CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING

UNIVERSITY OF WISCONSIN—MADISON

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Midterm Examination 1

In Class (50 minutes)

Friday, February 10, 2017

Weight: 17.5%

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

The exam has seven pages. **Circle your final answers**. Plan your time carefully since some problems are longer than others. You **must turn all pages.**

LAST NAME: ____

FIRST NAME: ____

ID# ____

Problem	Maximum Points	Points Earned
1	1	
2	4	
3	2	
4	3	
5	4	
6	3	
7	2	
8	5	
9	2	
10	3	
11	3	
Total	32	

Problem 1 (1 point)

Which of the below is **not** a property of an algorithm? (Choose one option.)

a) An algorithm must successfully terminate.
b) An algorithm must be efficient.
c) Each step of an algorithm must be precisely defined.
d) Each step of algorithm must be able to be carried out by a computer.

Problem 2 (4 points)

For each of the following statements, indicate whether it is true or false. If it is false, explain why it is incorrect.

a) Statements in assembly language can have multiple interpretations.

False. Can't be ambiguous.

b) A compiler converts an assembly language to the corresponding ISA.

False. An assembler does.

c) Microarchitecture defines the set of instructions that a computer can carry out.
False. ISA defines the set of instructions that a computer can carry out. Microarchitecture specifies how blocks are organized to implement an ISA.

d) The decimal number 7 can be represented with a 4-bit 2's complement number.

True

Problem 3 (2 points)

A teacher grades each question on an exam on a scale of -10 to +10 (inclusive, and only integers).

a) What is the minimum number of bits needed to represent the score for each question in 2's complement representation?

21 unique scores possible. Minimum 5 bits needed.

b) Assuming there are 3 questions in the exam, and each question is graded the same way mentioned above, what is the minimum number of bits needed to represent the **total** score for the exam in 2's complement representation? Explain your answer.

61 unique scores possible from -30 to +30. Minimum 6 bits needed.

Problem 4 (3 points)

4. Perform the calculations below on the following **two's complement** numbers. Show your work for full credit.

```
a)     0110001
   -    110010
  ------------
```

```
0111111 (49 - (-14) = 63)
```

```
b)        1101
   + 01011001
  -----------
 01010110 (-3 + 89 = 86)
```

c) Did an overflow error occur in (a) or (b)? State how you know.

No overflow. (a) because adding two positives results in a positive, which means no overflow occured. (b) because adding a positive and a negative can never result in overflow.

Problem 5 (4 points)
Fill in the table for the following equations given the starting values A, B, and C.

```
Q1 = (A AND B) OR NOT C
Q2 = B OR NOT(C AND B)
```

A	B	C	Q1	Q2
1001	1110	0011	1100	1111
0110	0011	1011	0110	1111

Problem 6 (3 points)
Perform the conversions below. **Show your work for full credit.**

a) Convert the decimal number -122 to 8-bit 2's complement.

1000 0110

b) Convert the 8-bit 2's complement 01101111 to decimal.

111

Problem 7 (2 points)
You have a new 8-bit fixed point binary notation. The bits will be divided as follows: 1 sign bit, 3 bits for the integer part, and 4 bits for the fractional part. xF4 is a a bit pattern for a number in our new format. What is the **decimal** equivalent? Explain your answer.
(x stands for Hexadecimal representation. Example: xA= 1010 in binary)

-1 * (7 + 0 .25) = -7.25

Problem 8 (5 points)

You are given a 8-bit binary number A = 11111111.

a) Write the decimal equivalent of A, assuming A is represented in 1's complement form.

0

b) Write the decimal equivalent of A, assuming A is represented in 2's complement form.

-1

c) What is the smallest decimal number that can be represented with an **8-bit 1's complement** number?

-127

d) What is the smallest decimal number that can be represented with an 8-bit **2's complement** number?

-128

e) How many unique numbers can be represented using 8-bit **1's complement**? Show your answer in **decimal** (exponent answers are allowed, ex: 2^5).

2^8 -1 = 255

Problem 9 (2 points)

Convert the IEEE number to decimal**:** `1 10000001 00110000000000000000000`

Show your work for full credit. Recall that the bits for the IEEE single-precision floating point number (N) are allocated as follows:

Sign (1 bit)	Exponent (8 bits)	Fraction (23 bits)

where the value N = $(-1)^{\text{sign}}$ x 1.Fraction x $2^{\text{Exponent-127}}$.

`-4.75`

Problem 10 (3 points)

a) Add the following hex values together. Your answer should be in **16-bit binary.** Show your work for full credit.

```
x3278 + xCD26

 0011 0010 0111 1000
+1100 1101 0010 0110
------------------------
 1111 1111 1001 1110
```

b) Interpret your answer from (a) as **16-bit two's complement.** What is its **decimal** equivalent? Show your work for full credit.

-98

Problem 11 (3 points)

You are given a 8-bit binary number **A** represented in 2's complement form. Your aim is to turn off the rightmost bit of **A** which is **ON** (i.e. equal to 1). For example if **A**= `0011 0110`, after turning off the rightmost **ON** bit of **A**, we get **B** = `0011 0100`. Answer the following questions:

a) Calculate the value of **A-1** (using the value of A=`0011 0110`). Express your answer in 8-bit 2's complement binary representation.

0011 0101

b) How would you obtain **B** from **A** and **A-1** using exactly one of the following logical operations: AND, OR, NOT, XOR ?

B = A & (A-1)