CSEE W3827

Fundamentals of Computer Systems

Homework Assignment 3

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Due October 15, 2014 at 10:10 AM

Write your name **and UNI** on your solutions

Show your work for each problem; we are more interested in how you get the answer than whether you get the right answer.

1. (10 points) Give a schematic for a Moore machine that takes one input bit (B). A pulse of any length on B (i.e., a sequence of one or more cycles where B=1) will switch a light on or off. The light is controlled via the single output bit (L), where when L=1 the light is on and L=0 the light is off. The machine should start with the light off. This implementation should use D flip-flops.

2. (10 points) Re-implement the light controller machine from the previous problem using T flip-flop(s) instead of D flip-flop(s). A T, or “toggle” flip-flop has one input T. When T=1, the contents of the flip-flop will toggle from 0 to 1 or 1 to 0. When T=0 there is no change in the flip-flop state. Provide a schematic for the new implementation.

3. (10 points) Give a schematic for a Mealy edge-detection machine that uses D flip-flops. It takes one bit of input (X) and produces two bits of output, R and F, which are true when a rising edge and falling edge are detected on X.

4. (20 points) Give a schematic for a “countdown detector” machine that accepts a 2-bit input X (i.e., X_1,X_0) and sets the blastoff output $B = 1$ for one cycle whenever the sequence 3, 2, 1 is seen on X.

5. (25 points) Give a schematic for a sprinkler controller. The controller should emit a one bit, ON, that when true turns the sprinkler on. The controller receives three inputs

   - MIDNIGHT: pulses daily at midnight
   - SIXAM: pulses daily at 6AM
   - RAIN: is 1 if it is raining

   The controller should turn the sprinkler on between midnight and 6AM every day, unless it has rained in the 24h period before midnight. Update: If it starts raining between midnight and 6AM, the sprinkler should shut off.

6. (25 points) Give a schematic for a bidirectional gate at the entrance to a building. Its inputs are

   - P_{in} and P_{out}: sensors indicating whether there is a person on the inside/outside of the gate who would like to pass
   - K_{in}: sensor indicating that the person outside the gate has swiped a valid keycard

   And its outputs are

   - O_{out}: actuator signal to open the gate outwards (so the person on the inside can exit)
   - O_{in}: actuator signal to open the gate inwards (so the person on the outside can enter)

   The gate should open inwards when there is a person outside and a valid keycard is swiped. The gate should open outwards when there is a person inside who would like to exit. When there are people on both sides of the gate, the people exiting have priority, and the gate opens outwards until there are no more people inside trying to exit. ~~If the person is still outside, he/she can re-swipe their card and enter.~~ Update: At which point the earlier swiper on the outside is allowed to enter.