CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING

UNIVERSITY OF WISCONSIN—MADISON

Prof. Mark D. Hill and Prof. Gurindar Sohi

TAs: Rebecca Lam, Pradip Vallathol, Preeti Agarwal, Mona Jalal

Midterm Examination 1

In Class (50 minutes)

Friday, February 15, 2013

Weight: 17.5%

NO: BOOK(S), NOTE(S), OR CALCULATORS OF ANY SORT.

The exam has 10 pages. **Circle your final answers**. Plan your time carefully since some problems are longer than others. You **must turn in the pages 1-8**.

LAST NAME: _____

FIRST NAME: _____

ID# _____

Problem	Maximum Points	Points Earned
1	9	
2	4	
3	3	
4	2	
5	3	
6	2	
7	1	
8	2	
9	4	
Total	30	

Problem 1 **(9 Points)**

For the following problems, circle the **best** answer. **Choose only one answer per question.**

i There are **n** bits to represent all the students in a class, and the students are numbered 0-62. What is the value of **n**?

- a 5
- b 4
- c 6
- d 7

ii Which of the following two's complement binary numbers is **not** a multiple of 2 (odd).

- a 1010100
- b 1101010
- c 0111010
- d 1110111

iii Two computers A and B are identical except that A has a multiply instruction and B does not. Both have add instructions. Assume the multiply and add instructions take the same amount of time to operate on two numbers. Which of the following is true about computers A and B?

- a B can compute all the same problems as A, but might take longer.
- b B can compute all the same problems as A, in the same amount of time.
- c B can compute all the same problems as A, in the same amount of time, given enough memory.
- d A can compute more types of problems than B.

iv Which of the following have **two** representations for 0?

- a Signed magnitude
- b Two's complement
- c All of the above
- d None of the above

v Which of the following are properties of an algorithm?

- a Each step has to be precisely stated.
- b The program implementing it has to use a minimum amount of memory.
- c The procedure should terminate.
- d a and b.
- e a and c.

vi Which of the following is the fixed point binary representation of $6\frac{5}{8}$?

a 0100.11
b 010.011
c 0110.101
d 0100.101

vii What is the most negative value that can be represented by an 8-bit two's complement integer?

a -127
b -128
c -255
d -256

viii What is the largest positive value that can be represented by a 5-bit two's complement integer?

a 32
b 31
c 16
d 15

ix When using two's complement notation, which of the following bit patterns represent the negation of 01100110?

a 10010101
b 10011001
c 10011010
d 10110110

Problem 2 **(4 Points)**

a Convert the ASCII string "w#4T" to its **hexadecimal** representation. Only represent the characters within the quotation marks and assume that the string is null terminated. **Hint: See attached ASCII to hexadecimal table.** (2 Points)

0x77 23 34 54 00

b Convert the following binary code into an ASCII string. (2 Points)
0010 0101 0011 1000 0011 1001 0111 0001 0000 0000

%89q

Problem 3 **(3 Points)**

Consider the 8-bit binary pattern 1000 1010. What decimal (base 10) value does it represent if we interpret it as:

a An unsigned integer? (1 Point)

138

b A signed magnitude integer? (1 Point)

-10

c A two's complement integer? (1 Point)

-118

Problem 4 **(2 Points)**

Perform binary arithmetic for the following pairs of 2's complement numbers and specify whether or not there is an overflow. Illustrate your answer by converting the operands and result to decimal. Assume the result has the same number of bits as the operands.

a
```
   101        -3
+  111     + -1
------
   100        -4 No overflow
```

b
```
   0110        6
-  1010    -(-6)
-------
   1100       -4 Overflow
```

Problem 5 **(3 Points)**

Suppose we have two operands X and Y, where X = 0x12 and Y = 0xDE.

a Convert X and Y into **binary**. (1 Point)

X = 0001 0010
Y = 1101 1110

b What is the result of **X AND Y**? Give your answer in **hexadecimal.** (1 Point)

0001 0010 = 0x12

c What is the result of **X OR Y**? Give your answer in **hexadecimal.** (1 Point)

1101 1110 = 0xDE

Problem 6 **(2 Points)**

Show the result of performing the following bitwise logic operations:

a (NOT(1101)) AND (0101 OR 1010)

0010

b NOT(00011 OR (01010 AND 10010))

11100

Problem 7 **(1 Point)**

What is the difference between an instruction set architecture (ISA) and a microarchitecture? Give your answer in **one** sentence.

A microarchitecture is the particular way an ISA is implemented on a processor.

Problem 8 **(2 Points)**

Suppose we have two 4-bit 2's complement integers 0111 and 1000. Express their sum as an 8-bit 2's complement number.

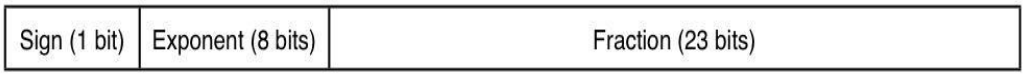
1111 1111

Problem 9 **(4 Points)**

Below is a single-precision floating point representation of some value. Note that the exponent bits have been left out.

0 _ _ _ _ _ _ _ _ 10001100000000000000000

Recall that the bits for the IEEE floating point number are as follows:



where $N = (-1)^{sign} * 2^{exponent-127} * 1.fraction$

a Find the smallest value for the exponent field such that the represented number is greater than the decimal value **4.0**. Give your answer in **binary**. (3 Points)

$(-1)^0 * 2^{exponent\ -\ 127} * 1.100011_2 > 4$

$\frac{99}{64} > 2^2 * 2^{127\ -\ exponent}$

$exponent\ >\ 129\ -\ \log_2(99/64)$

$min\ val\ of\ exponent\ =\ 129\ =>\ 1000\ 0001$

b What is the decimal value of the number represented in part a? (1 Point)

$(-1)^0 * 2^2 * 1.100011_2 = 110.0011_2 = 6\frac{3}{16}$