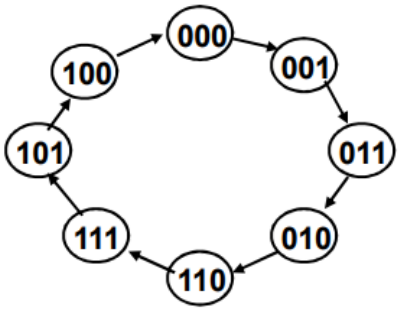
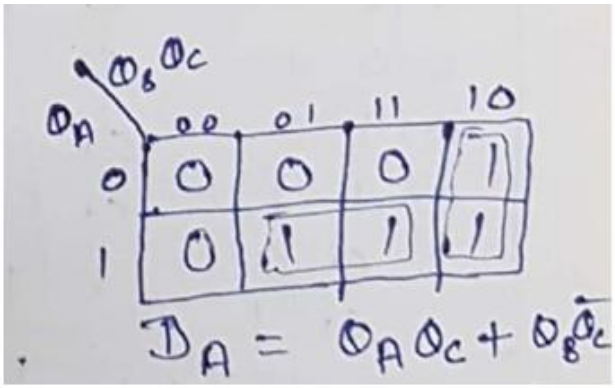
Solution Tutorial 8

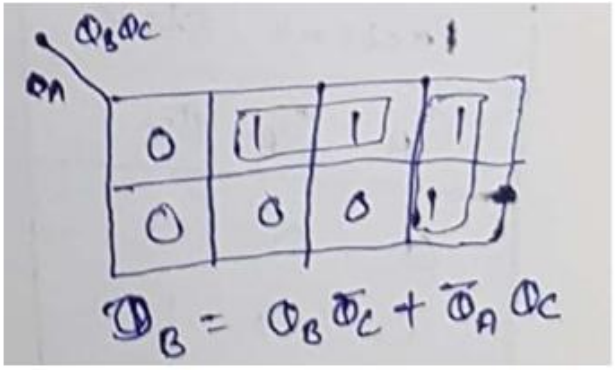
Ans 1 A 3-bit Gray code counter (using D flip-flops).

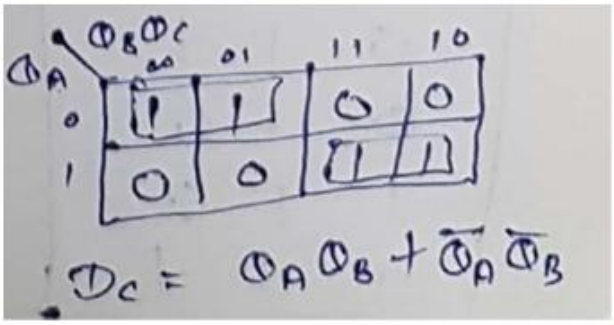


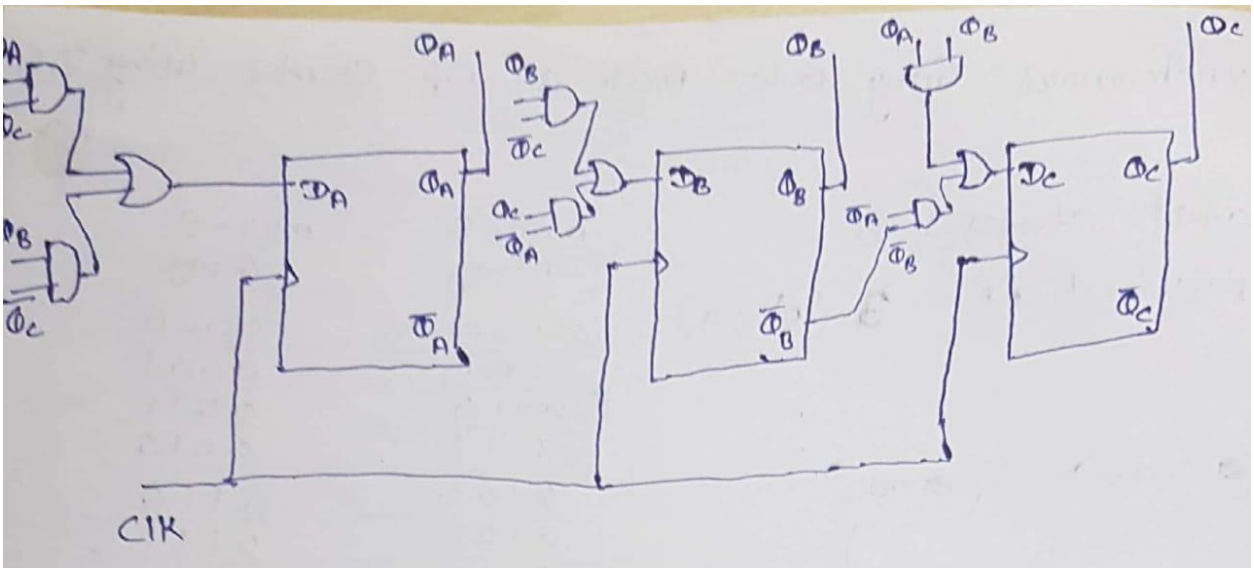
→ State table

Present State			Next State			ff i/p		
Q_A	Q_B	Q_C	Q_{A+1}	Q_{B+1}	Q_{C+1}	D_A	D_B	D_C
0	0	0	0	0	1	0	0	1
0	0	1	0	1	1	0	1	1
0	1	1	0	1	0	0	1	0
0	1	0	1	1	0	1	1	0
1	1	0	1	1	1	1	1	1
1	1	1	1	0	1	1	0	1
1	0	1	1	0	0	1	0	0
1	0	0	0	0	0	0	0	0









Ans 2

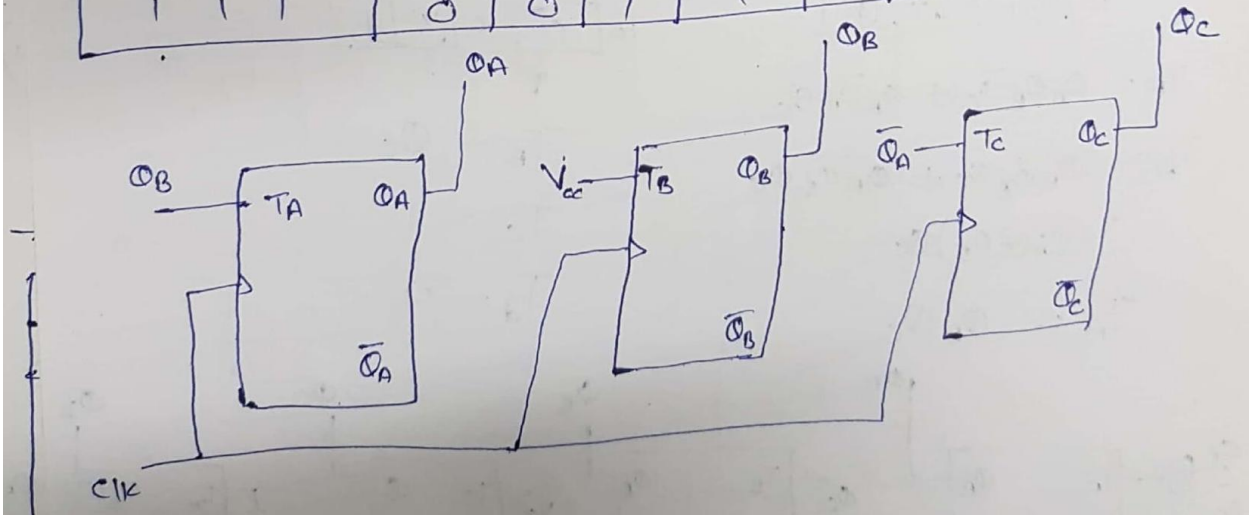
Unused states are 0, 3, 4, 6 → Consider them as don't care

Present state			Next state			F.F. inputs		
Q_A	Q_B	Q_C	Q_{A+1}	Q_{B+1}	Q_{C+1}	T_A	T_B	T_C
0	0	1	0	1	0	0	1	1
0	1	0	1	0	1	1	1	1
1	0	1	1	1	1	0	1	0
1	1	1	0	0	1	1	1	0

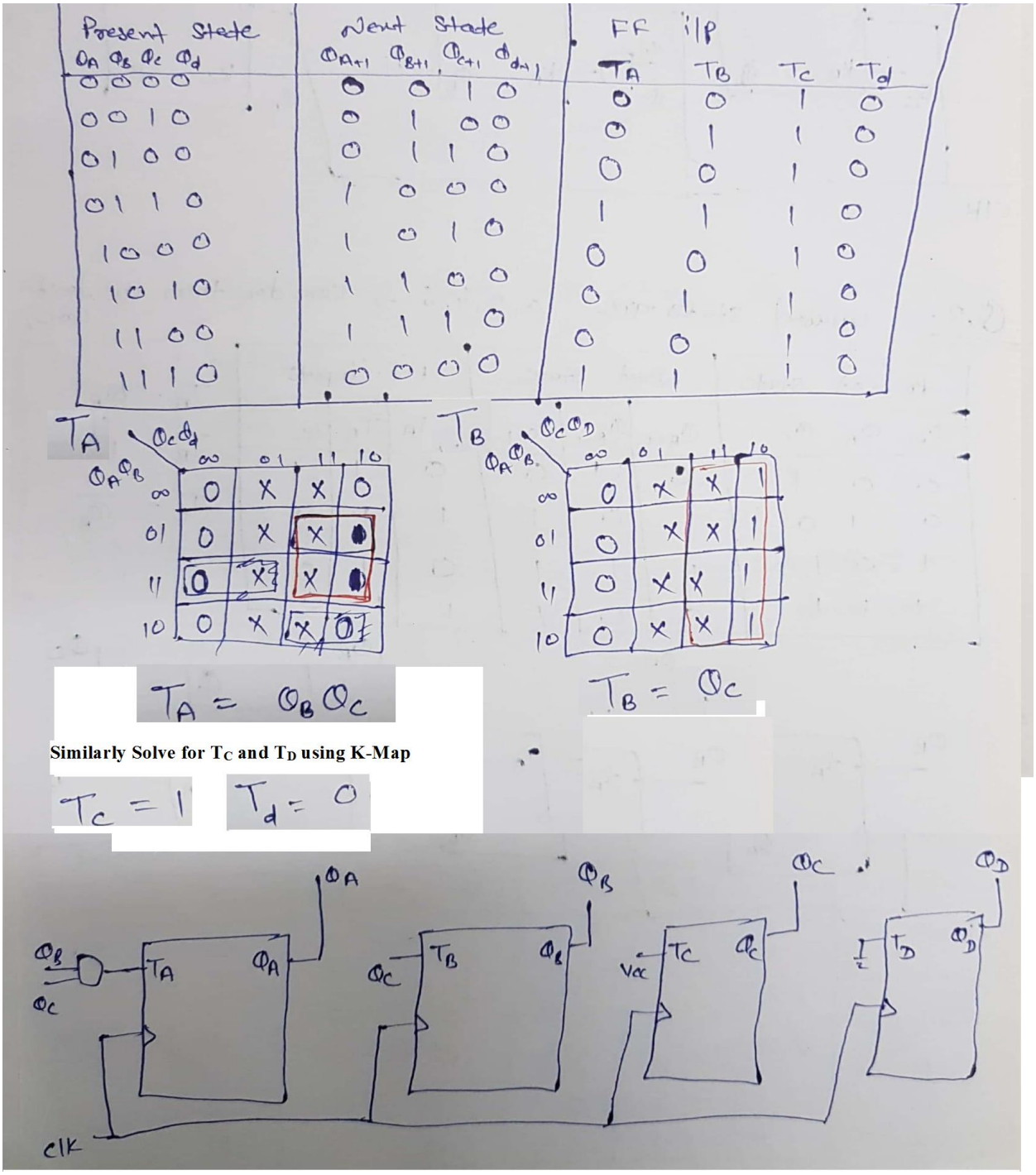
$T_A = Q_B$

$T_B = 1$

$T_C = \overline{Q_A}$



Ans 3



Present State $Q_A\ Q_B\ Q_C\ Q_D$	Next State $Q_{A+1}\ Q_{B+1}\ Q_{C+1}\ Q_{D+1}$	FF i/p $T_A\ T_B\ T_C\ T_d$
0 0 0 0	0 0 1 0	0 0 1 0
0 0 1 0	0 1 0 0	0 1 1 0
0 1 0 0	0 1 1 0	0 0 1 0
0 1 1 0	1 0 0 0	1 1 1 0
1 0 0 0	1 0 1 0	0 0 1 0
1 0 1 0	1 1 0 0	0 1 1 0
1 1 0 0	1 1 1 0	0 0 1 0
1 1 1 0	0 0 0 0	1 1 1 0

T_A K-map ($Q_A Q_B$ vs $Q_C Q_D$):

$Q_A Q_B$ \ $Q_C Q_D$	00	01	11	10
00	0	X	X	0
01	0	X	X	0
11	0	X	X	0
10	0	X	X	0

$T_A = Q_B Q_C$

T_B K-map ($Q_A Q_B$ vs $Q_C Q_D$):

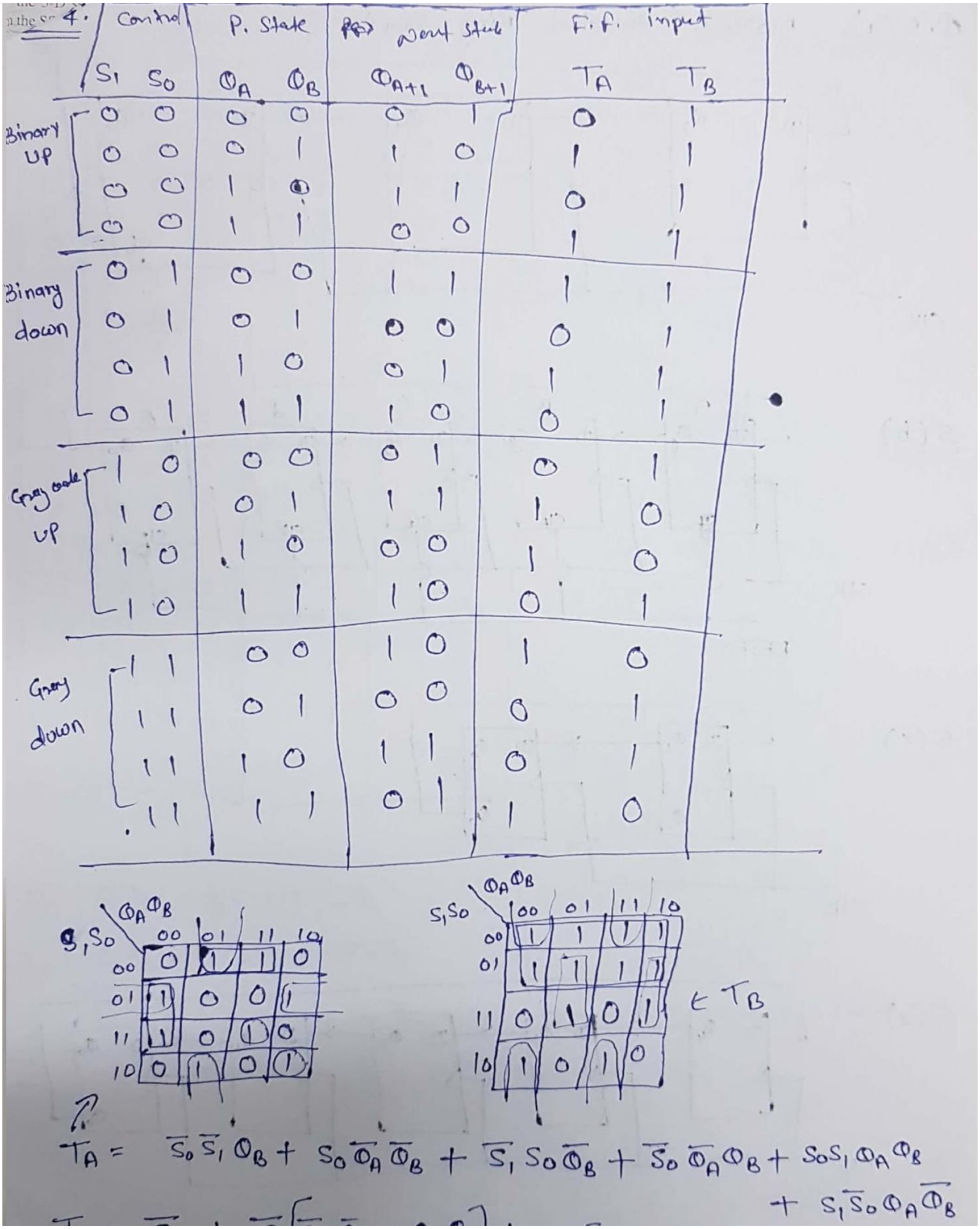
$Q_A Q_B$ \ $Q_C Q_D$	00	01	11	10
00	0	X	X	1
01	0	X	X	1
11	0	X	X	1
10	0	X	X	1

$T_B = Q_C$

Similarly Solve for T_C and T_D using K-Map

$T_C = 1$ $\quad T_d = 0$

Ans 4

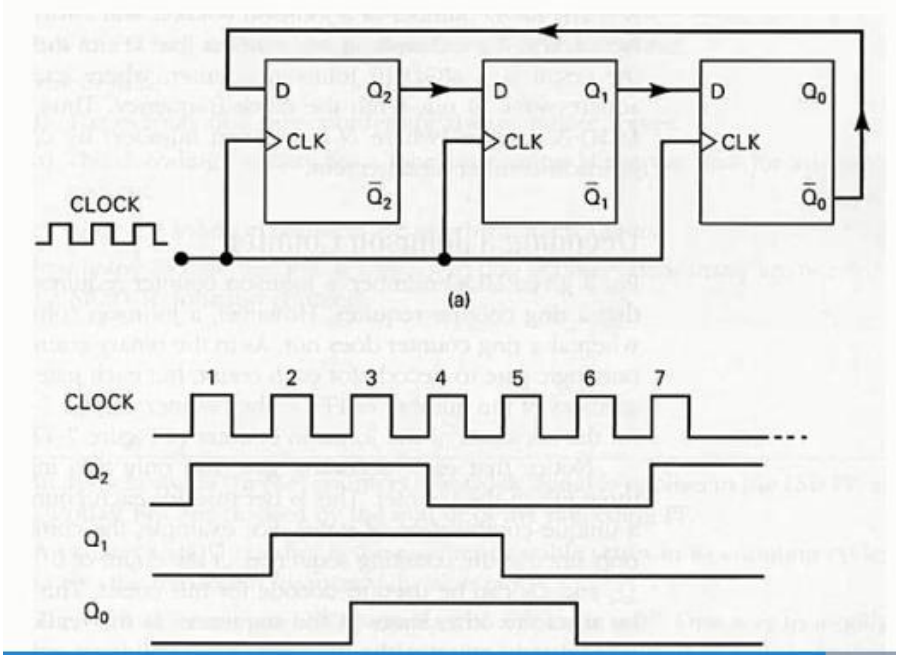


	Control S_1	Control S_0	P. State Q_A	P. State Q_B	Next State Q_{A+1}	Next State Q_{B+1}	F.F. Input T_A	F.F. Input T_B
Binary up	0	0	0	0	0	1	0	1
	0	0	0	1	1	0	1	1
	0	0	1	0	1	1	0	1
	0	0	1	1	0	0	1	1
Binary down	0	1	0	0	1	1	1	1
	0	1	0	1	0	0	0	1
	0	1	1	0	0	1	1	1
	0	1	1	1	1	0	0	1
Gray code up	1	0	0	0	0	1	0	1
	1	0	0	1	1	1	1	0
	1	0	1	0	0	0	1	0
	1	0	1	1	1	0	0	1
Gray down	1	1	0	0	1	0	1	0
	1	1	0	1	0	0	0	1
	1	1	1	0	1	1	0	1
	1	1	1	1	0	1	1	0

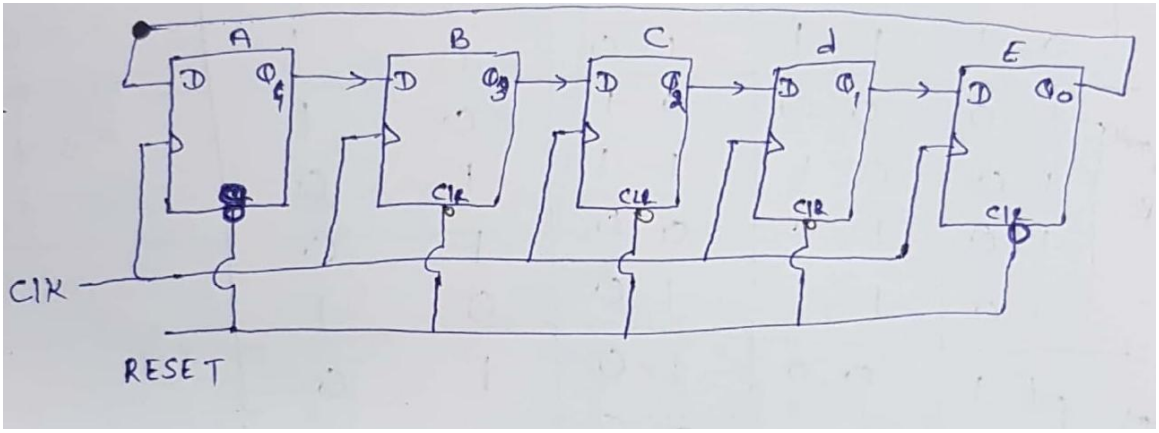
$$T_A = \bar{S_0}\bar{S_1}Q_B + S_0\bar{Q_A}\bar{Q_B} + \bar{S_1}S_0\bar{Q_B} + \bar{S_0}\bar{Q_A}Q_B + S_0S_1Q_AQ_B + S_1\bar{S_0}Q_A\bar{Q_B}$$

Ans 5

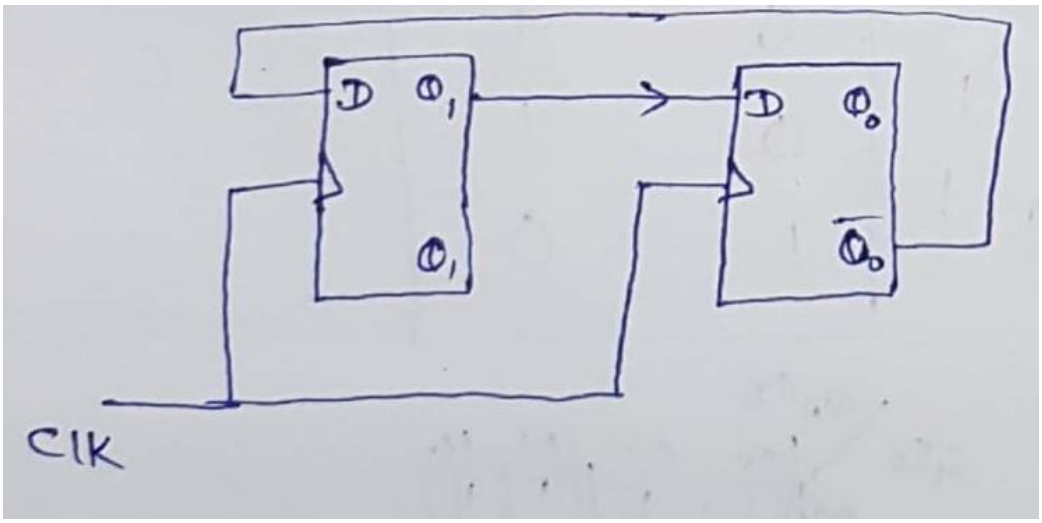
(a)


D
Q2
CLK
Q̄2
D
Q1
CLK
Q̄1
D
Q0
CLK
Q̄0
CLOCK
(a)
1
2
3
4
5
6
7
CLOCK
Q2
Q1
Q0

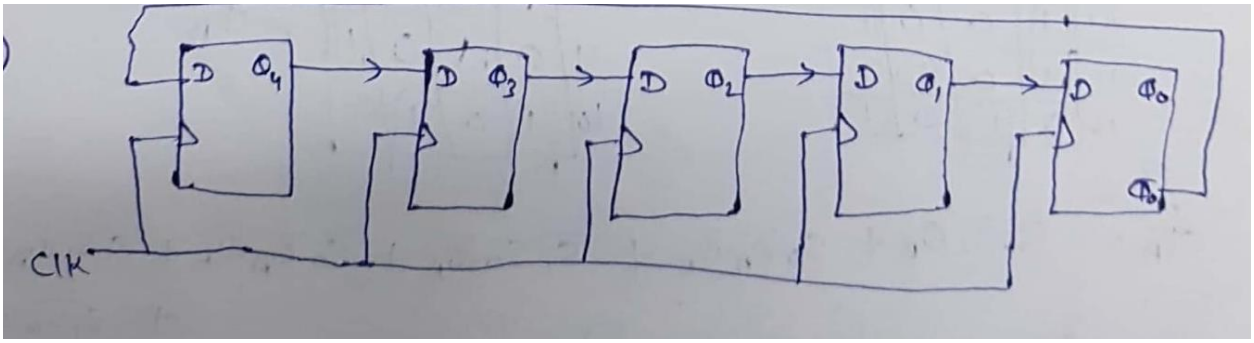
(b)


A
B
C
d
E
D
CLR
RESET

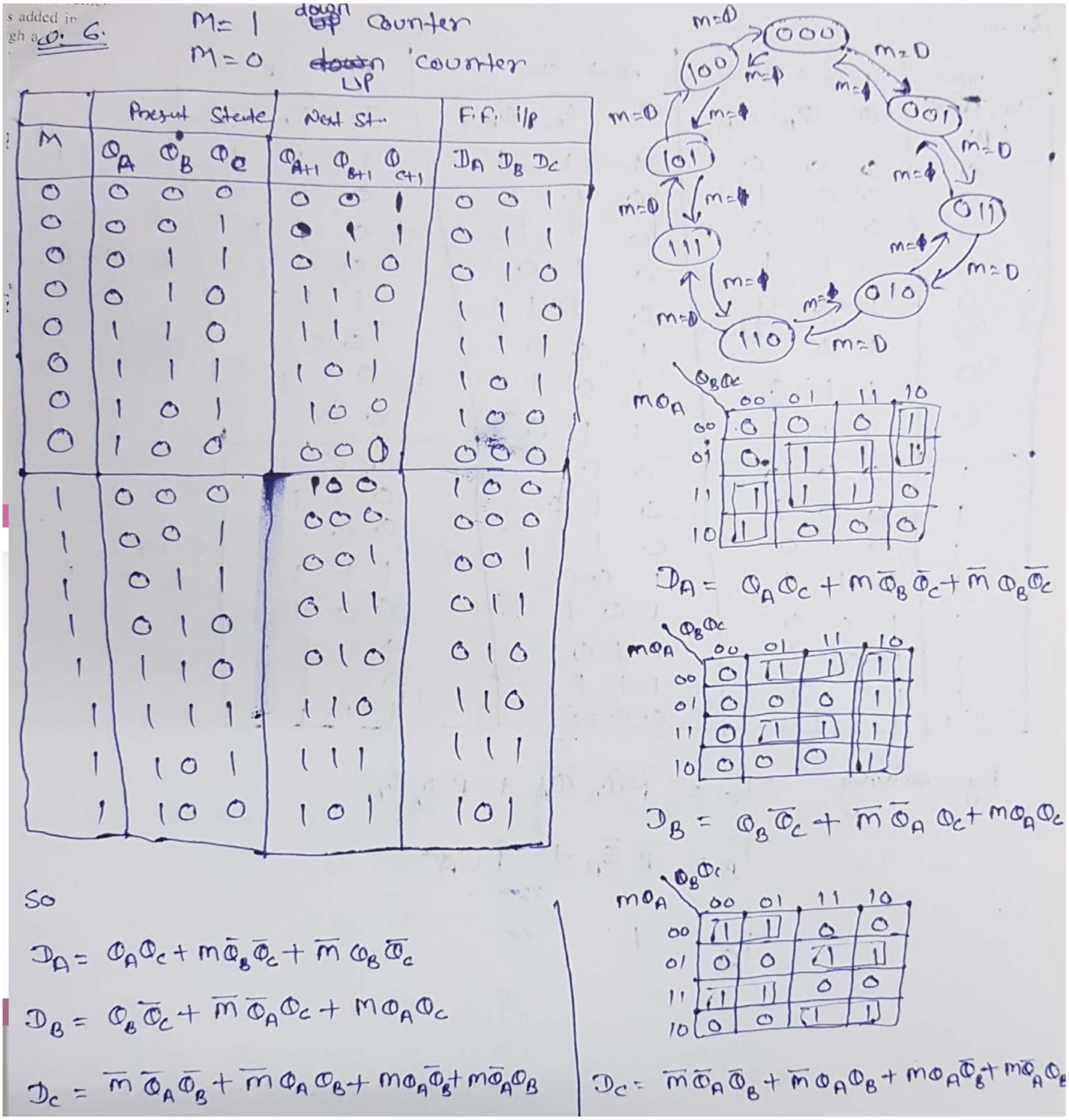
(c)



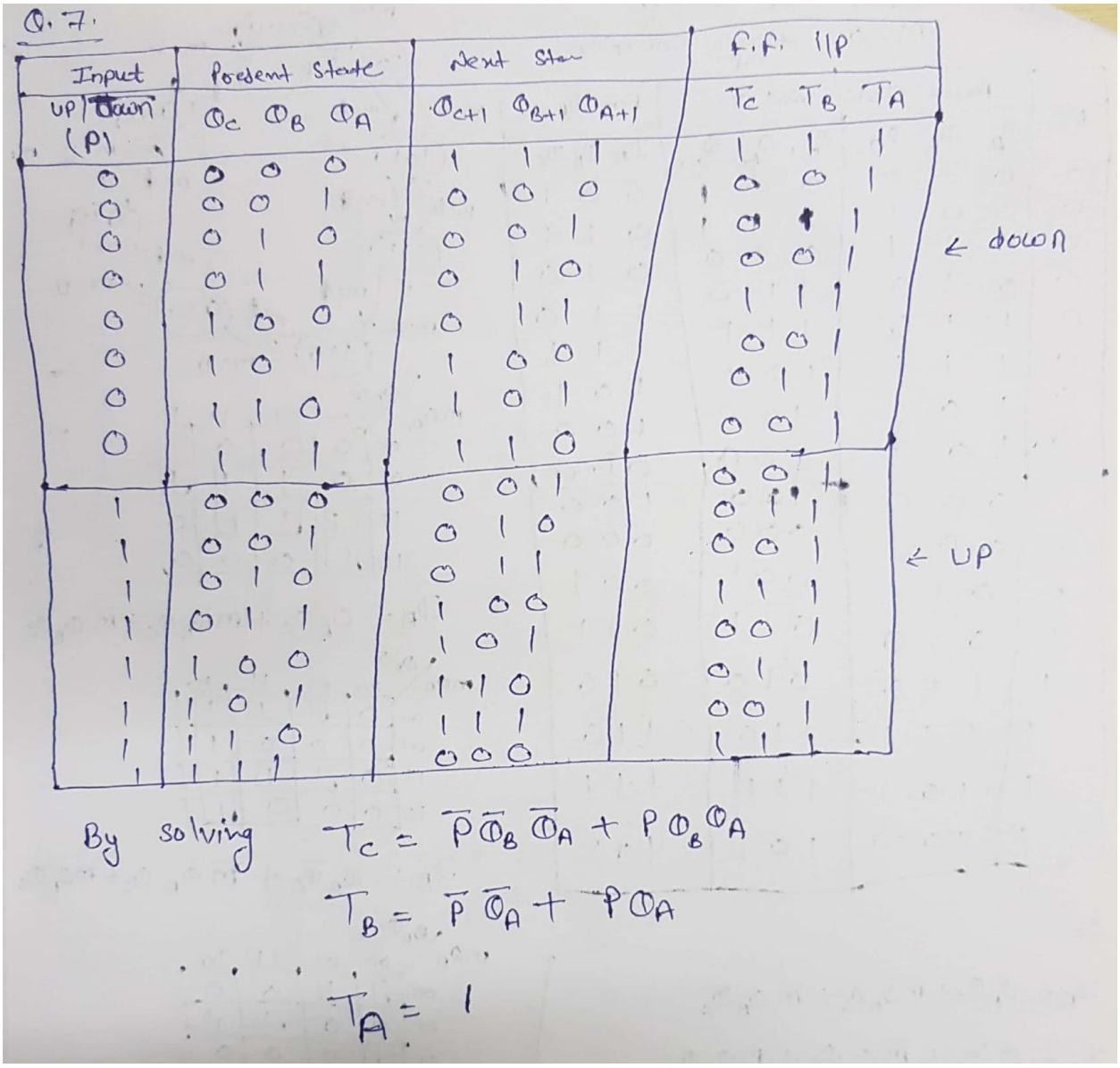
(d)



Ans 6


Q. 6.
M = 1 down counter
M = 0 up counter
Present State
Next St.
F.F. i/p
M
Q_A Q_B Q_C
Q_{A+1} Q_{B+1} Q_{C+1}
D_A D_B D_C
000
001
011
010
110
111
101
100
m=0
m=1
Q_BQ_C
mQ_A
00 01 11 10
$D_A = Q_AQ_C + m\bar{Q}_B\bar{Q}_C + \bar{m}Q_B\bar{Q}_C$
$D_B = Q_B\bar{Q}_C + \bar{m}\bar{Q}_AQ_C + mQ_AQ_C$
$D_C = \bar{m}\bar{Q}_A\bar{Q}_B + \bar{m}Q_AQ_B + mQ_A\bar{Q}_B + m\bar{Q}_AQ_B$
So
$D_A = Q_AQ_C + m\bar{Q}_B\bar{Q}_C + \bar{m}Q_B\bar{Q}_C$
$D_B = Q_B\bar{Q}_C + \bar{m}\bar{Q}_AQ_C + mQ_AQ_C$
$D_C = \bar{m}\bar{Q}_A\bar{Q}_B + \bar{m}Q_AQ_B + mQ_A\bar{Q}_B + m\bar{Q}_AQ_B$

Ans 7



Q. 7.

Input	Present State			Next State			F.F. I/P		
UP/~~Down~~ (P)	Q_C	Q_B	Q_A	Q_{C+1}	Q_{B+1}	Q_{A+1}	T_C	T_B	T_A
0	0	0	0	1	1	1	1	1	1
0	0	0	1	0	0	0	0	0	1
0	0	1	0	0	0	1	0	0	1
0	0	1	1	0	1	0	0	1	1
0	1	0	0	0	1	1	0	1	1
0	1	0	1	1	0	0	1	1	1
0	1	1	0	1	0	1	0	0	1
0	1	1	1	1	1	0	0	0	1
1	0	0	0	0	0	1	0	0	1
1	0	0	1	0	1	0	0	1	1
1	0	1	0	0	1	1	0	1	1
1	0	1	1	1	0	0	1	1	1
1	1	0	0	1	0	1	0	0	1
1	1	0	1	1	1	0	0	0	1
1	1	1	0	1	1	1	0	0	1
1	1	1	1	0	0	0	1	1	1

← down

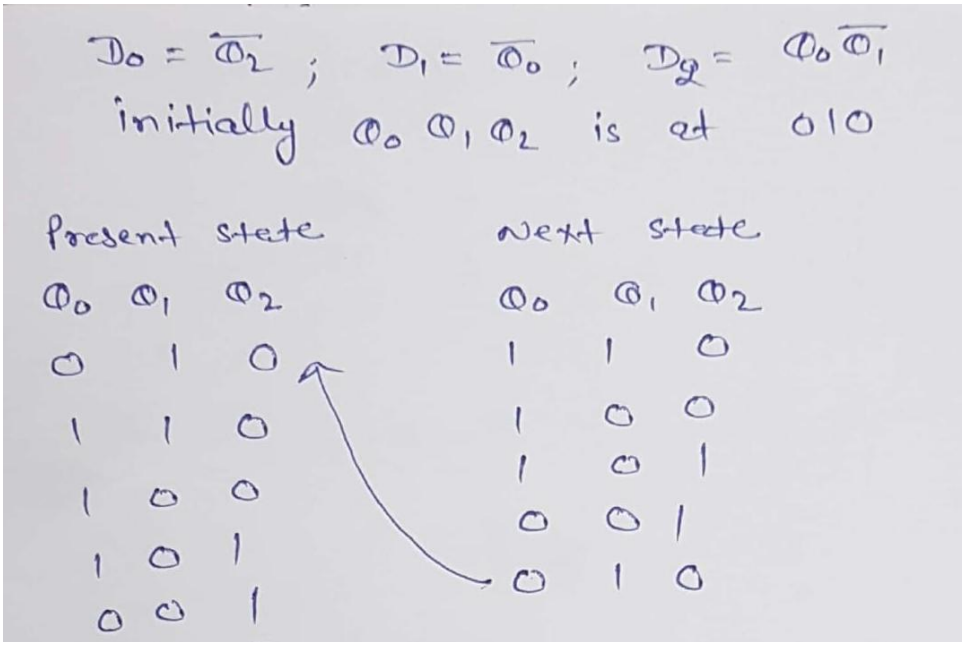
← UP

By solving $T_C = \bar{P}\bar{Q}_B\bar{Q}_A + PQ_BQ_A$

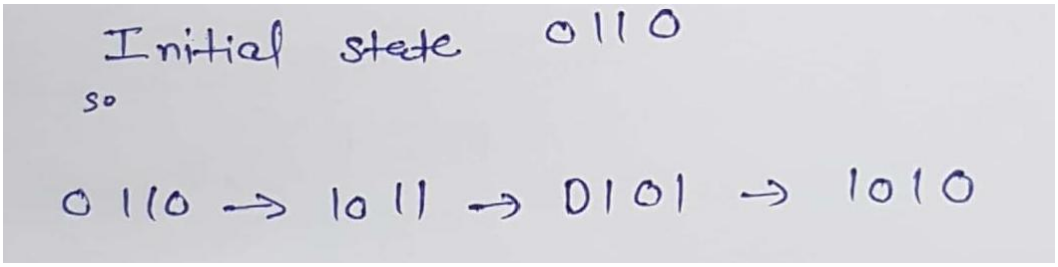
$T_B = \bar{P}\bar{Q}_A + PQ_A$

$T_A = 1$

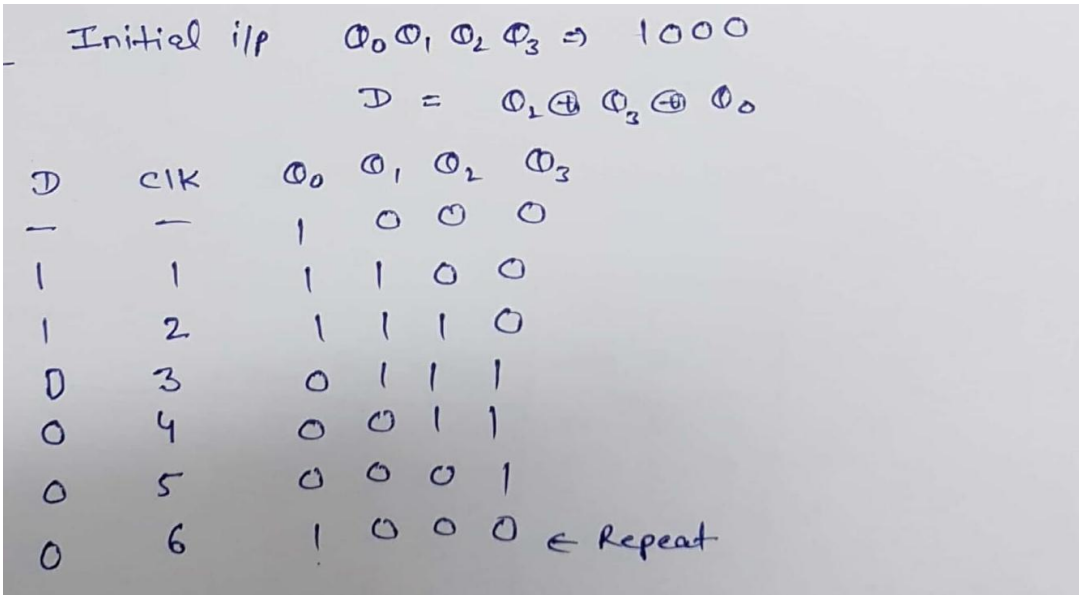
Ans 8


$D_0 = \overline{Q_2}$; $D_1 = \overline{Q_0}$; $D_2 = Q_0\overline{Q_1}$
initially $Q_0 Q_1 Q_2$ is at 010
Present state
Q_0 Q_1 Q_2
0 1 0
1 1 0
1 0 0
1 0 1
0 0 1
Next state
Q_0 Q_1 Q_2
1 1 0
1 0 0
1 0 1
0 0 1
0 1 0

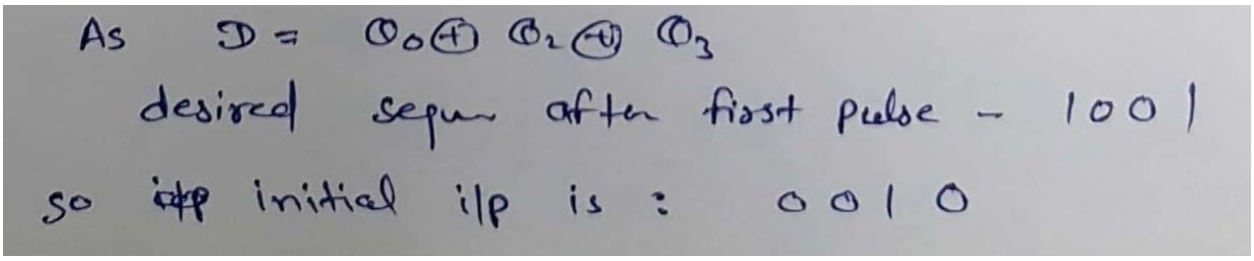
Ans 9


Initial state 0110
so
0110 → 1011 → 0101 → 1010

Ans 10


Initial i/p $Q_0 Q_1 Q_2 Q_3 \Rightarrow 1000$
$D = Q_1 \oplus Q_3 \oplus Q_0$
D CLK Q_0 Q_1 Q_2 Q_3
— — 1 0 0 0
1 1 1 1 0 0
1 2 1 1 1 0
0 3 0 1 1 1
0 4 0 0 1 1
0 5 0 0 0 1
0 6 1 0 0 0 ← Repeat

(b)


As $D = Q_0 \oplus Q_2 \oplus Q_3$
desired sequ after first pulse – 1001
so ~~i/p~~ initial i/p is : 0010