① Number system :-

How to represent Number

How to do counting

→ 1st Number system invented was Unary Number system

→ 2nd was decimal Number system

Unary Number System

- Symbols = Select 1 symbol
  - Represent no. accordingly

= 1 → @, @, $,

2 → a a

3 → a a a

⋮

5 → | | | | |

⋮

Decimal Number System

$\boxed{\text{Till now}}$

239.625

Decimal Number System

200
30
9
.6
.02
.005

239.625

$$\underbrace{\begin{matrix}2 & 3 & 9 & . & 6 & 2 & 5\\ 10^2 & 10^1 & 10^0 & & 10^{-1} & 10^{-2} & 10^{-3}\end{matrix}}_{\text{weights}}$$

Weighted code

$$2*10^2 + 3*10^1 + 9\times10^0 + 6*10^{-1} + 2*10^{-2} + 5*10^{-3}$$

10	239	
10	23	9
10	2	3
	0	2

10 → 0, 1, 2, ..., 9

'n' → 0 to n-1

n

$0.5 \times 10 = 5.0$

$0.25 * 10 = 2.5$

$0.625 \times 10 = 6.25$

$6\times10^{-1} * 10^1 = 6$

2 basic Terms used in N.S.

① **Base :-**

→ Total Number of digits supported by N.S.

→ Hence it can't be 0 or -ve

$1 \leq base \leq n$ ← any Natural Number

② **Digit :-**

→ Digits are reminder generated when any No. is divided by base.

→ If we divide any No. by 'n' then possible reminders are from 0 to n-1.

→ Hence if base is 'n' then digits will be from 0 to n-1

→ No. of digits from 0 to n-1 is 'n' which is nothing but base itself.

Q 234.52 min. base?

6 'n' 0 ... n-1

6 0 ... 5

(236.438)

9

(546.43)

7

Counting	Base 2	Base 3	Base 4	... Base 10	Base 12	Base 16
0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	10	2	2	2	2	2
3	11	10	3	3	3	3
4	100	11	10	4	4	4
5	101	12	11	5	5	5
6	110	20	12	6	6	6
7	111	21	13	7	7	7
8	1000	22	20	8	8	8
9	1001	100	21	9	9	9
10	1010	101	22	10	~~10~~ A	A
11	1011	102	23	11	~~11~~ B	B
12	1100	110	30	12	10	C
13	1101	111	31	13	11	D
14	1110	112	32	14	12	E
15	1111	120	33	15	13	F
16	10000	121	100	16	14	10
17	10001	122	101	17	15	11
18	10010	200	102	18	16	12
19	10011	201	103	19	17	13
20	10100	202	110	20	18	14
21	10101	210	111	21	19	15
22	10110	211	112	22	1A	16
23	10111	212	113	23	1B	17
24	11000	220	120	24	20	18
25	11001	221	121	25	21	19
26	11010	222	122	26	22	1A
				27		1B

$16 \times 1,$

22

$(1B)$

$16^1 \quad 16^0$

$(FF)_{16} \to (\quad)_{10}$

$16^1 \quad 16^0$

$16 \times 15 + 15$

255

$(FF)_{16} \to (\quad)_3$

$(10)_4 = (4)_{10}$

$4^1 \quad 4^0$

4

$(20)_3$

$3^1 \quad 3^0$

$(13)_4$

$4^1 \quad 4^0$

$1 \times 4^1 + 3 \times 4^0 = 7$

$(10)_{12}$

$12^1 \quad 12^0$

$12 = (12)_{10}$

$(1B)_{12}$

$12^1 \quad 12^0$

$12 + 11$

23

$(10)_{12}$

$10 * 12^0$

0

0 0 0 0
0 0 0 1
0 0 1 0
0 0 1 1
0 1 0 0
0 1 0 1
0 1 1 0
0 1 1 1
1 0 0 0
1 0 0 1
1 0 1 0
1 0 1 1
1 1 0 0
1 1 0 1
1 1 1 0
1 1 1 1

Base 10	Base 7
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	10
8	11
9	12
10	13
11	14
12	15
13	16
14	20
15	21
16	22
17	23
18	24
19	25
20	26
.	.
42	60
43	61
44	62
48	66
49	100

2 Conversions

$(\ )_{10} \to (\ )_x$

$(\ )_x \to (\ )_{10}$

$(\ )_x \to (\ )_y$

$(\ )_{10}$

$(\ )_{10} \rightarrow (\ )_{n}$

① Keep on dividing the number before point by n till it becomes 0 & write the reminders in reverse order.

② For after point number keep on multiplying the number by n & write number in same order which comes before point. Keep on doing this till number after point becomes 0 or same pattern is repeated & for that we have to apply bar.

Q $(25.625)_{10} \rightarrow (\quad)_2$

2	25		
2	12	$\boxed{1}$	2^0
2	6	$\boxed{0}$	2^1
2	3	$\boxed{0}$	2^2
2	1	$\boxed{1}$	2^3
	0	$\boxed{1}$	2^4

$$\begin{array}{r} .625 \\ \times 2 \\ \hline 2^{-1} \leftarrow \boxed{1}.250 \end{array}$$

$$\begin{array}{r} .250 \\ \times 2 \\ \hline 2^{-2} \leftarrow \boxed{0}.500 \end{array}$$

$$\begin{array}{r} .5 \\ \times 2 \\ \hline 2^{-3} \leftarrow \boxed{1}.\boxed{0} \end{array}$$

$$\boxed{(25.625)_{10} = (11001.101)_2}$$

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

Q $(25.625)_{10} \rightarrow (\ )_3,\ (\ )_8,\ (\ )_5,\ (\ )_6$

H.W.

$(25.625)_{10} \rightarrow (\ )_5$

$$\begin{array}{r|ll} 5 & 25 & \\ \hline 5 & 5 & 0 \\ 5 & 1 & 0 \\ & 0 & 1 \end{array}$$

$(100.30)_5$

$$\begin{array}{r} 0.625 \\ \times 5 \\ \hline 3.125 \end{array}$$

$$\begin{array}{r} 0.125 \\ \times 5 \\ \hline 0.625 \end{array}$$

Q $(36.5)_{10} \rightarrow (\ )_3$

$$\begin{array}{r|l l}
3 & 36 & \\
\hline
3 & 12 & 0 \\
3 & 4 & 0 \\
3 & 1 & 1 \\
 & 0 & 1
\end{array}$$

$$\begin{array}{r} .5 \\ \times 3 \\ \hline 1.5 \end{array} \qquad \begin{array}{r} .5 \\ \times 3 \\ \hline 1.5 \end{array} \qquad \begin{array}{r} .5 \\ \times 3 \\ \hline 1.5 \end{array}$$

$(1100.\bar{1})_3 = (36.5)_{10}$

Q $(2.6)_{10} \longrightarrow (\ \ )_2$

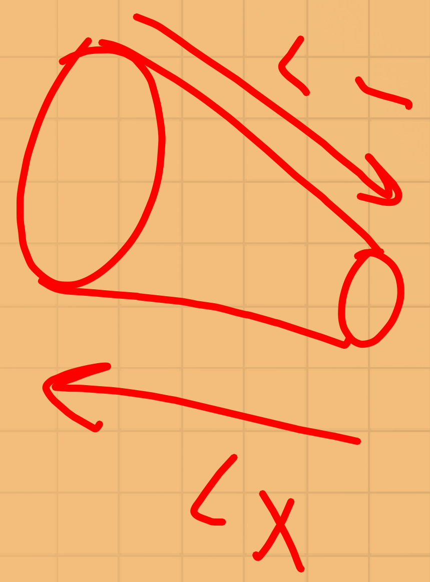
$a(ba)^* = (ab)^*a$

ababa ba

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

$$\begin{array}{r} .6 \\ \times\ 2 \\ \hline \boxed{1}.2 \end{array} \qquad \begin{array}{r} .2 \\ \times\ 2 \\ \hline \boxed{0}.4 \end{array} \qquad \begin{array}{r} .4 \\ \times\ 2 \\ \hline \boxed{0}.8 \end{array} \qquad \begin{array}{r} .8 \\ \times\ 2 \\ \hline \boxed{1}.6 \end{array} \qquad .6$$

$(2.6)_{10} = (10.\overline{1001})_2$



1 001 1001 1001 ... =

$(10.1\overline{0011})$

1001 1001 1001 1001

$(10.100\overline{110})$

$(10.100\overline{1100})_2$

1001 1001 1001 1001

Q $(189.75)_{10} \rightarrow (\ \ )_{32}$

$$(\underset{32^1}{5}\ \ \underset{32^0}{29}\ .\ \underset{32^{-1}}{24})_{32}$$

$$\begin{array}{r}32\\ \times 5\\ \hline 160\end{array}$$

$$\begin{array}{c|l} 32 & 189 \\ \hline 32 & 5 \quad 29 \\ & 0 \quad 5 \end{array}$$

$\dfrac{\cancel{75}\,3}{\cancel{100}\,4}$

$$\begin{array}{r}.75\\ \times 32\\ \hline 24.\boxed{0}\end{array}$$

$\dfrac{3}{\cancel{4}_1} \times \cancel{32}^{8} \Rightarrow 24$

$(\underset{32^2}{5}\ \underset{32^1}{2}\ \underset{32^0}{9})_{32}$

$(\underset{32^1}{5}\ \underset{32^0}{29})_{32}$

$(\underset{32^1}{5}\ \ \ \underset{32^0}{29})_{32}$

$\lceil \log_2(n+1) \rceil$

$\lfloor \log_2 n \rfloor + 1$

Q No. of steps needed to convert $(n)_{10} \rightarrow (\ )_2$

?? $\boxed{\text{bits}} \leftrightarrow$ division

binary digit

$$\begin{array}{c|l}
2 & 13 \\ \hline
2 & 6 \quad \boxed{1} \\
2 & 3 \quad \boxed{0} \\
2 & 1 \quad \boxed{1} \\
 & 0 \quad \boxed{1}
\end{array}$$

1st division

1st step

1st bit

Q Consider a decimal no. 'x'

No. of bits needed to represent it in binary

Let 'n' bits are needed to represent 'x'

$(11111111)_2 \to (\ )_{10}$

2^8-1

$11111 \to 2^5-1$

$2^4\ 2^3\ 2^2\ 2^1\ 2^0$

$2^0+2^1+2^2+2^3+2^4$

$\frac{a*(r^n-1)}{r-1}$ $\quad 2^5-1$ $\quad 1+2+4+8+16$

$\frac{1*(2^5-1)}{2-1}$

$2^{n-1} \leftarrow 100000\ldots$

$(n-1)$ 0s

10000

$2^4\ 2^3\ 2^2\ 2^1\ 2^0$

$16 \to 2^4$

100000

2^5

$\overbrace{11111\cdots1}^{n} \to 2^n-1$

$2^{n-1} \le x \le 2^n-1$

$2^{n-1} \le x$

$n-1 \le \log_2 x$

$n-1 = \lfloor \log_2 x \rfloor$

$\boxed{n = \lfloor \log_2 x \rfloor + 1}$

$x+1 \le 2^n$

$\log_2(x+1) \le n$

$\boxed{\lceil \log_2(x+1) \rceil = n}$

$\lfloor 1.9 \rfloor = 1$ $\quad \lfloor 23.01 \rfloor = 23$

$\lceil 1.9 \rceil = 2$ $\quad \lceil 23.01 \rceil = 24$

11001

25

$$\lfloor \log_2 25 \rfloor + 1 \Rightarrow 5$$

$$\lceil \log_2 (25+1) \rceil \Rightarrow 5$$

$\log_2 16$

$\cancel{\log_2 2^4}$

4

$(\ )_n \rightarrow (\ )_{10}$

Rule:-

→ Just apply weight on every digit & multiply the digit & its corresponding weight & add all these numbers

$$(11001.101)_2 \rightarrow (\quad)_{10}$$

$2^4 \quad 2^3 \quad 2^2 \quad 2^1 \quad 2^0 \quad 2^{-1} \quad 2^{-2} \quad 2^{-3}$

$$(25.625)_{10}$$

$$16 + 8 + 1 + \frac{1}{2} + \frac{1}{8}$$

$(1020)_3 \rightarrow (33)_{10}$

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

$1 * 27 + 2 * 3^1 \Rightarrow$

$27 + 6 \Rightarrow 33$

$(1010)_2 = (\ \ )_{10}$ $\quad 2^3 + 2^1 = 10$

$(1010)_3 = (\ \ )_{10}$ $\quad 3^3 + 3^1 = 30$

$(1010)_4 = (\ \ )_{10}$ $\quad 4^3 + 4^1 = 68$

$(1010)_x = (\ \ )_{10}$ $\quad x^3 + x^1$

$(36)_n = (30)_{10}$ **find n**

$n^1 \quad n^0$

$(\quad)_{10}$

$3 * n^1 + 6 * n^0 = 30$

$3n = 24$

$n = 8$

$(36)_8 = (30)_{10}$

$8^1 \quad 8^0$