

## **CSEE W3827**

# Fundamentals of Computer Systems Homework Assignment 2

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Due Monday, June 12th, 2017 at 1:00 PM

Name:

Uni:

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

You may use Logisim to draw your circuits. We also suggest you use Logisim to verify them.

1. (20 pts.) A sequential circuit with two D flip-flops  $S_0$  and  $S_1$ , two inputs  $X$  and  $Y$ , and one output  $Z$  behaves according to these equations:

$$S'_0 = X\bar{Y} + XS_0 \quad S'_1 = X\bar{S}_1 + XS_0 \quad Z = \bar{X}S_0$$

- Draw the corresponding circuit. Label each of the signals mentioned above.
- Derive the state table (next state and output as a function of present state and input).
- Draw the corresponding bubble-and-arc diagram.

2. (20 pts.) Determine the logic for a synchronous 4-bit counter that counts 0,1,2,... 9,10,11,0,1,... in binary. It should have four outputs  $Q_1, Q_2, Q_4, Q_8$ , (the subscripts indicate the value of each bit) each driven directly by a flip-flop.

Write Boolean expressions of the form  $D_i = Q_i \oplus (\dots)$  for each flip-flop's input. ( $\oplus$  is XOR). Implement your circuit in Logisim to verify it and include a schematic.

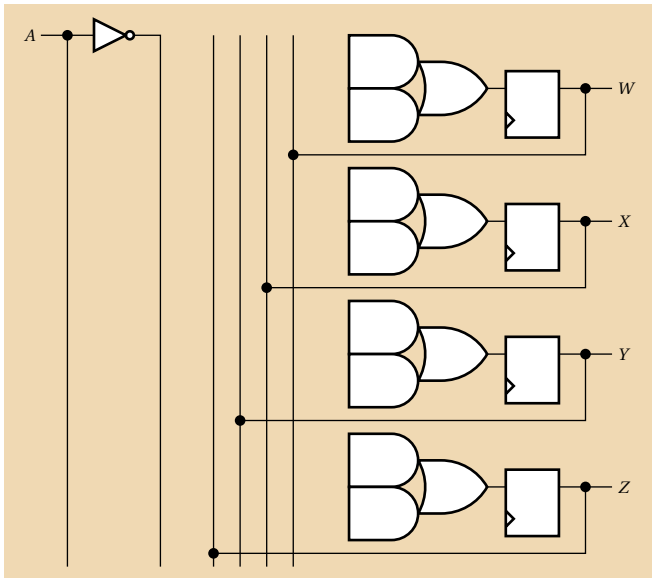
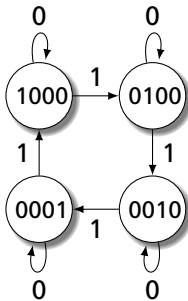
$$D_8 = Q_8 \oplus$$

$$D_4 = Q_4 \oplus$$

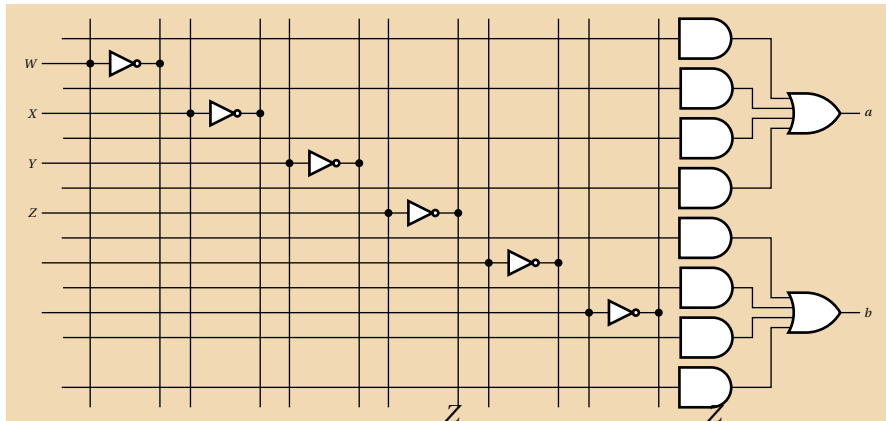
$$D_2 = Q_2 \oplus$$

$$D_1 = Q_1 \oplus$$

3. (20 pts.) Add wires to the inputs of the AND gates to implement the following Moore state machine. Assume it resets to the "1000" state.



4. (20 pts.) Use the PLA below to implement a decoder for the "a" and "b" segments of a seven-segment display. Indicate connections with an "X."



The segment functions:

$$\begin{array}{c}
 a \\
 \left. \begin{array}{c}
 1 \ 0 \ 1 \ 1 \\
 0 \ 1 \ 1 \ 1 \\
 X \ X \ 0 \ X \\
 1 \ 1 \ X \ X
 \end{array} \right\} \begin{array}{c}
 Z \\
 W \\
 Y
 \end{array}
 \end{array}$$

$$\begin{array}{c}
 b \\
 \left. \begin{array}{c}
 1 \ 1 \ 1 \ 1 \\
 1 \ 0 \ 1 \ 0 \\
 X \ X \ 0 \ X \\
 1 \ 1 \ X \ X
 \end{array} \right\} \begin{array}{c}
 Z \\
 W \\
 Y
 \end{array}
 \end{array}$$

5. (20 pts.) The circuit below is called a linear-feedback shift register. Fill in the bubble-and-arc diagram representing its behavior. Start from both the  $ABC = 000$  and  $ABC = 100$  states.

