EE 2740: Digital Logic

This is a first (freshman/sophomore-level) course on digital logic. The activity described here is a first try at designing a sequential circuit. It may span two-to-three 50 minute classes. The entire exercise could be broken up into several smaller assignments.

Pre-Class Assignment: Prior to the class, students will be expected to read a writeup (or view video) on an example of converting a simple 4-state, 2-input state diagram into a sequential circuit with 2 D flip-flops. This involves a first understanding of the following elements.

- Determining the structure of a state table and converting the state diagram into the state table
- Determining the number of flip-flops needed for a minimal assignment
- State assignment
- Converting a state table to a transition table
- Determining the flip-flop excitation table
- Drawing the circuit

The questions asked below will also be addressed in the pre-class reading assignment albeit in the context of a different example.

In-Class Activities: The anticipated format for each of the questions below is that of (1) posing a problem, (2) students come up with initial answers, (3) students discuss these answers within a peer group, (4) possibly try to answer the question a second time, (5) instructor discusses the question further.

Each of the questions below has an associated method of administration and an expected time to complete.

Question 1 (clicker-discuss-clicker-explain, 7 minutes):

How many rows does a state table corresponding to a state diagram with s states have?

(a) $s - 1$
(b) s
(c) $s + 1$
(d) 2^s
(e) none of the above

Question 2 (clicker-discuss-clicker-explain, 7 minutes):

How many columns are there in the state table corresponding to a state diagram with u binary input variables.

(a) $u - 1$
(b) u
(c) $u + 1$
(d) 2^u
(e) none of the above

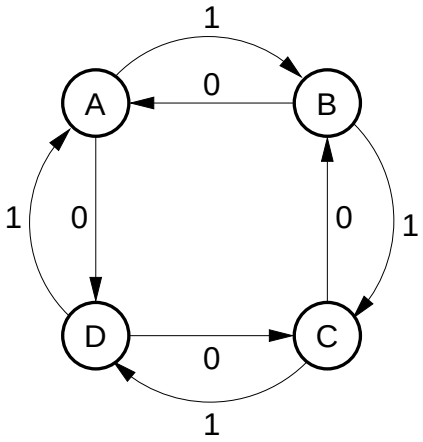
Question 3 (clicker-discuss-clicker-explain, 7 minutes):

If a state diagram has u binary input variables, then which of the following is/are true?

(a) Each state has at most u incoming edges
(b) Each state has at most u outgoing edges
(c) Each state has exactly u incoming edges
(d) Each state has exactly u outgoing edges
(e) none of the above

Question 4 (think-pair/group-report-discuss-explain, 14 minutes):

Draw the state table corresponding to the state diagram of a state machine with input variable x (shown on the right).



Question 5 (clicker-discuss-clicker-explain, 10 minutes):

If a state diagram has s states then a minimal state assignment requires

(a) s flip-flops
(b) $2s$ flip-flops
(c) 2^s flip-flops
(d) $\lceil \log_2 s \rceil$ flip-flops
(e) none of the above

Question 6 (think-pair/group-report-discuss-explain, 10 minutes): With the state assignment $A = 00$, $B = 01$, $C = 10$ and $D = 11$ draw a transition table for the state table in Question 4.

Question 7 (think-pair/group-report-discuss-explain, 15 minutes): Let Q_1Q_2 and $Q_1^*Q_2^* = D_1D_2$ be the present and next states (or excitations)

- Use the information in the transition diagram to draw a truth table that expresses D_1 in terms of Q_1, Q_2, x (where x is the input).
- Similarly draw a truth table for D_2 in terms of Q_1, Q_2, x

Question 8 (think-pair/group-report-discuss-explain, 15 minutes): Determine the excitation equations for D_1, D_2 in terms of Q_1, Q_2, x.

Question 9 (think-pair/group-report-discuss-explain, 10 minutes): Draw the logic diagram of the sequential circuit.