Systems I
Lab 4
Detecting a sequence
This assignment is due Thursday, Feb-26, 11:59 pm.

1 CircuitVerse

We will henceforth build our circuits using *CircuitVerse*, which is an online tool that you use in your browser at `circuitverse.org`. It is a *logic circuit simulator* that allows you not only to draw a circuit using gates, but also to test the circuit by simulating the values that would move through those gates. To get started with it:

1. Go to the web site. In the upper left, click the *Log In* button.

2. On the login page, you may need to verify that you are not a robot, and doing so may involve a captcha. Go ahead and do that. Then click the button to login with *Google*. Doing so will bring you to a page in which you can select your college Google account; select that, and confirm you want to login using that account.[1]

3. Once you are logged in, click on the *Launch Simulator* button.

4. Here is where the work actually happens. You will see, on the left, the ability to choose *Input* devices that provide 0 and 1 values to the circuit, *Gates* that perform the logic and can be connected to one another, and *Output* devices that display the values on selected connections in the circuit. **I will demonstrate** how to select input devices, gates, and show outputs.

5. I recommend creating some small circuit (e.g., your old half-adder) in this simulator. Then…

6. In the upper-left of the simulator window, click on the *Project* drop-down menu. Select *Save Online*. Name it (e.g., `half-adder`) and save it.

You will now have created a circuit and saved it. Later, we will see how you can submit work of this kind by sharing it with the instructor and your TA.

[1] CircuitVerse may require that you go back to the login page, enter your college email address in the email line, and then select *Google* again. It will send an email to verify your email address, which you should receive and follow that email's instructions so that you may finally login.

2 A sequence detector

We want to build a circuit that can detect whether a particular sequence of input values is being given to a sequential circuit. Specifically, for this project, we want to detect the following sequence of 1-bit values:

`0, 0, 1, 1, 0, 1`

Within CircuitVerse, create a new project and save it, naming it `lab-4-detector`. Then, create a circuit where a single switch will control the input value A, and a single button to provide the clock signal that determines when A is "entered" as the next value in the sequence. There should be a one-bit output Y that is `1` if the last six clocked values match the sequence above, and `0` otherwise.

The recommended approach is:

1. Draw the *finite state machine* that represents this problem.

2. Convert that FSM to a truth table representing the sequential logic.

3. Build the circuit that implements the sequential logic and its functions, using a ROM to store the truth table and thus implement those functions.

Making it debuggable: To see how the inputs affect the state, you should number the states of your FSM *in order of the progression through the sequence*. That is, the initially, the circuit should start in state 0; as each correct digit is entered, the state number should increment until the terminal state is reached. By numbering them in this way, you can connect the state number being emitted by the register to LED's, and track that the circuit is moving correctly through the states for any given input.

3 Submitting your work

Once you have a detector working, demonstrate the working circuit:

1. **Take a video:** Capture a video of the circuit by resetting to the initial state 0, and then moving through the following sequence of values as a test of it, resetting the circuit to state 0 before each sequence:

Input sequence	State number sequence
`1`	0
`0, 1`	1, 0
`0, 0, 0`	1, 2, 2
`0, 0, 1, 0`	1, 2, 3, 1
`0, 0, 1, 1, 1`	1, 2, 3, 4, 0
`0, 0, 1, 1, 0, 0`	1, 2, 3, 4, 5, 2
`0, 0, 1, 1, 0, 1`	1, 2, 3, 4, 5, **6** (terminal)

2. **Share the video:** Upload your video to the `lab-4` subfolder within your shared Google Drive folder for this class.

3. **Share your CircuitVerse project:**

   (a) Within CircuitVerse, in the upper right of the window, click on your own name to get a drop-down menu. Select *Dashboard*.

   (b) Your dashboard should show your `lab-4-detector` circuit. At the bottom of the pane for that circuit, click the *More* button.

   (c) A new window will open for more options of what to do with that circuit. Near the lower right, click *Add a collaborator*. A window will open in which you can enter email addresses. In that window, enter:

   - `sfkaplan@amherst.edu`, **and**…
   - `endayishimiye28@amherst.edu` for Section 01, **or**…
   - `ysantoslage28@amherst.edu` for Section 02.