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## CS/ECE 252 Introduction to Computer Engineering

Fall 2018 Instructor: Adil Ibrahim

Homework 2 Deadline: 09/19/2018

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For each question below you need to show the complete working to receive full points. Please utilize the space provided under each question and upload a PDF version of your answers on canvas.

Problem 1 (12 pts)

Convert these decimal numbers to 8-bit Signed Magnitude, 1's Complement and 2's Complement binary number: (1 point for each entry)

Decimal Number	Signed Magnitude	1's Complement	2's Complement
21	00010101	10101000	60010101
126	(01111110	01111110	01111110
-3	10000011	11111100	1011111
-117	10101111	10001610	10001011

Problem 2

(2 pts)

Convert the 2's complement integer 10101010<sub>2</sub> to a decimal integer value. (Correct answer with calculation steps: 2 points; Anything else: 1 point)

$$2^{7} 2^{6} 2^{5} 2^{4} 2^{3} 2^{2} 2^{1} 2^{6}$$

1 0 1 0 1 0 1 0

two's complement 0 1 0 1 0 1 1 0

Shortcut

 $2^{6} + 2^{4} + 2^{2} + 2^{4}$ 
 $= 64 + 16 + 4 + 2$ 
 $= 86$ 
 $= -86$ 
 $= -86$ 

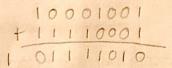
Problem 3

(9 pts)

a) Add the following 2's complement numbers together and represent the answers in 8 bits.

i. 10001001<sub>2</sub> + 110001<sub>2</sub>

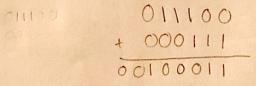
(Correct answer with calculation steps: 2 points; Anything else: 1 point)

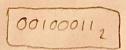


011110102

ii. 011100<sub>2</sub> + 0111<sub>2</sub>

(Correct answer with calculation steps: 2 points; Anything else: 1 point)





b) Which question in (a) creates overflow (if any)? (1 point)

the first (i) question

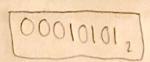
c) Why is sign-extension important when performing arithmetic with 2's complement number? (2 points)

When performing addition, both numbers must have the same amount of bits. Also, be wary of simply padding with zeroes, as this could incorrectly turn a negative number positive.

d) Solve 30 - 9 using 2's complement subtraction in 8 bits.

(Correct answer with calculation steps: 2 points; Anything else: 1 point)

$$30 = 00011110_2$$
  $30$   $00011110_2$   $9 = 00001001_2$   $-9 = 11110111_2$   $100010101_2$ 



Problem 4:

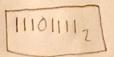
(3 pts)

Compute the following operations:

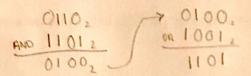
1. (NOT 10011001<sub>2</sub>) OR (NOT 01010110<sub>2</sub>) (1 point)

011001102 101010012

01100110

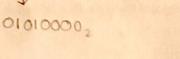


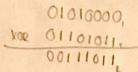
2. (01102 AND 11012) OR 10012 (1 point)

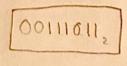


11012

3. (NOT 10101111<sub>2</sub>) XOR 01101011<sub>2</sub> (1 point)







Problem 5:

(4 pts)

Convert the following IEEE floating point number into decimal.

(Correct answer with calculation steps: 4 points; Anything else: you may get point deduction depending on the correctness and completeness of your calculation steps)

Sign 
$$A = -1$$

Exponent  $B = 10000101 = 2^7 + 2^2 + 2^0 = 128 + 4 + 1 = 133 - 127 = 6 \rightarrow 26$ 

Fraction  $C = 2^{-1} + 2^{-2} + 2^{-4} + 2^{-5} \rightarrow .5 + .25 + .0625 + .03125$ 

.5
.25

Problem 6

a) In 2's complement, how many distinct numbers can be represented using 8 bits?
(1 point)

b) What is the largest unsigned integer that may be represented using 16 bits? (1 point)

- c) Convert the following to their hex equivalent.
  - a. The decimal number 31 (1 point)

b. The ASCII string Computer (1 point)

