Digital Logic Theory Assignment 4

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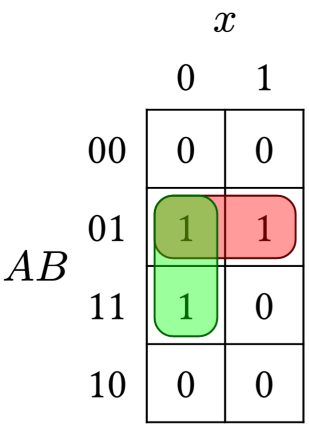
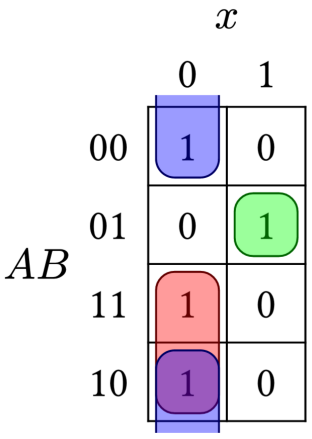
1. State table:

x	A	B	$A(t+1)$	$B(t+1)$	T_A	T_B
0	0	0	0	1	0	1
0	0	1	1	1	1	0
0	1	0	1	1	0	1
0	1	1	0	0	1	1
1	0	0	0	0	0	0
1	0	1	1	0	1	1
1	1	0	1	0	0	0
1	1	1	1	1	0	0





$T_A = B(x' + A')$ $T_B = x'(A + B') + xA'B$

$\therefore A(t+1) = T'_A A(t) + T_A A'(t) = (B' + xA)A + A'B(x' + A') = A \oplus B + x'A'B,$

$B(t+1) = T'_B B(t) + T_B B'(t) = x(A + B') + x'A'B.$

2. State table:

Present State	**Inputs**		**Next State**	**Flip-Flop Input**
Q	G	In	Q	D
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	1	1

Present State	Inputs		Next State	Flip-Flop Input
1	0	0	1	1
1	0	1	1	1
1	1	0	0	0
1	1	1	1	1

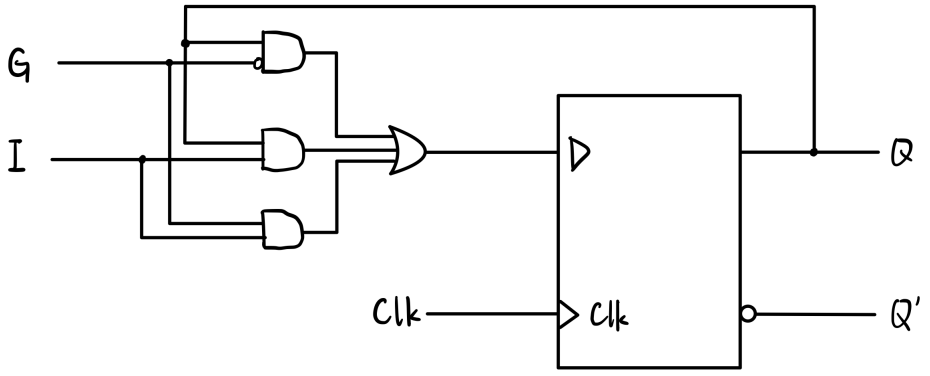
Characteristic Table:

G	In	$Q(t+1)$
0	x	$Q(t)$
1	0	0
1	1	1

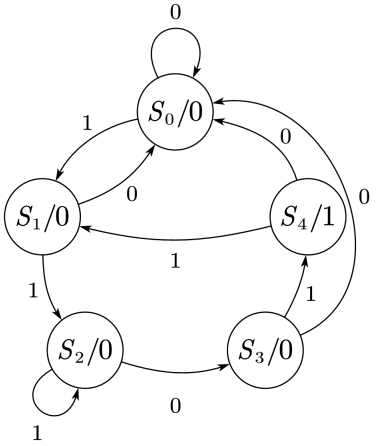
GIn \ $Q(t)$	0	1
00	0	1
01	0	1
11	1	1
10	0	0

$\therefore D = Q(t+1) = G'Q(t) + GIn.$

Logic Implementation:



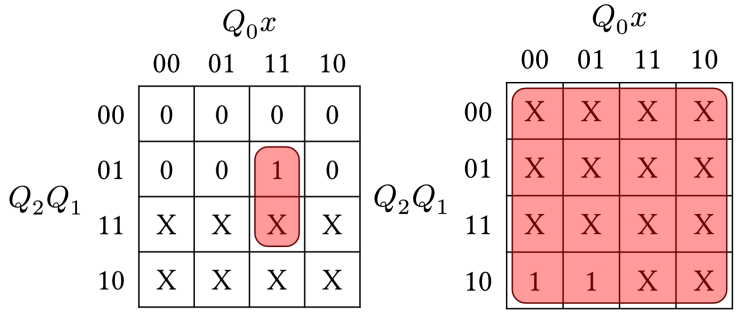
3. State diagram:



State table: $S_0 = 000, S_1 = 001, S_2 = 010, S_3 = 011, S_4 = 100$.

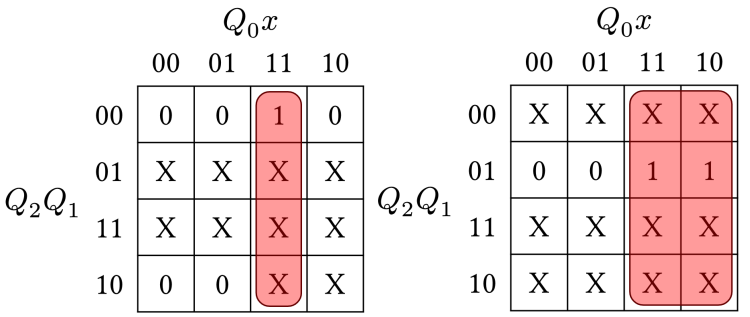
Present	**State**		**Input**	**Next**	**State**		**Flip-Flop**	**Inputs**				
Q_2	Q_1	Q_0	x	Q_2	Q_1	Q_0	J_{Q_2}	K_{Q_2}	J_{Q_1}	K_{Q_1}	J_{Q_0}	K_{Q_0}
0	0	0	0	0	0	0	0	x	0	x	0	x
0	0	0	1	0	0	1	0	x	0	x	1	x
0	0	1	0	0	0	0	0	x	0	x	x	1
0	0	1	1	0	1	0	0	x	1	x	x	1
0	1	0	0	0	1	1	0	x	x	0	1	x
0	1	0	1	0	1	0	0	x	x	0	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

K-maps and Input/Excitation equations:



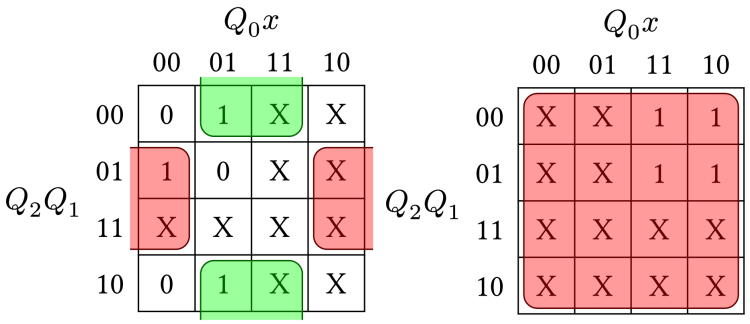
$J_{Q_2} = Q_1Q_0x$

$K_{Q_2} = 1$



$J_{Q_1} = Q_0x$

$K_{Q_1} = Q_0$



$J_{Q_0} = Q_1x' + Q_1'x = Q_1 \oplus x$

$K_{Q_1} = 1$

4. If we use 3 flip-flops:

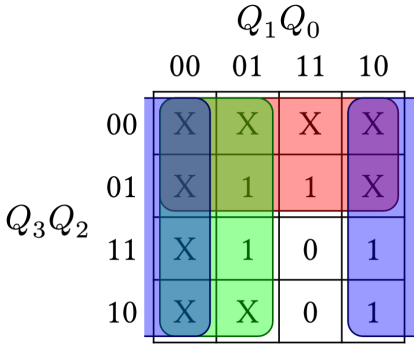
clk	Q_2	Q_1	Q_0	Z
↑	1	0	1	0
↑	0	1	0	1
↑	1	0	1	1
↑	1	1	0	1
↑	1	1	1	1
↑	1	1	1	0
↑	0	1	1	1

State 101 and 111 will occur twice, thus we need 4 flip-flops to generate 1011110.

State table:

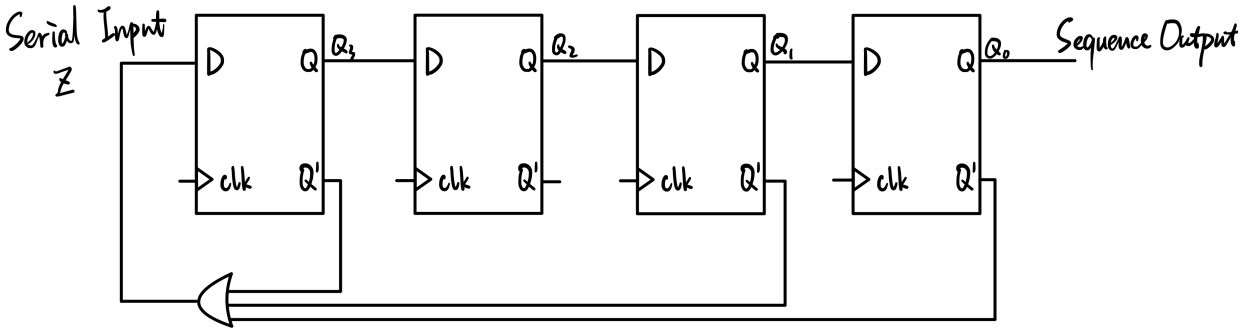
clk	Q_3	Q_2	Q_1	Q_0	Z
↑	1	0	1	1	0
↑	0	1	0	1	1
↑	1	0	1	0	1
↑	1	1	0	1	1
↑	1	1	1	0	1
↑	1	1	1	1	0
↑	0	1	1	1	1

K-map of Z:



$\therefore Z = Q_3' + Q_1' + Q_0'$.

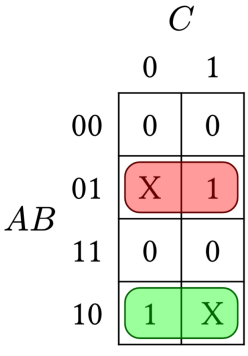
Logic Implementation:

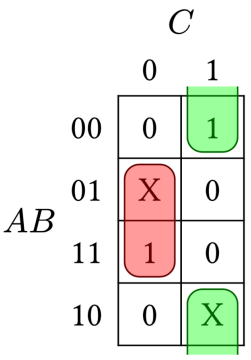


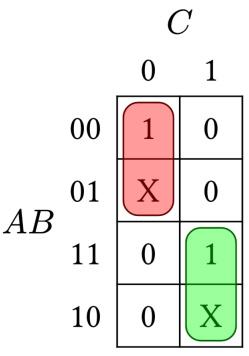
5. State table:

Present	**State**		**Next**	**State**		**Flip-Flop**	**Inputs**	
A	B	C	A	B	C	T_A	T_B	T_C
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

K-maps:







$T_A = A'B + AB' = A \oplus B$ $T_B = BC' + B'C = B \oplus C$ $T_C = A'C' + AC = A \odot C$

According to the input equation, the next state of state 010 and 101 are 101 and 010 separately.

Present	**State**		**Next**	**State**		**Flip-Flop**	**Inputs**	
A	B	C	A	B	C	T_A	T_B	T_C
0	1	0	1	0	1	1	1	1
1	0	1	0	1	0	1	1	1

If the state reaches 010 or 101 unexpectedly, then the state will switch between 101 and 010 repeatedly.

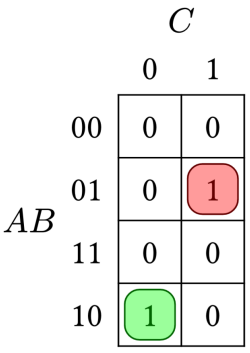
It's a Lock Out Problem.

To solve this problem, we can let the next state of state 010 and 101 return to 000 and 110 separately.

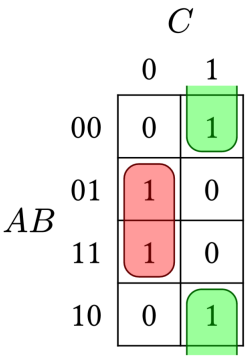
The corrected state table:

Present	**State**		**Next**	**State**		**Flip-Flop**	**Inputs**	
A	B	C	A	B	C	T_A	T_B	T_C
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	1	1	0	0	1	1
1	1	0	1	0	0	0	1	0
1	1	1	1	1	0	0	0	1

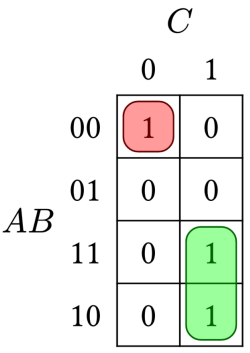
The corrected k-maps:



$T_A = A'BC + AB'C'$



$T_B = BC' + B'C = B \oplus C$



$T_C = A'B'C' + AC$

Logic Implementation: