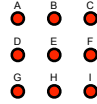# Computing Machinery II
Assignment 1

Combinational Logic: Binary-to-Nine-LED Decoder

A nine-LED display consists of nine individual LEDs that can be turned off or on in specific combinations to display particular patterns. The arrangement and labelling of the LEDS is shown below:

The following 16 display patterns correspond to the input bit patterns 0000, 0001, 0010 . . . 1111:
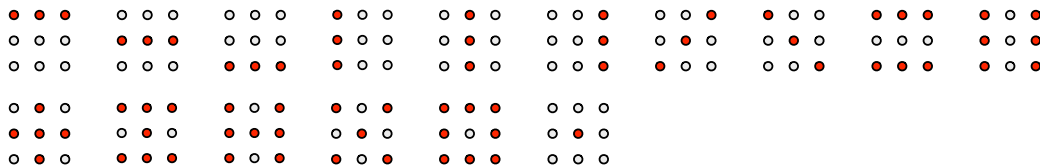
Design a combinational logic circuit that takes a 4-bit number as an input (that is, a binary number ranging from 0000 to 1111) and produces 9 outputs, one each for the 9 LEDs of the display. Assume that 0 means off and 1 means on. Use the design method outlined in class, and create a report showing all steps:

1. State the problem in words.
2. Determine the input and output variables.
3. Assign letter symbols to the variables.
4. Create the truth table that defines the relationships between inputs and outputs.
5. Obtain the simplified function for each output (show all steps for this, whether done algebraically or using the map method).
6. Implement the functions using the appropriate gates (show a logic diagram for this).

This report should be printed out and submitted on paper. Your diagrams and tables can be hand written or created using a graphics program.

Circuit Simulation

Implement your design in the *Logisim* application, using *Pins* as inputs, and 9 separate *LEDs* as outputs. Arrange the circuit so that the four inputs appear on the left, the decoder circuitry in the middle, and the display LEDs on the right. Save your design in a file called *assign1.circ*, which will be submitted electronically using D2L.

Bonus (10% if fully implemented)

Add a 4-bit counter to your *Logisim* circuit to drive the inputs of the decoder. It should cycle through the range 0000 to 1111, and then wrap around to 0000. Arrange this circuit so that the counter increments every time a button is pushed. Save this design in a file called *assign1bonus.circ*, which will be submitted electronically using D2L.

New Skills Needed for this Assignment:

- Ability to work with binary logic, Boolean algebra, and logic gates
- Ability to minimize Boolean functions, either algebraically or by using the map method
- Ability to design combinational circuits following the prescribed design procedure

Submit the following:

1. Your report on paper. Submit this using the assignment boxes located on the main floor of the Math Sciences Building (in the main floor Computer Science lab area).
2. Your *Logisim* file: *assign1.circ* (and *assign1bonus.circ* if doing the bonus) submitted using D2L.

Computing Machinery II
Assignment 1 Grading

Student:_____

Report

Statement of problem	4	_____
Input and output variables	2	_____
Assign letters to variables	2	_____
Truth table (1 point per column)	13	_____
Simplified functions (2 points per function)	18	_____
Logic diagram (2 points per function)	18	_____

Circuit simulation in Logisim (1 point per
input combination)   16   _____

Total   **73**   _____   _____**%**

Bonus (10% if fully implemented)   _____**%**

Assignment Grade   _____**%**