



LESSON 2 | Converting between Decimal, Binary and Hexadecimal number systems

Converting between binary to decimal

Method 1: Multiply each bit by its place value/positional notation.

$$\begin{aligned} 10111_2 &= (1 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) \\ &= 23_{10} \end{aligned}$$

Method 2: Create a binary table for the binary number and add the place values where the bits are 1.

16	8	4	2	1
1	0	1	1	1

 = 23₁₀

Did you know that the right-hand side bit of a binary number is called the **least significant bit** (LSB) while the left-hand side bit is the **most significant bit** (MSB)?

Converting between decimal to binary

Method 1: Repeatedly divide the number by 2 and write the remainders from bottom up. E.g. Convert 41₁₀ to binary.

$$\begin{array}{rcl} 41 & = & 2 \overline{) 41} \\ & & 2 \overline{) 20} \text{ r } 1 \\ & & 2 \overline{) 10} \text{ r } 0 \\ & & 2 \overline{) 5} \text{ r } 0 \\ & & 2 \overline{) 2} \text{ r } 1 \\ & & 2 \overline{) 1} \text{ r } 0 \\ & & 0 \text{ r } 1 \end{array} \quad \uparrow$$

= 101001₂



Method 2: Create a binary table and starting from the largest place value insert a 1 in appropriate column to form the number.

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

= **101001₂**

Converting between binary to hexadecimal

Note that hexadecimal ranges from **0** to **15** (**0 - 9, A, B, C, D, E, F**) where A is equivalent to 10, B to 11, C to 12, D to 13, E to 14 and F to 15).

E.g.: Convert 11010011₂ to Hex

Method: Divide the number into groups of 4 since the hexadecimal number ranges from 0 to 15 thus requiring only 4 bits).

$$\begin{array}{ccccc} 1101 & 0011 & & & \\ \mathbf{D} & \mathbf{3} & = & \mathbf{D3}_{16} \end{array}$$

Converting between hexadecimal to binary

E.g.: Convert EB₁₆ to Binary

Method: Divide the hexadecimal number into single digits and convert each hexadecimal digit in a 4 bit binary number as shown below.

$$\begin{array}{ccccc} \mathbf{E} & \mathbf{B} & & & \\ \mathbf{1110} & \mathbf{1011} & = & \mathbf{11101011}_2 \end{array}$$

Converting between decimal to hexadecimal

E.g.: Convert 114₁₀ to Hexadecimal

To convert between decimal into hexadecimal you need to do it into TWO steps. First you need to convert the decimal number into binary and then you need to convert the binary number into hexadecimal.

Step 1: Convert 114₁₀ to binary

$$\begin{array}{rcl} 114 & = & 2 \overline{)114} \\ & & 2 \overline{)57} \text{ r } 0 \\ & & 2 \overline{)28} \text{ r } 1 \\ & & 2 \overline{)14} \text{ r } 0 \\ & & 2 \overline{)7} \text{ r } 0 \\ & & 2 \overline{)3} \text{ r } 1 \\ & & 2 \overline{)1} \text{ r } 1 \\ & & 0 \text{ r } 1 \end{array} \quad \uparrow \quad = \mathbf{1110010}_2$$

Step 2: Convert 1110010_2 to hexadecimal

$$\begin{array}{ccc} 111 & 0010 & \\ 7 & 2 & = 72_{16} \end{array}$$

Therefore 114_{10} to hexadecimal is 72_{16}



1. We use the binary table or by multiplying each bit with the positional notation/place value of each bit to convert from binary to decimal.
2. We use the division by 2 method or the binary table to convert from decimal to binary.
3. We divide the binary number into groups of 4 to convert from binary to hexadecimal.
4. We divide the hexadecimal number into single digits and convert each hexadecimal digit in a 4 bit binary number to convert from hexadecimal to binary.
5. We use a **two-step** approach if we want to convert from decimal to hexadecimal. First we convert the decimal number into binary and then the binary into hexadecimal.



Work out on your own the examples you have covered during this lesson to learn how to convert between the number systems.

You can experiment with other numbers and the you can check your answers by using the following website link:

<https://www.mathsisfun.com/binary-decimal-hexadecimal-converter.html>

Then you can work out the worksheets attached with this lesson as described and listed on the next page.

The work that I have to do

1. By using the methods explained in this lesson now work out the worksheet provided
2. Check your work with the worksheet answers provided.

Converting between the number systems given a problem.

Did you know that you may also be given a problem to convert between the number systems as in worksheet no 5.

Can you find some other real life scenarios and convert the decimal numbers within the problem to binary or hexadecimal?

E.g. Last month, a traffic policeman issued 124 traffic tickets. Convert this decimal number into hexadecimal.



Video links:

- Converting between decimal, binary and hexadecimal number systems:
<https://www.youtube.com/watch?v=aW3qCch6Dao>

Web links:

- To check your work:
<https://www.mathsisfun.com/binary-decimal-hexadecimal-converter.html>



- Can you convert between the decimal to binary and vice versa?
- Can you convert between the binary to hexadecimal and vice versa?
- Can you convert between the decimal to hexadecimal and vice versa?
- Can you convert between the different number systems given a problem?

Did you know that?

A hexadecimal number 45_{16} is pronounced as four five base sixteen and can also be written as $0x45$.

"There are only ten types of people in this world: those who understand binary and those who don't." unknown



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