Name: Keith Ecker

Section: _____

Net-ID: kjecker@wisc.edu

CS/ECE 252 Introduction to Computer Engineering

Spring 2018
Instructor: Adil Ibrahim

Homework 2
Deadline: February 2nd 2018

Primary contact for this homework: Sandhya Srinivas (ssrinivas4@wisc.edu)

This Homework covers problems from chapter 2 of the textbook and is worth 44 points. For each question below you need to show the complete working to receive full points. Please utilize the space provided under each question. Please upload a PDF version on canvas.

Problem 1 **(12 pts)**

Convert these decimal numbers to 8-bit Signed Magnitude, 1's Complement and 2's Complement binary number:

Integer	Signed Magnitude	1's Complement	2's Complement
10	0000 1010	0000 1010	0000 1010
107	0110 1011	0110 1011	0110 1011
-1	1000 0001	1111 1110	1111 1111
-127	1111 1111	1000 0000	1000 0001

Problem 2 **(2 pts)**

Convert the 2's complement integer 11110011_2 to a decimal integer value.

$1111\ 0011_2 = -13_{10}$

$0000\ 1101$

-13_{10}

Problem 3 **(10 pts)**

a) Add the following 2's complement numbers together.

a. $1010_2 + 110001_2$

$$\begin{array}{r} 1111\ 1010 \\ +\ 1111\ 0001 \\ \hline 1\ 1111\ 1011 \end{array}$$

$1111\ 1010$

$1111\ 0001$

$1\ 1110\ 1011$

$1110\ 1011_2$

Overflow

b. $10011100_2 + 0101_2$

$$\begin{array}{r} 10011100 \\ 00000101 \\ \hline 10100001 \end{array}$$

$1010\ 0001_2$

c. For part (a), check your answer by translating the operands and results into decimal.

$1111\ 1010_2 = -6_{10}$

$1111\ 0001_2 = -15_{10}$

$1110\ 1011_2 = -21_{10}$

-6

-15

$-21_{10} =$

00010101

$-21_{10} = \boxed{1110\ 1011_2}$

d. Which of the above (if any) create overflow?

(a) creates overflow

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

Sign extension is important when performing arithmetic with 2's complement because we can represent numbers so they have the same amount of bits. We can only perform operations on numbers with the same amount of bits.

c) Solve for 23 – 11 using binary subtraction.

$23_{10} = 0001\ 0111_2$

$11_{10} = 0000\ 1011_2$

$-11_{10} = 1111\ 0101_2$

$23_{10} = 0001\ 0111_2$

$+(-11_{10}) = +\ 1111\ 0101_2$

$0000\ 1100$

$\boxed{0000\ 1100_2 = 12_{10}}$

Problem 4: **(2 pts)**

Compute the following operations:

1. NOT (11101100_2) OR NOT (01010001_2)

$NOT(11101100_2) = 0001\ 0011_2$
$NOT(01010001_2) = 1010\ 1110_2$
$0001\ 0011\ OR\ 1010\ 1110_2 = \boxed{1011\ 1111_2}$

2. (0011_2 AND 1001_2) AND 1111_2

$0011\ AND\ 1001 = 0001_2$
$0001\ AND\ 1111 = \boxed{0001_2}$

3. NOT (10011110_2) XOR 11110011_2

$NOT\ 10011110_2 = 0110\ 0001_2$
$0110\ 0001\ XOR\ 1111\ 0011_2 = \boxed{1001\ 0010_2}$

Problem 5: **(4 pts)**

Convert the following IEEE floating point number into decimal.

$1\ 10000011\ 10111000000000000000000_2$

$N = (-1)^1 \times 1.10111 \times 2^4$

$2^{10000011-127} \quad 131-127 \quad = 2^4 = 2^4$

-1.10111×2^4

$2^{-1} + 2^{-3} + 2^{-4} + 2^{-5}$

$\frac{1}{2} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} = \frac{23}{32} = 0.71875$

$-1.71875 \times 2^4 = -27.5$

$\boxed{-27.5}$

Problem 6 **(4 pts)**

a) In 2's complement, how many distinct numbers can be represented using 32 bits?

2^{32}

b) What is the largest unsigned integer that may be represented using 32 bits?

$2^{32} - 1$

c) Convert the following to their hex equivalent.

a. The decimal number 23

$23_{10} = 17_{16}$

16 | 23
1 7

b. The ASCII string **GOLDFISH**

G 47
O 4F
L 4C
D 44
F 46
I 49
S 53
H 48

GOLDFISH = 47 4F 4C 44 46 49 53 48$_{16}$