Homework 8

Homework 8 is due on Wednesday, April 15, at the start of the lecture. Remember to include your *Discussions section* (e.g. ED1) and follow the complete Homework submission guidelines.

Please ask all questions about this assignment during the office hours, or post them on piazza.

A few problems in this homework are design questions, so this homework is HARD. Therefore:

- Start early
- Come to office hours
- Elaborate your design clearly: follow the procedures we taught you in class.
- Tell us what each of your states mean in your state diagram
- Draw your circuit clearly (label DFFs, MUXs, etc)

This is not only a hard homework to do, but also a hard homework to grade. Be sure to label all states, transitions, inputs and outputs so we know what you mean. **If we cannot understand your design because it is not clearly labeled, you may not get points at all.**

FSM Analysis and Design

1. Analyzing sequential circuits

Refer to the circuit from problem 6 in Homework 7. Using the Boolean expressions from the Homework 7 solution of problem 6:

- Give the next state/output table.
- Draw the state transition diagram. Retain the S_2S_1 state labels 00, 01, 10, 11 and let S_2S_1 = 00 be the start state.
- What sequence of inputs will generate output **M=1**? Give example inputs sequence and the corresponding output sequence.

2. Down Counter

Using D flip-flops, design a 3-bit binary down-counter which counts in the following sequence: 111, 110, 101, 100, 011, 010, 001, 000, and then repeats the cycle. Follow the same steps as in the lecture notes: describe states, draw state transition diagram, fill in next-state table and derive Boolean expressions for next state, then draw circuit diagram consisting of 3 D flip-flops and the next-sate logic.

3. Counter with Control

Using D flip-flops, design a controlled 2-bit binary counter. "Controlled" means we are giving the counter external input signals to indicate how it should count. Here we have two external inputs: C and D. C=1 pauses the counter (next number is same as current number), while C=0 resumes counting; D=1 means counting up, D=0 is counting down.

C	D	Counter Behavior
1	X	Pause
0	1	Count up
0	0	Count down

Follow the same steps as in the lecture notes: describe states, draw state transition diagram, fill in next-state table and derive Boolean expressions, then draw circuit diagram.

4. Software FSM

Finite state machines also play important roles in software design, including digital control system implementation and event-driven software design (most web services, user interfaces, and a growing number of games are designed in this way) as well as parts of compilers. In this problem, you must draw a state transition diagram corresponding to an adventure game. In the game, each “room” is a state, and the input values (0, 1, or 2 for our game) correspond to transitions. Download the program dungeon.c, play the game, analyze the code, and draw a state transition diagram. Use the room number from the code to label the states, and the input value (0, 1, or 2) to label transitions between states. Note that the game ends in some of the rooms, so your diagram should not have transition arcs leaving these states.