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Homework Problem Set #4

**1. Consider the logic gate circuit shown below (5 points)**



1. (2 points) Derive a Boolean equation for the output X. **You don't need to simplify this equation, but feel free to try!**

**Equation: ~ACB~D + A~CB~D +~ACB + A~CB**

1. (3 points) Draw a truth table for the circuit.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **A** | **B** | **C** | **D** | **X** |
| **1** | **1** | **1** | **1** | **0** |
| **1** | **1** | **0** | **1** | **1** |
| **1** | **1** | **1** | **0** | **0** |
| **1** | **1** | **0** | **0** | **1** |
| **0** | **1** | **1** | **1** | **1** |
| **0** | **1** | **0** | **1** | **0** |
| **0** | **1** | **1** | **0** | **1** |
| **0** | **1** | **0** | **0** | **0** |
| **1** | **0** | **1** | **1** | **0** |
| **1** | **0** | **0** | **1** | **0** |
| **1** | **0** | **1** | **0** | **0** |
| **1** | **0** | **0** | **0** | **0** |
| **0** | **0** | **1** | **1** | **0** |
| **0** | **0** | **0** | **1** | **0** |
| **0** | **0** | **1** | **0** | **0** |
| **0** | **0** | **0** | **0** | **0** |

**2. Introduction to Logisim (3 points)**

This question will introduce you to Logisim – a graphical tool for designing and  simulating logic circuit/system

* Download the Logisim Software

             Go [http://www.cburch.com/logisim/download.html (Links to an external site.)Links to an external site.](http://www.cburch.com/logisim/download.html)

             Download Logisim from SourceForge.net.

* Go Through the Logisim Tutorial

 Visit the Logisim tutorial at: [http://www.cburch.com/logisim/docs/2.7/en/html/guide/tutorial/index.html (Links to an external site.)Links to an external site.](http://www.cburch.com/logisim/docs/2.7/en/html/guide/tutorial/index.html)

* Go to Documentation, official 2.7x
* Go to Beginner’s Tutorial
* Go through step 0: Orienting yourself
* Go through step 1: Adding Gates
* Go through step 2: Adding wires
* Go through step 3: Adding text
* Go through step 4: Testing your circuit.

After finishing all the steps, you should have a circuit file. **Save the circuit file and submit it as an individual file**!

**3. (14 points) Design a combinational circuit system.**

Design a combinational circuit with three inputs x,y,z, and three outputs A,B,C. When the binary inputs is 0,1,2,or 3, the binary output is two greater than the input. When the binary input is 4,5,6,or 7, the binary output is one less than the input.

Please answer all of the following sub-questions.

1) (3 points) x,y,z are inputs and A,B,C are outputs. Draw a truth table for the given function.op0

|  |  |
| --- | --- |
| Inputs | Outputs |
| |  |  |  | | --- | --- | --- | | X | Y | Z | | 0 | 0 | 0 | | 0 | 0 | 1 | | 0 | 1 | 0 | | 0 | 1 | 1 | | 1 | 0 | 0 | | 1 | 0 | 1 | | 1 | 1 | 0 | | 1 | 1 | 1 | | |  |  |  | | --- | --- | --- | | A | B | C | | 0 | 1 | 0 | | 0 | 1 | 1 | | 1 | 0 | 0 | | 1 | 0 | 1 | | 0 | 1 | 1 | | 1 | 0 | 0 | | 1 | 0 | 1 | | 1 | 1 | 0 | |

0,1,2,3



4,5,6,7



2) (3 points) Based on the truth table you draw, build Karnaugh maps for the output A,B,C.

**Karnaugh maps for the output A, B,C.**

For the output A

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | XY | ~XY | X~Y | ~X~Y |
| ~Z | 1 | 1 | 0 | 0 |
| Z | 1 | 1 | 1 | 0 |

For the output B

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | XY | ~X~Y | X~Y | ~XY |
| ~Z | 0 | 1 | 1 | 0 |
| Z | 1 | 1 | 0 | 0 |

For output C

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | XY | X~Y | ~XY | ~X~Y |
| ~Z | 1 | 1 | 0 | 0 |
| Z | 0 | 0 | 1 | 1 |

3) (3 points) Derive (as simple as possible) Boolean equations for A,B,C using the Karnaugh maps

Equation for output A

 = xy + ~xy + x~yz

**= y + xz**

Equation for output B

= **xy + ~x~y + ~y~z**

Equation for output C

= xy~z + x~y~z + ~xyz +~x~yz

= **x~z + ~xz**

4) (3 points) Based on the Boolean equations, draw the logical gate diagram (circuit) for this system in Logisim. **Save the circuit file and submit it as an individual file!**

5) (2 points) Test your circuit with the Logisim simulation and generate the truth table (In logisim, project-->analyze circuit-->table). **Copy & past the table in your submission**

A screenshot of a cell phone

Description automatically generated