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Comp 3350 – Dr. Li

9/4/20

COMP 3350 Project #1

Possible points: 100

Due: September 4, 2020 **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.
- Check deliverables section below. ZERO point for hand-written or scanned homework.

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 3 **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.

Questions:

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

A. 0110 0001 1111

0110 0001 1111

(0^3 + 2^2 + 2^1 + 0^0) (0^3 + 0^2 + 0^1 + 2^0) (2^3 + 2^2 + 2^1 + 2^0)

4+2 1 8+4+2+1

6 1 15

61F

B. 1000 1111 1100

1000 1111 1100

(2^3 + 0^2 + 0^1 + 0^0) (2^3 + 2^2 + 2^1 + 2^0) (2^3 + 2^2 + 0^1 + 0^0)

8 8+4+2+1 8+4

8 15 12

8FC

C. 0001 0110 0100 0101

0001 0110 0100 0101

(0^3 + 0^2 + 0^1 + 2^0) (0^3 + 2^2 + 2^1 + 0^0) (0^3 + 2^2 + 0^1 + 0^0) (0^3 + 2^2 + 0^1 + 2^0)

1 4+2 4 4+1

1 6 4 5

1645

2. (27 points) Convert the following binary numbers to base 10 numbers (decimal):

A. 1100 1010

B. 1111 0010

C. 1000 0111

Each time if binary numbers are represented in:

a) Signed magnitude representation.

b) One's complement representation.

c) Two's complement representation.

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 9 questions in total.

A.) Signed Magnitude Representation

a. 1100 1010

MSB = 1 so sign is negative

➔ 1001010

2^6 + 0^5 + 0^4 + 2^3 + 0^2 + 2^1 + 0^0

➔ -(64+8+2)

-74_d

b. 1111 0010

MSB = 1 so sign is negative

➔ 1110010

2^6 + 2^5 + 2^4 + 0^3 + 0^2 + 2^1 + 0^0

➔ -(64+32+16+2)

-114_d

c. 1000 0111

MSB = 1 so sign is negative

➔ 0000111

0^6 + 0^5 + 0^4 + 0^3 + 2^2 + 2^1 + 2^0

➔ - (1+2+4)

-7_d

B.) One's Complement

a. 1100 1010

Compliment ➔ 1011 0101

MSB = 1 so the sign is negative

➔ 0110101

0^6 + 2^5 + 2^4 + 0^3 + 2^2 + 0^1 + 2^0

➔ -(32 + 16 + 4 + 1)

-53_d

b. 1111 0010

Compliment ➔ 1000 1101

MSB = 1 so the sign is negative

➔ 0001101

0^6 + 0^5 + 0^4 + 2^3 + 2^2 + 0^1 +2^0

➔ -(8 + 4 + 1)

-13_d

c. 1000 0111

Compliment ➔ 1111 1000

MSB = 1 so the sign is negative

➔ 1111000

2^6 + 2^5 + 2^4 + 2^3 + 0^2 + 0^1 +0^0

➔ -(64 + 32 + 16 +8 + 0 + 0 + 0)

-120_d

C.) Two's Complement

a. 1100 1010

MSB = 1 so final solution will be negative.

Invert Bit ➔ 0011 0101

Add 1 ➔ 0011 0101

\+ 1

➔ 0011 0110

0^6 + 2^5 + 2^4 + 0^3 + 2^2 + 2^1 + 0^1

➔ -(32 + 16 + 4 + 2)

-54_d

b. 1111 0010

MSB = 1 so final solution will be negative

Invert Bit ➔ 0000 1101

Add 1 ➔ 0000 1101

\+ 1

➔ 0000 1110

0^6 + 0^5 + 0^4 + 2^3 + 2^2 + 2^1 + 0^0

➔ -(8 + 4 + 2)

-14_d

c. 1000 0111

MSB = 1 so final solution will be negative

Invert Bit ➔ 0111 1000

Add 1 ➔ 0111 1000

\+ 1

➔ 0111 1001

2^6 + 2^5 + 2^4 + 2^3 + 0^2 + 0^1 + 2^0

-(64 + 32 + 16 + 8 + 1)

-121_d

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

A. -100_d

B. -16_d

C. -21_d

D. -0_d

Each binary result represented in:

a) Signed magnitude representation.

b) One's complement representation.

c) Two's complement representation.

(Answer 12 questions in total.)

A.) Signed Magnitude Expression

a. -100_d

MSB = 1 because the sign for 100 is negative

➔ 2^6 + 2^5 + 0^4 + 0^3 + 2^2 + 0^1 + 0^0

➔ -(64 + 32 +4) = -100

1110 0100

b. -16_d

MSB = 1 because the sign for 16 is negative

➔ 0^6 + 0^5 + 2^4 + 0^3 + 0^2 + 0^1 + 0^0

➔ -(16)

1001 0000

c. -21_d

MSB = 1 because the sign for 21 is negative

➔ 0^6 + 0^5 + 2^4 + 0^3 + 2^2 + 0^1 + 2^0

➔ -(16 + 4 +1)

1001 0101

d. -0_d

MSB = 1 because the sign for 0 is negative

➔ 0^6 + 0^5 + 0^4 + 0^3 + 0^2 + 0^1 + 0^0

➔ -(0 + 0)

1000 0000

B.) One's Complement

a. -100_d

MSB = 1 because the sign for 100 is negative

➔ 2^6 + 2^5 + 0^4 + 0^3 + 2^2 + 0^1 + 0^0

➔ -(64 + 32 +4) = -100

1110 0100

Because One's Complement, Invert 1110 0100

➔

1001 1011

b. -16_d

MSB = 1 because the sign for 16 is negative

➔ 0^6 + 0^5 + 2^4 + 0^3 + 0^2 + 0^1 + 0^0

➔ -(16)

1001 0000

Because One's Complement, Invert 1001 0000

➔

1110 1111

c. -21$_d$

MSB = 1 because the sign for 21 is negative

➔ 0^6 + 0^5 + 2^4 + 0^3 + 2^2 + 0^1 + 2^0

➔ -(16 + 4 +1)

1001 0101

Because One's Complement, Invert 1001 0101

➔

1110 1010

d. -0$_d$

MSB = 1 because the sign for 0 is negative

➔ 0^6 + 0^5 + 0^4 + 0^3 + 0^2 + 0^1 + 0^0

➔ -(0 + 0)

1000 0000

Because One's Complement, Invert 1000 0000

➔

1111 1111

C.) Two's Complement

a. -100$_d$

MSB = 1 because the sign for 100 is negative

➔ 2^6 + 2^5 + 0^4 + 0^3 + 2^2 + 0^1 + 0^0

➔ -(64 + 32 +4) = -100

1110 0100

Subtract One bit

1110 0100

- 1

1110 0011

Because Two's Complement, Invert 1110 0100

➔

1001 1100

b. -16_d

MSB = 1 because the sign for 16 is negative

➔ 0^6 + 0^5 + 2^4 + 0^3 + 0^2 + 0^1 + 0^0

➔ -(16)

1001 0000

Subtract One bit

1001 0000

- 1

1000 1111

Because Two's Complement, Invert 1000 1111

➔

1111 0000

c. -21_d

MSB = 1 because the sign for 21 is negative

➔ 0^6 + 0^5 + 2^4 + 0^3 + 2^2 + 0^1 + 2^0

➔ -(16 + 4 +1)

1001 0101

Subtract One bit

1001 0101

- 1

1001 0100

Because Two's Complement, Invert 1001 0100

➔

1110 1011

d. -0_d

MSB = 1 because the sign for 0 is negative

➔ 0^6 + 0^5 + 0^4 + 0^3 + 0^2 + 0^1 + 0^0

➔ -(0 + 0)

1000 0000

Subtract One bit

1000 0000

- 1

➔ 0111 1111

Because Two's Complement, Invert

➔

0000 0000

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

A. An unsigned 7-bit number?
An unsigned 7-bit number ranges form 000 0000 to 111 1111 which would result in 000 0000 ➔ 0 and 111 1111➔ 127. This means that the range goes from 0 to 127.

B. A signed 7-bit number?

Signed 7 Bit number would go up to the 6^{th} power so ➔

-2^6 to (2^6 – 1)

-64 to 63

5. (12 points) Provide the answer to the following problems (∧ = AND, ∨ = OR)

1. 1000 ∧ 1110

   1000 (AND) 1110

   1000

   1110

   ➔ 1000

2. 1000∨1110

   1000 (OR) 1110

   1000

   1110

   ➔ 1110

3. (1000∧1110) ∨ (1001∧1110)

1000 (AND) 1110 (OR) 1001 (AND) 1110

1000 1001

1110 (OR) 1110

➔1000 (OR) ➔ 1000

➔ 1000

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

25 +(– 65) = -40

Signed

25 ➔ 0^6 + 0^5 +2^4 + 2^3 + 0^2 + 0^1 + 2^0 = 25 ➔ 0001 1001

-65 ➔ 2^6 + 0^5 + 0^4 + 0^3 + 0^2 + 0^1 + 2^0 = -65 ➔ 1000 0001

One's

25 ➔ 0001 1001 ➔ Invert ➔ 0110 0110 MSB = 0 because the decimal is positive

-65 ➔ 1000 0001 ➔ Invert ➔ 1111 1110 MSB = 1 because the decimal is negative

Two's

25 ➔ 0001 1001 ➔ Add 1 bit ➔ 0001 1010 ➔ Invert ➔ 0110 0101

-65 ➔ 1000 0001 ➔ Add 1 bit ➔ 1000 0010 ➔ Invert ➔ 1111 1101

25 + (-65) = -40_d

In Binary represented as

0001 1001

1000 0001

➔ 1101 1000 in Binary and -40_d in decimal

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

25 + (-65) = -40

Signed of -40_d
-40_d ➔ 0^6 + 2^5 + 0^4 + 2^3 + 0^2 + 0^1 + 0^0 ➔ 1010 1000 MSB = negative because -40 is negative

One's Complement
-40_d ➔ 1010 1000 ➔ Invert ➔ 1101 0111

Two's Complement
-40_d ➔ 1010 1000 ➔ Add 1 ➔ 1010 1001 ➔ Invert ➔ 1101 0110

The answer matches the solution in Question number 6.