

You are allowed to use one sheet of scrap paper. Feel free to request scrap paper from your Teaching Assistants. **Please make sure that all of your answers are contained within the answer boxes or the fill-in lines.** Do not write your work in the answer boxes, **keep all of your work on your scrap paper.** You will **NOT** be given credit for showing work. Having anything except the answer inside the boxes or above the fill-in lines reduces autograder performance and might cause incorrect results. **Make sure to write your name, username, and answers legibly. You will not receive credit for illegible answers.**

Logic Gates

1. Fill in the following truth tables.

Hint: $A \text{ XNOR } B$ is equivalent to $\text{NOT } (A \text{ XOR } B)$.

A	B	A AND B
0	0	
0	1	
1	0	
1	1	

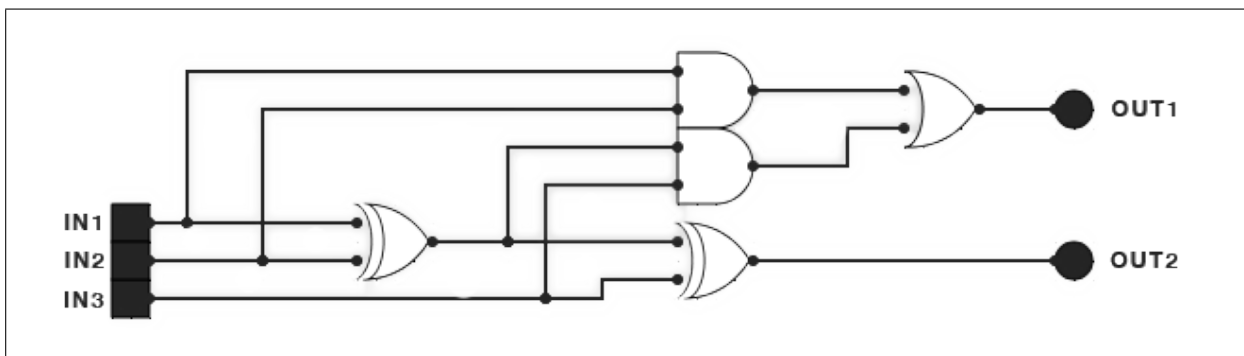
A	B	A OR B
0	0	
0	1	
1	0	
1	1	

A	B	A XNOR B
0	0	
0	1	
1	0	
1	1	

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Circuit Analysis

2. Fill in the blanks of the following truth table with respect to the circuit shown in the diagram.



IN1	IN2	IN3	OUT1	OUT2
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

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Plexers

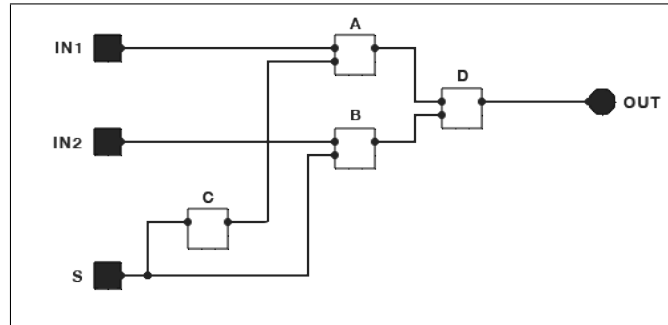
3. Answer the following questions about decoders and multiplexers.

- (a) What is the **minimum** number of select bits that a multiplexer can have if it needs to be able to select from **13** inputs? _____
- (b) What is the **maximum number of outputs** a decoder with a single 5-bit input can have? _____

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4. The diagram below represents a 2-input multiplexer, with $IN1$ and $IN2$ as its inputs, S as the select bit, and OUT as the output.



Boxes A, B, C, D each contain a single logic gate. **Answer the following questions by choosing the correct gate for each box.**

- (a) Box A: ☐ NOT ☐ AND ☐ NAND ☐ OR ☐ NOR ☐ XOR ☐ XNOR
- (b) Box B: ☐ NOT ☐ AND ☐ NAND ☐ OR ☐ NOR ☐ XOR ☐ XNOR
- (c) Box C: ☐ NOT ☐ AND ☐ NAND ☐ OR ☐ NOR ☐ XOR ☐ XNOR
- (d) Box D: ☐ NOT ☐ AND ☐ NAND ☐ OR ☐ NOR ☐ XOR ☐ XNOR

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Arithmetic Circuits

5. The diagram below represents a **4-bit full adder** with its A, B, Carry In, Carry Out and Sum pins marked.



The following diagrams contain two 4-bit inputs (marked $IN1$ and $IN2$ and an output marked OUT).

- (a) Using copies of the adder as shown above, wires, constants, and logic gates, complete the diagram below so that it represents a **4-bit subtractor** such that $OUT = IN1 - IN2$. You do not need to account for the Carry Out of the adder. Make sure that all adders have their Carry In bits connected to some input (which can be a constant). Do not attempt to make adders using logic gates - just draw adders as shown above.
- (b) You will be awarded **5 points of extra credit** if your submission includes **at most one adder and two logic gates**. It can still include as many wires and constants as you need.

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