Assignment 5-3: Hexadecimal Conversions

Name: _____

Objective

In this exercise, you will practice converting hexadecimal values to decimal and binary values.

Background – Hexadecimal Numbers

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

The hexadecimal (HEX) number system is used to refer to the binary numbers in a NIC MAC address or an IPv6 address. The word *hexadecimal* comes from the Greek word for 16 and is often abbreviated as 0x. HEX numbers use 16 unique digits – 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F where A = 10, B = 11, etc. – to display any combination of 8 binary digits as only 2 hexadecimal digits. The text (A–F) digits are not case sensitive.

A byte (8 bits) can range from 00000000 to 11111111, creating 256 combinations with decimal values ranging from 0 to 255 or HEX values 00 to FF. Each HEX value represents only four binary bits. The table at the right shows the 16 HEX digits plus their decimal and binary equivalents.

A simple table tool for easily converting hexadecimal to decimal values is similar to what we used in binary to decimal conversions except that the **Position** row has only two HEX positions. The **Value** row similarly has only two entries. There is a one (1) position and the second position is 16 (remember because it is base 16).

Position	2	1
Value	16	1

If some implementation required converting more than two HEX values, we could add columns to the left as we did in decimal and binary, except that each would be 16 times larger, making a third column 256. A fourth column would be 4096, etc.

Position	4	3	2	1
Value	4096	256	16	1

HEX to Decimal Steps

If we wanted to convert the HEX value 77CE to decimal.

1. Break the HEX value into pairs starting at the right edge, inserting a zero if necessary to complete the first pair (for example, 77ce becomes 77 and ce).

2. Put each HEX pair separately in row 3. The value in parentheses is the decimal value of A–F.

3. To get the decimal values in row 4, multiply the row 2 values by row 3.

4. Now just sum row 4 (across).

Position	2	1
Value	16	1
	7	7
	112	7

= 119

Position	2	1
Value	16	1
	C(12)	E(14)
	192	14

= 206

Decimal to HEX Steps

Assume that you want to convert 209 to HEX values.

1. To be a valid HEX value for our purposes, the decimal value will be between 0 and 256. The first HEX value is derived by dividing the decimal value by 16. If the value is greater than 9, needs to be converted to HEX form (A–F).

2. The second value is the remainder of step 1. If the value is greater than 9, needs to be converted to HEX form (A–F).

3. For example, 209 divided by 16 is 13 (D in HEX), with a remainder of 1 giving us a HEX value D1.

If we needed to convert a number larger than 256, we would do as we did with binary. We could just use the Values from our table tool.

Position	4	3	2	1
Value	4096	256	16	1

To convert 3000, we would divide by 256 and enter the whole number. The remainder would then be divided by 16 as above. Fortunately, we won't concern ourselves with numbers larger than 256.

HEX to Binary

This is the easiest conversion if you remember that each HEX value converts to four binary bits, so work right-to-left. For example, to convert **77ce** to binary.

1. Start with **e**, converting it first to decimal and then to binary. You could use the table at the beginning of the HEX section to go directly to binary.

   The other alternative is to convert the value to decimal (E = 14) and then use the last four positions of the table used in the decimal to binary conversions.

Position	4	3	2	1
Value	8	4	2	1
	1	1	1	0
	8	4	2	

   = 14

   14 divided by 8 is 1 with a remainder of 6.
   6 divided by 4 is 1 with a remainder of 2.
   2 divided by 2 is 1 with no remainder.
   Add 0s if necessary to end up with 4 bits. There are zero ones.
   We get E = **1110**

2. Using the same technique, C becomes **1010**, and the number so far is **10101110**.

Position	4	3	2	1
Value	8	4	2	1
	1	0	1	0
	8		2	

   = 10

3. Using the same technique, the two 7s each become **0111**, and the total is **01110111.10101110**.

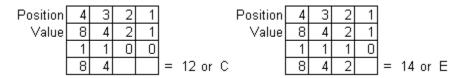 | Position | 4 | 3 | 2 | 1 |
   |---|---|---|---|---|
   | Value | 8 | 4 | 2 | 1 |
   | | 0 | 1 | 1 | 1 |
   | | | 4 | 2 | 1 |

   = 7

Binary to HEX

Assume we need to convert 01101110.11101100 to HEX for some reason.

4. Each HEX value equals four binary bits, so start by breaking the binary value into 4-bit units from right to left. Add any leading 0s required to end up with all 4-bit values.

   01101110.11101100 would become 0110 1110 1110 1100.

5. You could use the table at the beginning of the HEX section to go directly to HEX

   The alternative is to convert each 4-bit binary value to decimal (0–15) and then convert the decimal to HEX (0–F). The conversions of 1110 1100 would be,

Position	4	3	2	1		Position	4	3	2	1	
Value	8	4	2	1		Value	8	4	2	1	
	1	1	0	0			1	1	1	0	
	8	4			= 12 or C		8	4	2		= 14 or E

6. Repeat the process for the first two 4-bit numbers (0110 1110), and the result becomes 6E–EC.

Practice: Hexadecimal Conversions

Convert the following values to the other two forms:

Hex to Decimal and Binary

	Hex	Decimal	Binary
1	a9		
2	FF		
3	DD		
4	9F		
5	Bad1		
6	00-21-70-BE		

Decimal to Hex

	Decimal	Hex
1	53	
2	115	
3	19	
4	254	
5	212.65.119.45	

Binary to Hex

	Binary	Hex
1	10101010	
2	110	
3	11111100	
4	1.11111110	
5	00001100.10000000.11110000.11111111	

Answers for Hexadecimal Conversions

Convert the following values to the other two forms:

Hex to Decimal and Binary

	Hex	Decimal	Binary
1	a9	169	10101001
2	FF	255	11111111
3	DD	221	11011101
4	9F	159	10011111
5	Bad1	47,825	10111010.11010001
6	00-21-70-BE	2,191,550	10000101.11000010.111110

Decimal to Hex

	Decimal	Hex
1	53	35
2	115	73
3	19	13
4	254	FE
5	212.65.119.45	11010100.01000001.01110111.00101101

Binary to Hex

	Binary	Hex
1	10101010	AA
2	110	6
3	11111100	FC
4	1.11111111.11111110	1:FF:FE
5	00001100.10000000.11110000.11111111.11111111	C:80:F0:FF:FF