Boolean Logic, Circuits, and Hardware Homework #7 (9 points)
Due to Gradescope by 11:45 PM on Thursday, February 13th
You need to submit a pdf to Gradescope; failure to mark which pages your questions are on will result in a 10% deduction on your grade

Homework Goal: Practice evaluating Boolean expressions, writing truth tables, following/creating circuits, and a little bit of hardware

Vocab

1. Practice your vocab from these chapters! (1.5 point)

We moved away from using vacuum tubes, and now use ________________, devices that can be ON or OFF, and have no mechanical/moving parts.

A ___________________________ is a collection of logic gates that transforms a set of binary inputs into a set of binary outputs.

_____________________________ is a word used to describe a boolean expression that is never false.

RAM stands for ___________________________________________________, which is a type of volatile/non-volatile (circle one) memory.

ROM stands for ___________________________________________________, which is a type of volatile/non-volatile (circle one) memory.

Truth Tables

2. Provide a truth table for each of the following types of gates: (0.5 point)
   a. 2-input NAND gate
   b. 2-input NOR gate
3. Provide a truth table for each of the following types of gates: (0.5 point)
   a. 3-input AND gate
   b. 3-input OR gate

4. Create a truth table for the following boolean expression: (1 point)
   \(((a \text{ NOR } b) \text{ AND } \text{NOT } c) \text{ OR } b\)

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**Boolean Logic and Circuits**

5. Assume that \(a = 5\), \(b = 7\), and \(c = 5\). What is the result of each of the following boolean expressions? (1 point)
   a. \((a > 1) \text{ OR } (b == c)\)
   b. \([(a + b) > c] \text{ AND } (b < c)\)
   c. \(\text{NOT } (a == 1)\)
   d. \(\text{NOT } [(a == b) \text{ OR } (b == c)]\)
   e. \((a == 1) \text{ AND } (b == 1) \text{ AND } (c == 2)\)
6. Given the following circuit diagram, what is the value output when the inputs are A = 1, B = 1, C = 0, D = 0, E = 0? (0.5 point)

![Circuit Diagram]

7. Write the boolean expression and create the circuit diagram for the following truth table: (1 point)

<table>
<thead>
<tr>
<th>A</th>
<th>E</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Hardware

8. What are the three components that formally define a computer? (0.5 points)

9. What are the four key subsystems of von Neumann architecture, and what is the purpose of each subsystem? (1 point)

10. If you have 131,072 bytes (128 KB) of RAM memory, then how many bits are needed to have memory addresses for every byte-addressable memory location? (0.5 points)

11. Perform the following conversions, using $2^n$: (1 point)
   (you will always use $2^n$, not $10^n$, for this class for KB, MB, GB, etc.)
   a. 32,768 bytes to KB
   b. 4,194,304 bytes to MB
   c. 4 GB to MB
   d. 524,288 KB to GB