Digital Electronics:-

In digital electronics digital signals are used.

→ The digital signals has only two values i.e 0 and 1.

→ In digital electronics '0' is nothing but "0V" and '1' is nothing but "5V".

Signal:- A signal is nothing but whose value (or) amplitude is changes with time.

* Any thing is changed with time is called as Signal.

→ Digital electronics (or) digital circuits are designed with various components. These components are divided into two categories.

1. Active components: Transistors and diodes.
2. passive components: R, L, C.

Advantages :-

1. The data transmission in digital systems are very easy without noise.

• Disadvantage :-

These systems are expensive.

Applications :-

→ The display of digital watches is designed based on digital circuits.

→ The automatic doors works on the principle of digital electronics.

→ Traffic lights are based on digital circuits.

Base :- The base value is depends up on the number of digits used in number system. It is denoted by 'r'.

It is also called as "Radix".

I. Number Sys...

Number Systems:-

→ In digital electronics, the number system is used for representing the information.

→ There are different number systems with different bases.

→ Most commonly used number systems are.

1. Binary Number system
2. Octal Number system
3. Decimal Number system
4. Hexa decimal Number system.

1. Binary Number System:-

→ It uses only two digits i.e 0 and 1.

Any number represented in binary form it uses only 0 and 1.

→ The base (or) radix of binary number system is '2'.

Ex: $(101011)_2$.

2. Octal Number System:-

→ It uses '8' digits i.e 0 to 7 (0, 1, 2, 3, 4, 5, 6, 7).

→ The Base (or) Radix of octal number system is '8' because of it uses '8' digit

Ex: $(346)_8$.

3. Decimal Number System:-

→ It uses '10' digits i.e 0 to 9 (0, 1, 2, 3, 4, 5, 6, 7, 8, 9)

→ The base (or) Radix of decimal number system is '10' because it uses '10' digits.

Ex: $(896.43)_{10}$

4. Hexa decimal Number System:-

→ It uses '16' digits i.e 0 to 15 (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, $\overset{10}{A}$, $\overset{11}{B}$, $\overset{12}{C}$, $\overset{13}{D}$, $\overset{14}{E}$, $\overset{15}{F}$).

→ The Base (or) Radix of Hexa decimal number system is '16'.

Ex: $(8AF.3B)_{16}$

Base conversions :-

Binary Number System:

i) Binary to octal

ii) Binary to Decimal

iii) Binary to Hexa decimal.

Octal Number system:

i) Octal to Binary

ii) Octal to Decimal

iii) Octal to Hexa decimal

Decimal Number System:

i) Decimal to Binary

ii) Decimal to Octal

iii) Decimal to Hexa decimal

Hexa decimal Number System:

i) Hexa decimal to binary

ii) Hexa decimal to octal

iii) Hexa decimal to decimal.

i) Binary to octal conversion:-

To convert the binary number into octal number, the given binary number is divided in to '3' bits from "Right to Left".

* octal number system has '8' digits. so

$$\boxed{8 = 2^3}$$

Examples:-

i) $(101011)_2 = (?)_8$

Given binary number is 101011.

It can be divided in to '3' bits from Right to left.

101 | 011
5 | 3

$$\boxed{(101011)_2 = (53)_8}$$

ii) $(1001111)_2 = (?)_8$

001 | 001 | 111
1 | 1 | 7

$(1001111)_2 = (117)_8$.

iii) $(1010 \cdot 11001)_2 = (?)_8$

→ From the given binary number, before decimal point, the binary number is divided into 3 bits from Right to left.

→ After decimal point, the binary number is divided into 3 bits from left to Right.

Given binary number is

$$\begin{array}{c|c|c|c|c}
001 & 010 & \cdot & 110 & 010 \\
1 & 2 & \cdot & 6 & 2
\end{array}$$

$$\boxed{(1010 \cdot 11001)_2 = (12 \cdot 62)_8}$$

iv) $(110011 \cdot 01011)_2 = (?)_8$

ii) Binary to Decimal conversion:

In binary to decimal conversion, each binary digit is multipling with power's of '2' (from '0' i.e $2^0, 2^1, 2^2 \ldots$) from Right to left.

Examples:-

i) $(10110)_2 = (?)_{10}$

Given binary number is

$$\overset{4}{1}\ \overset{3}{0}\ \overset{2}{1}\ \overset{1}{1}\ \overset{0}{0}$$

$$1\times2^4 + 0\times2^3 + 1\times2^2 + 1\times2^1 + 0\times2^0$$

$$= 16 + 0 + 4 + 2 + 0$$

$$= 22$$

$$\boxed{\therefore (10110)_2 = (22)_{10}}$$

ii) $(1011.010)_2 = (?)_{10}$

Given binary number is

$$\overset{3}{1}\ \overset{2}{0}\ \overset{1}{1}\ \overset{0}{1}\ .\ \overset{-1}{0}\ \overset{-2}{1}\ \overset{-3}{0}$$

$$1\times2^3 + 0\times2^2 + 1\times2^1 + 1\times2^0 . 0\times2^{-1} + 1\times2^{-2} + 0\times2^{-3}$$

$= 8+0+2+1 \cdot 0+\frac{1}{2^2}+0$ $\qquad \frac{1}{2^2}=\frac{1}{4}=0.25$

$= 11 \cdot (0.25)$

$= 11.25$

$$\boxed{\therefore (1011.010)_2 = (11.25)_{10}}$$

iii) Binary to Hexa decimal conversion:-

To convert the binary to hexa decimal, the given binary number is divided into '4' bits from Right to left'.

* Hexa decimal number system has '16' digits.

so, $\boxed{16 = 2^4}$

Examples:

i) $(10101101)_2 = (?)_{16}$

Given binary number is 10101101. It is divided into 4-bits from Right to left.

1010 | 1101
A | D

$$\boxed{\therefore (10101101)_2 = (AD)_{16}}$$

iii) $(100101 \cdot 101011)_2 = (?)_{16}$

0010 | 0101 . 1010 | 1100

2 | 5 . A | C .

$$\boxed{(100101 \cdot 101011)_2 = (25 \cdot AC)_{16}}$$

* Given binary number is divided into 4 bits.

→ Before decimal point divided into 4-bits from Right to left.

→ After decimal point divided into 4-bits from left to Right.

iv) Octal to Binary Conversion:-

In octal to binary conversion, each octal digit is converted into 3-bits of binary form.

Examples:-

i) $(132)_8 = (?)_2$

Given octal number is

1 3 2

001 011 010

$$\boxed{\therefore (132)_8 = (001\ 011\ 010)_2}$$

ii) $(143 \cdot 24)_8 = (?)_2$

$$\begin{array}{ccccc} 1 & 4 & 3 & \cdot & 24 \\ \downarrow & \downarrow & \downarrow & & \\ 001 & 100 & 011 & & \end{array}$$

$2 \rightarrow 010$, $4 \rightarrow 100$

$$\boxed{(143 \cdot 24)_8 = (001100011 \cdot 010100)_2}$$

V) Octal to Decimal conversion :-

In octal to decimal conversion, each octal digit is multiplying with power's of '8' ($8^0, 8^1, 8^2 \ldots$) from Right to left.

Examples :-

i) $(1\ 3\ 2)_8 = (?)_{10}$

$(1\,3\,2)_8 = (?)_{10}$

$$\overset{2}{1}\ \overset{1}{3}\ \overset{0}{2} = 1 \times 8^2 + 3 \times 8^1 + 2 \times 8^0$$

$$= 64 + 24 + 2$$

$$= 94$$

$$\boxed{\therefore (132)_8 = (94)_{10}}$$

ii) $(143.24)_8 = (?)_{10}$

$$\overset{2}{1}\overset{1}{4}\overset{0}{3}.\overset{-1}{2}\overset{-2}{4}$$
$$8^2\ 8^1\ 8^0\ 8^{-1}\ 8^{-2}$$

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

$64 + 32 + 3 . \cancel{2}\times\frac{1}{\cancel{8}_4} + \cancel{4}\times\frac{1}{\cancel{64}_{16}}$

$= 99.3125$

$\frac{1}{4} = 0.25$

$\frac{1}{16} = 0.06$

$$\boxed{\therefore (143.24)_8 = (99.3125)_{10}}$$

vi) Octal to Hexa decimal conversion:-

In octal to hexa decimal conversion, first the octal number is converted into decimal then decimal is converted hexa decimal

Examples:-

i) $(51)_8 = (?)_{16}$

First, octal is converted into decimal

$(\overset{1}{5}\overset{0}{1})_8 = (?)_{10}$
$\quad 8^1 8^0$

$5\times 8^1 + 1\times 8^0 = 5\times 8 + 1\times 1 = 40 + 1 = 41.$

$(51)_8 = (41)_{10}$

$(41)_{10} = (?)_{16}$

To convert decimal to hexa decimal, using prime-factorization method.

$$\begin{array}{r|l} 16 & 41 \\ \hline 16 & 2 - 9 \\ \hline & 0 - 2 \end{array}$$

ii) $(48)_8 = (?)_{16}$

$$\boxed{(51)_8 = (29)_{16}}$$

vii) Decimal to Binary conversion:-

- To convert decimal number into binary method. we are using prime-factorization method.

Examples:-

i) $(37)_{10} = (?)_2$

$$\begin{array}{r|l} 2 & 37 \\ \hline 2 & 18 - 1 \\ \hline 2 & 9 - 0 \\ \hline 2 & 4 - 1 \\ \hline 2 & 2 - 0 \\ \hline & 1 - 0 \end{array}$$

$(37)_{10} = (100101)_2$

ii) $(51)_{10} = (?)_2$

iii) $(37.2)_{10} = (?)_2$

$(37)_{10} = (100101)_2$

$0.2 \times 2 = 0.4 \rightarrow 0$

$0.4 \times 2 = 0.8 \rightarrow 0$

$0.8 \times 2 = 1.6 \rightarrow 1$

$0.6 \times 2 = 1.2 \rightarrow 1$

$0.2 \times 2 = 0.4 \rightarrow 0$

$(0.2)_{10} = (0011)$

$\therefore (37.2)_{10} = \boxed{(100101.0011)_2}$

iv) $(47.83)_{10} = (?)_2$

viii) Decimal to Octal conversion:-

To convert decimal number into octal number, we are using prime factorization method.

Examples:-

i) $(37)_{10} = (?)_8$

$$\begin{array}{r|l} 8 & 37 \\ \hline 8 & 4 - 5 \\ \hline & 0 - 4 \end{array}\uparrow$$

$$\boxed{(37)_{10} = (45)_8}$$

ii) $(51)_{10} = (?)_8$

$$\begin{array}{r|l} 8 & 51 \\ \hline 8 & 6 - 3 \\ \hline & 0 - 6 \end{array}\uparrow$$

$$\boxed{(51)_{10} = (63)_8}$$

iii) $(37.2)_{10} = (?)_8$

$$\begin{array}{r|l} 8 & 37 \\ \hline 8 & 4 - 5 \\ \hline & 0 - 4 \end{array} \uparrow \qquad (45)_8$$

$0.2 \times 8 = 1.6 \rightarrow 1$

$0.6 \times 8 = 4.8 \rightarrow 4$

$0.8 \times 8 = 6.4 \rightarrow 6$

$0.4 \times 8 = 3.2 \rightarrow 3$

$(37.2)_{10} = (45.1463)_8$

ix) Decimal to Hexa decimal conversion:-

To convert decimal number into Hexa decimal number, we are using Prime-factorization method.

Examples:-

i) $(37)_{10} = (?)_{16}$

$$\begin{array}{r|l} 16 & 37 \\ \hline 16 & 2 - 5 \\ \hline & 0 - 2 \end{array} \uparrow$$

$(37)_{10} = (25)_{16}$

ii) $(37.2)_{10} = (?)_{16}$

$$\begin{array}{r|l} 16 & 37 \\ \hline 16 & 2 - 5 \\ \hline & 0 - 2 \end{array}$$

$0.2 \times 16 = 3.2 \rightarrow 3$

$0.2 \times 16 = 3.2 \rightarrow 3$

$\boxed{(25.3)_{16}}$

a) Hexa decimal to Binary conversion

In Hexadecimal to Binary conversion each number given hexa decimal number is repre-senting with 4-bits of binary form

Examples:-

i) $(5AC3)_{16} = (?)_2$

5 A C 3 → 0011

0101 1010 1100

$$\boxed{\therefore (5AC3)_{16} = (0101\ 1010\ 1100\ 0011)_2}$$

ii) $(94A.5C)_{16} = (?)_2$

9 4 A . 5 C → 1100

1001 0100 1010 . 0101

$$\boxed{(94A.5C)_{16} = (1001\ 0100\ 1010 . 0101\ 1100)_2}$$

a) Hexa decimal to octal conversion:-

In hexa decimal to octal conversion, first given hexa decimal number is converted into decimal, then decimal is converted into octal number.

Examples:-

i) $(1C)_{16} = (?)_8$

$HD \rightarrow D \longrightarrow O$

$\begin{array}{cc} 1 & 0 \\ 1 & C \\ 16^1 & 16^0 \end{array}$

$1 \times 16^1 + C \times 16^0 = 1 \times 16^1 + 12 \times 16^0$

$16 + 12 = (28)_{10}$

$(28)_{10} = (?)_8$

$$\begin{array}{r|l} 8 & 28 \\ \hline 8 & 3 - 4 \\ \hline & 0 - 3 \end{array}$$

$(34)_8$

$\boxed{\therefore (1C)_{16} = (34)_8}$

xii) Hexa decimal to Decimal conversion

In hexa decimal to decimal conversion we are using ~~Pre factorization method~~ multipliying with powers of 16.

Example:-

i) $\overset{2}{2}\ \overset{1}{A}\ \overset{0}{C}$
$(2\ A\ C)_{16} = (?)_{10}$
$16^2\ 16^1\ 16^0$

$2 \times 16^2 + 10 \times 16^1 + 12 \times 16^0$

$= 512 + 160 + 12$

$= (684)_{10}$.

Complements of Numbers

complements are used to represent the negative numbers. There are two types of complements.

1. r's complement
2. (r-1)'s complement.

Where 'r' is the base (or) Radix.

1. r's complement :-

* In r's complement, if base (or) radix value is '2' i.e r = 2. Then that type of complement is known as 2's complement.
* If base (or) radix value is '10' i.e r = 10. Then that type of complement is known as 10's complement.

2. (r-1)'s complement :-

* In (r-1)'s complement,

if base (or) radix value is '2' i.e

r = 2, Then r-1 = 2-1 = 1.

then that type of complement is called as 1's complement.

* If base (or) radix value is 10 i.e

r = 10, then r-1 = 10-1 = 9.

then that type of complement is called as 9's complement.

|
|---|
| 2's complement = 1's complement +1 |
| 10's complement = 9's complement + 1 |

1's complement:-

For 1's complement representation in a given binary number 1's are converted into 0's and 0's are converted into 1's.

Ex:
101011
↓ ↓
010100 (1's complement representation)

2's complement :-

For 2's complement representation, first given binary number is converted into 1's complement, then add '1' to the 1's complement.

$\boxed{\therefore \text{2's complement} = \text{1's complement} + 1}$

Ex: 1010 11

$$\begin{array}{r} 010100 \\ +1 \\ \hline 010101 \end{array}$$

010100 — 1's complement

010101 → 2's complement.

9's complement :-

For 9's complement representation, in a given number, each digit is subtract from the '9'.

Ex:- 376

Each digit is subtract from '9'.

$$\begin{array}{r} 999 \\ -376 \\ \hline 623 \end{array}$$

623 → 9's complement.

10's complement :-

For 10's complement representation, first given number is converted into 9's complement and add '1' to the 9's complement.

Ex: 856

$$\begin{array}{r} 999 \\ -856 \\ \hline 143 \end{array} \rightarrow \text{9's complement}$$

$$\begin{array}{r} 143 \\ +1 \\ \hline 144 \end{array} \rightarrow \text{10's complement}$$

1) Find 1's & 2's complement of 0101?

2) Find 1's & 2's complement of

i) 101101 ii) 01010010 c) 10110001

3) Find 9's and 10's complement of

i) 3572 ii) 74 iii) 5 iv) 738

v) 25.74 vi) 32.8 vii) 783.25

viii) 2354.72.