1. **Conversion of flip flops**

Rules for conversion:

- **Step-1:**

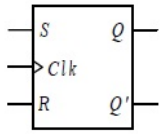
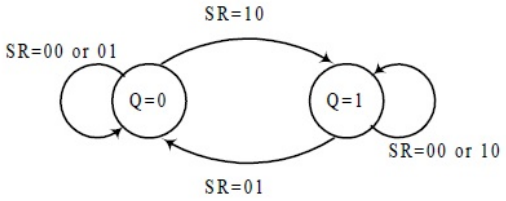
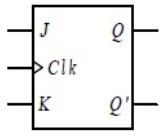
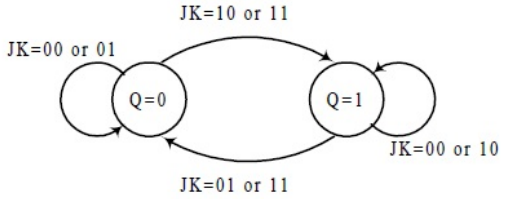
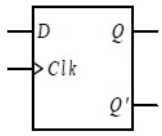
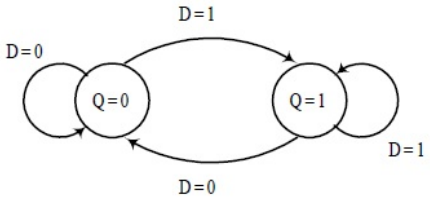
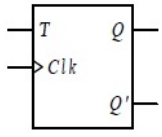
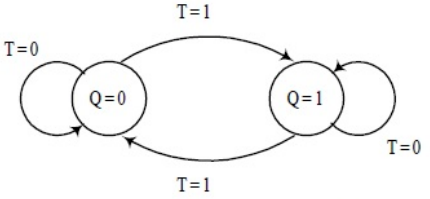
  Find the characteristics table of required flip-flop and the excitation table of the existing (given) flip-flop.

- **Step-2:**

  Find the expression of given flip-flop in terms of required flip-flop using K-map.

- **Step-3:**

  Find the circuit diagram of required flip-flop.

Name / Symbol	Characteristic (Truth) Table	State Diagram / Characteristic Equations	Excitation Table
SR 	$S\ R\ Q\ Q_{next}$ 0 0 0 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 1 1 0 1 1 1 1 0 × 1 1 1 ×	 $Q_{next} = S + R'Q$ $SR = 0$	$Q\ Q_{next}\ S\ R$ 0 0 0 × 0 1 1 0 1 0 0 1 1 1 × 0
JK 	$J\ K\ Q\ Q_{next}$ 0 0 0 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 1 1 0 1 1 1 1 0 1 1 1 1 0	 $Q_{next} = J'K'Q + JK' + JKQ'$ $= J'K'Q + JK'Q + JK'Q' + JKQ'$ $= K'Q(J'+J) + JQ'(K'+K)$ $= K'Q + JQ'$	$Q\ Q_{next}\ J\ K$ 0 0 0 × 0 1 1 × 1 0 × 1 1 1 × 0
D 	$D\ Q\ Q_{next}$ 0 × 0 1 × 1	 $Q_{next} = D$	$Q\ Q_{next}\ D$ 0 0 0 0 1 1 1 0 0 1 1 1
T 	$T\ Q\ Q_{next}$ 0 0 0 0 1 1 1 0 1 1 1 0	 $Q_{next} = TQ' + T'Q = T \oplus Q$	$Q\ Q_{next}\ T$ 0 0 0 0 1 1 1 0 1 1 1 0

Convert SR To D FlipFlop:

1. **Make characteristic table and excitation table .**
2. **Using k map ,convert.**

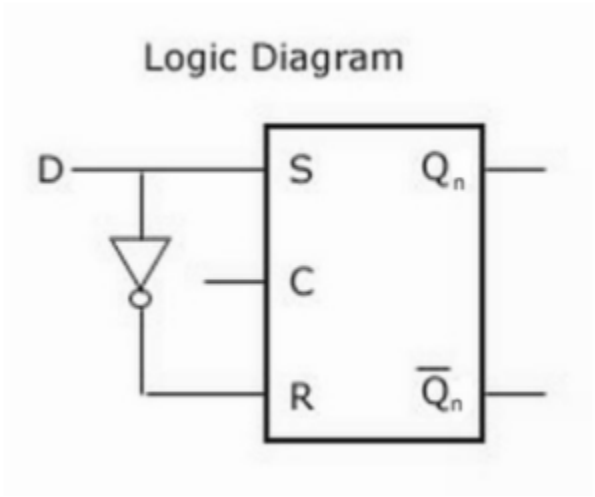
D	Q_N	Q_{N+1}	S	R
0	0	0	0	X
0	1	0	0	1
1	0	1	1	0
1	1	1	X	0

S:

D,Q_N		
	0	0
	1	X

R:

D,Q_N		
	X	1
	0	0



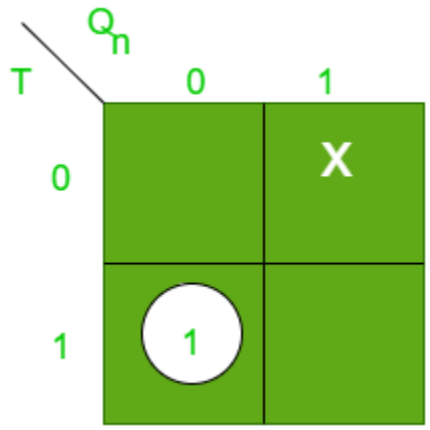
Conversion of S-R Flip-Flop into T Flip-Flop

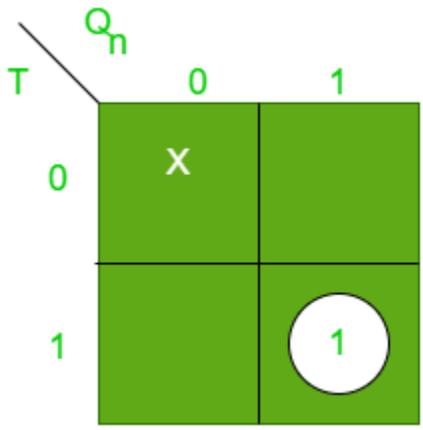
Excitation Table

Characteristic Table

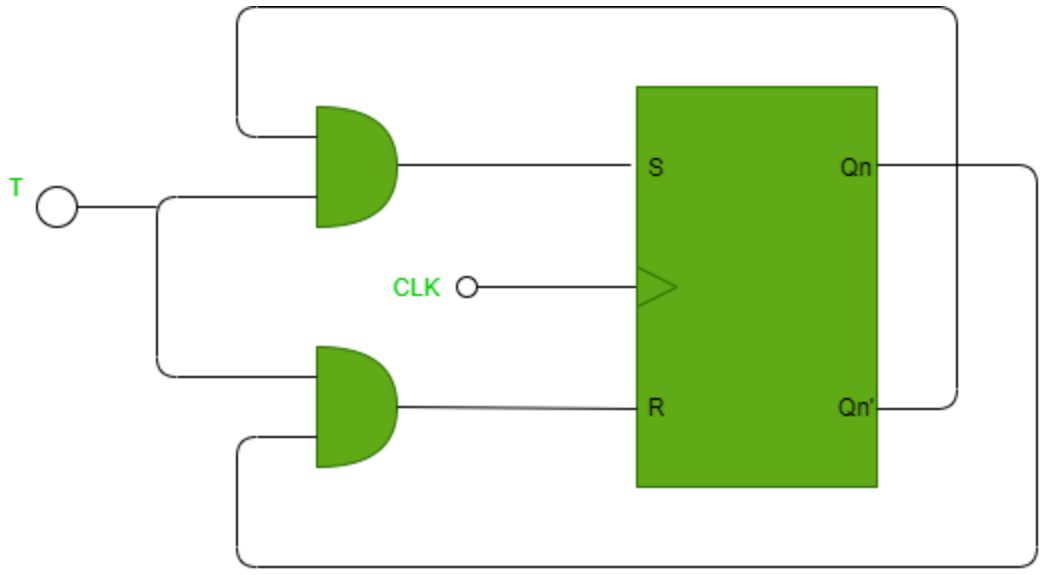
T	Qn	Qn+1	S	R
0	0	0	0	x
0	1	1	x	0
1	0	1	1	0
1	1	0	0	1

Now, using K-map we get the expression for of S & R in terms of T.





S = TQn' & R = TQn

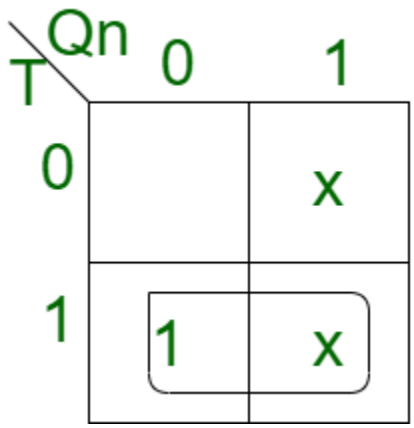


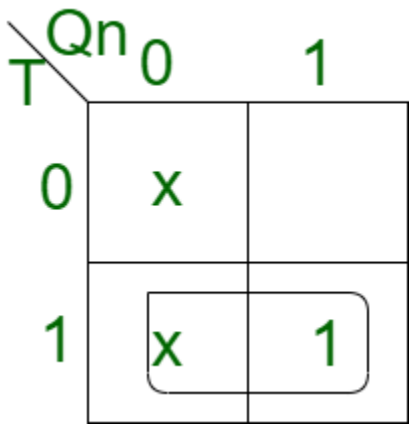
Conversion of J-K Flip-Flop into T Flip-Flop

Step-1: Construct the characteristic table of T flip-flop and excitation table of the J-K flip-flop.

T	Qn	Qn+1	J	K
0	0	0	0	x
0	1	1	x	0
1	0	1	1	x
1	1	0	x	1

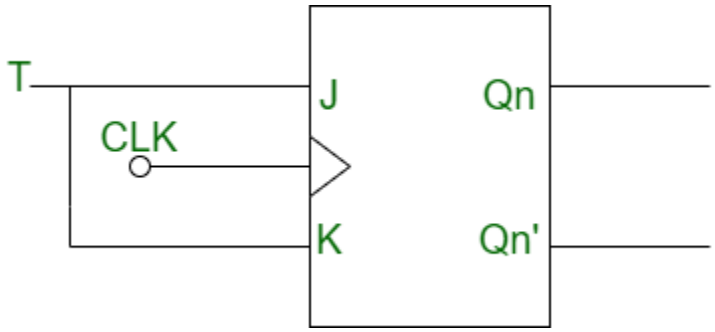
Step-2: Using the K map, find the boolean expression for J and K in terms of T






```
J = T
K = T
```

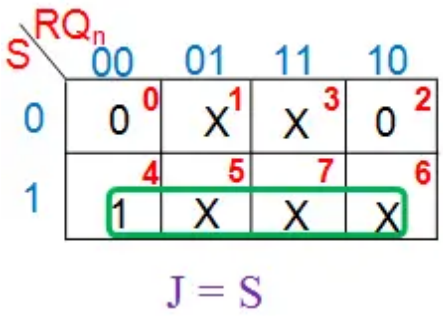
Step-3: Construct the circuit diagram for the conversion of the J-K flip-flop into a T flip-flop.



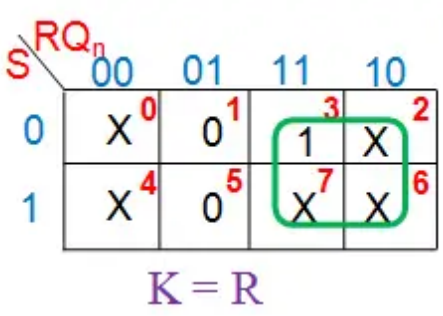
Conversion of JK Flip-Flop to SR Flip-Flop

Conversion Table

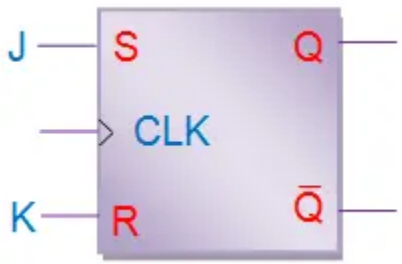
S	R	Q_n	Q_{n+1}	J	K
0	0	0	0	0	X
0	0	1	1	X	0
0	1	0	0	0	X
0	1	1	0	X	1
1	0	0	1	1	X
1	0	1	1	X	0
1	1	invalid		X	X
1	1	invalid		X	X



J = S



K = R



Conversion of SR Flip Flop to JK Flip Flop

1. Truth Table for JK flip-flop

Inputs		Outputs	
J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

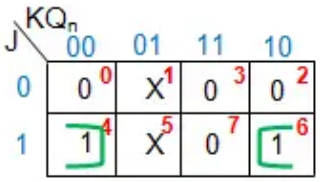
2. Excitation Table for SR flip-flop

Outputs		Inputs	
Q_n	Q_{n+1}	S	R
0	0	0	X
0	1	1	0
1	0	0	1
1	1	X	0

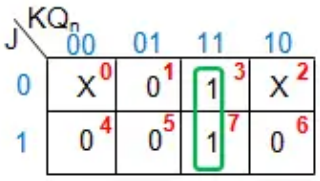
3. Conversion Table

J	K	Q_n	Q_{n+1}	S	R
0	0	0	0	0	X
0	0	1	1	X	0
0	1	0	0	0	X
0	1	1	0	0	1
1	0	0	1	1	0
1	0	1	1	X	0
1	1	0	1	1	0
1	1	1	0	0	1

4. K-map Simplification

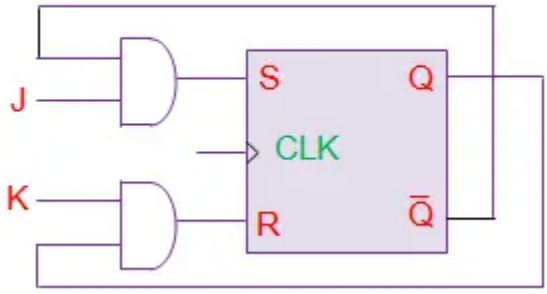


$S = J\bar{Q}_n$



$R = KQ_n$

5. Circuit Design



State diagram

- A state diagram is a diagram used in computer science to describe the behavior of a system considering all the possible states of an object when an event occurs.

- State diagrams are often used to represent the dynamic behavior of systems.

- The circles in a state diagram correspond to states of the system being modeled, and the arcs connecting those circles correspond to the events, which result in transitions between those states.

State Table

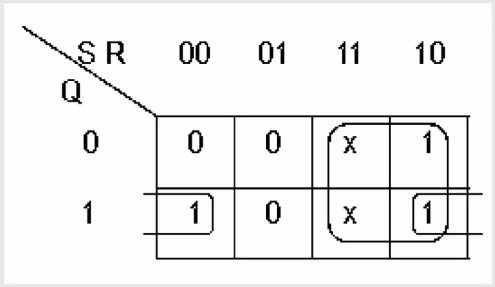
The state table representation of a sequential circuit consists of three sections labeled *present state*, *next state* and *output*.

- The present state designates the state of flip-flops before the occurrence of a clock pulse.
- The next state shows the states of flip-flops after the clock pulse
- The output section lists the value of the output variables during the present state

State diagram

state table

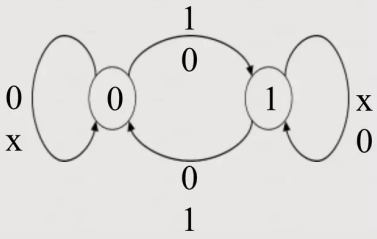
S	R	Q(t+1)
0	0	Q(t)
0	1	0
1	0	1
1	1	x



$Q(t+1) = S + R'Q(t)$

characteristic equation

The state diagram

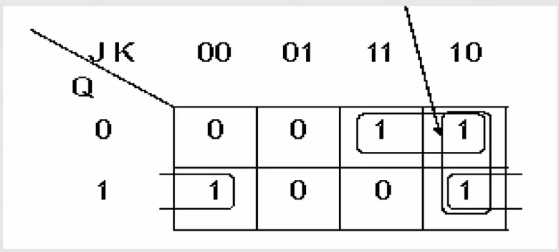


State Diagrams: J-K

state table

J	K	Q(t+1)
0	0	Q(t)
0	1	0
1	0	1
1	1	Q(t)'

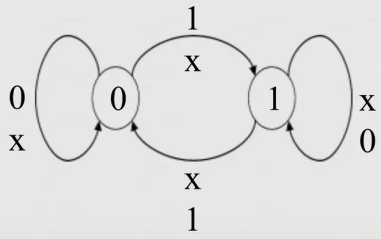
static hazard!!



Q(t+1) = J Q(t)' + K' Q(t), or
Q(t+1) = J Q(t)' + K' Q(t) + J K'

characteristic equation

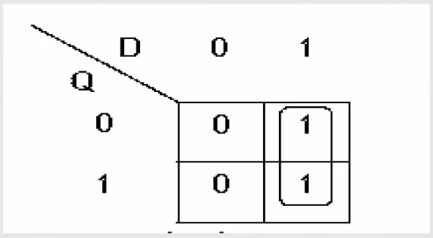
The state diagram



State diagram

- *state table*

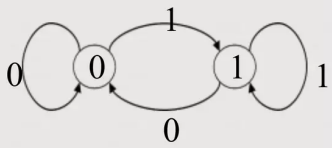
D	Q(t+1)
0	0
1	1



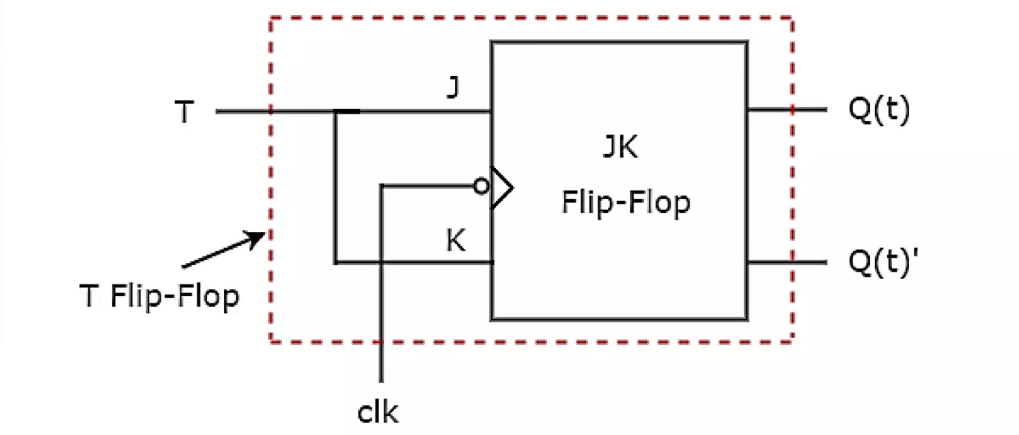
$$Q(t+1) = D$$

characteristic equation

- *state diagram*



T-FLIP FLOP



clk	T	J	K	Q	Q'	S	R	Q	Q'	
1	0	0	0	1	0	0	0	1	0	previous values
				0	1	0	0	0	1	
1	1	1	1	1	0	0	1	0	1	compliment of previous values
				0	1	1	0	1	0	

State diagram

state table

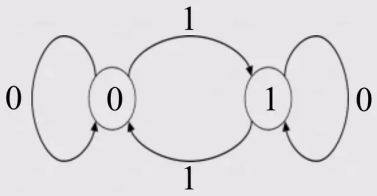
T	Q(t+1)
0	Q(t)
1	Q(t)'

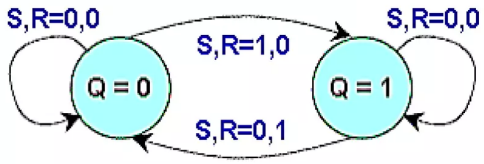
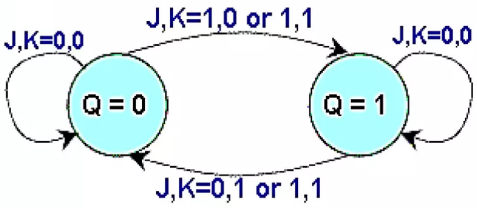
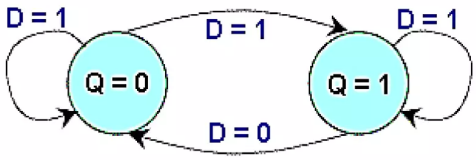
Q \ T	0	1
0	0	1
1	1	0

$$Q(t+1) = TQ(t)' + T'Q(t) = T \oplus Q(t)$$

characteristic equation

state diagram



NAME	STATE DIAGRAM
SR	
JK	
D	
T