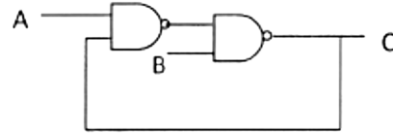


**Exercise 1 :**

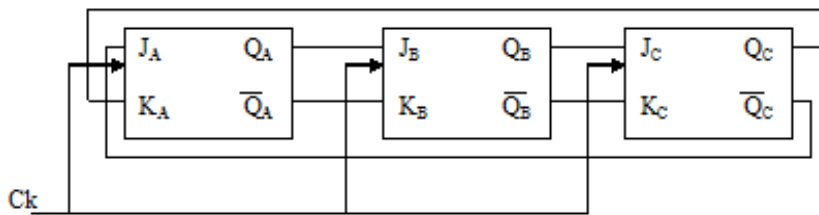
Let the circuit be :

1. Establish the truth table of the circuit.
2. Is it a combinational or sequential circuit?



**Exercise 2 :**

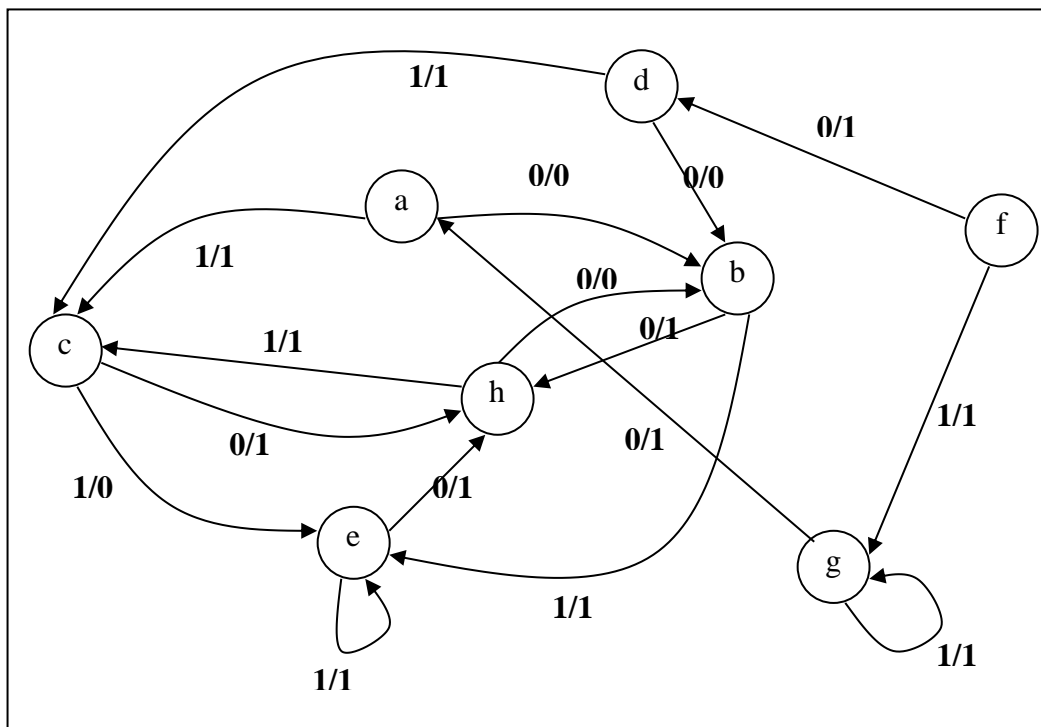
Consider the following sequential circuit :



- 1) Give the expressions of:  $J_A$ ,  $K_A$ ,  $J_B$ ,  $K_B$  and  $J_C$ ,  $K_C$  as a function of  $Q_A$ ,  $Q_B$  and  $Q_C$ .
- 2) Establish the characteristic table of this circuit. Deduce the sequence it represents (initial state 000)

**Exercise 3 :**

We want to create a sequential circuit whose automata is the following



1. Represent the graph (automata) in tabular form (transition table)
2. Reduce the automata
3. Give the new graph
4. Code the states (alphabetical order ascending  $\longrightarrow$  binary code)
5. Establish the table of excitement
6. Find the simplified input equations to the T flip-flops
7. Draw the circuit

**Exercise 4:**

Build a sequential circuit that simulates the operation of a robot. The robot can move **forward**, **backward**, **turn** or be at **rest**. It is connected to two wires X and Y. X is used to receive orders and Y to turn a lamp on or off. The operation of this robot is as follows:

- If the robot is at **rest** and it receives a '1' on X then it moves **forward** and turns on the lamp.
  - If the robot is at **rest** and it receives a '0' on X then it goes **backwards** and turns on the lamp.
  - If the robot moves **forward** and receives a '1' on X then it **turns** and turns on the lamp.
  - If the robot moves **forward** and receives a '0' on X then it goes to **rest** and turns off the lamp.
  - If the robot moves **backwards** and receives a '1' on X then it **turns** and turns on the lamp.
  - If the robot moves **backwards** and receives a '0' on X then it goes to **rest** and turns off the lamp.
  - If the robot **turns** and receives a '1' on X then it moves **forward** and turns on the lamp.
  - If the robot **turns** and receives a '0' on X then it goes **backwards** and turns on the lamp.
- Synthesize this circuit using **D flip-flops**, respecting the following coding:

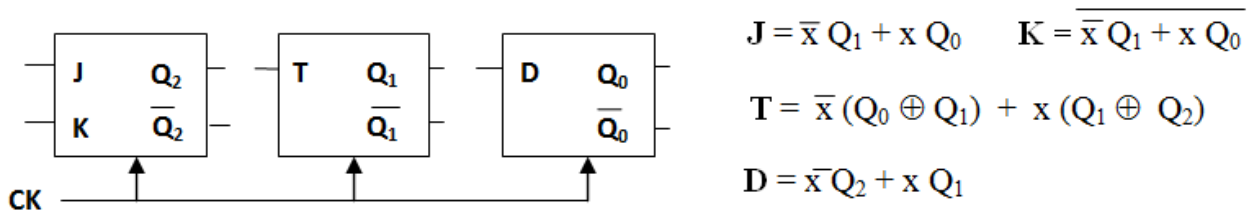
States	Output
A : rest	Lamp : 1 $\rightarrow$ On 0 $\rightarrow$ Off
B : forward	
C : backward	
D : turn	

**Exercise 5:**

1. Give the equations of the D flip-flop inputs of a **right circular shift register** on 4 bits :  
 $Q_3 Q_2 Q_1 Q_0 \rightarrow Q_0 Q_3 Q_2 Q_1$
2. Give the equations of the D flip-flop inputs of a **left circular shift register** on 4 bits :  
 $Q_3 Q_2 Q_1 Q_0 \rightarrow Q_2 Q_1 Q_0 Q_3$
3. Consider the so-called “creeping” counter whose states are:  
 $0000 \rightarrow 0001 \rightarrow 0011 \rightarrow 0111 \rightarrow 1111 \rightarrow 1110 \rightarrow 1100 \rightarrow 1000 \rightarrow 0000 \dots$
5. Give the general equations of the circuit which fulfills the 3 previous functions

**Exercise 6 :**

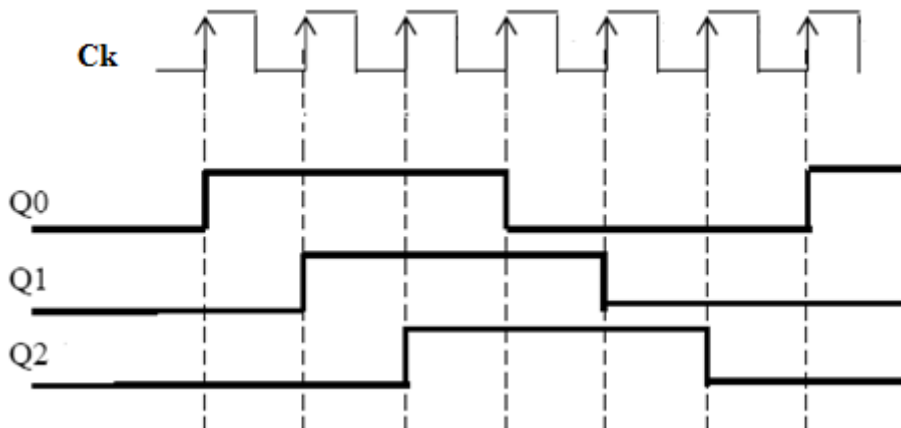
A sequential circuit is made up of 3 flip-flops, a JK flip-flop, a T flip-flop and a D flip-flop. The JK flip-flop represents the most significant and the D flip-flop the least significant.



- 1) Give the characteristic table of this circuit.
- 2) Determine the state diagrams (automata) for  $x = 0$  and for  $x = 1$  (initial state 001)
- 3) What is the role of  $x$ ? Deduce the function of this circuit.

**Exercise 7:**

Consider the following timing diagram of a counter:

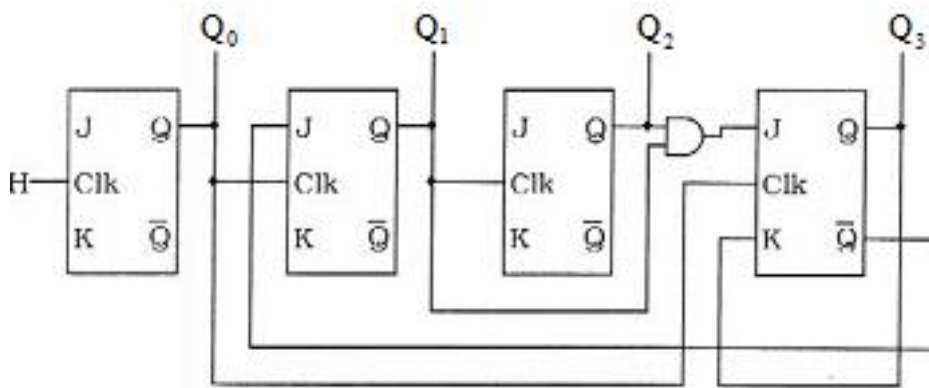


1. What is the cycle (sequence) carried out by this circuit.
2. Create this circuit using D flip-flops sensitive to the rising edge.
  - a. Give the state table + excitation table corresponding to this cycle.
  - b. Determine the simplified equations for the flip-flop inputs.
  - c. Draw the circuit.

**Exercise 8 :**

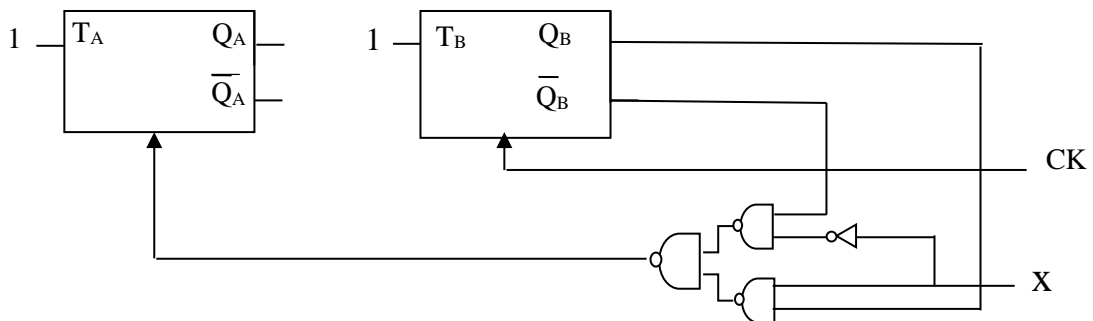
Consider the counter corresponding to the circuit below:

1. Draw the timing diagram for outputs  $Q_0$ ,  $Q_1$ ,  $Q_2$  and  $Q_3$ , starting from 0000 for 14 clock periods.  
When no connection is visible, it should be understood that the corresponding input is always 1.
2. What is the sequence carried out by this counter?



**Exercise 9 :**

Consider the following sequential circuit:



- 1/ What is the type of this circuit?
- 2/ Give the expressions of the functions  $T_A$ ,  $T_B$ ,  $CK_A$  and  $CK_B$
- 3/ Draw the timing diagrams of the  $Q_A$  and  $Q_B$  outputs for  $X = 0$  then for  $X = 1$ .

We will take as initial state  $Q_A Q_B = 00$

- 4/ Create the corresponding state diagram (automata).

- 5/ What does this circuit represent?