)_8$

| | | |
|---|---|---|
| 8 | 29 | LSB |
| | 3 | 5 |
| | | 3 ← MSB |

$0.25 \times 8 = 2.$

$\boxed{(29.25)_{10} = (35.2)_8}$

*) $(29.25)_{10} = (\quad)_{16}$




$0.25 \times 16 = 4.$

A = 10
B = 11
C = 12
D = 13
E = 14
F = 15

$$(29.25)_{10} = (1D.4)_{16}$$

## ② Other Base System to Decimal System

### Steps

① ⇒ Determine the column (positional) value of each digit (this depends on the position of the digit & the base of the Number system).

② ⇒ Multiply the obtained column values (in step ①) By the digits in the corresponding columns.

③ ⇒ Sum the products calculated in step ②. The total is the equivalent value in decimal.

### Eg

→ Binary to Decimal

$$(11101.0101)_2 = (\ ?\ )_{10}$$

$\Rightarrow$ 4 3 2 1 0
11101

$\Rightarrow 2^0 * 1 + 0 * 2^1 + 2^2 * 1 + 2^3 * 1 + 2^4 * 1$

$= 1 + 0 + 4 + 8 + 16$

$= \boxed{29}$

1 2 3 4
.0101

$\Rightarrow 2^{-1} * 0 + 2^{-2} * 1 + 2^{-3} * 0 + 2^{-4} * 1$

$\Rightarrow 0 + \frac{1}{4} + 0 + \frac{1}{16}$

$\Rightarrow \frac{1}{4} + \frac{1}{16} \Rightarrow \frac{4+1}{16} = 5/16 = 0.3125.$

$\Rightarrow \boxed{(11101.0101)_2 = (29.3125)_{10}}$

→ Binary to octal.

$(11101.0101)_2 = (\ ?\ )_8$

4 5 6 1 0 . 1 2 3 4
11101 . 0101

$\Rightarrow$

$\rightarrow 8^0 * 1 + 8^1 * 0 + 8^2 * 1 + 8^3 * 3 + 8^4 * 1 .$

$8^{-1} * 0 + 8^{-2} * 1 + 8^{-3} * 0 + 8^{-4} * 1$

$\rightarrow 1 + 0 + 64 + 512 + 4096 . 0 + \frac{1}{64} + 0 + \frac{1}{4096}$

$\Rightarrow 4673 . \frac{1}{64} + \frac{1}{4096}$

$\Rightarrow 4673 . \frac{64+1}{4096} \Rightarrow 4673 . \frac{65}{4096} \Rightarrow (4673.015)_8$

$(11101.0101)_2 = (4673.015)_8$

*) Binary to Hexadecimal

→ $(11101.0101)_2 = (\ ?\ )_{16}$

→ 11101.0101

⇒ $16^0 * 1 + 16^1 * 0 + 16^2 * 1 * + 16^3 * 1 + 16^4 * 1$

$\cdot\ 16^{-1} * 0 + 16^{-2} * 1 + 16^{-3} * 0 + 16^{-4} * 1$

⇒ $1 + 0 + 256 + 4096 + 65,536 \cdot 0 + \frac{1}{256} + 0 + \frac{1}{65,536}$

→ $69889 \cdot \frac{256+1}{65536}$

→ 69889.0039

$(11101.0101)_2 = (69889.0039)_{16}$

③ other Base system to Non-decimal system.

Steps

① ⇒ Convert the original number to a decimal number (base 10)

② ⇒ Convert the decimal number so obtained. to the new base Number.

exg Octal Number $(25)_8 = (\quad)_2$

Step 1 : Convert to Decimal.

$(25)_8 = (\quad)_{10}$

$\Rightarrow 8^0 * 5 + 8^1 * 2$

$\rightarrow 5 + 16$

$\rightarrow (21)_{10}$

$\Rightarrow$ Step 2 Convert Decimal to Binary.

| | | |
|---|---|---|
| 2 | 21 | |
| 2 | 10 | 1 |
| 2 | 5 | 0 |
| 2 | 2 | 1 |
| | 1 | 0 |

$\hookrightarrow 1$

$\Rightarrow 10101$

$\Rightarrow (25)_8 = (10101)_8$

(4) Shortcut Method : Octal to Binary

Step

① $\Rightarrow$ Convert the each octal digit to 3 digit binary number.

② $\rightarrow$ Combine all the resulting binary groups (of 3 digit each) into a single Binary number.

exg $(25)_8$

$\rightarrow 010 \quad 101$

$\Rightarrow (010101)_2$.

## (3) Shortcut Method : Binary to Octal

**Steps**

(1) → Divide the binary digit into groups of three (Starting from the Right)

(2) → Convert each group of three binary digits to one Octal digit.

**Eg**

$10101101$

→ $10 \quad 101 \quad 101$

$\downarrow \quad \downarrow \quad \downarrow$

$2 \quad 5 \quad 5$

$\Rightarrow \boxed{(10101101)_2 = (255)_8}$

## (6) Shortcut Method : Binary to Hexa

**Steps**

(1) ⇒ Divide the Binary digits into groups of four (Starting from the Right)

(2) ⇒ Convert each group of four binary digits to one hexa.

**exa**

$(1100111100001)_2 = (\ ?\ )_{16}$

⇒

| 1100 | 0111 | 0001 |
|---|---|---|
| 6 | 7 | 1 |

$\Rightarrow (1100111100001)_2 = (671)_{16}$.

## (7) Shortcut Method : Hexa to Binary

**Steps**

(1) ⇒ Convert each Hexadecimal digit to a 4 digit binary number (Hexa. digit may be treated as decimal for this conversion)

(2) ⇒ Combine all the resulting binary groups (of 4 digit) into a single binary number.

**exa** $(27)_{16} \Rightarrow (\ ?\ )_2$

0010 0111. ⇒ So $(27)_{16} = (00100111)_2$