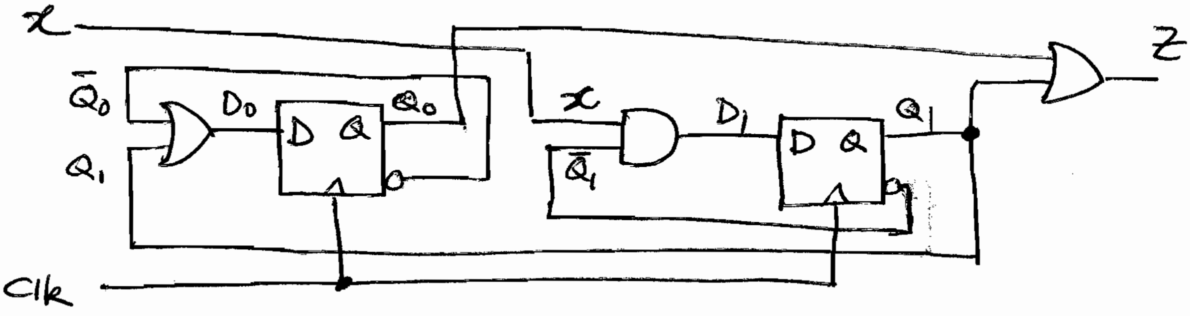
Solution to HW#4

1.



$$D_0 = Q_0^* = Q_1 + \bar{Q}_0$$
$$D_1 = Q_1^* = x \cdot \bar{Q}_1$$
] excitation Equation

$$Z = Q_0 + Q_1$$
] output Equation

Excitation / Transition Table

Present Values: Input x	State Q_1	State Q_0	Next Values Q_1^*	Q_0^*	Present output Z
0	0	0	0	1	0
0	0	1	0	0	1
0	1	0	0	1	1
0	1	1	0	1	1
1	0	0	1	1	0
1	0	1	1	0	1
1	1	0	0	1	1
1	1	1	0	1	1

Let state $S = Q_1 Q_0$

$A = 00$

$B = 01$

$C = 10$

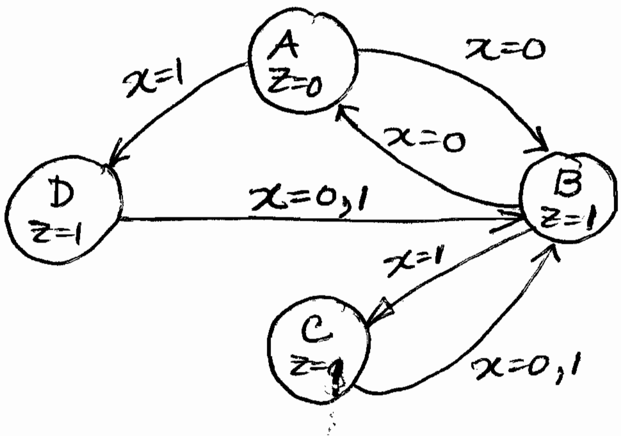
$D = 11$

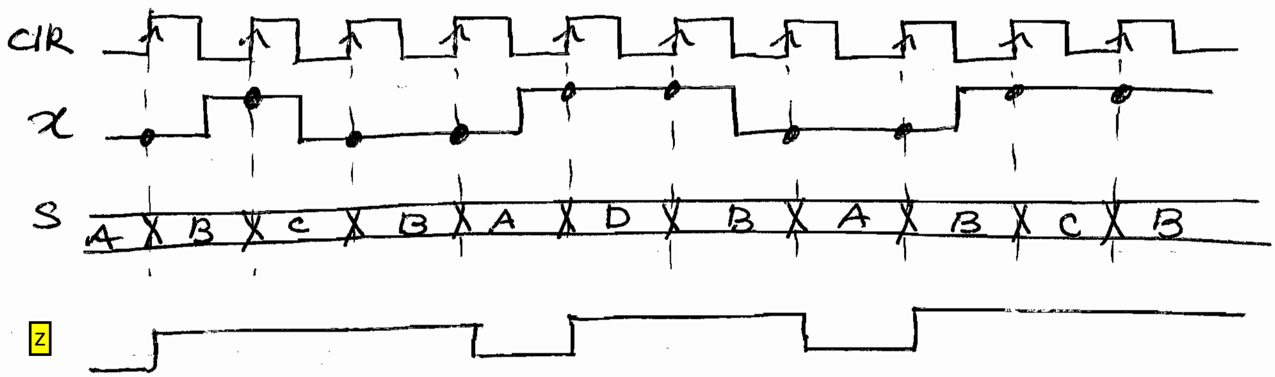
Next state $\Rightarrow S^*$

State Output Table

x	S	S^*	Z
0	A	B	0
0	B	A	1
0	C	B	1
0	D	B	1
1	A	D	0
1	B	C	1
1	C	B	1
1	D	B	1

State Diagram (always useful to draw)





2. Swap AND + OR gates in Prob 1.

$$D_0 = Q_0^* = Q_1 \cdot \overline{Q_0} \qquad Z = Q_0 \cdot Q_1$$
$$D_1 = Q_1^* = x + \overline{Q_1}$$

Excitation Transition Table

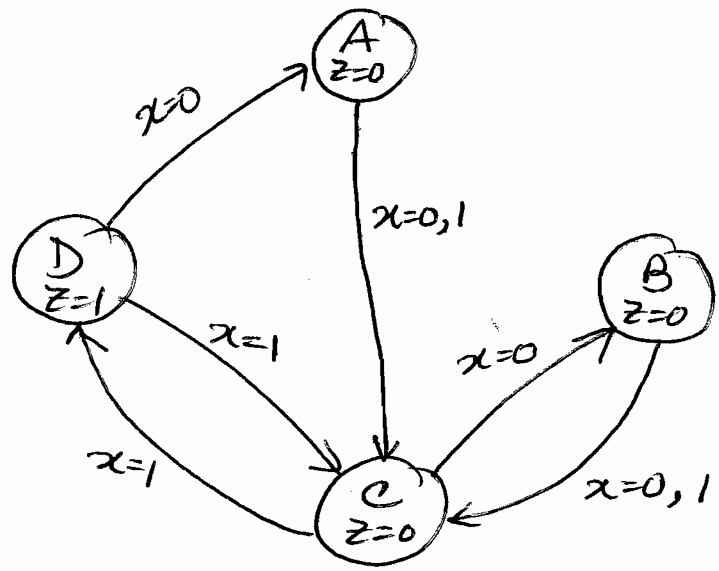
x	Q_1	Q_0	Q_1^*	Q_0^*	Z
0	0	0	1	0	0
0	0	1	1	0	0
0	1	0	0	1	0
0	1	1	0	0	1
1	0	0	1	0	0
1	0	1	1	0	0
1	1	0	1	1	0
1	1	1	1	0	1

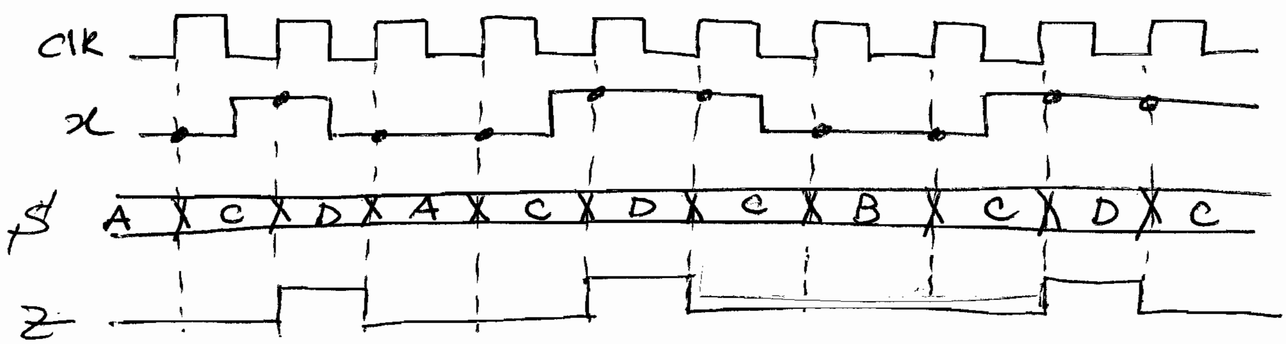
State/output Table

x	S	S^*	Z
0	A	C	0
0	B	C	0
0	C	B	0
0	D	A	1
1	A	C	0
1	B	C	0
1	C	D	0
1	D	C	1

$A = Q_1 Q_0 = 00 \qquad C = 10$
$B = 01 \qquad D = 11$

State Diagram





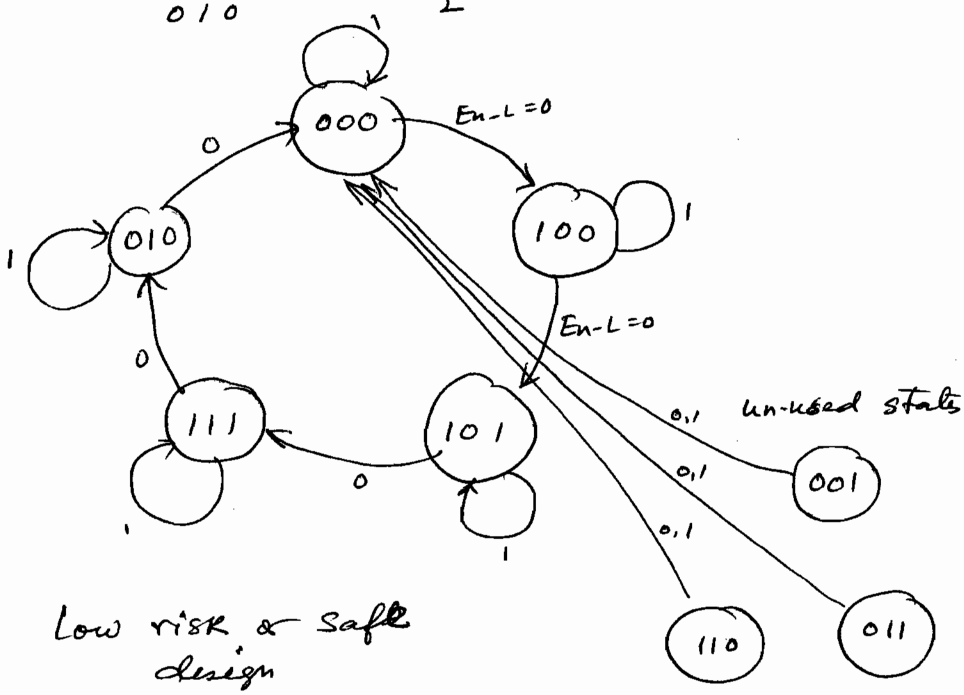
5. Design a counter with an active-low enable En-L & the follow sequence

$\rightarrow 0 \rightarrow 4 \rightarrow 5 \rightarrow 7 \rightarrow 2 \rightarrow$

Solution

Highest number is 7. $\log_2 7 > 2$.
use 3 Flipflops.

Counter state $Q_2 Q_1 Q_0$	Number
0 0 0	0
1 0 0	4
1 0 1	5
1 1 1	7
0 1 0	2



Low risk & safe design

Excitation Transition Table

En-L	Q_2	Q_1	Q_0	Q_2^*	Q_1^*	Q_0^*
0	0	0	0	1	0	0
0	0	0	1	0	0	0
0	0	1	0	0	0	0
0	0	1	1	0	0	0
0	1	0	0	1	0	1
0	1	0	1	1	1	1
0	1	1	0	0	0	0
0	1	1	1	0	1	0
1	0	0	0	0	0	0
1	0	0	1	0	0	0
1	0	1	0	0	1	0
1	0	1	1	0	0	0
1	1	0	0	1	0	0
1	1	0	1	1	0	1
1	1	1	0	0	0	0
1	1	1	1	1	1	1

K-map for $Q_2^* = D_2$

En-L Q_2 \ Q_1Q_0	00	01	11	10
00	1	0	0	0
01	1	1	0	0
11	1	1	1	0
10	0	0	0	0

Q_0 Q_2 En-L Q_1

$$Q_2^* = D_2 = (\overline{En\text{-}L} \cdot \overline{Q}_1 \cdot \overline{Q}_0) + (Q_2 \cdot \overline{Q}_1) + (En\text{-}L \cdot Q_2 \cdot Q_0)$$

K-map for $Q_1^* = D_1$

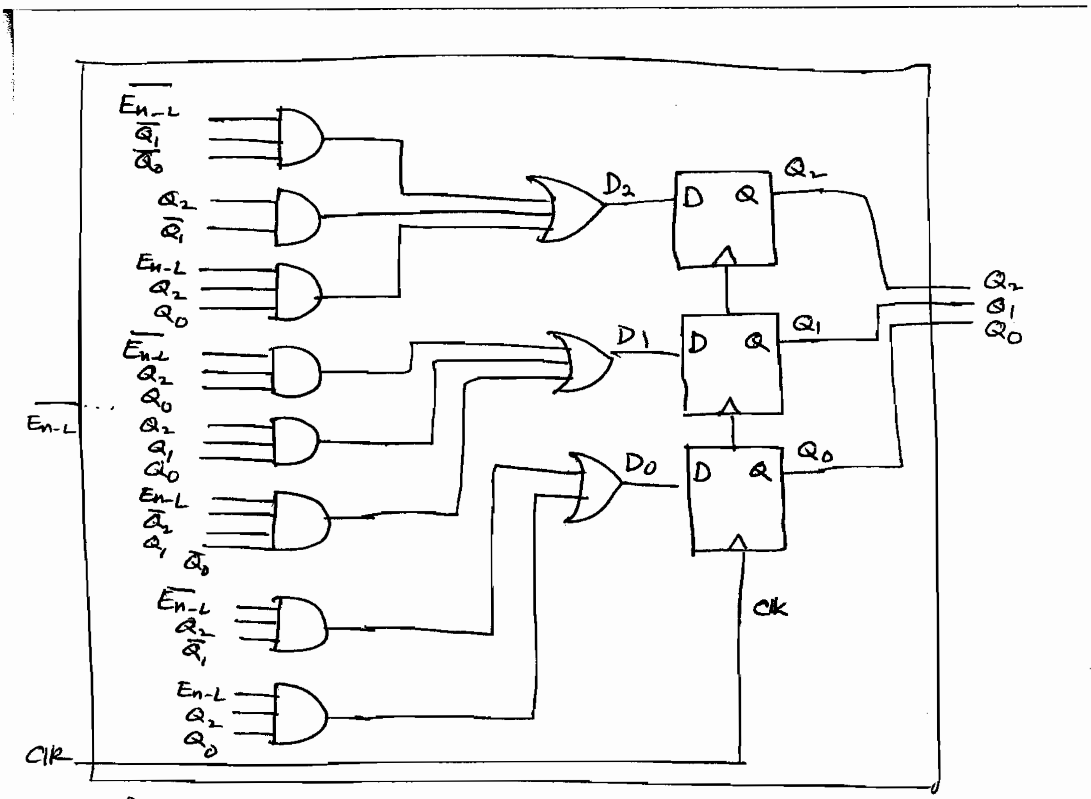
En-L Q_2 \ Q_1Q_0	00	01	11	10
00	0	0	0	0
01	0	1	1	0
11	0	0	1	0
10	0	0	0	1

$$Q_1^* = D_1 = (\overline{En\text{-}L} \cdot Q_2 \cdot Q_0) + (Q_2 \cdot Q_1 \cdot Q_0) + (En\text{-}L \cdot \overline{Q}_2 \cdot Q_1 \cdot \overline{Q}_0)$$

K-map for $Q_0^* = D_0$

En-L Q_2 \ Q_1Q_0				
	0	0	0	0
	1	1	0	0
	0	1	1	0
	0	0	0	0

$$Q_0^* = D_0 = (\overline{En\text{-}L} \cdot Q_2 \cdot \overline{Q}_1) + (En\text{-}L \cdot Q_2 \cdot Q_0)$$



Inverters are not shown