

## HW6 Solutions ECE2060 Sp 2018

**Lectures Covered: Lessons 24 to 27**

Show all relevant steps. Don't just write down the answers.

**Late HWs will not be accepted.** Lecture Students: turn in your HW in class. Recitation students: turn in your HW at the ECE Office Front Desk. **HWs turned-in anywhere else will not be accepted.**

Show your work on these pages, attach additional pages if necessary.

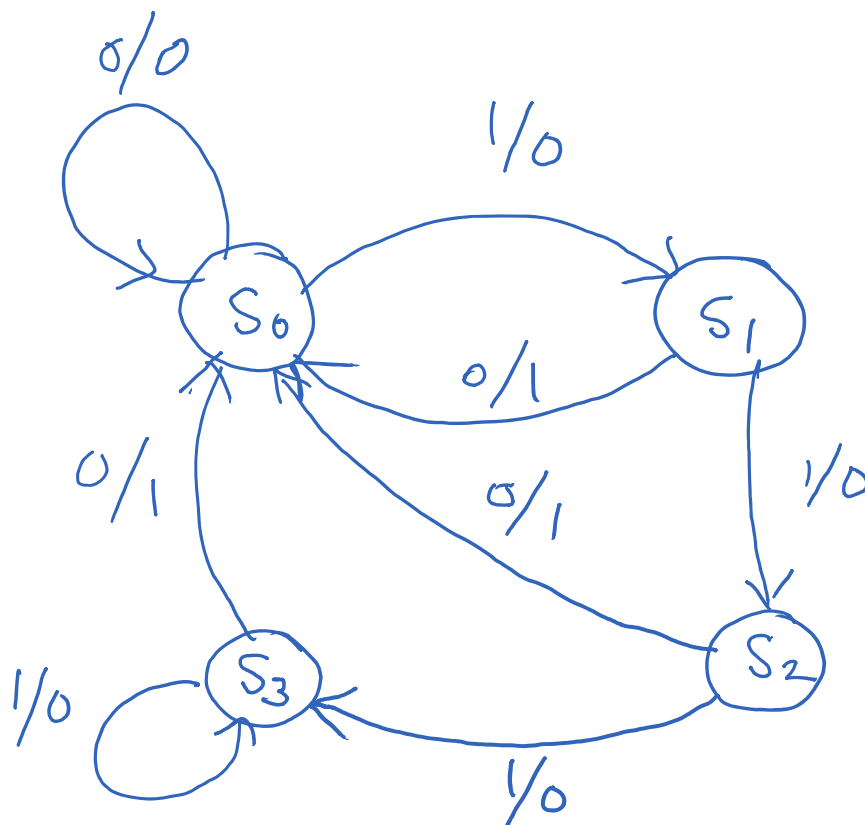
- Be sure to organize the pages **in order** and **staple** them all together, **otherwise you will lose one point**
- Fill out the following section. **You will lose an additional point if you fail to provide these details**

Your Last Name \_\_\_\_\_ Your First Name \_\_\_\_\_

1. Lecture Student \_\_\_\_\_ or Recitation Student \_\_\_\_\_ (check one)
2. If Recitation then fill out the following  
Name of recitation instruction \_\_\_\_\_ Date/time of recitation \_\_\_\_\_

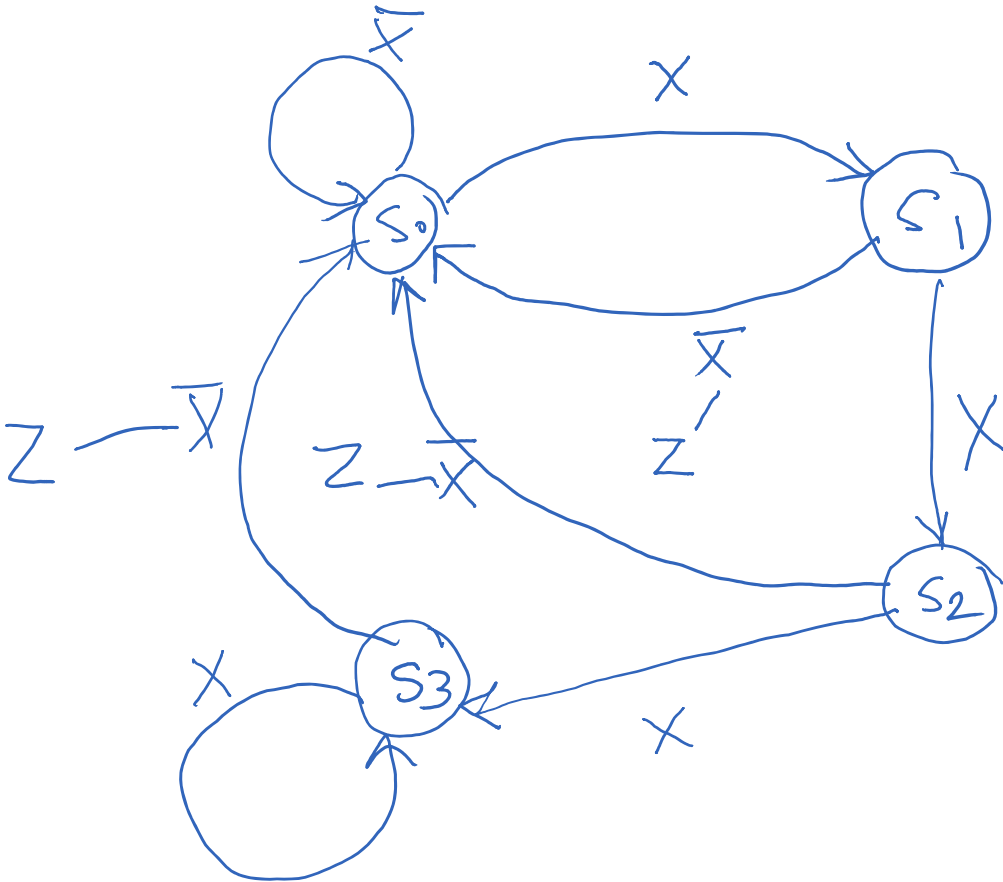
Problem starts on next page. There is only one problem worth 10 points.

- 1) **10 Points:** Based on the problem solved in Screencast32, design a circuit using the State Machine Diagrams given below using four T-Flip Flops which implements the State Diagram given below. Go through the whole design process: i) Convert the State Diagram to a State Machine Diagram ii) Determine the State machine Table iii) Determine the Flip Flop input equations and the output equations and iv) finally draw the circuit. You do not have to simplify the equations so no need for K-maps.



Most of this problem was solved in the lecture (screencast 23)

1) Continued ...



1) Continued ...

State	state code	TC	Next State	Next State Code	Non output
$S_0$	1000	$\bar{X}$	$S_0^+$	1000	
$S_0$	1000	X	$S_1^+$	0100	
$S_1$	0100	$\bar{X}$	$S_0^+$	1000	Z
$S_1$	0100	X	$S_2^+$	0010	
$S_2$	0010	X	$S_3^+$	0001	
$S_2$	0010	$\bar{X}$	$S_0^+$	1000	Z
$S_3$	0001	X	$S_3^+$	0001	
$S_3$	0001	$\bar{X}$	$S_0^+$	1000	Z

$$\begin{aligned}
 S_0^+ &= S_0 \cdot \bar{X} + S_1 \cdot X + S_2 \cdot \bar{X} + S_3 \cdot \bar{X} \\
 &= \underbrace{(S_0 + S_1 + S_2 + S_3)}_1 \cdot \bar{X} = \bar{X}
 \end{aligned}$$

$$S_1^+ = S_0 \cdot X$$

1) Continued ...

$$S_2^+ = S_1 \cdot X$$

$$S_3^+ = S_2 \cdot X + S_3 \cdot X = (S_2 + S_3)X$$

output

$$Z = S_1 \cdot \bar{X} + S_2 \cdot \bar{X} + S_3 \cdot \bar{X} = (S_1 + S_2 + S_3) \cdot \bar{X}$$

$$Z = (S_1 + S_2 + S_3) \bar{X}$$

For a T flip flop

$$Q^+ = Q \oplus T_Q$$

from this we can get (as derived in the lecture)

$$T_Q = Q \oplus Q^+$$

1) Continued ...

$$T_{S_0} = S_0 \oplus S_0^+ = S_0 \oplus \bar{X}$$

$$T_{S_1} = S_1 \oplus S_1^+ = S_1 \oplus (S_0 \cdot X)$$

$$T_{S_2} = S_2 \oplus S_2^+ = S_2 \oplus (S_1 \cdot X)$$

$$T_{S_3} = S_3 \oplus S_3^+ = S_3 \oplus (S_2 + S_3) \cdot X$$

