**Lab 2: Combinational Design**

**Primary Objectives**

1. Analyze and design a combinational system

2. Implement the system using the Logisim software

3. Test to verify the functionality of said system

*Objective 1 Design*

There are four inputs and two outputs in this project: A, B, C, and D for the inputs, and P (representing “pair”) and T (representing “trio”) for the outputs. The system is supposed to turn on P when exactly two of the inputs are true and turn on T when exactly three of the inputs are true.

If this system is functional, the truth table should look like this:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| A | B | C | D | P | T |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | **1** | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | **1** | 0 |
| 0 | 1 | 1 | 0 | **1** | 0 |
| 0 | 1 | 1 | 1 | 0 | **1** |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | **1** | 0 |
| 1 | 0 | 1 | 0 | **1** | 0 |
| 1 | 0 | 1 | 1 | 0 | **1** |
| 1 | 1 | 0 | 0 | **1** | 0 |
| 1 | 1 | 0 | 1 | 0 | **1** |
| 1 | 1 | 1 | 0 | 0 | **1** |
| 1 | 1 | 1 | 1 | 0 | 0 |

Table 1 Design

*Objective 2 Implementation*

Figure 1 shows one way the system could be implemented via Logisim. Each gate in this system is labeled with the part of the Boolean expression that it represents. Given that there are two outputs, the Boolean expressions that represent this circuit are P=~A~BCD+~AB~CD+~ABC~D+A~B~CD+A~BC~D+AB~C~D and T=~ABCD+A~BCD+AB~CD+ABC~D.

A diagram of a circuit

Description automatically generated

Figure 1 Implementation

*Objective 3 Testing*

Table 1 shows the actual truth table provided by the Logisim software’s combinational analysis feature. This truth table matches the predicted truth table (Table 1) perfectly. Based on this, the circuit functions as intended.

Table 1 Combinational Analysis Truth Table

A screenshot of a computer screen

Description automatically generated

**Conclusion**

The lab went smoothly with no issues. The initial table made from the problem description matches the table generated after the circuit was designed and implemented in Logisim. Therefore, the circuit was designed properly, and the lab was successful.