1 JK flip-flop

characteristic table

J	K	Q_{t+1}	
0	0	Q_t	No change
0	1	0	Reset
1	0	1	Set
1	1	Q_t'	Complement

characteristic equation

$Q_{t+1} = J Q_t' + K' Q_t$

T flip-flop

characteristic table

T	Q_{t+1}	
0	Q_t	No change
1	Q'_t	Complement

$Q_{(t+1)} = J Q' + K' Q$

$T Q_{t+1} = T \oplus Q_t$

2 a. $A_{t+1} = x' A_t' + B_t' A_t$

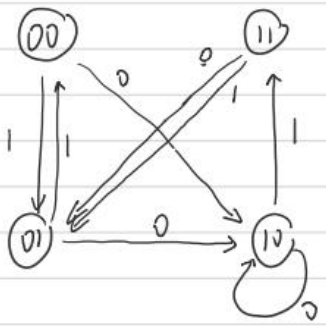
$B_{t+1} = x B_t' + A_t B_t$

$J_A = x' \quad K_A = B$

$J_B = x \quad K_B = A'$

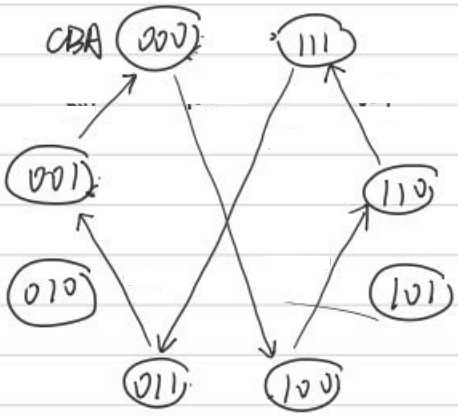
b

Present A	Present B	Input x	Next A	Next B	J_A	K_A	J_B	K_B
0	0	0	1	0	1	0	0	1
0	0	1	0	1	0	0	1	1
0	1	0	1	0	1	1	0	1
0	1	1	0	0	0	1	1	1
1	0	0	1	0	1	0	0	0
1	0	1	1	1	0	0	1	0
1	1	0	0	1	1	1	0	0
1	1	1	0	1	0	1	1	0



3

Present State			Next State			Flip-Flop Inputs		
C(t)	B(t)	A(t)	C(t+1)	B(t+1)	A(t+1)	TC	TB	TA
0	0	0	1	0	0	1	0	0
0	0	1	0	0	0	0	0	1
0	1	0	x	x	x	x	x	x
0	1	1	0	0	1	0	1	0
1	0	0	1	1	0	0	1	0
1	0	1	x	x	x	x	x	x
1	1	0	1	1	1	0	0	1
1	1	1	0	1	1	1	0	0



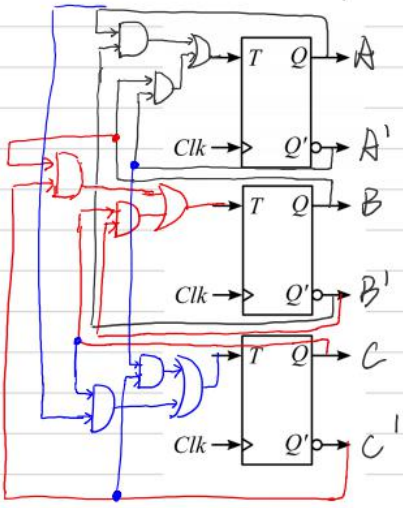
T_C = $A'C' + AC$

T_B = $B'C + BC'$

T_A = $AB' + A'B$

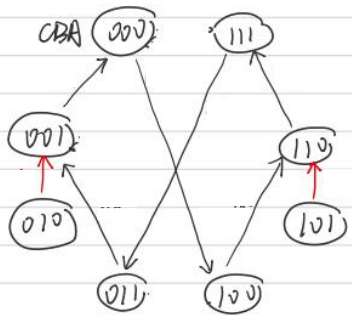
Explanation of why the counter may not operate properly

Because when 010 the {TC, TB, TA} = 3'b111, then the output is 101.
When 101, the {TC, TB, TA} = 3'b111, then the output is 010. It goes the cycle.



After

Present State			Next State			Flip-Flop Inputs		
C(t)	B(t)	A(t)	C(t+1)	B(t+1)	A(t+1)	TC	TB	TA
0	0	0	1	0	0	1	0	0
0	0	1	0	0	0	0	0	1
0	1	0	x 0	x 0	x 1	x0	x1	x1
0	1	1	0	0	1	0	1	0
1	0	0	1	1	0	0	1	0
1	0	1	x 1	x 1	x 0	x0	x1	x1
1	1	0	1	1	1	0	0	1
1	1	1	0	1	1	1	0	0



Explanation of idea: When the counter reaches 010 or 101, let them go into the correct cycle

4.

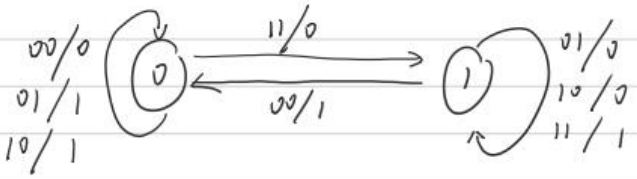
Present Q_t	Input x	Input y	Next Q_{t+1}	Output S	Output C
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	0	1	0
0	1	1	1	0	1
1	0	0	0	1	0
1	0	1	1	0	1
1	1	0	1	0	1
1	1	1	1	1	1

$S = x \oplus y \oplus Q$

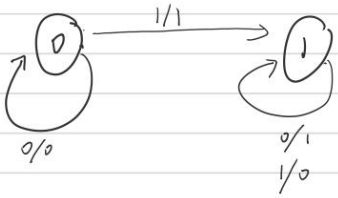
$C = xy + Q_t y + Q_t x$

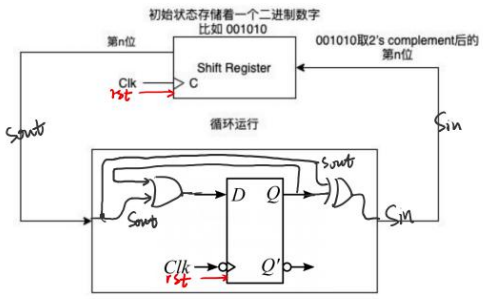
$D = xy + Q_t y + Q_t x$

$Q_{t+1} = xy + Q_t y + Q_t x$



5.





The initial stored in D flip-flop is 0

Sout is the output of the shift register

Sin is the input of the shift register

Q_t	Sout	Sin	Q_{t+1}
0	0	0	0
0	1	1	1
1	0	1	1
1	1	0	1

input equation $D = Sout + Q_t$

output equation $Sin = Sout \oplus Q_t$

Task 1: Design of JK flip-flop in Verilog