CSC 258 practice lab

In this lab you will construct some addition circuits. This is a ‘‘practice lab’’; that is, it is not going to be graded. However, you should still be sure to attend. And the familiarization session is mandatory so that we don’t end up with a lot of broken equipment due to improper use.

A ‘‘half adder’’ computes the following, so as to add two one-bit numbers with a carry-out:

$$s = a \oplus b$$
$$c = ab$$

A ‘‘full adder’’ involves adding two digits (‘‘a_i’’ and ‘‘b_i’’) and a carry-in (‘‘c_{i-1}’’), using two half adders; the carry-out (‘‘c_i’’) is simply the OR of the carries from the two half adders.

In this practice lab you will build a two-bit adder using two one-bit adders. Since we will need no carry-in to the rightmost (least significant bit) adder, it can be a half adder.

Although you need not hand in a write-up (as this lab is not being graded), you should plan your implementation prior to the lab, as described in the lab notes. Actually, this practice lab is substantially shorter than the graded labs, so you can do *some* of your implementation plan during the lab time if you need help from the lab TA; but you will not complete your labs successfully if you do not draw circuit diagrams and label them with some information about chips and pins—the wiring is very difficult to read directly.

1. Construct and test the circuit for a one-bit full adder. Use input switches for the two input bits, and also one for the carry-in (which you will disconnect after testing); use output LEDs for both the sum and carry outputs. (Do not use adjacent input switches for the two inputs, because you will be expanding to two two-bit inputs shortly.) Test all eight possible input patterns and verify the output. *(When you see such an instruction in a lab handout, you should come prepared with a table of the correct output so that you can perform the verification quickly!)*

2. Construct a half adder, with two inputs from new switches, wiring its carry-out to the carry-in of the full adder. You now have a two-bit adder. Test it thoroughly (test all of the 16 possible input patterns). The three output LEDs can be construed as a three-bit sum, or the s_1 and s_0 bits can be construed as a two-bit sum and the c_1 carry as an error indication that the sum would not fit in two bits.

3. Remove the above wiring and chips. (With the power *off*!)

4. Similar to your connection of the half adder to the full adder, use two four-bit (full) adder chips (74LS283) to construct an eight-bit adder. One of the eight-bit input numbers should come from the eight input switches; the other can be hardwired to anything non-trivial, for example, 85 (01010101). Choose a few input numbers between 0 and 255, convert them to binary, enter them on the input switches, convert the sum as displayed in the LEDs back to decimal, and verify the sum.
(Again, this conversion should be performed in advance for a lab session, and you should be ready with the expected output in both binary and decimal.)