UNIVERSITY OF VIRGINIA
ECE 2330 DIGITAL LOGIC DESIGN
STUDIO ASSIGNMENT 1

This assignment is to be completed without any aid from anyone other than the teaching staff for this class. You may use only the class text, other materials provided to you by the teaching staff for this class, and your own class notes to complete this assignment. You must not offer or provide unauthorized aid to others taking this class. Submission of any part of this assignment represents your affirmation that you have complied with these requirements.

OBJECTIVE

This studio assignment will give you the opportunity to perform a complete combinational logic design for a four-input, two-output device. You will work with a written description of the problem to define the functions. You will then develop logic equations to realize the function and will use Boolean algebra to reduce your logic equations. You will build a simulation model of your design to verify its correctness.

PROBLEM DESCRIPTION

A bagel shop has two registers at the checkout counter, but the second one is only used when needed. If there are more than 9 people waiting in line, the second register is opened. If there are fewer than 6 people waiting in line, the second register is closed.

There is a counting system that indicates the number of people waiting in line as a 4-bit positive binary number $N = n3\ n2\ n1\ n0$. These four bits will be the inputs to your circuit. For example if there are 6 people in line, $n3$=$n0$=0, $n2$=$n1$=1, that is N=0110.

Design a circuit that will indicate two conditions. One output indicates that there more than 9 people waiting in line (telling the manager that the second register should be open). The second output indicates that there are fewer than 6 people waiting in line (telling the manager that the second register can be closed). Assume that there are never more than 15 people in line; when the line is too long customers leave in frustration.

PRE-WORK

Before reporting for your scheduled studio meeting, you are required to complete the following tasks:

1. Download *Logisim* and install it on your computer. Watch the introductory video and to learn how to use it for a simple circuit. Links to the source are posted on the class *collab* site.
2. Create a truth table for the assigned functions (there are two output functions). In addition to the standard inputs and outputs, you must label each row in the table with the integer represented by the binary input pattern of that row. (You may use the table on the next page for this if you want.)
3. Write logic equations for the two functions represented by your truth table.
4. Use Boolean algebra to reduce the logic equations so that your implementation will be easier. *Do not use Logisim to perform this step. It's important for you to learn how to manipulate the functions*.
5. Using *Logisim*, draw the logic diagram for your circuit and verify that it is correct. To verify correctness, try every possible input combination and check to see that the outputs are correct for each. There is a "skeleton" file on the collab site that you can use as a starting point.
6. Connect LED's in *Logisim* to the outputs of the circuit. The LED should be illuminated in whatever color you want when the output signal is asserted. It should be black otherwise.

IN STUDIO

Bring your completed *Logisim* file and your documented design procedure to the studio to be reviewed by your studio instructor. Be prepared to answer questions about your design and make suggested changes to demonstrate understanding.

The studio assignment may be completed before you come to the session. It will be graded on the spot. No report is needed.

n_3	n_2	n_1	n_0	Decimal	F_1 *(more than 9)*	F_2 *(fewer than 6)*
0	0	0	0	0	0	1
0	1	0	1	5	0	1
1	1	1	1	15	1	0