**CIST 1305 Converting Number Systems**

**Binary, Decimal, and Hexadecimal**

# Objectives:

The objective of this lab is to help you become familiar with different number formats and the methods used to convert them into data that is used by a computer.

After performing this lab, you should be able to convert**:**

|  |  |
| --- | --- |
|  | * Decimal numbers into hexadecimals and binary numbers |
|  | * Hexadecimal numbers into binary and decimal numbers |
|  | * Binary numbers into hexadecimal and decimal numbers |

# Background Information:

The Binary number system was the first machine language written so we could communicate with a computer. It is the language a computer uses to communicate internally. Number systems like decimal and hexadecimal are used to make it easier for users to interpret numbers being used within a computer. However, the computer can not read nor translate these other number systems. When a program that was written in a language other than a machine language, the computer has to use a compiler or an interpreter to convert it into machine language before the program can be executed.

## Binary Number System

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Col 7 | Col 6 | Col 5 | Col 4 | Col 3 | Col 2 | Col 1 | Col 0 |
| **Base**power | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 |
| **Positional Value** | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Table 4.1

# Steps for converting a Binary number to a Decimal number:

1. When converting the Binary number 10100110 into a Decimal number, place the binary number into Example 4.1, as shown below. Place one number in each of the columns starting on the right side of the table.
2. Find the number that is in the ***Positional Value*** row that correlates to the “1”s (ones) in the ***Binary Number*** row below it.
3. Take the numbers you found in step #2 and add them together.  The sum is the equivalent Decimal number for the Binary number 10100110. See example 4.1.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Positional Value** | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| **Binary Number** | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| **Add these numbers** | **128** | - | **32** | - | - | **4** | **2** | - |

128 + 32 + 4 + 2 = 166 1 0 1 0 0 1 1 0 = 166 in Decimal

## Example 4.1

### Decimal Number System

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Column4 | Column3 | Column2 | Column1 |
| **Base**power | 103 | 102 | 101 | 100 |
| **Positional Value** | 1000 | 100 | 10 | 1 |

 Table 4.2

# Steps for converting a Decimal Number to a Binary Number:

1. When converting a Decimal number (166) into a Binary number, subtract the number in the ***Positional Value*** row shown in Table 4.1, the ***Binary Number*** table.
2. Choose the largest number that is less than or equal to the Decimal number you are converting.  Follow this process until the answer equals “0”.
3. Place a “1” under each of the ***Positional Values*** that were used in the subtraction in step 2.  A “0” is placed in all the columns that were not used in the subtraction.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Positional**  **Value** | **128** | 64 | **32** | 16 | 8 | **4** | **2** | 1 |
| **Binary**  **Number** | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |

166-**128** = 38

38-**32** = 6

6-**4** = 2

2-**2** = 0

**166 = 1 0 1 0 0 1 1 0 Binary**

## Example 4.2

### Hexadecimal Number System

|  |  |  |  |
| --- | --- | --- | --- |
|  | Column 3 | Column 2 | Column 1 |
| **Base**power | 162 | 161 | 160 |
| **Positional Value** | 256 | 16 | 1 |

Table 4.3

# Steps for converting a Hexadecimal Number to a Decimal Number:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Positional Value** | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| **Binary Number** | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| **Hexadecimal**  **Conversion** | **8** | 4 | **2** | 1 | 8 | **4** | **2** | 1 |

# Exercises

1. Convert the hexadecimal number to a decimal number.

a) 17h= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) FBh= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c) A43h= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d) 3DEh= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e) 2AD4h= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Convert the decimal numbers to hexadecimal numbers.

a) 15= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) 157= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c) 225 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d) 1552= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e) 42564= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Convert the hexadecimal numbers to binary numbers.  NOTE: Hexadecimal numbers are followed by the letter “h” so they do not get confused as being a decimal number.

a) 13h= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) 2Fh= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c) AAh= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d) 1AFh= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e) 4BEh= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. Convert the binary numbers to hexadecimal numbers.

a) 110= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) 1101= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c) 100110= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d) 1101110= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e) 11100010= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_