Introduction to Computer Architecture — Lab 2
A 4-bit incrementor

For this week, we will perform a slightly different kind of arithmetic operation—similar to the addition we have discussed during lectures, but a bit specialized and thus simplified. This one will later be used, in Lab 3[1], to build a fundamentally different kind of circuit. Until then, though, this circuit has a simple definition …

1 An incrementor

Specifically, you will design and implement a *4-bit binary incrementor*. There are 16 possible integers that can be formed with 4 bits, from 0 to 15 (or, in binary, from 0000 to 1111). Given that the incrementor should add 1 to each of these possible input values, we can make a table that shows each possible input value and its corresponding output value:

(original) input value	**(incremented) output value**
0	1
1	2
2	3
3	4
4	5
5	6
6	7
7	8
8	9
9	10
10	11
11	12
12	13
13	14
14	15
15	0

Notice that when the input is at its maximum possible value (15), the output "wraps around" to the minimum possible value (0).

[1] Don't click on the link right away—Lab 3 won't be available until next week.

2 A suggested approach

Here is a set of suggested steps that may help you both solve this problem and implement your solution as a circuit:

1. **Determine the output functions:** The output of your circuit should be a 4-bit number. Therefore, you have four output bits, each of whose value is determined by some Boolean logic function composed of the four inputs. Write out a truth table for the four input bits and their corresponding output bits, and then use the table to write the four output functions in disjunctive normal form.

2. **Simplify the output functions:** The output functions determined in the previous step are helpful, but likely more complex than necessary. Use Boolean algebraic transformations to simplify those functions.

3. **Draw the circuit:** Draw a circuit that computes the four simplified output functions that you developed in the previous step. You may have to draw the circuit a few times to come up with a clean layout that is easy to read.

4. **Build the circuit:** Use the switches, LEDs, chips, and wires to implement the circuit you've drawn. Be sure to leave time for debugging!

3 Submitting your work

Submitting your completed work: For this lab, demonstrate your working incrementor *on every possible input value*:

1. **Take a video:** Caputure a video of your incrementor on *all sixteen possible input patterns*. Move through the inputs in order, clearly showing the setting of the input switches and the outputs shown on the LED's for each possible input combination.

2. **Share the video:** Upload your video to your *college Google Drive account*. Then, **share the video** with me: `sfkaplan@amherst.edu`

This assignment is due Thursday, Sep-16, 11:59 pm.