

① Binary Values table for 0 to 10  
decimal values :-  
dec:

	<u>Binary values</u>
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010

② from Decimal to Binary :-

(a) 12

$$\begin{array}{r} 12 \\ \hline 2 | 6 - 0 \\ \hline 2 | 3 - 0 \\ \hline 2 | 1 - 1 \end{array}$$

$\Rightarrow 1100$

(b) 20

$$\begin{array}{r} 20 \\ \hline 2 | 10 - 0 \\ \hline 2 | 5 - 0 \\ \hline 2 | 2 - 1 \\ \hline 2 | 1 - 0 \end{array}$$

$\Rightarrow 10100$

(c) 45

$$\begin{array}{r} 45 \\ \hline 2 | 22 - 1 \\ \hline 2 | 11 - 0 \\ \hline 2 | 5 - 1 \\ \hline 2 | 2 - 1 \\ \hline 1 - 0 \end{array}$$

$\Rightarrow 101101$

(d) 77

$$\begin{array}{r}
 2 | 77 \\
 \hline
 2 | 38 - 1 \\
 \hline
 2 | 19 - 0 \\
 \hline
 2 | 9 - 1 \\
 \hline
 2 | 4 - 1 \\
 \hline
 2 | 2 - 0 \\
 \hline
 1 - 0
 \end{array}$$

$$\Rightarrow 1001101$$

(e) 103

$$\begin{array}{r}
 2 | 103 \\
 \hline
 2 | 51 - 1 \\
 \hline
 2 | 25 - 1 \\
 \hline
 2 | 12 - 1 \\
 \hline
 2 | 6 - 0 \\
 \hline
 2 | 3 - 0 \\
 \hline
 1 - 1
 \end{array}$$

$$\Rightarrow 1100111$$

③ Octal of  $(9910)_{10}$  :-

$$\begin{array}{r}
 8 | 9910 \\
 \hline
 8 | 1238 - 6 \\
 \hline
 8 | 154 - 6 \\
 \hline
 8 | 19 - 2 \\
 \hline
 2 - 3
 \end{array} \Rightarrow 23266$$

④ from Binary - to Decimal :-

$$\textcircled{a} \quad 1101 \Rightarrow 1101^{\substack{8^4 \\ 8+4+1}} \Rightarrow 13$$

$$\textcircled{b} \quad 1110 \Rightarrow 1110^{\substack{8^3 \\ 8+4+2}} \Rightarrow 14$$

①

$$\textcircled{c} \quad 1111 \ 0101 \Rightarrow 11110101 = 245$$

$128 + 64 + 32 + 16 + 4 + 1$

$$\textcircled{d} \quad 0101 \ 0101 \Rightarrow 01010101 = 85$$

$64 + 16 + 4 + 1$

$$\textcircled{e} \quad 10001111 \Rightarrow 10001111 = 143$$

$128 + 8 + 4 + 2 + 1$

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⑤ Convert numbers to base indicated  
or vice-versa (cross-verify):-

$$\textcircled{a} \quad (1101)_2 \Rightarrow (13)_8 \quad (1101)_3 \rightarrow (15)_7$$

$$\begin{array}{r} 8 \quad 4 \quad 2 \\ \overline{1 \ 1 \ 0 \ 1} \\ 8+4+1=13 \end{array}$$

$$\begin{array}{r} 8 \quad | \quad 13 \\ \hline 1 \quad -5 \end{array} = 15$$

$$\begin{array}{r} 8 \quad | \quad 13 \\ \hline 1 \quad -5 \end{array} = 15$$

$$\Rightarrow \begin{array}{r} 8 \quad 4 \quad 2 \\ \overline{1 \ 1 \ 0 \ 1} \\ 8+4+1=13 \end{array} \checkmark$$

$$\begin{array}{r} 8 \quad | \quad 13 \\ \hline 1 \quad -5 \end{array} = 15 \checkmark$$

Bin to Dec.

$$\textcircled{b} \quad (1111 \ 1111 \ 1110)_2 \Rightarrow (4094)_{10}$$

$$\begin{array}{r} 2048 \quad 1024 \quad 512 \quad 256 \quad 128 \quad 64 \quad 32 \quad 16 \quad 8 \quad 4 \quad 2 \\ | \quad | \end{array}$$

$$2048 + 1024 + 512 + 256 + 128 + 64 + 32 + 16 + 8 + 4 + 2 = 4094$$

(For see back)

$$\textcircled{O} (221201)_3 \xrightarrow{\text{Ternary to Dec}} (694)_{10} \quad (\text{For C.V. see back})$$

$\begin{array}{cccccc} 3 & 3 & 3 & 3 & 3 & 3 \\ 2 & 2 & 1 & 2 & 0 & 1 \end{array}$   
 $486 + 162 + 27 + 18 + 1 = 694 \checkmark$

$$\textcircled{a} (76)_8 \Rightarrow (62)_{10} \quad (\text{Octal - Dec}) \quad (11110)_2$$

$\begin{array}{cc} 8' & 8^0 \\ 7 & 6 \end{array}$

$$56 + 6 \Rightarrow 62$$

$$\begin{array}{r}
 62 \\
 \hline
 2 | 3,1 - 0 \\
 \hline
 2 | 15 - 1 \\
 \hline
 2 | 7 - 1 \\
 \hline
 2 | 3 - 1 \\
 \hline
 1 - 1
 \end{array} = 11110$$

$$= 62$$

$$\begin{array}{r}
 8 | 62 \\
 \hline
 7 - 6 \\
 \hline
 \end{array} \Rightarrow 76 \checkmark$$

$$\textcircled{c} (231)_8 \Rightarrow (22)_{10} \quad (\text{Octal to Bin})$$

$\begin{array}{ccccc} 8' & 8^0 & 1 \\ 2 & 3 & 1 \end{array}$

$$128 + 24 + 1 = 153$$

$$\begin{array}{r} 153 \\ \hline 2 \end{array}$$
$$10011001$$
$$\begin{array}{r} 76-1 \\ \hline 2 \end{array}$$

$$128 + 16 + 8 + 1 = 153$$

$$\begin{array}{r} 38-0 \\ \hline 2 \end{array}$$
$$\begin{array}{r} 19-0 \\ \hline 2 \end{array}$$
$$\begin{array}{r} 9-1 \\ \hline 2 \end{array}$$
$$\begin{array}{r} 4-1 \\ \hline 2 \end{array}$$
$$\begin{array}{r} 2-0 \\ \hline 2 \end{array}$$
$$\begin{array}{r} 1-0 \\ \hline 2 \end{array}$$
$$\begin{array}{r} 153 \\ \hline 8 \end{array}$$
$$\begin{array}{r} 19-1 \\ \hline 8 \end{array}$$
$$2-3$$
$$\Rightarrow 231$$

✓

$$= 10011001$$

⑦  $(f00)_{16} \Rightarrow ()_8$

Hexa  $\rightarrow$  Dec  $\rightarrow$  octal

$\begin{array}{c} 1500 \\ 16^2 \\ \hline 100 \\ 16^1 \\ \hline 0 \\ 16^0 \end{array} \quad \begin{array}{c} 3840 \\ 10 \\ \hline 40 \\ 10 \end{array} \quad \begin{array}{c} 7400 \\ 8 \\ \hline 40 \\ 8 \end{array}$

$$\boxed{15 \ 10 \ 01}$$

$$\Rightarrow 256 \times 15 = 3840$$

$$\begin{array}{r} 3840 \\ \hline 8 \end{array}$$
$$\begin{array}{r} 480-0 \\ \hline 8 \end{array}$$
$$\begin{array}{r} 60-0 \\ \hline 8 \end{array}$$
$$\begin{array}{r} 7-4 \\ \hline 8 \end{array}$$
$$\Rightarrow 7400$$

C.V 82 42 8' 80  
7400

$$3584 + 256 = (3840)_{10}^{\text{per}} \checkmark$$

$$\begin{array}{r} 16 | 3840 \\ \hline 16 | 240 - 0 \\ \hline 15 - 0 \end{array} \quad 1500 \checkmark$$

13 10 12 14    wka - duodec  
③  $(DACE)_{16} \Rightarrow (284BA)_2$

$$\boxed{13|10|12|14}$$

$$53248 + 2560 + 192 + 14 \\ \Rightarrow 56014$$

$$\begin{array}{r} (DACE)_{16} \quad (284BA)_{12} \\ \downarrow \qquad \qquad \qquad \downarrow \\ \begin{array}{r} 12 | 56014 \\ \hline 12 | 4667 - 10 \\ \hline 12 | 388 - 11 \\ \hline 12 | 32 - 4 \\ \hline 2 - 8 \end{array} \Rightarrow 284BA \end{array}$$

C.V !

$(2 \mid 8 \mid 4 \mid 11 \mid 10)$

$$\Rightarrow 41472 + 13824 + 576 + 132 + 10 \\ \Rightarrow 56014 \checkmark$$

16	5610
16	3500 — 14
16	218 — 12
	13 — 10

$$\Rightarrow 13101214 \\ (\text{DACE})_{16} \checkmark$$

3500
16) 56014
-48
80
80
0
14
0
14

h)  $(2B)_{16} \Rightarrow (53)_8$  (Hexa - octal)

2	11
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$$32 + 11 = 43$$

$$\frac{8}{\cancel{5}} \mid \cancel{4}3 = 53 \Rightarrow \underline{\underline{53}} \rightarrow \begin{array}{r} 8 \\ 5 \\ 3 \end{array}$$

$$\begin{array}{r} 8 \\ 16 \mid 43 \\ 2 - 11 \end{array} = 43 \quad \begin{array}{r} 8 \\ 40 + 23 \\ \hline 63 \end{array} \checkmark$$

$$\Rightarrow 2B \checkmark$$

⑥ Convert no. to decimal base 10 :-

⑦  $(3312)_8$  o-dec

$8^3 \quad 8^2 \quad 8^1 \quad 8^0$

3 3 1 2

$$1536 + 192 + 8 + 2$$

$$\Rightarrow (1738)_{10}$$

536      64  
192      8  
10      1  
192      64  
64      8  
8      1  
1536      3

C.V. | 17,358  
8 | 2157 - 2  
8 | 27 - 1  
----- | 3 - 3  $\Rightarrow 3312$

⑧  $(167)_8$  o-dec

$8^2 \quad 8^1 \quad 8^0$

1 6 7

$$64 + 48 + 7$$

$$= (119)_{10}$$

8 | 119  
8 | 14 - 7  
----- | 1 - 6

$$\Rightarrow 167 \checkmark$$

⑨  $(202103)_9$  nonary-dec

$9^5 \quad 9^4 \quad 9^3 \quad 9^2 \quad 9^1 \quad 9^0$

2 0 2 1 0 3

$$\Rightarrow 118098 + 1458 + 81 + 3 = 119640$$

C.V. | 11,9,6,4,0  
9 | 13,283 - 3  
9 | 147 - 0  
9 | 16 - 1  
9 | 18 - 2

= 202103  $\checkmark$

d)  $(3132334)_{16}$

$$\begin{array}{ccccccc} 16^6 & 16^5 & 16^4 & 16^3 & 16^2 & 16^1 & 16^0 \\ 3 & 1 & 3 & 2 & 3 & 3 & 4 \end{array}$$

$$\Rightarrow 50331648 + 1048576 + 196608 + 8192 + 768 + 48 + 4 = (51585844)_{10}$$

c.v

$$\begin{array}{r} 16 | 51585844 \\ \hline 3224115 - 4 \\ \hline 201507 - 3 \\ \hline 12594 - 3 \\ \hline 787 - 2 \\ \hline 49 - 3 \end{array} \quad \left. \begin{array}{r} 16 | 49 \\ \hline 3 - 1 \end{array} \right\} \Rightarrow 3132334$$

e)  $(F2)_{16}$

$$(152)_{16} \Rightarrow (338)_{10}$$

$$\begin{array}{r} 16^2 16^1 16^0 \\ 152 \end{array}$$

$$256 + 80 + 2 = 338$$

c.v

$$\begin{array}{r} 16 | 338 \\ \hline 21 - 2 \\ \hline 1 - 5 \\ \hline \end{array}$$
$$\Rightarrow 152 \checkmark$$

$$\begin{array}{r} 256 \\ 80 \\ 338 \end{array}$$

$$\begin{array}{r} 16^2 \\ 15 \\ 80 \\ 338 \\ \hline 256 \end{array}$$

⑦ Base 10 no.'s to base indicate!

dec - bin

⑧  $(5610)_{10} \Rightarrow (1010111101010)_2$

$$\begin{array}{r} 2 | 5610 \\ 2 | 2805 - 0 \\ 2 | 1402 - 1 \\ 2 | 701 - 0 \\ 2 | 350 - 1 \\ 2 | 175 - 0 \\ 2 | 87 - 1 \\ 2 | 43 - 1 \\ 2 | 21 - 1 \\ 2 | 10 - 1 \\ 2 | 5 - 0 \\ 2 | 2 - 1 \\ \hline & 1 - 0 \end{array}$$

C.V.:-

4096 2048 1024 512 256 128 64 32 16 8 4 2 1  
1 0 1 0 1 1 1 0 1 0 1 0

$$\Rightarrow 4096 + 1024 + 256 + 128 + 64 + 32 + 8 + 2 \Rightarrow 5610$$

⑨  $(5610)_{10} \stackrel{\text{dec - tr}}{\Rightarrow} (21200210)_3$

$$\begin{array}{r} 3 | 5610 \\ 3 | 1870 - 0 \\ 3 | 6023 - 1 \\ 3 | 207 - 2 \\ 3 | 69 - 0 \\ 3 | 23 - 0 \\ 3 | 7 - 2 \\ \hline & 2 - 1 \end{array}$$

C.V.:-

27 9 35 11 3 3 3 3 1 3 1 3 0  
2 1 2 0 0 2 1 0

$$\Rightarrow 4374 + 729 + 486 + 18 + 3 \Rightarrow 5610$$

$\Rightarrow 21200210 \checkmark$

$$\textcircled{c} \quad (5610)_{10} \Rightarrow (12752)_8$$

$$\begin{array}{r} 5610 \\ \hline 8 | 701 \rightarrow 2 \\ \hline 8 | 87 \rightarrow 5 \\ \hline 8 | 10 \rightarrow 7 \\ \hline 1 \rightarrow 2 \end{array}$$

$$\Rightarrow 12752$$

$$\begin{array}{r} \text{C.V. 1-} \\ 8^4 \frac{8^3}{8^3} 8^2 8^1 8^0 \\ \hline 1 \ 2 \ 7 \ 5 \ 2 \end{array}$$

$$\Rightarrow 4096 + 1024 + 448 + 40 + 2 = 5610 \checkmark$$

$$\textcircled{d} \quad (5610)_{10} \Rightarrow (32b6)_{12} \text{ dec-duodec.}$$

$$\begin{array}{r} 56_{10} \\ \hline 12 | 46 \rightarrow 6 \\ \hline 12 | 38 \rightarrow 11 \\ \hline 3 \rightarrow 2 \end{array}$$

$$\begin{array}{r} 12^3 \ 12^2 \ 12^1 \ 12^0 \\ \hline 3 \ 2 \ 11 \ 6 \end{array}$$

$$\Rightarrow 5184 + 288 + 132 + 6 = 5610$$

$\Rightarrow 32b6$

$\nearrow (11) \text{ i.e., base } 12.$

$$\textcircled{e} \quad (5610)_{10} \Rightarrow (15BA)_{16} \text{ dec-Hexa.}$$

$$\begin{array}{r} 56_{10} \\ \hline 16 | 35 \rightarrow 10 \\ \hline 16 | 21 \rightarrow 14 \\ \hline 1 \rightarrow 5 \end{array}$$

$$\begin{array}{r} 16^3 \ 16^2 \ 16^1 \ 16^0 \\ \hline 1 \ 5 \ 14 \ 10 \end{array}$$

$$\Rightarrow 4096 + 1280 + 224 + 10$$

$$\Rightarrow 5610 \checkmark$$

$$\textcircled{f} \quad (22110)_10 \Rightarrow (10101100101110)_2$$

$$\begin{array}{r}
 2 | 22110 \\
 \hline
 2 | 11055 - 0 \\
 \hline
 2 | 5527 - 1 \\
 \hline
 2 | 2763 - 1 \\
 \hline
 2 | 1381 - 1 \\
 \hline
 2 | 690 - 1 \\
 \hline
 2 | 345 - 0 \\
 \hline
 2 | 172 - 1 \\
 \hline
 2 | 86 - 0 \\
 \hline
 2 | 43 - 0 \\
 \hline
 2 | 21 - 1 \\
 \hline
 2 | 10 - 1 \\
 \hline
 2 | 5 - 0 \\
 \hline
 2 | 2 - 1 \\
 \hline
 1 - 0
 \end{array}
 \quad
 \begin{array}{l}
 \text{CV} \\
 8192 \swarrow 4096 \swarrow 2048 \swarrow 1024 \swarrow 512 \swarrow 256 \swarrow 128 \swarrow 64 \swarrow 32 \swarrow 16 \swarrow 8 \swarrow 4 \swarrow 2 \\
 10101100101110
 \end{array}
 \quad
 \begin{array}{l}
 \Rightarrow 16384 + 4096 \\
 + 1024 + 512 \\
 + 64 + 16 + 8 \\
 + 4 + 2 \\
 \Rightarrow 22110 \\
 \checkmark
 \end{array}
 \quad
 \Rightarrow 10101100101110$$

$$\textcircled{g} \quad (22110)_10 \Rightarrow (101002222)_3$$

$$\begin{array}{r}
 3 | 221_2 0 \\
 \hline
 3 | 73_2 0 - 0 \\
 \hline
 3 | 245_2 0 - 2 \\
 \hline
 3 | 81_2 8 - 2 \\
 \hline
 27_2 - 2
 \end{array}
 \quad
 \begin{array}{r}
 3 | 272 \\
 \hline
 3 | 90 - 2 \\
 \hline
 3 | 30 - 0 \\
 \hline
 3 | 10 - 0 \\
 \hline
 3 | 3 - 1 \\
 \hline
 1 - 0
 \end{array}$$

$\Rightarrow 1010022220$

C.V:  $\begin{array}{ccccccccc} 19683 & 6561 & 2187 & 729 & 243 & 81 & 27 & 9 & 3 \\ \hline 1 & 0 & 1 & 0 & 0 & 2 & 2 & 2 & 0 \end{array}$

$\Rightarrow 19683 + 2187 + 162 + 54 + 18 + 6$

$\Rightarrow 22110 \checkmark$

④  $(22110)_{10} \Rightarrow (53136)_8$

$$\begin{array}{r} 22110 \\ \hline 8 | 2763 - 6 \\ \hline 8 | 345 - 3 \\ \hline 8 | 43 - 1 \\ \hline 5 - 3 \end{array}$$

C.V:  $\begin{array}{ccccccccc} 4096 & 512 & 64 & 8 & 0 \\ 8^4 & 8^3 & 8^2 & 8 & 8^0 \\ \hline 5 & 3 & 1 & 36 \end{array}$

$\Rightarrow 20480 + 1536 + 64 + 24 + 6$

$\Rightarrow 53136 \checkmark = 22110 \checkmark$

①  $(22110)_{10} \Rightarrow (10966)_{12}$

$$\begin{array}{r} 22110 \\ \hline 12 | 18642 - 6 \\ \hline 12 | 153 - 6 \\ \hline 12 | 12 - 9 \\ \hline 1 - 0 \end{array}$$

C.V:  $\begin{array}{ccccccccc} 20736 & 1296 & 72 & 0 \\ 12^4 & 12^3 & 12^2 & 12^0 \\ \hline 10966 \end{array}$

$\Rightarrow 20736 +$

$1296 +$

$72 + 6 =$

$22110 \checkmark$

$$\textcircled{3} (22110)_{10} \Rightarrow (565E)_{16}$$

$$\begin{array}{r}
 \begin{array}{c|ccccc}
 16 & 2 & 2 & 6 & 1 & 1 & 0 \\
 \hline
 16 & 1 & 3 & 8 & 0 & 1 & 4 \\
 \hline
 16 & & 8 & 6 & - & 5 & \\
 \hline
 & 5 & - & 6 & & &
 \end{array}
 & = 14 - E \\
 & & & & \begin{array}{c}
 \text{C.V} = \text{Ans} \\
 408 \frac{16^3}{5} 16^2 16^1 16^0 \\
 5 \quad 6 \quad 5 \quad 14
 \end{array} \\
 \Rightarrow 565E & \rightarrow 20480 + 1536 \\
 & + 80 + 14 \\
 & \checkmark \Rightarrow 22110
 \end{array}$$

### ⑧ Binary Addition :-

$$9 + 12$$

$$\begin{array}{r}
 9 \rightarrow 1001 \\
 12 \rightarrow 1100 \\
 \hline
 21 \quad \underline{10101}
 \end{array}$$

$16 + 4 + 1$

$$\begin{array}{r}
 2 | 9 \\
 2 | 4 - 1 \\
 2 | 2 - 0 \\
 2 | 1 - 0
 \end{array}$$

$$\begin{array}{r}
 2 | 12 \\
 2 | 6 - 0 \\
 2 | 3 - 0 \\
 2 | 1 - 1
 \end{array}$$

$$40 + 31$$

$$\begin{array}{r}
 40 \rightarrow 101000 \\
 + 31 \rightarrow 11111 \\
 \hline
 71 \quad \underline{1000111}
 \end{array}$$

$64 + 4 + 2 + 1$

$$\begin{array}{r}
 2 | 40 \\
 2 | 20 - 0 \\
 2 | 10 - 0 \\
 2 | 5 - 0 \\
 2 | 2 - 0 \\
 2 | 1 - 1
 \end{array}$$

$$\begin{array}{r}
 2 | 31 \\
 2 | 15 - 1 \\
 2 | 7 - 1 \\
 2 | 3 - 1 \\
 2 | 1 - 1
 \end{array}$$

$$\textcircled{c} \quad 1110 + 0101$$

$$8+4+2 \rightarrow 1110 \rightarrow 14$$

$$4+1 \rightarrow 0101 \rightarrow 5$$

$$\begin{array}{r} \overline{10011} \\ \hline 16+2+1 \end{array} \quad \checkmark \quad \begin{array}{r} \overline{19} \\ \hline \end{array}$$

$$\textcircled{d} \quad 11110101 + 01111100$$

$$\begin{array}{r} \overline{11110101} \\ \hline 245 \\ 01111100 \\ \hline \overline{101110001} \\ \hline 369 \end{array}$$

$$256+64+32+16+1 \quad \checkmark$$

$$\textcircled{e} \quad 11000011 + 0101110$$

$$\begin{array}{r} \overline{11000011} \\ \hline 195 \\ 0101110 \\ \hline \end{array}$$

$$\begin{array}{r} \overline{100100001} \\ \hline 94 \end{array}$$

$$\begin{array}{r} \overline{256 \ 128 \ 64 \ 32 \ 16 \ 8 \ 4} \\ \hline 289 \end{array}$$

$$256+32+1$$

# ⑨ Binary Subtraction :

⑩  $8 - 3$

$$\begin{array}{r} 8 \\ (-) 3 \\ \hline 5 \end{array}$$

$$01.0\overset{1}{\cancel{1}}.\overset{1}{\cancel{0}}.\overset{1}{\cancel{0}}$$

$$\begin{array}{r} 1 \\ + \\ \hline 1.01 \end{array}$$

$$\begin{array}{r} 2 \\ | \\ 8 \\ 2 \\ | \\ 4 \\ 2 \\ | \\ 2 \\ 2 \\ | \\ 0 \\ 1 \\ - \\ 0 \end{array}$$

$$\begin{array}{r} 2 \\ | \\ 3 \\ 1 \\ - \\ 1 \end{array}$$

$$4 + 1 = \checkmark$$

⑪  $17 - 11$

$$\begin{array}{r} 17 \\ (-) 11 \\ \hline 6 \end{array}$$

$$\begin{array}{r} 0110.0\overset{1}{\cancel{0}}.\overset{1}{\cancel{0}}1 \\ + 1011 \\ \hline 110 \end{array}$$

$$\begin{array}{r} 2 \\ | \\ 17 \\ 2 \\ | \\ 8 \\ 2 \\ | \\ 4 \\ 2 \\ | \\ 2 \\ 2 \\ | \\ 0 \\ 1 \\ - \\ 0 \end{array}$$

$$\begin{array}{r} 2 \\ | \\ 11 \\ 2 \\ | \\ 5 \\ 2 \\ | \\ 2 \\ 2 \\ | \\ 1 \\ 1 \\ - \\ 0 \end{array}$$

$$4 + 2 = 6$$

⑫  $25 - 7$

$$\begin{array}{r} 25 \\ (-) 7 \\ \hline 18 \end{array}$$

$$\begin{array}{r} 110010 \\ + 111 \\ \hline 10010 \end{array}$$

$$\begin{array}{r} 2 \\ | \\ 25 \\ 2 \\ | \\ 12 \\ 2 \\ | \\ 6 \\ 2 \\ | \\ 3 \\ 2 \\ | \\ 1 \\ 1 \\ - \\ 1 \end{array}$$

$$\begin{array}{r} 2 \\ | \\ 7 \\ 2 \\ | \\ 3 \\ 2 \\ | \\ 1 \\ 1 \\ - \\ 1 \end{array}$$

$$\checkmark 16 + 2$$

$$\textcircled{d} \quad 86 - 31$$

$$\begin{array}{r}
 86 \rightarrow 100010 \\
 31 \rightarrow 11111 \\
 \hline
 55 \qquad \qquad \qquad 11111
 \end{array}$$

$32 + 16 + 8 + 4 + 2 + 1$

$$\begin{array}{r}
 2 | 86 \\
 2 | 43 - 0 \\
 2 | 21 - 1 \\
 2 | 11 - 1 \\
 2 | 5 - 1 \\
 2 | 2 - 1 \\
 1 - 0
 \end{array}$$

$$\textcircled{e} \quad 11010001 - 01000111$$

$$\begin{array}{r}
 11010001 \rightarrow 209 \\
 01000111 \rightarrow 71 \\
 \hline
 10001010 \qquad \qquad \qquad 138
 \end{array}$$

$128 + 8 + 2 \quad \checkmark$

### ⑩ Binary Multiplication :

$$\textcircled{a} \quad 12 \times 3$$

$$\begin{array}{r}
 12 \\
 \times 3 \\
 \hline
 36
 \end{array}
 \quad
 \begin{array}{r}
 1100 \times 11 \\
 \hline
 1100 \\
 1100 \times \\
 \hline
 10100
 \end{array}$$

$$\begin{array}{r}
 2 | 12 \\
 2 | 6 - 0 \\
 2 | 3 - 0 \\
 1 - 1
 \end{array}$$

$$\begin{array}{r}
 2 | 3 \\
 1 - 1
 \end{array}$$

$$32 + 4 \quad \checkmark$$

⑥ 20 x 5

$$\begin{array}{r}
 20 \\
 5 \\
 \hline
 100
 \end{array}
 \quad
 \begin{array}{r}
 101000 \times 101 \\
 \hline
 10100 \\
 + 00000 \times - (0) \\
 \hline
 010100 \\
 + 10100 \times x - (1) \\
 \hline
 1100100
 \end{array}$$

$$\begin{array}{r}
 2 | 20 \\
 \hline
 2 | 10 - 0 \\
 \hline
 2 | 5 - 0 \\
 \hline
 2 | 2 - 1 \\
 \hline
 & 1 = 0
 \end{array}$$

$$\begin{array}{r} \underline{2} \Big| 5 \\ \underline{2} \Big| 2 - 1 \\ \hline & 1 - 0 \end{array}$$

$$\Rightarrow 64 + 32 + 4 = 100 \quad \checkmark$$

© 0111 x 0010

$$\begin{array}{r} \overset{1}{\cancel{0}}\overset{1}{\cancel{1}}\overset{1}{\cancel{1}} \\ 4 + 2 + 1 = 7 \\ \overset{1}{\cancel{0}}\overset{1}{\cancel{0}}\overset{1}{\cancel{0}} = \underline{\underline{2}} \\ 14 \end{array}$$

$$\begin{array}{r}
 01111 \times 0010 \\
 \hline
 & 00000 \quad -(0) \\
 (+) & 0\ 1\ 1\ 1\ 1\ \times \quad -(1) \\
 \hline
 & 0\ 1\ 1\ 1\ 0 \\
 (+) & 0\ 0\ 0\ 0\ \times\ \times \quad -(0) \\
 \hline
 & 0\ 0\ 1\ 1\ 1\ 0 \\
 & 0\ 0\ 0\ 0\ \times\ \times\ \times \quad -(0) \\
 \hline
 & 0\ 0\ 0\ 1\ 1\ 1\ 0
 \end{array}$$

$$\rightarrow 8 + 4 + 2 \\ = 14 \quad \checkmark$$

d)  $0110\ 0111 \times 101$

$01100111$

$$64 + 32 + 4 + 2 + 1$$

$$= 103$$

$\overset{1}{1}01$

$4+1$

$$= \frac{5}{515}$$

$$\Rightarrow 512 + 2 + 1 \checkmark$$

$01100111 \times 101$

$01100111 - 0$

$\times 00000000 \times - 0$

$\hline 001100111$

$\times 01100111 \times x x - 10$

$\hline 10000000011$

$\begin{matrix} 512 & 256 & 128 & 64 & 32 & 16 & 8 & 4 & 2 \\ \hline 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 \end{matrix}$

(e)  $10101010 \times 0101$

$10101010$

$$128 + 32 + 8 + 2$$

$$= 170$$

$\overset{5}{0}101$

$$4+1 = \frac{5}{850}$$

$$512 + 256 + 64 + 16$$

$$+ 2 = 850 \checkmark$$

$10101010 \times 0101$

$10101010 - 0$

$\times 00000000 \times - 0$

$\hline 010101010$

$\times 10101010 \times x x - 4$

$\hline 1101010010$

$\times 00000000 \times x x$

$\hline 1101010010$

$\begin{matrix} 512 & 256 & 128 & 64 & 32 & 16 & 8 & 4 & 0 \\ \hline 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 & 0 \end{matrix}$

# ⑩ Binary Division !

try to take  
1 bit.

$$\textcircled{a} \quad 15 / 2$$

$$2) \overline{15} (7.5$$

$$\begin{array}{r} 14 \\ -10 \\ \hline 10 \\ -10 \\ \hline 0 \end{array}$$

$$10) \overline{1111} (111$$

$$\begin{array}{r} 10 \\ \downarrow \\ 11 \\ -10 \\ \hline 11 \\ -10 \\ \hline 1 \end{array}$$

$$10 < 11-1$$

$$10 > 1-0$$

$$\Rightarrow 111 = 4 + 2 + 1 = 7$$

$$\textcircled{b} \quad 45 / 5$$

$$5) \overline{45} (9$$

$$\begin{array}{r} 45 \\ -0 \\ \hline 0 \end{array}$$

$$101) \overline{101101} (1001$$

$$\begin{array}{r} 101 \\ \downarrow \\ 101 \\ \hline 0 \\ \downarrow \\ 10 \\ \hline 0 \\ \downarrow \\ 101 \\ -101 \\ \hline 0 \end{array}$$

$$\begin{array}{r|l} 2 & 45 \\ \hline 2 & 22-1 \\ 2 & 11-0 \\ 2 & 5-1 \\ 2 & 2-1 \\ \hline & 1-0 \end{array}$$

$$101101$$

$$\begin{array}{r|l} 2 & 5 \\ \hline 2 & 2-1 \\ \hline & 1-0 \end{array}$$

$$101$$

$$1001$$

$$= 9$$



© 10101010 / 0111

$$128 + 32 + 8 + 2 = 170$$

$$4 + 2 + 1 = 7$$

$$\begin{array}{r}
 7) 170(24 \\
 \underline{-14} \downarrow \\
 \hline
 30 \\
 \underline{28} \\
 \hline
 2
 \end{array}$$

A handwritten diagram of a binary subtraction problem:

$$\begin{array}{r}
 10111 \\
 - 0110 \\
 \hline
 10111
 \end{array}$$

The result 10111 is circled. To the right of the subtraction line, there are four comparison results:  
 0111 < 10  
 0111 > 1  
 0111 < 1  
 0111 < 1

## ⑫ floating Numbers :-

④  $(34 \cdot 34)_{10}$

34 → 100010 - exp

\* Binary

$$34 + \overline{0.34} \times 2 = \underline{0.68} \rightarrow \textcircled{1}$$

$$34 + 0.68 \times 2 = 36 \rightarrow q$$

$$34 + 0.36 \times 2 = 0.72 \rightarrow 0$$

$$34 + 0.72 \times 2 = 34.44 \rightarrow 34$$

$$34 + 0.44 \times 2 = 0.88 \rightarrow 0$$

$$30 + 0.76 \times 2 = 31.52 \rightarrow$$

$$34 + 0.52 \times 2 = ?$$

$\Rightarrow 100010.0101 \checkmark$

Base 3 :-  $(34 \cdot 34)$

1021 — Exp.

$$34 + 0.34 \times 3 = 1.02 - 1$$

$$34 + 0.02 \times 3 = 0.06 - 0$$

$$34 + 0.06 \times 3 = 0.18 - 0$$

$$34 + 0.18 \times 3 = 0.54 - 0$$

$\Rightarrow 1021.1000 \checkmark$

$$\begin{array}{r} 3 | 34 \\ 3 | 11 - 1 \\ 3 | 3 - 2 \\ \hline & 1 - 0 \end{array}$$

1000  
↓  
 $\Rightarrow 0.33$

Octal :-  $(34 \cdot 34)_{12}$  — Exp.

$$34 + 0.34 \times 8 = 2.72 - 2$$

$$34 + 0.72 \times 8 = 5.76 - 5$$

$$34 + 0.76 \times 8 = 6.08 - 6$$

$$34 + 0.08 \times 8 = 0.64 - 0$$

$\Rightarrow 42.2560 \checkmark$

$$\begin{array}{r} 8 | 34 \\ 4 - 2 \end{array}$$

2560

$$\frac{1}{16} + \frac{1}{320} + \frac{1}{3072}$$

$$\Rightarrow 0.06 + 0.00 + 0.00$$

$$\Rightarrow 0.06$$

Hexadecimal :-  $(34 \cdot 34)$

22 → Exp.

$$34 + 0.34 \times 16 = 5.44 - 5$$

$$34 + 0.44 \times 16 = 7.04 - 7$$

$$34 + 0.04 \times 16 = 0.64 - 0$$

$$34 + 0.64 \times 16 = 10.24 - 10$$

$\Rightarrow 22.570A$

$$\begin{array}{r} 16 | 34 \\ 2 - 2 \end{array}$$

$$\textcircled{b} (125 \cdot 125)_{10}$$

$$125 \rightarrow 1111001$$

Binary :-

$$125 + 0.125 \times 2 = 0.25 \rightarrow 0$$

$$125 + 0.25 \times 2 = 0.5 \rightarrow 0$$

$$125 + 0.5 \times 2 = 1 \rightarrow 1$$

$$\Rightarrow 1111001.001 \checkmark$$

2	125
2	62 - 1
2	31 - 0
2	15 - 1
2	7 - 1
2	3 - 1
	1 - 1

$\frac{2}{3} \rightarrow 0.125$

Base 3 : (125.125)

11122 - Exp.

$$125 + 0.125 \times 3 = 0.375 - 0$$

$$125 + 0.375 \times 3 = 1.125 - 1$$

$$125 + 0.125 \times 3 = 0.375 - 1$$

$$125 + 0.375 \times 3 = 1.125 - 1$$

$$\Rightarrow 1112 \cdot 0.111$$

3	125
3	41 - 2
3	13 - 2
3	4 - 1
	1 - 1

$$\begin{aligned}
 & 0.92781 \\
 & 0111 \\
 & \frac{1}{9} + \frac{1}{27} + \frac{1}{81} \\
 & 0.11 + 0.03 + 0.01 \\
 & = 0.15
 \end{aligned}$$

Octal<sub>8</sub> : (125.125)

175 - Exp

$$125 + 0.125 \times 8 = 1.00 - 1$$

8	125
8	15 - 5
	1 - 1

$$\frac{1}{8} \rightarrow 0.125$$

$$\Rightarrow 175 \cdot 1$$

Hexadecimal :- (125.125)

7D - Exp

$$\begin{array}{r} 16 \mid 125 \\ \hline 7 \quad 13 \end{array}$$

$$125 + 0.125 \times 16 = 2$$

$$2^{\frac{16}{1}} = 32$$

$\Rightarrow 7D \cdot 2$

③ (10.16)<sub>10</sub>

Binary :-

1010 — Exp.

$$10 + 0.16 \times 2 = 0.32 - 0$$

$$10 + 0.32 \times 2 = 0.64 - 0$$

$$10 + 0.64 \times 2 = 1.28 - 1$$

$$10 + 0.28 \times 2 = 0.56 - 0$$

$\Rightarrow 1010.0010$

$$\begin{array}{r} 2 \mid 10 \\ \hline 2 \mid 5-0 \\ \hline 2 \mid 2-1 \\ \hline 1-0 \end{array}$$

$$\begin{array}{r} 0010 \\ \hline \frac{1}{8} \rightarrow 0125. \end{array}$$

Base 3 :

101 — Exp

$$\begin{array}{r} 3 \mid 10 \\ \hline 3 \mid 3-1 \\ \hline 1-0 \end{array}$$

$$10 + 0.16 \times 3 = 0.48 - 0$$

$$0.48 \times 3 = 1.44 - 1$$

$$0.44 \times 3 = 1.32 - 1$$

$$10 + 0.32 \times 3 = 0.96$$

0110

$$\frac{1}{9} + \frac{1}{27}$$

$$\Rightarrow 101.0110$$

$$0.11 + 0.03$$

Octal 1-(10.16)  
12 → EXP

$$\begin{array}{r} 8 | 10 \\ \hline 1 - 2 \end{array}$$

$$10 + 0.16 \times 8 = 1.28 - 1$$

$$\begin{array}{r} 8^0 8^1 8^2 8^3 8^4 \\ | 2 1 7 \end{array}$$

$$0.28 \times 8 = 2.24 - 2$$

$$0.24 \times 8 = 1.92 - 1$$

$$\frac{1}{8} + \frac{1}{128} + \frac{1}{512} +$$

$$0.92 \times 8 = 7.36 - 7$$

$$\frac{1}{28672}$$

$$\Rightarrow 12.1217$$

$$\Rightarrow 0.12 + 0.00  
+ 0.00 + 3.48$$

Hexadecimal : (10.16)

A (16) → EXP

$$\begin{array}{r} 16 | 10 \\ \hline 2 8 \end{array}$$

$$10 + 0.16 \times 16 = 2.56 - 2$$

$$\begin{array}{r} 16^0 16^1 16^2 16^3 16^4 \\ | 2 8 15 5 \end{array}$$

$$0.56 \times 16 = 8.96 - 8$$

$$0.96 \times 16 = 15.36 - 15$$

$$\frac{1}{32}, \frac{1}{2048}, \frac{1}{61440}$$

$$0.36 \times 16 = 5.76 - 5$$

$$\Rightarrow 0.02 + 0.00  
+ 1.62 + 3.05$$

$$\Rightarrow 10.28F5$$

(13) largest positive number one can represent in a 12-bit 2's Complement Code :-

Binary 0111 1111 1111  $\Rightarrow$  2047  
Decimal value

2's Complement :-

$\hookrightarrow 1'sc + 1$

0  $\leftarrow$  indicates +ve no.  
1  $\leftarrow$  indicates -ve no.

$$\begin{array}{r} 0111 1111 1111 \\ 1000 0000 0000 \leftarrow 1'sc \\ + \\ \hline 1000 0000 0001 \end{array}$$

(15) Biggest binary number you can write with 5-bits :-

$\Rightarrow 11111 \rightarrow 31$  (Decimal value)

$$\begin{aligned} 5\text{ bits} &\rightarrow 1^6 8^4 2^2 1^1 \Rightarrow 16 + 8 + 4 + 2 + 1 \\ &\Rightarrow 31 // \end{aligned}$$

## ⑯ Hexa add'

$$\begin{array}{r} 2 B F C \\ (+) 5 4 A 7 \\ \hline 8 0 A 3 \\ (5) \end{array}$$

$$\begin{array}{r}
 & 1 & 1 \\
 12 & 11 & 15 & 12 \\
 \hline
 54 & 10 & 7 \\
 \hline
 80 & 10 & 3 \\
 & 10
 \end{array}$$

## ⑯ Hexa to Binary :-

A B C 7  
16° 16° 16° 16°  
A B C 7

$$(ABC7)_{16} \quad C7_2$$

$$\Rightarrow (4096 \times 10) + (256 + 11) \\ + (16 \times 12) + (16 \times 7)$$

$$\Rightarrow 40960 + 2816 + 192 + 7 \Rightarrow 43975$$

<u>2</u>	<u>439,75</u>	<u>2</u>	<u>3,43</u>
<u>2</u>	<u>219,87 - 1</u>	<u>2</u>	<u>17,1 - 1</u>
<u>2</u>	<u>109,9,3 - 1</u>	<u>2</u>	<u>85 - 1</u>
<u>2</u>	<u>5,49,6 - 1</u>	<u>2</u>	<u>42 - 1</u>
<u>2</u>	<u>27,48 - 0</u>	<u>2</u>	<u>21 - 0</u>
<u>2</u>	<u>13,7,4 - 0</u>	<u>2</u>	<u>10 - 1</u>
<u>2</u>	<u>687 - 0</u>	<u>2</u>	<u>5 - 0</u>
<u>2</u>	<u>3,43 - 1</u>	<u>2</u>	<u>2 - 1</u>
		<u>2</u>	<u>1 - 0</u>

$\Rightarrow 101010111000111$

$$\begin{aligned}
 & 1010101111000111 \\
 \Rightarrow & 32768 + 8192 + 2048 + 512 \\
 & + 256 + 128 + 64 + 4 + 2 + 1 \\
 \Rightarrow & 43975 \checkmark
 \end{aligned}$$

$$\begin{array}{r}
 16 \overline{)439.75} \\
 16 \overline{)274.8} - 7 \\
 16 \overline{)17.1} - 12 \\
 \hline 10 - 11 \quad \Rightarrow A B C 7 \checkmark
 \end{array}$$

⑯ In hex,  $AC74 - 83F$  :-

$$\begin{array}{r}
 A \ C \ 7 \ 4 \\
 \rightarrow B \ 3 \ F \\
 \hline
 A \ 1 \ 3 \ 5
 \end{array}
 \qquad
 \begin{array}{r}
 10 \ 12 \ 7 \ 4^{\text{16}} \\
 \rightarrow 11 \ 3 \ 15 \\
 \hline
 10 \ 1 \ 3 \ 5
 \end{array}$$

⑰ Binary fractions to Ordinary fractions :-

$$\begin{array}{l}
 \text{a) } 0.1001 \\
 \Rightarrow 0.5625 \\
 \qquad\qquad\qquad
 \begin{array}{l}
 0.1001 \\
 \rightarrow 0.5 + 0.0625 \\
 \Rightarrow 0.0625 \\
 \qquad\qquad\qquad
 \hline
 0.5625
 \end{array}
 \end{array}$$

(b)  $1.0011$

$\Rightarrow 1.1875$

$1.125 + 0.0625$

$0.125 + 0.0625$

$\Rightarrow 0.0625$

$0.125$

$\underline{-} \quad \quad \quad$   
 $= 0.1875$

(c)  $1.1111$

$\Rightarrow 1.9375$

$0.5 + 0.25 + 0.125$

$\Rightarrow 0.0625$

$0.125$

$0.25$

$0.5$

$\underline{-} \quad \quad \quad$   
 $= 0.9375$

$+ 0.0625$

(20) Decimal expansion of  $11/17 \rightarrow 0.\overline{647}$

Binary expansion of  $11/17 \rightarrow ?$

$10.647$

$$0.647 \times 2 = 1.294 - 1$$

$$0.294 \times 2 = 0.588 - 0$$

$$0.588 \times 2 = 1.176 - 1$$

$$0.176 \times 2 = 0.352 - 0$$

$\Rightarrow 1010$

$$\begin{array}{r} 1010 \\ 0.5 + 0.125 \\ \hline 0.125 \\ 0.5 \\ \hline 0.625 \end{array}$$

(14) 8-bit patterns of "CODE/THS  $\frac{20}{22}$ " from ASCII table:-

C - 67 - 1000011

O - 79 - 1001111

D - 68 - 1000100

E - 69 - 1000101

I - 47 - 101111

T - 84 - 1010100

H - 72 - 1001000

S - 83 - 1000011

Space - 32 - 1000000

Z - 50 - 110010

O - 48 - 1100000

2 - 50 - 110010

2 - 50 - 110010



Q1 Decimal expansion of  $3/11 \rightarrow 0.\underline{2727}$

Binary expansion of  $3/11 \rightarrow ?$

0.2727

$$0.2727 \times 2 = 0.5454 - 0$$

$$0.5454 \times 2 = 1.0908 - 1$$

$$0.0908 \times 2 = 0.1816 - 0$$

$$0.1816 \times 2 = 0.3632 - 0$$

$\Rightarrow 0100$

$\begin{array}{r} 2^{-1} 2^{-2} 2^{-3} 2^{-4} \\ \times 0.100 \\ \hline \end{array}$

$\therefore 0.025$

Q2 Same as above ↑