3.EXCITATION TABLE:

The *characteristic table* is useful for **analysis** and for defining the operationof the Flip-Flop. It specifies the next state (Q_{n+1}) when the inputs and present state are known.

The *excitation or application table* is useful for **design** process. It is used to find the Flip-Flop input conditions that will cause the required transition, when the present state (Q_n) and the next state (Q_{n+1}) are known.

SR Flip- Flop:

SR Flip- Flop:

Present State	Inputs		Next State
Q_n	S	R	Q_{n+1}
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	x
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	x

Characteristic Table

Present State	Next State	Inputs		Inputs	
Q_n	Q_{n+1}	S	R	S	R
0	0	0	0	0	x
0	0	0	1		
0	1	1	0	1	0
1	0	0	1	0	1
1	1	0	0	x	0
1	1	1	0		

Modified Table

Characteristic Table

Present State	Next State	Inputs	
Q_n	Q_{n+1}	S	R
0	0	0	x
0	1	1	0
1	0	0	1
1	1	x	0

Excitation Table

The above table presents the excitation table for SR Flip-Flop. It consists of present state (Q_n), next state (Q_{n+1}) and a column for each input to show how therequired transition is achieved. There are 4 possible transitions from present state to next state. The required Input conditions for each of the four transitions are derived from the information available in the characteristic table. The symbol 'x' denotes the don't care condition; it does not matter whether the input is 0 or 1.

JK Flip-Flop:

Present State	Inputs		Next State
Q_n	J	K	Q_{n+1}
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

Characteristic Table

Present State	Next State	Inputs		Inputs	
Q_n	Q_{n+1}	J	K	J	K
0	0	0	0	0	x
0	0	0	1		
0	1	1	0	1	x
0	1	1	1		
1	0	0	1	x	1
1	0	1	1		
1	1	0	0	x	0
1	1	1	0		

Modified Table

Present State	Next State	Inputs	
Q_n	Q_{n+1}	J	K
0	0	0	x
0	1	1	x
1	0	x	1
1	1	x	0

Excitation Table

D Flip-Flop:

Present State	Input	Next State
Q_n	D	Q_{n+1}
0	0	0
0	1	1
1	0	0
1	1	1

Characteristic Table

Present State	Next State	Input
Q_n	Q_{n+1}	D
0	0	0
0	1	1
1	0	0
1	1	1

Excitation Table

T Flip-Flop:

Present State	Input	Next State
Q_n	T	Q_{n+1}
0	0	0
0	1	1
1	0	1
1	1	0

Characteristic Table

Present State	Next State	Input
Q_n	Q_{n+1}	T
0	0	0
0	1	1
1	0	1
1	1	0

Excitation Table

REALIZATION OF ONE FLIP-FLOP USING OTHER FLIP-FLOPS

It is possible to convert one Flip-Flop into another Flip-Flop with some additional gates or simply doing some extra connection. The realization of one Flip- Flop using other Flip-Flops is implemented by the use of characteristic tables and excitation tables. Let us see few conversions among Flip-Flops.

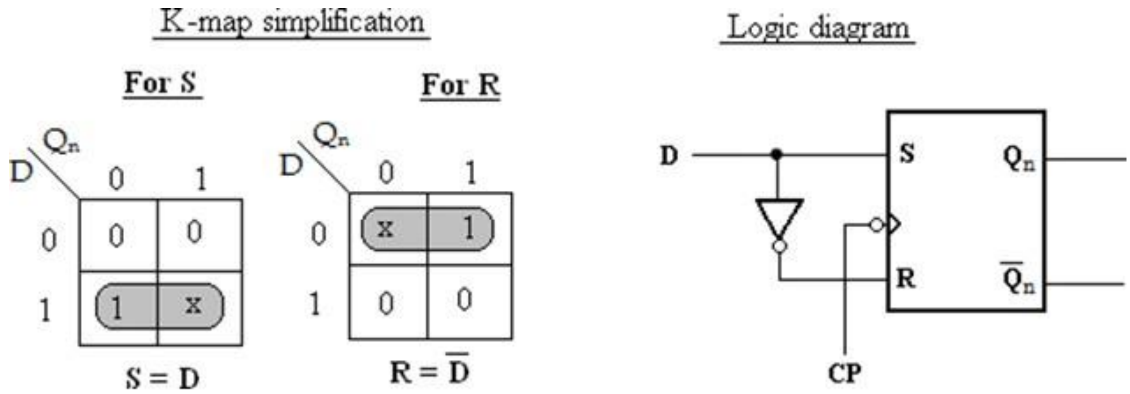
- SR Flip-Flop to D Flip-Flop
- SR Flip-Flop to JK Flip-Flop
- SR Flip-Flop to T Flip-Flop
- JK Flip-Flop to T Flip-Flop
- JK Flip-Flop to D Flip-Flop
- D Flip-Flop to T Flip-Flop
- T Flip-Flop to D Flip-Flop

SR Flip-Flop to D Flip-Flop:

- Write the characteristic table for required Flip-Flop (D Flip-Flop).
- Write the excitation table for given Flip-Flop (SR Flip-Flop).
- Determine the expression for given Flip-Flop inputs (S & R) by using K-map.
- Draw the Flip-Flop conversion logic diagram to obtain the required flip- flop(D Flip-Flop) by using the above obtained expression.

The excitation table for the above conversion is

Required Flip-Flop (D)			**Given Flip-Flop (SR)**	
Input	**Present state**	**Next state**	**Flip-Flop Inputs**	
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



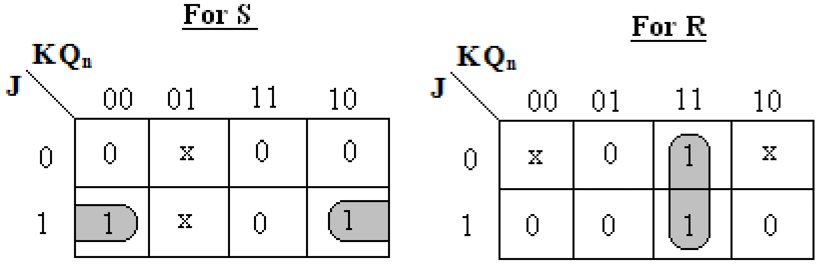
SR to D Flip-Flop

SR Flip-Flop to JK Flip-Flop

The excitation table for the above conversion is, Q_n

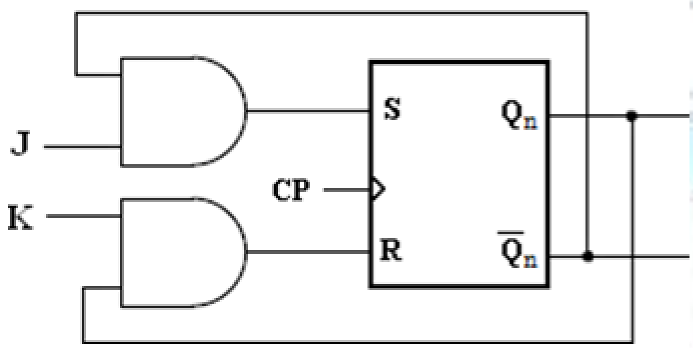
Inputs		Present state	Next state	Flip-Flop Inputs	
J	K	Q_n	Q_{n+1}	S	R
0	0	0	0	0	x
0	0	1	1	x	0
0	1	0	0	0	x
0	1	1	0	0	1
1	0	0	1	1	0
1	0	1	1	x	0
1	1	0	1	1	0
1	1	1	0	0	1

K-map simplification



$S = J\overline{Q}_n$ $R = KQ_n$

Logic diagram



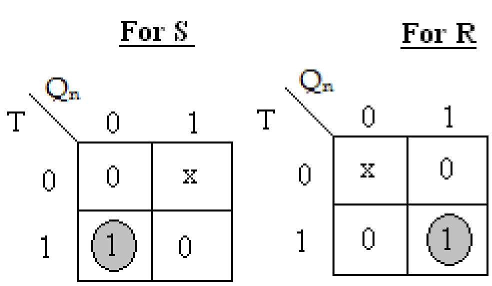
SR to JK Flip-Flop

SR Flip-Flop to T Flip-Flop

The excitation table for the above conversion is

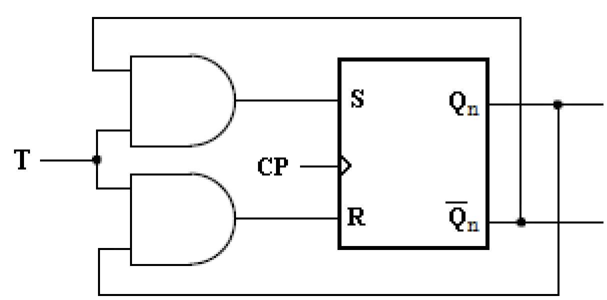
Input	Present state	Next state	Flip-Flop Inputs	
T	Q_n	Q_{n+1}	S	R
0	0	0	0	x
0	1	1	x	0
1	0	1	1	0
1	1	0	0	1

K-map simplification



$S = T\overline{Q}_n$ $R = TQ_n$

Logic diagram



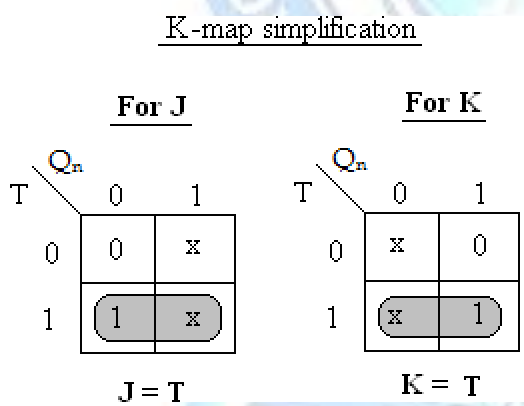
SR to T Flip-Flop

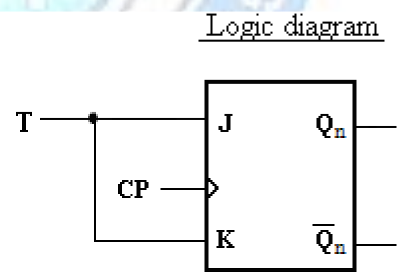
JK Flip-Flop to T Flip-Flop

The excitation table for the above conversion is

Input	Present state	Next state	Flip-Flop Inputs	
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

JK to T Flip-Flop

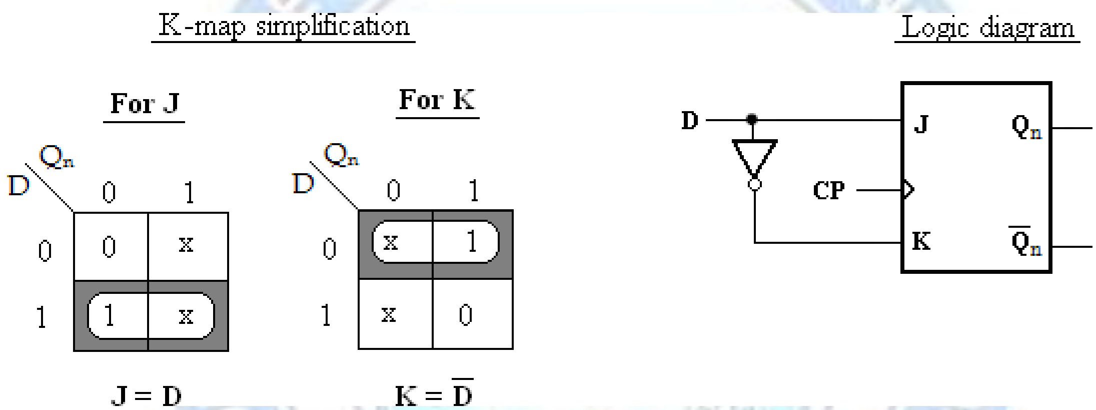




JK Flip-Flop to D Flip-Flop

The excitation table for the above conversion is

Input	Present state	Next state	Flip-Flop Inputs	
D	Q_n	Q_{n+1}	J	K
0	0	0	0	x
0	1	0	x	1
1	0	1	1	x
1	1	1	x	0



JK to D Flip-Flop

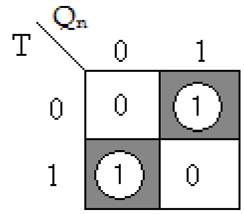
D Flip-Flop to T Flip-Flop

The excitation table for the above conversion

Input	Present state	Next state	Flip-Flop Input
T	Q_n	Q_{n+1}	D
0	0	0	0
0	1	1	1
1	0	1	1
1	1	0	0

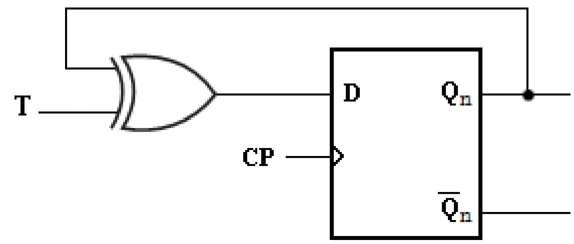
D to T Flip-Flop

K-map simplification



$$D = \overline{T}Q_n + T\overline{Q_n}$$
$$= T \oplus Q_n$$

Logic diagram

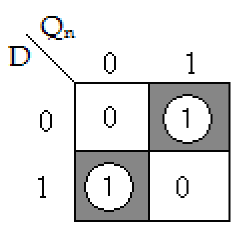


T Flip-Flop to D Flip-Flop

The excitation table for the above conversion is

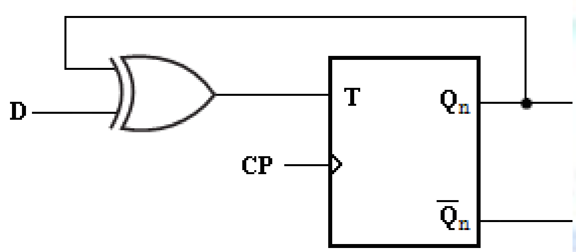
Input	Present state	Next state	Flip-Flop Input
D	**Q_n**	**Q_{n+1}**	**T**
0	0	0	0
0	1	0	1
1	0	1	1
1	1	1	0

K-map simplification



$$T = D\overline{Q_n} + \overline{D}Q_n$$
$$= D \oplus Q_n$$

Logic diagram



T to D Flip-Flop