NAME: _____ **Score:** _____/ 49

ECEN 324
Homework #4 – Integers

1. (12 points) Similar to Practice Problem 2.16

Fill in the table below showing the effects of the different shift operations on single-byte quantities. The best way to think about shift operations is to work with binary representations. Convert the initial value in each row to binary, perform the shifts in that row using the initial value of `x`, and then convert the shifted value to hexadecimal. Give answers in both binary (8 bits) and hexadecimal (2 digits).

`x`		`x << 3`		`x >> 2` Logical		`x >> 2` (Arithmetic)	
Hex	Binary	Binary	Hex	Binary	Hex	Binary	Hex
0xF0							
0x0F							
0xCC							
0x55							

2. (6) Similar to Practice Problem 2.19

Fill in the following table describing the function $T2U_4$. Give answers in decimal, as the solutions to PP 2.19 show in the book. You might wish to review problem 2.17 in the book before doing this problem.

x	$T2U_4(x)$
-8	
-6	
-4	
-1	
0	
3	

3. (10) The following table represents a small memory. Refer to this table for the following questions.

Address	Data
0000	0001 1110 0100 0011
0001	1111 0000 0010 0101
0010	0110 1111 0000 0001
0011	0000 0000 0000 0000
0100	0000 0000 0110 0101
0101	0000 0000 0000 0110
0110	1111 1110 1101 0011
0111	0000 0110 1101 1001

A. What 16 bit **binary** value (write it in binary) does location 3 (0011_2) contain? _____

B. What **binary** value (write it in binary) does location 6 contain? _____

The binary value within each location can be interpreted in many ways. We have seen that binary values can represent unsigned numbers, 2's complement signed numbers, floating point numbers, and so forth. For example, the binary value of $0000\ 0110\ 1101\ 1001_2$ in location 7 could be interpreted as the decimal value of 1,753.

C. Interpret location 0 as a 2's complement integer: _____(decimal)

D. Interpret location 1as a 2's complement integer: _____(decimal)

E. Interpret the lower byte of location 4 (0100_2) as an ASCII character: _____

F. Interpret location 0 as an unsigned integer: _____ (decimal answer)

G. Interpret location 1 as an unsigned integer: _____ (decimal answer)

H. In the Von Neumann model, the contents of a memory location can also be an instruction. If the binary pattern in location 0 were interpreted as an LC-2 instruction, what type of instruction would it represent? [See "Basics of Computer Architecture" PowerPoint slide set for LC-2 information.]

_____

I. A binary value can also be interpreted as a memory address. Say the value stored in location 5 is a memory address. To which memory location does it refer? (Convert the binary value of the "address" stored in location 5 to decimal for your answer:

_____

J. Express in **hexadecimal** the contents of the memory location that was the answer for the previous problem (part I). [This is the value of a memory location that is "pointed to" by the contents of memory address/location 5.]

0x _____

4. (10) <u>Similar to Practice Problem 2.23</u>

Consider the following C functions:

```
int fun1 (unsigned word)
{
      return (int) ((word << 24) >> 24);
}

int fun2 (unsigned word)
{
      return ((int) word << 24) >> 24;
}
```

Assume these are executed on a machine with a 32-bit word size that uses two's complement arithmetic. Assume also that right sifts of unsigned values are performed logically.

A. (8) Fill in the following table showing the effect of these functions for several example arguments (the arguments shown are in decimal and hexadecimal; provide answers in both decimal and hexadecimal):

w	fun1 (w)	fun2 (w)
127 (0x7F)		
128 (0x80)		
255 (0xFF)		
256 (0x100)		

B. (2) Describe in words the useful computation each of these functions performs.

Assignment continued on the next page. →

5. (3) Practice Problem 2.25

Consider the following code, which attempts to sum the elements of an array `a`, where the number of elements is given by parameter `length`:

```
1     /* WARNING: This is buggy code */
2     float sum_elements (float a [], unsigned length)
3     {
4           int i;
5           float result = 0;
6
7           for (i = 0; i <= length-1; i++)
8                 result += a [i];
9           return result;
10    }
```

When run with argument `length` equal to 0, this code should return 0.0. Instead, it encounters a memory error. Explain why this happens, and show how the code can be corrected.

6. (7.5 + 0.5) Similar to Practice Problem 2.33 – [note that the order of the columns has changed]

We can represent a two's complement number that has a bit pattern of length $w = 4$ with a single hex digit. Fill in the second column of the table below with the decimal values of the two's complement hex values in the first column. In the third column, write the hex value that is the additive inverse of the hex value in the first column. In the fourth column, give the decimal value of the two's complement number in the third column.

x		$-_4^t x$	
Hex	Decimal	Hex	Decimal
0			
3			
8			
A			
F			