Homework #8
Due Tu. 11/12

Note: Do not use a calculator or computer to complete the following exercises. You must show all your work and put a box around your final answer to receive credit. Messy or unreadable submissions will receive no credit.

Homework will only be accepted at the beginning of class and all pages must be stapled together.

Total Points: 100

1. (0 points) How long did it take you to complete the homework? This will not affect your grade (unless omitted) but it helps gauge the workload for this and future semesters. If you do not answer this question you will get -5 points.
2. (8 points) More state timing diagrams
   (a) (4 points) Harris 3.4
   (b) (4 points) Harris 3.6
3. (22 points) Harris 3.22
   (a) (2 points) Description in words of state machine function
   (b) (2 points) Binary state encodings
   (c) (4 points) State transition table
   (d) (3 points) Output table
   (e) (4 points) Next state equations
   (f) (2 points) Output equation
   (g) (5 points) Schematic of FSM
4. (25 points) Harris 3.24 (Recall the clock period is 5 seconds).
   (a) (5 points) New state transition diagram
   (b) (2 points) Binary state encodings
   (c) (4 points) State transition table
   (d) (3 points) Output table
   (e) (4 points) Next state equations
   (f) (2 points) Output equation
   (g) (5 points) Schematic of FSM
5. (45 points) FSM: 1965 Ford Thunderbird Tail Lights[1]

   Design a finite state machine to control the tail lights of a 1965 Ford Thunderbird. There are three lights on each side that operate in sequence to indicate the direction of a turn. Figure 1 shows the taillights and Figure 2 shows the flashing sequence for (a) left turns and (b) right turns.

[1] Exercise derived from an example by John Wakerly's Digital Design Book.

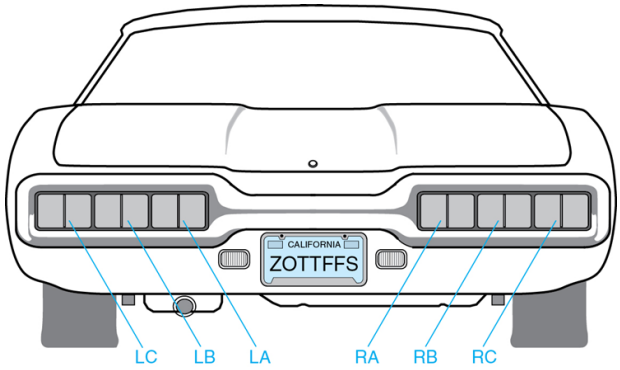

Figure 1: Thunderbird Tail Lights

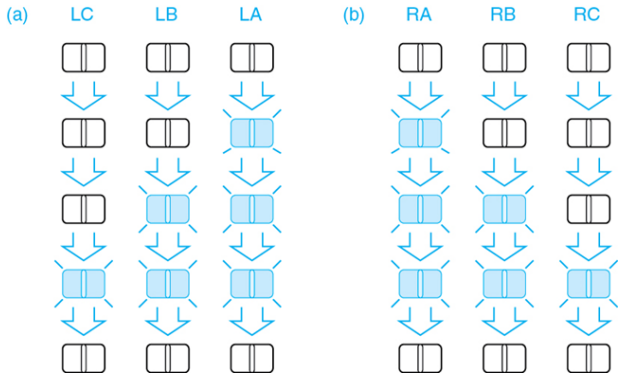

Figure 2: Flashing Sequence for T-Bird Tail Lights (a) Left Turn (b) Right Turn

Your FSM should have the following inputs and outputs:

- Inputs: $clk, reset, left, right$
- Outputs: LA, LB, LC, RA, RB, RC

where LA, LB, LC, RA, RB, RC are the lights for the left and right turn signals.

On reset, the FSM should enter a state with all lights off. When input $left$ is pressed, the flashing sequence should be LA, then LA and LB, then LA, LB, and LC, then finally all lights off again. This pattern should occur even if $left$ is released during the sequence and should continue if $left$ is still down upon return to the lights off state (the pattern should repeat. The same operation works for $right$. You can assume that exclusively one of the inputs ($left$ or $right$) can be asserted at once (i.e. only a left turn or right turn signal is on at a time).

(a) (10 points) Sketch the state transition diagram.

(b) (5 points) Define binary state encodings. **Hint**: with careful choice of encoding, your output and next state logic can be quite simple.

(c) (8 points) Give state transition and output tables.

(d) (13 points) Give the next state and output Boolean equations.

(e) (9 points) Sketch the schematic of FSM