CS 2110 — Quiz 1 (75 minutes)
January 27th, 2020

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This quiz is worth a total of **100 points**.

In accordance with the Georgia Institute of Technology Honor Code, I have neither given nor received aid on this quiz.

Signature: Bandhan

Binary Addition, Subtraction and Base Conversion

Put ALL scratch work in the blank areas at the bottom of each page. Any stray writing near the answer blanks affects the autograder.

Represent all binary and hexadecimal results in 8 bits unless stated otherwise, disregarding carries from the high-order bit and overflows; truncating down to 8 bits when necessary. The 0b prefix is used to denote a binary number. E.g. $0b10 = 10_2 = 2$. Spaces have been added to binary numbers for readability. **When writing a binary or hexadecimal number, do not use a negative sign (−).** Hexadecimal and binary numbers should consist of valid characters of that respective base only.

Representations of Numbers

1. Convert A to the corresponding decimal integer value using the specified representation.
   $A = 0b1101\ 1010$

   (a) Interpret A as an unsigned binary integer. What is its value in **decimal?** 234 [4]

   (b) Interpret A as a signed magnitude binary integer. What is its value in **decimal?** -90 [4]

   (c) Interpret A as a 2's complement binary integer. What is its value in **decimal?** -38 [4]

   (d) Convert A to a two digit hex integer: 0xDA [3]

128 64 32 16 8 4 2 1
1 1 0 1 1 0 1 0

1101 1010
0010 0110
32 4 2

1101 1010

216
×14
64
160
224

224
10
234

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Binary Math

2. Consider two 2's complement binary integers, $A = 0101\ 0111$ and $B = 1011\ 0100$.

   (a) Calculate **A + B**, representing the result in 2's complement binary. Does Overflow occur? [6]

   0b 0000 1011 Overflow? (yes/no) YES

   (b) Calculate **A - B**, representing the result in 2's complement binary. Does Overflow occur? [6]
   Hint: Convert the problem to addition first and then do the calculation.

   0b 1010 0011 Overflow? (yes/no) NO

Ranges

3. Answer the following questions about **8-bit 2's complement integers.**

   (a) What is the negative number with the greatest absolute value? [4]

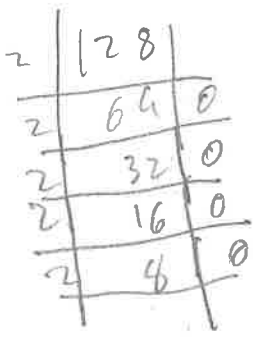
   Hex: 0x 81, Decimal: -128

   (b) What is the negative number with the smallest absolute value? [4]

   Hex: 0x FF, Decimal: -1

   (c) What is the positive number with the greatest absolute value? [4]

   Hex: 0x 7F, Decimal: 127



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IEEE-754 Floating-Point Numbers

4. Answer the following questions assuming that X, Y, and Z are IEEE-754 floating point numbers.

Function	Sign	Exponent								Mantissa																			
Bit Index	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
X	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Y	0	0	0	0	1	1	0	1	0	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	1	0	0	0
Z	0	1	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0

(a) Which of the following is true for X? [5]

○ $X = 0$ ● $X = NaN$ ○ $X = \infty$ ○ $X > 0$ AND $X != \infty$ ○ $X < 0$ AND $X != \infty$

(b) Which of the following is true for Y? [5]

○ $Y = 0$ ○ $Y = NaN$ ○ $Y = \infty$ ● $Y > 0$ AND $Y != \infty$ ○ $Y < 0$ AND $Y != \infty$

(c) Which of the following is true for numbers Y and Z? [5]

○ $Y > Z$ ○ $Y = Z$ ● $Y < Z$

Bitwise Operator

5. The following questions ask you do perform bit operations on binary and hex numbers. Please present all answers in the specified notation.
Note: The symbol ∧ denotes XOR.

(a) 0x1D6A | 0x76FB = 0x 7FFB [5]

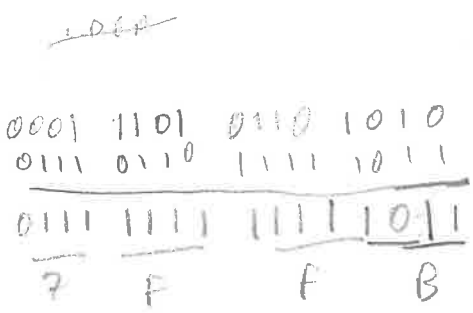
(b) 0b11011001 ∧ 0b10110101 = 0b 0110 1100 [5]

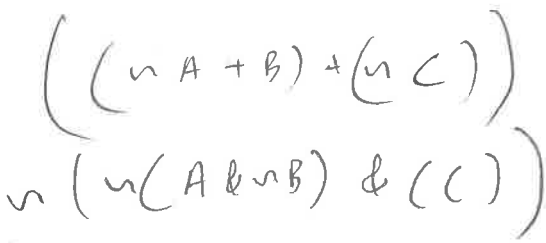
(c) 0b10101010 & ~ (1 << 5) = 0b 10001010 [5]

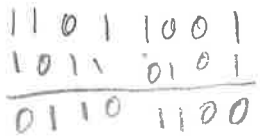
De Morgan's Law

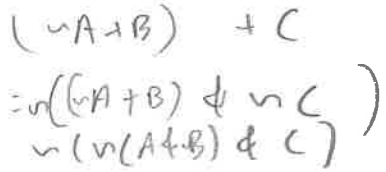
6. Write an equivalent boolean expression to $(\sim A \mid B \mid \sim C)$ using only ANDs(&) and NOTs(~). [5]

Expression: ~(~(A&~B)&C)









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Boolean Translations

7. Given the boolean expression, fill in the truth table to the right. [8]

$$Z = \sim A \,\&\, (B \mid \sim C)$$

A	B	C	Z
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

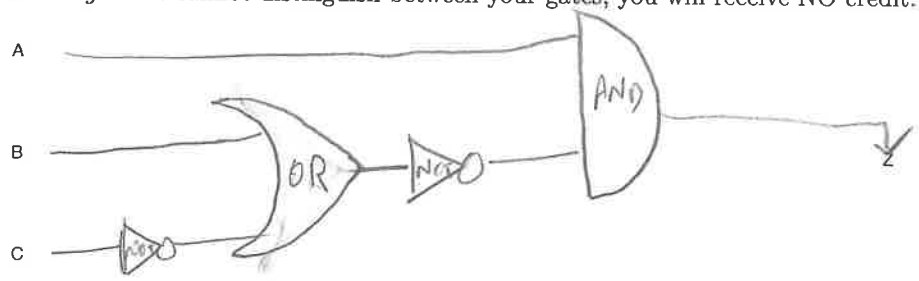
8. Consider the following boolean expression with three inputs and one output: [10]

$$Z = A \,\&\, \sim (B \mid \sim C)$$

Draw the corresponding circuit. **You are allowed (not required) to simplify the expression!**

You may use any of the following logic gates: NOT, AND, OR, XOR

Warning: If we cannot distinguish between your gates, you will receive NO credit.



9. Given the truth table below, write an equivalent boolean expression. [8]
Note: It is not necessary to fully reduce the expression.

A	B	C	S
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

Answer: $\sim(A \mid (B \wedge \sim C))$

$(A \wedge B \wedge C$

$\sim(\sim B \wedge C) \wedge A$

$(\sim A \,\&\, \sim B) \wedge C$