

UNIVERSITY OF VIRGINIA  
ECE 2330 DIGITAL LOGIC DESIGN  
STUDIO ASSIGNMENT 3

---

*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 allow you to work with different forms of a function, both in equation form and when implemented in a circuit.

#### PROBLEM DESCRIPTION

Consider the following function of four variables:

$$F(a,b,c,d) = \Pi M(1,3,6,7,9,11,12,13)$$

You will implement this function four different ways and compare the results.

#### SKELETON CIRCUIT

There is a "skeleton" circuit on the syllabus that you can use for implementing your design. It contains 4 circuits already set up – all you need to do is to complete the connections. There is also a circuit that you can use to facilitate testing.

#### PRE-WORK

Before reporting for your scheduled studio meeting, you are required to complete the following tasks, each on a separate circuit in a single *Logisim* file:

1. Reduce the function to its minimal Sum-Of-Products (SOP) form and implement it in *Logisim* using appropriately-sized AND and OR gates and inverters as needed. Use the circuit labeled "AND/OR" to implement your function. The gates that are in the circuit are the sizes that you need if you have the correct minimal form.
2. Reduce the function to its minimal Product-Of-Sums (POS) form and implement it in *Logisim* using appropriately-sized OR and AND gates and inverters as needed. Use the circuit labeled "OR/AND" to implement your function. The gates that are in the circuit are the sizes that you need if you have the correct minimal form.

3. Implement the function using a minimal number of appropriately-sized NAND gates.
4. Implement the function using a minimal number of appropriately-sized NOR gates.
5. Carefully copy and paste each of your four circuits to the last circuit so that you can see all four circuits operating at the same time. Use the copy & paste functions under the "edit" command in *Logisim*. To test the circuit, Click "Simulate-> Enabled" and then "Simulate-> Ticks Enabled" (or CTRL-K) and admire the ingenuity of this test arrangement. If you find an error (i.e. if your outputs do not match in all cases) go back to the individual circuits and fix them.

#### 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.

#### GRADE SCALE

2 points for each of the 4 circuits, which includes the design procedure and correct implementation in a logic circuit

2 points for professionalism, including the ability to describe your design approach and answer questions