

# Assignment 4

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T1. present state

present state		input	next state		Flip-Flop inputs	
A(t)	B(t)	X	A(t+1)	B(t+1)	TA	TB
0	0	0	0	1	0	1
0	0	1	0	0	0	0
0	1	0	1	1	1	0
0	1	1	1	0	1	1
1	0	0	1	1	0	1
1	0	1	1	0	0	0
1	1	0	0	0	1	1
1	1	1	1	1	0	0

TA:

A	B	X	00	01	11	10
0	0	0	1	1		
1	0	0	0	0	1	

A	B	X	00	01	11	10
0	0	1	0	1	1	0
1	1	0	1	0	0	1

$$TA = A'B + Bx'$$

$$TB = B'x' + A'Bx + Ax'$$

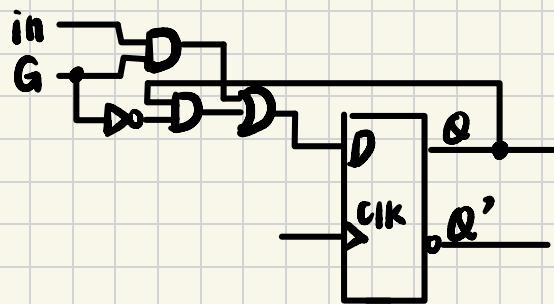
T2. present state

Q(t)	G	in	Q(t+1)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

~~Q(t+1) :~~

<del>Q(t+1)</del>	<del>G in</del>	00	01	11	10
0	0	0	0	1	0
1	1	1	1	1	0

$$\begin{aligned} Q(t+1) &= Q(t)G' \\ &\quad + G \text{ in} \\ Q(t+1) &= D(t) \end{aligned}$$



T3.

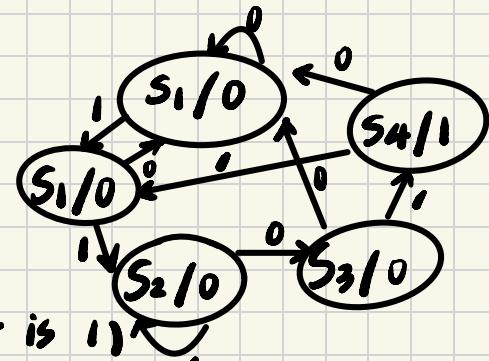
let  $S_0 : 000$  detect none

$S_1 : 001$  detect 1

$S_2 : 010$  detect 11

$S_3 : 011$  detect 110

$S_4 : 100$  detect 1101 (output is 1)



present state $Q_2\ Q_1\ Q_0$	input $\chi$	next state $Q_2\ Q_1\ Q_0$	Flip-Flop inputs $J_3\ K_3\ J_2\ K_2\ J_1\ K_1$
0 0 0	0	0 0 0	0 X 0 X 0 X
0 0 0	1	0 0 1	0 X 0 X 1 X
0 0 1	0	0 0 0	0 X 0 X X 1
0 0 1	1	0 1 0	0 X 1 X X 1
0 1 0	0	0 1 1	0 X X 0 1 X
0 1 0	1	0 1 0	0 X X 0 X 0 X
0 1 1	0	0 0 0	0 X X 1 X 1
0 1 1	1	1 0 0	1 X X 1 X 1
1 0 0	0	0 0 0	X 1 0 X 0 X
1 0 0	1	0 0 1	X 1 0 X 1 X

$$J_3 = \cancel{Q_0}x$$

$$Q_2 Q_1 \quad 00 \quad 01 \quad 11 \quad 10$$

00	0	0	0	0
01	0	0	1	0
11	x	x	x	x
10	x	x	x	x

$$J_3 = Q_1 Q_0 x$$

$$K_3 = \cancel{Q_0}x$$

$$Q_2 Q_1 \quad 00 \quad 01 \quad 11 \quad 10$$

00	x	x	x	x
01	x	x	x	x
11	x	x	x	x
10	1	1	x	x

$$K_3 = 1$$

$$J_2 = \cancel{Q_0}x$$

$$Q_2 Q_1 \quad 00 \quad 01 \quad 11 \quad 10$$

00	0	0	1	0
01	x	x	x	x
11	x	x	x	x
10	0	0	x	x

$$J_2 = Q_0 x$$

$$K_2 = \cancel{Q_0}x$$

$$Q_2 Q_1 \quad 00 \quad 01 \quad 11 \quad 10$$

00	x	x	x	x
01	0	0	1	1
11	x	x	x	x
10	x	x	x	x

$$K_2 = Q_0$$

$$J_1 = \cancel{Q_1}x + \cancel{Q_1}x'$$

$$Q_2 Q_1 \quad 00 \quad 01 \quad 11 \quad 10$$

00	0	1	x	x
01	1	0	x	x
11	x	x	x	x
10	0	1	x	x

$$J_1 = Q_1' x + Q_1 x'$$

$$= Q_1 \oplus x$$

$$\Rightarrow \begin{cases} J_3 = Q_1 Q_0 x & J_2 = Q_0 x \\ K_3 = 1 & K_2 = Q_0 \end{cases}$$

$$K_1 = 1$$

$$K_1 = 1$$

$$K_2 = Q_0 \quad K_3 = 1$$

$$T4. \ N \leq 2^n - 1 \quad N = 7 \Rightarrow n = 3$$

clk	$Q_2$	$Q_1$	$Q_0$
↑	1	0	1
↑	0	1	0
↑	1	0	1
↑	1	1	0
↑	1	1	1
↑	1	1	1
↑	0	1	1

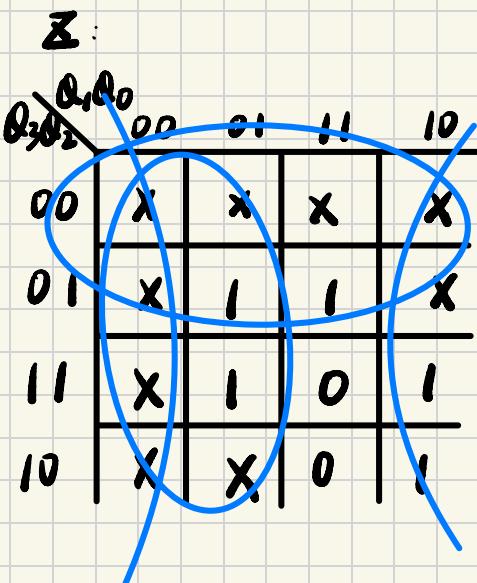
state 101 \ 111

occurs twice

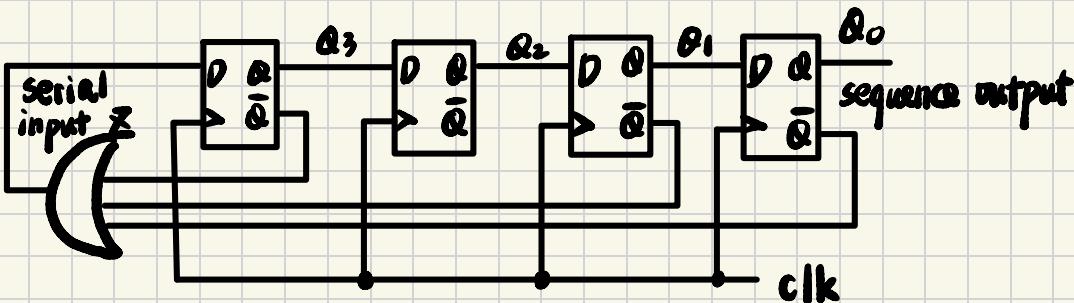
⇒ 3 flip-flops are not sufficient.

we need 4 flip-flops

clk	$Q_3$	$Q_2$	$Q_1$	$Q_0$
↑	1	0	1	1
↑	0	1	0	1
↑	1	0	1	0
↑	1	1	0	1
↑	1	1	1	0
↑	1	1	1	1
↑	0	1	1	1



$$Z = Q_3' + Q_1' + Q_0'$$



present state			next state			flip-flop input		
$Q_2$	$Q_1$	$Q_0$	$Q_2$	$Q_1$	$Q_0$	$T_2$	$T_1$	$T_0$
0	0	0	0	0	1	0	0	1
0	0	1	0	1	1	0	1	0
0	1	0	X	X	X	X	X	X
0	1	1	1	1	1	1	0	0
1	0	0	0	0	0	1	0	0
1	0	1	X	X	X	X	X	X
1	1	0	1	0	0	0	1	0
1	1	1	1	1	0	0	0	1

$Q_2$	$Q_1Q_0$	00	01	11	10
0	00	0	0	1	X
1	11	1	X	0	0

$Q_2$	$Q_1Q_0$	00	01	11	10
0	00	0	1	0	X
1	10	X	0	0	1

$Q_2$	$Q_1Q_0$	00	01	11	10
0	11	0	0	0	X
1	0X	1	X	1	0

$$\begin{aligned} T_2 &= Q_2 Q_1' + Q_2' Q_1 \\ &= Q_2 \oplus Q_1 \end{aligned}$$

$$\begin{aligned} T_1 &= Q_1' Q_0 + Q_1 Q_0' \\ &= Q_1 \oplus Q_0 \end{aligned}$$

$$\begin{aligned} T_0 &= Q_2' Q_0' + Q_2 Q_0 \\ &= (Q_2 \oplus Q_0)' \end{aligned}$$

if  $Q_2 Q_1 Q_0 = 0|0$  then  $T_2 = T_1 = T_0 = 1$

next state  $Q_2 Q_1 Q_0 = 1|0$  then  $T_2 = T_1 = T_0 = 1$

then next state  $Q_2 Q_1 Q_0 = 0|1$  will lead to a dead cycle between  $0|0$  and  $1|0$ , it's incorrect.

we make  $0|0$  and  $1|0$ 's next state  $0|0|0$

then for  $0|0$   $T_2 = 0$   $T_1 = 1$   $T_0 = 0$

for  $1|0$   $T_2 = 1$   $T_1 = 0$   $T_0 = 1$

present state

	$Q_2$	$Q_1$	$Q_0$
0	0	0	0
0	0	0	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

next state

	$Q_2$	$Q_1$	$Q_0$
0	0	0	1
0	0	1	1
0	0	0	0
0	1	1	1
1	0	0	0
0	0	0	0
1	0	0	0
1	1	0	0

flip - flop input

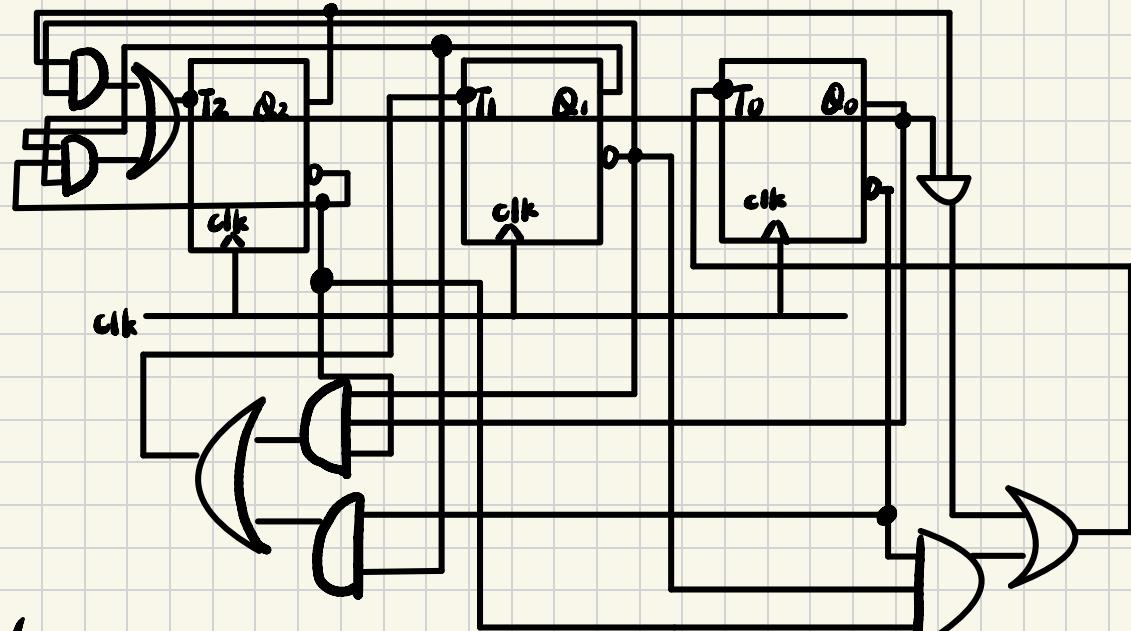
	$T_2$	$T_1$	$T_0$
0	0	0	1
0	0	1	0
0	1	0	0
1	0	0	0
1	0	1	1
1	1	0	0
0	0	1	0
0	1	0	1

	$T_2$	$Q_2$	$Q_1$	$Q_0$
0	0	0	0	1
1	1	1	1	0

	$T_1$	$Q_2$	$Q_1$	$Q_0$
0	0	0	1	0
1	0	0	0	1

	$T_0$	$Q_2$	$Q_1$	$Q_0$
0	0	1	0	0
1	0	1	1	0

$$T_2 = Q_2 Q_1' + Q_2' Q_1 Q_0 \quad T_1 = Q_2' Q_1' Q_0 + Q_1 Q_0' \quad T_0 = Q_2' Q_1' Q_0' + Q_2 Q_0$$



(I never meant to draw the diagram in a such complex way ... )