Homework 9 Solutions

(A) Put amplifiers at the feedback loops of Q_1 and Q_2 and call the signals y_1 and y_2.

Excitation Functions:

$$S_1 = X_2 y_2, \quad R_1 = X_1 y_2, \quad S_2 = X_2 \bar{y}_1 + X_1 y_1, \quad R_2 = X_1 + X_2$$

So the transition table is

y_1y_2 \ X_1X_2	00	01	11	10
00	(00)	01	01	(00)
01	(01)	11	11	00
11	(11)	10	(11)	01
10	(10)	(10)	11	11

Y_1Y_2

→ state table

S \ X_1X_2	00	01	11	10
1	(1)	2	2	(1)
2	(2)	3	3	1
3	(3)	4	(3)	2
4	(4)	(4)	3	3

S

So the flow table is

S \ X_1X_2	00	01	11	10
1	(1)	4	3	(1)
2	(2)	4	3	1
3	(3)	4	(3)	1
4	(4)	(4)	3	1

S

(B) One such flow table that contains an essential hazard is :

S_2R $(S_1=0)$

S	00	01	11	10
1	(1)	1	(1)	2
2	(2)	1	1	(2)
3	(3)	4	4	(3)
4	(4)	(4)	(4)	3
5	(5)	4	4	3

S

S_2R $(S_1=1)$

S	00	01	11	10
1	(1)	(1)	(1)	(1)
2	(2)	3	3	(2)
3	(3)	(3)	(3)	(3)
4	(4)	1	1	(4)
5	(5)	(5)	(5)	(5)

S

In this flow-table, an essential hazard exists when $S_2=0$, $R=1$, and internal state 3, and S_1 changes from 0 to 1.

If S_1 changes from 0 to 1 once, it ends up in state 3. If S_1 changes two more times, the machine ends up in state 4 which is different than 3.

Hence it is an essential hazard.

(C)

Excitation equations:

$J_1 = XQ_2$
$K_1 = X'Q_2'$
$J_2 = X'Q_1$
$K2 = XQ_1'$
$Z = XQ_1'$

Transition table:

Q1Q2	X = 0	X = 1
00	00	00
01	01	10
11	11	11
10	01	10

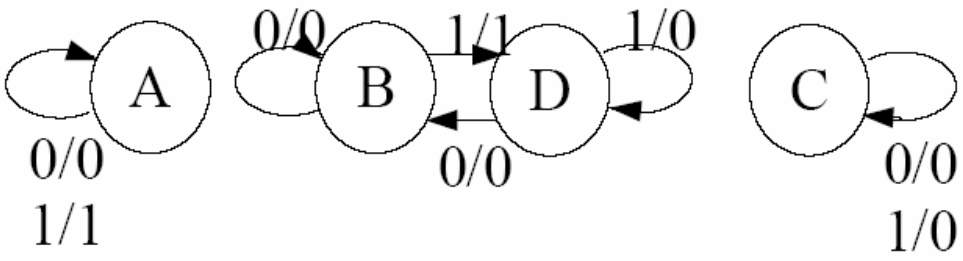
Q1+Q2+

State/Output table:

s	X = 0	X = 1
A 00	A,0	A,1
B 01	B,0	D,1
C 11	C,0	C,0
D 10	B,0	D,0

S

State/Output diagram:



(D)

Partitioning according to their outputs we get the following grouping:

0110 – [1, 3, 4]
1011 – [2, 6, 7, 8]
1100 – [5]

Looking at the next state, we see that 8 is distinguishable from [2, 6, 7] when $X_1X_2 = 10$. Now we see that 7 is distinguishable from [2, 6] when $X_1X_2 = 01$. So we form the indinstinguishability classes:

[1, 3, 4] – A
[2, 6] – B
[5] – C
[7] – D
[8] – E

Reduced state table:

s	X1X2 = 00	01	11	10
A	B,0	C,1	A,1	A,0
B	A,1	E,0	A,1	C,1
C	B,1	C,1	A,0	D,0
D	A,1	B,0	A,1	C,1
E	A,1	B,0	A,1	A,1

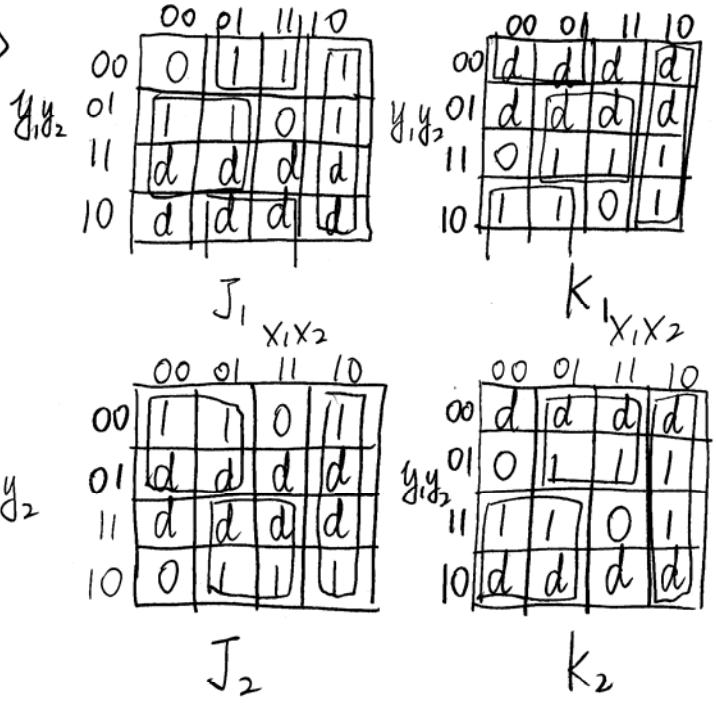
S, Z

(E) Based on the flow table, the transition table should be:

y_1y_2 \ x_1x_2	00	01	11	10
00	01	11	10	11
01	11	10	00	10
11	10	00	01	00
10	00	01	11	01

$y \to Y$	J	K
0 0	0	d
0 1	1	d
1 0	d	1
1 1	d	0

⇒



So $J_1 = x_1\bar{x}_2 + x_2\bar{y}_2 + y_2\bar{x}_1$, $K_1 = \bar{y}_2\bar{x}_1 + y_2x_2 + x_1\bar{x}_2$

$J_2 = \bar{y}_1\bar{x}_1 + y_1x_2 + x_1\bar{x}_2$, $K_2 = \bar{y}_1x_2 + y_1\bar{x}_1 + x_1\bar{x}_2$

So the implementation of this machine with J-k flip-flop is: