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Digital Electronics

For

Second class

by

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Number system

1- Binary numbers.
2- Octal numbers.
3- Hexadecimal number.

1. The types of number system:

1-Decimal Number System

This system is composed of 10 numbers or symbols, these 10

Symbols are:

0 1 2 3 4 5 6 7 8 9

These symbols are called digits.

The decimal system, also called base 10 system, because it has

10 digits which is a naturally result of the fact that man has 10

fingers.

2- Binary Number System

In this system there are only two symbols or possible

digit values , 0 or 1 . Even so , this base-2 system.

3- Octal Number System

This system is composed of 8 numbers or symbols:

0 1 2 3 4 5 6 7

This is a base -8 system

4- Hexa- Decimal System

This system is composed of 16 numbers or symbols (digit):

0 1 2 3 4 5 6 7 8 9 A B C D E F

It is a base – 16 systems

2. Representation of numbers:

1) Decimal :-

$(124)_{10} = 4 \times 10^0 + 2 \times 10^1 + 1 \times 10^2$

$(252.512)_{10} = 2 \times 10^0 + 5 \times 10^1 + 2 \times 10^2 + 5 \times 10^{-1} + 1 \times 10^{-2} + 2 \times 10^{-3}$

2)Binary :-

$(1011101)_2 = 1 \times 2^0 + 0 \times 2^1 + 1 \times 2^2 + 1 \times 2^3 + 1 \times 2^4 + 0 \times 2^5 + 1 \times 2^6$

$= (93)_{10}$

$(101.11)_2 = 1 \times 2^0 + 0 \times 2^1 + 1 \times 2^2 + 1 \times 2^{-1} + 1 \times 2^{-2}$

$=(5.75)_{10}$

3) Octal :-

$(537)_8 = 7 \times 8^0 + 3 \times 8^1 + 5 \times 8^2$

$=(351)_{10}$

4) Hexa- Decimal :-

$(A01B)_{16} = 11 \times 16^0 + 1 \times 16^1 + 0 \times 16^2 + 10 \times 16^3$

$=(40987)_{10}$

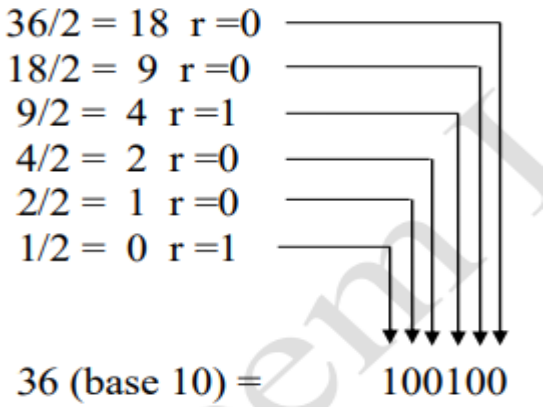
1. Convert between the types of numbers systems

any base-to-decimal conversion :-
just use the definition given above.

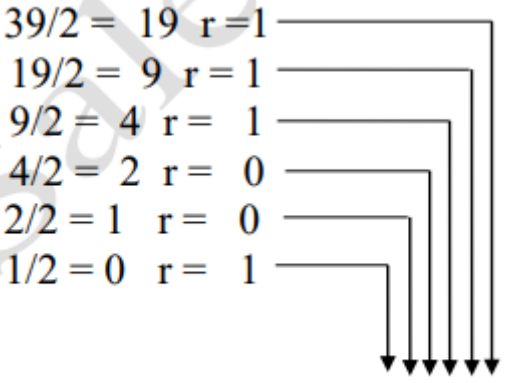
Decimal-to-binary :-

divide decimal value by 2 (the base) until the value is 0

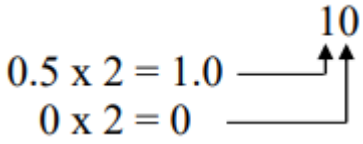
example: convert the following decimal numbers to the equivalent binary numbers (36 , 39.5).



36 (base 10) = 100100



39.5 (base 10) == 100111

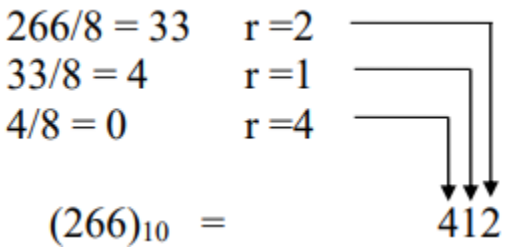


The binary equivalent of (39.5)10 is (100111.10)2.

Decimal-to-Octal :-

A decimal integer can be converted to octal by using the same repeated-division method that we used in the decimal-to-binary conversion, but with a d

Example: convert the following decimal number to equivalent octal number $(266)_{10}$ & $(20.75)_{10}$



20/8 = 2 r =4 0.75 x 8 = 6.0

2/8 = 0 r =2

The equivalent octal number is $(24.6)_8$

Octal-to-binary :-

The conversion from octal to binary is performed by converting each octal digit to its 3-bit binary equivalent. The eight possible digits are converted as indicated in the following table:

Octal digit	0	1	2	3	4	5	6	7
Binary digit	000	001	010	011	100	101	110	111

Example: convert the following octal number to it's equivalent binary number $(472)_8$

4	7	2
100	111	010

The equivalent binary number is $(100111010)_2$

Binary-to-octal :-

1. group into 3's starting at least significant symbol (if the number of bits is not evenly divisible by 3, then add 0's at the most significant end)

2. write 1 octal digit for each group

example:

$$\underline{100}\ \underline{010}\ \underline{111}\ \text{(binary)}$$
$$4\quad 2\quad 7\ \text{(octal)}$$

$$\underline{10}\ \underline{101}\ \underline{110}\ \text{(binary)}$$
$$2\quad 5\quad 6\ \text{(octal)}$$

example:- convert (177)10 to its 8-bit binary equivalent by first converting to octal.

Solution:-

177/8 = 22 + reminder of 1

22/8 = 2 + reminder of 6

2/8 = 0 + reminder of 2

$(177)_{10} = (261)_8$

$$\underline{2}\ \ \underline{6}\ \ \underline{1}$$
$$010\ \ 110\ \ 001$$

$(177)_{10} = (261)_8 = (010110001)_2$

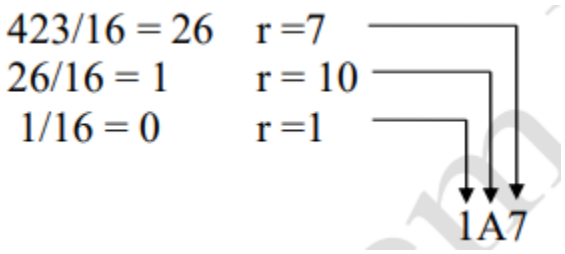
Tutorials:-

1- Convert (641)8 to decimal (Ans. 369).
2- Convert (146)10 to octal then from octal to binary (Ans. 222 and 010010010).
3- Convert (10011101)2 to octal (Ans. 235).
4- Write the next three numbers in this octal counting sequence: 624, 625, 626,
5- Convert (975)10 to binary by first converting to octal (Ans. 1111001111).
6- Convert binary 1010111011 to decimal by first converting to octal (Ans. 699).

Decimal-to-hex :-

This conversion can be done using repeated division by 16.

Example: convert (423)10 to hex.



Hex-to-binary :-

Each hex digit is converted to it's 4-bit binary equivalent as show in the table below :

Hex	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Binary	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111

Example:

3 9 C 8
0011 1001 1100 1000

Binary-to-hexadecimal:-

This conversion is just the reverse of the hexa-to-binary conversion process

Example:

1001 1110 0111 0000
9 E 7 0

1 1111 1010 0011
1 F A 3

Tutorials:-

1- Convert (24CE)16 to decimal (Ans. 9422).

2- Convert (3117)10 to hex, then from hex to binary (Ans. C2D and 110000101101)

3- Convert (1001011110110101)2 to hex (Ans 97B5).

4- Write the next four numbers in this hex counting sequence: E9A, E9B, E9C, E9D, ….., ……., ……, …….

5- Convert (3527)8 to hex (Ans. (757)16).