

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 be efficient.**
- b) An algorithm must successfully terminate.
- 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) The decimal number 5 can be represented with a 3-bit 2's complement number.

False. Using 3-bit 2's complement number, you can represent only decimal numbers from -4 to 3.

- b) Statements in assembly language can have multiple interpretations.

False. Can't be ambiguous.

- c) An assembler converts an assembly language to the corresponding ISA.

True

- d) 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.

Problem 3 (2 points)

A teacher grades each question on an exam on a scale of -11 to +11 (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? Show your work for full credit.

23 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.

65 unique scores possible from -33 to +33. Minimum 7 bits needed.

Problem 4 (3 points)

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

$$\begin{array}{r} \text{a)} \quad 0101100 \\ - \quad 101110 \\ \hline \end{array}$$

$$0111110 \ (44 - (-18)) = 62$$

$$\begin{array}{r} \text{b)} \quad 1110 \\ + \quad 01010110 \\ \hline \end{array}$$

$$01010100 \ (-2 + 86 = 84)$$

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 occurred. (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.

$$Q1 = (A \text{ AND } B) \text{ OR NOT } C$$

$$Q2 = B \text{ OR NOT } (C \text{ AND } B)$$

A	B	C	Q1	Q2
1010	1000	1001	1110	1111
0111	1011	1001	0111	1111

Problem 6 (3 points)

Perform the conversions below. **Show your work for full credit.**

- a) Convert the decimal number -127 to 8-bit 2's complement.

1000 0001

- b) Convert the 8-bit 2's complement 10101111 to decimal.

-81

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. xB2 is 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 * (3 + 0.125) = -3.125

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 2's complement form.

-1

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

0

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

-128

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

-127

- 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 10000000 11100000000000000000000**

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

-3.75

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.

$\times B3D3 + \times 4BC8$

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1011 0011 1101 0011
+0100 1011 1100 1000
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1111 1111 1001 1011

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

-101

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** = 0111 0110, after turning off the rightmost **ON** bit of **A**, we get **B** = 0111 0100. Answer the following questions:

- a) Calculate the value of **A-1** (using the value of **A**=0111 0110). Express your answer in 8-bit 2's complement binary representation.

0111 0101

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

$B = A \& (A-1)$