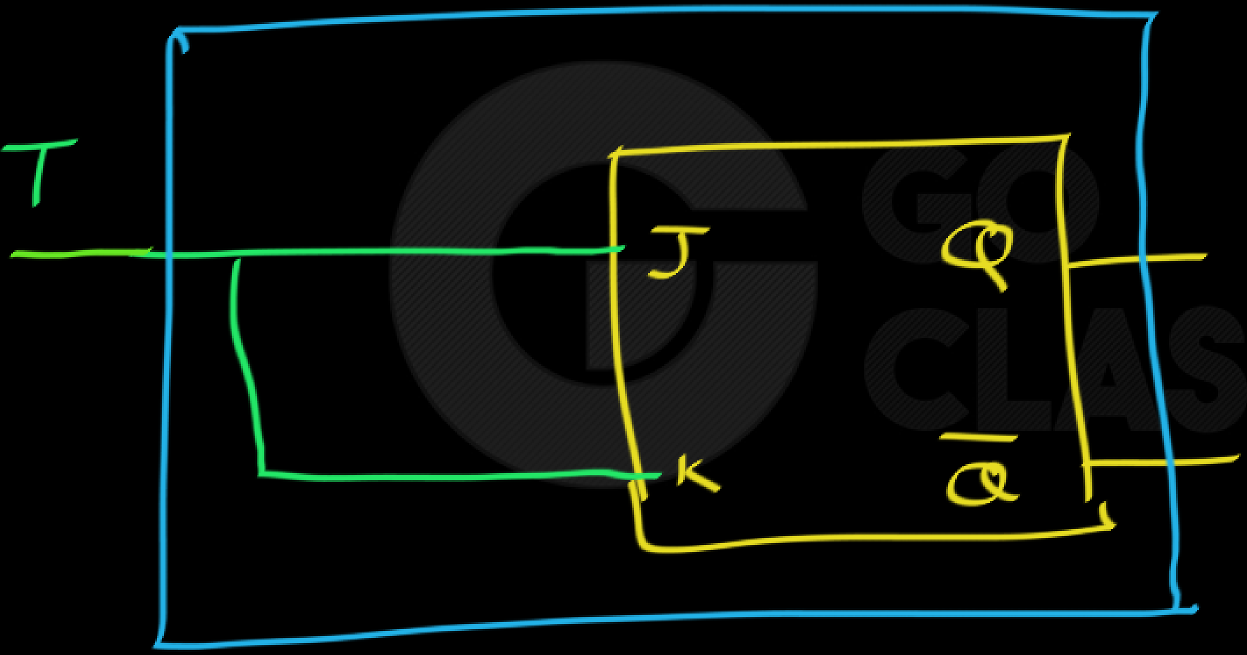
Next Topic :

Flipflop Conversion

Flip-Flop Conversion(Topics Covered) :

1. Flipflop Conversion Concept
2. All standard flipflop conversions with Variations
3. Standard Book(Morris Mano) Questions
4. ALL GATE CSE, ECE Questions
5. All Chegg & University Questions

JK-ff to T-ff :



Desired ff :

T-ff

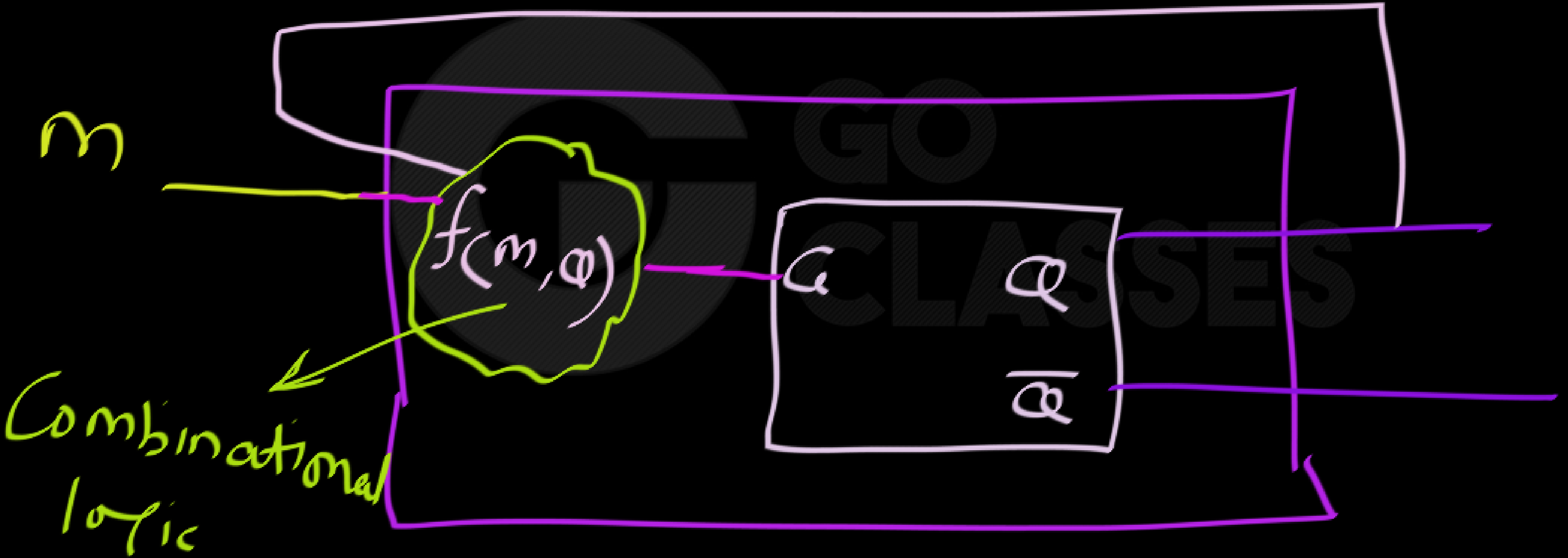
Used/Given ff :

JK-ff

T-ff using JK ff.

Given ff ✓ (G)
Desired ff (M)

M-ff using G-ff



$$\boxed{G = f(m, Q)} \Rightarrow \text{Idea}$$

m	Q	Q_n

Truth Table of m

$G = f(m, Q)$

Excitation Table of G.

Conversion of Flipflops

- Steps for the conversions
  - Step 1: Write the Truth Table of the Desired Flip-Flop
  - Step 2: Obtain the Excitation Table for the given Flip-Flop from its Truth Table
  - Step 3: Append the Excitation Table of the given Flip-Flop to the Truth Table of the Desired Flip-Flop Appropriately to obtain Conversion Table
  - Step 4: Simplify the Expressions for the Inputs of the given Flip-Flop
  - Step 5: Design the Necessary Circuit and make the Connections accordingly

PROCEDURE FOR CONVERSION

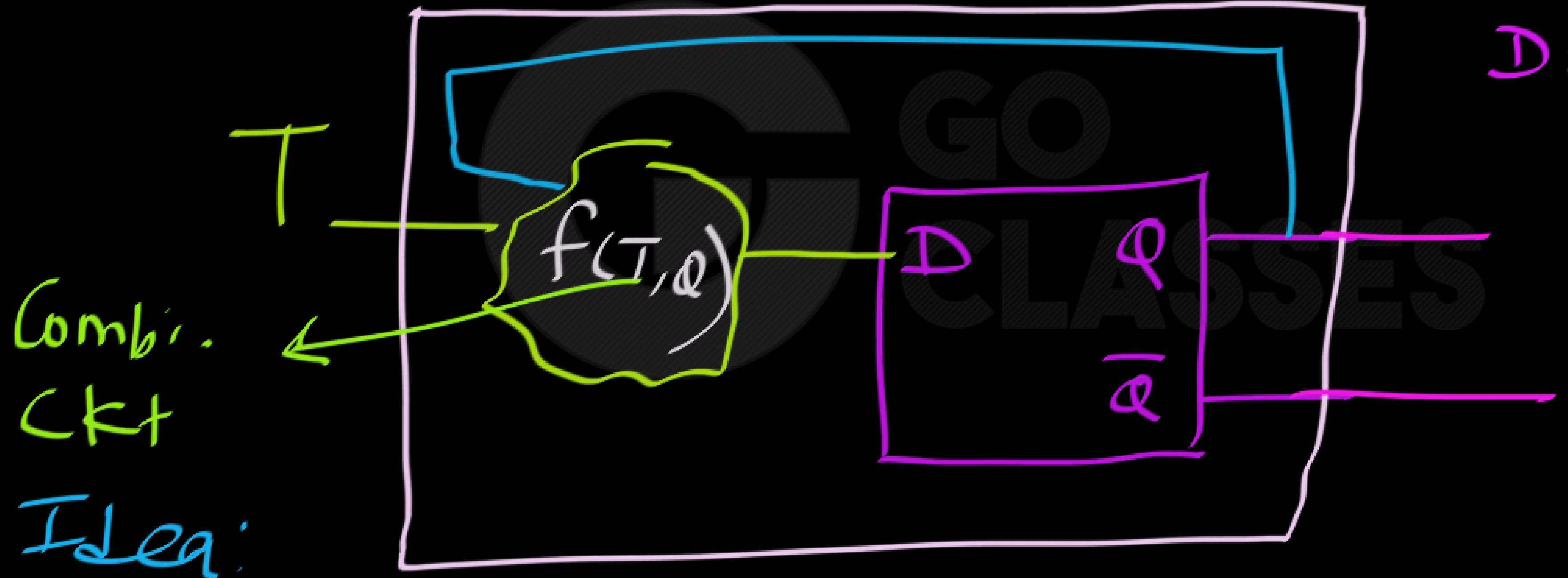
1. Draw the block diagram of the target flip flop from the given problem.
2. Write truth table for the target flip-flop.
3. Write excitation table for the available flip-flop.
4. Draw k-map for target flip-flop.
5. Draw the block diagram.

Next Topic :

D to T Flipflop Conversion

① D to T :

Given : D ; Desired ff : T



$D = f(T, Q)$

Idea:

Target: $D = f(T, Q)$

T	Q	Q_n	$D = f(T, Q)$

Truth Table of T-FF

$? \Longrightarrow$ Excitation Table of D.

Target: $D = f(T, Q)$

Present state — Next state

$D = f(T, Q)$

	T	Q	Q_n	
T=0	0	0	0	?
	0	1	1	
T=1	1	0	1	
	1	1	0	

Target: $D = f(T, Q)$

Next state

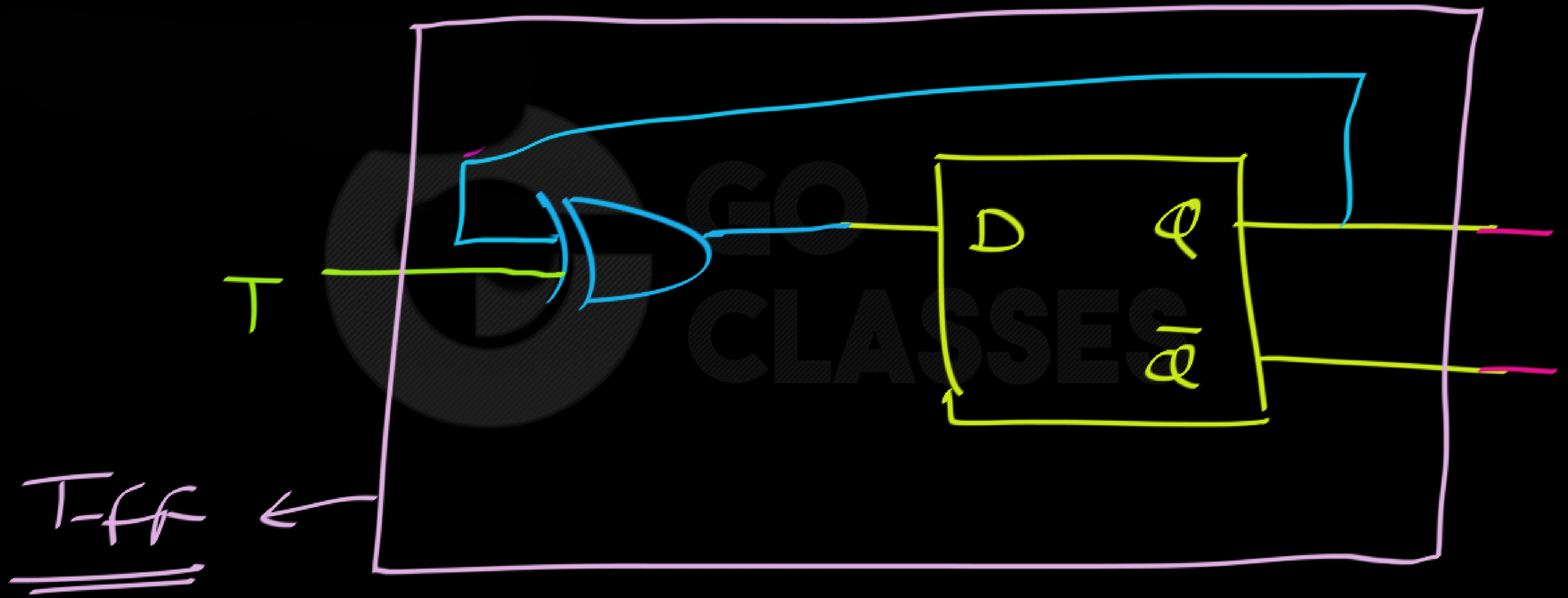
Present state

$D = f(T, Q)$

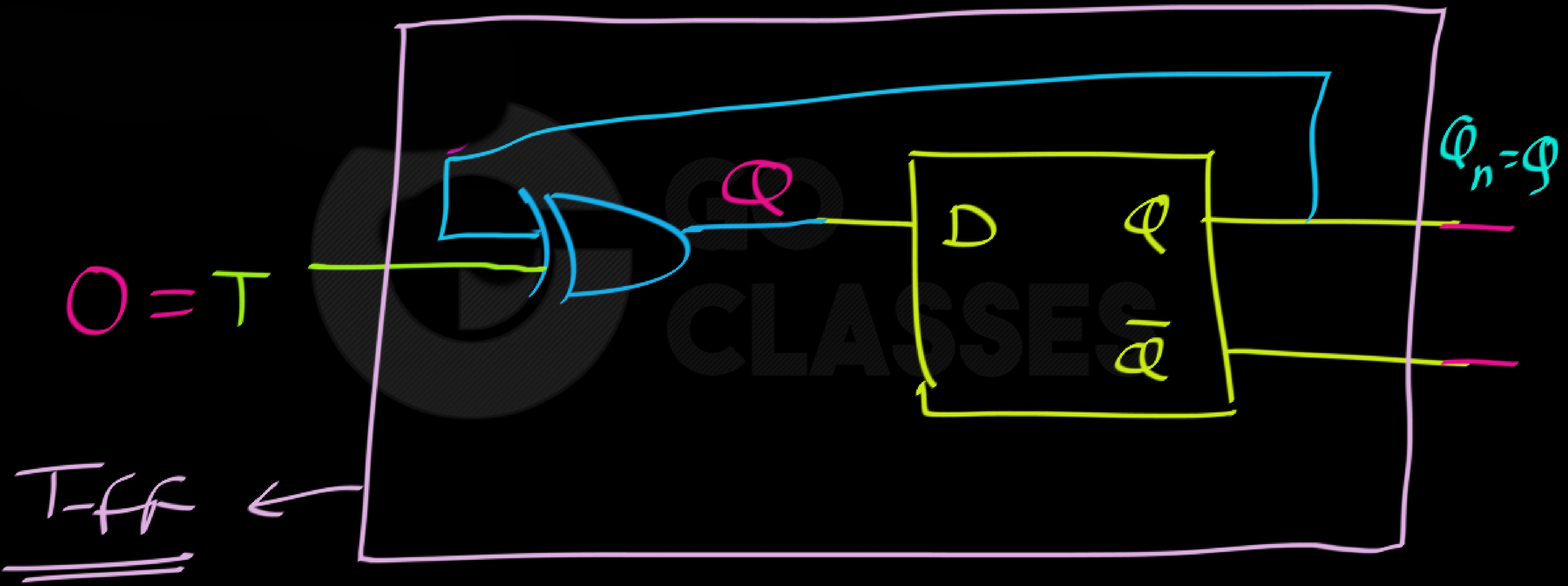
	T	Q	Q_n	D
T=0	0	0	0	0
	0	1	1	1
T=1	1	0	1	1
	1	1	0	0

$\boxed{Q_n = D}$

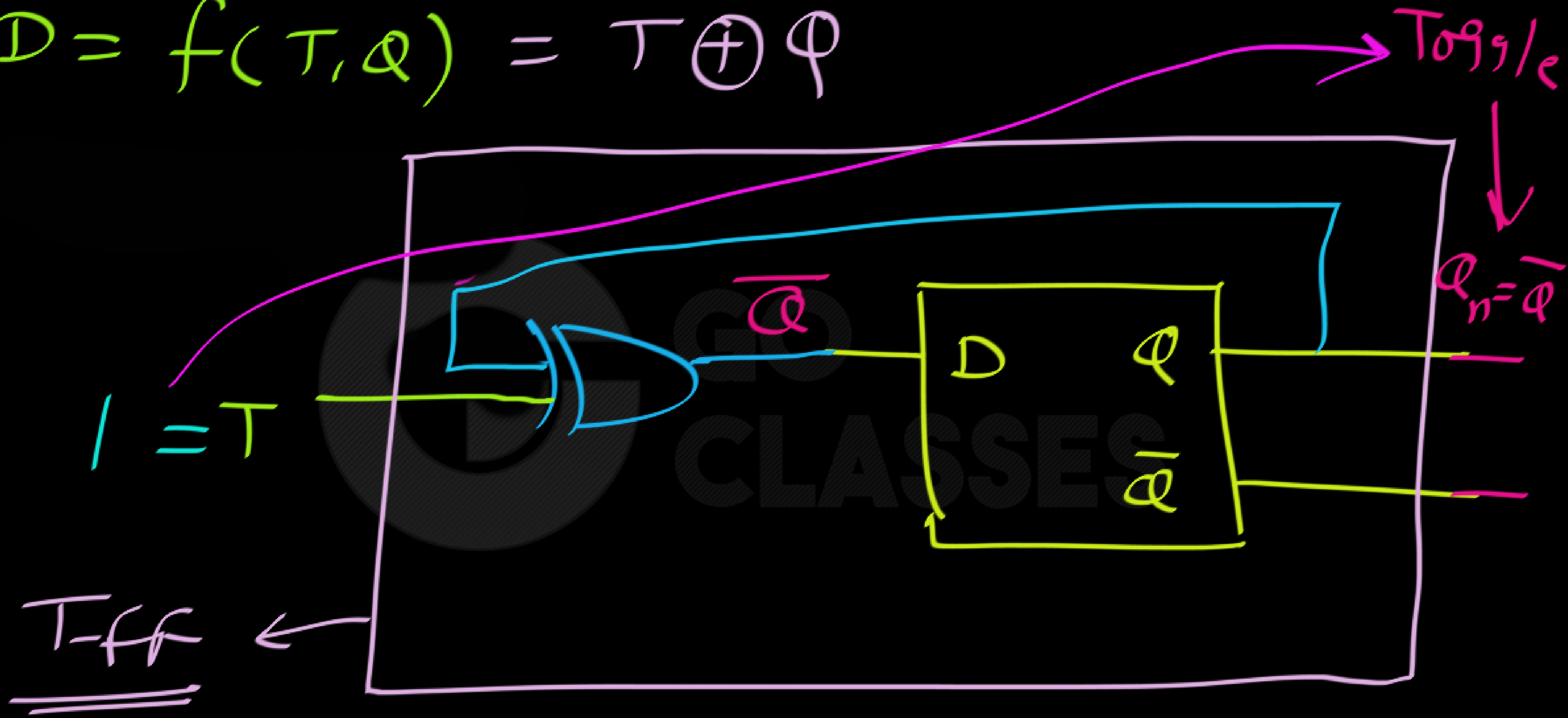
$D = f(T, Q) = T \oplus Q$



$D = f(T, Q) = T \oplus Q$



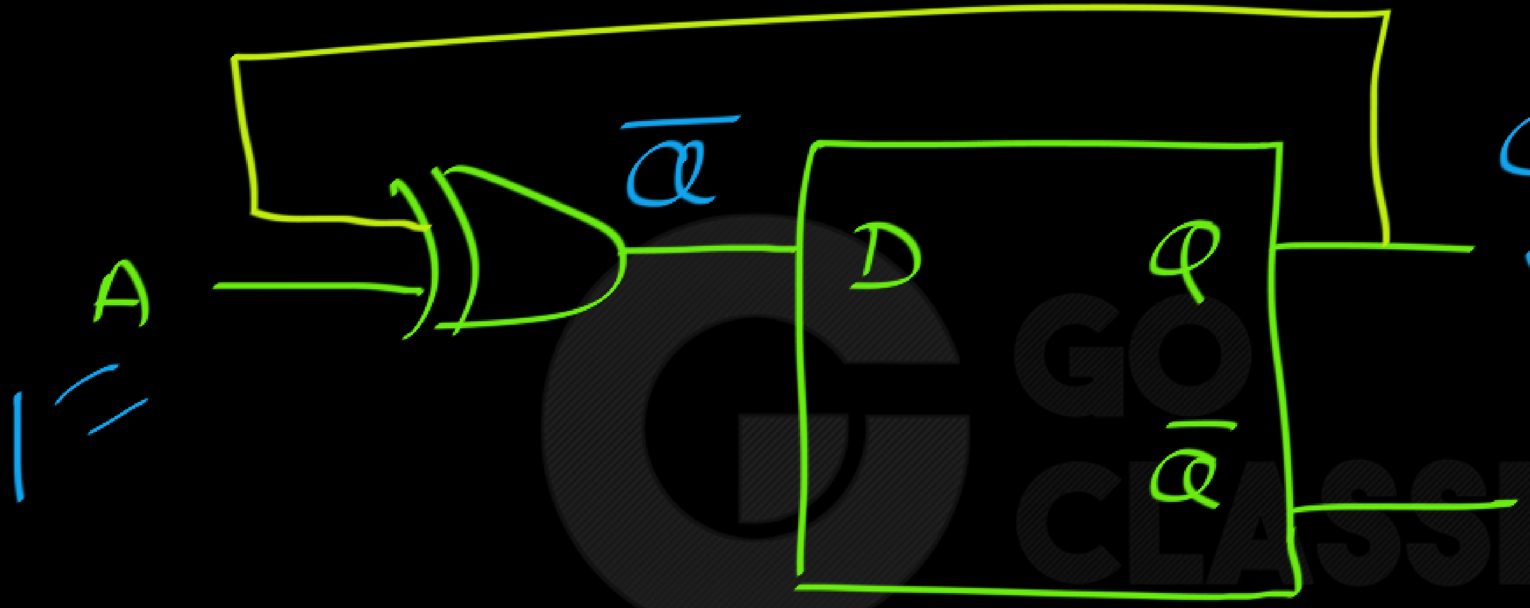
$D = f(T, Q) = T \oplus Q$



Q:

What is A-FF?

Q:

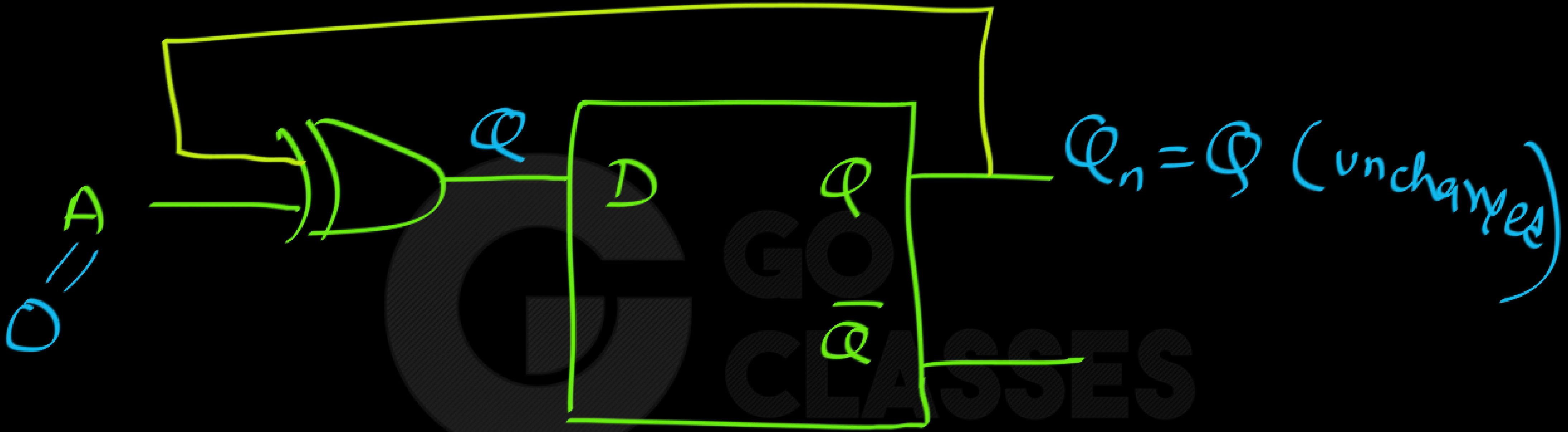


$Q_n = \overline{Q}$ Toggle

What is A-ff?

When $A=1 \Rightarrow Q_n = \overline{Q}$

Q :

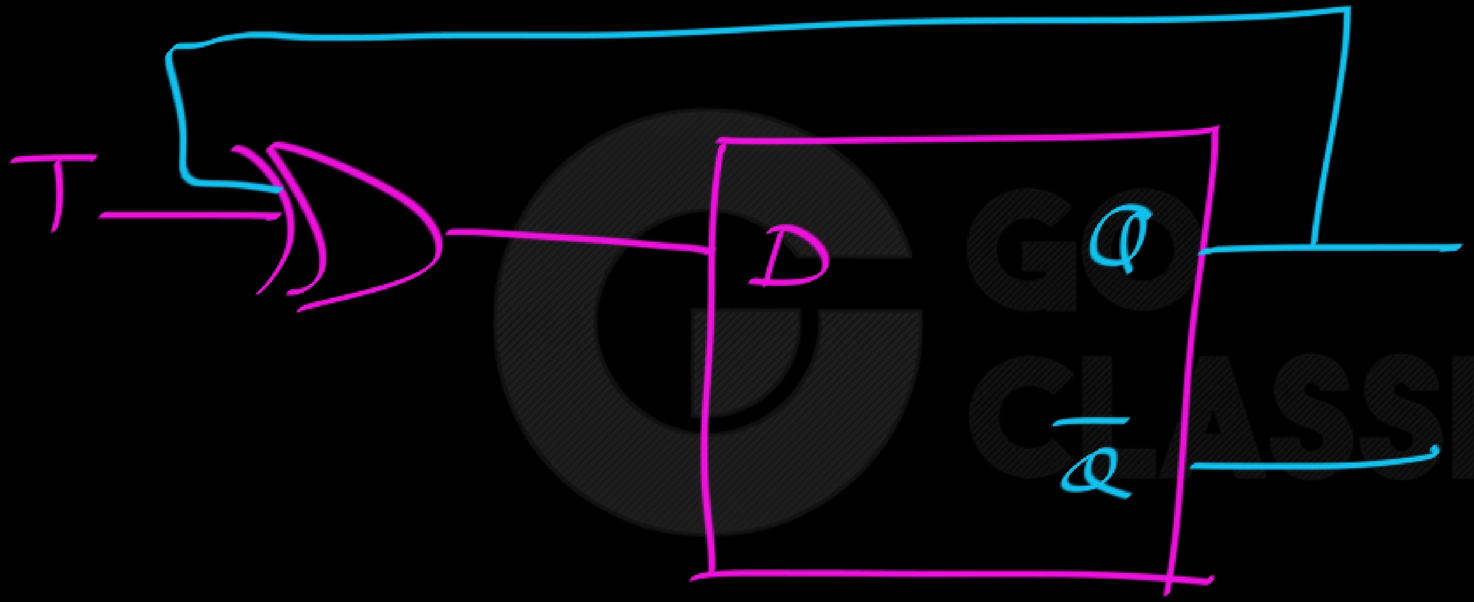


What is A-ff?

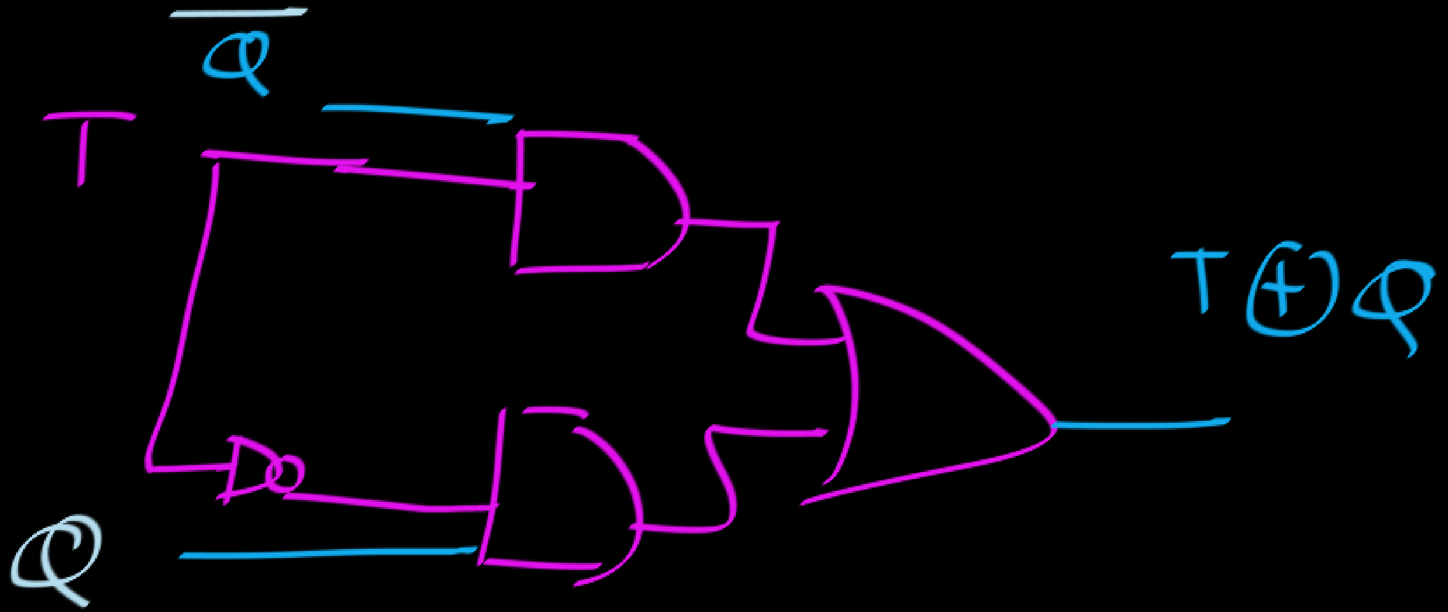
↳ T-ff ✓

$\underline{\underline{A=0}} \Rightarrow Q_n = Q$

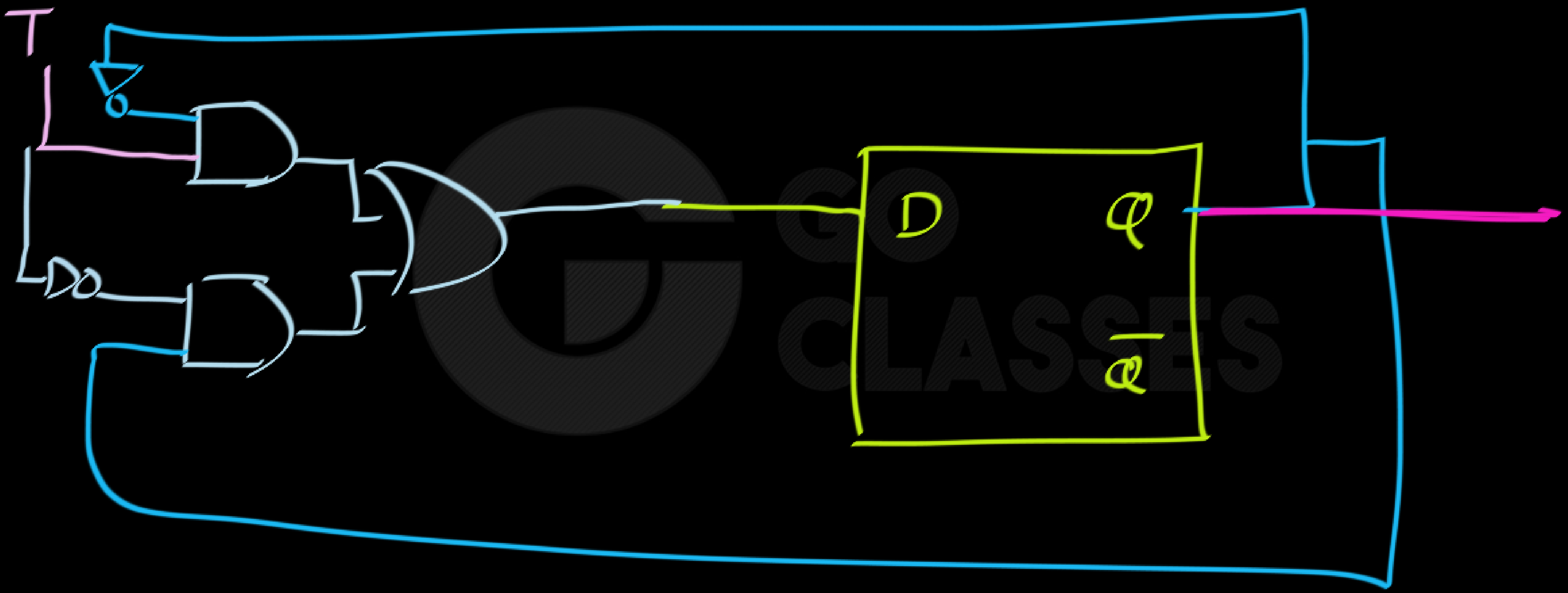
Variations of D to T ff :



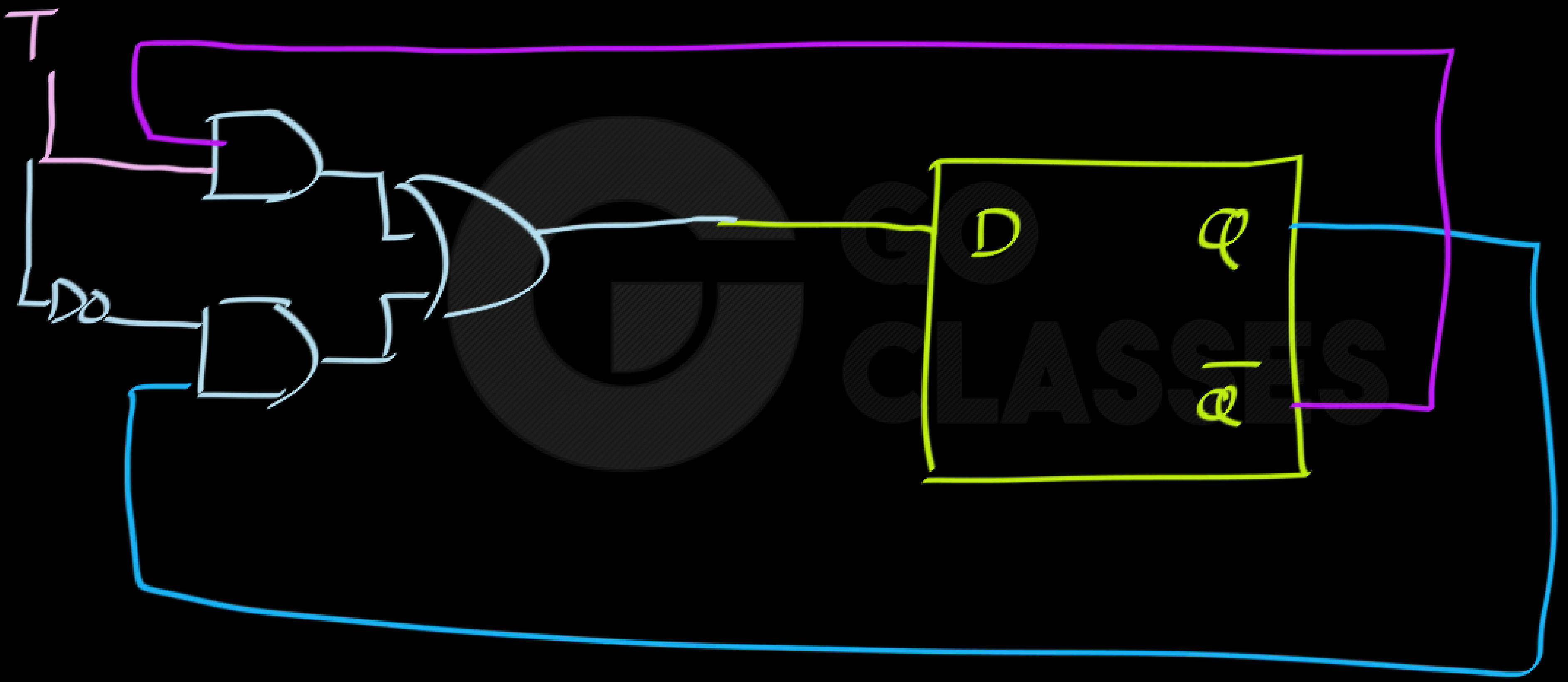
$T \oplus Q = T\bar{Q} + \bar{T}Q$



Variations of D to T ff :



Variations of D to T ff :



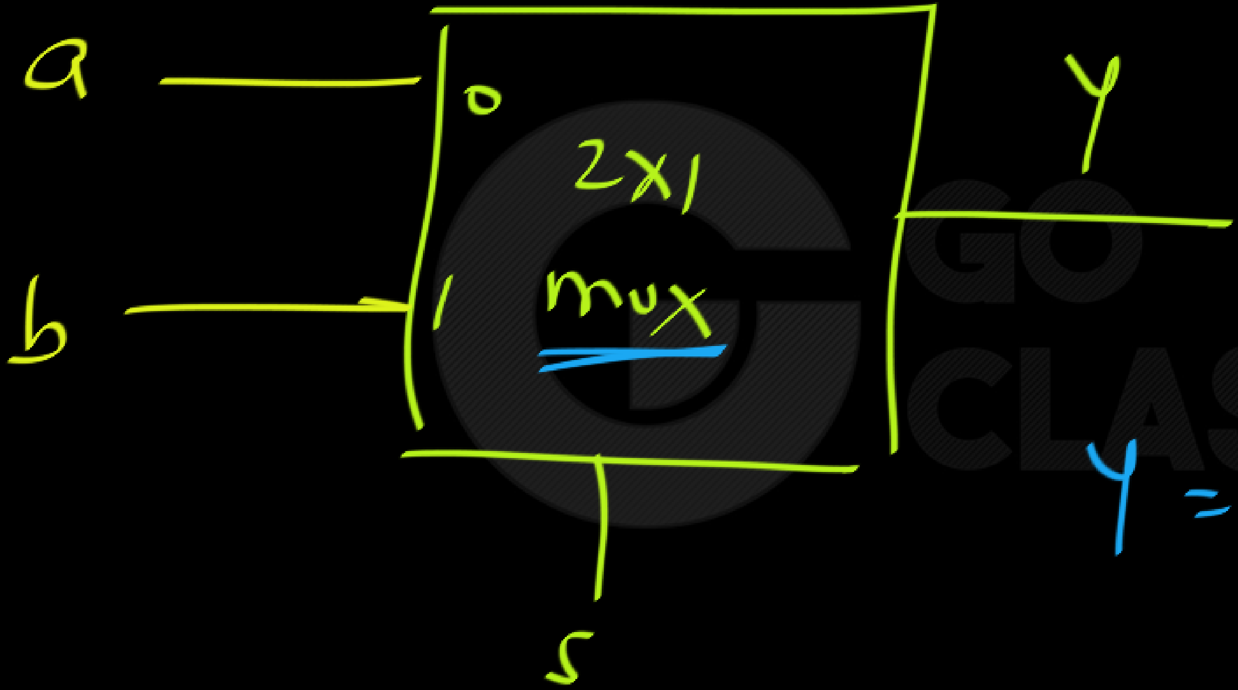
$$D = T \oplus Q = \underbrace{T\overline{Q} + \overline{T}Q}$$

mux equation

$$= \underbrace{T\overline{Q} + \overline{T}Q}$$

mux equation

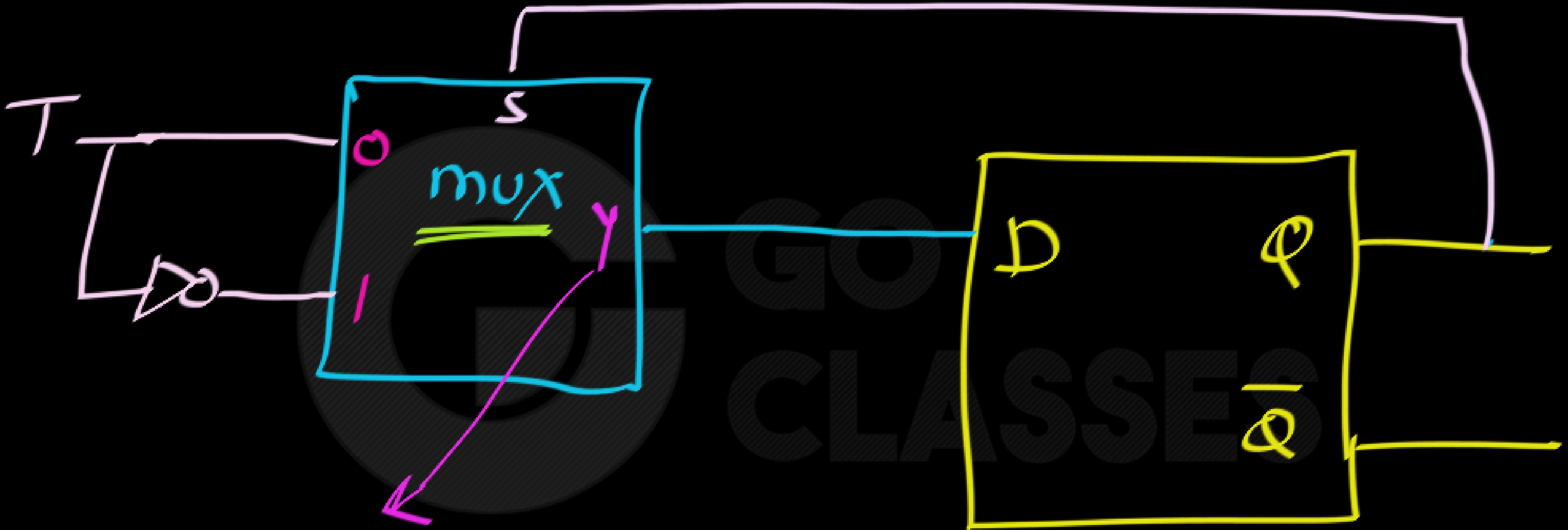
mux equation:



$$y = \bar{s}a + sb$$

D to T ff:

$D = T\bar{Q} + \bar{T}Q$



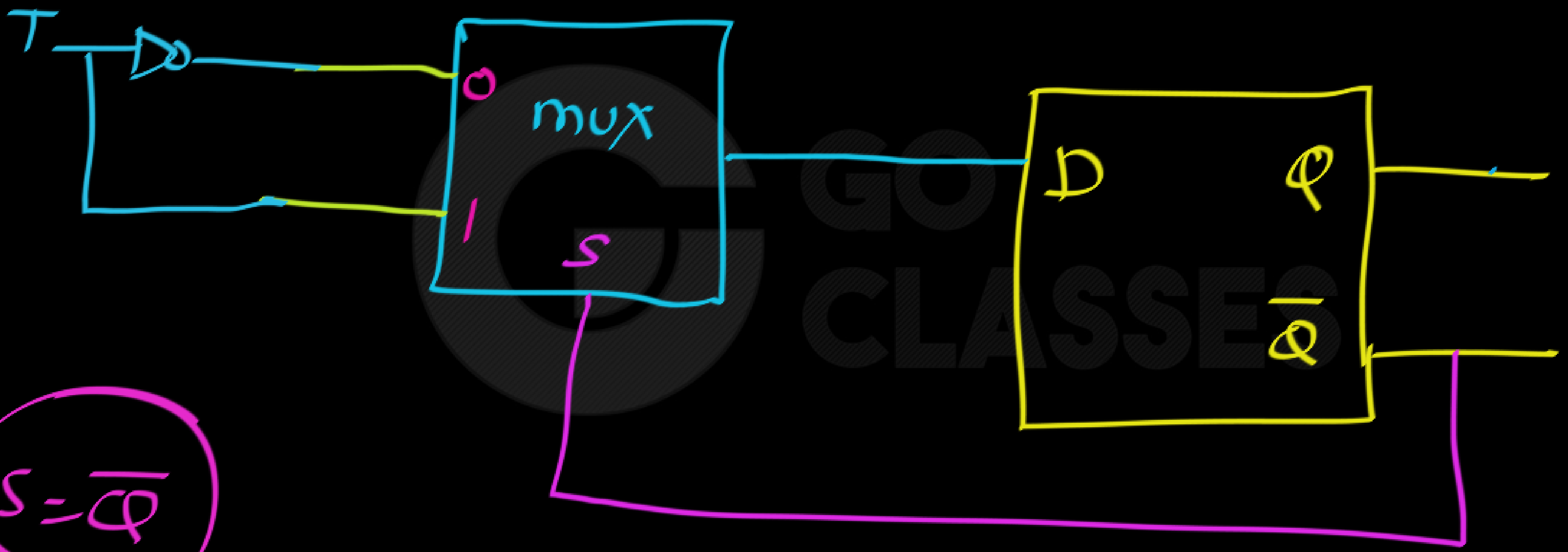
$\underline{T \oplus s}$ ✓

$= T \oplus Q$

$\boxed{D = T \oplus Q}$ ✓

D to T ff:

$D = T\overline{Q} + \overline{T}Q$

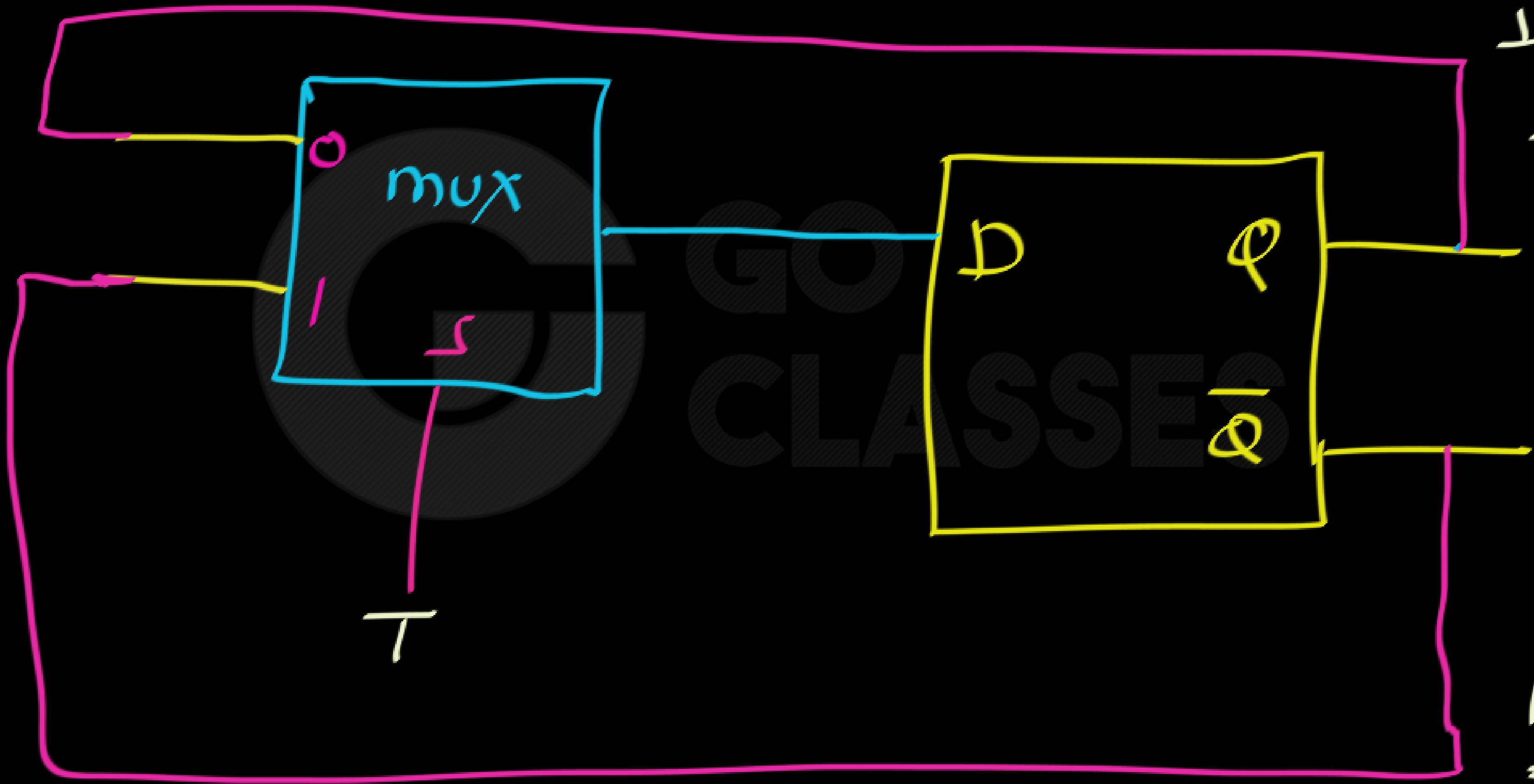


$S = \overline{Q}$

D to T ff:

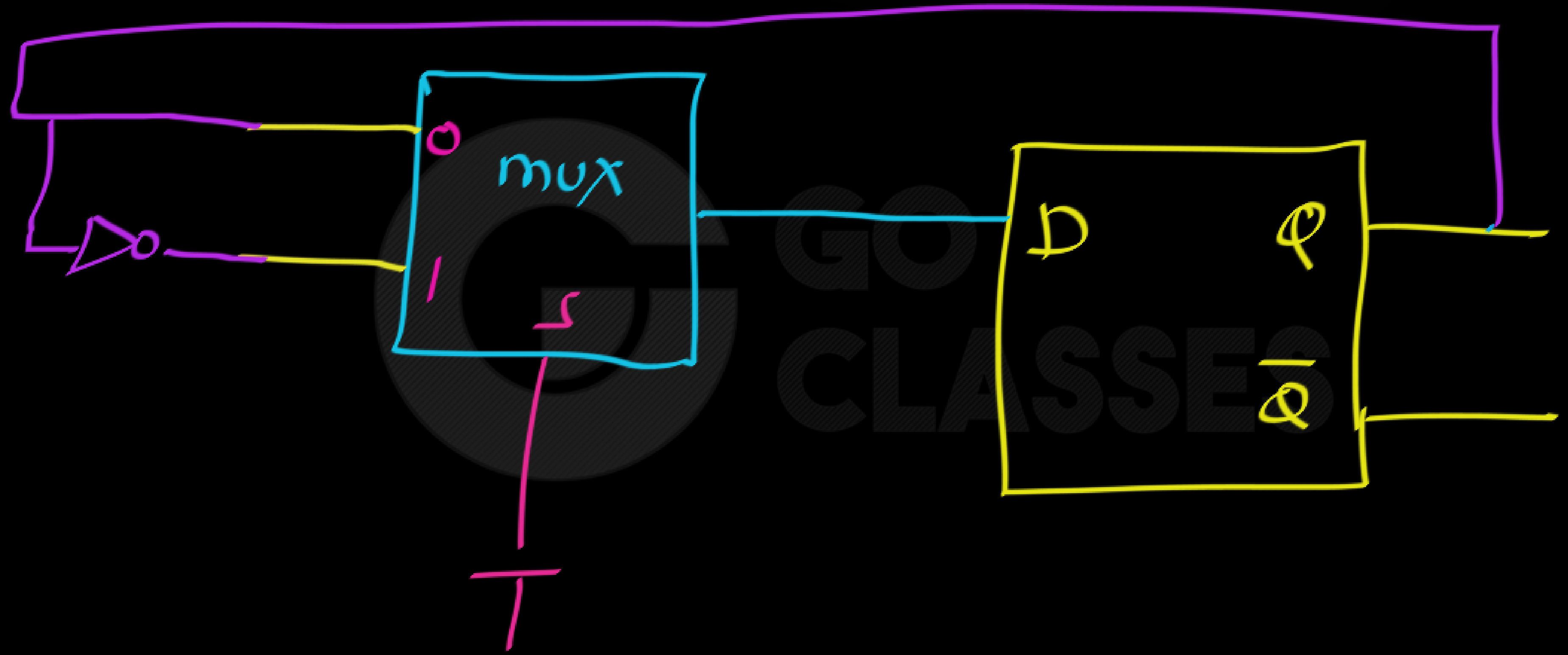
$D = \overline{T}Q + T\overline{Q}$

Best Implem-entation ⇓ No Extra gate Requires



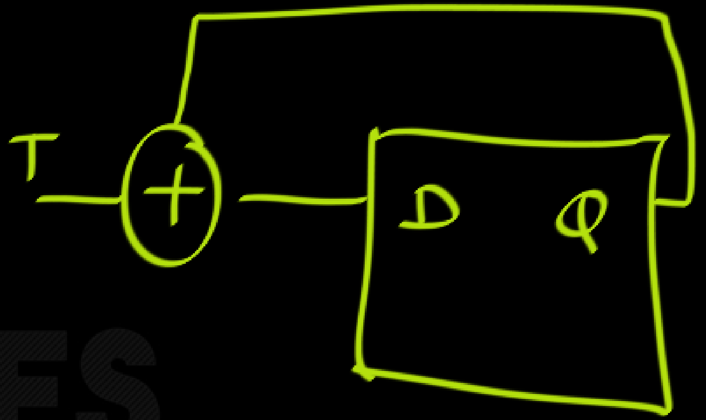
D to T ff:

$D = \overline{T} Q + T \overline{Q}$



D - ff to T - ff

$D = T \oplus Q$



many implementations possible

Convert D FlipFlop to T Flipflop

1. Truth Table for T Flip Flop

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

2. Excitation Table for D Flip Flop

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

3. Conversion Table

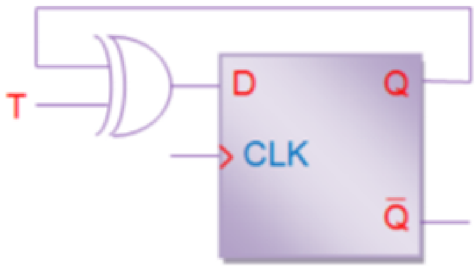
T	Q_n	Q_{n+1}	D
0	0	0	0
0	1	1	1
1	0	1	1
1	1	0	0

4. K-map Simplification

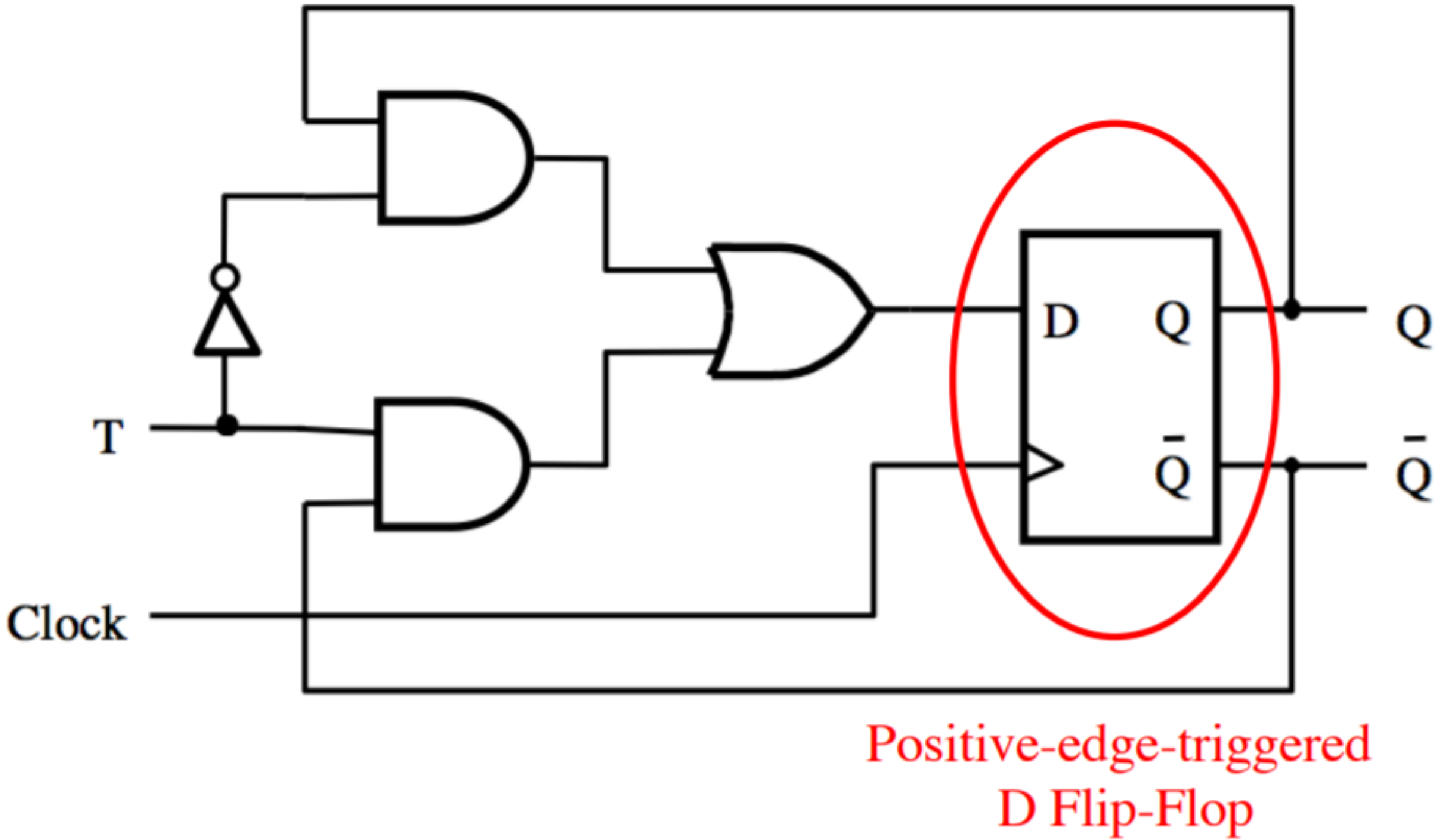
T \ Q_n	0	1
0	0 [0]	$\boxed{1}$ [1]
1	$\boxed{1}$ [2]	0 [3]

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

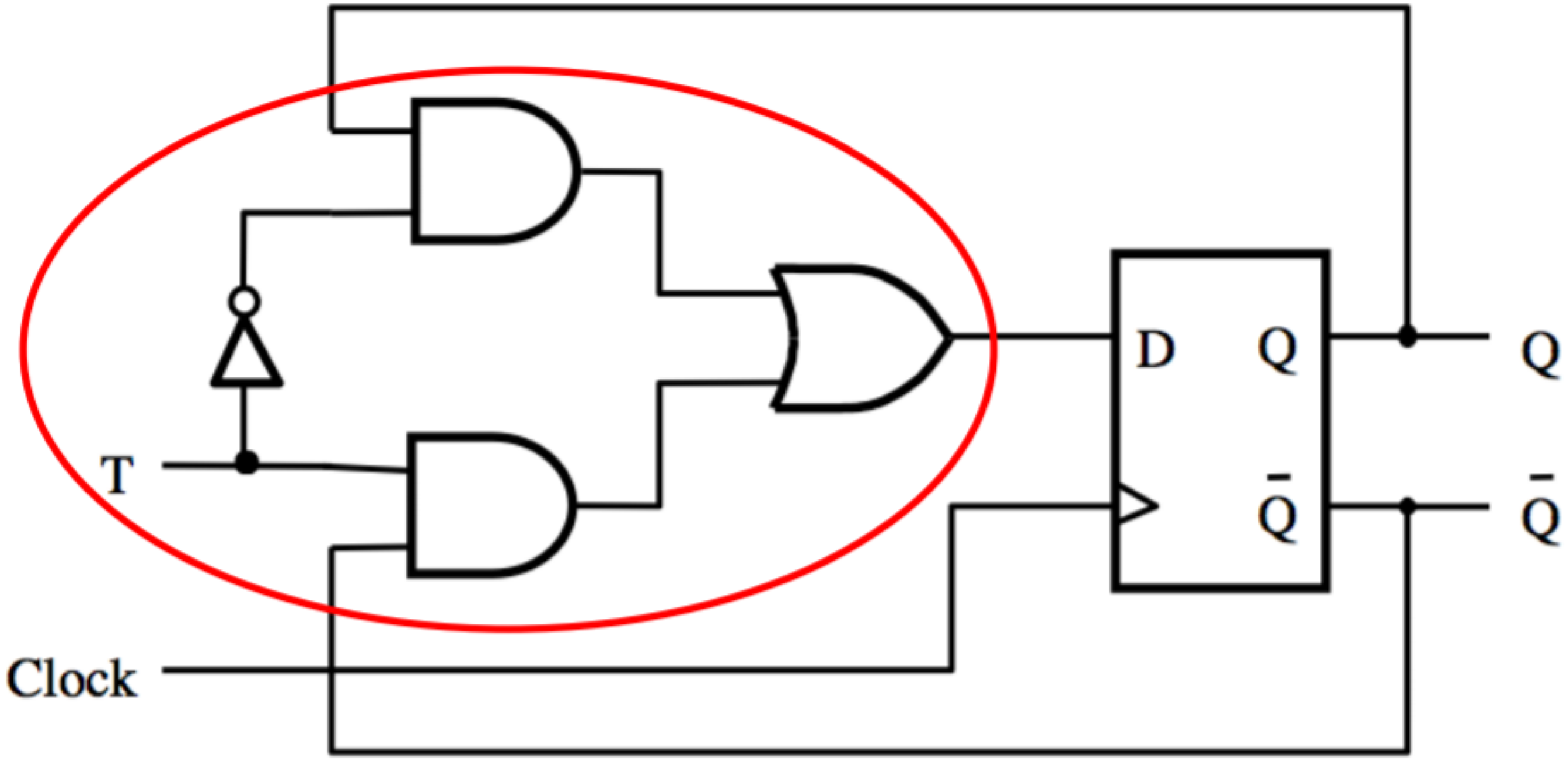
5. Circuit Design



T Flip-Flop

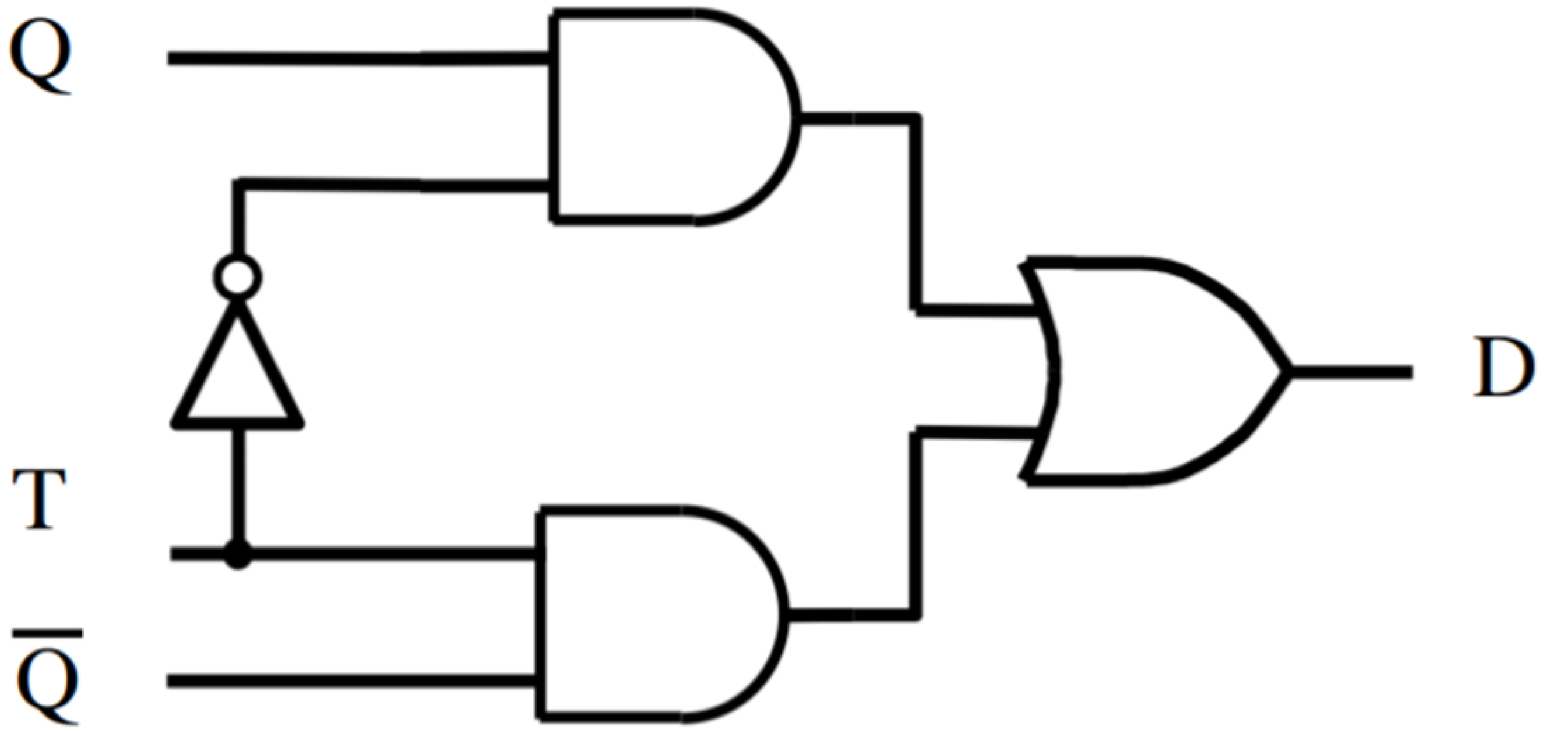


T Flip-Flop

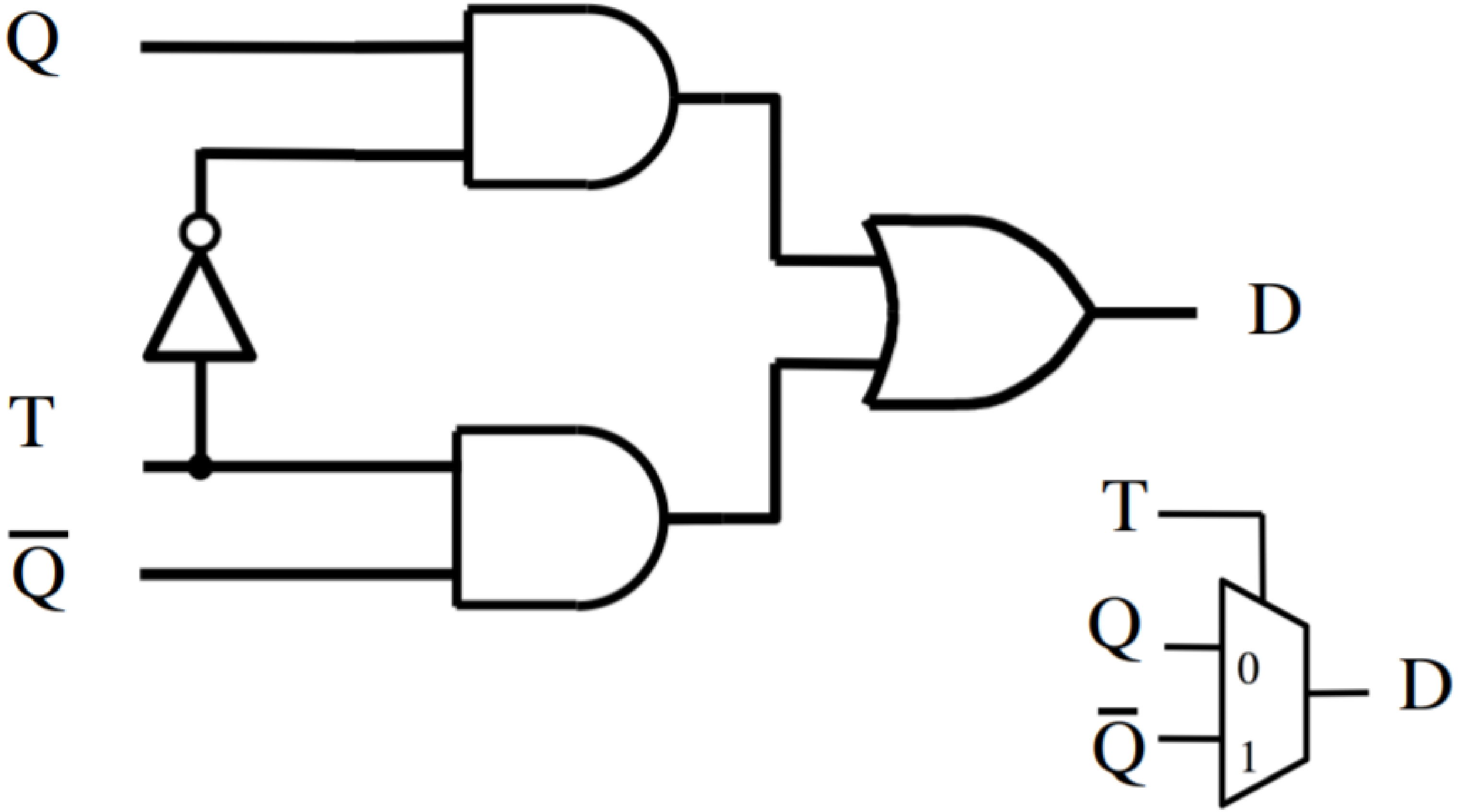


What is this?

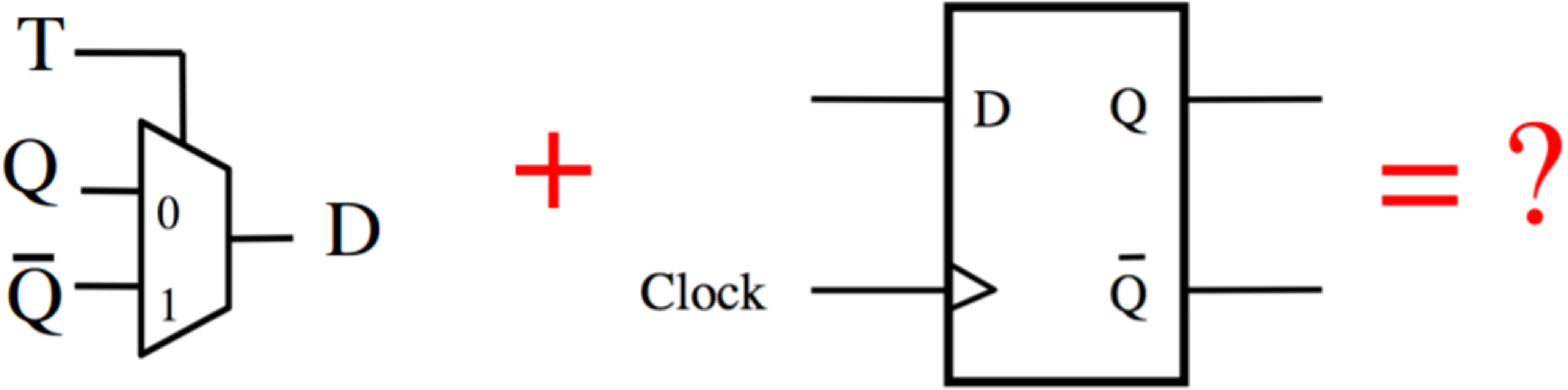
What is this?



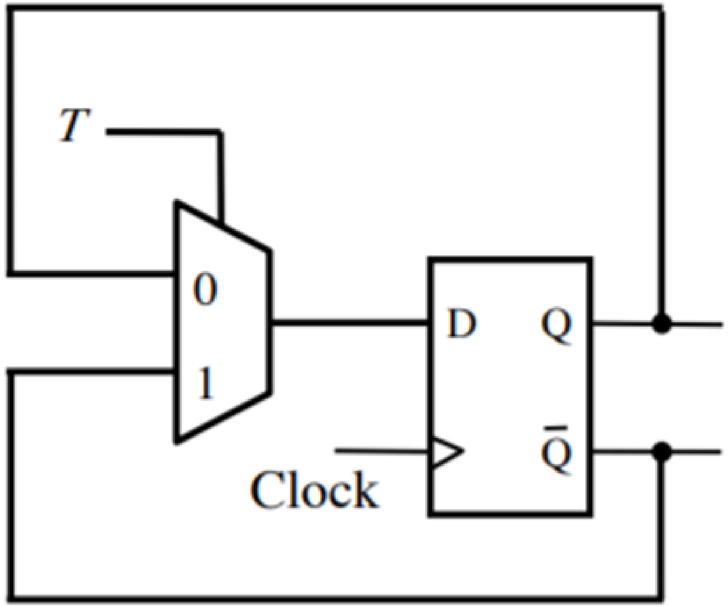
It is a 2-to-1 Multiplexer



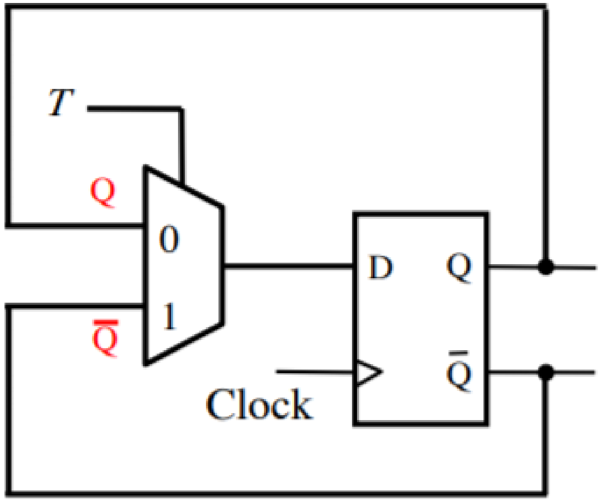
What is this?



It is a T Flip-Flop

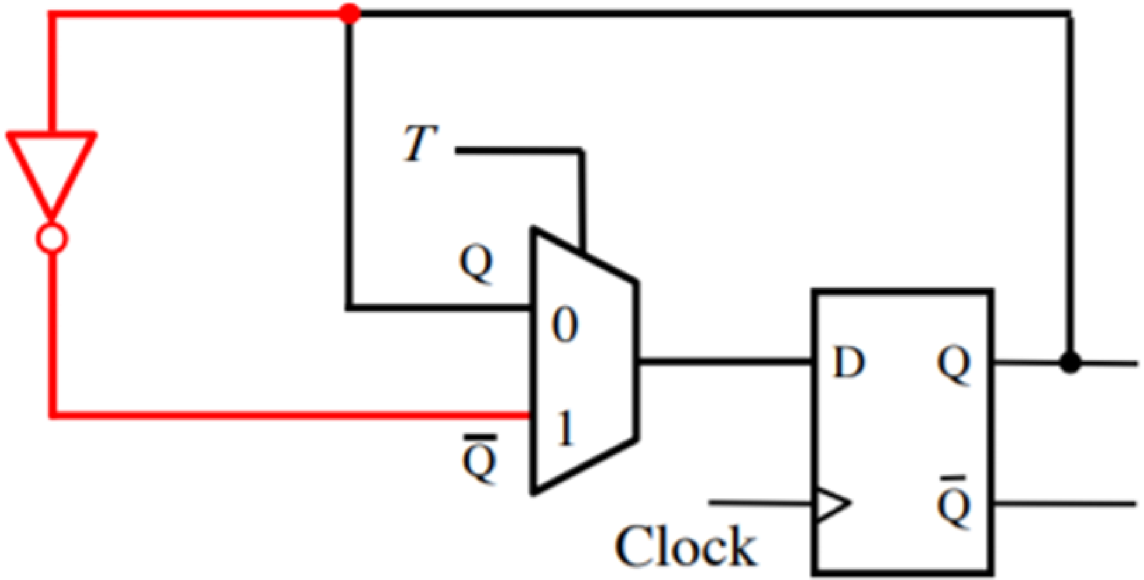


It is a T Flip-Flop

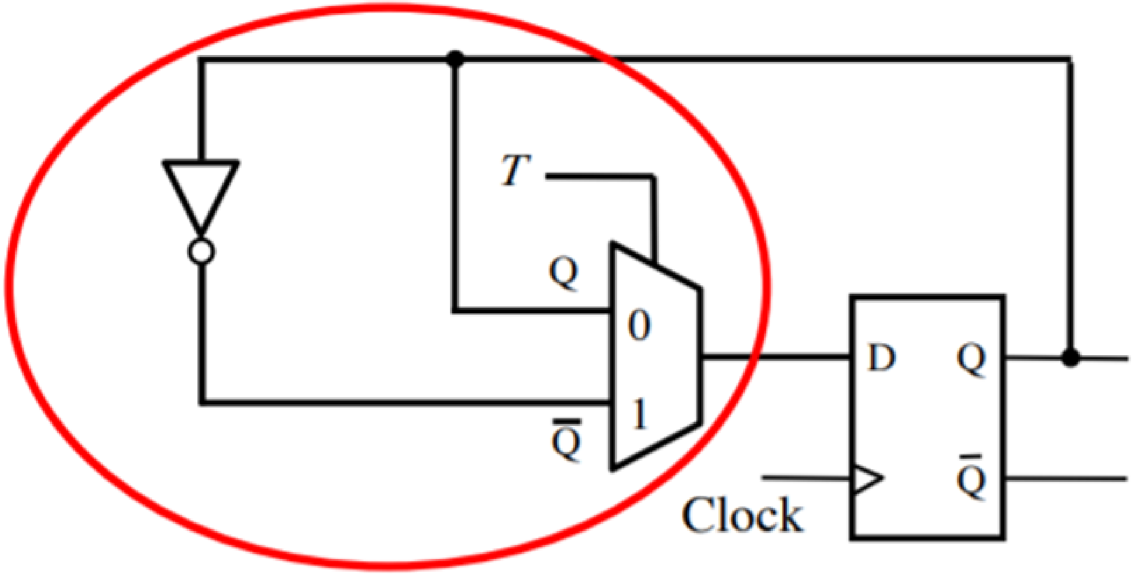


Note that the two inputs to the multiplexer are inverses of each other.

Another Way to Draw This

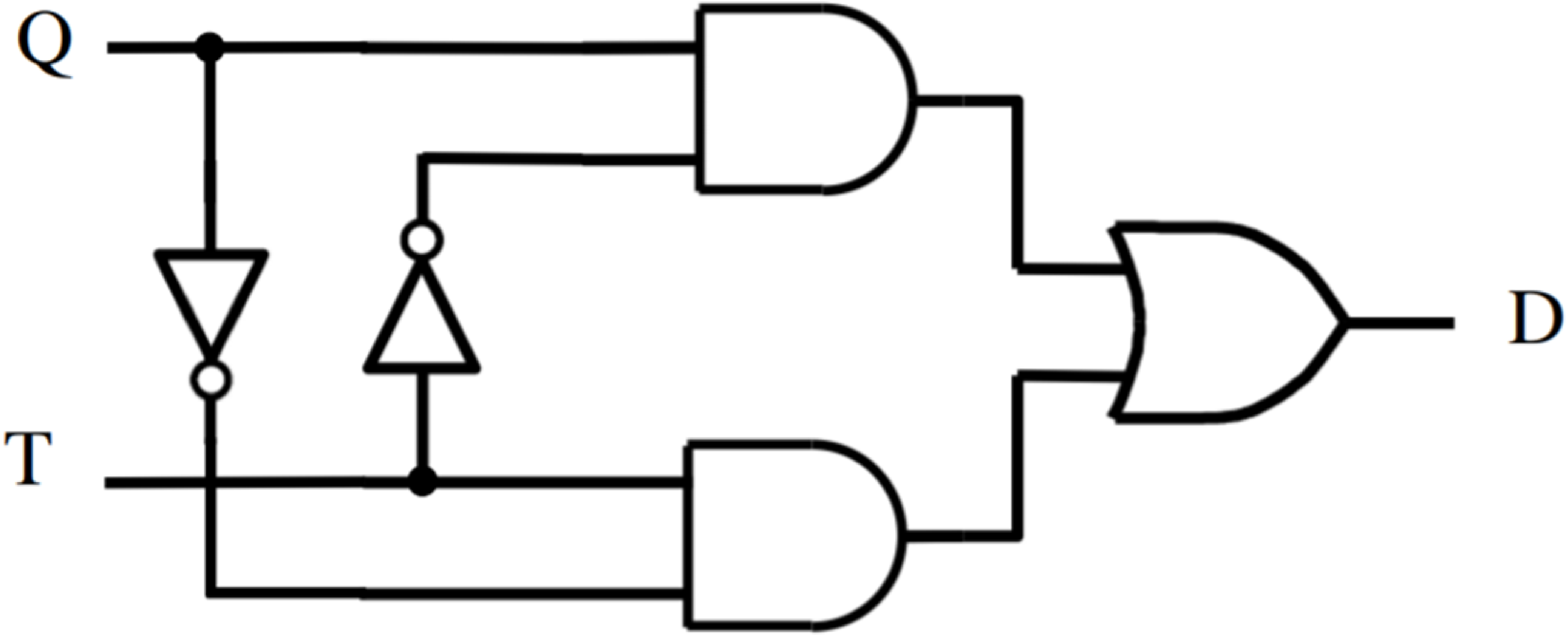


Another Way to Draw This

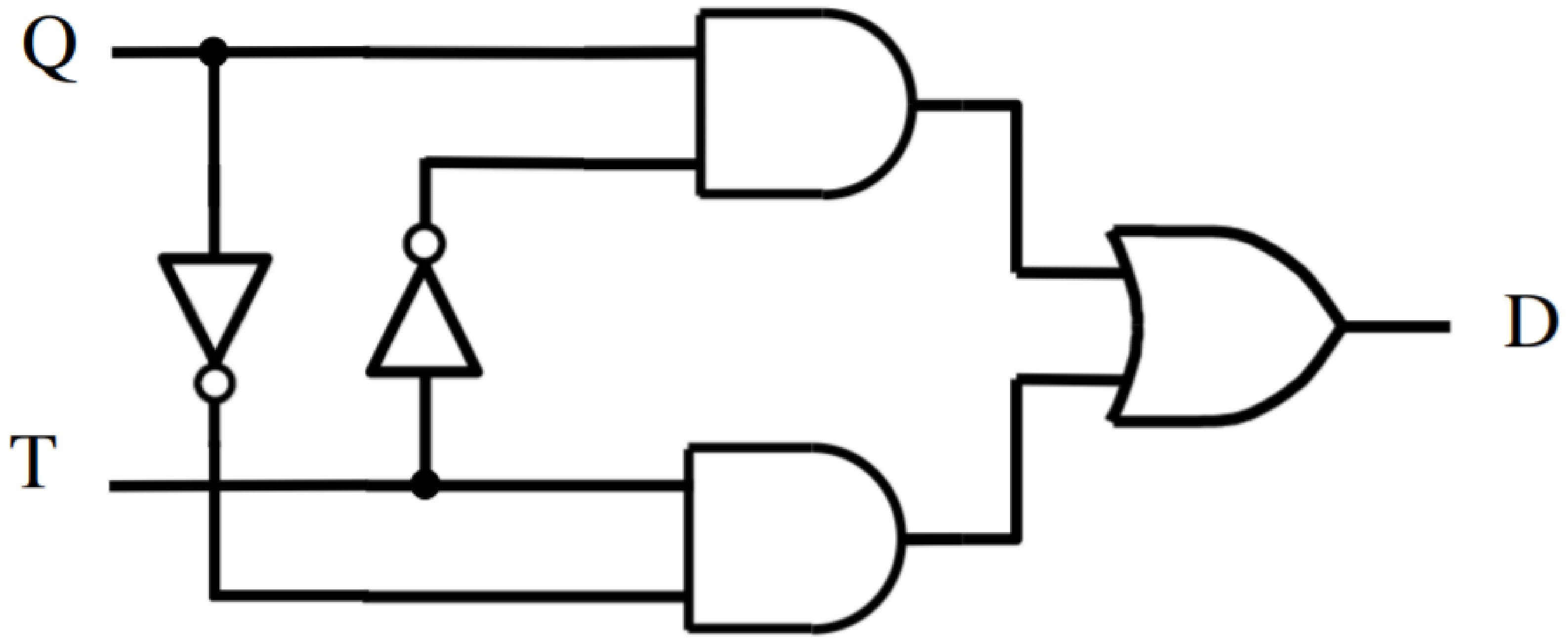


What is this?

What is this?

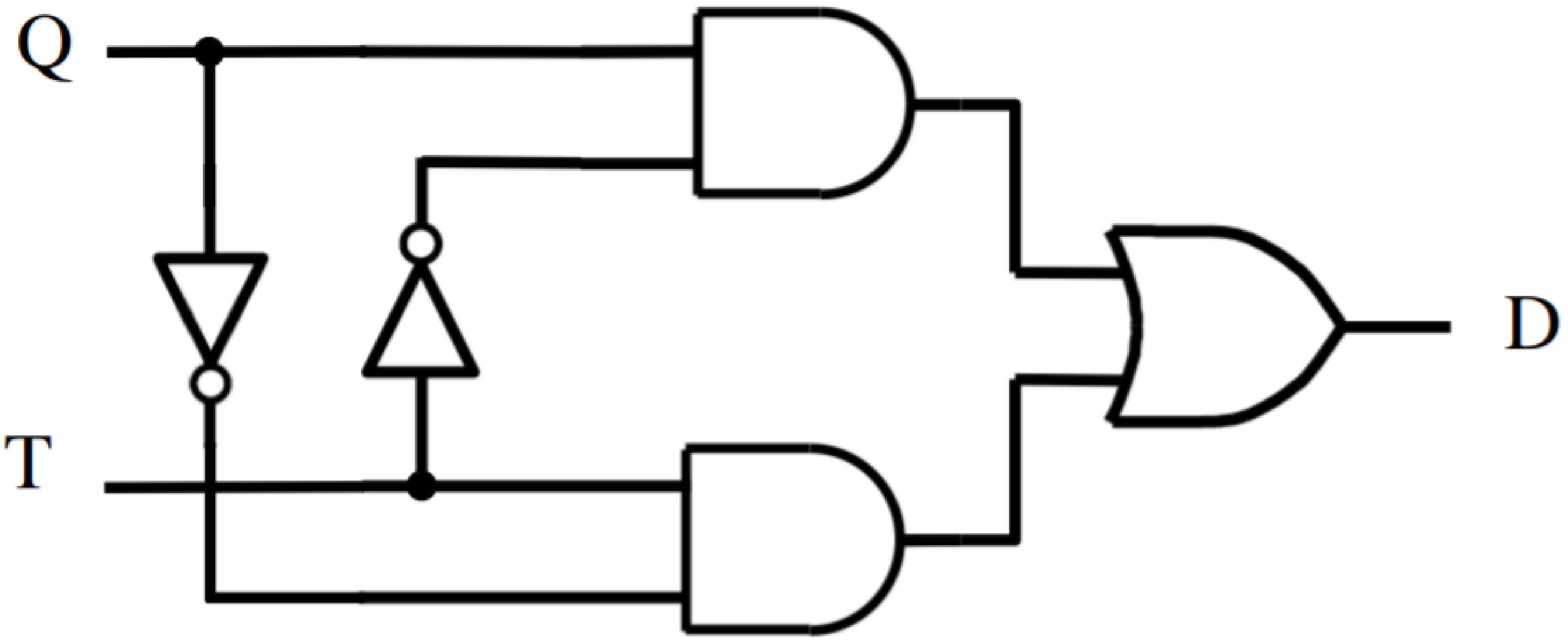


What is this?



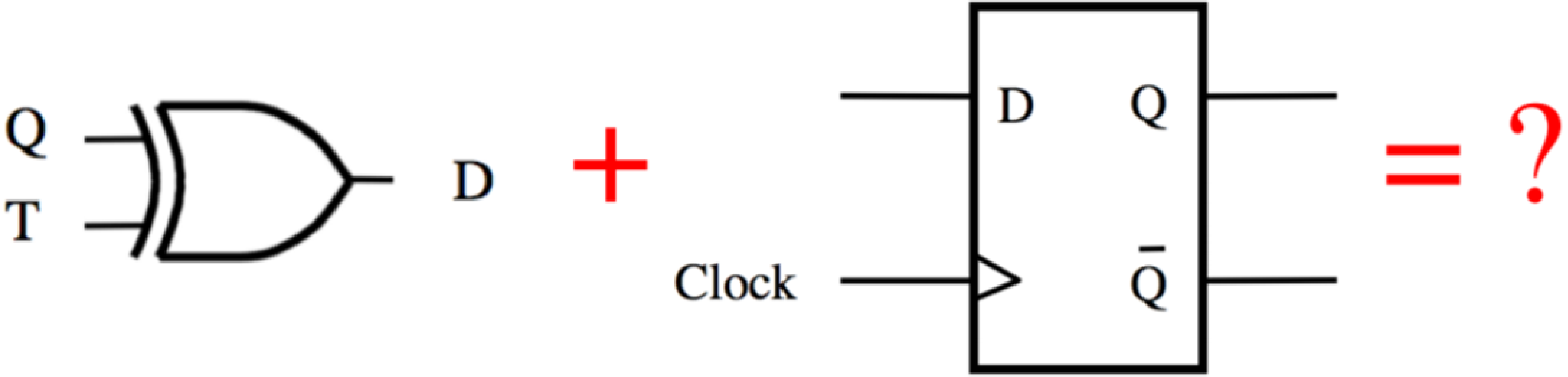
$$D = Q\overline{T} + \overline{Q}T$$

It is an XOR

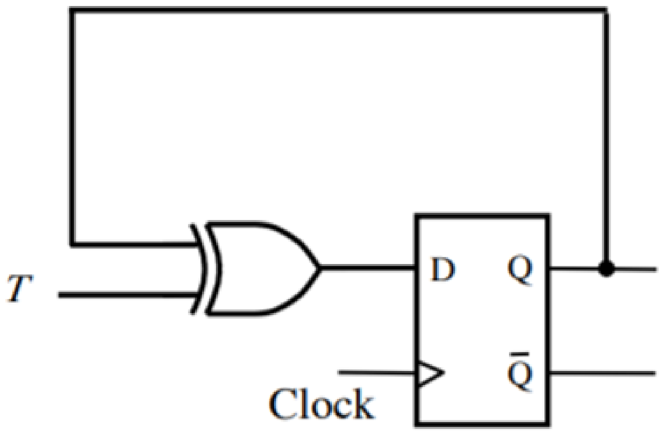


$$D = Q \oplus T$$

What is this?



It is a T Flip-Flop too



T	Q	D	
0	0	0	Q
0	1	1	
1	0	1	$\overline{Q}$
1	1	0	

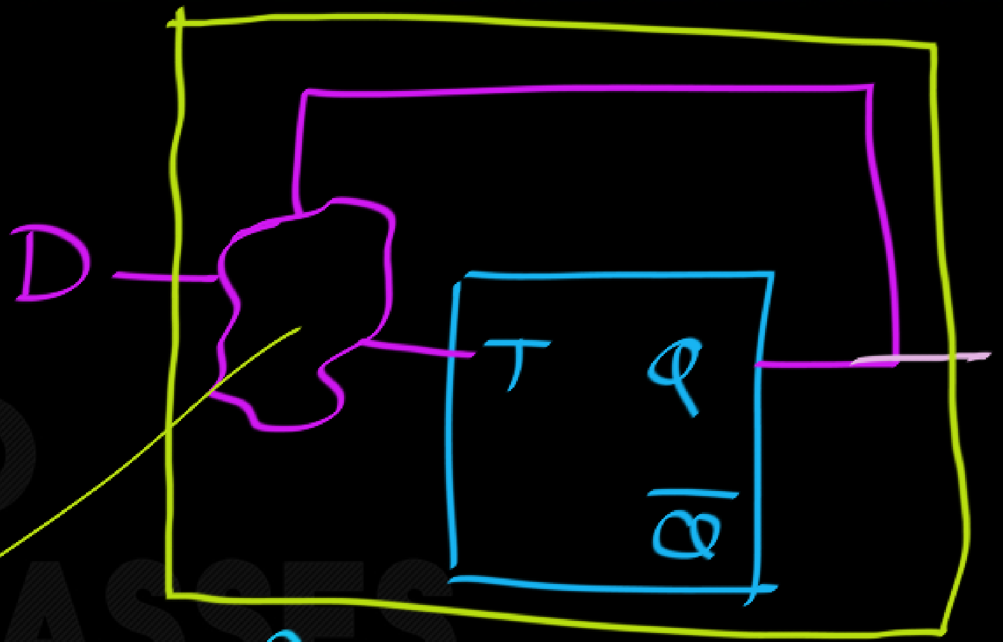
Next Topic :

T to D Flipflop Conversion

T to D - ff :

Given ff : T - ff

Desired ff : D - ff



Combinational ckt

$T = f(D, Q)$

$T = f(D, Q)$

D	Q	Q_n	$T = f(D, Q)$
0	0	0	
0	1	0	
1	0	1	
1	1	1	

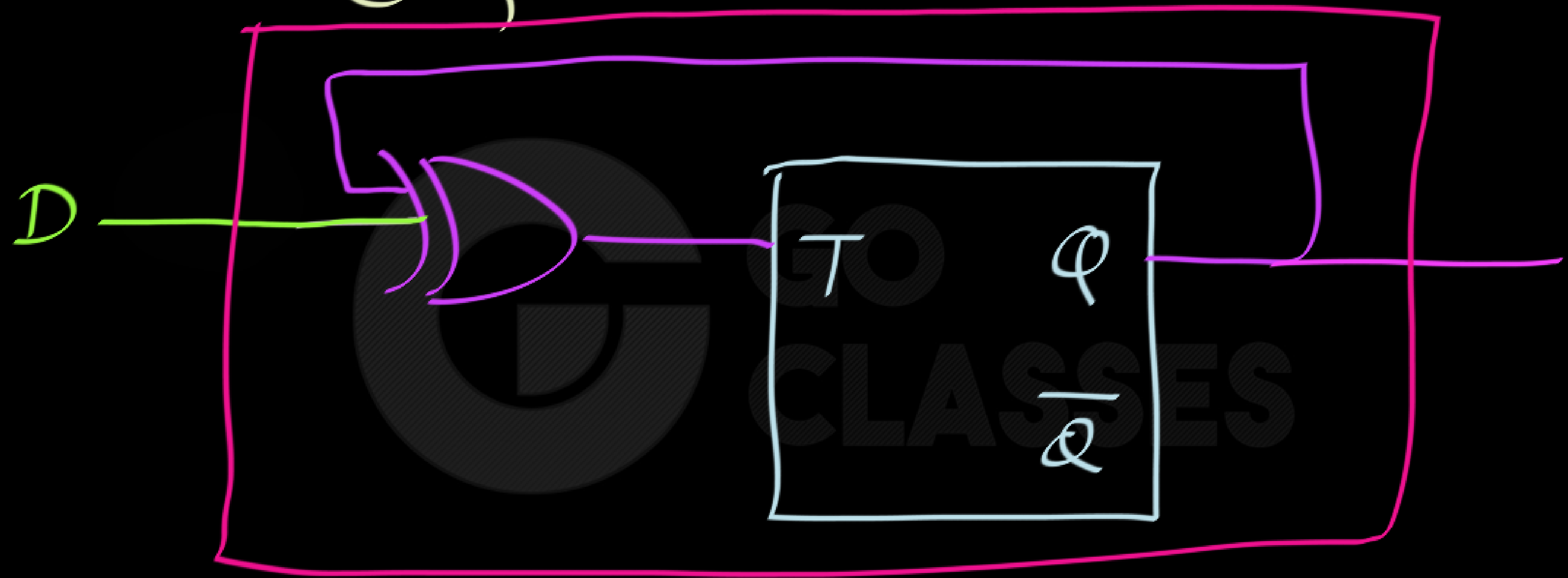
? using Excitation Table of T-ff

$T = f(D, Q)$

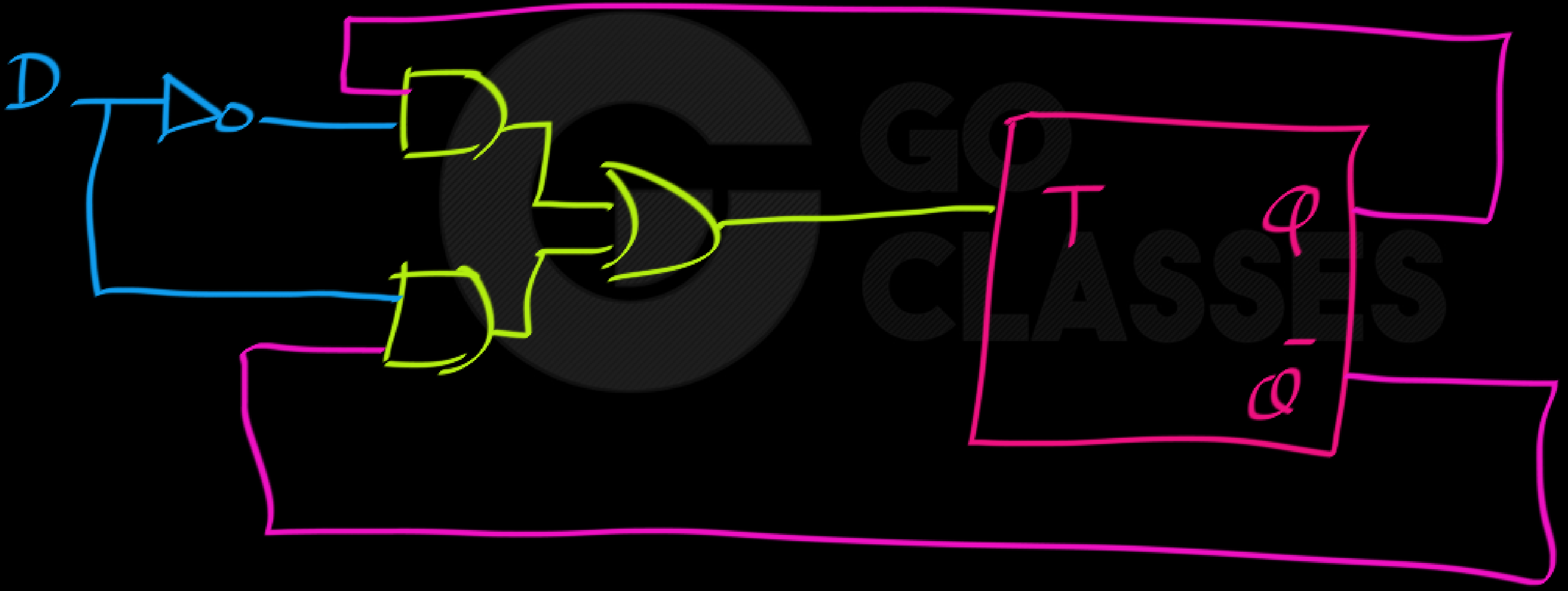
D	Q	Q_n	$T = f(D, Q)$
0	0	0	0
0	1	0	1
1	0	1	1
1	1	1	0

$T = D \oplus Q$

$T = D \oplus Q$



$$T = \underbrace{D \oplus Q} = \overline{D}Q + D\overline{Q}$$



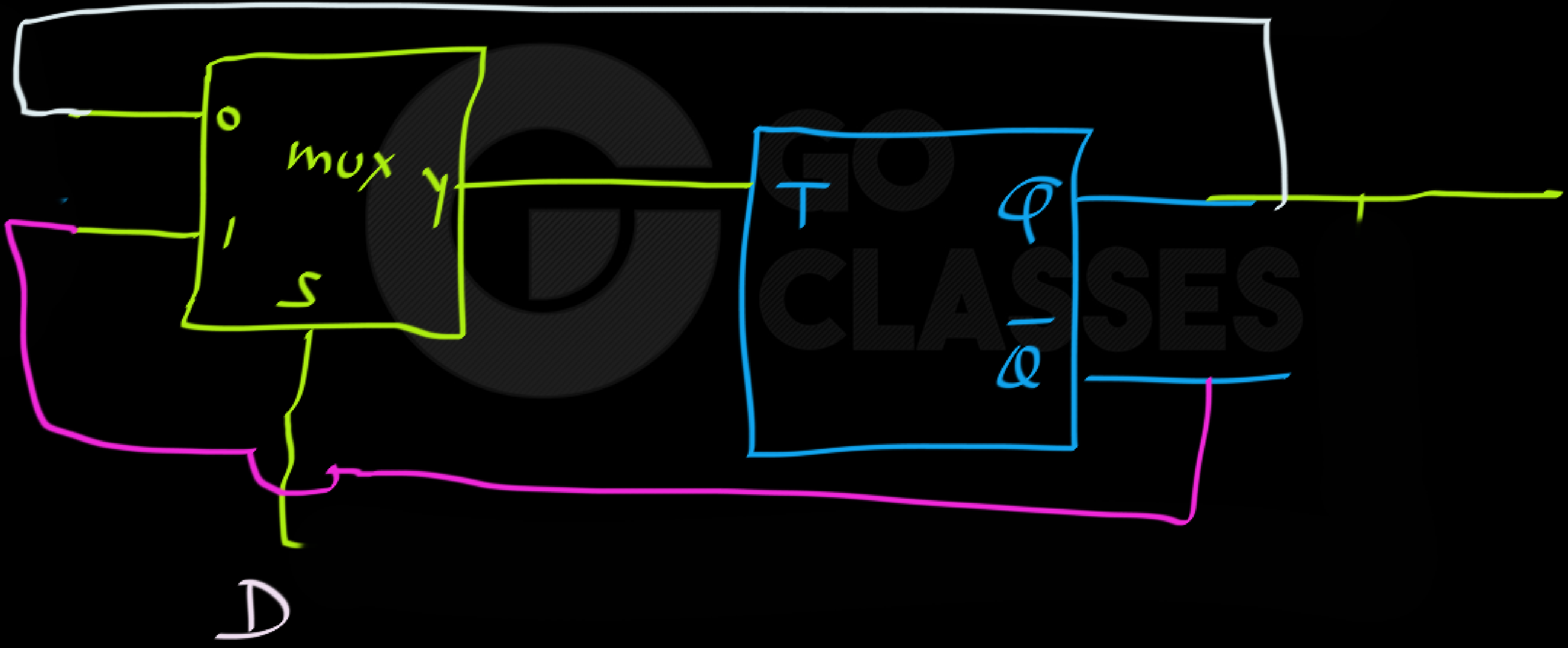
$$T = D \oplus Q = \overline{D}Q + D\overline{Q}$$

$$= \overline{D}Q + D\overline{Q}$$

mux equation

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

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



Convert T Flipflop to D Flipflop

1. Truth Table for D Flip Flop

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

2. Excitation Table for T Flip Flop

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

3. Conversion Table

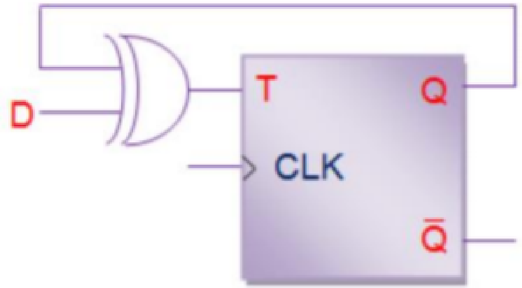
D	Q_n	Q_{n+1}	T
0	0	0	0
0	1	0	1
1	0	1	1
1	1	1	0

4. K-map Simplification

D \ Q_n	0	1
0	0^{0}	$\boxed{1}^{1}$
1	$\boxed{1}^{2}$	0^{3}

$$D = D\bar{Q}_n + \bar{D}Q_n$$
$$= D \oplus Q_n$$

5. Circuit Design

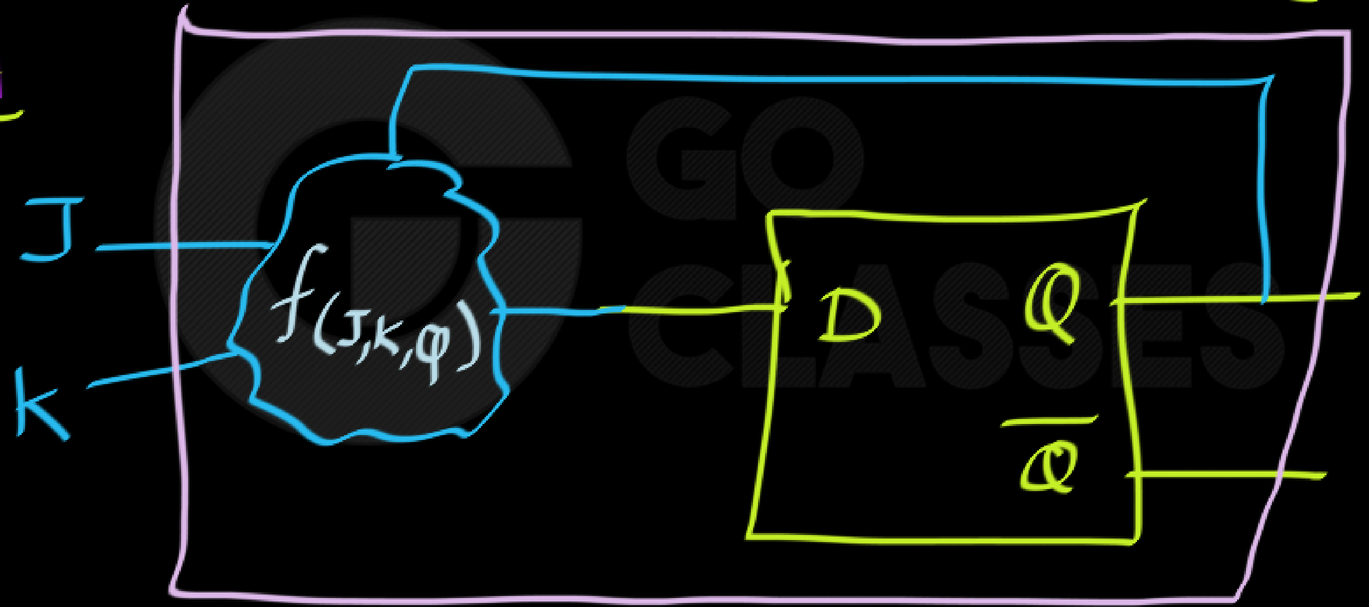


Next Topic :

D to JK Flipflop Conversion

D to JK : Given FF : D FF
Desired FF : JK FF

Idea :



$D = f(J, K, Q)$

$D = f(J, K, Q)$

J	K	Q	Q_n	$D = f(J, K, Q)$

Truth Table of JK-ff

Excitation Table of D

$D = f(J, k, Q)$

	J	k	Q	Q_n	$D = f(J, k, Q)$
$J=0, k=0$	0	0	0	0	
	0	0	1	1	
$J=0, k=1$	0	1	0	0	
	0	1	1	0	
$J=1, k=0$	1	0	0	1	
	1	0	1	1	
$J=1, k=1$	1	1	0	1	
	1	1	1	0	

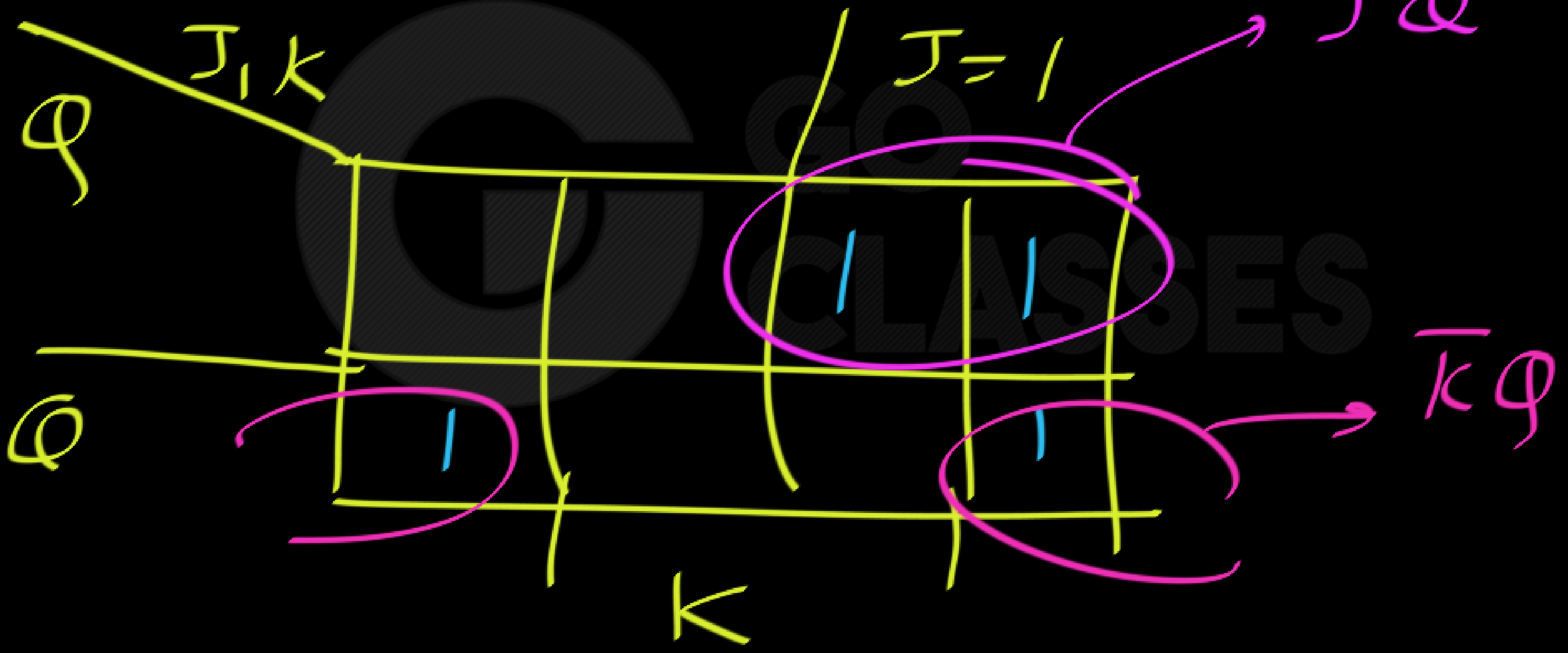
Excitation of D.

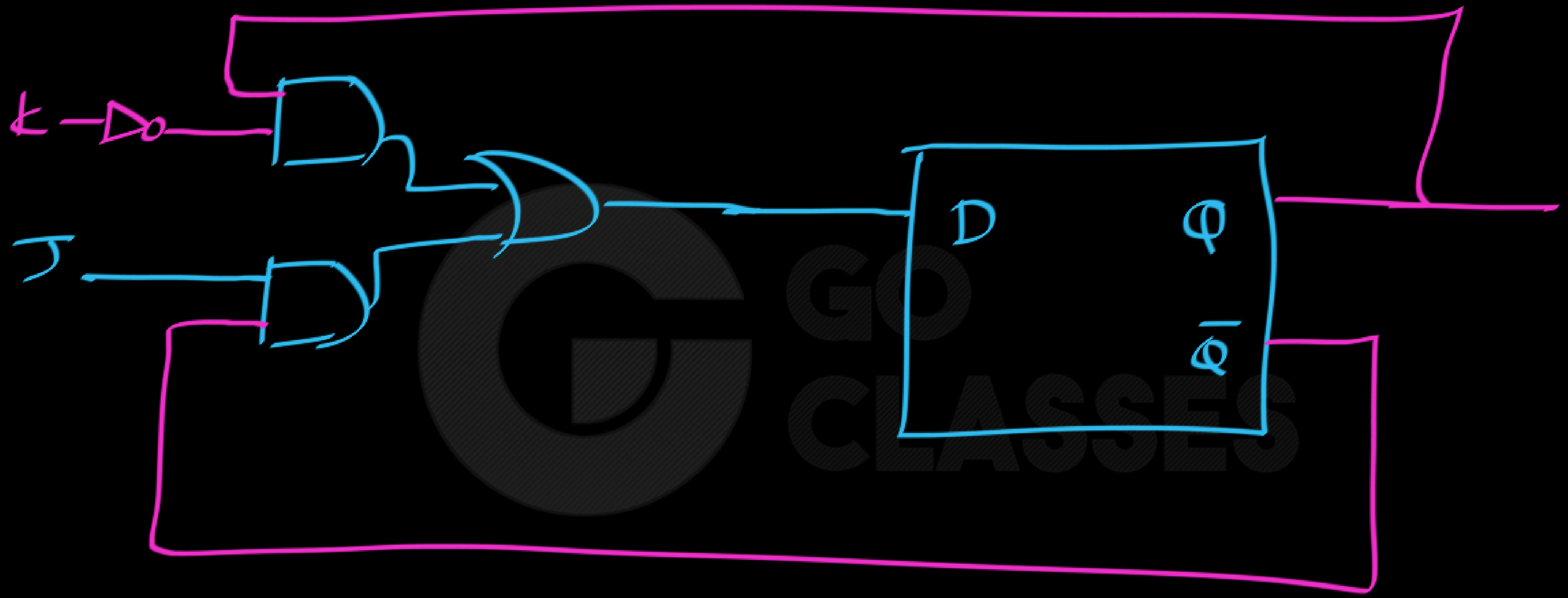
$D = f(J, K, Q)$

	J	K	Q	Q_n	$D = f(J, K, Q)$
J=0, K=0	0	0	0	0	0
	0	0	1	1	1 ✓
J=0, K=1	0	1	0	0	0
	0	1	1	0	0
J=1, K=0	1	0	0	1	1 ✓
	1	0	1	1	1 ✓
J=1, K=1	1	1	0	1	1 ✓
	1	1	1	0	0

$D = f(J, K, Q) \Rightarrow D = J\overline{Q} + Q\overline{K}$

K-map for D




K
J
D
Q
$\bar{Q}$

Digital Logic

$D = J\overline{Q} + Q\overline{K}$ mux equation

Q:

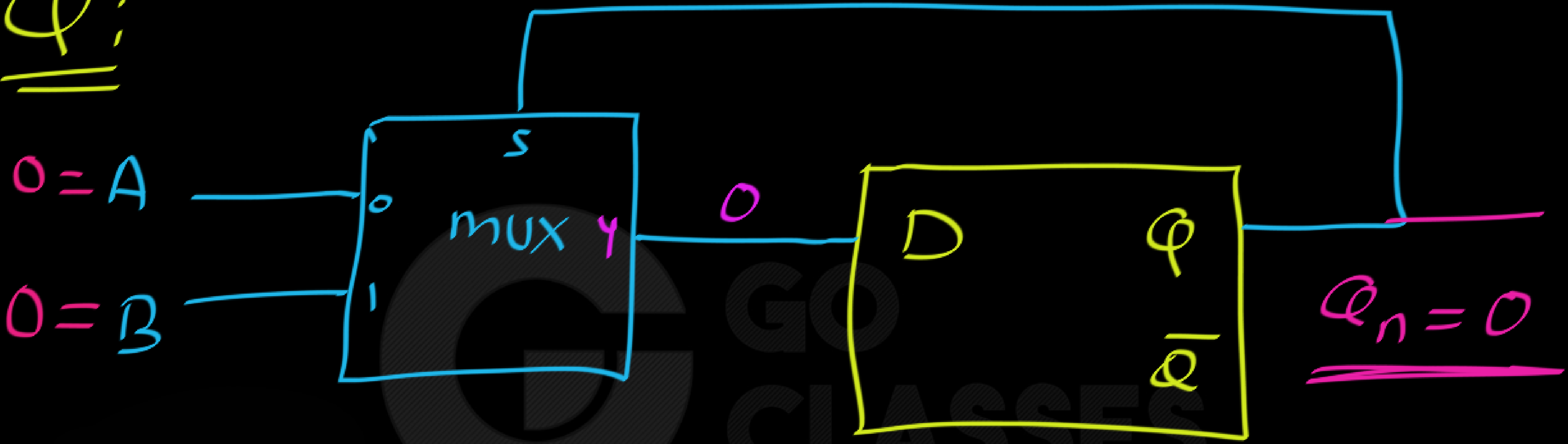
Q: Relate AB-ff to JK-ff ?

Q:

$\overline{A = J}$

$B = \overline{K}$

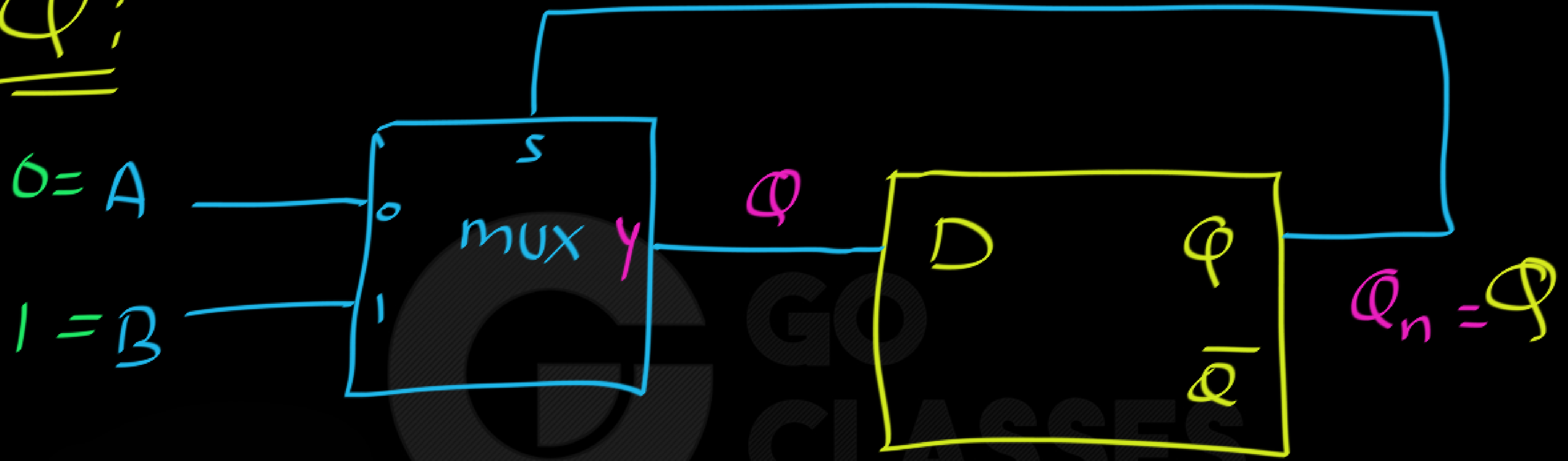
Q:



$$Y = 0\bar{Q} + 0Q = 0$$

A	B	Q_n	
0	0	0	Reset

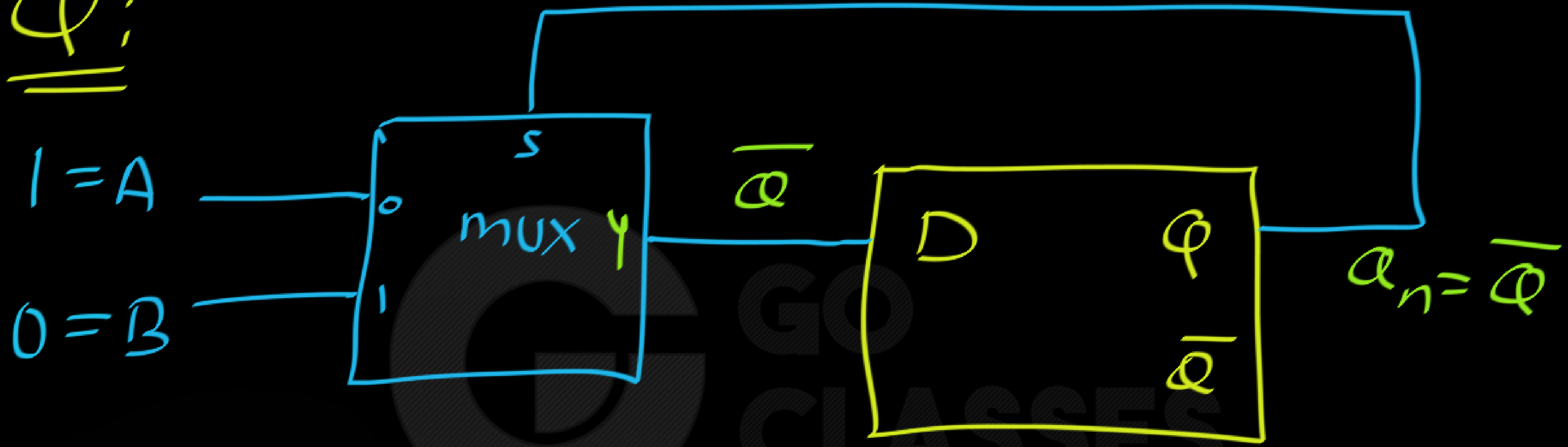
Q:



$$Y = 0\bar{Q} + 1Q = Q$$

A	B	Q_n
0	1	Q Retain

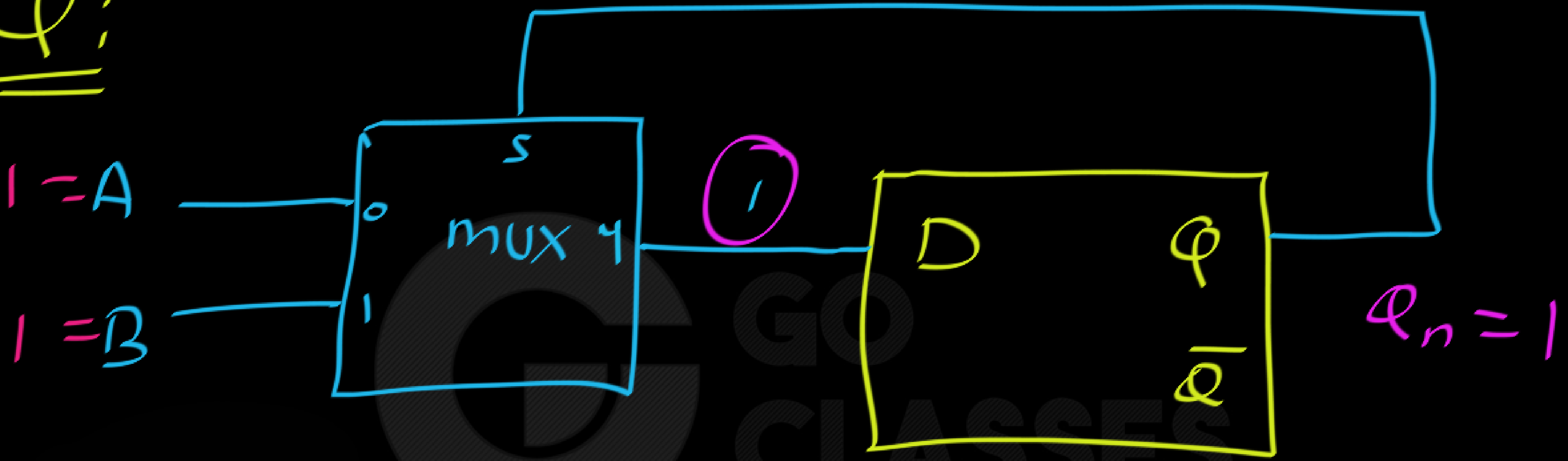
Q:



$$Y = 1\overline{Q} + 0Q = \overline{Q}$$

A	B	Q_n	
1	0	$\overline{Q}$	Toggle

Q:



$$y = 1\overline{Q} + 1Q$$

$$= Q + \overline{Q} = 1$$

A	B	Q_n	
1	1	1	set

After Analysis: (AB – ff Characteristic Table)

A	B	Q_n	
0	0	0	Reset
0	1	Q	Unchanged
1	0	$\overline{Q}$	Toggle
1	1	1	Set

After Analysis:

$J = A$; $B = \bar{K}$ ✓

A	B	Q_n	J	K
0	0	0	0	1
0	1	Q	0	0
1	0	$\bar{Q}$	1	1
1	1	1	1	0

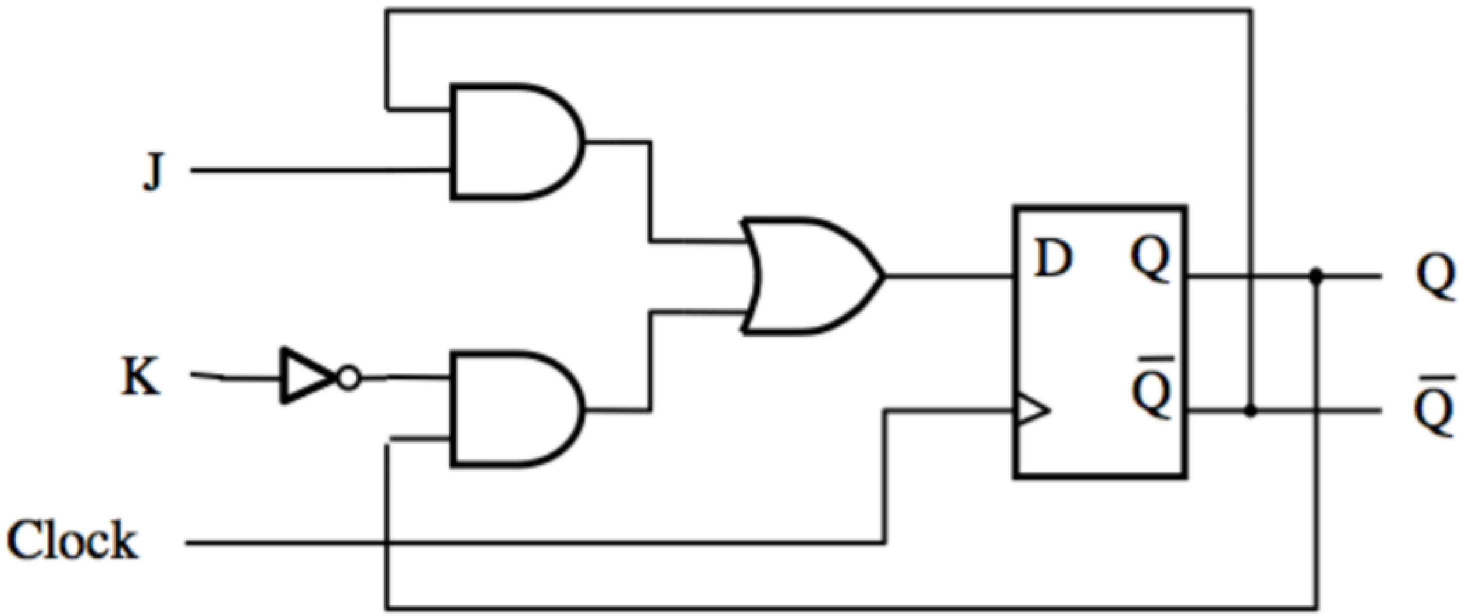
Note:

Don't use your Brain as a Hard Drive.

Use it as a CPU.

Just Analyse

JK Flip-Flop

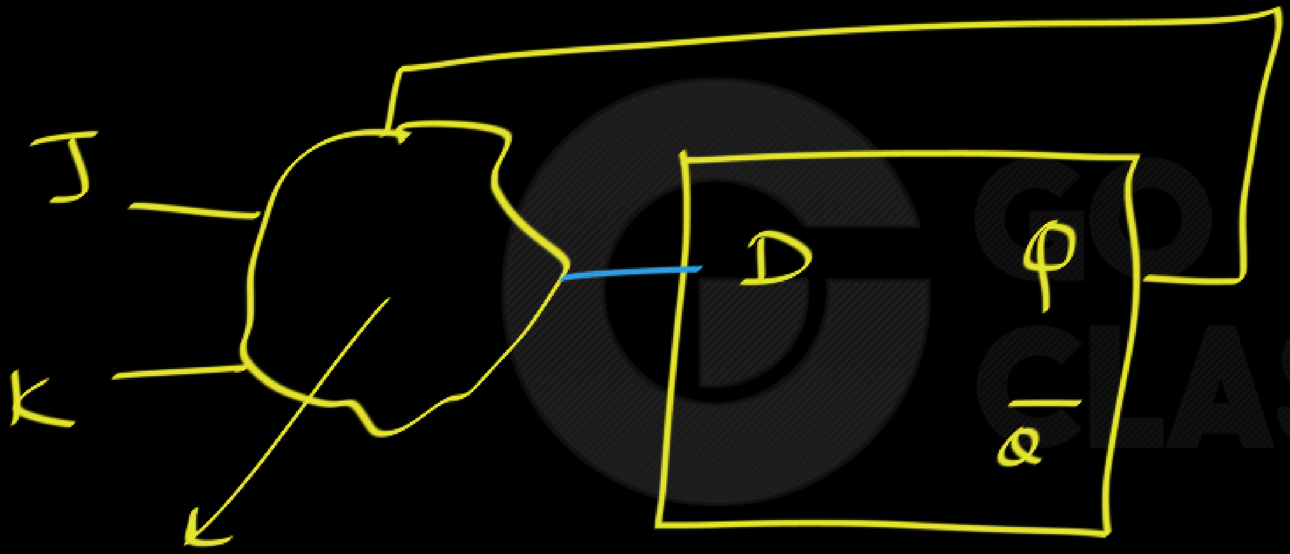


$$D = J\overline{Q} + \overline{K}Q$$

5.2 (Digital Design, M. Mano, 3rd Edition, Chapter 5)

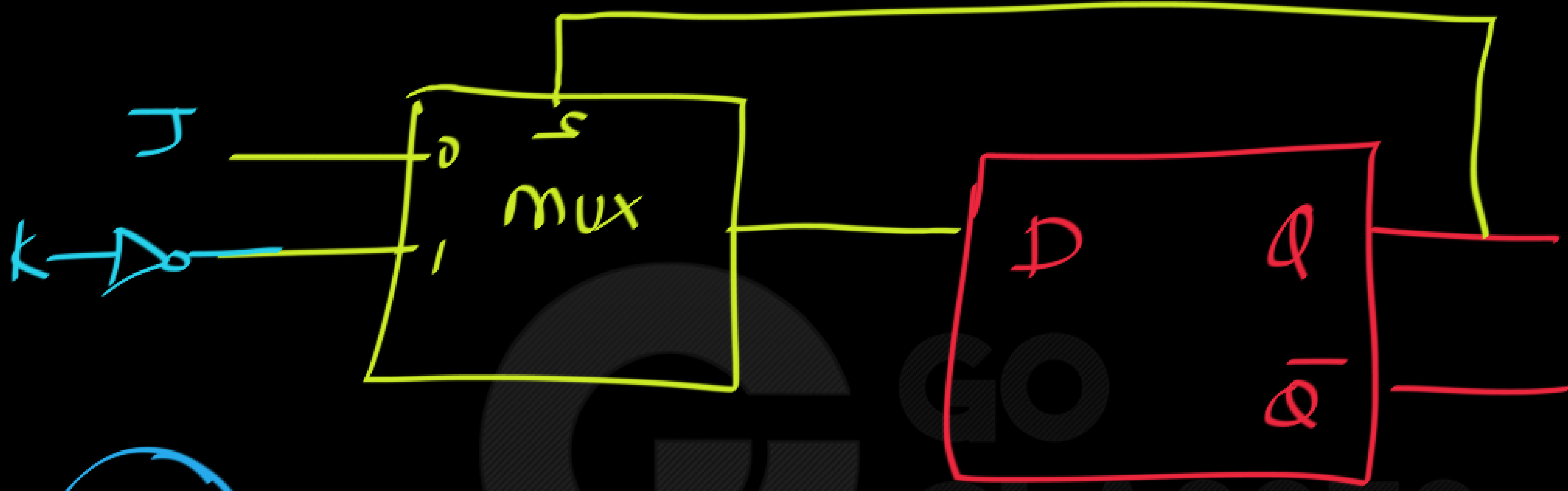
Construct a JK flip-flop using a D flip-flop, a two-to-one-line multiplexer, and an inverter.

JK using D-ff :

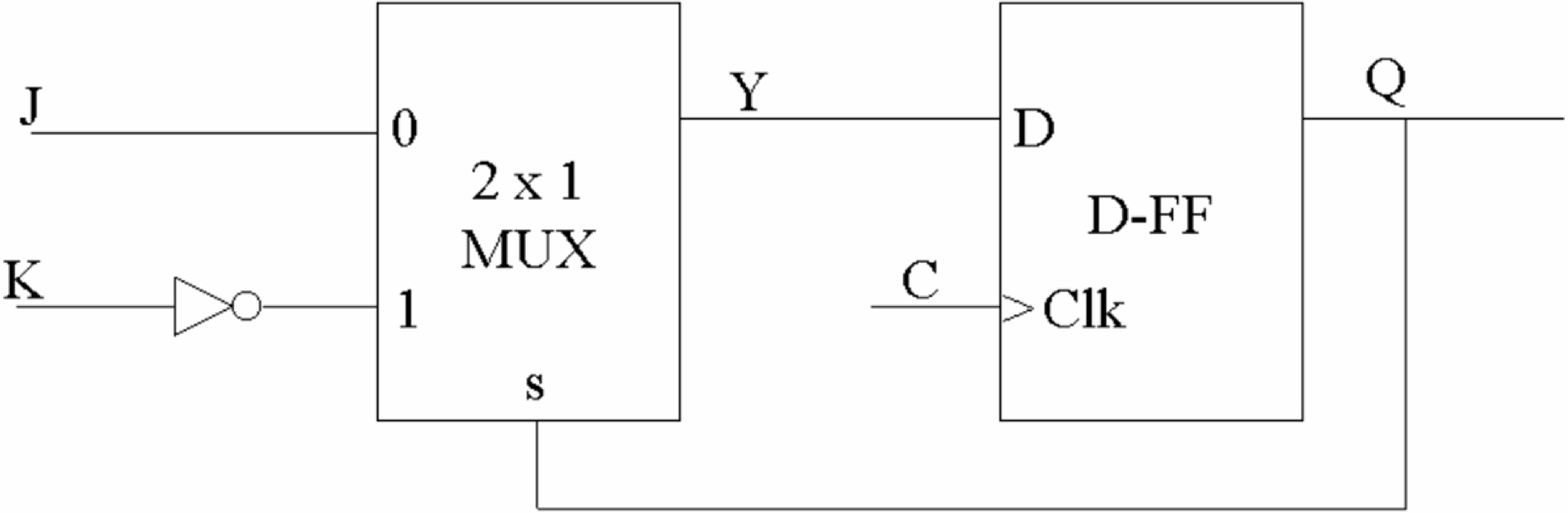


mux equation

$$D = f(J, K, Q) = \boxed{J\overline{Q} + \overline{K}Q}$$



JK using D + mux + inverter


J
K
0
1
2 x 1
MUX
s
Y
D
D-FF
C
Clk
Q

5.4 (Digital Design, M. Mano, 3rd Edition, Chapter 5)

A PN flip-flop has four operations: clear to 0, no change, complement, and set to 1, when inputs P and N are 00, 01, 10, and 11, respectively.

a) Tabulate the characteristic table. b) Derive the characteristic equation. c) Tabulate the excitation table. d) Show how the PN flip-flop can be converted to a D flip-flop.

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PN - FF :

$\bar{P} = A$	$\bar{N} = B$	Q_n	
0	0	0	Reset
0	1	Q	No change
1	0	$\overline{Q}$	Toggle
1	1	1	set

Char. Table ✓

PN-ff is same as AB-ff of Prev. Question.

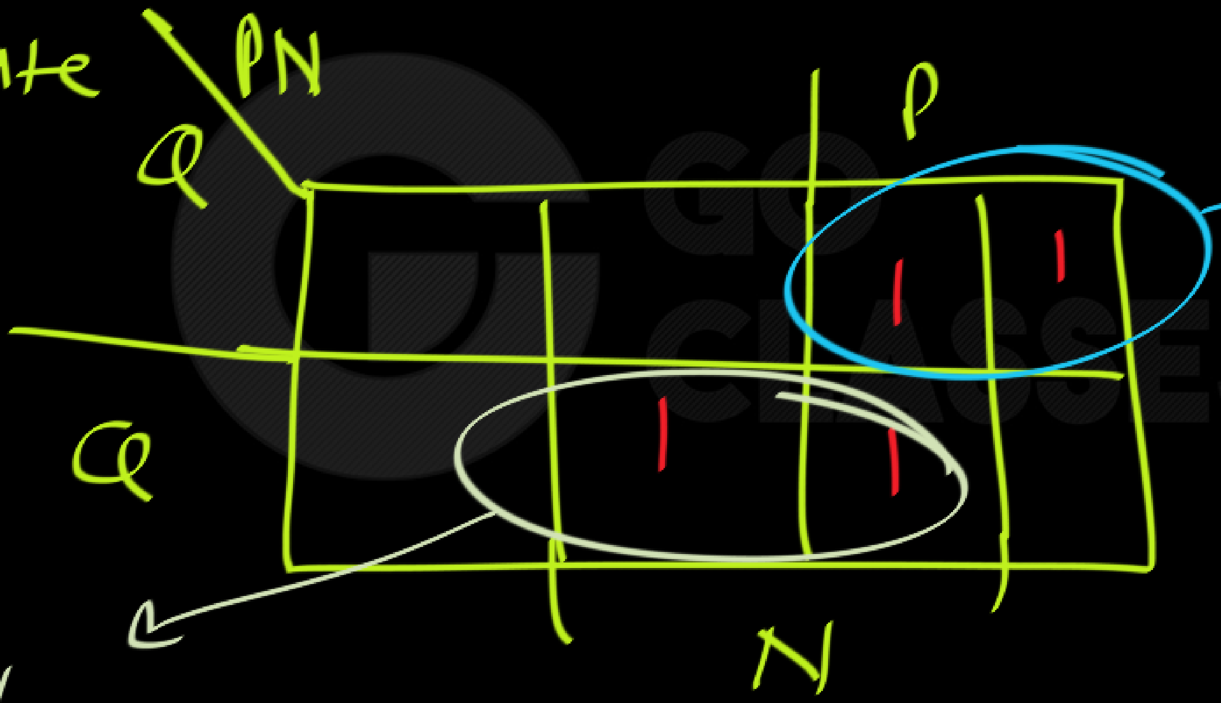
$$\boxed{\begin{aligned} P &= A = \overline{J} \\ N &= B = \overline{K} \end{aligned}}$$

Truth Table:

	P	N	Q	Q_n	
P=N=0	0	0	0	0	Reset
	0	0	1	0	
PN=01	0	1	0	0	No change
	0	1	1	1	
PN=10	1	0	0	1	Toggle
	1	0	1	0	
PN=11	1	1	0	1	set
	1	1	1	1	

$Q_n = f(P, N, Q)$ → present state

Next state



$\rightarrow P\bar{Q}$

QN

$$Q_n = P\bar{Q} + QN$$

Excitation Table of PN-FF:

Q	Q_n	P N
0 →	0	Retain / Reset
0 →	1	Toggle / Set
1 →	0	Toggle / Reset
1 →	1	Set / Retain

Excitation Table of PN-FF :

Q		Q_n	P	N
0	$\rightarrow$	0	0 0	0 1
0	$\rightarrow$	1	1 1	0 1
1	$\rightarrow$	0	1 0	0 0
1	$\rightarrow$	1	0 1	1 1

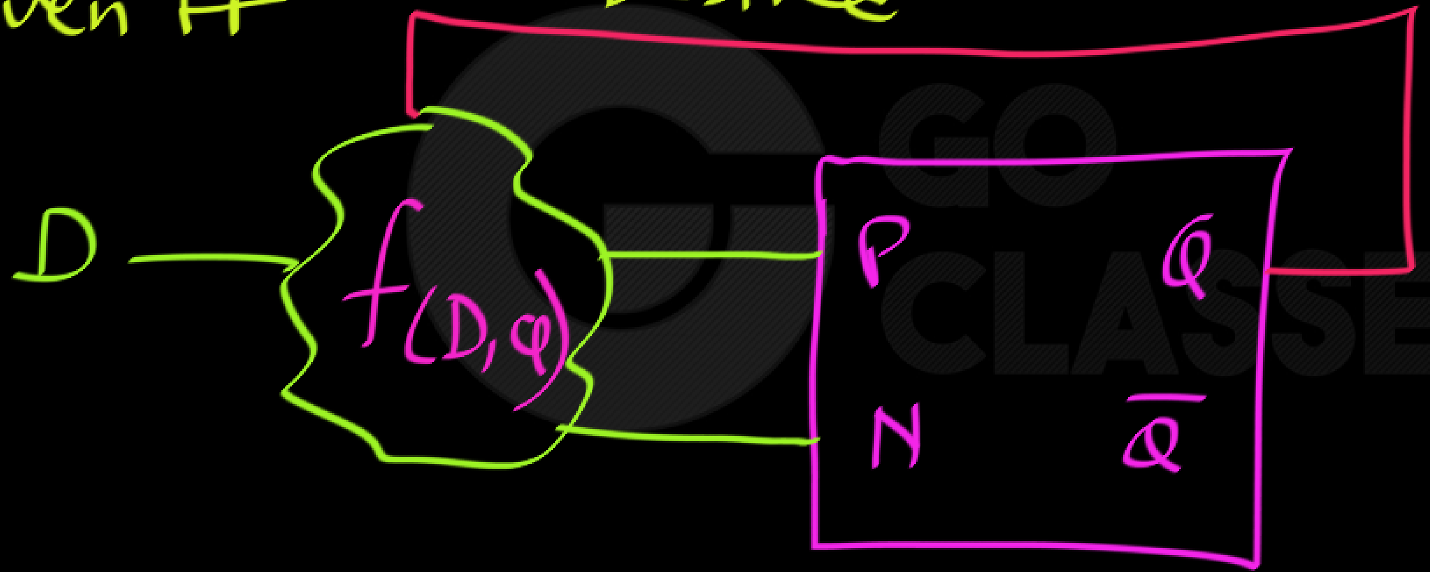
Excitation Table of PN-FF:

Q		Q_n	P	N
0	$\rightarrow$	0	0	X
0	$\rightarrow$	1	1	X
1	$\rightarrow$	0	X	0
1	$\rightarrow$	1	X	1

PN-ff to D-ff :

Given ff

Desired



$P = f(D, Q)$

$N = f(D, Q)$

$P = f(D, Q)$; $N = f(D, Q)$

D	Q	Q_n	$P = f(D,Q)$	$N = f(D,Q)$
0	0	0	0	X
0	1	0	X	0
1	0	1	1	X
1	1	1	X	1

$P = f(D, Q)$

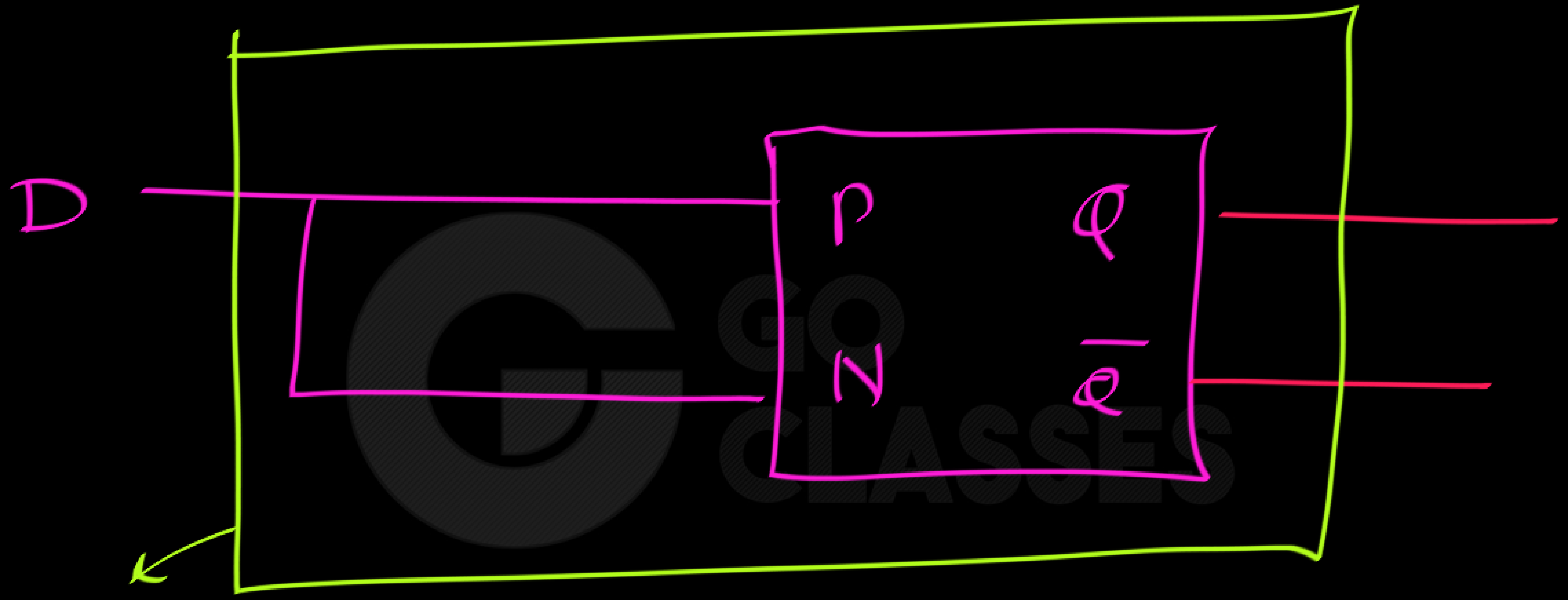
Q \ D		D
		1
Q	X	X

$P = D$

$N = f(D, Q)$

Q \ D		D
	X	X
Q		1

$N = D$



D-ff using PN-ff.

a)

P	N	Q(t+1)
0	0	0
0	1	Q(t)
1	0	Q′(t)
1	1	1

b)

P	N	Q(t)	Q(t+1)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

N

P

P\NQ	00	01	11	10
0	0	0	1	0
1	1	0	1	1

$$Q(t+1) = PQ' + NQ$$

c)

Q(t)	Q(t+1)	P	N
0	0	0	X
0	1	1	X
1	0	X	0
1	1	X	1

d) By connecting P and N together.

$$Q(t+1) = DQ' + DQ = D$$

Next Topic :

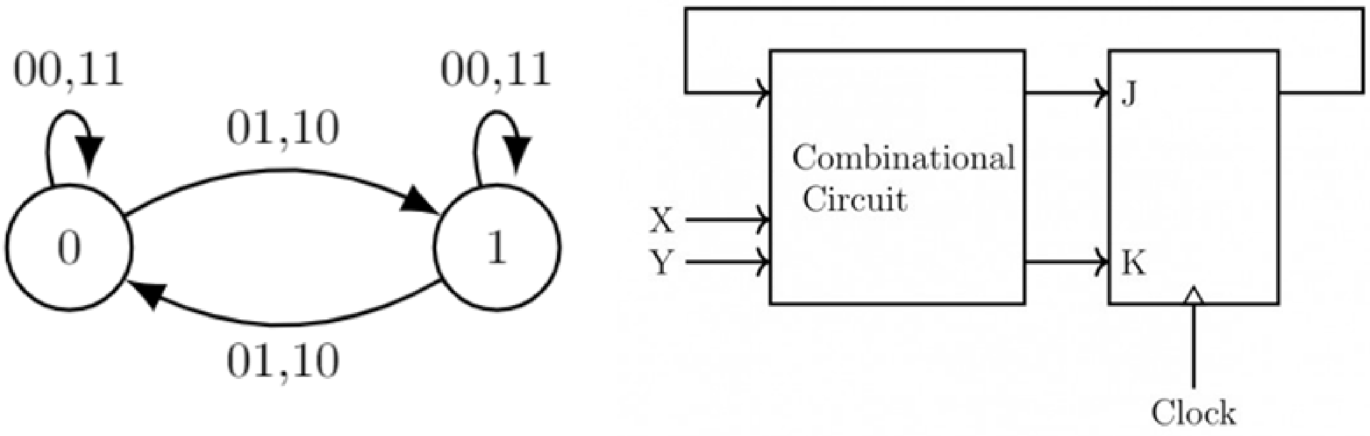
GATE CSE 2008

JK flipflop to XY Flipflop Conversion

4.12.10 Digital Counter: GATE IT 2008 | Question: 37 top

https://gateoverflow.in/3347

Consider the following state diagram and its realization by a JK flip flop



The combinational circuit generates J and K in terms of x, y and Q.
The Boolean expressions for J and K are :

A. $\overline{x \oplus y}$ and $\overline{x \oplus y}$
B. $\overline{x \oplus y}$ and $x \oplus y$
C. $x \oplus y$ and $\overline{x \oplus y}$
D. $x \oplus y$ and $x \oplus y$

4.12.10 Digital Counter: GATE IT 2008 | Question: 37 top

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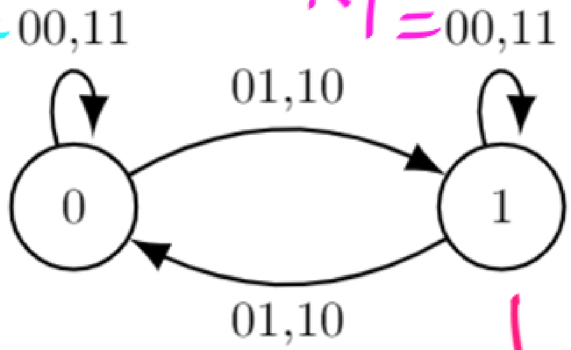
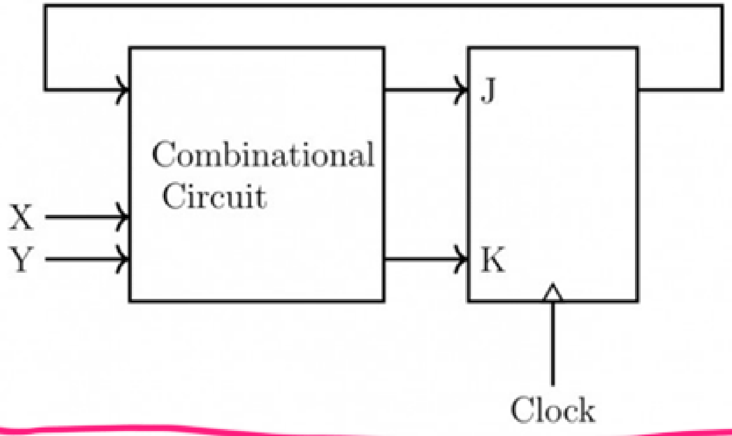
Consider the following state diagram and its realization by a JK flip flop

JK-FF → XY-FF





→ XY-FF (using JK-FF)

State Diagram of XY-FF.

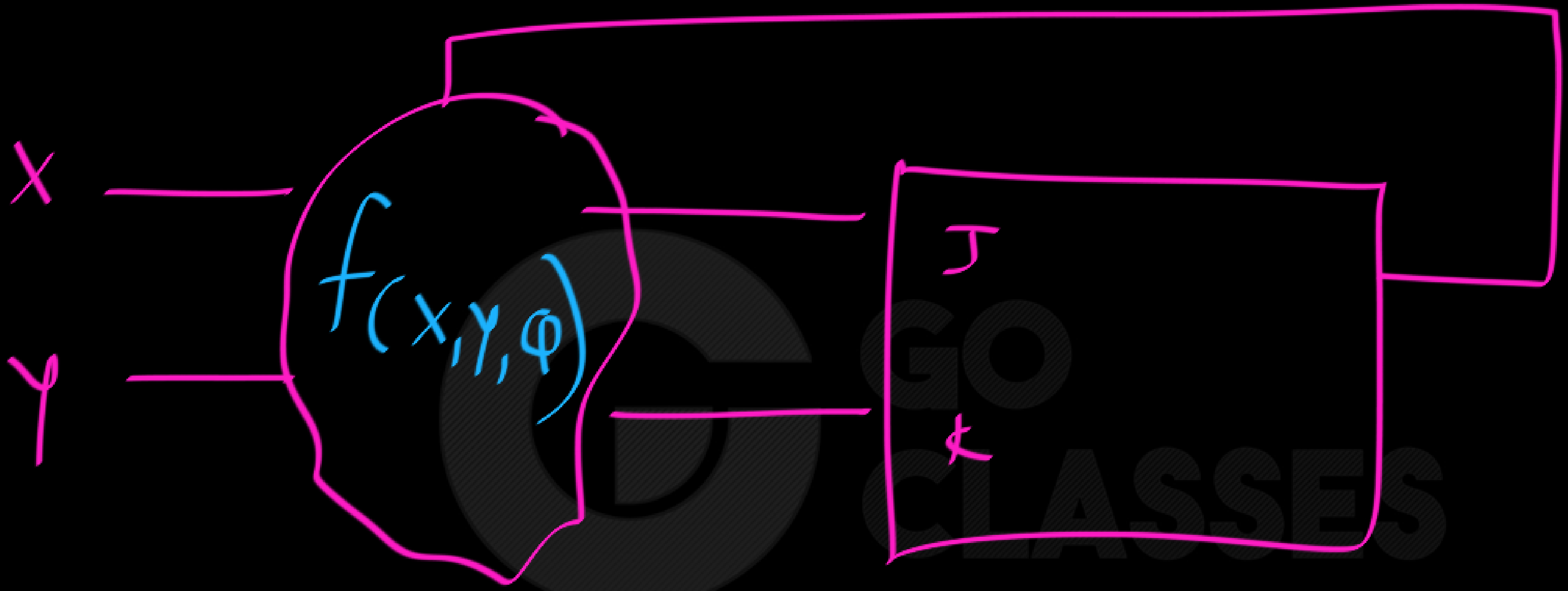
The combinational circuit generates J and K in terms of x, y and Q.
The Boolean expressions for J and K are :

A. $\overline{x \oplus y}$ and $\overline{x \oplus y}$
B. $\overline{x \oplus y}$ and $x \oplus y$
C. $x \oplus y$ and $\overline{x \oplus y}$
D. $x \oplus y$ and $x \oplus y$

Method 1: JK to XY FF Conversion:

XY-FF:

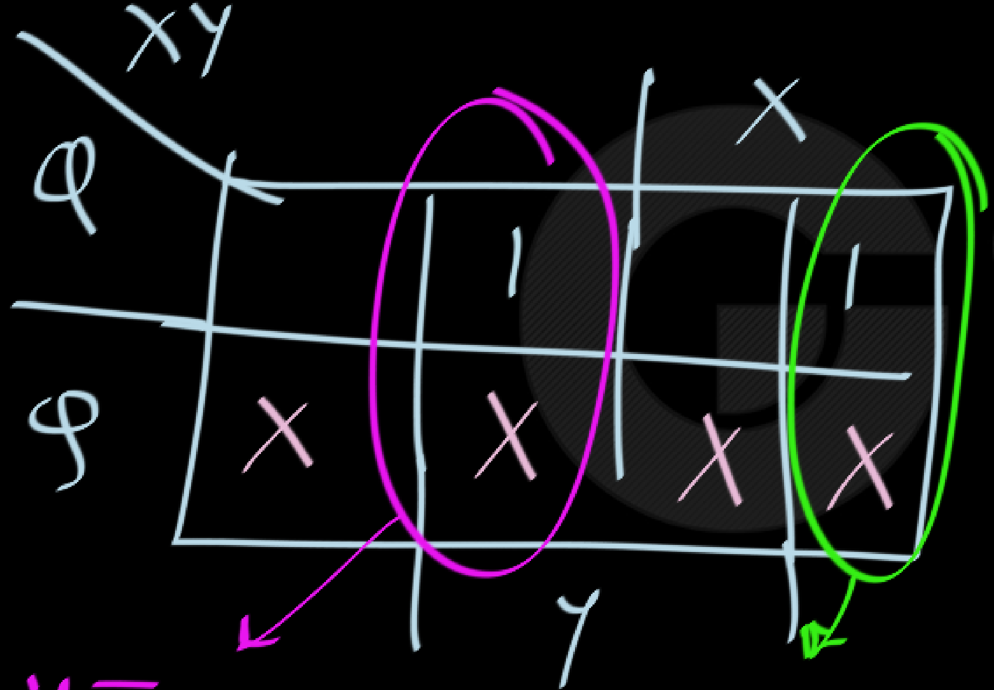
X	Y	Q_n	
0	0	Q	No change/Retain
0	1	$\overline{Q}$	Toggle
1	0	$\overline{Q}$	Toggle
1	1	Q	Retain



$$J = \underline{f(x, y, \varphi)} \ ; \ k = \underline{f(x, y, \varphi)}$$

x	y	Q	Q_n	$J = f(x,y,Q)$	$K = f(x,y,Q)$
0	0	0	→ 0	0	X
0	0	1	→ 1	X	0
0	1	0	→ 1	1	X
0	1	1	→ 0	X	1
1	0	0	→ 1	1	X
1	0	1	→ 0	X	1
1	1	0	→ 0	0	X
1	1	1	→ 1	X	0

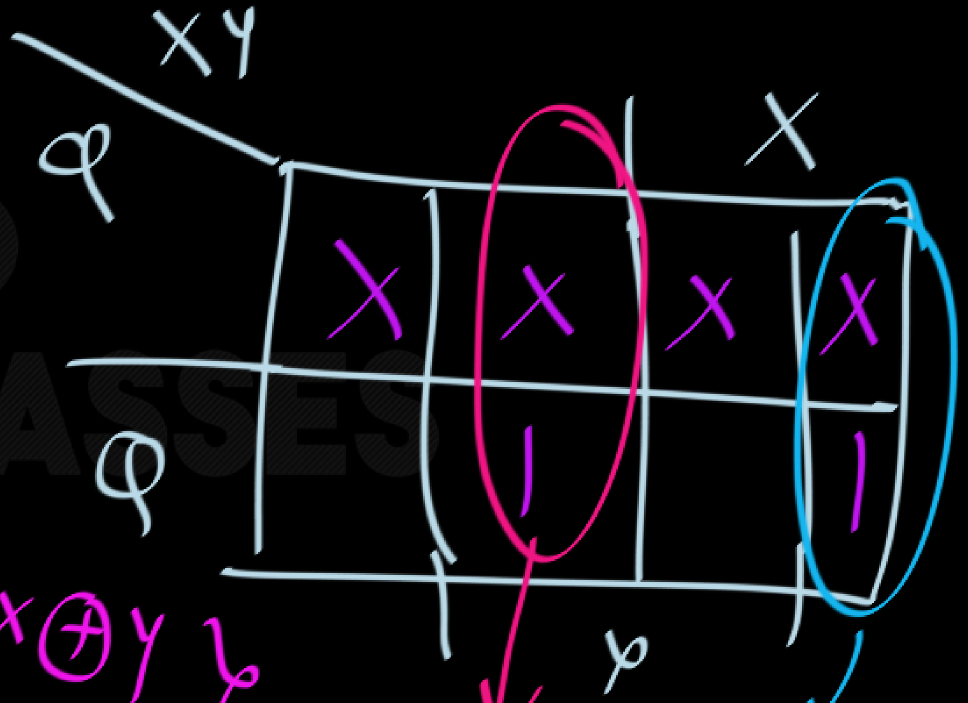
$J = f(X, Y, Q)$



$Y\overline{X}$

$X\overline{Y}$

$K = f(X, Y, Q)$



$K = X \oplus Y$

$J = X \oplus Y$

$\overline{X}Y$

$X\overline{Y}$

method 1 :

Inefficient

method 2 : Put x, y values and Verify with State Diagram

4.12.10 Digital Counter: GATE IT 2008 | Question: 37 top

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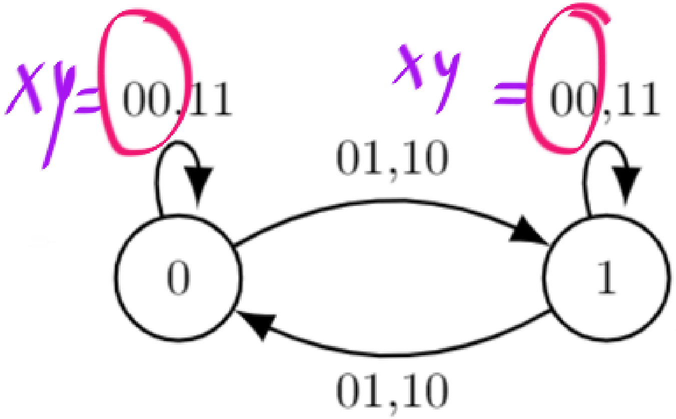
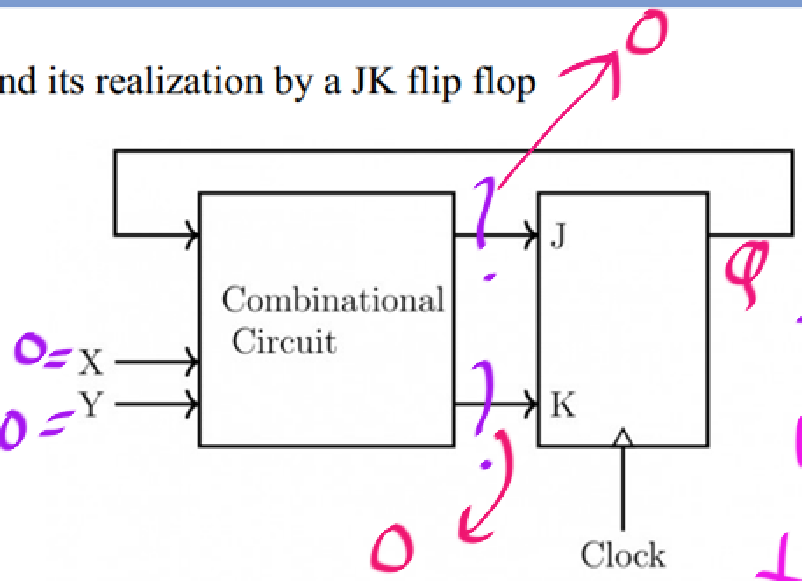
Consider the following state diagram and its realization by a JK flip flop





x	y	Q_n	J	K
0	0	φ	0	0

when x = y = 0
then what
Should be J, K
such that State not change?

The combinational circuit generates J and K in terms of x, y and Q.
The Boolean expressions for J and K are :

A. $\overline{x \oplus y}$ and $\overline{x \oplus y}$
B. $\overline{x \oplus y}$ and $x \oplus y$
C. $x \oplus y$ and $\overline{x \oplus y}$
D. $x \oplus y$ and $x \oplus y$

When $x=0, y=0$ then $J=0, k=0$

option A : $J=1, k=1$

option B : $J=1, k=0$

option C : $J=0, k=1$

Eliminated

option D : $J=0, k=0$ ✓

4.12.10 Digital Counter: GATE IT 2008 | Question: 37 top

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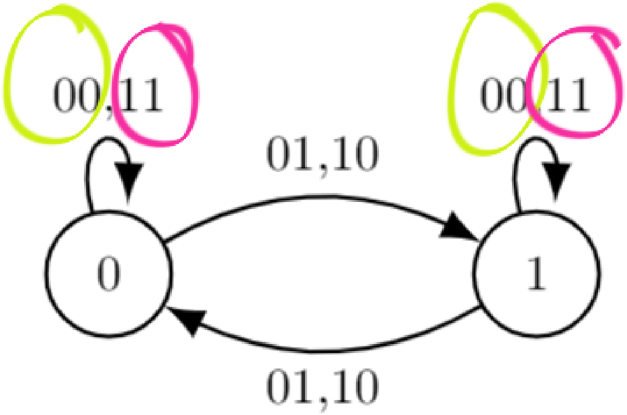
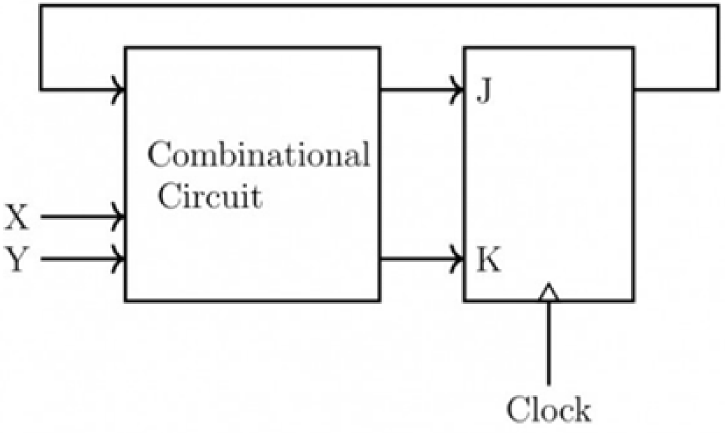
Consider the following state diagram and its realization by a JK flip flop





method 3:

Compare XY-ff with JK-ff

The combinational circuit generates J and K in terms of x, y and Q.
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B. $\overline{x \oplus y}$ and $x \oplus y$
C. $x \oplus y$ and $\overline{x \oplus y}$
D. $x \oplus y$ and $x \oplus y$

x	y	Q_n	J	K
0	0	Q	0	0
0	1	$\overline{Q}$	1	1
1	0	$\overline{Q}$	1	1
1	1	Q	0	0

$J = f(x, y)$

$J = x \oplus y$

$K = f(x, y)$

$K = x \oplus y$

Next Topic :

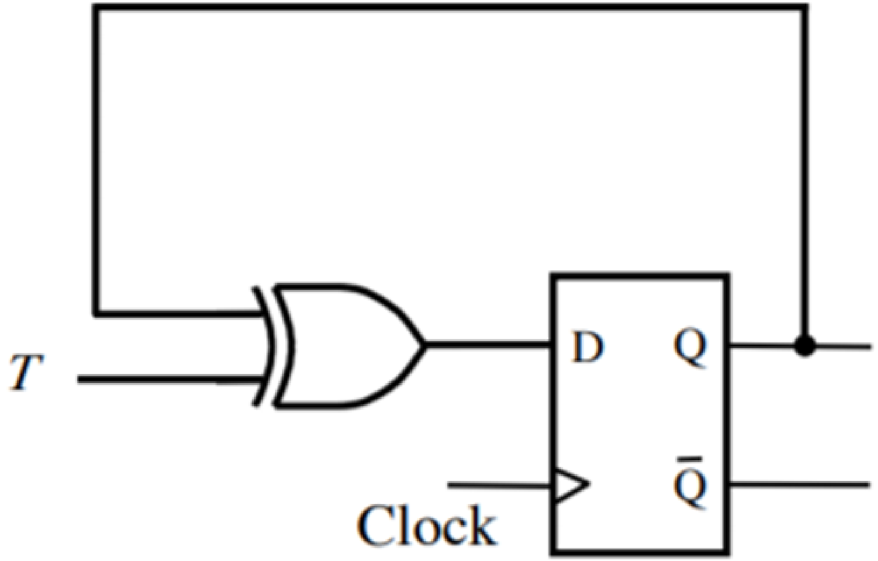
Summary Standard Flipflop Conversions

GO CLASSES

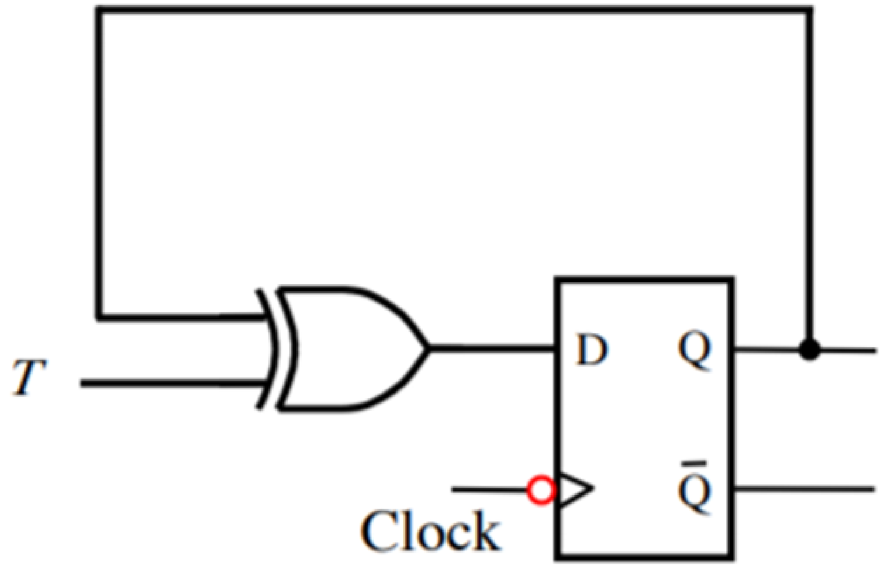
Conversion of Flipflops

- Steps for the conversions
  - Step 1: Write the Truth Table of the Desired Flip-Flop
  - Step 2: Obtain the Excitation Table for the given Flip-Flop from its Truth Table
  - Step 3: Append the Excitation Table of the given Flip-Flop to the Truth Table of the Desired Flip-Flop Appropriately to obtain Conversion Table
  - Step 4: Simplify the Expressions for the Inputs of the given Flip-Flop
  - Step 5: Design the Necessary Circuit and make the Connections accordingly

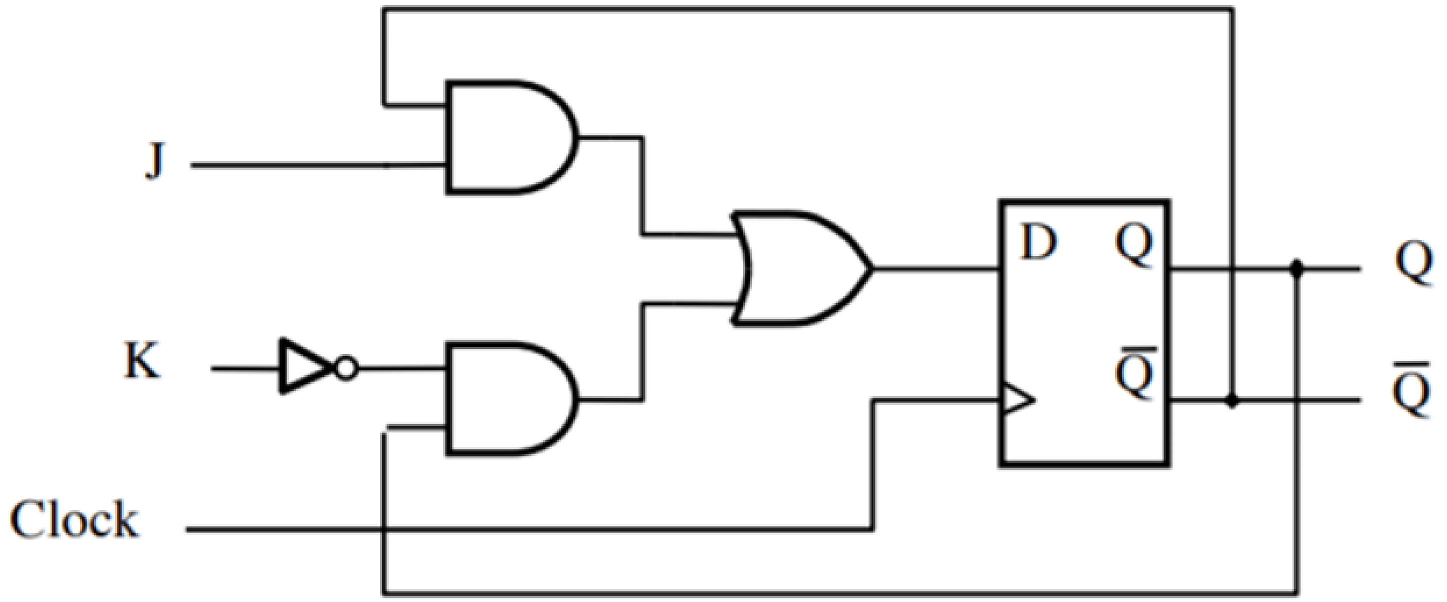
Positive-Edge-Triggered T Flip-Flop



Negative-Edge-Triggered T Flip-Flop



Positive-Edge-Triggered JK Flip-Flop



Negative-Edge-Triggered JK Flip-Flop