College of Charleston
Computer Science Department

CSCI 350 Digital Logic and Computer Organization
Fall 2011
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Assignment 6 Revised: **Due October 24, 2011**

Course Outcomes Being Addressed:

11. Analyze sequential circuits by constructing state diagram/state tables.
12. Design sequential circuits using state diagrams – state tables.
13. Implement combinational and sequential using logic design kits.

Assignment Activities

1. Give below is the characteristic table for the "GP" flip-flop (it doesn't really exist; I just made it up).

G	P	Q+
0	0	0
0	1	Q
1	0	$\bar{Q}$
1	1	1

   a. Give the excitation table for this flip-flop.
   b. Implement the GP flip-flop using a D flip-flop.
   c. Implement the serial adder we developed in class so that it uses a GP flip-flop. In addition to drawing the circuit you must show the state table, K-maps and flip-flop input equations.

2. Give the flip-flop input equations for examples 2 and 3 from the last page of Chapter 1 of your notes. Their statement is given below:

   2. A *synchronous counter* is a register that changes states in accordance with a given sequence (e.g. 00, 01, 10, 11, 00, 01. etc. for a 2-bit synchronous counter; 000, 001, 010, 011, 100, 101, 110, 111, 000, etc. for a 3-bit binary counter). We illustrate the design procedure for sequential circuits by designing a 2-bit synchronous counter which changes states as above when an external input X has value 1. It leaves the state of the circuit unchanged when X = 0.

   3. A *shift register* is a register capable of shifting its binary information either to the right or left or both. For this example we shall design a 2-bit two-way shift register. The register has a single "shift control" input to enable the shift operation (0 = right, 1 = left), a serial-input going to the register to allow new binary information to enter the register one bit at a time, a serial output coming from the register so the two bits stored in the register can leave the register a bit at a time depending on how the register is shifting, and two parallel output lines - one from each flip-flop - so the information stored in the register can be inspected through all these lines at once. We also assume the shift register has a CLEAR control to asynchronously clear the register to 00.

   Use JK flip-flops for the synchronous counter, and D flip-flops for the shift register. You do not have to draw the circuit. I expect the flip-flop input equations to represent a minimal POS or SOP expression (your choice).

3. Implement a sequential circuit that has a single input value X and a single output value Z. The input data are received serially. Initially the first output value is to be the same value as the first input bit in the serial string. Afterwards output Z is to change only when 3 consecutive inputs have had the same value. Note, if there are 4 consecutive inputs X0, X1, X2 and X3 with the same value then there would be a change of output value with value X2 since X0, X1 and X2 will have the same values, and then again with the arrival of input X3 since X1, X2, and X3 will have had the same value.

   Shown below are examples of strings of input and output values, where the input sequences are to be read from left to right. The boldface highlights where output values changed and the consecutive inputs that caused thoise changes.

X: 0 0 **1 1 1** 0 1 **0 0 0 0 0 0** 1 0
Z: 0 0 0 0 **1** 1 1 1 1 **0 1 0 1** 1 1

X: **1 1 1 0 0 0** 1 **0 0 0** 1 1 0
Z: 1 1 **0** 0 0 **1** 1 1 1 **0** 0 0 0

a. Draw a state diagram and give a corresponding state table foir this sequence.
b. Give the flip-flop input equations for each flip-flop you use. Use D flip-flops.
c. Draw the circuit.

X: 0 0 **1 1 1** 0 1 **0 0 0 0 0 0** 1 0
Z: 0 0 0 0 **1** 1 1 1 1 **0 1 0 1** 1 1

4. Implement a sequential circuit that has a single input value X and a single output value Z. The input data are received serially. Initially the first output value is to be the same value as the first input bit in the serial string. Afterwards output Z is to change only when ~~2~~ consecutive inputs have had the same value. Note, if there are 4 consecutive inputs X0, X1, X2 and X3 with the same value then there would be a change of output value with value X2 since X0, X1 and X2 will have the same values, and then again with the arrival of input X3 since X1, X2, and X3 will have had the same value.

   Shown below are examples of strings of input and output values, where the input sequences are to be read from left to right. The boldface highlights where output values changed and the consecutive inputs that caused thoise changes.

   X: **1 1 1 0 0 0** 1 **0 0 0** 1 1 0
   Z: 1 0 **1** 1 0 **1** 1 0 1 **0** 0 1 1

   a. Draw a state diagram and give a corresponding state table for this sequence.
   b. Give the flip-flop input equations for each flip-flop you use. Use D flip-flops.
   c. Draw the circuit.