COMP 3350 Project #1

Possible points: 100

Due: January 28th, 2022 **11:59pm CST (Central Standard Time)**

Goals:

- Get you familiar with data representation and simple logic operations for this course.

Requirements:

- Finish the questions section below. Points for each question included in parenthesis.
- Show your work to get full credit. **ZERO** point without steps for a result.
- Please start early. **ZERO** point for late submission. After the **11:59pm** on the due day, you can't submit your assignment anymore.

Deliverables:

- Save your solutions of questions as a **pdf** document. You can use this document as worksheet.
- Name document as a "**Firstname_Lastname.pdf**".
- Submit your "**Firstname_Lastname.pdf**" through the Canvas system. You do not need to submit hard copies.

Rebuttal period:

- You will be given a period of 2 **business** days to read and respond to the comments and grades of your homework or project assignment. The TA may use this opportunity to address any concern and question you have. The TA also may ask for additional information from you regarding your homework or project.

0000 0
0001 1
0010 2
0011 3
0100 4
0101 5
0110 6
0111 7
1000 8
1001 9
1010 A 10
1011 B 11
1100 C 12
1101 D 13
1110 E 14
1111 F 15

Questions:

1. (9 points) Convert the following unsigned base 2 numbers (binary) to base 16 numbers (hexadecimal):

A. 0110 0001 1111 = $(61F)_H$
(6) (1) (F)

B. 1000 1111 1100 = $(8FC)_H$

C. 0001 0110 0100 0101 = $(1645)_H$

2. (27 points) Convert the following **binary numbers** to **base 10 numbers (decimal)**. Each time if binary numbers are represented in:

a) Signed magnitude representation.

1) 1100 1010 = $-(1\times2^6+1\times2^3+1\times2^1)=(-74)_{10}$
2) 1111 0010 = $-(1\times2^6+1\times2^5+1\times2^4+1\times2^1)=(-114)_{10}$
3) 1000 0111 = $(-7)_{10}$

b) One's complement representation.

1) 1100 1010 = 0011 0101 = $-(2^5+2^4+2^2+1)=(-53)_{10}$
2) 1111 0010 = 0000 1101 = $(-13)_{10}$
3) 1000 0111 = 0111 1000 = $(2^6+2^5+2^4+2^3)=(-120)_{10}$

c) Two's complement representation.

1) 1100 1010 = 0011 0110 = $-(2^5+2^4+2^2+2^1)=(-54)_{10}$
2) 1111 0010 = 0000 1110 = $(2^3+2^2+2^1)=(-14)_{10}$
3) 1000 0111 = 0000 1001 = $(-9)_{10}$

For example, question A, if 1100 1010 is a binary number represented in signed magnitude representation, what is the decimal value? Also do it again if 1100 1010 is a binary number in one's complement representation and two's complement representation. There are 9 separate answers in total.

3. (36 points) Convert the following **base 10 (decimal)** values to **binary numbers (8-bits)**. Each binary result represented in:

a) Signed magnitude representation.

1) -100_d = 11100100
2) -16_d = 1001 0000
3) -21_d = 1001 0101
4) -0_d = 1000 0000 ?

b) One's complement representation.

1) -100_d = 10011011
2) -16_d = 1110 1111
3) -21_d = 1110 1010

$2\overline{)100}$ 50, -10, 00; $2\overline{)50}$ 25, -4, 10, -10, 0; $2\overline{)25}$ 12, -2, 15, -14, 1; $2\overline{)12}$ 6, -12, 0; $2\overline{)6}$ 3, -6, 0; $2\overline{)3}$ 1, -2, 1; $2\overline{)1}$ 0, -0, 1

$(100)_d=(1100100)_b$

$2\overline{)21}$ 10, -2, 01; $2\overline{)10}$ 5, -10, 0; $2\overline{)5}$ 2, -4, 1; $2\overline{)2}$ 1, -2, 0; $2\overline{)1}$ 0, -0, 1

10101

4) -0_d = 11111111

c) Two's complement representation.

1) -100_d = 10011100
2) -16_d = 11110000
3) -21_d = 11101011
4) -0_d = 10000000

(There are 12 separate answers in total.)

4. (4 points) What is the range of:

A. An unsigned 7-bit number?

$0 - (2^7 - 1) = N < 127$

B. A signed 7-bit number?

$-2^6 \rightarrow 2^6 - 1$

$-64 \rightarrow 63$ $\quad -64 < N < 63$

5. (12 points) Solve following bitwise operations (∧ = AND, ∨ = OR)

e.g. 0101 ∧ 0011 = 0001

1. 1000 ∧ 1110 = 1000
2. 1000 ∨ 1110 = 1110
3. (1000 ∧ 1110) ∨ (1001 ∧ 1110)

1000 ∨ 1000

1000

1000001

11001

6. (9 points) Please demonstrate each step in the calculation of the arithmetic operation 25 - 65. (both 25 and 65 are signed decimal numbers)

11001 $\quad$ 1'1001

-1000001 $\xrightarrow{\text{convert to 2's complement}}$ +0111111

11011000

7. (3 points) Mathematically the answer in Q6 is -40d. Please verify your answer in Q6 using a conversion of 2's and decimal numbers.

(1011000)$_{\text{d 2CNS}}$

(0101000)$_d$

$2^5 + 2^3 = 40$

101000 ✓

= 40