

LABORATORY 11

Logic Circuit Design and Simplification

In this lab, we will do some exercises with Karnaugh maps and connect a “voting” logic circuit using NAND gates. We will learn to use LogicAid, which is a computer program for logic circuit design. Finally, you will work on logic circuits for a 7–segment display driver and a heating system.

1. E–Lessons

Please study the electronic lessons in the “Exploring Engineering” program on digital logic. There are three lessons, located under “Elements” and “Logic Circuits”. The lessons are:

“Gates” — You probably know this material, but review it quickly.

“Minterms” and “Karnaugh Maps” — Like we discussed in class.

2. Majority Logic Circuit

Three partners in a small company have hired you to build a circuit that will automate their voting. Each partner owns an equal share of the company, so decisions are made by majority vote. You are to design, build, and test the circuit. Please go through the following steps.

1. Write the truth table for the circuit.
2. Write a Boolean function in the standard sum–of–products form for the circuit. Simplify the function using a Karnaugh map. Also simplify using algebraic manipulations. Can you interpret the expression?
3. Draw an implementation for the circuit using only NAND gates with 2 inputs.
4. Before you connect and test your design, let us repeat the same steps using the LogicAid computer program, which is installed on the PCs in the lab. You can enter your truth table for the majority function by choosing New under the File menu, and then choosing Truth Table on the pop–up menu. On the next menu, choose 3 variables, and change the variable names if you wish. Then enter the truth table values. To get a simplified Boolean function, choose Simplify under the Routine menu. Compare with the results that you obtained previously.
You can also input the Karnaugh map to LogicAid. Simply choose K–Map under the Input menu, specify 3 variables, change the names if you like, and fill in the 1’s in the map. Then under the K–map menu, choose Derive Minimum Equation. You can also choose Plot Map under the K–map menu to see the proper circling of 1’s in the map.
5. Finally, connect your NAND gate design for the majority function. Use the 7400 chips from your kit. Test and demonstrate your circuit for all input combinations. Use an LED for the output.