# Homework 4 Solution

1. (5 points)
   a. (2 points) Derive a Boolean equation for the output X

$$X = \overline{\overline{B} + \overline{A \oplus C}}\ \overline{\overline{B}(B + D)}$$

**Grade guide: correct: 2; incorrect 0. It's not required to simplify this Boolean equation.**

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

**If the table is incorrect with up to 4 (or 2 for reduced table) mismatches: 2; If the table is incorrect with more than 4 mismatches: 1; no table: 0.**

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

2. (3 points) Introduction to Logisim
**Grade guide: If the circuit file is submitted and correct: 3, no file: 0**
**Either a screenshot in file or individual submitted file is OK.**

3. (14 points) Design a combinational circuit system.
1) (3 points) x, y, and z are inputs; A, B, and C are outputs. Draw a truth table for the given function.

**Grade guide: all correct 3; If the table is incorrect with up to 4 (or 2 for reduced table) mismatches: 2; If the table is incorrect with more than 4 mismatches: 1; no table: 0.**

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

2) (3 points) Based on the truth table you draw, build K-maps for the output A, B, and C.
**Grade guide: each incorrect table: -1; no table at all: 0.**

**Table for A**

| | ~Y~Z | ~YZ | YZ | Y~Z |
|---|---|---|---|---|
| ~X | | | 1 | 1 |
| X | | 1 | 1 | 1 |

**Table for B**

| | ~Y~Z | ~YZ | YZ | Y~Z |
|---|---|---|---|---|
| ~X | 1 | 1 | | |
| X | 1 | | 1 | |

**Table for C**

| | ~Y~Z | ~YZ | YZ | Y~Z |
|---|---|---|---|---|
| ~X | | 1 | 1 | |
| X | 1 | | | 1 |

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

**Grade guide: each incorrect equation: -1**

**A = Y + XZ**

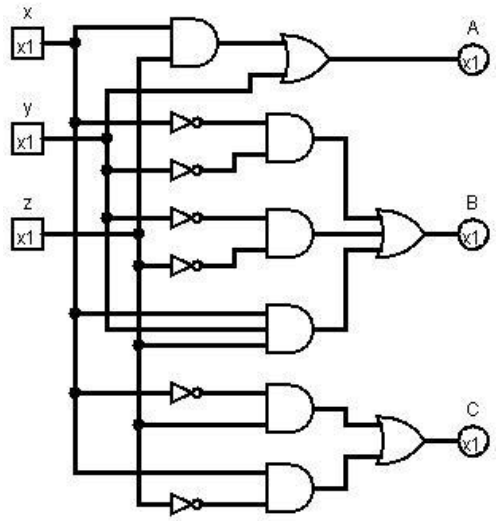
**B = ~X~Y + ~Y~Z + XYZ**

**C = ~XZ + X~Z**

4) (3 points) Based on the Boolean equations, draw the logical gate diagram (circuit) for this system in Logisim. Attach the circuit file and image.

**Grade guide: If the circuit file is submitted and correct: 3, incorrect: 1, no file: 0**

**Either a screenshot in file or individual submitted file is OK.**




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

**Grade guide: no table: 0**

| x | y | z | A | B | C |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 | 0 |