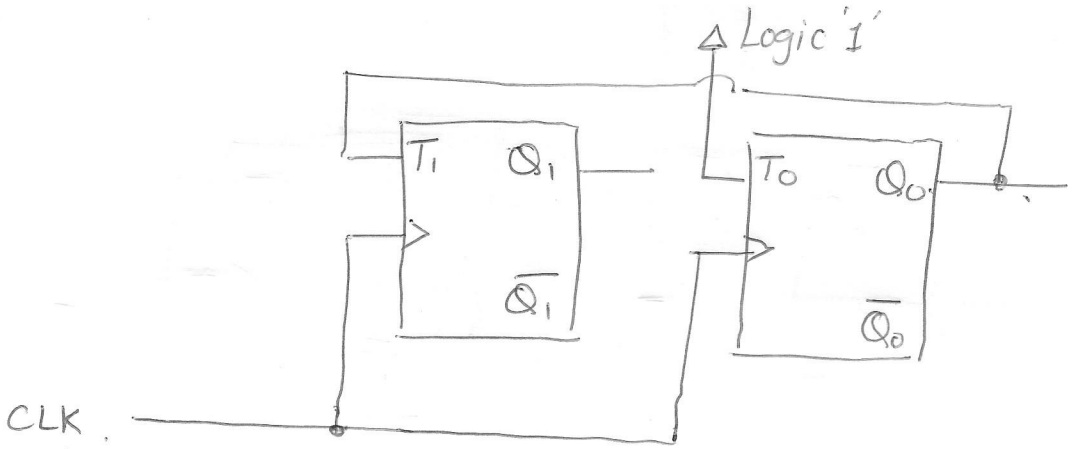
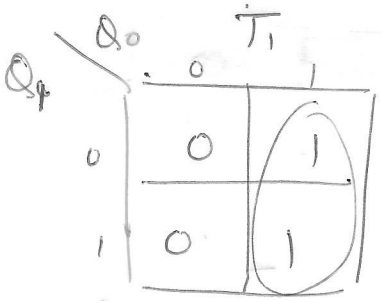
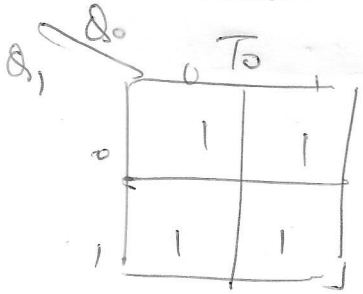
Synchronous 2 Bit UP counter using T FF



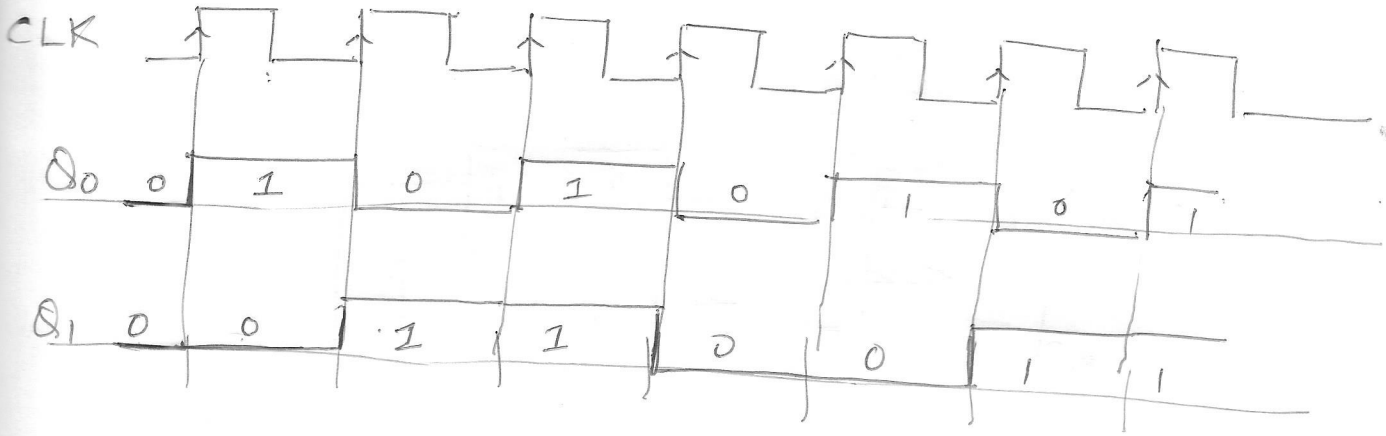
Q_1	Q_0	Q_1^+	Q_0^+	T_1	T_0
0	0	0	1	0	1
0	1	1	0	1	1
1	0	1	1	0	1
1	1	0	0	1	1

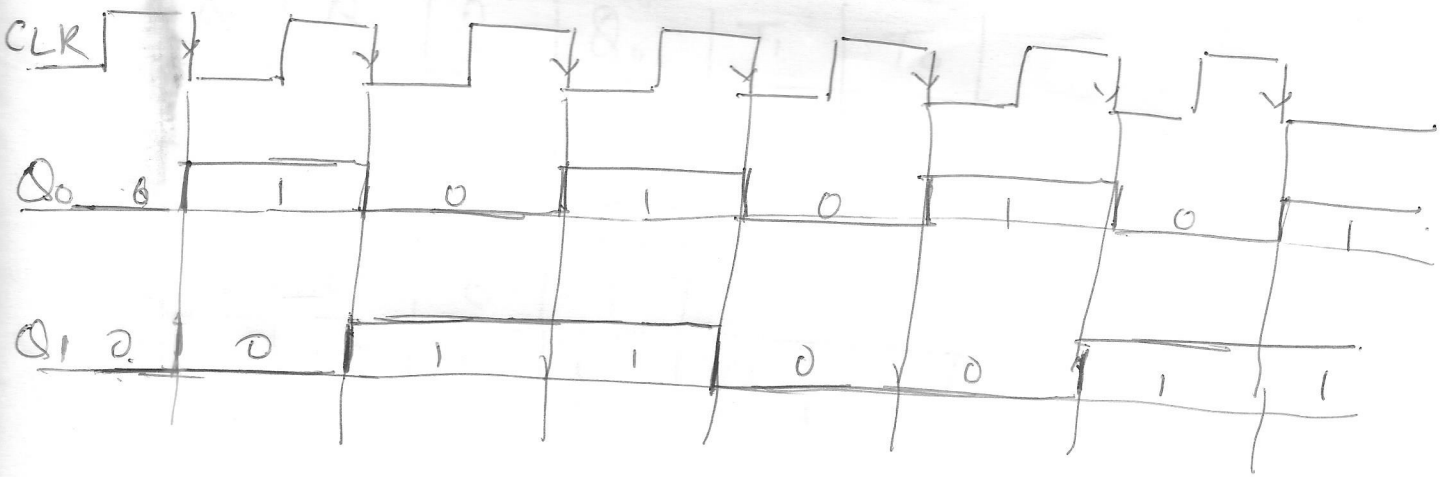


$T_1 = Q_0$

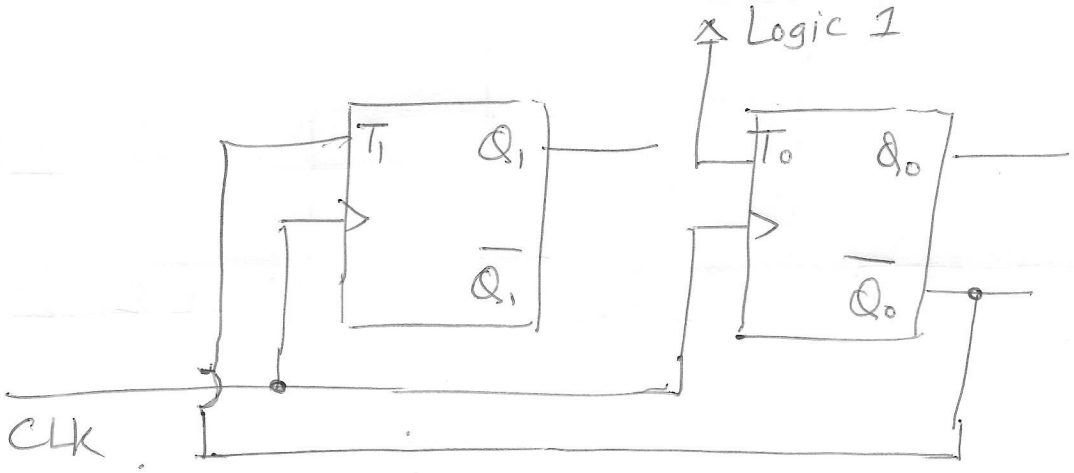


$T_0 = 1$

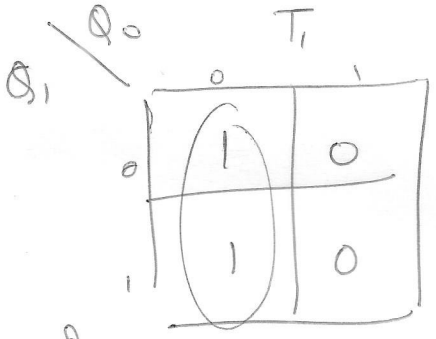

CLK
Q_0 0 1 0 1 0 1 0 1
Q_1 0 0 1 1 0 0 1 1


CLK
Q_0 0 1 0 1 0 1 0 1
Q_1 0 0 1 1 0 0 1 1

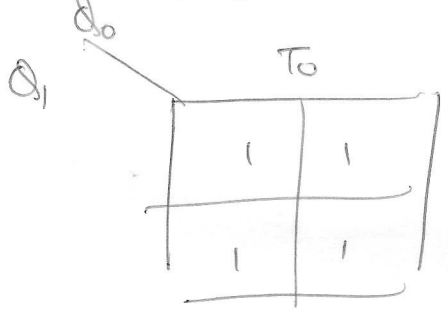
Synchronous 2 Bit DN Counter using T FF



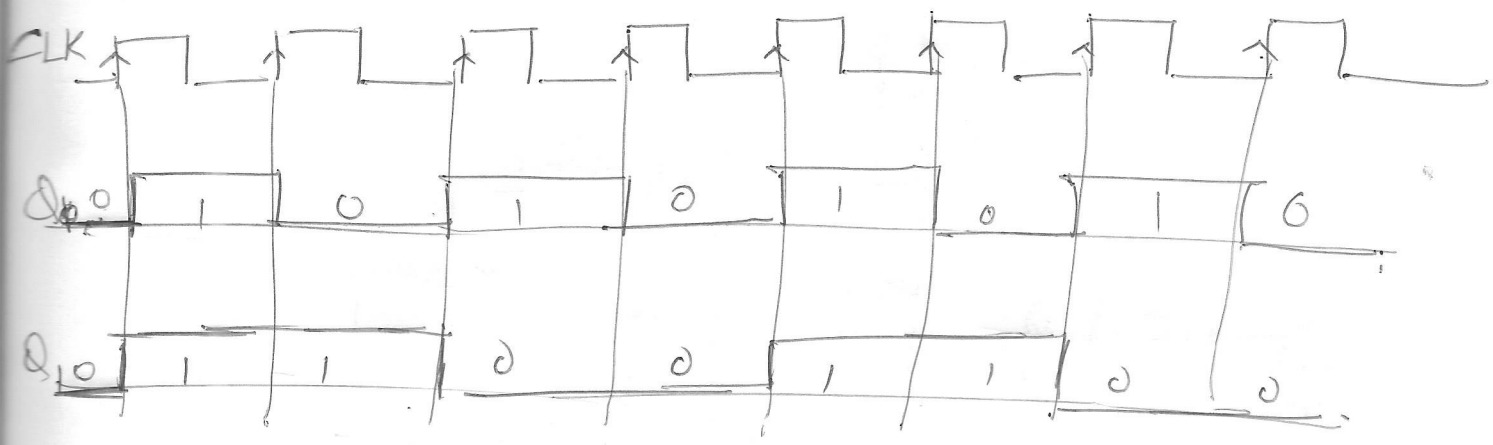
Q_1	Q_0	Q_1^+	Q_0^+	T_1	T_0
0	0	1	1	1	1
0	1	0	0	0	1
1	0	0	1	1	1
1	1	1	0	0	1



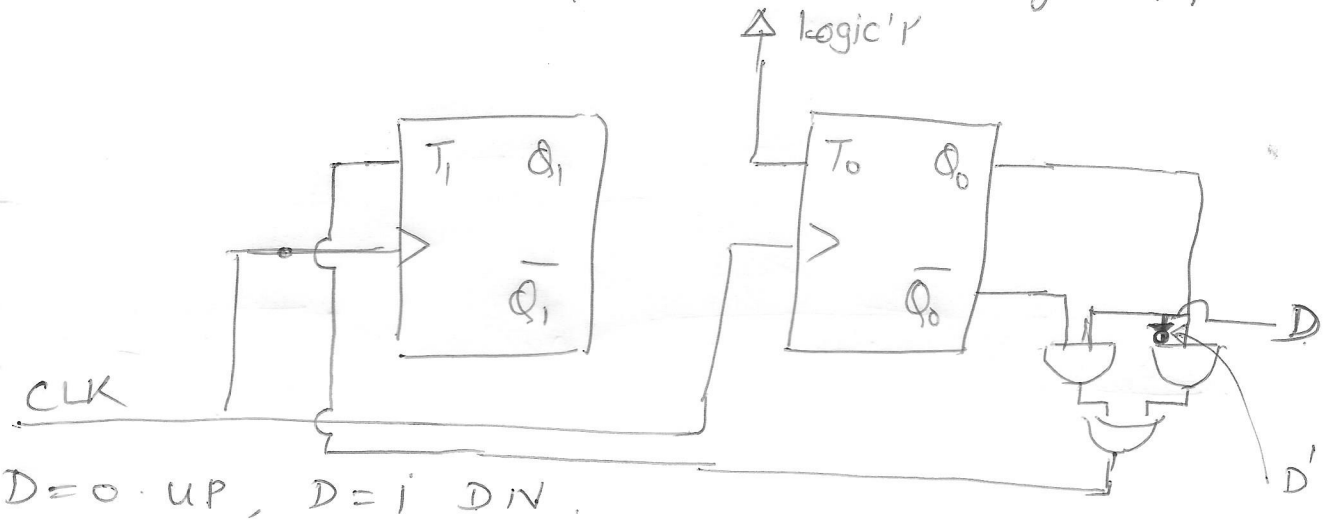
$$T_1 = \overline{Q_0}$$



$$T_0 = 1.$$

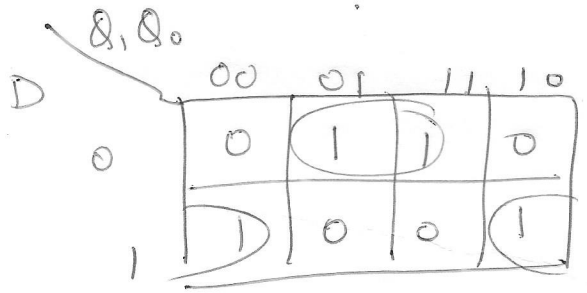

CLK
Q_0
Q_1

Synchronous 2 Bit UP/DN Counter using T FF

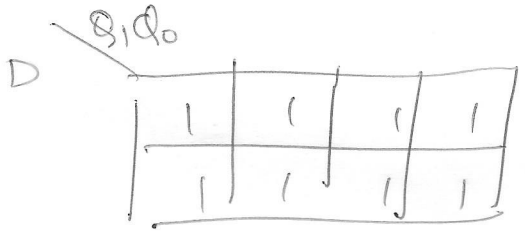


D=0 UP, D=1 DN.

D	Q_1	Q_0	Q_1^+	Q_0	T_1	T_0
0	0	0	0	1	0	1
0	0	1	1	0	1	1
0	1	0	1	1	0	1
0	1	1	0	0	1	1
1	0	0	1	1	1	1
1	0	1	0	0	0	1
1	1	0	0	1	1	1
1	1	1	1	0	0	1

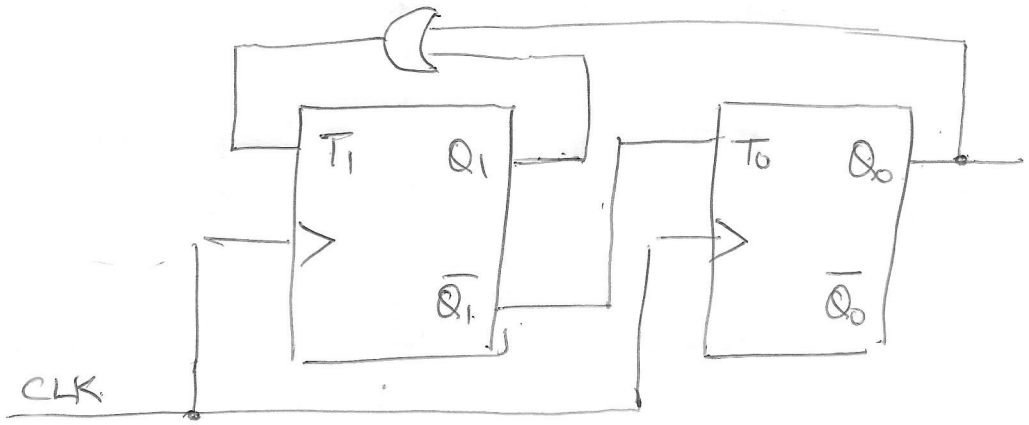


$T_1 = D'Q_0 + DQ_0'$

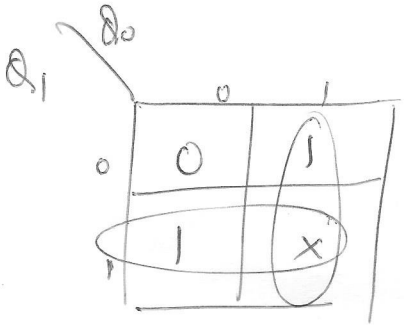


$T_0 = 1$

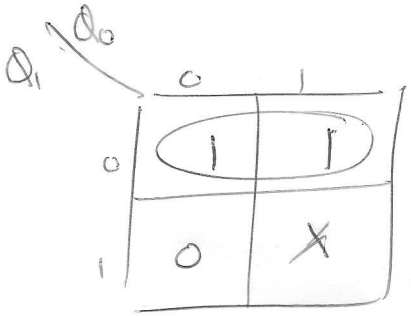
Synchronous 2 bit mod-3 UP counter using T FF
(0→1→2)



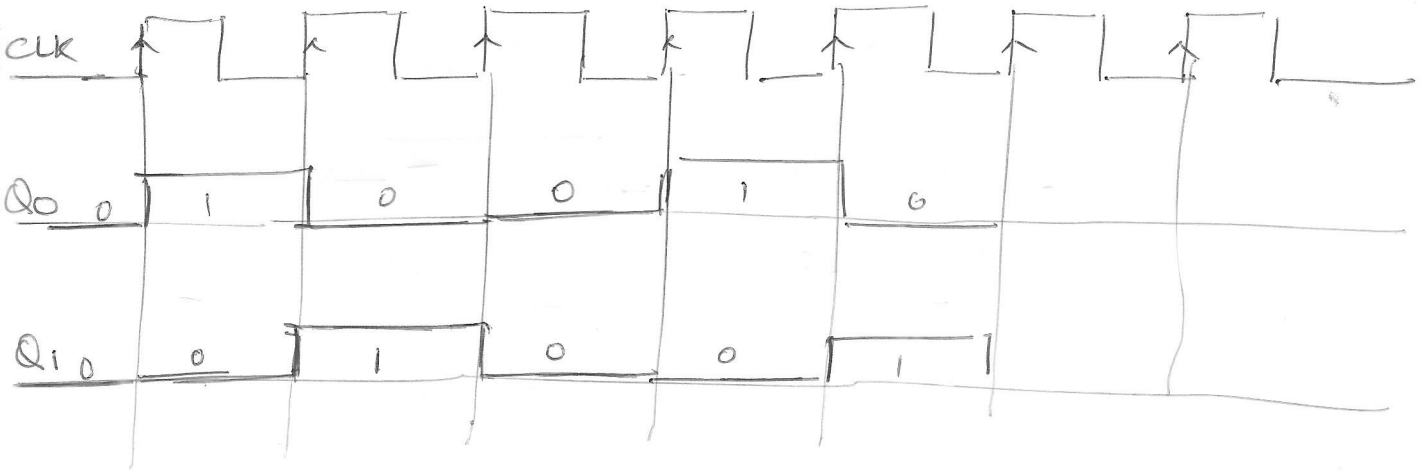
Q_1	Q_0	Q_1^+	Q_0^+	T_1	T_0
0	0	0	1	0	1
0	1	1	0	1	1
1	0	0	0	1	0
1	1			X	X



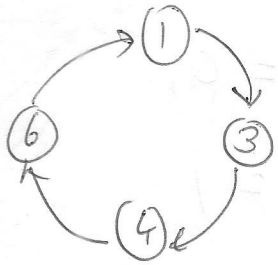
$T_1 = Q_1 + Q_0$



$T_0 = \overline{Q_1}$

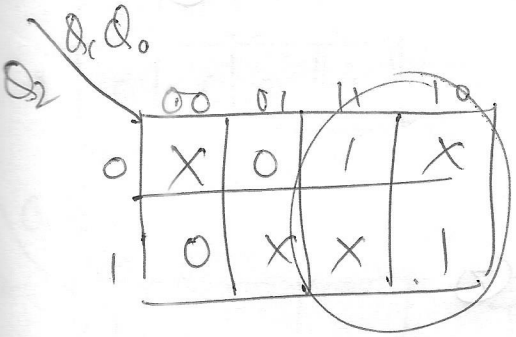

CLK
Q0
0
1
0
0
1
0
Q1
0
0
1
0
0
1

3 bit sequence generator using T FF

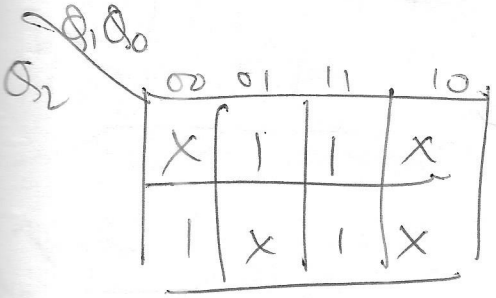


Q	Q^+	T
0	0	0
0	1	1
1	0	1
1	1	0

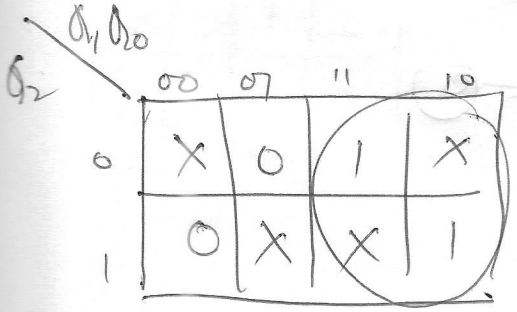
Q_2	Q_1	Q_0	Q_2^+	Q_1^+	Q_0^+	T_2	T_1	T_0
0	0	0						
0	0	1	0	1	1	0	1	0
0	0	0						
0	1	1	1	0	0	1	1	1
1	0	0	1	1	0	0	1	0
1	0	1						
1	1	0	0	0	1	1	1	1
1	1	1						



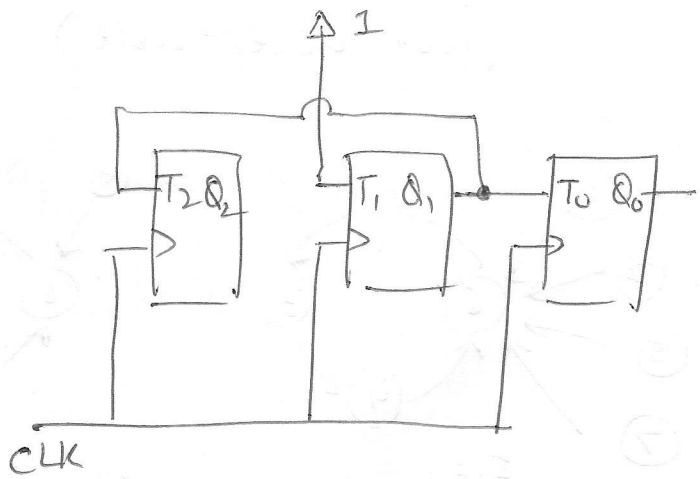
$T_2 = Q_1$



$T_1 = 1$



$T_0 = Q_1$

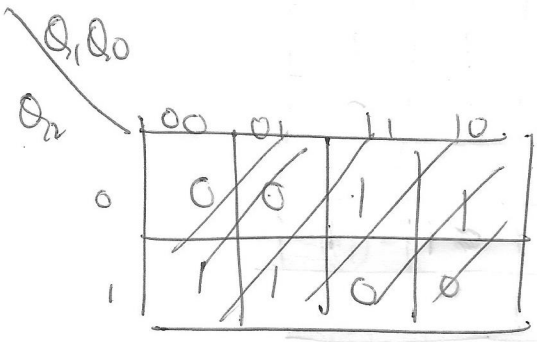


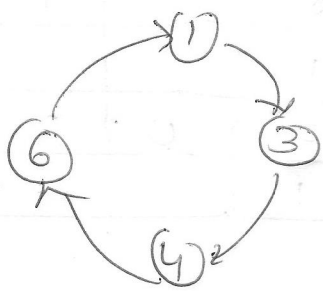
Q_2	Q_1	Q_0	Q_2^+	Q_1^+	Q_0^+
0	0	0	0	1	0
0	0	1	0	1	1
0	1	0	1	0	1
0	1	1	1	0	0
1	0	0	1	1	0
1	0	1	1	1	1
1	1	0	0	0	1
1	1	1	0	0	0

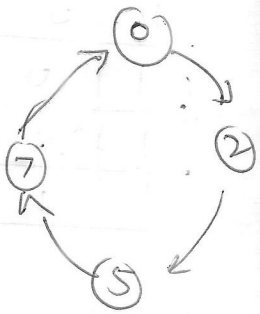
$T_2 = Q_1$

$T_1 = 1$

$T_0 = Q_1$







Lockout condition!
(Not acceptable)

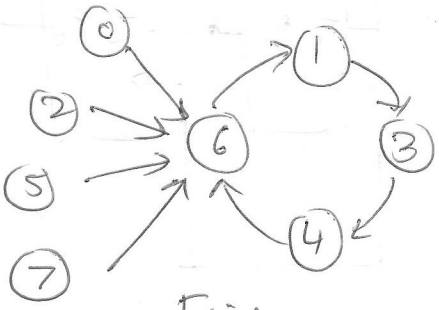


Fig 1

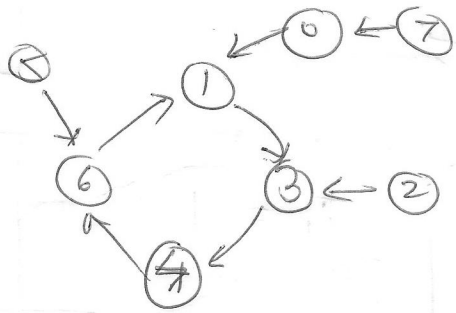


Fig 2

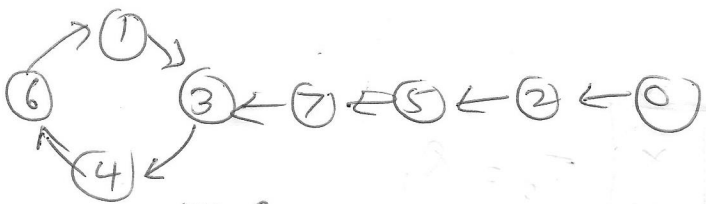
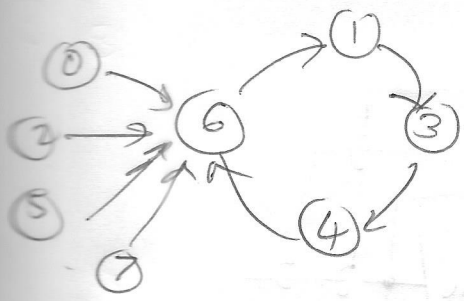
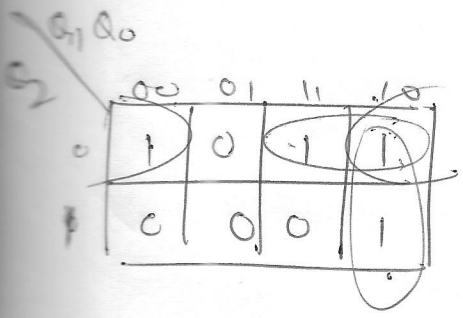


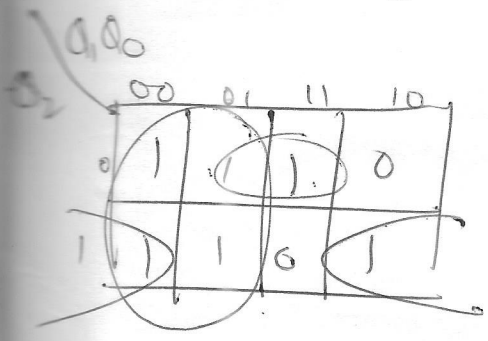
Fig 3



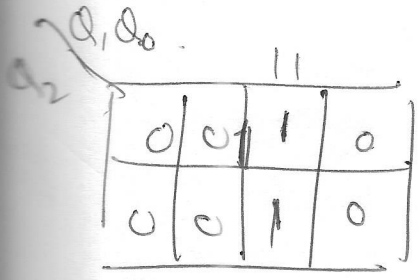
Q_2	Q_1	Q_0	Q_2^+	Q_1^+	Q_0^+	T_2	T_1	T_0
0	0	0	1	1	0	1	1	0
0	0	1	0	1	1	0	1	0
0	1	0	1	1	0	1	0	0
0	1	1	1	0	0	1	1	1
1	0	0	1	1	0	0	1	0
1	0	1	1	1	0	0	1	0
1	1	0	0	0	1	1	1	0
1	1	1	1	1	0	0	0	1



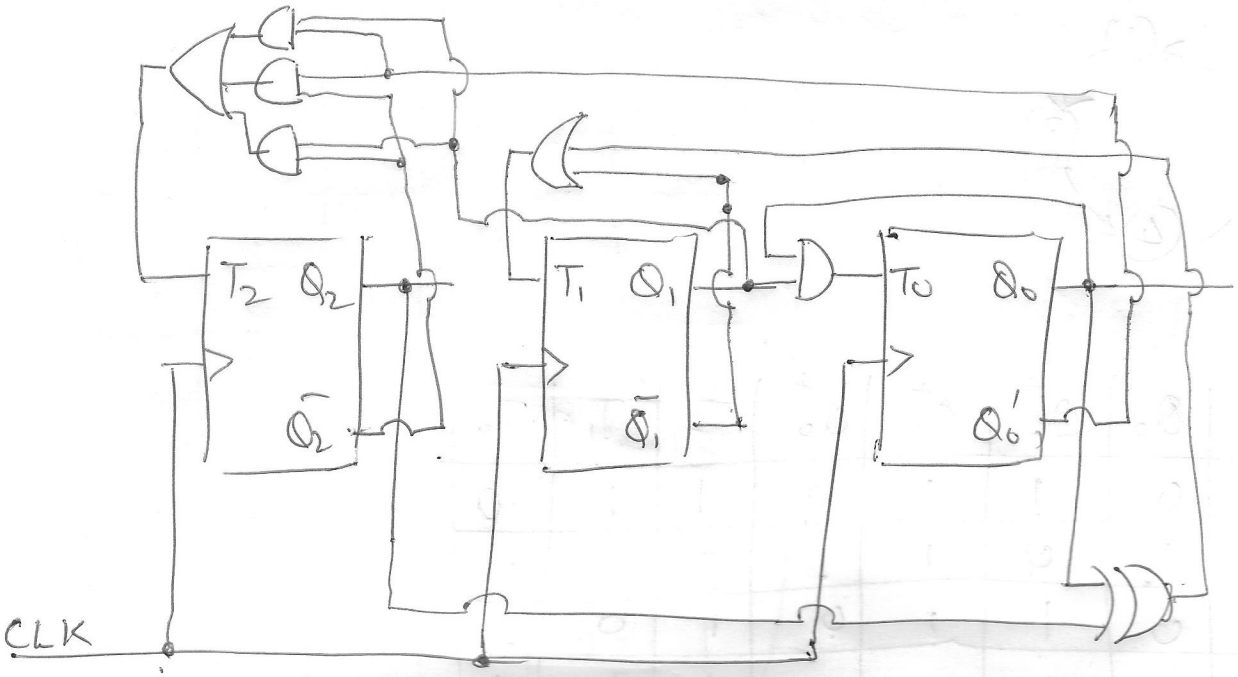
$$T_2 = Q_1 Q_0' + Q_2' Q_1 + Q_2' Q_0'$$



$$T_1 = Q_1' + Q_2' Q_0 + Q_2 Q_0'$$
$$= Q_1' + Q_2 \oplus Q_0$$



$$T_0 = Q_1 Q_0$$


T_2 Q_2
$\bar{Q}_2$
T_1 Q_1
$\bar{Q}_1$
T_0 Q_0
Q_0'
CLK