CS 3843 Midterm Exam One Fall 2012 **Name (Last)____________, (First)__________**

You may use a calculator and one sheet of notes on this exam, but no other materials and no computer.

This test has a full score of 110 points. Answer question worth 100 points or more. The exam will be graded for a maximum score of 100 points. Show all the major steps in your work to receive partial credits.

Problem 1 (24 points)

(a) (4 points) Convert to decimal: 0x4F9

Sol: 0x4F9 = $4 \times 16^2 + 15 \times 16 + 9 = 1273$

(b) (4 points) Convert to binary: 0xC9D = 1100,1001,1101

(c) (4 points) Convert from decimal to hexadecimal: 1834

Sol: 1834 = $7 \times 16^2 + 2 \times 16 + 10 = 0x72\text{A}$

(d) (4 points) Convert from decimal to binary: 1834

Sol: 1834 = 0111,0010,1010

Show how to use shift, adding and/or subtracting to efficiently multiply the following numbers:

(e) (4 points) 159

Sol: x×159 = x× (128+32-1) = x× $(2^7 + 2^5 - 1)$=(x<<7)+(x<<5)-x

Alternative solution:

x×159 = x×(128+16+8+4+2+1)=(x<<7)+(x<<4)+(x<<3)+(x<<2)+(x<<1)+x

(f) (4 points) $(0111{,}1110)_2$

Sol: x×$(0111{,}1110)_2$= x×[$(1000{,}000)_2$-2]=x× $(2^7 - 2^1)$=(x<<7)-(x<<1)

Problem 2 (12 points)

Assume x = 0x45 and y=0xF8, what is the following value:

(a) (2 points) x & y

Sol: x = 0100,0101

y = 1111,1000

$x \ \& \ y$ = 0100,0000 = 0x40

(b) (2 points) $x \mid y$ = 1111,1101 = 0xFD

(c) (2 points) $\sim x \ \& \sim y$

$\sim x$ = 1011,1010
~y = 0000,0111

$\sim x \ \& \sim y$ = 0000,0010 = 0x2

(d) (2 points) $x \ \&\& \ y$

Sol: $x \ \&\& \ y$ = TRUE && TRUE = TRUE = 0x1

(e) (2 points) $!x \ \& \ y$

Sol: $!x \ \& \ y$ = !TRUE & y = FALSE & y = 0x 0 & y = 0x0

(f) (2 points) $\sim x \ || \ y$

Sol: $\sim x \ || \ y$ = TRUE || TRUE = TRUE = 0x1

Problem 3 (20 points)

(a) (10 points) Use an 8-bit word, find the binary representation of -47 in

i) (4 points) two's complement

ii) (3 points) one's complement

iii) (4 points) sign-magnitude

Sol: N=47 = $(0010,1111)_2$

Its two's complement N* = 1101,0001 and one's complement 1101,0000.

Its sign-magnitude is 1010,1111.

(b) (10 points) Repeat the above question using a 12-bit word.

Sol: It's two's complement N* = 1111,1101,0001 and one's complement 1111,1101,0000.

Its sign-magnitude is 1000,0010,1111.

Problem 4 (30 points)

Determine the output of the following code segment (without running it):

Assume that a short is represented by 7 bits and an int is represented by 12 bits. What is the output generated by the following code segment:

```
int  x = 63;
int  y= -63;
short sx = (short) x;
short sy = (short) y;
printf("%d , %d, %d, %d\n", x, y, (int)sx, (int)sy);    (10 points)
printf("%x, %x, %x, %x\n", x, y, (int)sx, (int)sy);      (10 points)
printf("%u, %u, %u, %u\n", x, y, (int)sx, (int)sy);      (10 points)
```

You may use a calculator to generate the values, but you must show you calculated them.

Sol: 63 = 32+31 = $(11,1111)_2$

int x = 0000,0011,1111 = 0x3F

int y = 1111,1100,0001 = 0xFC1   its unsigned number is $2^{12} - 63 = 4096 - 63 = 4033$

sx = 011,1111 = 0x3F

sy = 100,0001 = 0x41= -[011,1111]= -63

(int) sx = 0000,0011,1111 = 0x3F = 63

(int) sy = 1111,1100,0001 = 0xFC1 = -63   its unsigned number is 4033.

(a) 63, -63, 63, -63

(b) 0x3F, 0xFC1, 0x3F, 0XFC1

(c) 63, 4033, 63, 4033

Problem 5 (24 points)

Consider a hypothetical 8-bit IEEE floating point representation:

```
--------------------------------------
| s | exp ( 3 bits) | frac (4 bits)    |
--------------------------------------
```

a) (4 points) What is the bias?

b) (4 points) How many different values can be represented with 8 bits?

c) (4 points) What is the smallest positive normalized value?

d) (4 points) What is the largest positive normalized value?

e) (4 points) What is the largest positive denormalized value?

f) (4 points) What is the floating-point representation for 1.0?

Sol: k = 3 and n = 4

a) $Bias = 2^{k-1} - 1 = 2^{3-1} - 1 = 3$

b) $2^8 = 256$

c) exp = 001 $frac$ = 0000

$M = 1 + frac \times 2^{-n} = 1.0$ $E = exp - Bias = 1-3 = -2$

$V = = (-1)^S \times M \times 2^E = 1 \times 1.0 \times 2^{-2} = (.01)_2 = \frac{1}{4}$

d) exp=110, $frac$=1111

$M = 1 + \text{frac} \times 2^{-n} = 1.1111$ $E = exp - Bias = 6-3 = 3$

$V = = (-1)^S \times M \times 2^E = 1 \times 1.1111 \times 2^3 = (1111.1)_2 = \frac{31}{2}$

e) exp=000, $frac$=1111

$M = frac \times 2^{-n} = .1111$ $E = 1 - Bias = 1-3 = -2$

$V = = (-1)^S \times M \times 2^E = 1 \times .1111 \times 2^{-2} = (.001111)_2 = \frac{8+4+2+1}{64} = \frac{15}{64}$

f) $1 = 1.0 \times 2^1 = M \times 2^E$

$M = 1.0 = 1 + frac \times 2^{-n}$ => $frac$ = 0000

$exp = E + Bias = 0 + 3 = 3$ => exp = 011

So its floating-point representation is 0 011 0000