Homework #10

6.16* The BCD ripple counter shown in Fig. 6.10 has four flip-flops and 16 states, of which only 10 are used. Analyze the circuit and determine the next state for each of the other six unused states. What will happen if a noise signal sends the circuit to one of the unused states?

6.19 The flip-flop input equations for a BCD counter using T flip-flops are given in Section 6.4. Obtain the input equations for a BCD counter that uses (a) JK flip-flops and (b)* D flip-flops. Compare the three designs to determine which one is the most efficient.

6.21* The counter of Fig. 6.14 has two control inputs—*Load* (L) and *Count* (C)—and a data input, (I_i).

(a) Derive the flip-flop input equations for J and K of the first stage in terms of L, C, and I.

(b) The logic diagram of the first stage of an equivalent circuit is shown in Fig. P6.21. Verify that this circuit is equivalent to the one in (a).

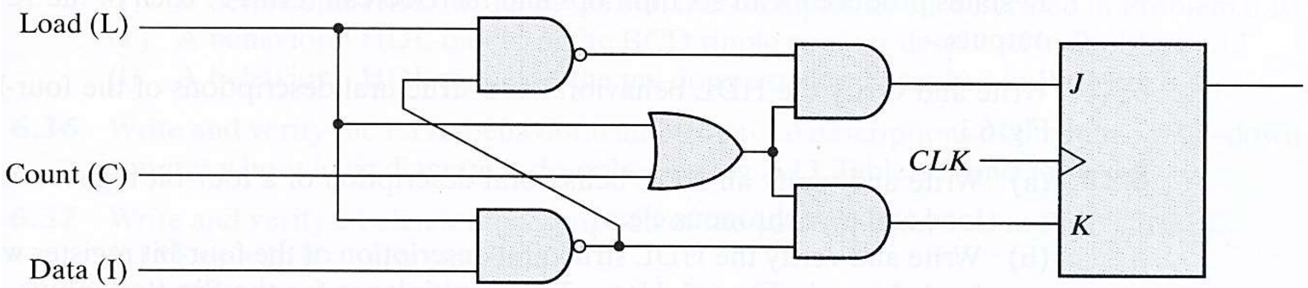


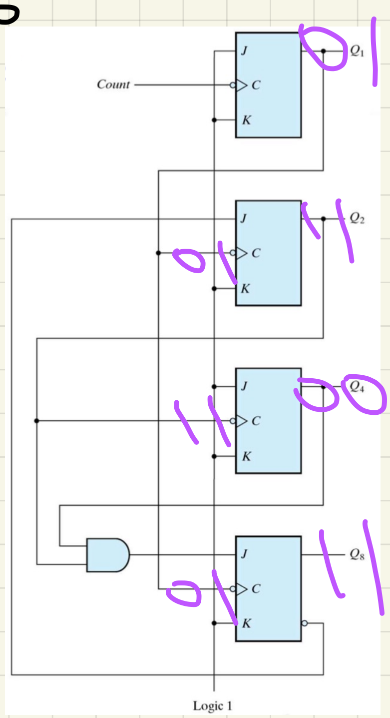
FIGURE P6.21

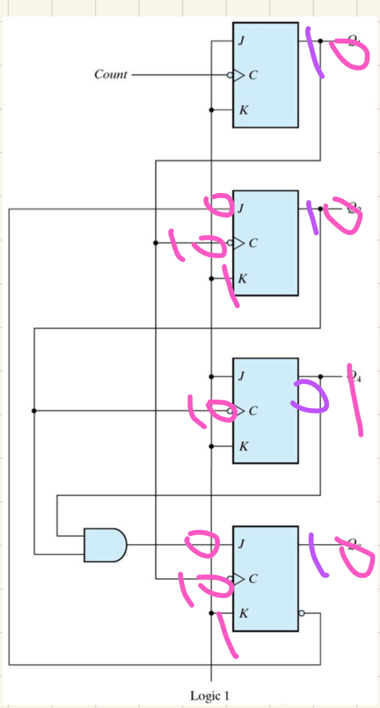
6.24* Design a counter with T flip-flops that goes through the following binary repeated sequence: 0, 1, 3, 7, 6, 4. Show that when binary states 010 and 101 are considered as don't care conditions, the counter may not operate properly. Find a way to correct the design.

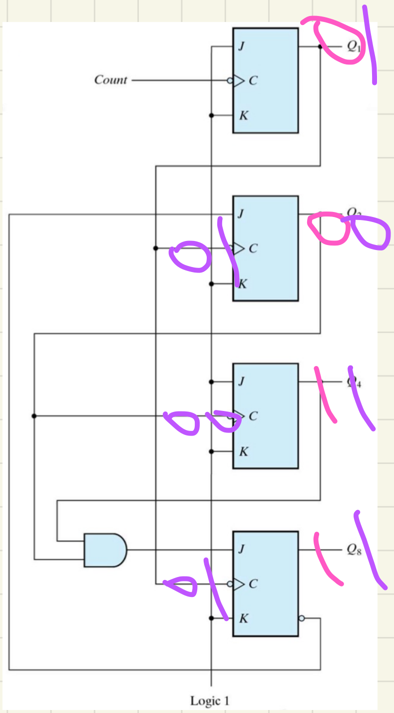
6.28 Using D flip-flops,

(a) *Design a counter with the following repeated binary sequence: 0, 1, 2, 4, 6.

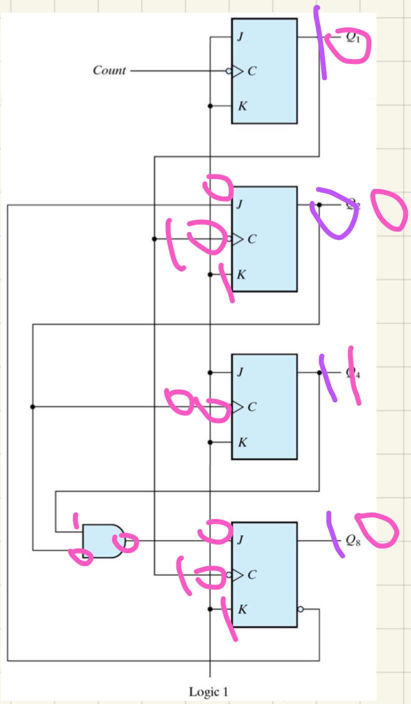
6.16

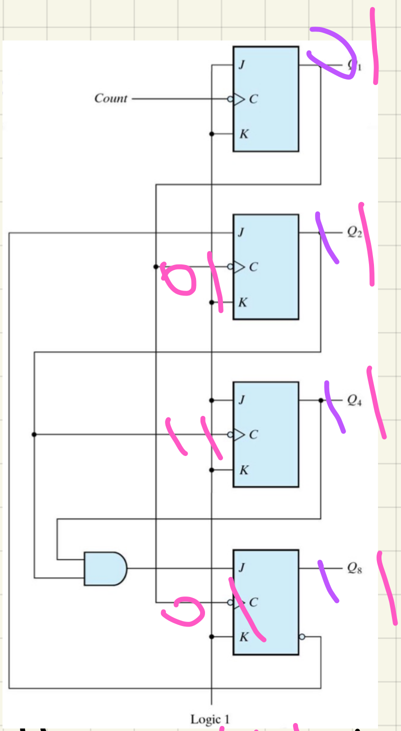


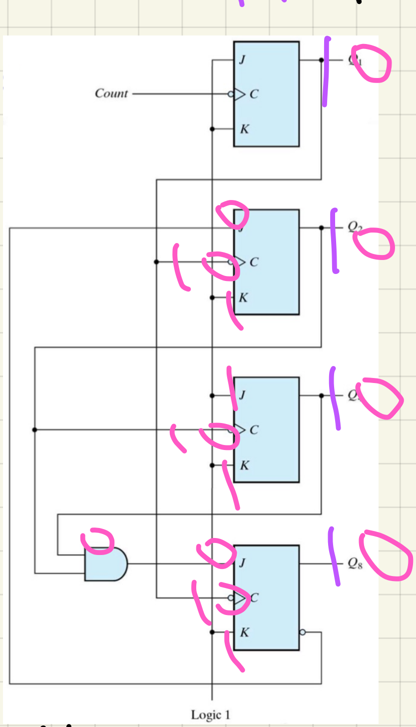




1010 → 1011 1011 → 0100 1100 → 1101







1101 → 0100 1110 → 1111 1111 → 0000

explan: 一次修正: 1011, 1101, 1111

二次修正: 1010, 1100, 1110

6.19 (JK-Flip-Flop)

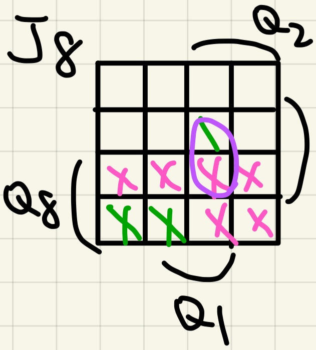
Ex. BCD counters

Present State				Next State				Output	Flip-Flop Inputs			
Q_8	Q_4	Q_2	Q_1	Q_8	Q_4	Q_2	Q_1	y	TQ_8	TQ_4	TQ_2	TQ_1
0	0	0	0	0	0	0	1	0				
0	0	0	1	0	0	1	0	0				
0	0	1	0	0	0	1	1	0				
0	0	1	1	0	1	0	0	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	1	1	0				
0	1	1	1	1	0	0	0	0				
1	0	0	0	1	0	0	1	0				
1	0	0	1	0	0	0	0	1				

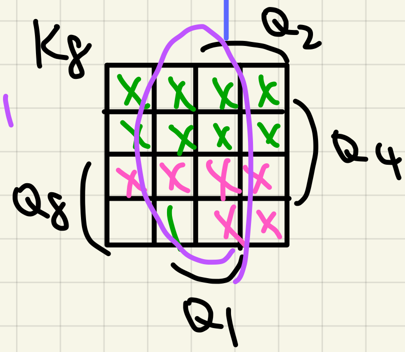
excitation table

Q	Q(t+1)	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

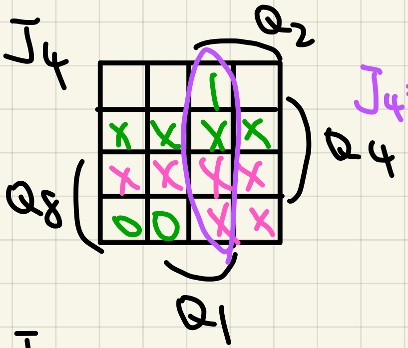
	present state				next state				Flip-Flop							
	Q_8	Q_4	Q_2	Q_1	Q_8	Q_4	Q_2	Q_1	J_8	K_8	J_4	K_4	J_2	K_2	J_1	K_1
0	0	0	0	0	0	0	0	1	0	X	0	X	0	X	1	X
1	0	0	0	1	0	0	1	0	0	X	0	X	1	X	X	1
2	0	0	1	0	0	0	1	1	0	X	0	X	X	0	1	X
3	0	0	1	1	0	1	0	0	0	X	1	X	X	1	X	1
4	0	1	0	0	0	1	0	1	0	X	X	0	0	X	1	X
5	0	1	0	1	0	1	1	0	0	X	X	0	1	X	X	1
6	0	1	1	0	0	1	1	1	0	X	X	0	X	0	1	X
7	0	1	1	1	1	0	0	0	1	X	X	1	X	1	X	1
8	1	0	0	0	1	0	0	1	X	0	0	X	0	X	1	X
9	1	0	0	1	0	0	0	0	X	1	0	X	0	X	X	1



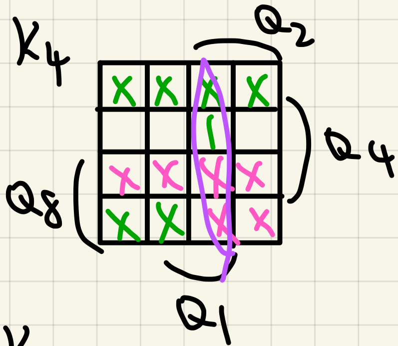
$J_8 = Q_4 Q_2 Q_1$



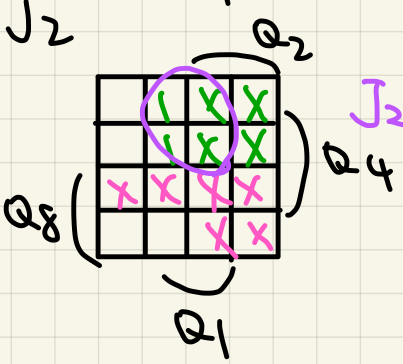
$K_8 = Q_1$



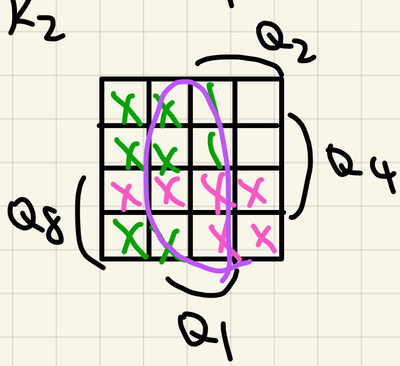
$J_4 = Q_2 Q_1$



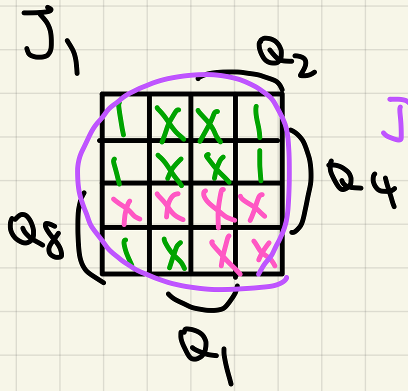
$K_4 = Q_2 Q_1$



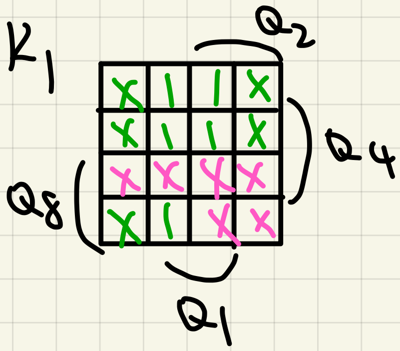
$J_2 = Q_8' Q_1$



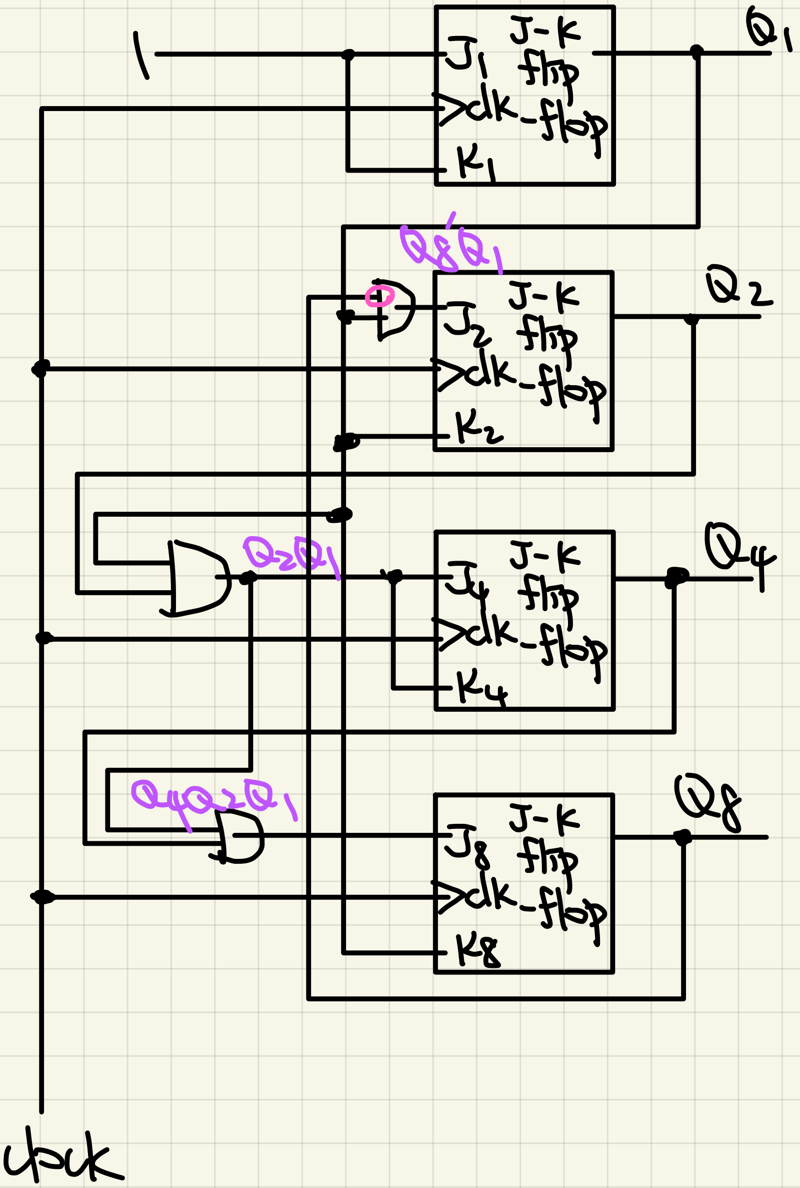
$K_2 = Q_1$



$J_1 = 1$



$K_1 = 1$



$J_8 = Q_4Q_2Q_1$ ✓ $K_8 = Q_1$ ✓

$J_4 = Q_2Q_1$ ✓ $K_4 = Q_2Q_1$ ✓

$J_2 = Q_8'Q_1$ ✓ $K_2 = Q_1$ ✓

$J_1 = 1$ ✓ $K_1 = 1$ ✓

6.19 (D-Flip-Flop)

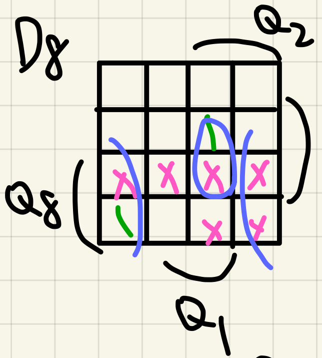
Ex. BCD counters

Present State				Next State				Output	Flip-Flop Inputs			
Q_8	Q_4	Q_2	Q_1	Q_8	Q_4	Q_2	Q_1	y	TQ_8	TQ_4	TQ_2	TQ_1
0	0	0	0	0	0	0	1	0				
0	0	0	1	0	0	1	0	0				
0	0	1	0	0	0	1	1	0				
0	0	1	1	0	1	0	0	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	1	1	0				
0	1	1	1	1	0	0	0	0				
1	0	0	0	1	0	0	1	0				
1	0	0	1	0	0	0	0	1				

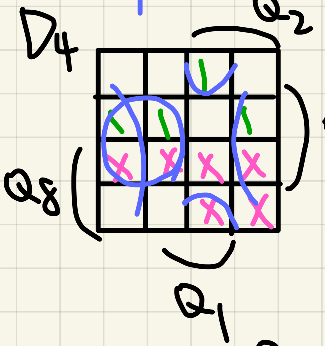
excitation table

Q	$Q(t+1)$	D
0	0	0
0	1	1
1	0	0
1	1	1

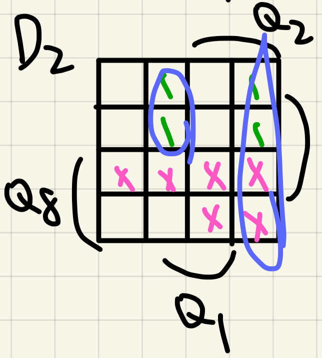
	present state				next state				Flip-Flop			
	Q_8	Q_4	Q_2	Q_1	Q_8	Q_4	Q_2	Q_1	D_8	D_4	D_2	D_1
0	0	0	0	0	0	0	0	1	0	0	0	1
1	0	0	0	1	0	0	1	0	0	0	1	0
2	0	0	1	0	0	0	1	1	0	0	1	1
3	0	0	1	1	0	1	0	0	0	1	0	0
4	0	1	0	0	0	1	0	1	0	1	0	1
5	0	1	0	1	0	1	1	0	0	1	1	0
6	0	1	1	0	0	1	1	1	0	1	1	1
7	0	1	1	1	1	0	0	0	1	0	0	0
8	1	0	0	0	1	0	0	1	1	0	0	1
9	1	0	0	1	0	0	0	0	0	0	0	0



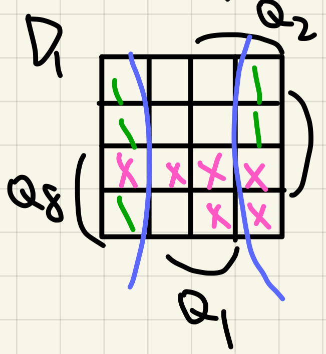
$D_8 = Q_4Q_2Q_1 + Q_8Q_1'$



$D_4 = Q_4Q_2' + Q_4'Q_2Q_1 + Q_4Q_1'$



$D_2 = Q_2Q_1' + Q_8'Q_2'Q_1$



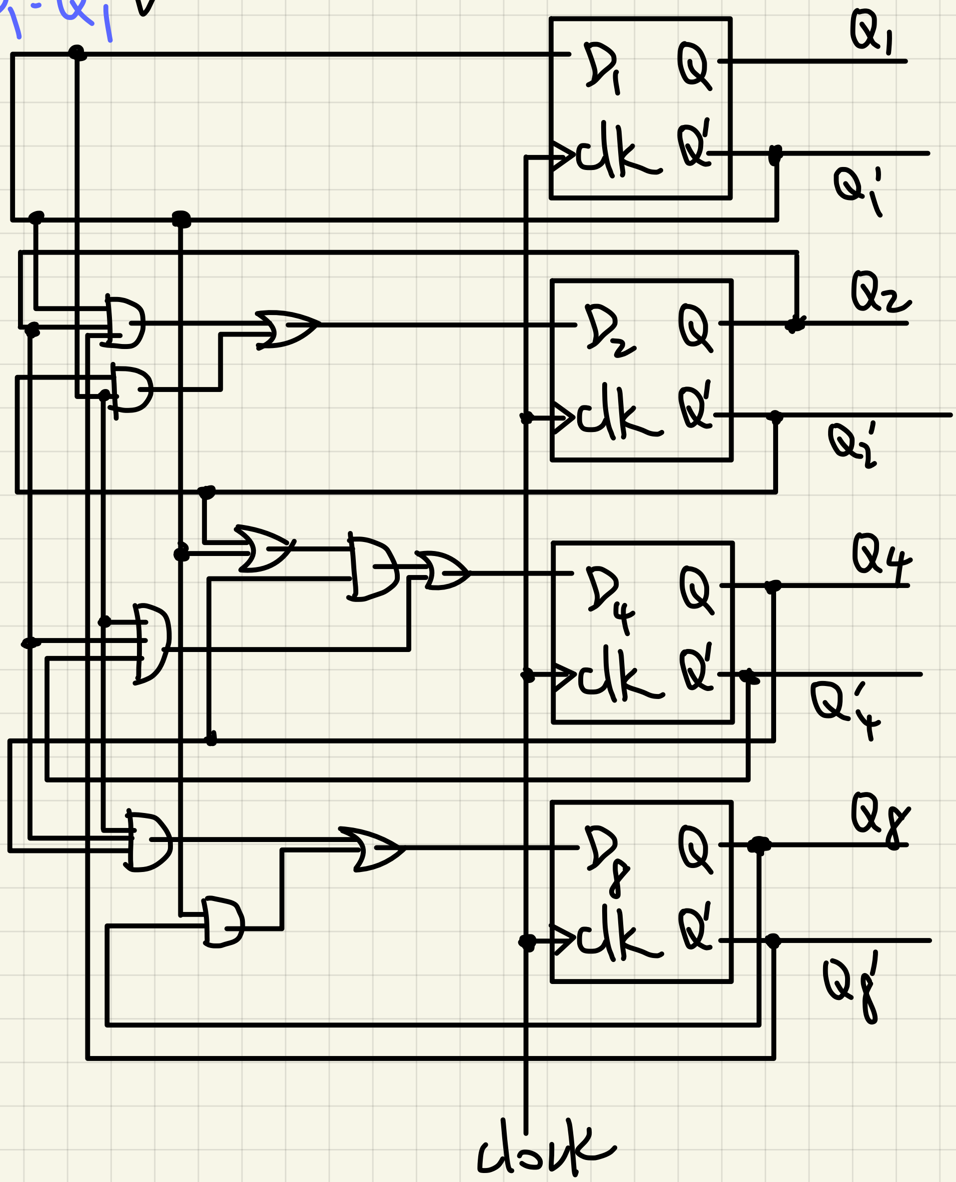
$D_1 = Q_1'$

$D_8 = Q_4Q_2Q_1 + Q_8Q_1'$ ✓

$D_4 = Q_4Q_2' + Q_4'Q_2Q_1 + Q_4Q_1' = Q_4(Q_1'+Q_2') + Q_4'Q_2Q_1$

$D_2 = Q_2Q_1' + Q_8'Q_2'Q_1$ ✓

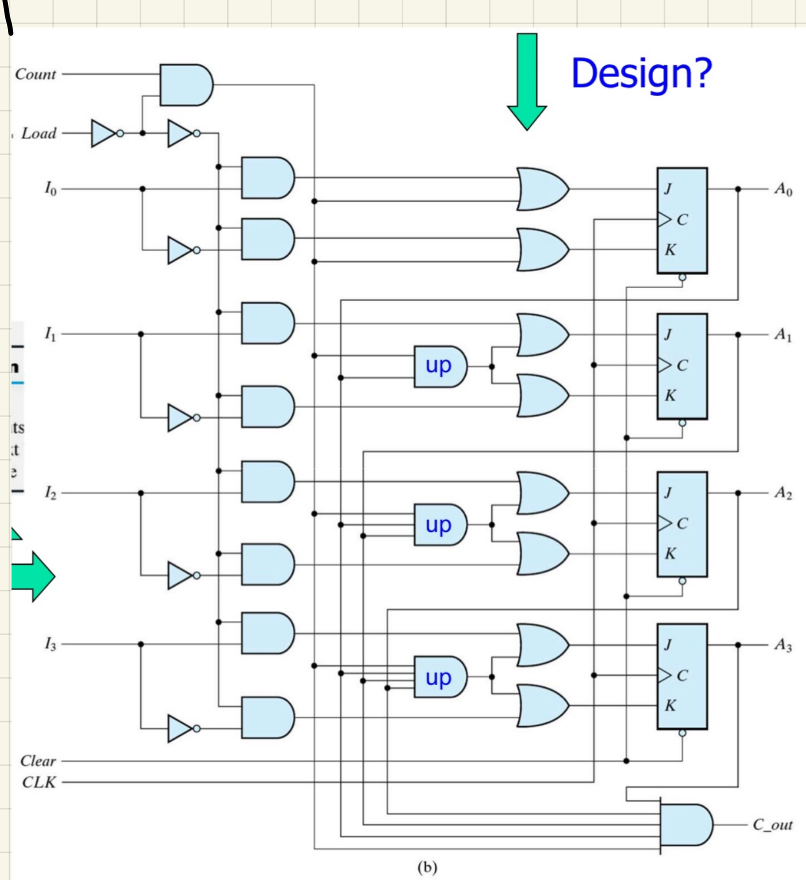
$D_1 = Q_1'$ ✓



JK flip-flops 最有效率：只有三個gate

且1 level (delay最小) □

6.21



(a) $J_{A_0} = (\text{Load}\, I_0) + (\overline{\text{Load}}\, \text{Count})$

$K_{A_0} = (\text{Load}\, \overline{I_0}) + (\overline{\text{Load}}\, \text{Count})$

(b)

Load	Count	Data (I)	J_{new}	K_{new}	J_{A_0}	K_{A_0}
0	0	0	0	0	0	0
0	0	1	0	0	0	0
0	1	0	1	1	1	1
0	1	1	1	1	1	1
1	0	0	0	1	0	1
1	0	1	1	0	1	0
1	1	0	0	1	0	1
1	1	1	1	0	1	0

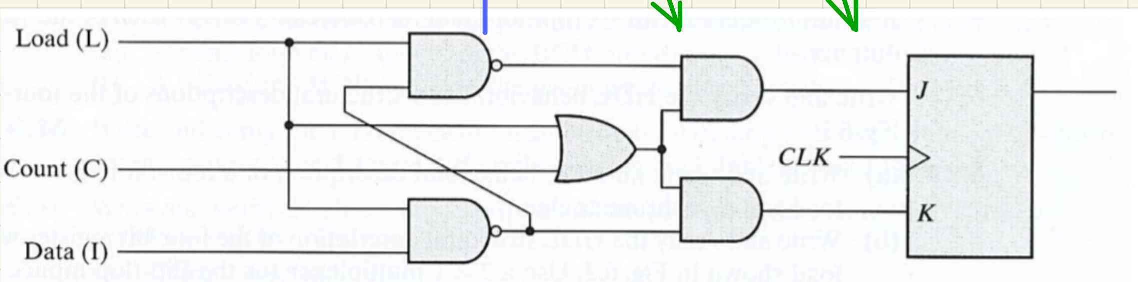
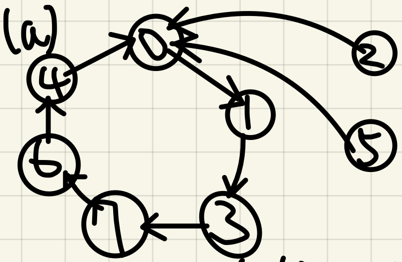
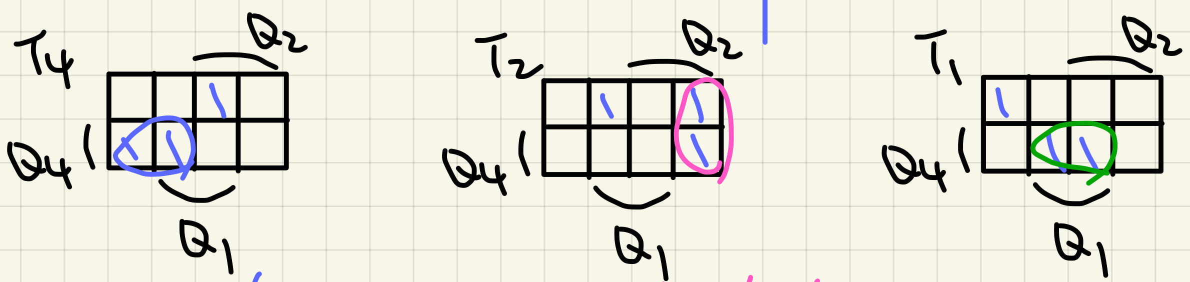


FIGURE P6.21

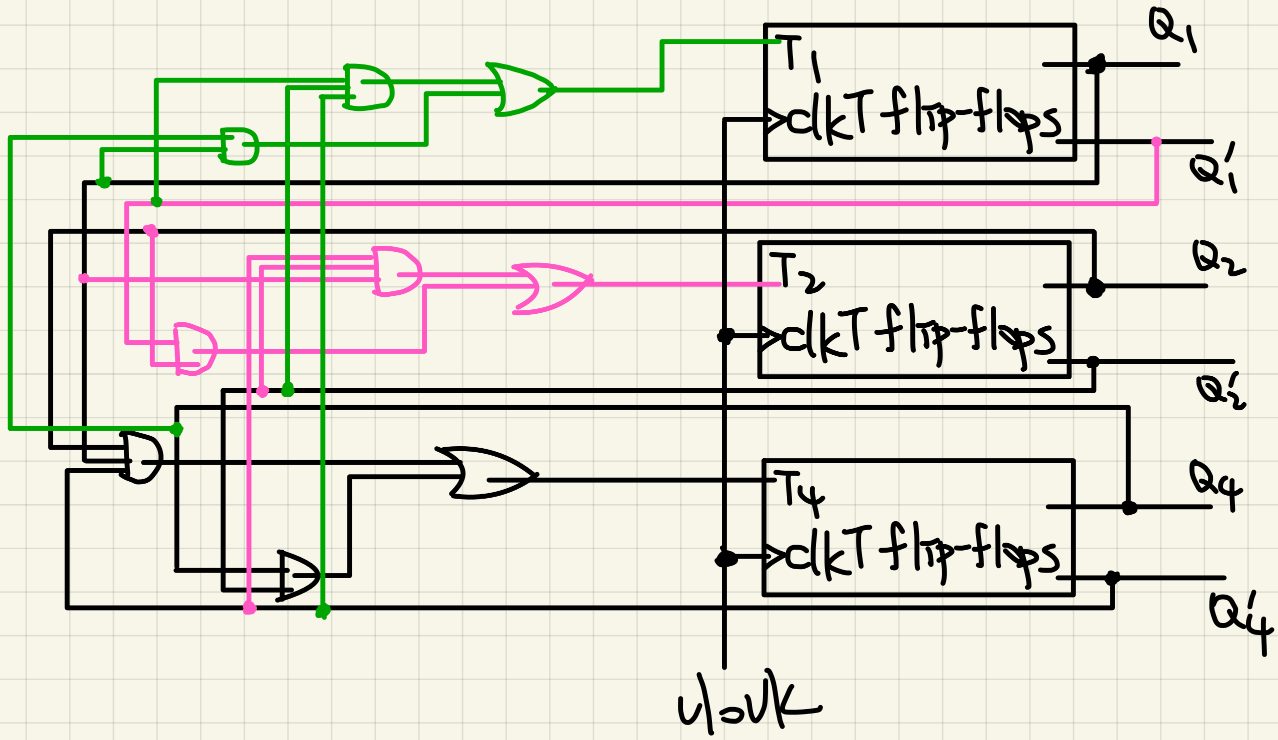
6.24 (a)



present state			next state					
Q_4	Q_2	Q_1	Q_4	Q_2	Q_1	T_4	T_2	T_1
0	0	0	0	0	1	0	0	1
0	0	1	0	1	1	0	1	0
0	1	0	0	0	0	0	1	0
0	1	1	1	1	1	1	0	0
1	0	0	0	0	0	1	0	0
1	0	1	0	0	0	1	0	1
1	1	0	1	0	0	0	1	0
1	1	1	1	1	0	0	0	1



$T_4 = Q_4Q_2' + Q_4'Q_2Q_1$ $T_2 = Q_2Q_1' + Q_4'Q_2'Q_1$ $T_1 = Q_4Q_1 + Q_4'Q_2'Q_1'$



(b)

present state			next state					
Q_4	Q_2	Q_1	Q_4	Q_2	Q_1	T_4	T_2	T_1
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

T_4 (columns: Q_1 under middle two, Q_2 over right two)

			1	x
Q_4 1	1	x		

T_2

		1		x
Q_4 1		x		1

T_1

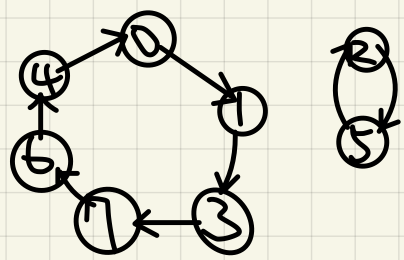
	1			x
Q_4 1		x	1	

$T_4 = Q_4Q_2' + Q_4'Q_2$
$= Q_4 \oplus Q_2$

$T_2 = Q_2'Q_1 + Q_2Q_1'$
$= Q_2 \oplus Q_1$

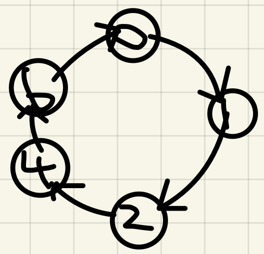
$T_1 = Q_4Q_1 + Q_4'Q_1'$
$= \overline{Q_4 \oplus Q_1}$

present state			next state					
Q_4	Q_2	Q_1	Q_4	Q_2	Q_1	T_4	T_2	T_1
0	0	0	0	0	1	0	0	1
0	0	1	0	1	1	0	1	0
0	1	0	1 ~~x~~	0 ~~x~~	1 ~~x~~	~~x~~ 1	~~x~~ 1	~~x~~ 1
0	1	1	1	1	1	1	0	0
1	0	0	0	0	0	1	0	0
1	0	1	0 ~~x~~	1 ~~x~~	0 ~~x~~	~~x~~ 1	~~x~~ 1	~~x~~ 1
1	1	0	1	0	0	0	1	0
1	1	1	1	1	0	0	0	1

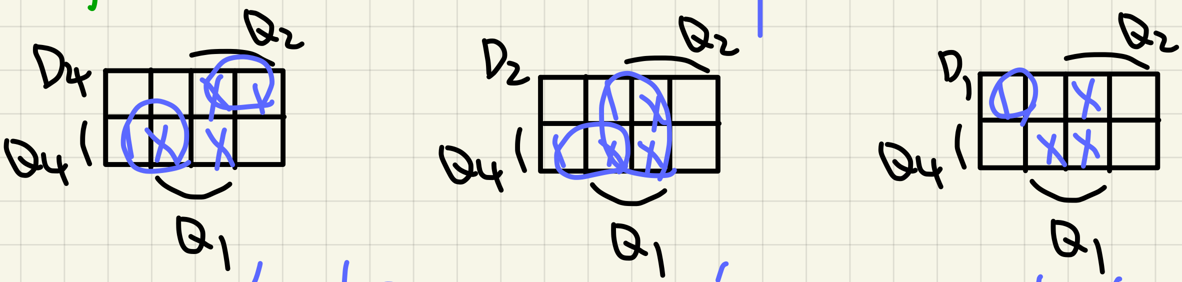
⇒ 

⇒ 無法修正

6.28



present state			next state					
Q_4	Q_2	Q_1	Q_4	Q_2	Q_1	D_4	D_2	D_1
0	0	0	0	0	1	0	0	1
0	0	1	0	1	0	0	1	0
0	1	0	1	0	0	1	0	0
0	1	1	X	X	X	X	X	X
1	0	0	1	1	0	1	1	0
1	0	1	X	X	X	X	X	X
1	1	0	0	0	0	0	0	0
1	1	1	X	X	X	X	X	X



$D_4 = Q_4Q_2' + Q_4'Q_2$ $\quad D_2 = Q_4Q_2' + Q_1$ $\quad D_1 = Q_4'Q_2'Q_1'$

$= Q_4 \oplus Q_2$