EEC180A DIGITAL SYSTEMS I Winter, 2006.

Solutions for Homework # 7

13.2 Notice that this is a shift register. At each falling clock edge, Q_3 takes on the value Q_2 had right before the clock edge, Q_2 takes on the value Q_1 had right before the clock edge, and Q_1 takes on the value X had right before the clock edge. For example, if the initial state is 000 and the input sequence is $X = 1100$, the state sequence is = 100, 110, 011, 001, and the output sequence is $Z = (0)0011$. Z is always Q_3, which does not depend on the present value of X. So it's a Moore machine. *See FLD p. 653 for the state graph.*

13.3 (a) $A^+ = AK_A' + A'J_A = A(B' + X) + A'(BX' + B'X)$
$B^+ = B'J_B + BK_B' = AB'X + B(A' + X')$
$Z = AB$

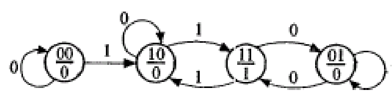
A+

AB \ X	0	1
00	0	1
01	1	0
11	0	1
10	1	1

B+

AB \ X	0	1
00	0	0
01	1	1
11	1	0
10	0	1

Present State	Next State (A^+B^+)		Z
AB	$X=0$	$X=1$	
00	00	10	0
01	11	01	0
11	01	10	1
10	10	11	0



13.3 (b)

$X =$		0	1	1	0	0
$AB =$	00	00	10	11	01	11
$Z =$	(0)	0	0	1	0	1

13.3 (c) *See FLD p. 653 for solution.*

13.7 (a) Notice that Z depends on the input X, so this is a Mealy machine.
$Q_1^+ = J_1Q_1' + K_1'Q_1 = XQ_1'Q_2 + X'Q_1$
$Q_2^+ = J_2Q_2' + K_2'Q_2 = XQ_1'Q_2' + X'Q_2$
$Z = Q_2 \oplus X = XQ_2' + X'Q_2$

Q1+

Q1 Q2 \ X	0	1
00	0	0
01	0	1
11	1	0
10	1	0

Q2+

Q1 Q2 \ X	0	1
00	0	1
01	1	0
11	1	0
10	0	0

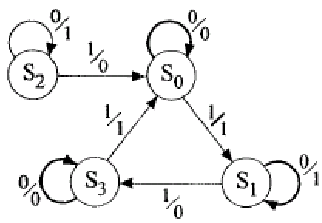
Z

Q1 Q2 \ X	0	1
00	0	1
01	1	0
11	1	0
10	0	1

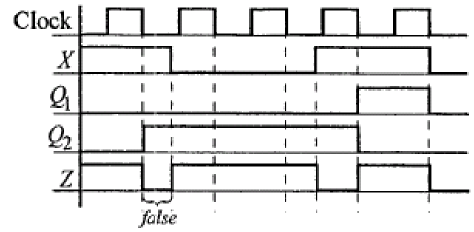
State	Present State	Next State ($Q_1^+Q_2^+$)		Z	
	Q_1Q_2	$X=0$	$X=1$	$X=0$	$X=1$
S_0	00	00	01	0	1
S_1	01	01	10	1	0
S_2	11	11	00	1	0
S_3	10	10	00	0	1

Alternate solution: Swap states S_2 and S_3.

13.7 (a) (contd)



13.7 (b)



13.8 (a) Notice that Z does not depend on this input X, so this is a Moore machine.

$Q_1^+ = X_1X_2Q_1 + Q_1Q_2 + X_1Q_2$
$Q_2^+ = Q_1'(X_1 + X_2) + Q_2(X_1' + X_2') = X_1Q_1' + X_2Q_1' + X_1'Q_2 + X_2'Q_2$
$Z = Q_1Q_2'$

Q1 Q2 \ X1 X2	00	01	11	10
00	0	0	0	0
01	0	0	1	1
11	1	1	1	1
10	0	0	1	0

Q1+

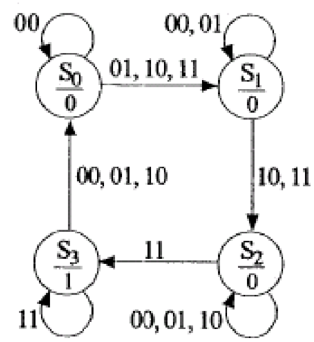
Q1 Q2 \ X1 X2	00	01	11	10
00	0	1	1	1
01	1	1	1	1
11	1	1	0	1
10	0	0	0	0

Q2+

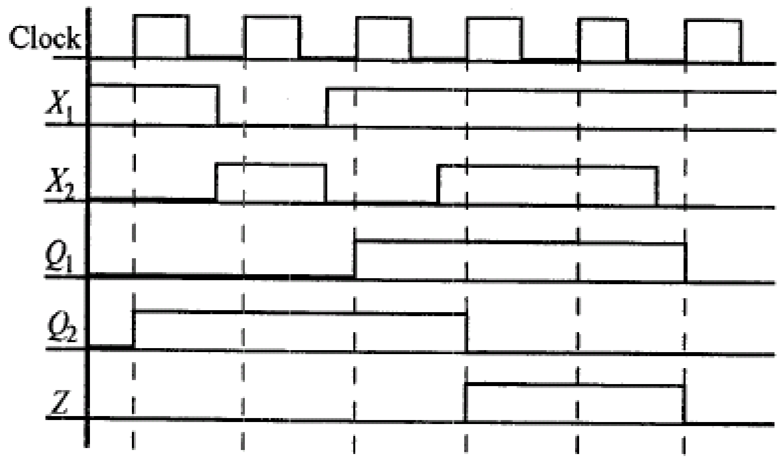
Q2 \ Q1	0	1
0	0	1
1	0	0

Z

State	Present State	Next State X_1X_2				Z
	Q_1Q_2	00	01	11	10	
S_0	00	00	01	01	01	0
S_1	01	01	01	11	11	0
S_2	11	11	11	10	11	0
S_3	10	00	00	10	00	1



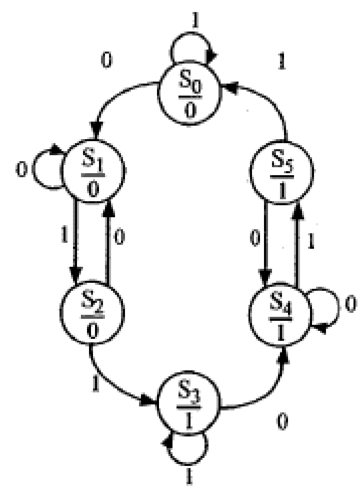
13.8 (b)



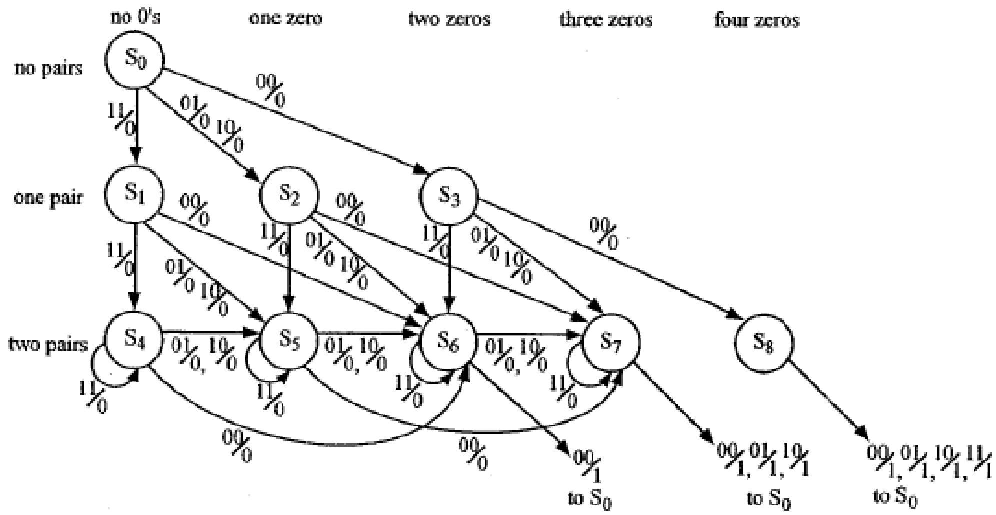
Correct output: $Z = 0, 0, 0, 1, 1, 0$

14.17 There are two identical parts: one with an output of 0 and one with an output of 1.

State	Meaning
S_1, S_4	Previous input was 0
S_2, S_5	Previous inputs were 01
S_3, S_0	Previous input was 1 / Reset (S_0)



14.19 This is another problem similar to 14.10. Plot the number of 0's horizontally and the number of pairs vertically:



Pairs	0's	Present State	Next State 00	01	10	11	Z_1Z_2 00	01	10	11
0	0	S_0	S_3	S_2	S_2	S_1	0	0	0	0
1	0	S_1	S_6	S_5	S_5	S_4	0	0	0	0
1	1	S_2	S_7	S_6	S_6	S_5	0	0	0	0
1	2	S_3	S_8	S_7	S_7	S_6	0	0	0	0
2	0	S_4	S_6	S_5	S_5	S_4	0	0	0	0
2	1	S_5	S_7	S_6	S_6	S_5	0	0	0	0
2	2	S_6	S_0	S_7	S_7	S_6	1	0	0	0
2	3	S_7	S_0	S_0	S_0	S_7	1	1	1	0
2	4	S_8	S_0	S_0	S_0	S_0	1	1	1	1

Note: There is a seven-state solution.

14.23 Example: $X = 0\,0\,1\,1\,0\,0\,1\,1\,0\,1\,0\,1$

$Z = 0\,0\,1\,1\,1\,0\,1\,1\,1\,1\,0\,1$

Note: Overlapping sequences are allowed.

State	Meaning
S_0	No sequence
S_1	0
S_2	00
S_3	001
S_4	0011

State	Next State $X=0$	Next State $X=1$	Z $X=0$	Z $X=1$
S_0	S_1	S_0	0	1
S_1	S_2	S_0	0	1
S_2	S_2	S_3	0	1
S_3	S_1	S_4	0	1
S_4	S_1	S_0	1	1