Assignment 4 Answer

Q1. 总分10分

- **状态表**

A_n	B_n	**input: x**	A_{n+1}	B_{n+1}
0	0	0	0	1
0	0	1	0	0
0	1	0	1	1
0	1	1	1	0
1	0	0	1	1
1	0	1	1	0
1	1	0	0	0
1	1	1	1	1

当$A_nB_n = 01$与$A_nB_n = 10$时，会得到相同的$A_{n+1}B_{n+1}$，因此简化后得到的状态表如下：

A_n	B_n	**input: x**	A_{n+1}	B_{n+1}
0	0	0	0	1
0	0	1	0	0
0	1	0	1	1
0	1	1	0	1
1	1	0	0	0
1	1	1	1	1

我们有$A(n+1) = T \oplus A(n)$， 因此$T = A(n) \oplus A(n+1)$，状态表如下：

A_n	B_n	input: x	A_{n+1}	B_{n+1}	T_A	T_B
0	0	0	0	1	0	1
0	0	1	0	0	0	0
0	1	0	1	1	1	0
0	1	1	0	1	0	0
1	0	0	x	x	x	x
1	0	1	x	x	x	x
1	1	0	0	0	1	1
1	1	1	1	1	0	0

- **K-map化简并得出激励方程**

A \ Bx	00	01	11	10
0	0	0	0	1
1	x	x	0	1

A \ Bx	00	01	11	10
0	1	0	0	0
1	x	x	0	1

得出激励方程：

$T_A = Bx' + Ax'$

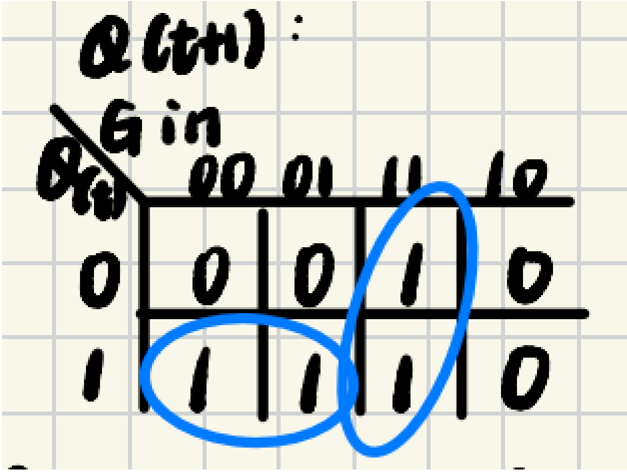
$T_B = B'x' + Ax'$

Q2. 总分10分

- **获得表达式**
  - 真值表：

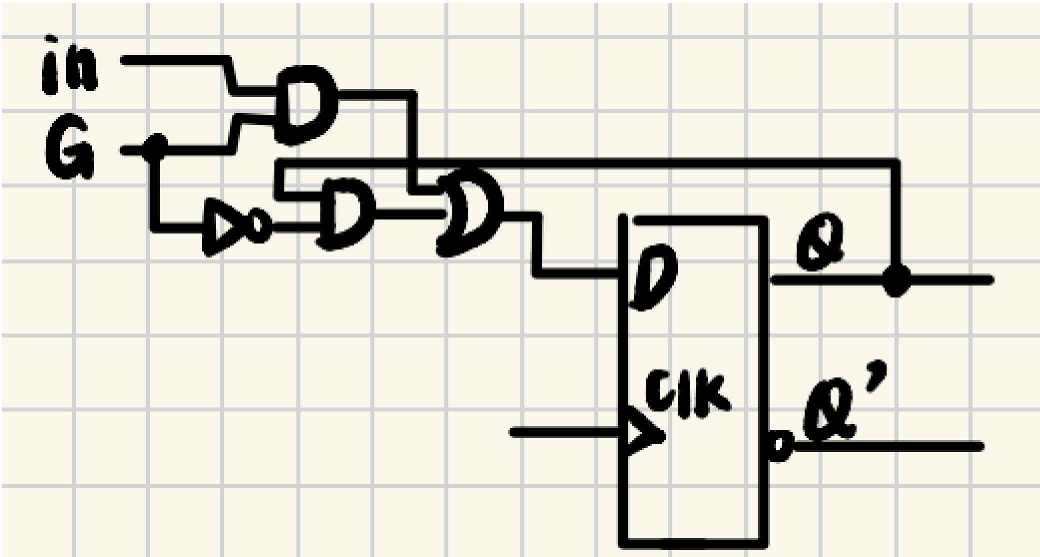
Q(t)	G	In	Q(t+1)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

  - K-map：



得出激励方程：$Q(t+1) = G'Q(t) + GIn$

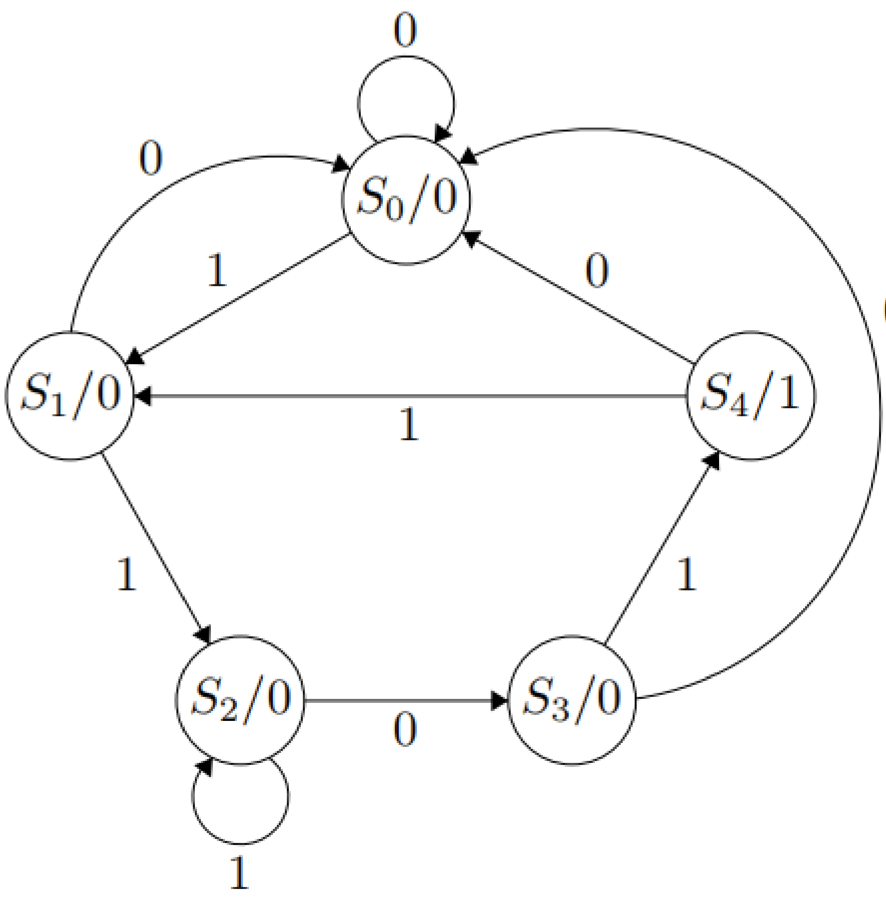
- 电路图



Q3. 总分25分

$S_0 = None, S_1 = 1, S_2 = 11, S_3 = 110, S_4 = 1101$

- 状态图



- 状态表

Present State	Next State		Output	
	$x=0$	$x=1$	$x=0$	$x=1$
S_0	S_0	S_1	0	0
S_1	S_0	S_2	0	0
S_2	S_3	S_2	0	0
S_3	S_0	S_4	0	0
S_4	S_0	S_1	1	1

- 状态编码（State Encoding/Assignment）

  $S_0=000, S_1=001, S_2=010, S_3=011, S_4=100$

- 状态表和JK触发器输入

A	B	C	x	$A(t+1)$	$B(t+1)$	$C(t+1)$	J_A	K_A	J_B	K_B	J_C	K_C
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
1	0	1	X	X	X	X	X	X	X	X	X	X
1	1	X	X	X	X	X	X	X	X	X	X	X

注意：ABC=101、110、111(unused state)可以填也可以不填,不在状态表中做要求，但需要在K-map中的需要体现出是X

- **推导激励方程**

ab \ cd	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	X	X	X	X
10	X	X	X	X

ab \ cd	00	01	11	10
00	X	X	X	X
01	X	X	X	X
11	X	X	X	X
10	1	1	X	X

$$J_A = BCx, \quad K_A = 1$$

ab \ cd	00	01	11	10
00	0	0	1	0
01	X	X	X	X
11	X	X	X	X
10	0	0	X	X

ab \ cd	00	01	11	10
00	X	X	X	X
01	0	0	1	1
11	X	X	X	X
10	X	X	X	X

$$J_B = Cx, \quad K_B = C$$

ab \ cd	00	01	11	10
00	0	1	X	X
01	1	0	X	X
11	X	X	X	X
10	0	1	X	X

ab \ cd	00	01	11	10
00	X	X	1	1
01	X	X	1	1
11	X	X	X	X
10	X	X	X	X

$$J_C = B \oplus x, \quad K_C = 1,$$

Q4. 总分25分

$7 \leq 2^n - 1, n \geq 3$，至少需要3个FF以生成 `1011110`

- $n=3$ 时，状态表如下:

Clock	Sequence	FF's Output		
	Z	Q_2	Q_1	Q_0
↑	0	1	0	1
↑	1	0	1	0
↑	1	1	0	1
↑	1	1	1	0
↑	1	1	1	1
↑	0	1	1	1
↑	1	0	1	1

存在相同Q_2, Q_1, Q_0但输出结果不同的情况，因此3个FF不足以生成序列 `1011110`

- $n=4$ 时，状态表如下：

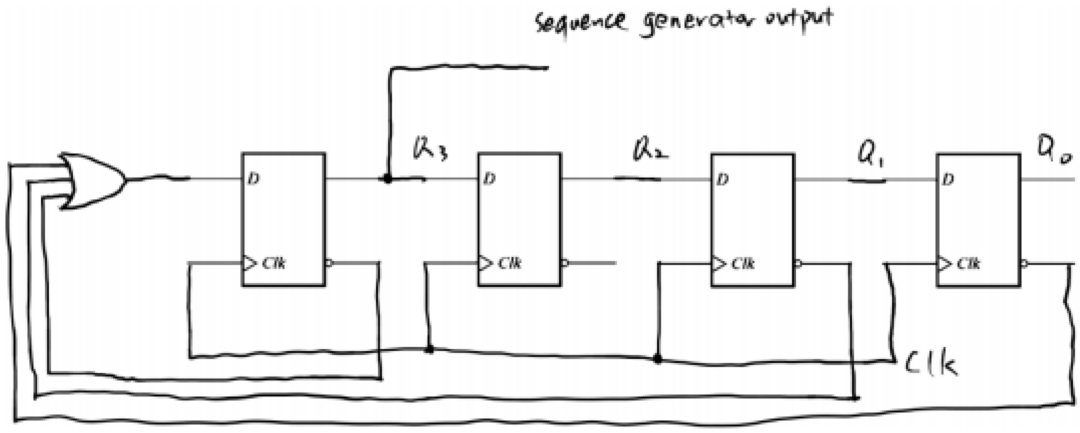
Clock	Sequence	FF's	Output		
	Z	Q_3	Q_2	Q_1	Q_0
↑	0	1	0	1	1
↑	1	0	1	0	1
↑	1	1	0	1	0
↑	1	1	1	0	1
↑	1	1	1	1	0
↑	0	1	1	1	1
↑	1	0	1	1	1

- 推导方程

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

ab \ cd	00	01	11	10
00	X	X	X	X
01	X	1	1	X
11	X	1	0	1
10	X	X	0	1

- 电路图

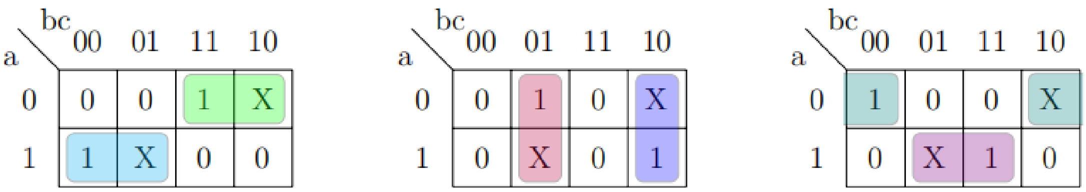


Q5. 总分30分

- 状态表

Present		State	Next		State			
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

- 推导方程



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

- 将don't care conditions情况进行修改，修改合理即可：

1）修改一：

设定`010`和`101`下一状态均为`000`：

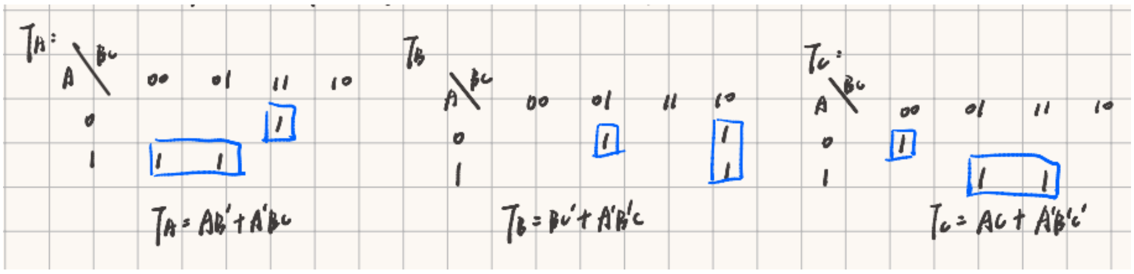
Present State			Next State			Flip-Flop Inputs		
A	B	C	A	B	C	T_A	T_B	T_C
0	0	0	0	0	1	0	0	1
0	0	1	0	1	1	0	1	0
0	1	0	0	0	0	0	1	0
0	1	1	1	1	1	1	0	0
1	0	0	0	0	0	1	0	0
1	0	1	0	0	0	1	0	1
1	1	0	1	0	0	0	1	0
1	1	1	1	1	0	0	0	1

推导方程：

$T_A = AB' + A'BC$

$T_B = BC' + A'B'C$

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



2）修改二：

设定 010 的下一状态为 100， 101 的下一状态为 011

Present		State	Next		State			
A	B	C	A	B	C	T_A	T_B	T_C
0	1	0	1	0	0	1	1	0
1	0	1	0	1	1	1	1	0

推导方程：

a \ bc	00	01	11	10
0	0	0	1	1
1	1	1	0	0

a \ bc	00	01	11	10
0	0	1	0	1
1	0	1	0	1

a \ bc	00	01	11	10
0	1	0	0	0
1	0	0	1	0

The final equation is

$$T_A = AB' + A'B = A \oplus B$$

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

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