CS & IT ENGINEERING

DIGITAL LOGIC
Sequential Circuit

Lecture No. 4

By- CHANDAN SIR
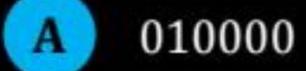
TOPICS TO BE COVERED

01 SR , JK ,D , T Flip Flop
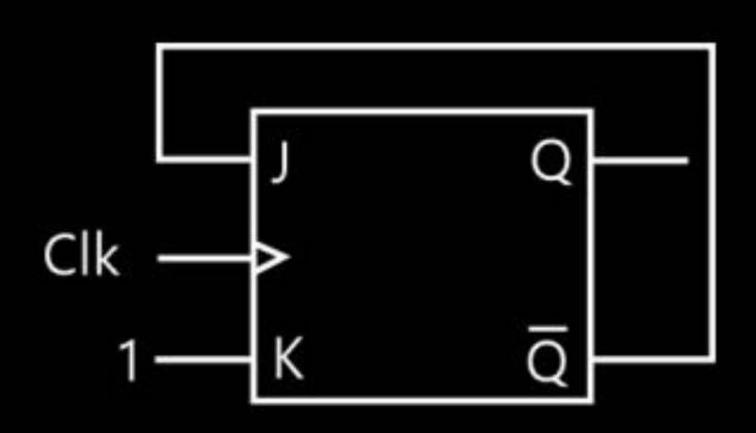
02 PRACTICE

03 DISCUSSION

The J-K FF shown below is initially cleared and then clocked for 5 pulses, the sequence at the Q output will be

A 010000

B 011001

C 010010

D 010101

D FLIP-FLOP

(i) It is known as Delay FF or Transparent FF.

(ii) In the D FF what ever the input is applied it will directly come to the output along with the clock.

1. Symbol

Figure 1: D Flip Flop

2. Truth Table

D	Q_{n+1}
0	0
1	1

Table 1: Truth Table of D Flip Flop

D FLIP-FLOP

3. Characteristics Table

D	Q_n	Q_{n+1}
0	0	0
0	1	0
1	0	1
1	1	1

Table 2 : Characteristic Table of D Flip Flop

4. Characteristics Equation

$$Q_{n+1} = D$$

D FLIP-FLOP

5. Excitation table

Q_n	Q_{n+1}	D
0	0	0
0	1	1
1	0	0
1	1	1
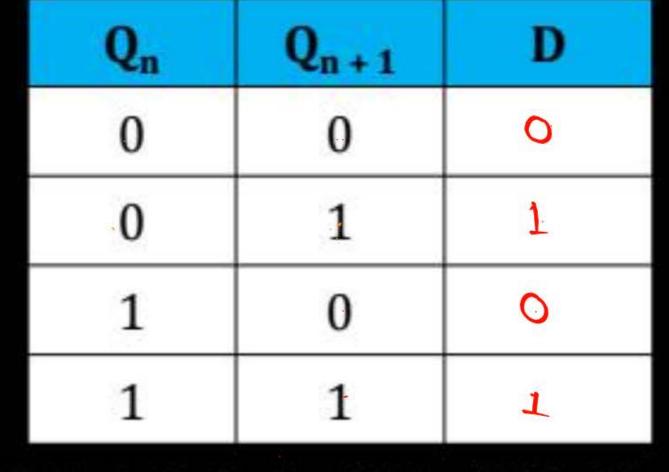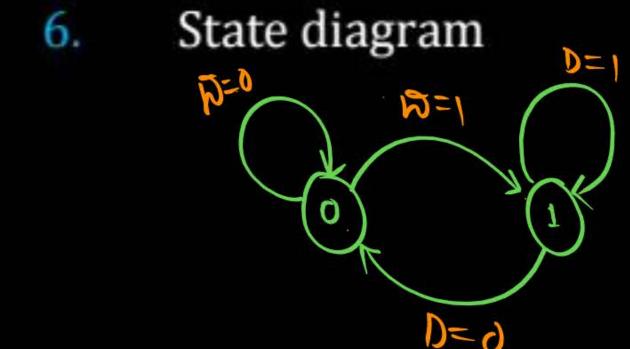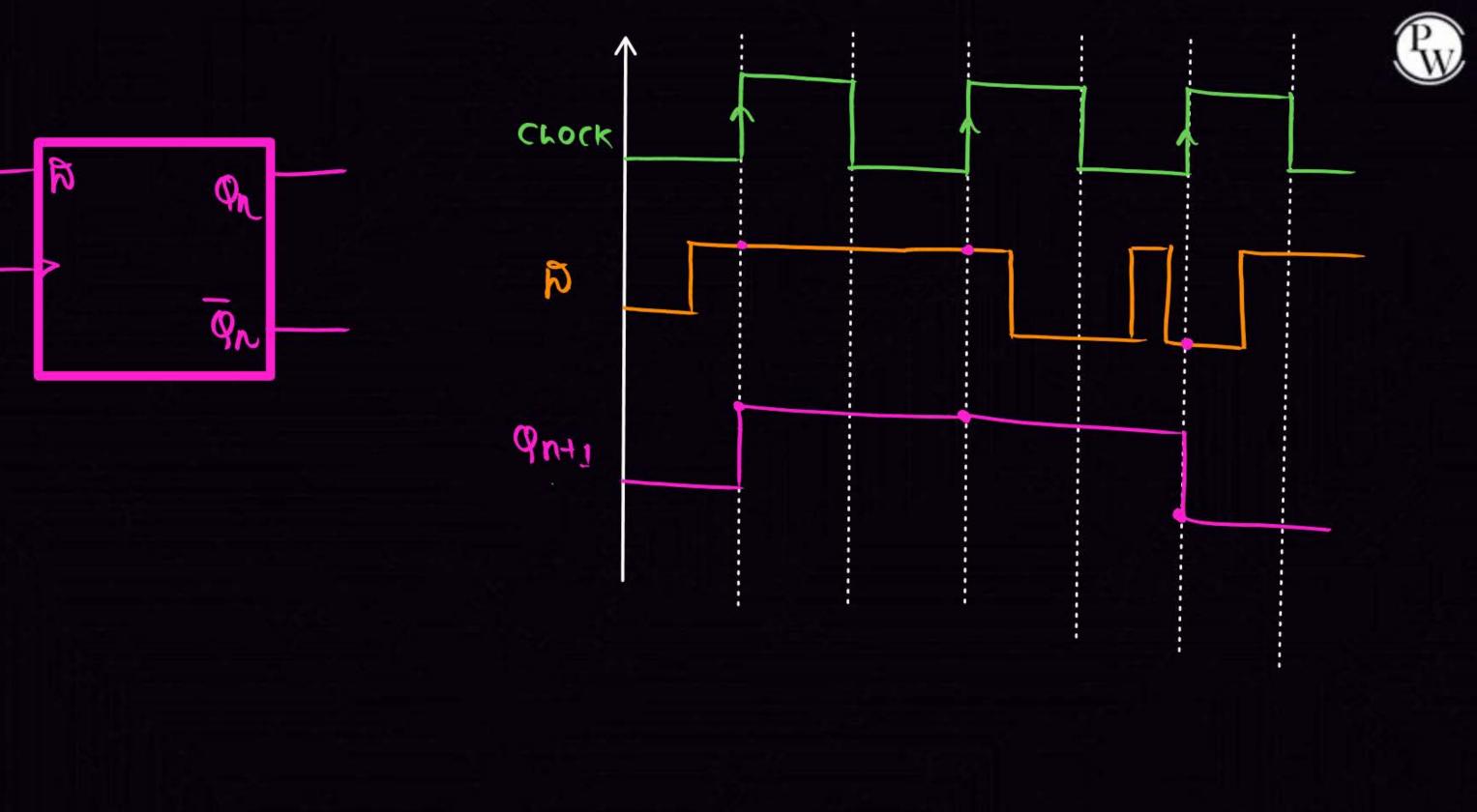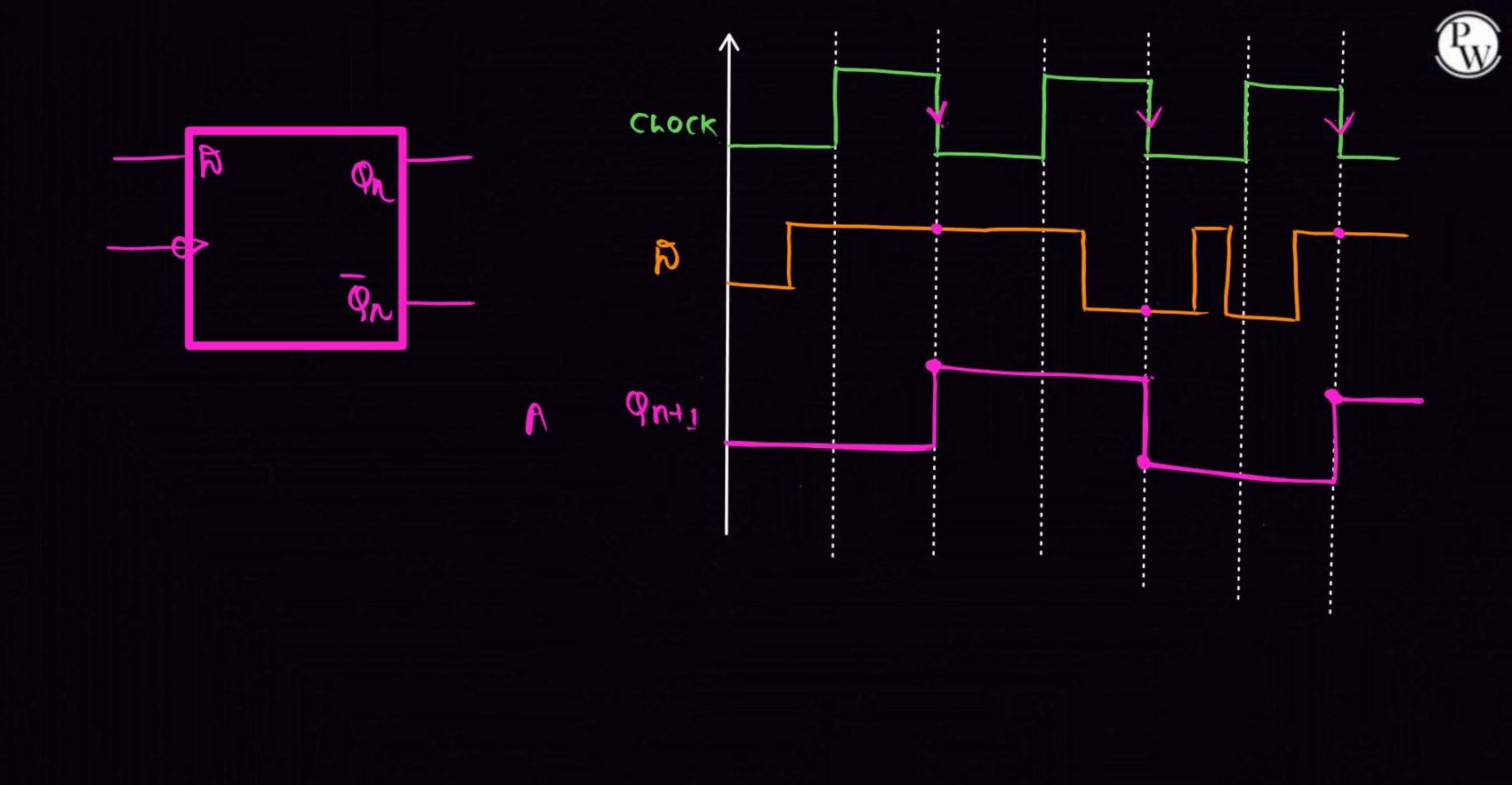
Table 3 : Excitation Table of D Flip Flop

6. State diagram

D=0 D=1 D=1

0   1

D=0

T FLIP FLOP (TOGGLE FLIP-FLOP)

1. Symbol

Figure 2 : T Flip Flop

2. Truth Table

T	Q_{n+1}
0	Q_n
1	$\overline{Q}_n$

Table 4 : Truth Table of T Flip Flop

T FLIP FLOP (TOGGLE FLIP-FLOP)

3. Characteristics Table

T	Q_n	Q_{n+1}
0	0	0
0	1	1
1	0	1
1	1	0

Table 5 : Characteristic Table of T Flip Flop

4. Characteristics Equation

$$Q_{n+1} = \overline{T} Q_n + T \overline{Q}_n$$

$$\boxed{Q_{n+1} = T \oplus Q_n}$$

5. Excitation table

Q_n	Q_{n+1}	T
0	0	0
0	1	1
1	0	1
1	1	0

Table 6 : Excitation Table of T Flip Flop

6. State diagram
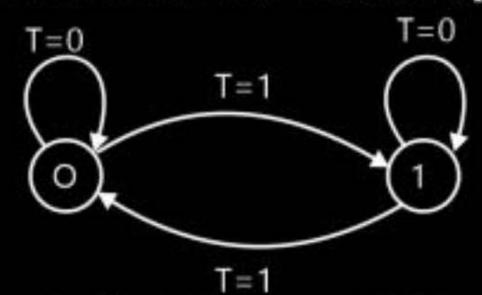
Figure 3 : State diagram of T Flip Flop

MASTER-SLAVE FF

Note: J-K FF is also known as universal FF.

	J	K	Q_{n+1}
SR f/f	0	0	Q_n
	0	1	0
	1	0	1
	1	1	$\overline{Q_n}$

Diff.F

T.F.F.

SR FF

$$Q_{n+1} = S + \bar{R}Q_n$$

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

JK FF

$$Q_{n+1} = J\bar{Q}_n + \bar{K}Q_n$$

J	K	Q_{n+1}
0	0	Q_n
0	1	0
1	0	1
1	1	$\bar{Q}_n$

D-FF

$$Q_{n+1} = D$$

D	Q_{n+1}
0	0
1	1

T-FF

$$Q_{n+1} = T \oplus Q_n$$

T	Q_{n+1}
0	Q_n
1	$\bar{Q}_n$

Excitation Table.

Q_n	Q_{n+1}	S	R	J	K	D	T
0	0	0	x	0	x	0	0
0	1	1	0	1	x	1	1
1	0	0	1	x	1	0	1
1	1	x	0	x	0	1	0

Designing of Flip-Flop

CD

characteristic   Desire.

Step 1 :→ Write the characteristic Table of desired FF.

Step 2 :→ Write the excitation table of avaliable FF.

Step 3 :→ Write the Logical expression.

Step 4 :→ Minimize the Logical expression.

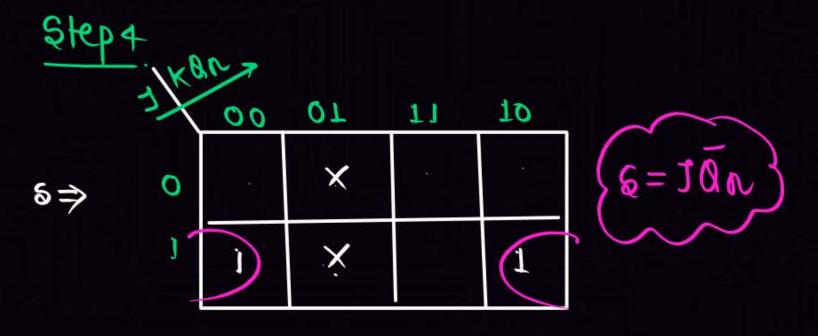Step 5 :→ Hardware Implementation.

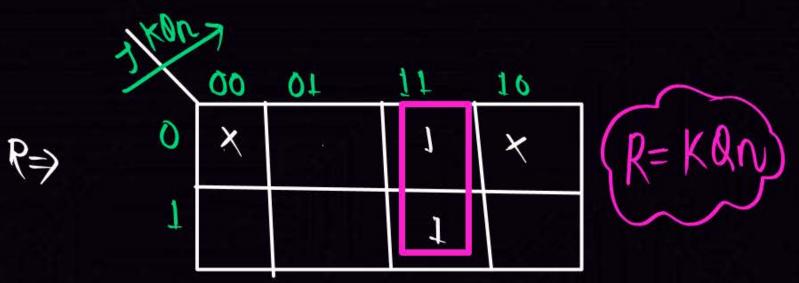Q Design JK FF by using SR FF?

Desired ⟵   ⟶ avaliable

Step 1
Step 2

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

Step 3. $S(J,K,Q_n) = \Sigma m(4,6) + \Sigma d(1,5)$
$R(J,K,Q_n) = \Sigma m(3,7) + \Sigma d(0,2)$

Step 4

$S \Rightarrow$

J \ KQ_n	00	01	11	10
0		X		
1	1	X		1

$S = J\bar{Q}_n$

$R \Rightarrow$

J \ KQ_n	00	01	11	10
0	X		1	X
1			1	

$R = KQ_n$

Step 5

$\overline{Q}$

$X\overline{Q_n}$

X

y

$y Q_n$

S

R

Q_n

$\overline{Q_n}$

$\overline{JK-FF}$

$$Q_{n+1} = J\overline{Q_n} + \overline{K}Q_n$$

$$S = X\overline{Q_n} \qquad R = yQ_n$$

$$Q_{n+1} = S + \overline{R}Q_n$$

$$= X\overline{Q_n} + \overline{yQ_n} \cdot Q_n$$

$$= X\overline{Q_n} + (\overline{y} + \overline{Q_n})Q_n$$

$$= X\overline{Q_n} + \overline{y}Q_n + \overline{Q_n} \cdot Q_n$$

$$= X\overline{Q_n} + \overline{y}Q_n$$

$$X = J \qquad y = K$$

Q. Design a D-FF by using SR FF?

Step 1:

Step 2

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

Step 3 & step 4

$$\boxed{S = D}$$

$$\boxed{R = \bar{D}}$$

Step 5:

Q.
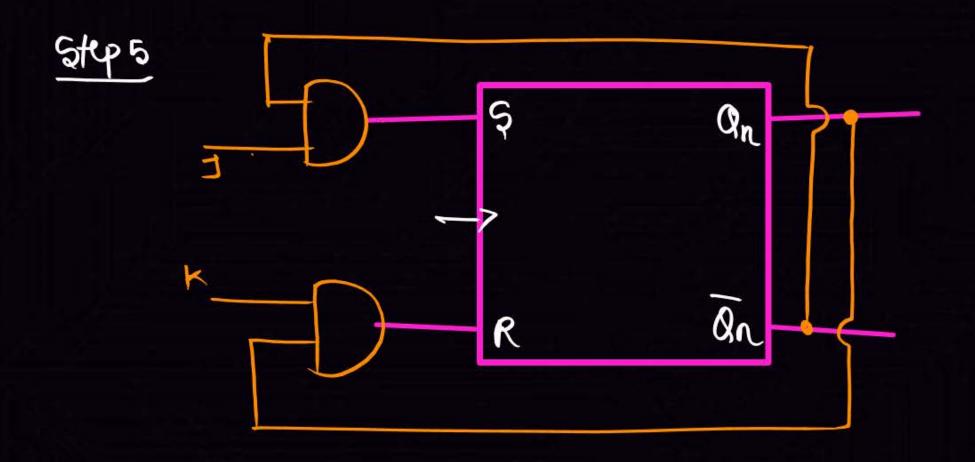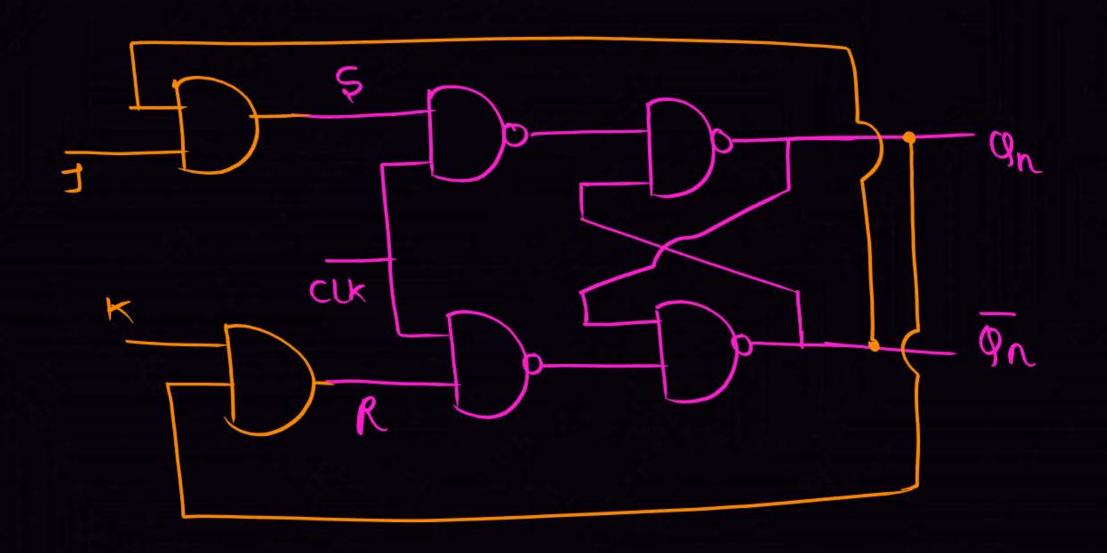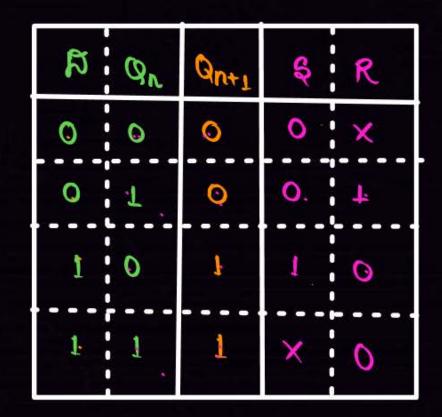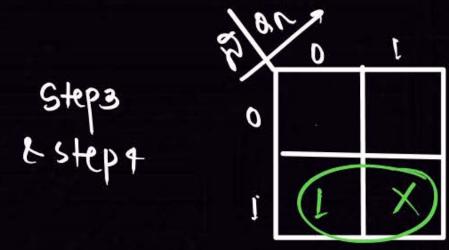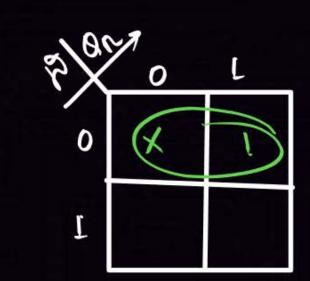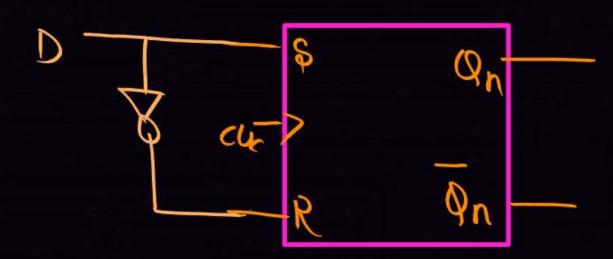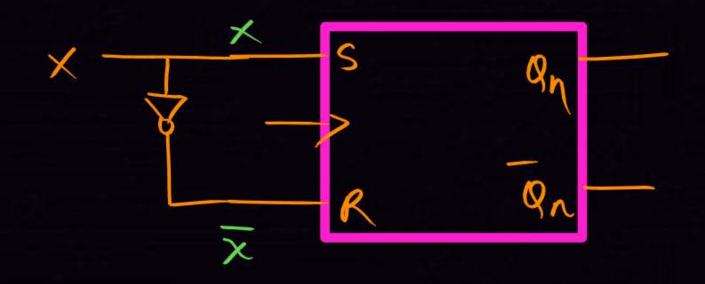
$$S = X \qquad R = \bar{X}$$

$$Q_{n+1} = S + \bar{R} \cdot Q_n$$

$$= X + \bar{\bar{X}} \, Q_n$$

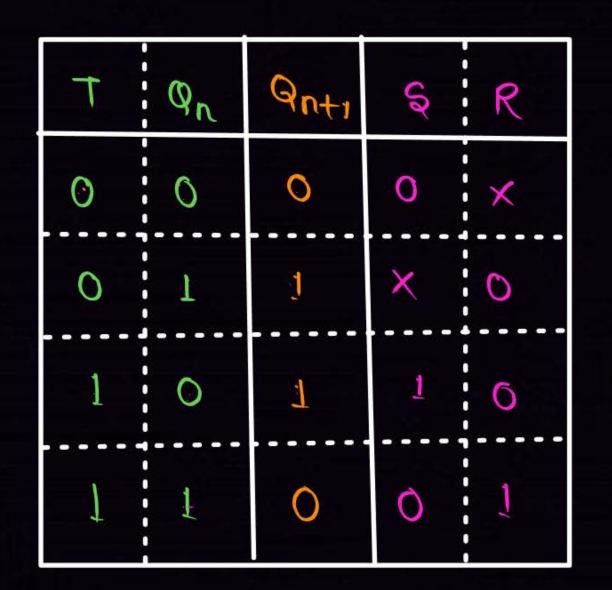$$= X + X Q_n = X(1 + Q_n)$$

$$\boxed{Q_{n+1} = X}$$

$$\boxed{Q_{n+1} = D}$$
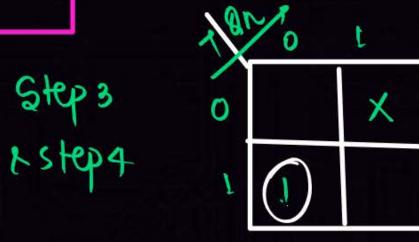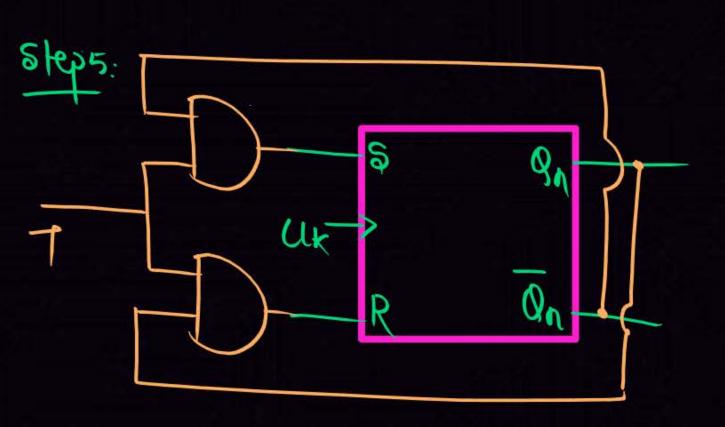
$$X = D$$

D-FF

Q Design a T-FF by using SR FF?

Step 1

& step 2.

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

Step 3

& step 4

$S = T\bar{Q_n}$

$R = TQ_n$

Step 5:

Q Design a T-FF by using D-FF ?

Step 1:-

Step 2.

T	Q_n	Q_{n+1}	D
0	0	0	0
0	1	1	1
1	0	1	1
1	1	0	0

Step 3
& Step 4

$$D = T \oplus Q_n$$

Step 5.
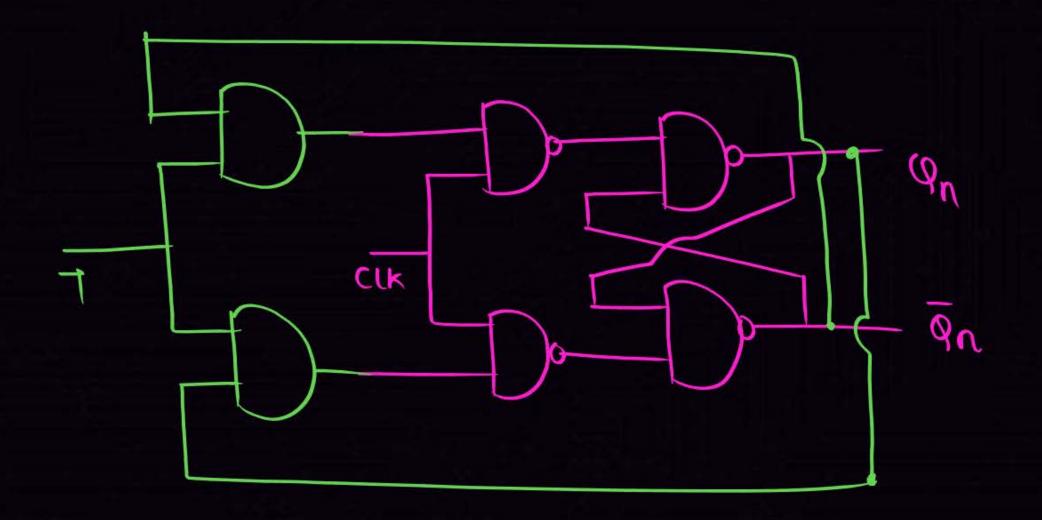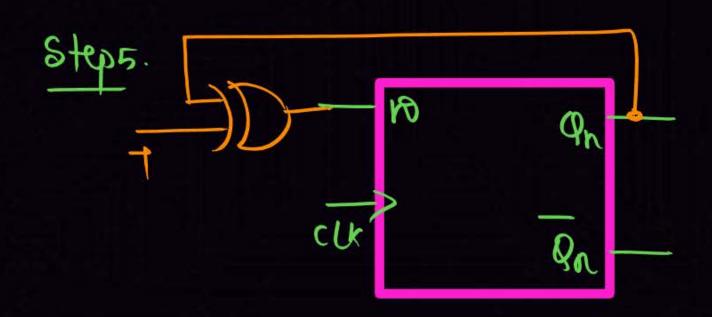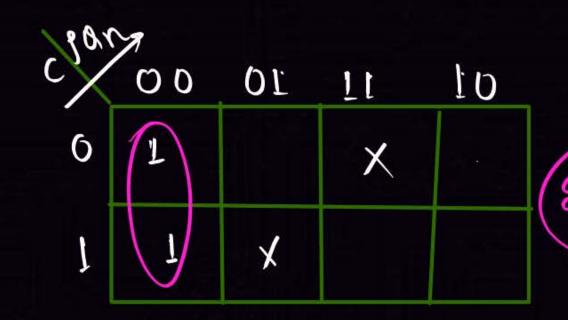
Q Design a CJ FF by using SR FF ?

truth
Table

C	J	Q_{n+1}
0	0	$\overline{Q_n}$
0	1	Q_n
1	0	1
1	1	0

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

K-map for S:

$CJ \backslash Q_n$	00	01	11	10
0	1		X	
1	1	X		

$$S = \bar{J}\bar{Q_n}$$

K-map for R:

$CJ \backslash Q_n$	00	01	11	10
0		1		X
1			1	X

$$R = \bar{C}J\bar{Q_n} + CJ$$

S.R   JK   D   T.

HW   ⑫   ✓

H.W Q Design a HS FF by using T-FF?

H	S	Q_{n+1}
0	0	1
0	1	0
1	0	$\overline{Q_n}$
1	1	Q_n