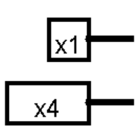
Exam 2

CS/COE 0447 Computer Organization
Fall 2018 (2191), T-Th 14:30 – 15:45

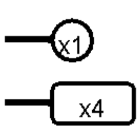
(out of 100 points)

Directions: This exam is closed book. You may use a non-programable calculator. Put all materials under your desk, including cell/smart phones, smart watches, headphones, calculators, laptops, tablets, etc. All questions are marked with their point value. There should be plenty of workspace provided in the exam booklet, but if you need extra pages, you may use blank pieces of paper.

Show work: Be sure to show all work and turn in any extra pages that you use. If you do not show your work, you may not receive full or partial credit for a correct or wrong answer. Write legibly. If your handwriting cannot be read, then you will not receive credit



Input Pin (xN means Y bit pin, e.g. x1 is 1 bit, x4 is 4 bits input)



Output Pin (xN means Y bit pin, e.g. x1 is 1 bit, x4 is 4 bits output)

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Part I (54 points)

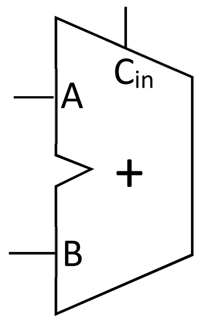
1. *4 points.* Given two n-bit numbers, how many bits are needed for their:
   a. Sum: ____
   b. Product: ____

2. *16 points.* Consider the following table. **If you cannot answer a.** use **`1000`** as the result for b.-e..
   a. Perform the **binary addition** on the right showing all the carries. Use only the white boxes.
   b. Interpret the binary addends and result as unsigned decimal numbers and write them in the **Unsigned** column. Interpret the binary numbers, do not try to do the addition correctly.
   c. Interpret the binary addends and result as signed decimal numbers and write them in the **Signed** column. Interpret the binary numbers, do not try to do the addition correctly.
   d. Was there an overflow in the **unsigned** interpretation? How can you tell?

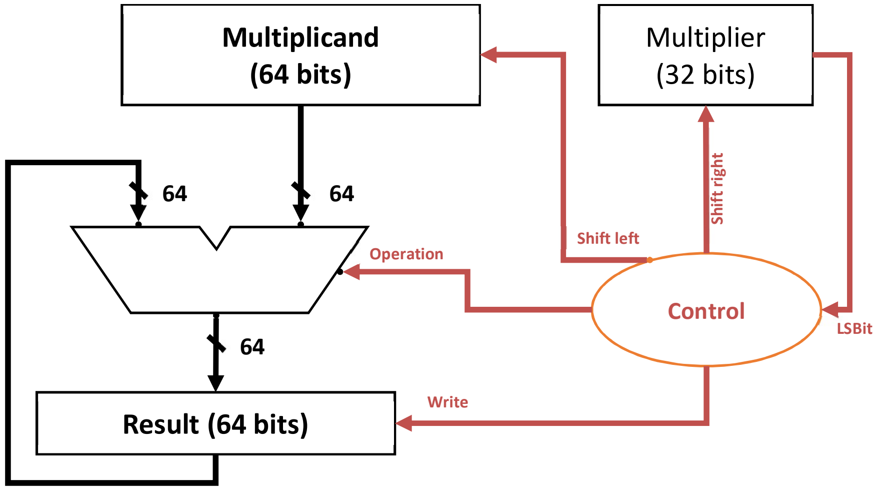
   e. Was there an overflow in the **signed** interpretation? How can you tell?

Binary	Unsigned	Signed
0 1 1 0		
+ 0 1 1 1	+	+

3. *4 points.* Consider the following diagram representing an adder. How would you modify the circuit to subtract two numbers? Draw your answer below.



4. *4 points.* The hardware below represents the **first design** of a **multiplier** we saw in lecture. List two changes you can make to improve this design.



5. *6 points.* What are the **three ways** we can respond to arithmetic overflow? **Describe each** with a few words.

6. *6 points.* This is a diagram of an IEEE754 half-precision float. The **bias** is 15! **Encode this integer** as a float into the diagram: **`0000 1101 0111 0000`.** Truncate any bits that do not fit in the fraction.

15	14				10	9									0
S	**Exponent**					**Fraction**									

7. *6 points.* Fill the following table with the mask and position of each of the bitfields that compose the floating-point number above. Write the mask in hex and leave it at position 0, do not shift it!

Field	Mask	Position
Sign	`0x`	
Exponent	`0x`	
Fraction	`0x`	

8. *2 points.* How do you **negate** a floating-point number?

9. *3 points.* Write Java/C expressions to **extract the field values.** Use the following operators:
   <</>> - shift left/right logical;
   | - bitwise-or,
   & - bitwise-and;
   ~ - bitwise not

   a. Sign = ________________________

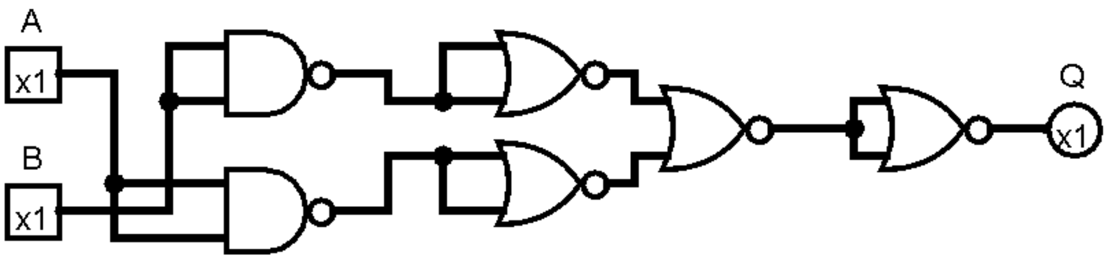
   b. Exponent = ________________________

   c. Fraction = ________________________

10. *3 points.* Write a Java/C expression to **combine** the variables **sign, exp,** and **fraction** into a single bitfield.

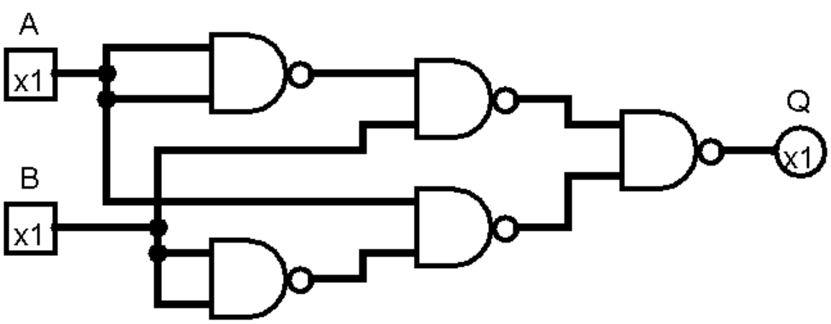
Part II (32 points)

11. *9 points.* In the following problems, **fill in the truth table** and **indicate the logical operation** that is being done. The possible choices are OR, AND, NOT, NOR, NAND, and XOR.



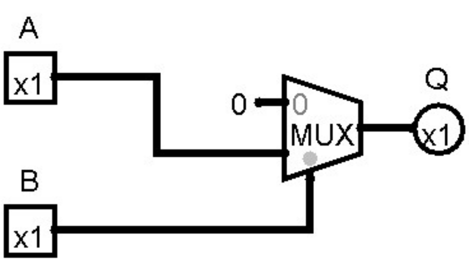
A	B	Q
0	0	
0	1	
1	0	
1	1	

Operation = ________________



A	B	Q
0	0	
0	1	
1	0	
1	1	

Operation = ________________



A	B	Q
0	0	
0	1	
1	0	
1	1	

Operation = ________________

12. *4 points.* An even parity generator circuit outputs a 1 when the number of 1s in the inputs is an odd number. Fill in the truth table below for the even parity generator function. **P** over three inputs **A**, **B**, **C**.

A	**B**	**C**	**P**
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

13. *4 points.* For the even parity function above (with 3 bits of input), which statement is true?

   a. The even parity generator function is equivalent to the **carry-out function** of a 1-bit full adder (which has inputs A, B, carry-in; and outputs sum, carry-out).

   b. The even parity generator function is equivalent to the **sum function** of a 1-bit full adder (which has inputs A, B, carry-in; and outputs sum, carry-out).

   c. The function has redundant minterms.
   d. C should always be X (don't care).

14. *4 points.* **Create a Karnaugh Map** for the parity function above. **Do NOT solve the map!** And remember, **GREY CODE!**

15. *6 points.* Consider the following Karnaugh map representing a Boolean function **Q** (both K-maps are the same, read the next question).

AB

CD	00	01	11	10
00	0	0	1	1
01	1	1	0	1
11	1	1	0	1
10	0	0	0	1

Work here!

AB

CD	00	01	11	10
00	0	0	1	1
01	1	1	0	1
11	1	1	0	1
10	0	0	0	1

Answer here!

a. Find the rectangles of 1s in the Karnaugh map above (Use the left one as your working/test area, your **final answer should be on the right**).

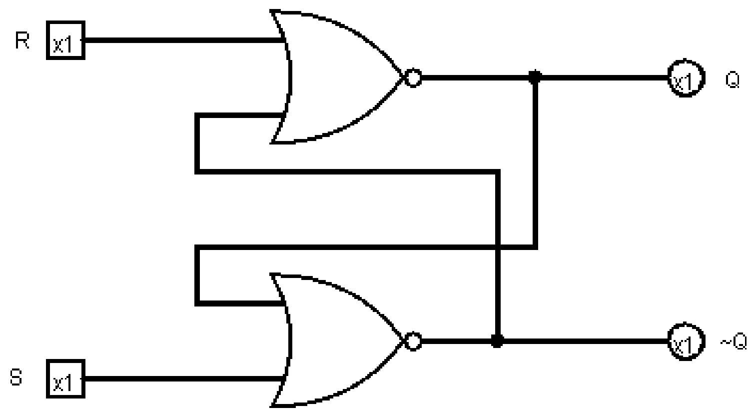
(remember: as big as possible, as few as possible, no side length of 3!)

b. Write the simplified Boolean function encoded in the Karnaugh map.

Q = ______+______+______

16. *5 points.* Draw the circuit from your equation.

Part III (14 points)



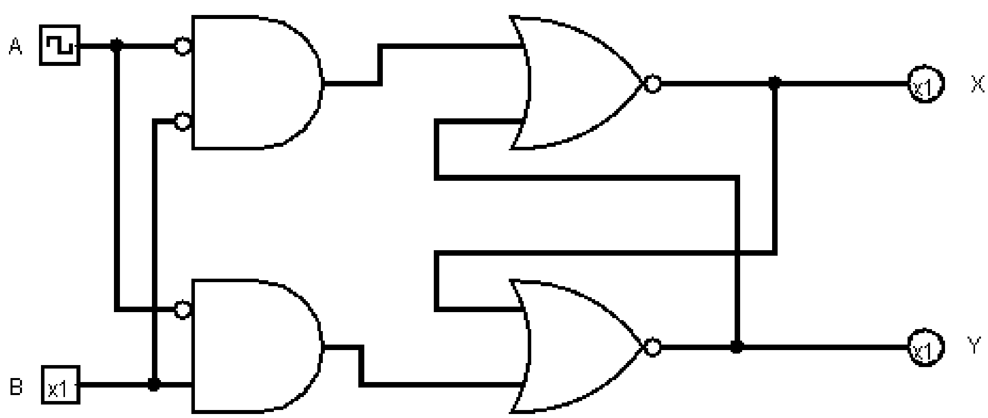
17. *4 points.* Which of the following statements apply to the figure above (circle the correct statement):

    a. All input combinations are valid.

    b. Can be used to store a single bit.

    c. Is synchronous.

    d. Is a flip-flop.



18. *6 points.* The figure above is a Latch. However, it has a **different design** than the one we analyzed in class. For the given inputs, indicate the outputs. t is the current time and t+1 is the time in the future (once the circuit stabilizes for the given inputs).

    a. Inputs are A=0, B=0, X(t)=1, Y(t)=0

       The outputs are X(t+1)=__________ Y(t+1)=__________

b. Inputs are A=1, B=1, X(t)=0, Y(t)=1

The outputs are X(t+1)=__________ Y(t+1)=__________

c. Inputs are A=0, B=1, X(t)=0, Y(t)=1

The outputs are X(t+1)=__________ Y(t+1)=__________

19. *4 points.* Which of the following statements about D Flip-flops is true? (circle the correct answer):

   a. A D Flip-flop uses less transistors than a D Latch.
   b. A D Flip-flop can be used as output and input simultaneously
   c. The D Flip-flop state transition is independent of the clock
   d. The D Flip-flop is useless.

Extra Credit

1. What is the most delicious branch instruction?

2. What software tool converts a program written in assembly language into machine instructions? ರ_ರ

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