Octal numeration system

Octal numeration system**:** To convert **from binary to octal** numeration system, we just have to divide the number into groups of binary numbers having **3 bits each**. And each group of 3 bits is replaced by its equivalent in octal.

Let's convert the following binary numbers in octal:

A = 10110101

B = 11010111.01

$$A = \underbrace{010}_{2}\,\underbrace{110}_{6}\,\underbrace{101}_{5_8}$$

$$10110101_2 = 265_8$$

The bits are grouped from the right to the left. A zero has been added to the two firs bits to form a group of 3 bits. That zero is called an implied zero.

$$B = \underbrace{011}_{3}\,\underbrace{010}_{2}\,\underbrace{111}_{7}\,.\,\underbrace{010}_{2_8}$$

$$11010111.01_2 = 327.2_8$$

Two implied zeros have been added to the number to form groups of 3 bits.

Example 1: Let us convert the following **octal** number to **decimal**:

$A = 264.74_8$

$$\begin{matrix} & 2 & 1 & 0 & -1 & -2 \\ A = & 2 & 6 & 4. & 7 & 4_8 \end{matrix}$$

$$A = 2\times 8^2 + 6\times 8^1 + 4\times 8^0 + 7\times 8^{-1} + 4\times 8^{-2}$$

$$A = 180.9375_{10}$$

Hexadecimal numeration system

The hexadecimal numeration system is a place weighted system with a base of sixteen. Valid ciphers include the normal decimal symbols “0”,”1”,”2”,”3”,”4”,”5”,”6”,”7”;”8”;9” plus six alphabetical characters A, B, C, D, E, and F. The following table summarizes the equivalence between decimal, binary, octal and hexadecimal systems.

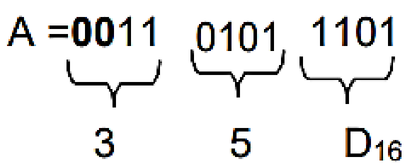
To convert from binary to hexadecimal numeration, **we group bits in fours**. Each group of four bit is replaced by its hexadecimal equivalent.

Convert the following **binary** numbers in **hexadecimal**.

A = 1101011101

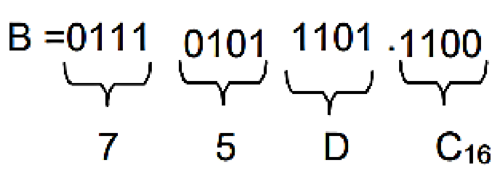
B = 11101011101.11

As explained above, we just have to group the binary number in groups of four bits each:



$$1101011101_2 = 35D_{16}$$

The binary number has been grouped is groups of four bits each, from the right to the left two implied zeros have been added at the extreme left. In the same way the number B can also be converted.



$$11101011101.11_2 = 75DC_{16}$$

Octal and hexadecimal to binary

It is obvious that, to convert from octal to binary, we just have to convert each octal cipher to its binary equivalent in **3 bits**. In the same way, to convert from hexadecimal to binary, we should convert each hexadecimal symbol into its binary equivalent in **4 bits**.

Example 2: a) Convert the following octal number (523_8) to binary.

b) Convert the following hexadecimal number ($4DC2_{16}$) to binary.

$$523_8 = \underbrace{101}_{5}\ \underbrace{010}_{2}\ \underbrace{011}_{3}{}_2$$

$$\boxed{523_8 = 101010011_2}$$

$$4DC2_{16} = \underbrace{0100}_{4}\ \underbrace{1101}_{D}\ \underbrace{1100}_{C}\ \underbrace{0010}_{2}{}_2$$

$$\boxed{4DC2_{16} = 100110111000010_2}$$

Hexadecimal to decimal

The technique for converting hexadecimal notation to decimal is the same as the one used above, except that each successive place weight changes by a factor of sixteen.

Let us convert the following **hexadecimal** number to **decimal**:

$A = 34DF.AC2_{16}$

$$\begin{matrix} & 3 & 2 & 1 & 0 & & -1 & -2 & -3 \\ A = & 3 & 4 & D & F & . & A & C & 2_{16} \end{matrix}$$

$$A = 3 \times 16^3 + 4 \times 16^2 + 13 \times 16^1 + 15 \times 16^0 + 10 \times 16^{-1} + 12 \times 16^{-2} + 2 \times 16^{-3}$$
$$A = 12288 + 1024 + 208 + 15 + 0.625 + 0.046875 + 0.000488281$$
$$A = 13535.67236_{10}$$

H.W. Convert from decimal to binary:

$A = 0.8125_{10}$ $C = 0.875_{10}$ $B = 0.625_{10}$ $D = 0.40625_{10}$

Decimal to octal conversion

The process of decimal-to-octal conversion is similar to that of decimal-to-binary conversion. The progressive division in the case of the integer part and the progressive multiplication while working on the fractional part here are by '8' which is the radix of the octal number system.

Example 3:- We will find the octal equivalent of $(73.75)_{10}$.

Solution

- The integer part = 73

Divisor	Dividend	Remainder
8	73	—
8	9	1
8	1	1
—	0	1

- The octal equivalent of $(73)_{10} = (111)_8$
- The fractional part = 0.75
- $0.75 \times 8 = 0$ with a carry of 6
- The octal equivalent of $(0.75)_{10} = (.6)_8$
- Therefore, the octal equivalent of $(73.75)_{10} = (111.6)_8$

Decimal to hexadecimal conversion

The process of decimal-to-hexadecimal conversion is also similar. Since the hexadecimal number system has a base of 16, the progressive division and multiplication factor in this case is 16.

Example 4: Let us determine the hexadecimal equivalent of $(82.25)_{10}$.

Solution

- The integer part = 82

Divisor	Dividend	Remainder
16	82	—
16	5	2
—	0	5

- The hexadecimal equivalent of $(82)_{10} = (52)_{16}$
- The fractional part = 0.25
- $0.25 \times 16 = 0$ with a carry of 4
- Therefore, the hexadecimal equivalent of $(82.25)_{10} = (52.4)_{16}$