# CS 51 Homework 1

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## Q1

The circuit should output 1 if and only if three of four inputs are 1. Some screenshots of my circuit demonstrating this behavior are shown below:
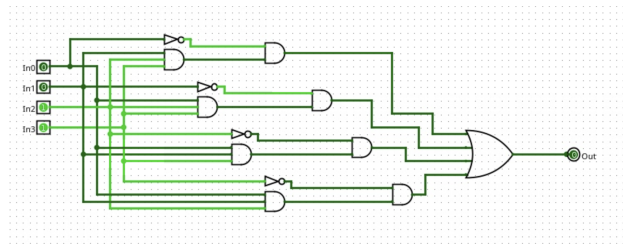


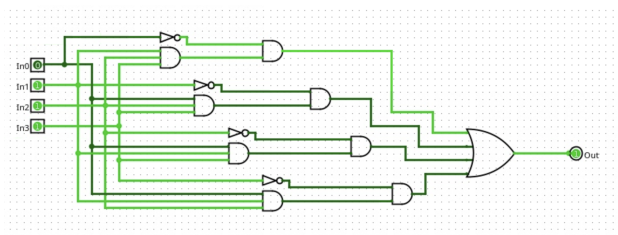Figure 1: Output should be 0 since only two inputs are 1.



Figure 2: Output is 1 when three of the four inputs are 1.

**Testing**

To test, I followed [Logisim Test Vectors][1] to create a test vector `test_q1.txt` covering all 16 possible input combinations and verified that the circuit outputs 1 when exactly three inputs are 1, 0 otherwise.
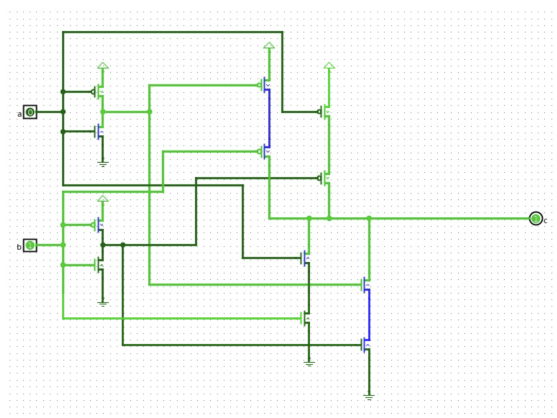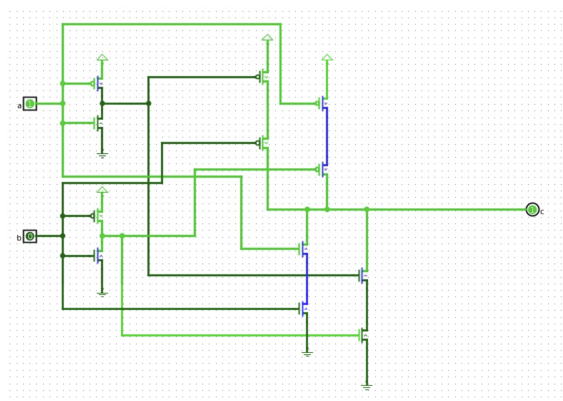
# Q2

## A

An XOR circuit should output 1 when the two inputs are different (captured by the top half of my circuit) and 0 when they are the same (bottom half of my circuit). My XOR circuit uses 12 transistors in total.
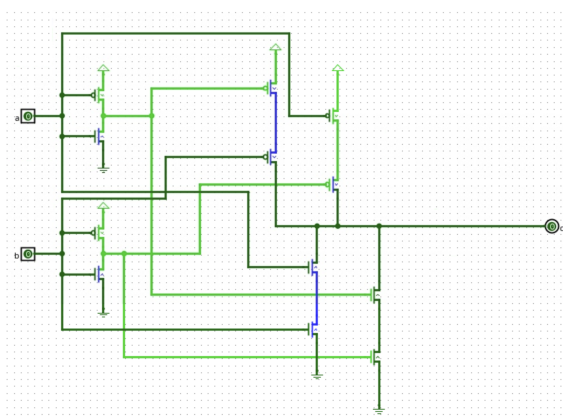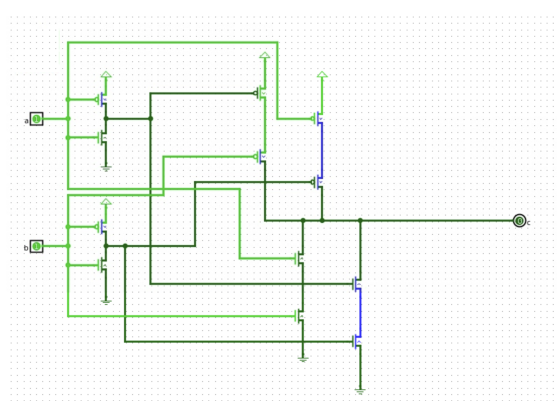


(a) $a = 0$, $b = 0$ ($c = 0$)



(b) $a = 0$, $b = 1$ ($c = 1$)



(c) $a = 1$, $b = 0$ ($c = 1$)



(d) $a = 1$, $b = 1$ ($c = 0$)

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[1] www.youtube.com/watch?v=GdDnEPFlXbI

**Testing**

As in Q1, I loaded a test vector `test_q2.txt` with the four cases shown above to confirm that the output of my XOR circuit was correct for each pair of inputs.

**B**

In class, we saw that an alternative approach to automated testing was using a counter to iterate through all possible input combinations. For Q2B, I decided decided to follow Getting started with Logisim - A Basic Counter[2] and Command-line verification[3] and hook my XOR subcircuit to a counter to demonstrate its functionality.
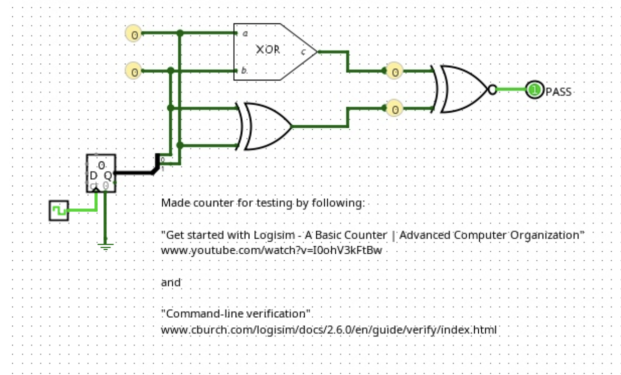


Figure 4: Sample circuit in `main` using my styled XOR circuit.

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[2] www.youtube.com/watch?v=I0ohV3kFtBw

[3] www.cburch.com/logisim/docs/2.6.0/en/guide/verify/index.html