DIGITAL LOGIC MINIMIZATION

ECE 221 **Fall 2003**

I. OBJECTIVE

The objective of this experiment is to investigate various design implementations of a BCD to Excess-5 converter using small scale integration (SSI) circuits. The goal to create digital circuits that involve a minimum number of gates and integrated circuits (ICs).

II. BACKGROUND

Once a digital design has been synthesized into a minimized logic expression there are a number of hardware circuits that can be created to implement the expression. Typically, logic designers try to optimize the implementation by minimizing the number of ICs used or the number of wires (literals) that must be connected. SSI ICs (AND, OR, INVERTERS, etc.) are easy to implement but may not always give you a minimized implementation. Typically there are a number of ICs needed and a number of wires that must be connected. SSI implementations may be minimized further if universal gates (NANDs, NORs) are utilized because only one gate type is used and therefore possibly fewer ICs are needed.

III. PRE-LAB

In the lab you will implement your minimized IC design of the converter created in Design Project #2. If your implementation is going to require a total of more than four chips (including inverters), you should go back and attempt to factor variables out of the SOP equations to reduce the number of gates needed. Perhaps the use of universal logic gates would also reduce the total chip count. When you have your design down to four or fewer ICs, print out the schematic, add pin numbers to the schematic and bring it to lab.

IV. PROCEDURE

1. Create the minimized implementation that you designed in problem 2 of the pre-lab. Use 4 switches as your inputs (**B3**, **B2**, **B1** and **B0**) to your circuit and 4 LEDs for outputs (**E3_IC**, **E2_IC**, **E1_IC** and **E0_IC**). Connect the switches and LED's as you did in laboratory #2, being sure to include all appropriate current-limiting resistors.

2. When the switch is open (off) the value going into the circuit is a logical '1'. When the switch is closed, the value going in is a logical '0'. Choose five different combinations to test the circuit's operation (put them in your lab notebook) and, using those combinations, verify that your circuit works properly. If you find problems with your circuit, document them in your write-up. Have the instructor or a lab assistant sign off on your design when it is working.

HINTS ON TROUBLESHOOTING YOUR DESIGN

- Check to make sure each IC has power and ground connected properly.
- Use literal analysis to work through your design and verify each pin has the correct value.
- Make sure all LED's are inserted in the circuit in the correct direction.

V. SUMMARY AND ANALYSIS

In a paragraph summarize today's lab and then answer the following questions.

1. If a design has two or more implementations that use the same number of gates, what other characteristics of the design do you want to try and minimize?

2. How can you minimize the implementation of a design that has multiple outputs? Give specifics.