

1. Conversion of flip flops

Rules for conversion:

- Step-1:

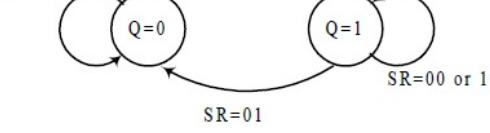
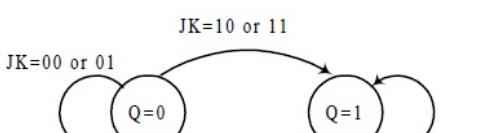
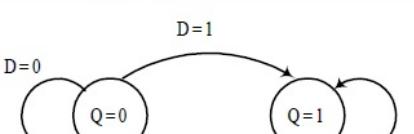
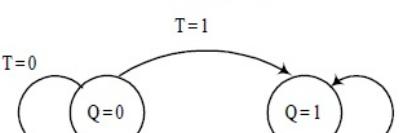
Find the characteristics table of required flip-flop and the excitation table of the existing (given) flip-flop.

- 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 	<table border="1"> <thead> <tr> <th>S</th><th>R</th><th>Q</th><th>Q_{next}</th></tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>1</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>×</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>×</td></tr> </tbody> </table>	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	×	 $Q_{next} = S + R'Q$ $SR = 0$	<table border="1"> <thead> <tr> <th>Q</th><th>Q_{next}</th><th>S</th><th>R</th></tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>×</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>×</td><td>0</td></tr> </tbody> </table>	Q	Q _{next}	S	R	0	0	0	×	0	1	1	0	1	0	0	1	1	1	×	0
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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

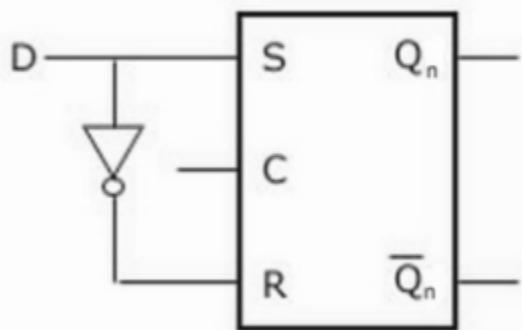
S:

D,Q _n		
	0	0
	1	X

R:

D,Q _n		
	X	1
	0	0

Logic Diagram



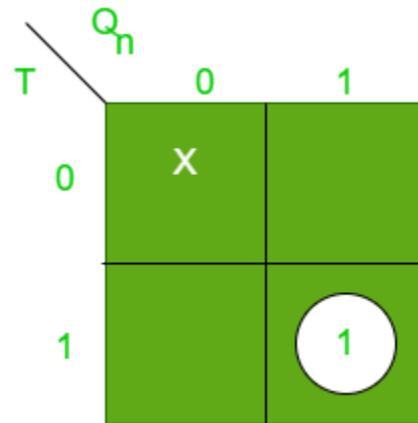
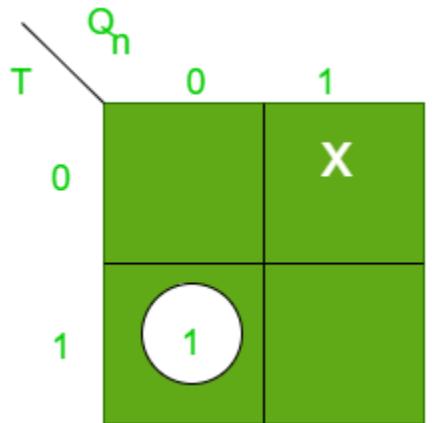
Conversion of S-R Flip-Flop into T Flip-Flop

Excitation Table

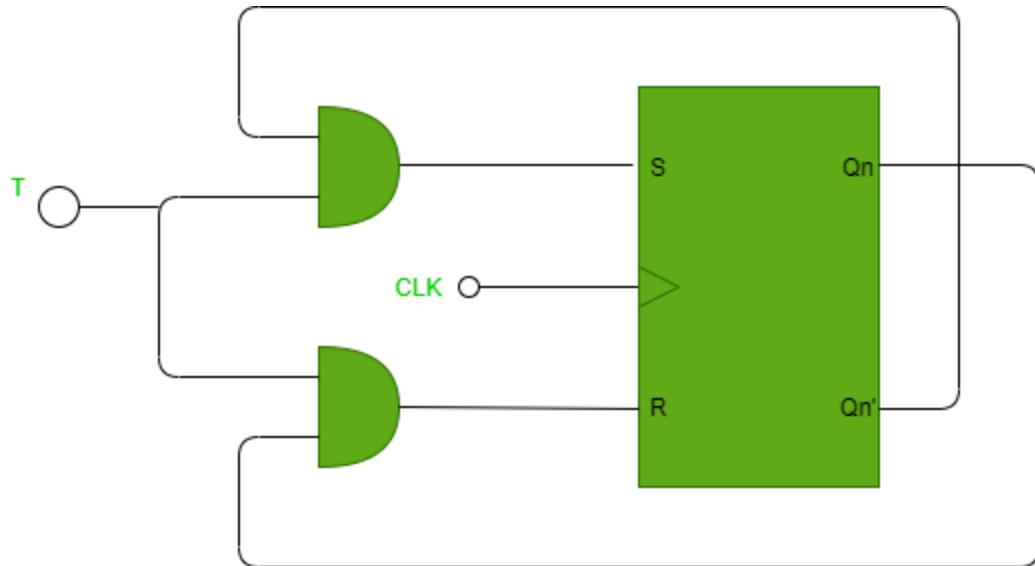
Characteristic Table

T	Q_n	Q_{n+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 S & R in terms of T.



$$S = TQ_n' \quad \& \quad R = TQ_n$$

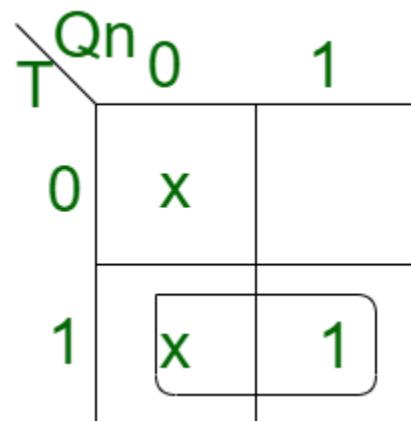
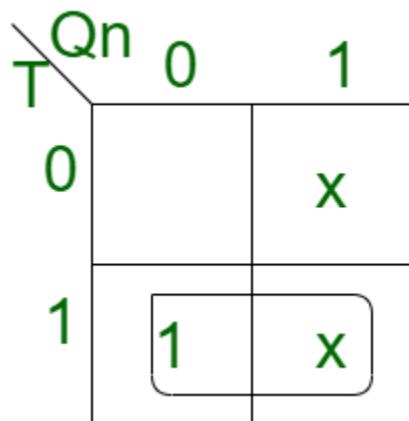


Conversion of J-K Flip-Flop into T Flip-Flop

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

T	Q _n	Q _{n+1}	J	K
0	0	0	0	x
0	1	1	x	0
1	0	1	1	x
1	1	0	x	1

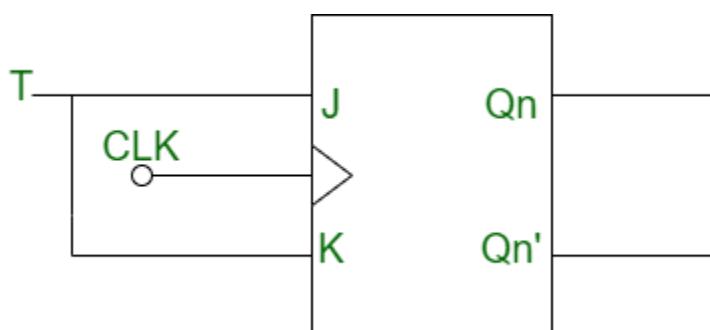
Step-2: Using the K map, find the boolean expression for J and K in terms of T



$$J = T$$

$$K = T$$

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

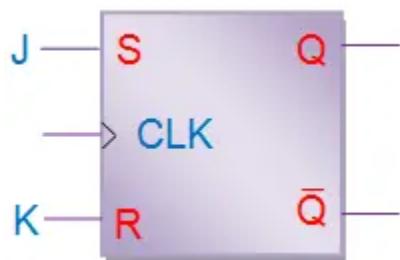
S	R	Q_n	Q_{n+1}	J	K
0	0	0	0	0	X
0	0	1	1	X	0
0	1	0	0	0	X
0	1	1	0	X	1
1	0	0	1	1	X
1	0	1	1	X	0
1	1	invalid		X	X
1	1	invalid		X	X

S	RQ_n			
	00	01	11	10
0	0	X	X	0
	4	5	7	6
1	1	X	X	X

$$J = S$$

S	RQ_n			
	00	01	11	10
0	X	0	1	X
1	X	0	1	X

$$K = R$$



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

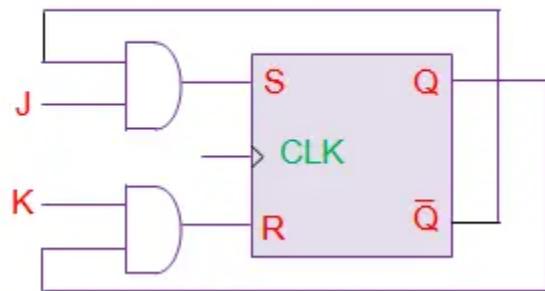
		KQ_n	00	01	11	10
J	K	0	0 ⁰	X ¹	0 ³	0 ²
		1	1 ⁴	X ⁵	0 ⁷	1 ⁶

$$S = J\bar{Q}_n$$

		KQ_n	00	01	11	10
J	K	0	X ⁰	0 ¹	1 ³	X ²
		1	0 ⁴	0 ⁵	1 ⁷	0 ⁶

$$R = KQ_n$$

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



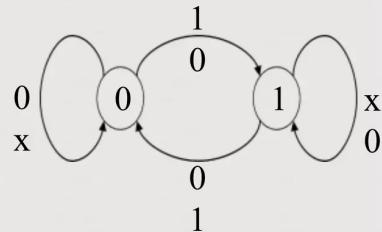
state table

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

S R \ Q	00	01	11	10
0	0	0	x	1
1	1	0	x	1

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

The state diagram



↑
characteristic equation

State Diagrams: J-K

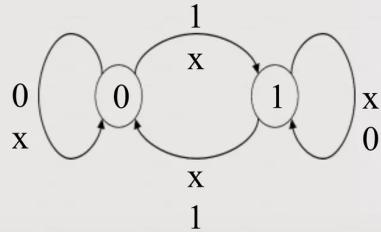


	J	K	Q(t+1)
state table	0	0	Q(t)
	0	1	0
	1	0	1
	1	1	Q(t)'

static hazard!!

JK	00	01	11	10
Q	0	0	1	1
Q	1	1	0	1

The state diagram



$$Q(t+1) = J Q(t)' + K' Q(t), \text{ or}$$

$$Q(t+1) = J Q(t)' + K' Q(t) + JK'$$

characteristic
equation

State diagram



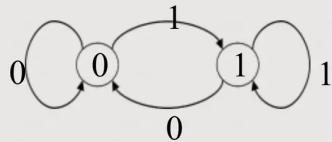
◦ state table

D	Q(t+1)
0	0
1	1

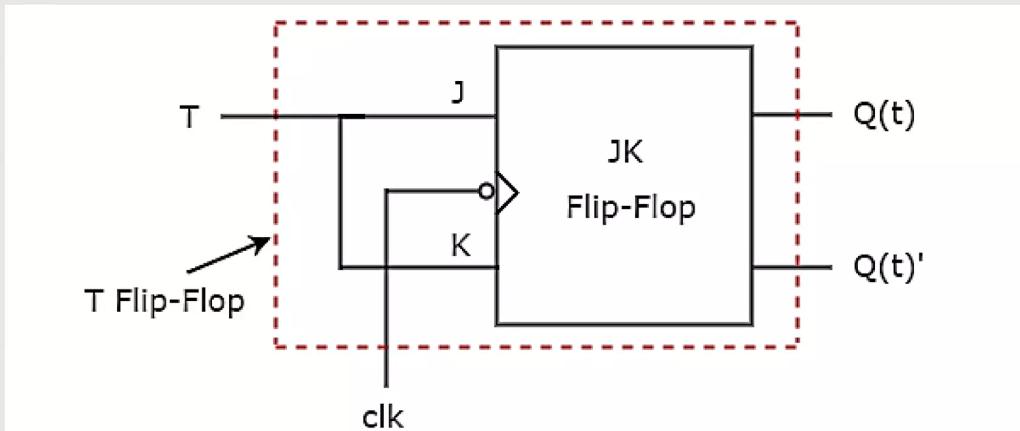
D	0	1
Q	0	1
0	0	1

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

characteristic
equation



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

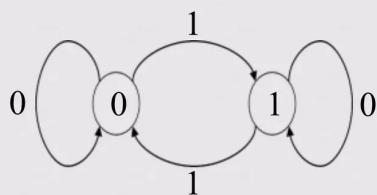
T	Q(t+1)
0	Q(t)
1	Q(t)'

3

Q	0	1
0	0	1
1	1	0

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

state diagram



characteristic
equation

NAME	STATE DIAGRAM
SR	<p>State diagram for SR flip-flop:</p> <ul style="list-style-type: none"> States: Q = 0, Q = 1 Initial state: S,R=0,0 Transitions: <ul style="list-style-type: none"> From Q = 0 to Q = 0: S,R=0,0 From Q = 0 to Q = 1: S,R=1,0 From Q = 1 to Q = 0: S,R=0,1 From Q = 1 to Q = 1: S,R=0,0
JK	<p>State diagram for JK flip-flop:</p> <ul style="list-style-type: none"> States: Q = 0, Q = 1 Initial state: J,K=0,0 Transitions: <ul style="list-style-type: none"> From Q = 0 to Q = 0: J,K=0,0 From Q = 0 to Q = 1: J,K=1,0 or 1,1 From Q = 1 to Q = 0: J,K=0,1 or 1,1 From Q = 1 to Q = 1: J,K=0,0
D	<p>State diagram for D flip-flop:</p> <ul style="list-style-type: none"> States: Q = 0, Q = 1 Initial state: D = 1 Transitions: <ul style="list-style-type: none"> From Q = 0 to Q = 0: D = 1 From Q = 0 to Q = 1: D = 1 From Q = 1 to Q = 0: D = 0 From Q = 1 to Q = 1: D = 1
T	<p>State diagram for T flip-flop:</p> <ul style="list-style-type: none"> States: Q = 0, Q = 1 Initial state: T = 0 Transitions: <ul style="list-style-type: none"> From Q = 0 to Q = 0: T = 0 From Q = 0 to Q = 1: T = 1 From Q = 1 to Q = 0: T = 1 From Q = 1 to Q = 1: T = 0