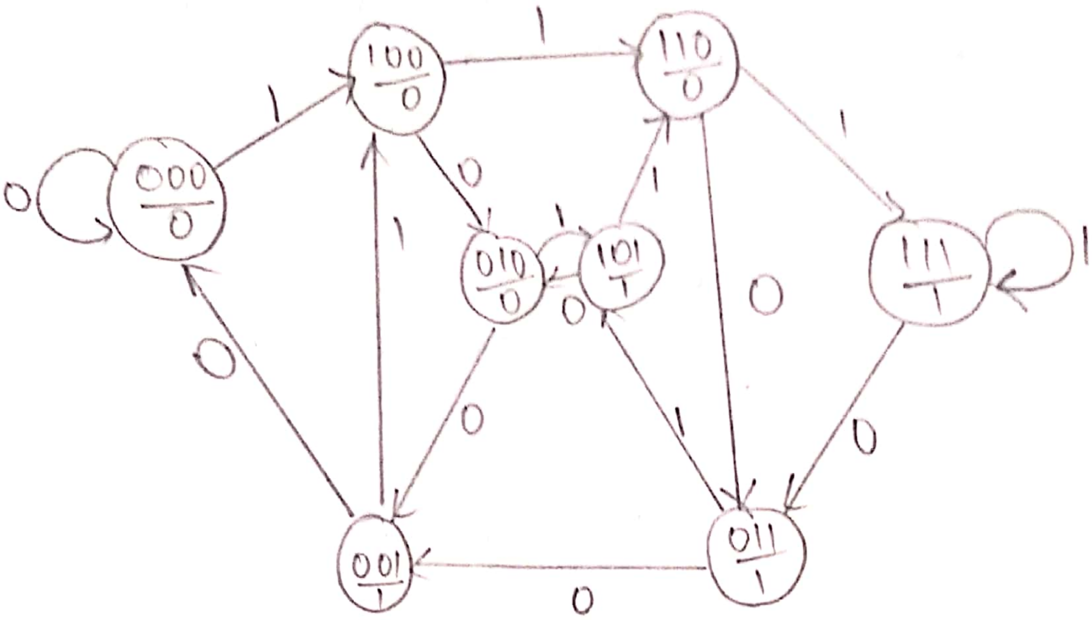
1



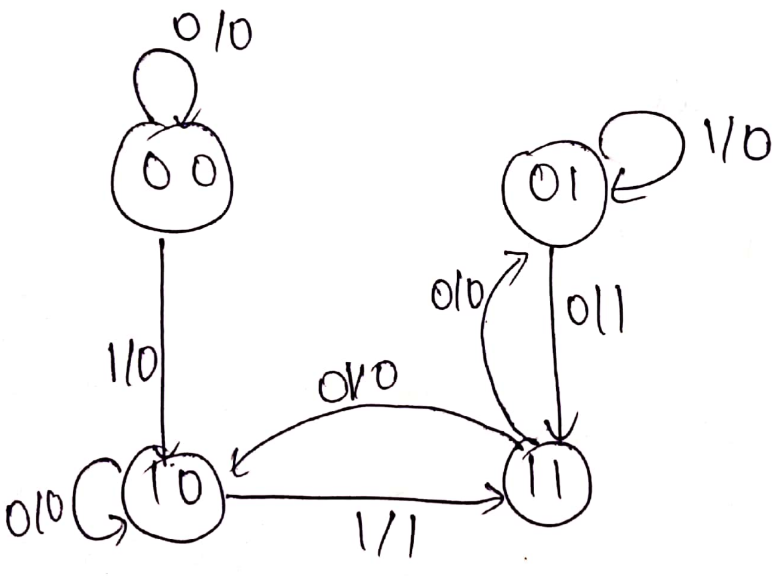
As the output depends only on the present state hence moore state machine.

2 For the given circuit

$J_A = X\bar{B} + \bar{X}B = X \oplus B$
$K_A = \bar{X}B$
$J_B = XA$
$K_B = XA$
Out $= AB$

A	B	X	J_A ($X \oplus B$)	K_A ($\bar{X}B$)	J_B (XA)	K_B (XA)	A^+	B^+	Out (AB)
0	0	0	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	0	0
0	1	0	1	1	0	0	1	1	1
0	1	1	0	0	0	0	0	1	0
1	0	0	0	0	0	0	1	0	0
1	0	1	1	0	1	1	1	1	1
1	1	0	1	1	0	0	0	1	0
1	1	1	0	0	1	1	1	0	0

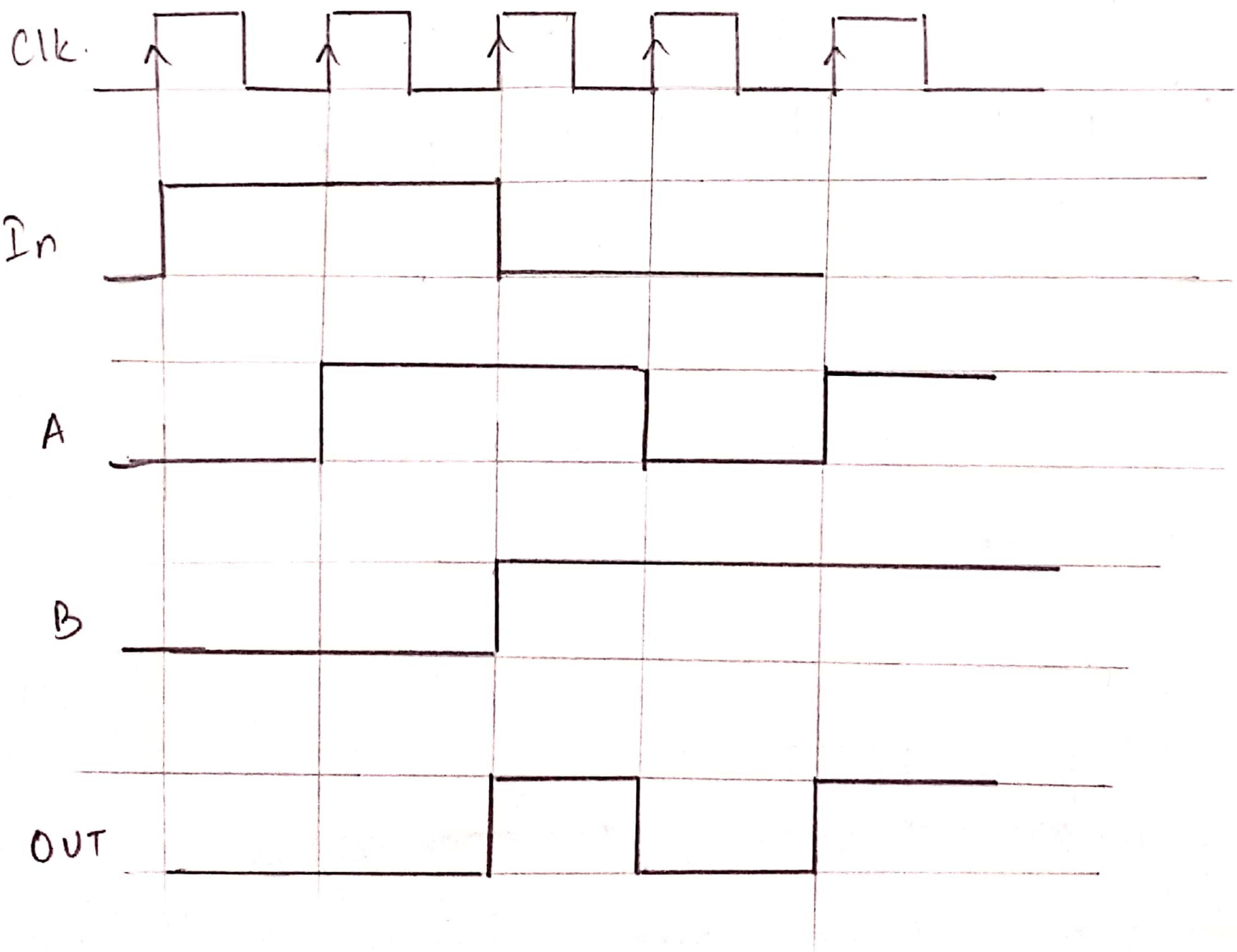
State representation



State graph

) $X = 01100$

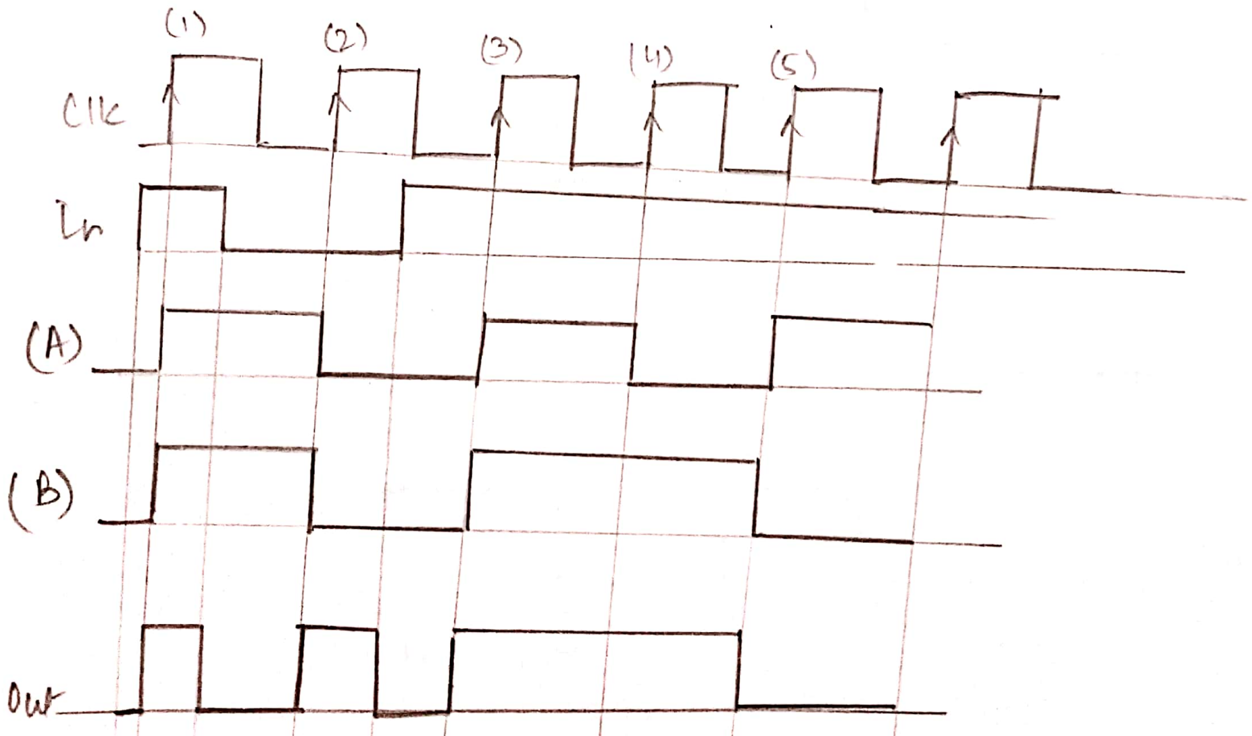
A	B	X	J_A ($X \oplus B$)	K_A ($\bar{X} B$)	J_B (XA)	K_B (XA)	A^+	B^+	Out = (AB̄)
0	0	0	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	0	0
1	0	1	1	0	1	1	1	1	~~0~~ 1
1	1	0	1	1	0	0	0	1	0
0	1	0	1	1	0	0	1	1	1



(3)

$J_1 = X$	$K_1 = \bar{X} + Q_2$
$J_2 = X$	$K_2 = \bar{Q_1} + \bar{X}$
$Out = X \oplus \bar{Q_2}$	

A	B	In	J_A	K_A	J_B	K_B	A^+	B^+	Out.
0	0	1	1	0	1	0	1	1	
1	1	0	0	1	0	1	0	0	
0	0	1	1	0	1	1	1	1	
1	1	1	1	1	1	0	0	1	
0	1	1	1	1	1	1	1	0	



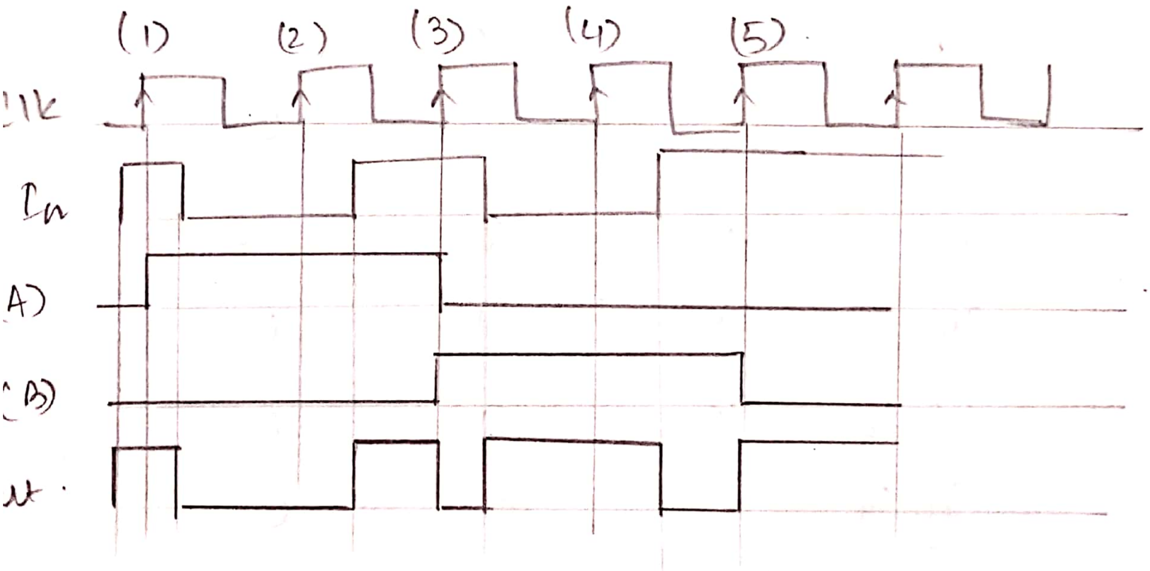
$k_1 = k_2 = x.$

$J_1 = \bar{Q}_2 \, x$

$Out = x \oplus Q_2$

$J_2 = x Q_1$

A	B	In	J_A	K_A	J_B	K_B	A^+	B^+	Out
0	0	1	1	1	0	1	1	0	
1	0	0	0	0	0	0	1	0	
1	0	1	1	1	1	1	0	1	
0	1	0	0	0	0	0	0	1	
0	1	1	0	1	0	1	0	0	



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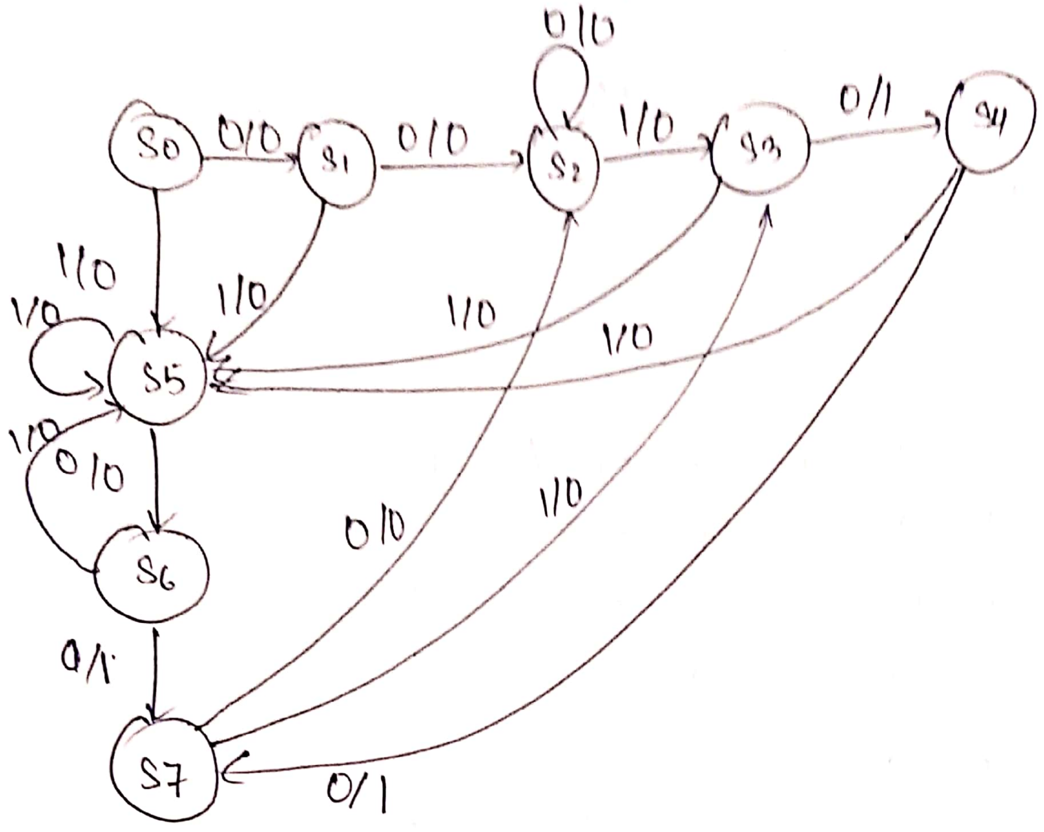
(5) to detect 0010 | 100



Present state	Next state X=0	Next state X=1	Output X=0	Output X=1
S_0	S_1	S_5	0	0
S_1	S_2	S_5	0	0
S_2	S_2	S_3	0	0
S_3	S_4	S_5	1	0
S_4	~~S_4~~ S_2	S_5	1	0
S_5	~~S_6~~ S_4	S_5	0	0
~~S_6~~	~~S_7~~	~~S_5~~	~~1~~	~~0~~
~~S_7~~	~~S_2~~	~~S_3~~	~~0~~	~~0~~

From here $S_2 = S_7$ and $S_6 = S_4$

$\therefore$ S_6 and S_7 redundant states.

State table.

A	B	C	In	A^+	B^+	C^+	Out
0	0	0	0	0	0	~~0~~ 1	0
0	0	0	1	1	0	1	0
0	0	1	0	0	1	0	0
0	0	1	1	1	0	1	0
0	1	0	0	0	1	0	0
0	1	0	1	0	1	1	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	0	1	0	1
1	0	0	1	1	0	1	0
1	0	1	0	1	0	0	0
1	0	1	1	1	0	1	0

A^+

	$\bar{C}\bar{X}$	$\bar{C}X$	CX	$C\bar{X}$
$\bar{A}\bar{B}$	0	1	1	0
$\bar{A}B$	0	0	1	1
AB	x	x	α	α
$A\bar{B}$	0	1	1	1

$$\boxed{A^+ = \bar{B}X + BC + CX + AC}$$

B^+

	$\bar{C}\bar{X}$	$\bar{C}X$	CX	$C\bar{X}$
$\bar{A}\bar{B}$	0	0	0	1
$\bar{A}B$	1	1	0	0
AB	α	α	α	α
$A\bar{B}$	1	0	0	0

$$\boxed{B^+ = A\bar{C}\bar{X} + B\bar{C} + \bar{A}\bar{B}C\bar{X}}$$

Out

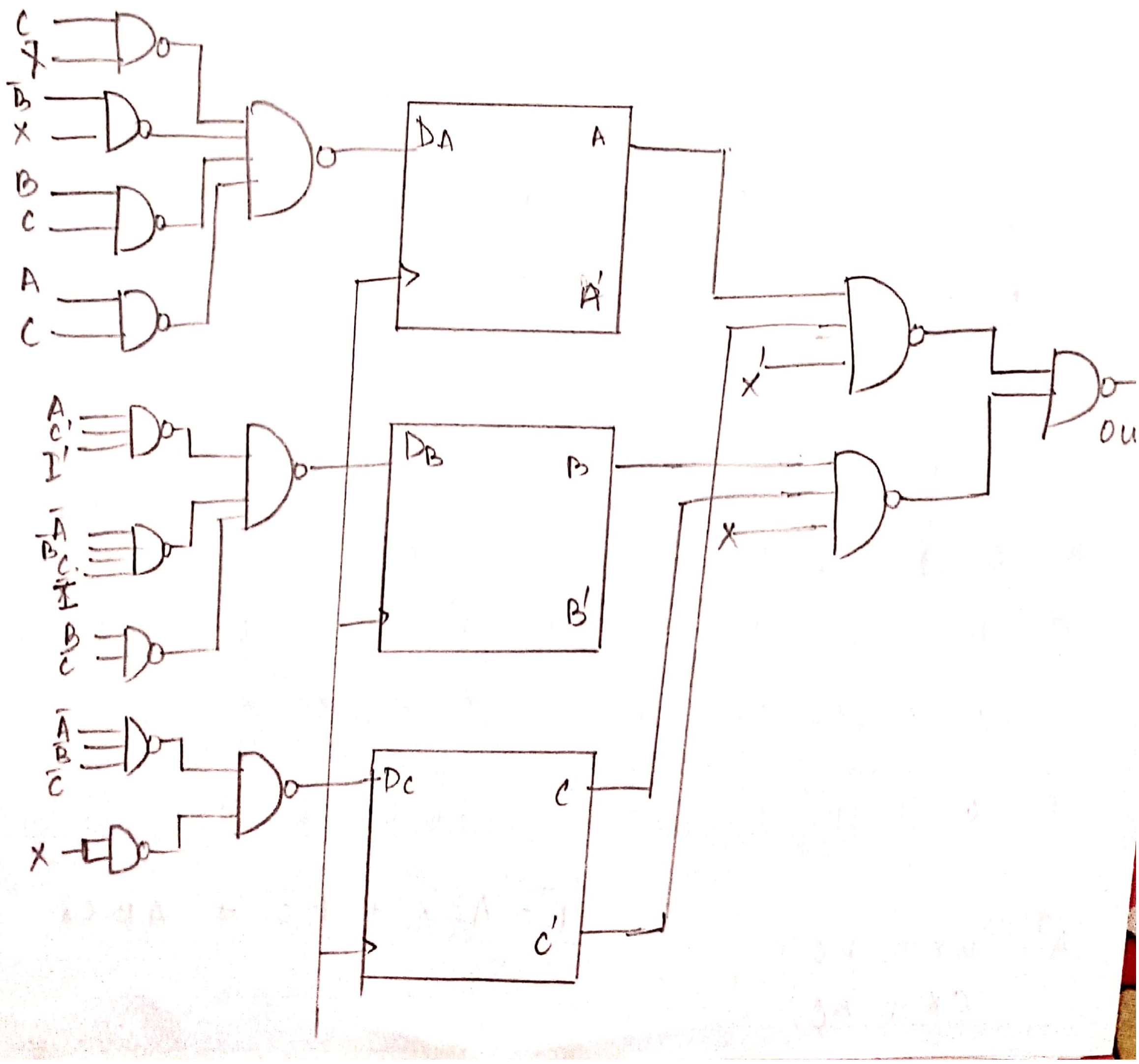
	$\bar{C}\bar{X}$	$\bar{C}X$	CX	$C\bar{X}$
$\bar{A}\bar{B}$	0	0	0	0
$\bar{A}B$	0	0	0	1
AB	x	x	x	x
$A\bar{B}$	1	0	0	0

$$Out = A\bar{C}\bar{X} + BC\bar{X}$$

C^+

	$\bar{C}\bar{X}$	$\bar{C}X$	CX	$C\bar{X}$
$\bar{A}\bar{B}$	1	1	1	0
$\bar{A}B$	0	1	1	0
AB	x	x	x	x
$A\bar{B}$	0	1	1	0

$$C^+ = \bar{A}\bar{B}\bar{C} + X.$$



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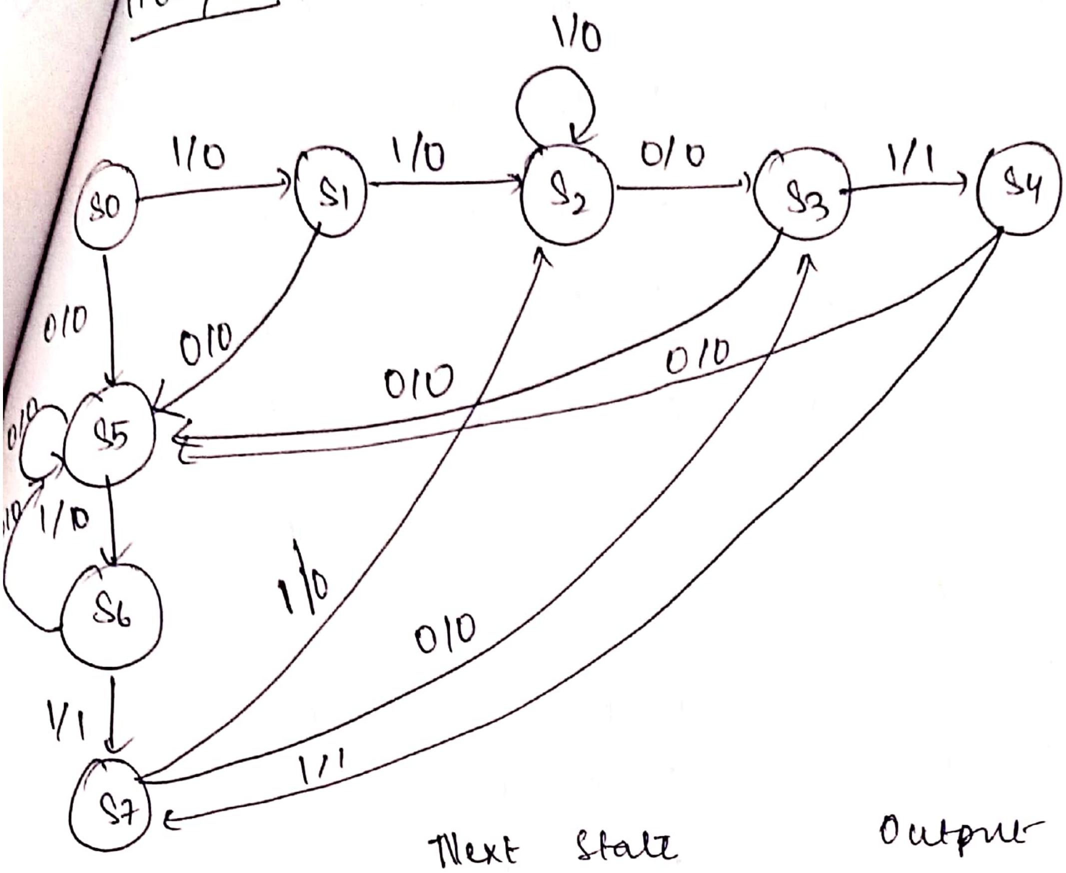
1101/011



Present	Next State $X=0$	Next State $X=1$	Output $X=0$	Output $X=1$
S_0	S_5	S_1	0	0
S_1	S_5	S_2	0	0
S_2	S_3	S_2	0	0
S_3	S_5	S_4	0	1
S_4	S_5	S_2	0	1
S_5	S_5	S_6	0	0
S_6	S_5	S_7	0	~~0~~ 1
S_7	S_3	S_2	0	0

From here $\boxed{S_7 = S_2}$

and $\boxed{S_4 = S_6}$

Scanned by CamScanner

A	B	C	In	A^+	B^+	C^+	Output
0	0	0	0	1	0	1	0
0	0	0	1	0	0	1	0
0	0	1	0	1	0	1	0
0	0	1	1	0	1	0	0
0	1	0	0	0	1	1	0
0	1	0	1	0	1	0	0
0	1	1	0	1	0	1	0
0	1	1	1	1	0	0	1
1	0	0	0	1	0	1	0
1	0	0	1	0	1	0	1
1	0	1	0	1	0	1	0
1	0	1	1	1	0	0	0

A^+

	$\bar{C}\bar{X}$	$\bar{C}X$	CX	$C\bar{X}$
$\bar{A}\bar{B}$	1	0	0	1
$\bar{A}B$	0	0	1	1
AB	α	α	α	α
$A\bar{B}$	1	0	1	1

B^+

0	0	1	0
1	1	0	0
α	α	α	α
0	1	0	0

$A^+ = C\bar{X} + \bar{B}\bar{X} + BC + AC +$

$= AC + BC + \bar{B}\bar{X} + C\bar{X}$

$B^+ = B\bar{C} + A\bar{C}X + \bar{A}\bar{B}CX.$

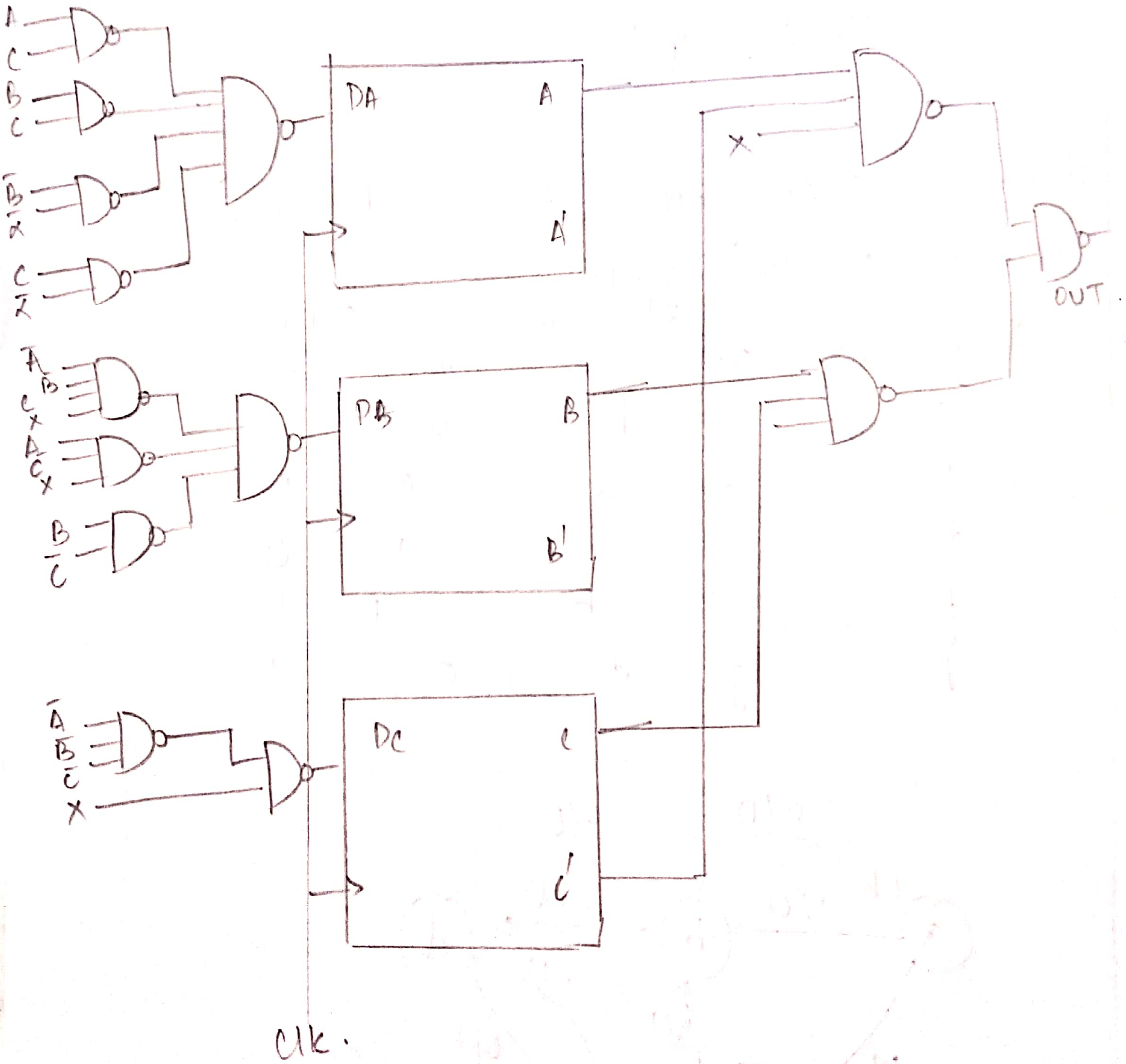
1	1	0	1
1	0	0	φ
x	x	x	x
1	0	0	1

$C^+ = \bar{X} + \bar{A}\bar{B}\bar{C}$

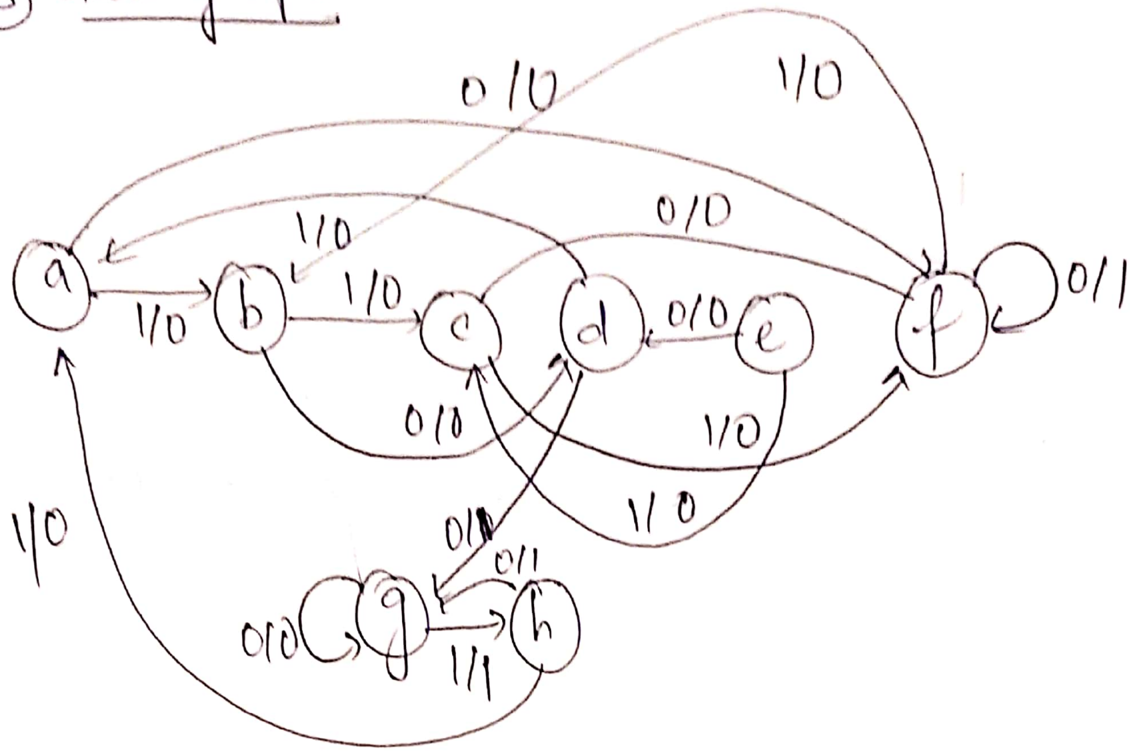
Out

0	0	0	0
0	0	1	0
x	x	x	1
0	1	0	0

$out = A\bar{C}X + BCX.$



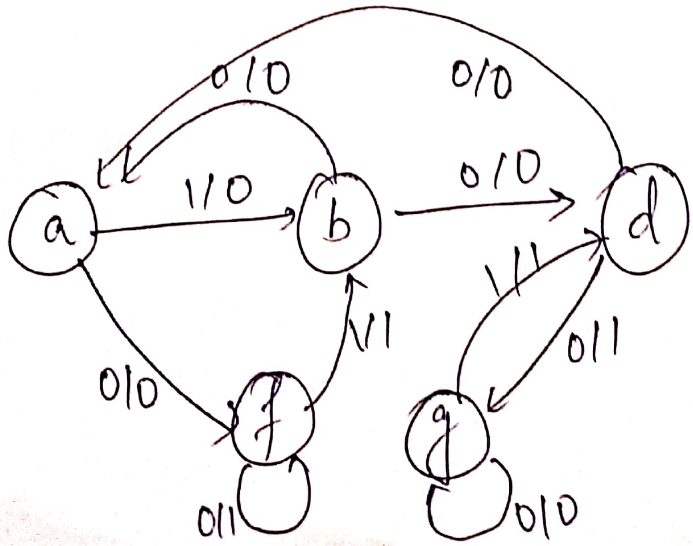
8 State graph



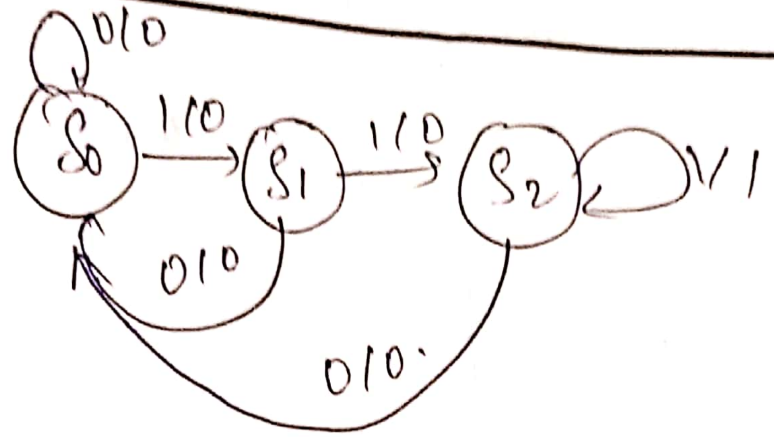
from the state graph, d=h ; b=e ; a=c

So reduced state graph:

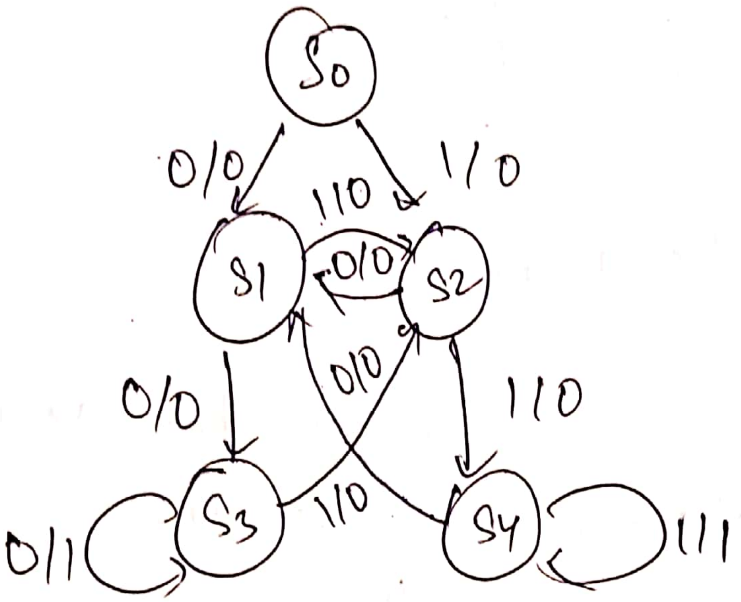
Present state	Next state $x=0$	Next state $x=1$	Output $x=0$	Output $x=1$
a	f	b	0	0
b	d	a	0	0
d	g	a	1	0
f	f	b	1	1
g	g	d	0	1



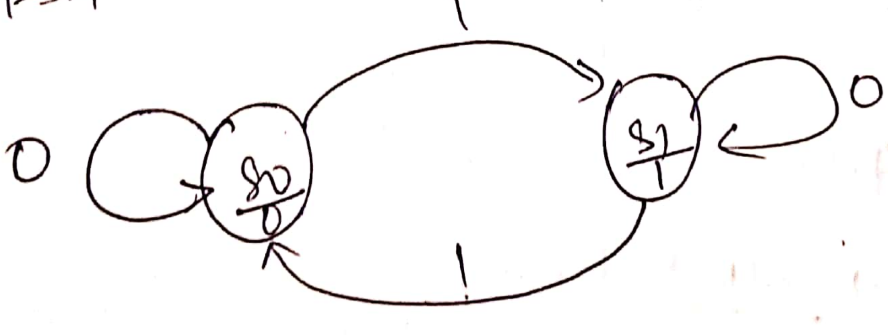
9



10



The output of this FSM to the following FSM



(11) $T_{min} = (T_{clk-q})_{longest} + T_{setup} + (T_{or-gate})_{longest}$

$= 12ns + 5ns + 4ns.$

$$\boxed{T_{min} = 21ns.}$$

$$\Rightarrow \boxed{f_{max} = \frac{10^9}{21} Hz}$$

Minimum delay = $(6+1)$ ns.

the minimum delay should have positive slack for hold time = $7ns - 3ns$

$= 4ns.$

∴ Minimum time after rising edge at which the input can change

$= 21ns - 4ns$

$\boxed{= 17ns} \rightarrow$ latest time.

$$\boxed{\text{earliest time} = 21ns - 17ns + 3ns = 7ns}$$

(12) $T_{min} = (T_{clk-q})_{longest} + (T_{c.c})_{longest} + T_{setup}$

$= 24ns + 16ns + 8ns$

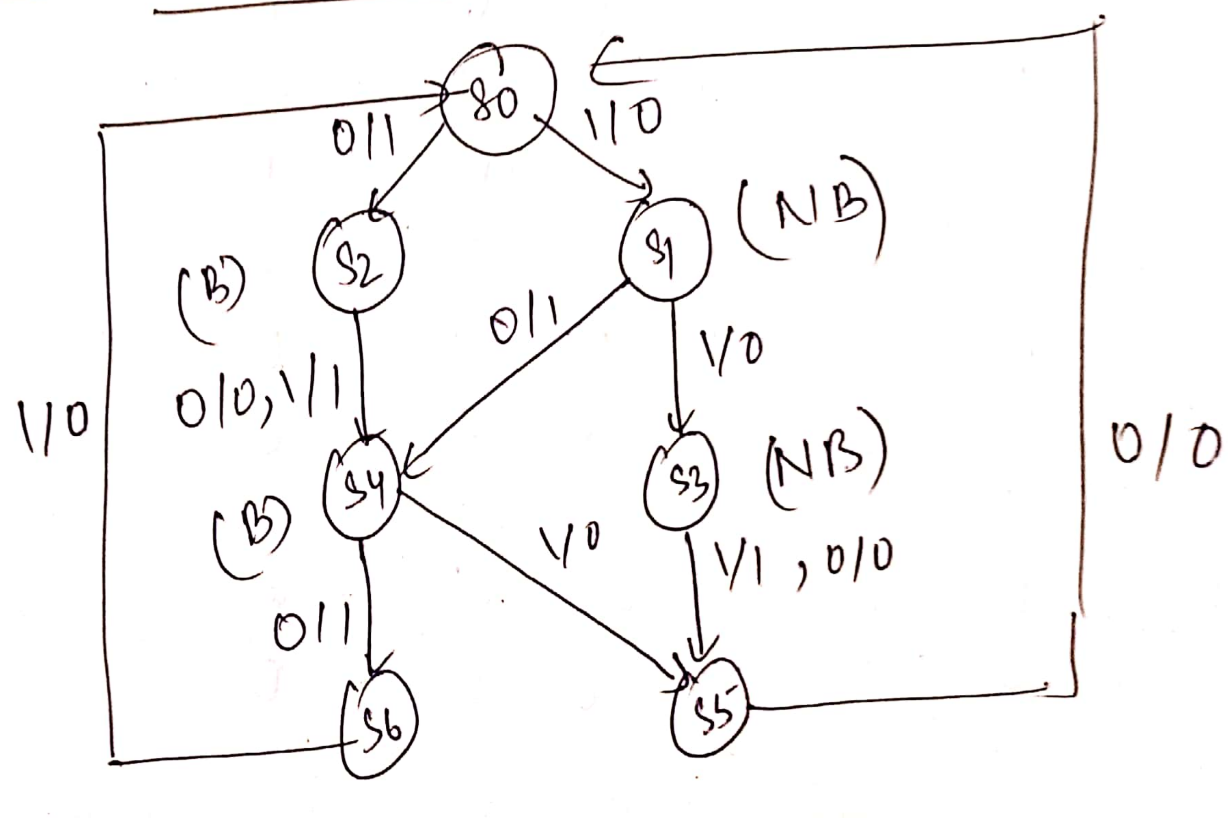
$= 48ns$

$$\boxed{f_{max} = \frac{10^9}{48} Hz}$$

Earliest can be changed at 12ns.

Latest can be changed at 38ns.

(7) FSM for excess 3 to BCD.



	0	1	0	1
S_0	S_2	S_1	1	0
S_1	S_4	S_3	1	0
S_2	S_4	S_4	0	1
S_3	S_5	S_5	0	1
S_4	S_6	S_5	1	0
S_5	S_0	–	0	x
S_6	–	S_0	x	0

A	B	C	In	A^+	B^+	C^+	Out
0	0	0	0	0	1	0	1
0	0	0	1	0	0	1	0
0	0	1	0	1	0	0	1
0	0	1	1	0	1	1	0
0	1	0	0	1	0	0	0
0	1	0	1	1	0	0	1
0	1	1	0	1	0	1	0
0	1	1	1	1	0	1	1
1	0	0	0	1	1	0	1
1	0	0	1	1	0	1	0
1	0	1	0	0	0	0	0
1	0	1	1	α	α	α	α
1	1	0	0	α	α	α	α
1	1	0	1	0	0	0	0

⇒ gives

$$\boxed{A^+ = \bar{A}B + \bar{A}C\bar{I} + A\bar{B}\bar{C}}$$

$$\boxed{B^+ = B\bar{C}\bar{I} + \bar{B}CI}$$

$$\boxed{C^+ = CI + BI + BC}$$

$$\boxed{Out = \bar{A}\bar{B}\bar{I} + A\bar{C}\bar{I} + B\bar{I}}$$