Number systems and Binary codes.

Definition:- The no. systems are used to quantify the magnitude of something. One way of quantifying the magnitude of something is by proportional values. This is called analog representation. The other way of representation of any quantity is numerical (Digital).

The no. systems are called position weighted systems. since in which the weight of each digit depends on its relative position with in the number.

Base (or) radix of system:-

The base (or) radix of no. system is defined as the no. of different symbols (Digits (or) characters) used in that no. system.

Key points:-

1. If the Base of the no. system is 'r', the no. of different symbols used in the system are 'r' (the different symbols are '0 to r-1').
2. The largest value of digits in base 'r' system is 'r-1'.

Types of Number of systems:-

1. Binary number system:- The base value of binary number system '2'.

The different symbols used in this system are $= 0 \text{ to } r-1$
$= 0 \text{ to } 1$
$= 0, 1.$

The maximum value of digit in binary system $= r-1$
$= 2-1 = 1$

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2. Octal Number system:- The base value of octal no. system is '8'.

(i) The no. of different symbols used in octal system is = 0 to $r-1$
= 0 to 8 − 1
= 0 to 7

(ii) The maximum digit in octal no. system is = $r-1$
= 8 − 1
= 7

3. Decimal number system:- The base value of Decimal number system is '10'.

(i) The no. of different symbols used in decimal system is
0 to $r-1$
= 0 to 10 − 1
= 0 to 9.

i.e. 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

(ii) The maximum digit in decimal system is = $r-1$
= 10 − 1 = 9.

4. Hexa decimal no. system:- The base value of Hexadecimal no. system is '16'.

(i) The no. of different symbols used in Hexadecimal no. system is = 0 to $r-1$
= 0 to 16 − 1
= 0 to 15

(ii) The maximum digit in Hexadecimal system is = $r-1$
= 16 − 1 = 15 (F).

Key points :-

Any positional Number system can be expressed as sum of products of place value and digits value

The place (or) weights of different digits is mixed no. systems is :-

1) Decimal No. system :- $\cdots 10^4\ 10^3\ 10^2\ 10^1\ 10^0 .\ 10^{-1}\ 10^{-2}\ 10^{-3} \cdots$

2) Binary no. system :- $\cdots 2^4\ 2^3\ 2^2\ 2^1\ 2^0 .\ 2^{-1}\ 2^{-2}\ 2^{-3} \cdots$

3) octal no. system :- $\cdots 8^4\ 8^3\ 8^2\ 8^1\ 8^0 .\ 8^{-1}\ 8^{-2}\ 8^{-3} \cdots$

Ex :- (1) $(256.12)_{10} - 2\times10^2 + 5\times10^1 + 6\times10^0 + 1\times10^{-1} + 2\times10^{-2}$

(2) $(346.71)_8 - 3\times8^2 + 4\times8^1 + 6\times8^0 + 7\times8^{-1} + 1\times8^{-2}$

(3) $(10111.101) - 1\times2^4 + 0\times2^3 + 1\times2^2 + 1\times2^1 + 1\times2^0 + 1\times2^{-1}$
$+ 0\times2^{-2} + 1\times2^{-3}$

No. system conversions :-

Decimal to binary conversion :-

1. Integer No.s :- Divide the given decimal no. repeatedly by '2' and collect the remainders. This must continue until the integer quotient becomes zero.

Ex :- $(52)_{10}$

successive division by '2' remainder.

$$
\begin{array}{r|l l}
2 & 52 & \\
2 & 26 & --- 0 \\
2 & 13 & --- 0 \\
2 & 6 & --- 1 \\
2 & 3 & --- 0 \\
2 & 1 & --- 1 \\
 & 0 & --- 1
\end{array}
$$

$(52)_{10} = (110100)_2$

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(*) Key point :-

The conversion from decimal No. to any 'base-r' system is similar to the above example except the division is done by 'r' instead of '2'.

2. Fractional Numbers :- Find the given fractional no. multiplied by '2' to give an integer and a fraction, the new fraction is multiplied by '2' to give a new integer and a new fraction. This process continued until the fraction becomes zero (or) until the no. of digits has sufficient accuracy.

Ex:- $(0.75)_{10}$

		Integer
given fraction	0.75	
Multiply 0.75 by 2	1.50	1
Multiply 0.50 by 2	1.00	1

Binary to decimal Conversion :- Binary numbers converted to decimal equivalent by the positional weights methods. In this method each binary digit of the no. is multiplied by its position weight and the product terms are added to obtain the decimal number.

Integer :-

$(10101)_2$

Ex:- positional weights $2^4 \; 2^3 \; 2^2 \; 2^1 \; 2^0$

$= (1 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0)$

Binary no $1 \; 0 \; 1 \; 0 \; 1 = 16 + 4 + 1 = (21)_{10}$

Fraction $(.101)_2$

positional weights 2^{-1} 2^{-2} 2^{-3}

$1 \quad 0 \quad 1$

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

$$= 0.625$$

Assignment

1. Convert $(163.875)_{10}$ to binary.
2. Convert $(11011.110)_2$ to decimal.