BME 328 Lab 2 – Function Implementation and Minimization

10 Marks (1 week)
Due Date: Week 4

1. Objectives

- The main objective of this lab is to introduce you to the implementation of simple logical functions using NAND gates.
- You will also design, build and test a logic function using the Karnaugh map method. Your design must use only NAND gates, and possibly some inverters. You will be given a custom set of minterms to implement.

2. Pre-Lab Preparation

Implementation of Simple Logic Functions with NAND Gates

1. Make up a truth table for a 2-input NAND gate.
2. Determine 2 ways to implement an inverter with a 2-input NAND gate.
3. Determine how to implement a 3-input NAND function using 2-input NAND gates only, and draw a schematic diagram.
4. Determine how to implement a 2-input OR function using 2-input NAND gates only, and draw a schematic diagram.
5. Implement the function $Z = f(A,B) = (A+B)\overline{AB}$ using one 2-input OR gate, one 2-input AND gate and one 2-input NAND gate.
   (a) Implement the same function using only NAND gates.
   (b) Make up a truth table for the function. What is the common name for this function?
   (c) Expand and simplify the Boolean equation to express Z as a sum of products. Implement the sum of products notation using only NAND gates. Note: It is possible to do this with 4 NAND gates and no additional inverters.

Implementation of Customized Logic Function

6. Show the unsimplified logic equation for your customized function (see next page), expressed as a sum of minterms.
7. Obtain the truth table for the function.
8. Simplify the function using K-map.
9. Convert the simplified logic equation into a NAND gate implementation. Use of stand-alone inverters is also allowed. Draw a schematic diagram for the implementation.

3. Laboratory Work

1. Construct the optimized circuit of your assigned function using NAND gates.
2. Use the outputs of the 4029 Counter from Lab1 circuit Q0, Q1, Q2, Q3 to drive the inputs of your optimized function.
3. Change the counter circuit from decade to binary.
4. Use an LED with a resistor in series, as shown in Figure 1, to show the output F of your function for all conditions.
5. Write a truth table showing how the output F changes with respect to changes in Q0, Q1, Q2, Q3.

Customized Functions

(One of the following customized functions will be assigned to you by your laboratory instructor)

1. $F1 = (2, 7, 9,12,13,14,15)$
2. $F2 = (2, 4, 5, 6,11,12,14)$
3. $F3 = (2, 5, 7, 9,13,14,15)$
4. $F4 = (0, 4, 5, 8,10,12,15)$
5. $F5 = (0, 2, 7, 8, 9,12,13)$
6. $F6 = (0, 5, 8,10,11,12,14)$
7. $F7 = (3, 6, 8, 9,10,11,13)$
8. $F8 = (1, 2, 3, 6, 7,10,13)$
9. $F9 = (1, 6, 8, 9,10,12,14)$
10. $F10 = (1, 2, 3, 6, 7,10,13)$
11. $F11 = (0, 2, 4, 5, 6, 8,15)$
12. $F12 = (2, 3, 5, 6, 7, 8,10)$
13. $F13 = (0,1, 2, 4, 6, 9,10)$

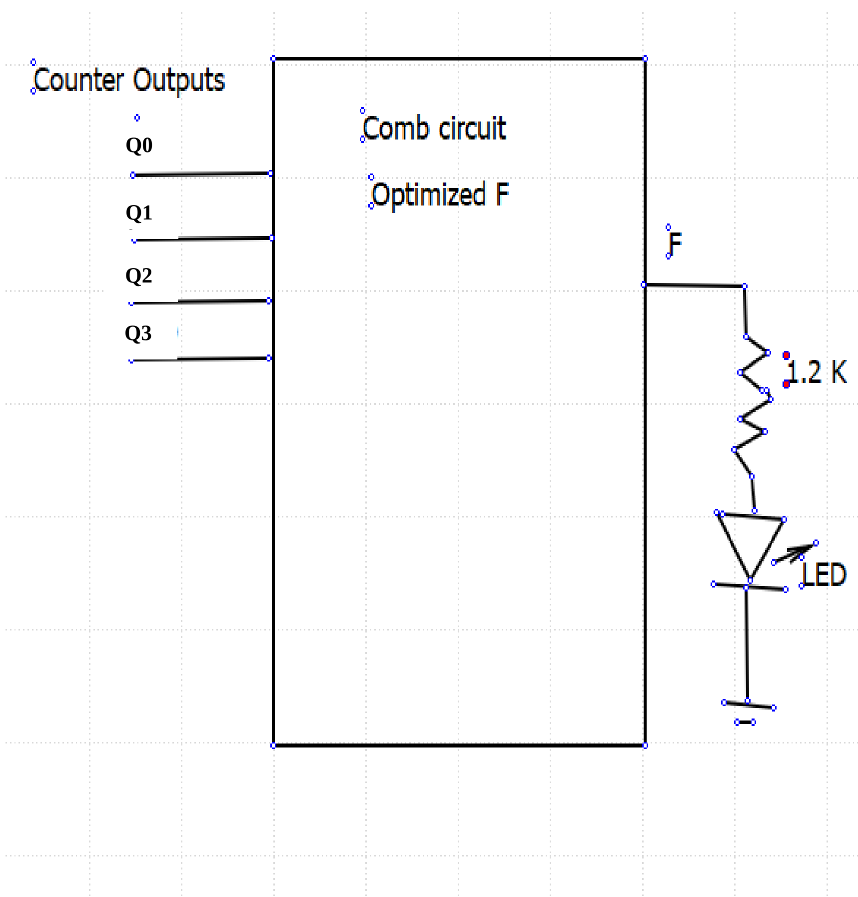

Figure 1