

Number System

Binary NS \Rightarrow 0, 1 (base 2)

Octal NS \Rightarrow 0 to 7 (base 8)

Decimal NS \Rightarrow 0 to 9 (base 10)

Hexadecimal NS \Rightarrow 0 to 9, A to F (base 16)

Conversion \Rightarrow

(i) Other no. system to decimal:-

[Multiplication Operation is performed]

(ii) Decimal to other no. system:-

[Division operation is performed]

(iii) One no. to another no. system

(i) Other no. system to decimal \Rightarrow
(Binary / Octal / Hexadecimal)

(a) Binary to Decimal \Rightarrow

Q. $(101)_2 \rightarrow (?)_{10}$

$$1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$

$$1 \times 4 + 0 \times 2 + 1 \times 1 = 4 + 0 + 1 = (5)_{10}$$

Q. $(1111.10)_2 \rightarrow (?)_{10}$

$$1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-1} + 0 \times 2^{-2}$$

$$8 + 4 + 2 + 1 + \frac{1}{2} + \frac{1}{2^2} \times 0$$

$$15 + 0.5 + 0 = (15.5)_{10}$$

H.W 2016

Q. $(10110001101)_2 \rightarrow (?)_{10}$

(b) Octal to decimal \Rightarrow

Q. $(561)_8 \rightarrow (?)_{10}$

$$5 \times 8^2 + 6 \times 8^1 + 1 \times 8^0 = 5 \times 64 + 6 \times 8 + 1 \times 1$$

$$= 320 + 48 + 1 = (369)_{10}$$

H.W Q. $(651.24)_8 \rightarrow (?)_{10}$

Q. $(4312.16)_8 \rightarrow (?)_{10}$

$$4 \times 8^3 + 3 \times 8^2 + 1 \times 8^1 + 2 \times 8^0 + 1 \times 8^{-1} + 6 \times 8^{-2}$$

$$2048 + 192 + 8 + 2 + \frac{1}{8} + \frac{6}{64}$$

$$(2250.218)_{10}$$

(c) Hexadecimal \rightarrow decimal

Q. $(AA)_{16} \rightarrow (?)_{10}$

0-9 A-F

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

$$(0 \times 16^1 + 10 \times 16^0 = 160 + 10 \times 1 = 170)_{10}$$

Q. $(43F.38)_{16} \rightarrow (?)_{10}$

$$4 \times 16^2 + 3 \times 16^1 + 15 \times 16^0 + 3 \times 16^{-1} + 11 \times 16^{-2}$$

$$(1087.23)_{10}$$

H.W

Q. $(89D)_{16} \rightarrow (?)_{10}$

(2) Decimal to other no. system

Q. $(27)_{10} \rightarrow (?)_2$

2	27	1
2	13	1
2	6	0
2	3	1

(1)

$$(11011)_2$$

Q. $(135.23)_{10} \rightarrow (?)_2$

2	135	1
2	67	1
2	33	1
2	16	0
2	8	0
2	4	0
2	2	0

(1)

$$0.23 \times 2 = 0.46$$

$$0.46 \times 2 = 0.92$$

$$0.92 \times 2 = 1.84$$

$$(10000111.001)_2$$

Q. $(147.381)_{10} \rightarrow (?)_8$

8	147	3
8	18	2
2		

$$0.381 \times 8 = 3.048$$

$$0.048 \times 8 = 0.384$$

$$(223.30)_8$$

Q. $(9896)_{10} \rightarrow (?)_{16}$

16	9896	8
16	618	10
16	38	6
2		

$$(26A8)_{16}$$

(3) Conversion from one system to other \Rightarrow

Q. $(57)_8 \longrightarrow (?)_2$

Step-I $(57)_8 \longrightarrow (?)_{10}$

$$5 \times 8^1 + 7 \times 8^0 = 40 + 7 = (47)_{10}$$

Step-II $(47)_{10} \longrightarrow (?)_2$

2	47	1
2	23	1
2	11	1
2	5	1
2	2	0
	①	

$(101111)_2$

$(57)_8 \longrightarrow (101111)_2$ *

(Q.) $(347.55)_8 \longrightarrow (?)_{16}$

Step-I $(347.55)_8 \longrightarrow (?)_{10}$

$$3 \times 8^2 + 4 \times 8^1 + 7 \times 8^0 + 5 \times 8^{-1} + 5 \times 8^{-2}$$

$$64 \times 3 + 4 \times 8 + 7 \times 1 + \frac{5}{8} + \frac{5}{64}$$

$$(231.703)_{10}$$

Step-II $(231.703)_{10} \longrightarrow (?)_{16}$

Q. $(32)_x \longrightarrow (53)_8$

$$(32)_x \longrightarrow (?)_{10} = (53)_8 \longrightarrow (?)_{10}$$

$$3 \times x^1 + 2 \times x^0 = 5 \times 8^1 + 3 \times 8^0$$

$$3x + 2 = 40 + 3 \times 1 = 43$$

$$3x = 43 - 2 = 41 \Rightarrow x = \frac{41}{3} = 13.67$$

16	231	14
	14	

$(E7.B3)_{16}$

$$0.703 \times 16 = 11.248$$

$$0.248 \times 16 = 3.968$$

$(E7.B3)_{16}$

(H.w.) Q. $(ABC)_{16} \longrightarrow (?)_8$

(Q.) $(341.227)_8 \longrightarrow (?)_2$

Compliments \rightarrow 1's, 2's, 9's, 10's, R's, (R-1)'s

$$1's \rightarrow (1011) \rightarrow (0100) \leftarrow (1's)$$

$$2's \rightarrow (1011) \rightarrow (0100)$$

$$\begin{array}{r} +1 \\ \hline (0101)_{2's} \end{array}$$

Q. $(89)_{10} \rightarrow 9's, 10's$

$$(89)_{10} \Rightarrow \begin{array}{l} 10's \\ 9's \end{array}$$

$$(R)^n - N$$

$$(10)^2 - 89$$

$$100 - 89$$

$$= 11$$

$$(R)^n - N - 1$$

$$(10)^2 - 89 - 1$$

$$100 - 90$$

$$= 10$$

Q.

(R-1)'s of $(3A12)_{16}$

$$R^n - N - 1$$

$$(16)^4 - (3A12)_{16} - 1$$

$$65536 - 14866 - 1 = (50669)_{10} \rightarrow (?)_{16}$$

$$(?)_{16}$$

16	50669	13
16	3166	14
16	197	5
	12	

$$(C5ED)_{16}$$

R's & (R-1)'s of $(1011)_2$

$$R^n - N$$

$$(2)^5 - (1011)_2$$

$$(2)^5_{10} - (23)_{10} = 32 - 23$$

$$= 9$$

$$(1001)_2$$

$$R^n - N - 1$$

$$(2)^5 - (1011)_2 - 1$$

$$32 - 23 - 1$$

$$= 8$$

$$\rightarrow (1000)_2$$

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

H.W

R's & (R-1)'s of

(a) $(101.001)_2$

(b) $(7F3B)_{16}$

(c) $(34056)_8$

(d) $(8750)_{10}$

(i) Binary Addition :-

$$0 + 0 = 0$$

$$0 + 1 = 1$$

$$1 + 0 = 1$$

$$1 + 1 = 10$$

↑
(Carry)

Q. $(1110011)_2 + (100011)_2$

$$\begin{array}{r} 1110011 \\ + 100011 \\ \hline 10010110 \end{array}$$

Q. $(1011.1100)_2 + (1000.11)_2$

$$\begin{array}{r} 1011.1100 \\ + 1000.11 \\ \hline 10100.1000 \end{array}$$

Q. $(11100010)_2 - (00100111)_2$

$$\begin{array}{r} 11100010 \\ - 00100111 \\ \hline 10000111 \end{array}$$

(ii) Binary Subtraction :-

$$0 - 0 = 0$$

$$0 - 1 = 1 \quad \text{Borrow}$$

$$1 - 0 = 1$$

$$1 - 1 = 0$$

Q. $(010011001)_2 - (1001110)_2$

$$\begin{array}{r} 010011001 \\ - 1001110 \\ \hline 011011101 \end{array}$$

Q. $(101)_2 \times (11)_2$

$$\begin{array}{r} 101 \\ \times 11 \\ \hline \end{array}$$

$$\begin{array}{r} 101 \\ + 1010 \\ \hline 1111 \end{array}$$

Q. $(11100010)_2 - (00100111)_2$

$$\begin{array}{r} 11100010 \\ - 00100111 \\ \hline 11000011 \end{array}$$

$$\begin{array}{r} 10111011 \end{array}$$

(iii) Binary Multiplication :-

$$0 \times 0 = 0$$

$$0 \times 1 = 0$$

$$1 \times 0 = 0$$

$$1 \times 1 = 1$$

Q. $(0100)_2 \div (0010)_2$

$$\begin{array}{r} 0100 \\ - 0010 \\ \hline 0010 \\ - 0010 \\ \hline 0000 \end{array}$$

Q. $(101010)_2 \div (0110)_2$

$$\begin{array}{r} 0110 \overline{) 101010} \\ - 0110 \\ \hline 0100 \\ - 0100 \\ \hline 0000 \end{array}$$

$$\begin{array}{r} 110 \\ - 1 \\ \hline 101 \end{array}$$

$$\begin{array}{r} 101010 \\ - 0010 \\ \hline 0111 \end{array}$$

$$\begin{array}{r} 0111 \end{array}$$

$$\begin{array}{r} 101010 \\ - 0010 \\ \hline 0111 \end{array}$$

$$\begin{array}{r} 0111 \end{array}$$

$$\begin{array}{r} 101010 \\ - 0010 \\ \hline 0111 \end{array}$$

$$\begin{array}{r} 0111 \end{array}$$

Binary Coded Decimal :- This code is basically decimal number coded in binary. This is weighted code in which a weight has been assigned to each symbol position in the code word. In this a string of binary digits represent a decimal digit. Each decimal digit 0 through 9 is represented by a string of four bits.

(i) 8421 BCD code \Rightarrow (ii) 2421 BCD code :-

	8421 BCD		2421 BCD
0	0000	0	0000
1	0001	1	0001
2	0010	2	0010
3	0011	3	0011
4	0100	4	0100
5	0101	5	1011
6	0110	6	1100
7	0111	7	1101
8	1000	8	1110
9	1001	9	1111

Excess-3 code \Rightarrow It is a non weighted code used to represent decimal numbers. This is called excess-3

0	0011
1	0100
2	0101
3	0110
4	0111
5	1000
6	1001
7	1010
8	1011
9	1100

Gray code \rightarrow

The gray code is called reflective digital code which has the special property that any two subsequent codes differ by only one bit. This is called 'Unit Distance Code'.

$G_0 \rightarrow B_1 \oplus B_0$
 $G_1 \rightarrow B_2 \oplus B_1$
 $G_2 \rightarrow B_3 \oplus B_2$
 $G_3 \rightarrow B_3$

	8421	Gray
0	0000	0000
1	0001	0001
2	0010	0010
3	0011	0011
4	0100	0100
5	0101	0101
6	0110	0110
7	0111	0111
8	1000	1000
9	1001	1001

ASCII :- This code is popular in the data comms, is used almost exclusively to represent in micro computers.

ASCII is of two types:- ASCII 7 & ASCII 8

ASCII-7:- It is seven bit code. That allows $2^7 = 128$ different characters.

ASCII-8:- It is a standard version of ASCII-7. It is an 8 bit code. That allows $2^8 = 256$ different characters. ASCII also uses hexadecimal as its four-to-one short cut notation for memory dump.

000 0000 to 001 1111 [0 to 31] → special non printable
 010 0000 to 010 1111 [32 to 47] → special characters
 011 0000 to 100 0000 [48 to 64] → Number & math symbol
 1000 01 to 1011 010 [65 to 90] → A to Z
 110 0001 to 1111 010 [97 to 122] → a to z

100001 — A → 65
 100010 — B → 66
 100011 — C → 67

1100001 — a → 97
 1100010 — b → 98
 1100011 — c → 99

Eg- INDIA
 73 78 68 73 65

1001001 100110 1000100 1001001 1000001

EBCDIC:- This character code was developed by the IBM. This is alphanumeric code which stands for 'Extended Binary Coded Decimal Interchange Code.'

It is a 8 bit character format to represent no., char. in system.

This code is used by large computers for transferring alphanumeric data.

EBCDIC also uses hexadecimal no. system is used as shortcut notation for memory dump. This results in a one to four reduction in the volume of memory dump.

character	EBCDIC	Code digit	Hexadecimal
A	1100	0001	C1
B	1100	0010	C2
C	1100	0011	C3
D	1100	0100	C4
⋮	⋮	⋮	⋮
9	1111	1001	F9