Question 1: for the combinational circuit shown in Figure 1,

a) Write the Boolean expression of T_1, T_3, T_4, F_1 and F_2 in terms of the four input variables A, B, C, D.

b) Write the truth table showing binary values of T_1, T_3, T_4, F_1 and F_2 for all combinations of four inputs (A, B, C, D)

c) Simplify the functions of F_1 and F_2 by using Karnaugh map method.

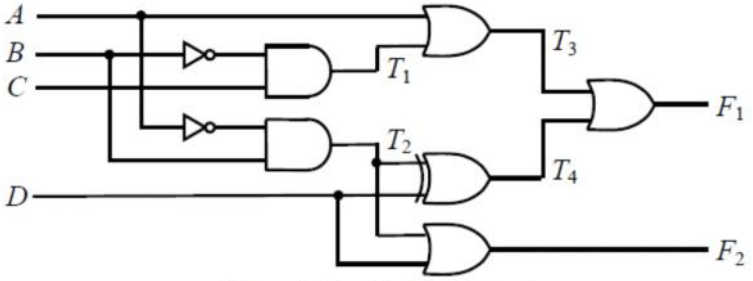


Figure 1. Combinational circuit

BOOLEAN EXPRESSIONS

(A)

$T_1 = \bar{B}C$

$T_3 = A + \bar{B}C$

$T_4 = D \oplus \bar{A}C$

$F_1 = (A + \bar{B}C) + (D \oplus \bar{A}C)$

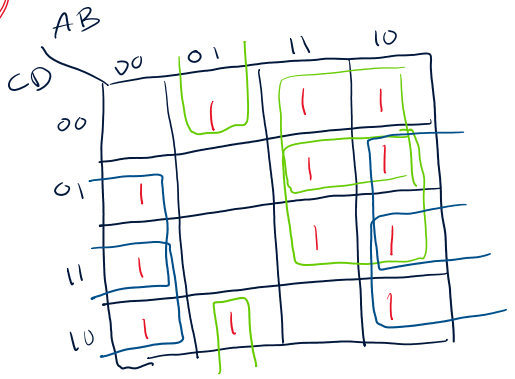
$F_2 = \bar{A}C + D$

(B) TRUTH TABLE

ABCD	T1	T3	T4	F1	F2
0000	0	0	0	0	0
0001	0	0	1	1	1
0010	1	1	0	1	0
0011	1	1	0	1	1
0100	0	0	1	1	1
0101	0	0	0	0	1
0110	0	0	1	1	1
0111	0	0	0	0	1
1000	0	1	0	1	0
1001	0	1	1	1	1
1010	1	1	0	1	0
1011	1	1	1	1	1
1100	0	1	0	1	0
1101	0	1	1	1	1
1111	0	1	1	1	1

(C) KMAPS FOR F_1 and F_2

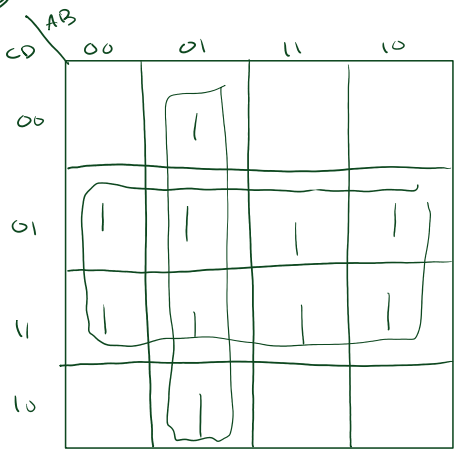
F1



(5) groups

$F_1 = \bar{B}D + \bar{B}C + \bar{A}B\bar{D} + A\bar{C} + AD$

F2



(2) GROUPS

$F_2 = D + \bar{A}B$

Question 2: consider the following sequential building blocks in Figure 2,

a) What type of sequential block is it?
b) Assume that S = R =1, what happens to the outputs Q and Q' when CLK transitions from a 1 to 0?

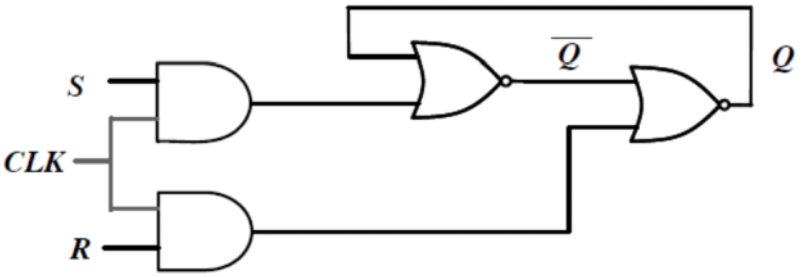
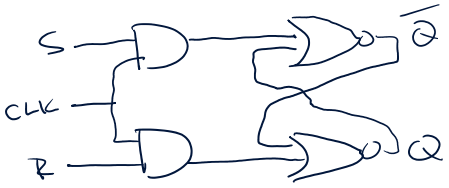


Figure 2 Sequential circuit

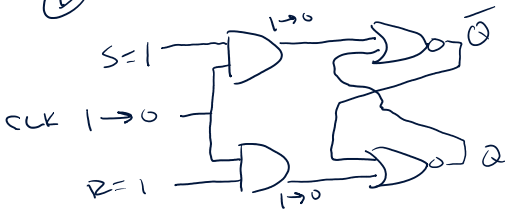
(A)

Redrawing the circuit



We can see this is an SR LATCH

(B)



$\overline{Q} = \overline{Q+0} = \overline{Q}$

$Q = \overline{\overline{Q}+0} = \overline{\overline{Q}} = Q$

In this state the outputs are held at their previous values

Question 3: the circuit in Figure 3 looks like a counter. What is the sequence that this circuit counts in? Complete the timing diagram given in Figure 3. The initial conditions of $Q_0Q_1Q_2$ are 000.

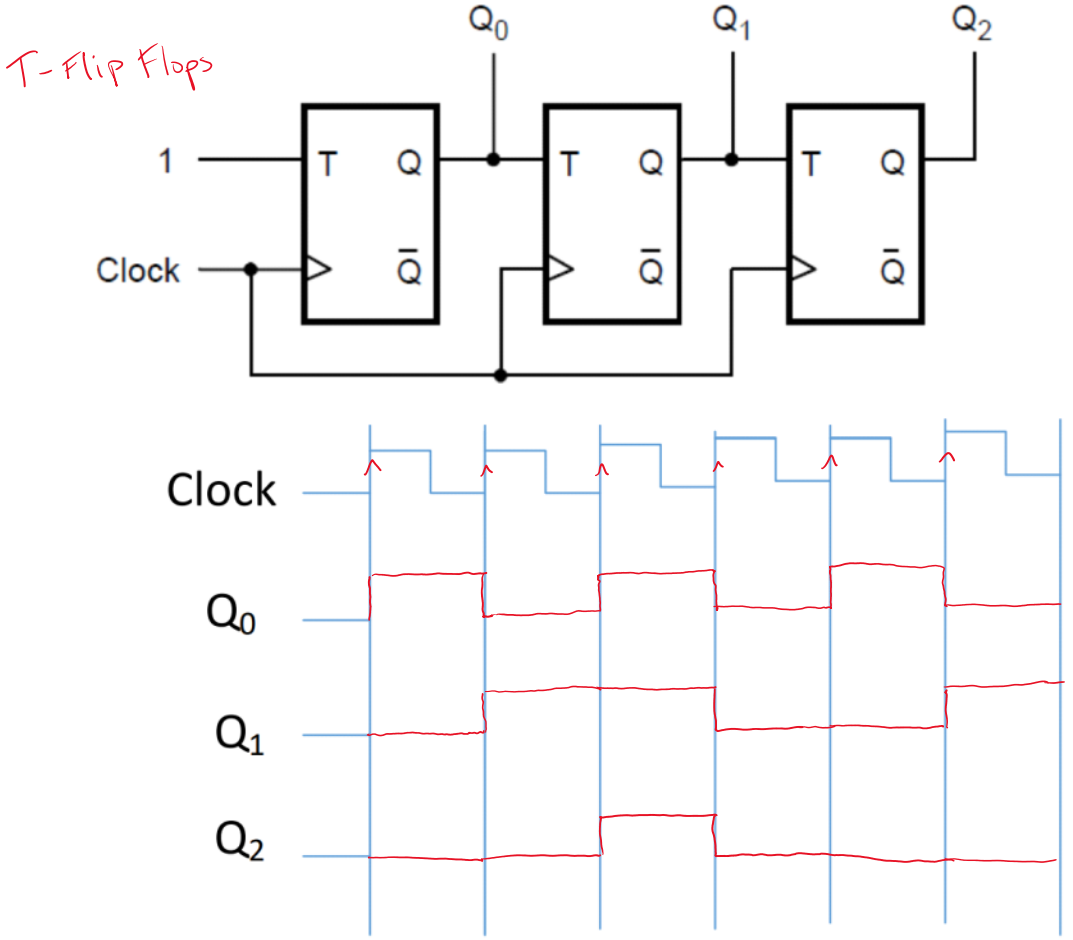
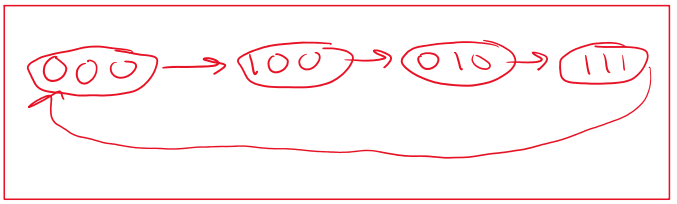
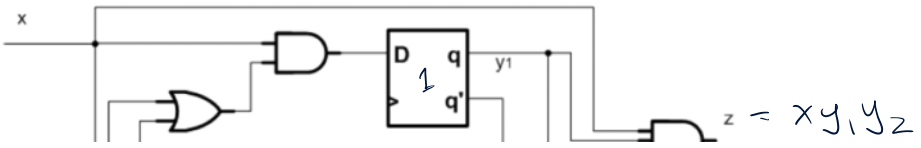


Figure 3. Counter-type circuit

The sequence we see out of this counter, where its in the form $Q_0Q_1Q_2$ is:



Question 4: you are given the sequential circuit shown in Figure 4. Find the state diagram, state assigned table and state table for the circuit using Mealy-type FSM. Assume the state assignments as {A=00, B=01, C=10, D=11}.



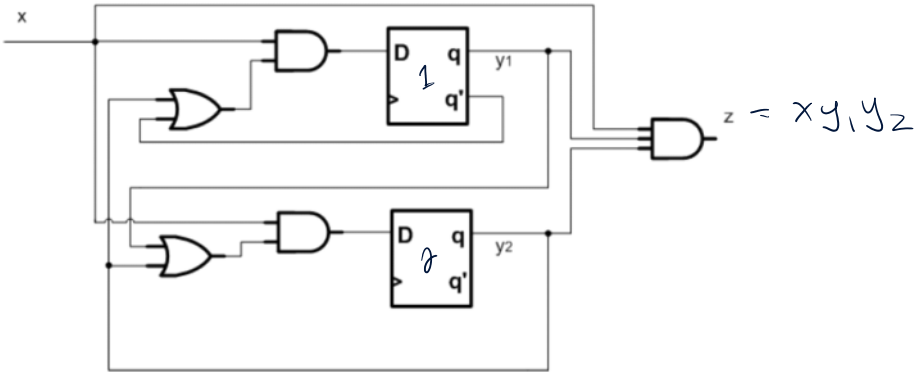


Figure 4. Finite-State Machine circuit

$D_1 = x(\bar{y}_1 + y_2)$

$D_2 = x(y_1 + y_2)$

B/c DFF, we know $Q_{t+1} = D$

$Y_{1,t+1} = x(\bar{y}_1 + y_2) = x\bar{y}_1 + xy_2$

$Y_{2,t+1} = x(y_1 + y_2) = xy_1 + xy_2$

$z = xy_1y_2$

A = 00
B = 01
C = 10
D = 11

STATE TRANSITION TABLE

PRESENT STATE y_1	PRESENT STATE y_2	INPUT x	NEXT STATE $y_{1,t+1}$	NEXT STATE $y_{2,t+1}$	OUTPUT z
0	0	0	0	0	0
0	0	1	1	0	0
0	1	0	0	0	0
0	1	1	1	1	0
1	0	0	0	0	0
1	0	1	0	1	0
1	1	0	0	0	0
1	1	1	1	1	1

⇒

P.S. y_1y_2	INPUT x	N.S. $y_1^+y_2^+$	OUTPUT z
A	0	A	0
A	1	C	0
B	0	A	0
B	1	D	0
C	0	A	0
C	1	B	0
D	0	A	0
D	1	D	1

STATE DIAGRAM

*unless specified, z=0.