

Chapter - 5

Sequential circuits

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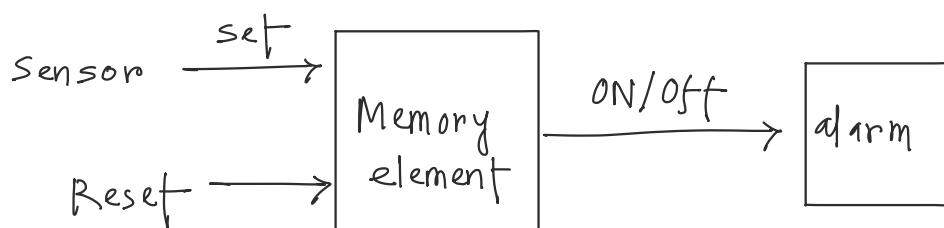
Sequential Logic:

Sensor  $\rightarrow$  1 input মিলে

↓  
ON

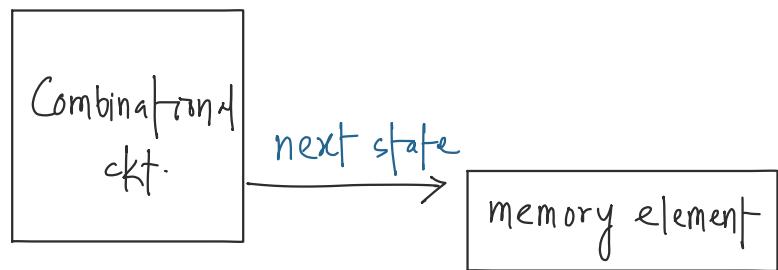
Reset না এবং পর্যন্ত  $\rightarrow$  ON থাকবে

sensor দ্বারা input  $\rightarrow$  memory element & store



combinational ckt.

memory  $\rightarrow$  current state & input মিলিয়ে  $\rightarrow$  output



Synchronous  $\rightarrow$  clock user रखते

$\hookrightarrow$  behaviour clock पर controlled.

$\hookrightarrow$  memory element flip-flop

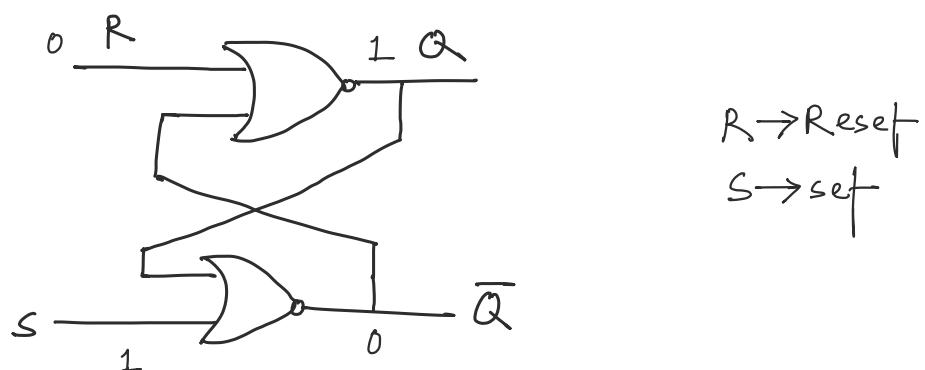
Asynchronous  $\rightarrow$  design complexity बढ़ती

Latch  $\rightarrow$  Fundamental memory block.

### Memory Elements

Latch  $\rightarrow$  Level sensitive

Flip-flop  $\rightarrow$  edge triggered



<u>S</u>	<u>R</u>	$Q_0$	$Q$	$Q'$	
0	0	0 ↓ initial value	0	1	$Q = Q_0$
0	0	1	1	0	retain $Q = Q_0$

value change হলো, তাই input ফিল্টের জন্য retain

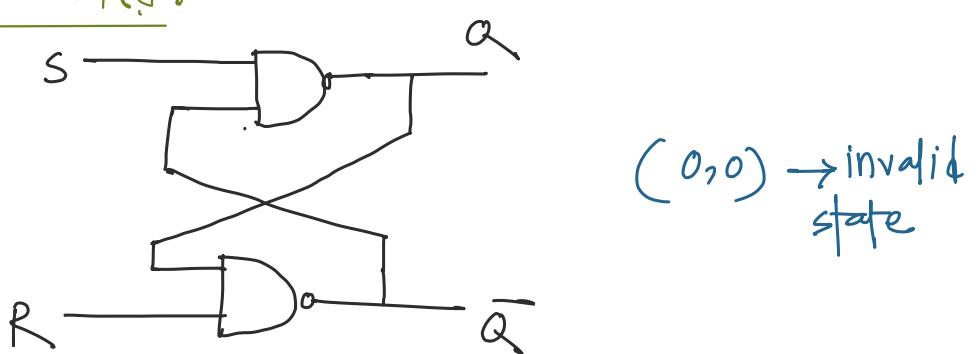
0	1	0	0	1	$Q = 0$
0	1	1	0	1	reset $Q = 0$

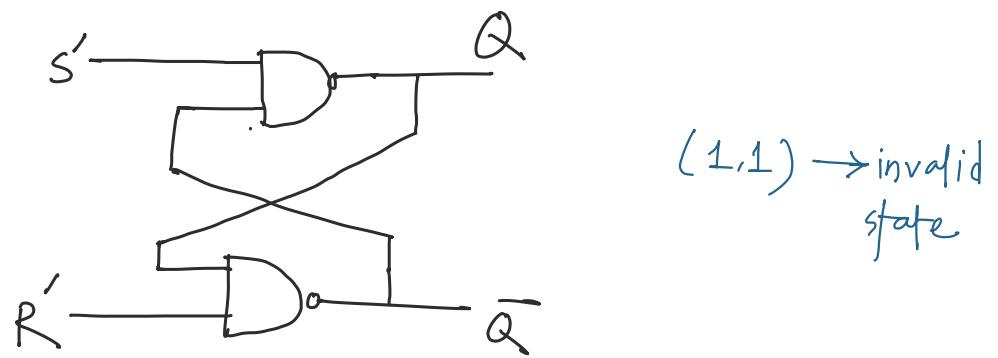
1	0	0	1	0	$Q = 1$
1	0	1	1	0	set

1	1	0	0	0	$Q = 0$
1	1	1	1	0	$\overline{Q} \neq 1$ $= 0$ invalid state

$R = 1$   
 $S = 1$  } Forbidden state

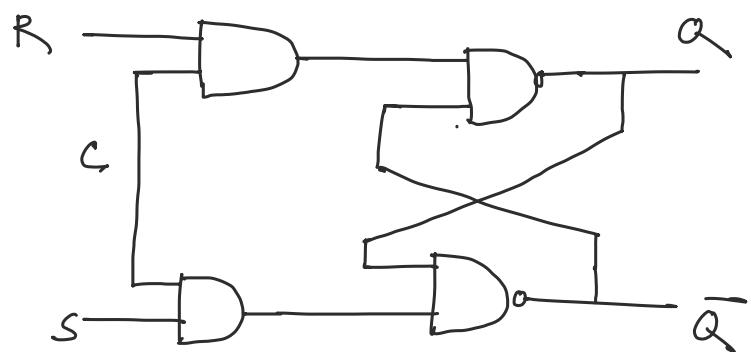
Nand gate ফিল্টে:





22.01.2024

Control  $\rightarrow 1$   
 $\hookrightarrow$  input ଏବା affect memory (କାମୀ)



C	S	R	Q
0	X	X	$Q_0$
1	0	0	$Q_0$
1	0	1	0
1	1	0	1
1	1	1	$Q'$

$C \rightarrow 0$  থাবলে

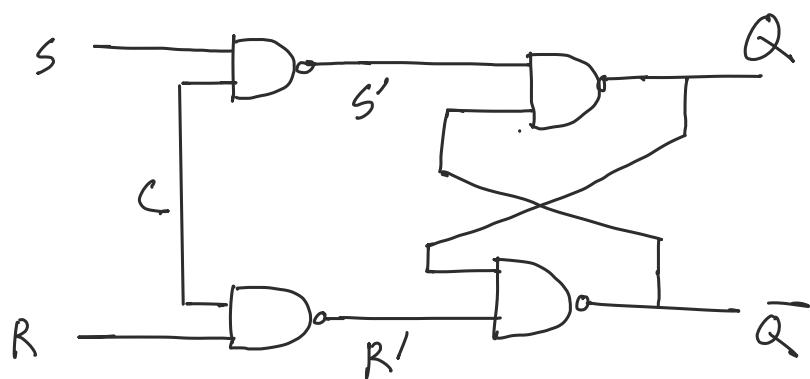
↳  $R, S \rightarrow$  Don't care

↳ output এ থাববে  $\rightarrow$  previous state

$C \rightarrow 1$  থাবলে

↳ যাগের মতই  
 $C$  এর ফোল্জ এফেক্ট নাই।

NAND Latch + Control input:



$S, R$  এই থার্মুক  $\rightarrow C = 0$  হলে

↓

NAND এর output  $S'$

$C \quad S \quad R$   
1      1      1

এখন control 0 করা হলো

↪ unstable অবস্থা

(limitation)

↪ control user এর কাছে দিলে

$Q, \bar{Q}$  একসাথে 0 not possible

$R/S \rightarrow$  update যাব।

↓  
যদি dominate হবে।

### Controlled Latches:

$C$	$D$	$Q$
0	X	$Q_0$
1	0	0
1	1	1

no change

Reset

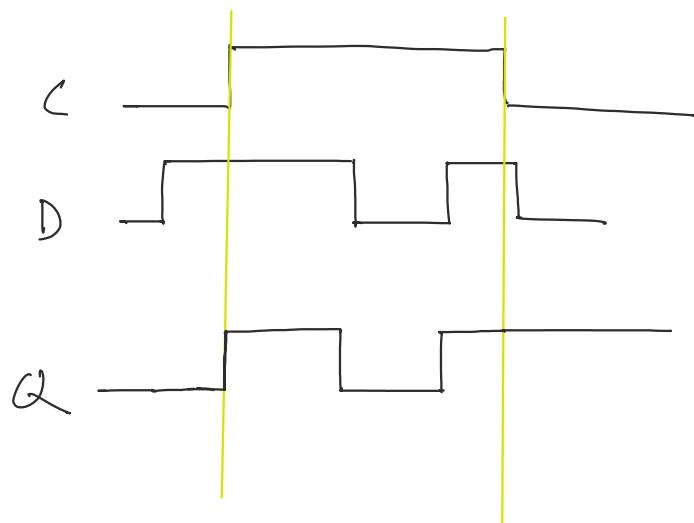
Set

$S = 1$        $R = 0 \rightarrow Q_0$  (এটা আর পাইন)

but  $Q_0$  (no change)

state র পাই,  
C থেকে।

$Q_0 \rightarrow$  initially 0



problem :       $C = 1$  হলে D কে follow

continuously change  
↓

যব application এ desired নাও হত

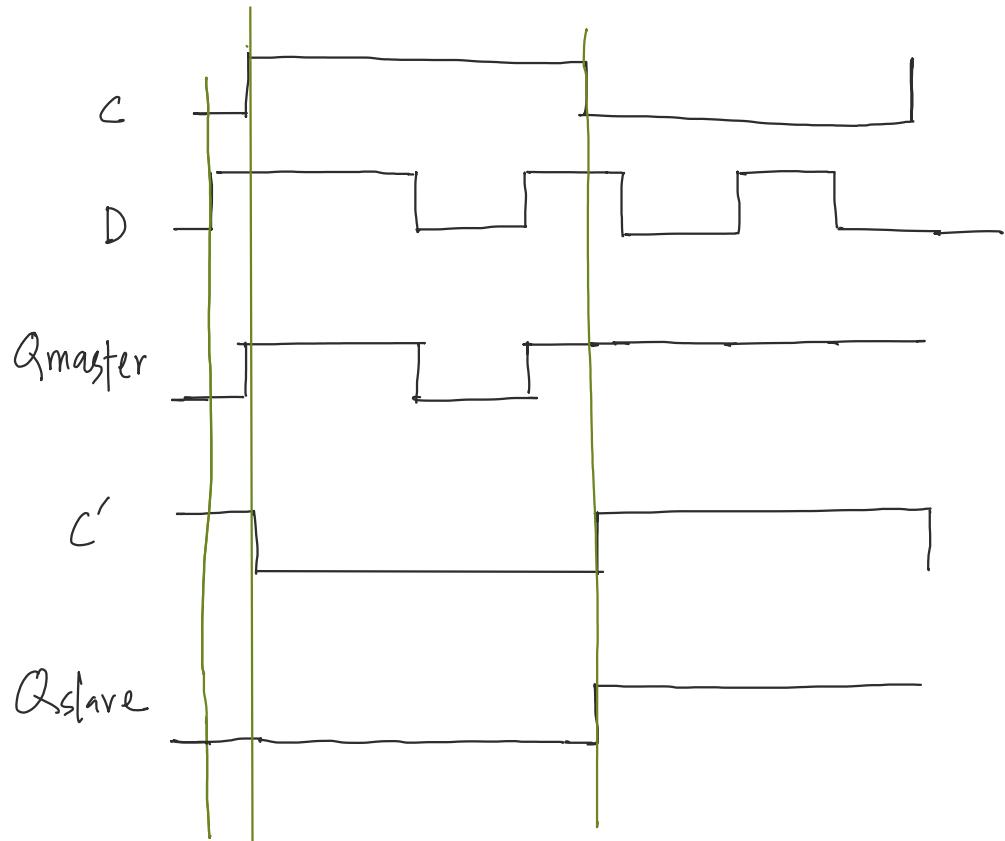
পাবে। Sharp change থাই /

common clock দিয়ে full ckt. control

Flip - Flop

edge triggered

Latch  $\rightarrow$  Level triggered



$Q_{slave}$ ,  $Q_{master}$  এ follow করবে যখন

$$\text{clock} = 1$$

(-ve) edge triggered

(+ve) edge " বাস্তুত

→ দ্রুত থাকবে

## (+ve) Edge triggered D Flip Flop

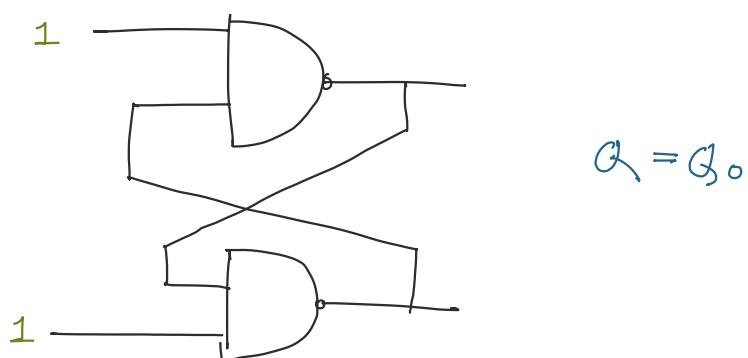
$$\textcircled{1} \quad CL = 0, \quad D = 0/1 \quad Q = Q_0$$

$$\textcircled{2} \quad CL \uparrow (0 \rightarrow 1) \quad D = 0 \quad Q = 0 \\ D = 1 \quad Q = 1$$

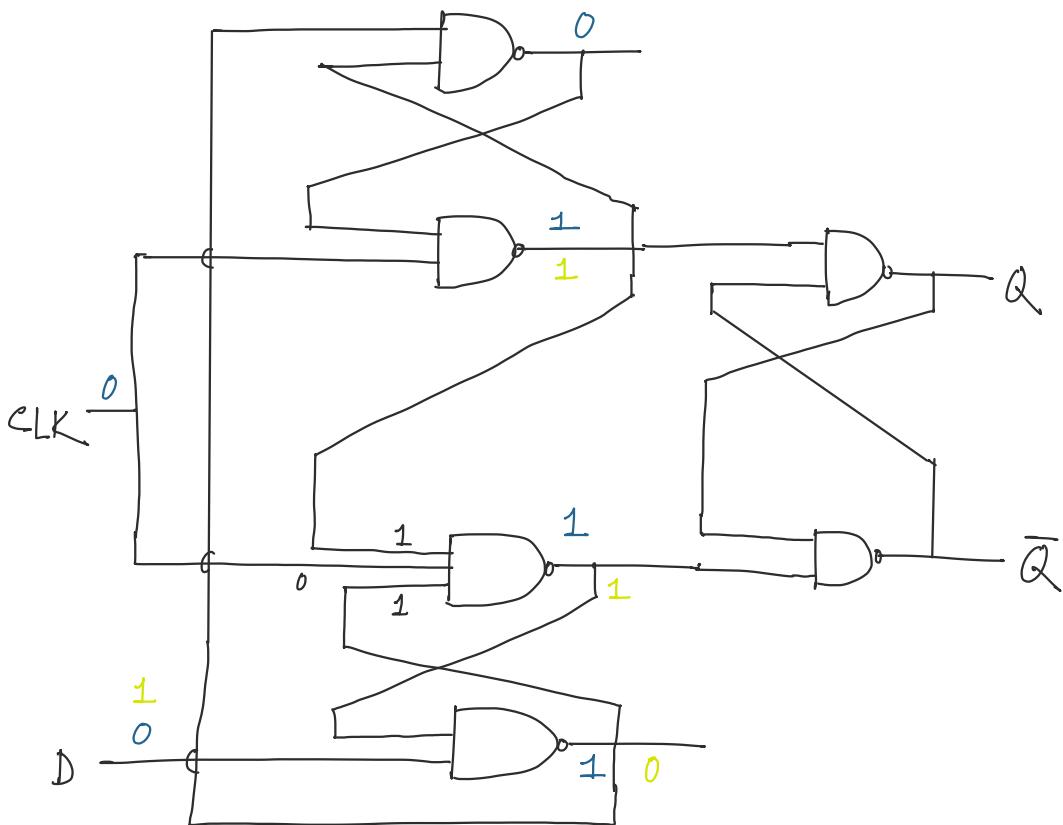
$$\textcircled{3} \quad CL \text{ continued } \uparrow \quad D = 0 \rightarrow 1 \quad Q = Q_0 \\ 1 \rightarrow 0 \\ \text{ie } 1$$

$$\textcircled{4} \quad CL \downarrow (1 \rightarrow 0) \quad D = 0/1 \quad Q = Q_0 \\ \hookrightarrow \text{negative edge}$$

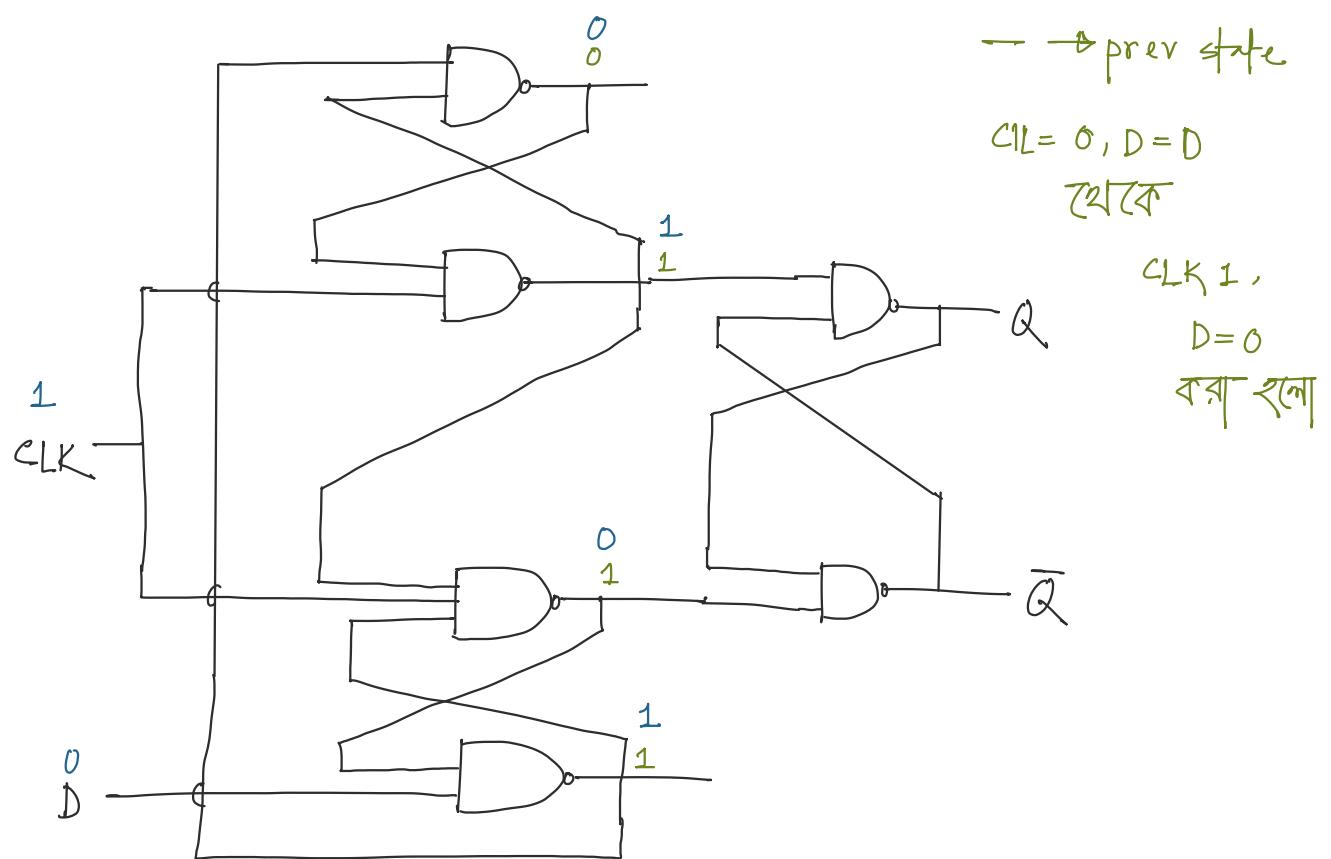
S-R Latch  $\rightarrow$  NAND দিয়ে তৈরি করা হলো  $\rightarrow$

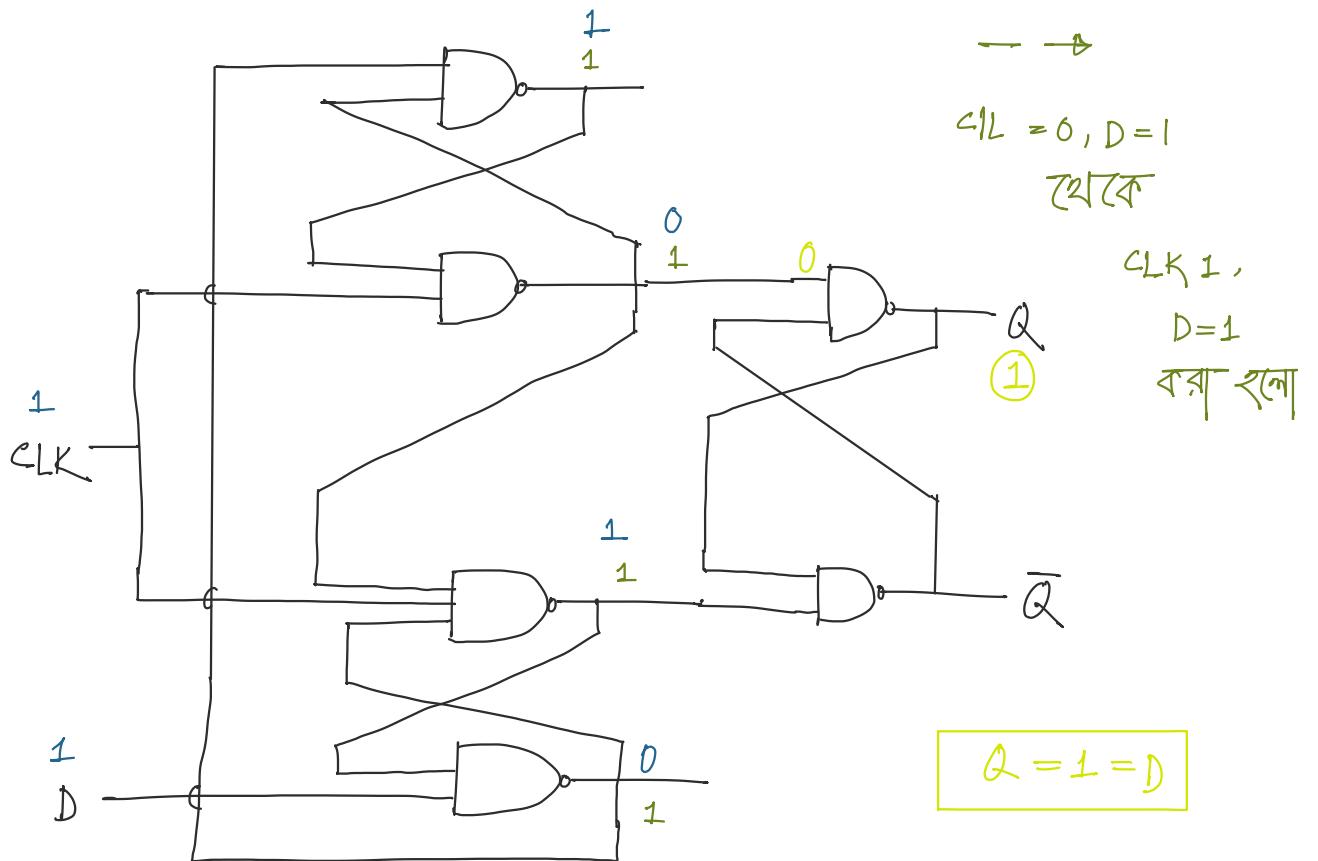


$$CIL = 0, D = 0/1 \rightarrow Q = Q_0$$

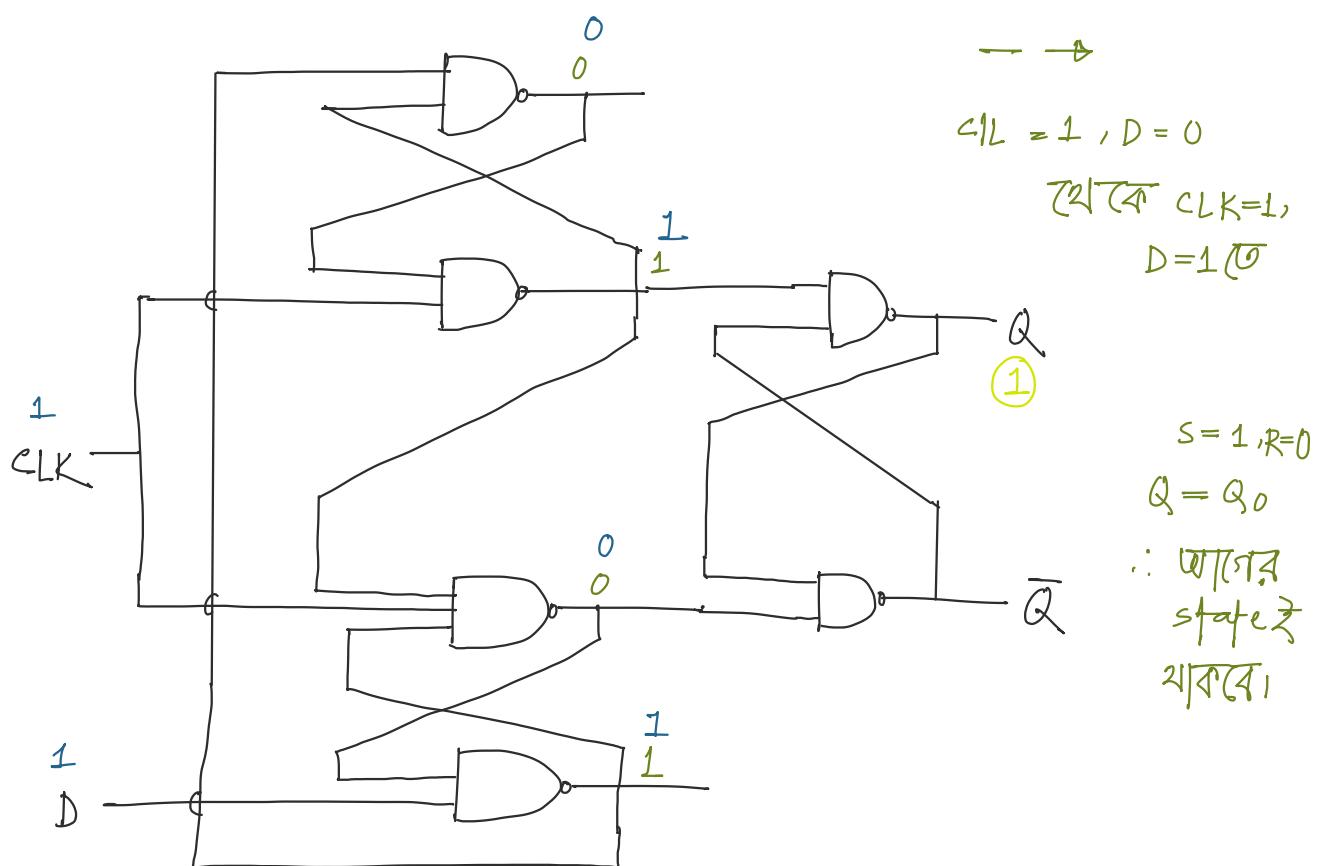


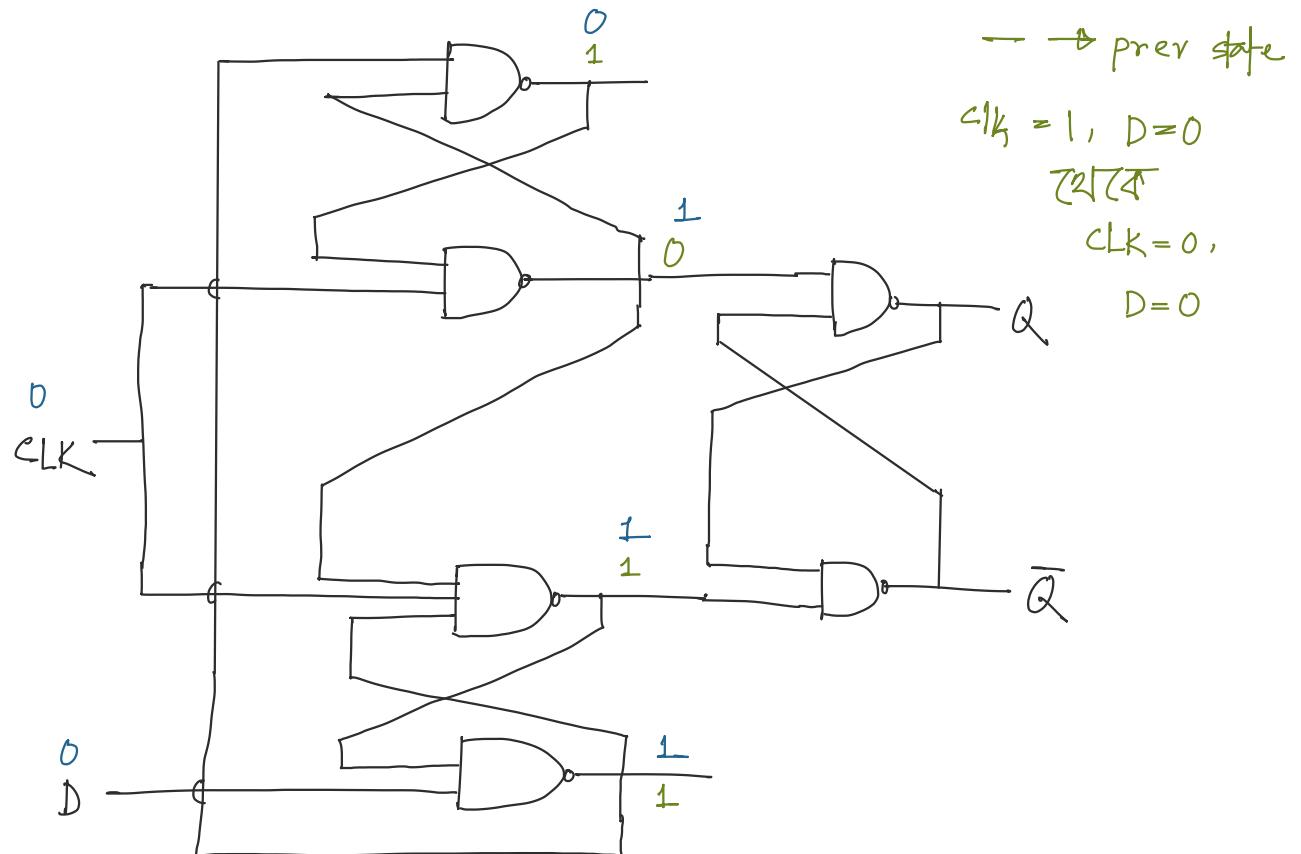
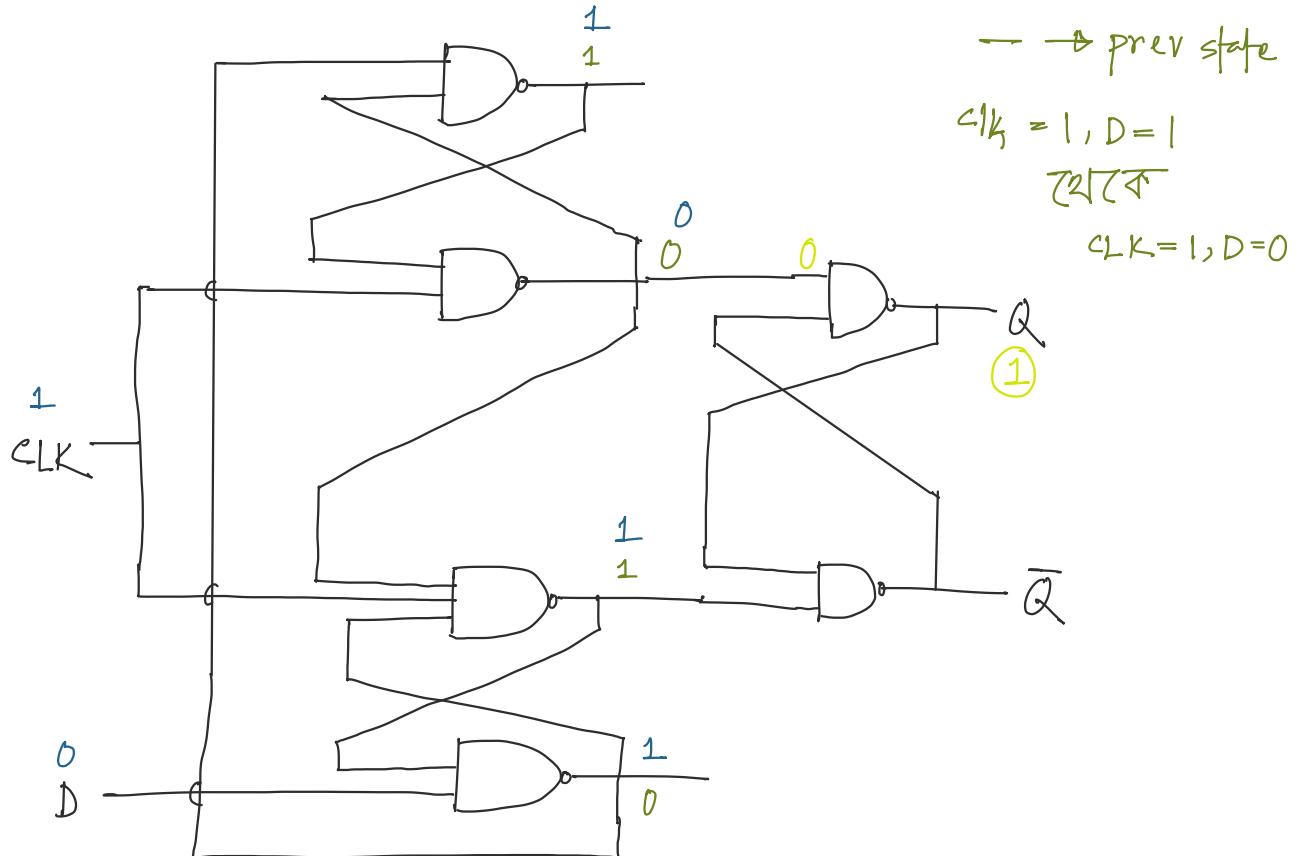
$$\left. \begin{array}{l} CIL = 0 \\ D = 1 \\ CIL = 0 \\ D = 0 \end{array} \right\} Q = Q_0$$

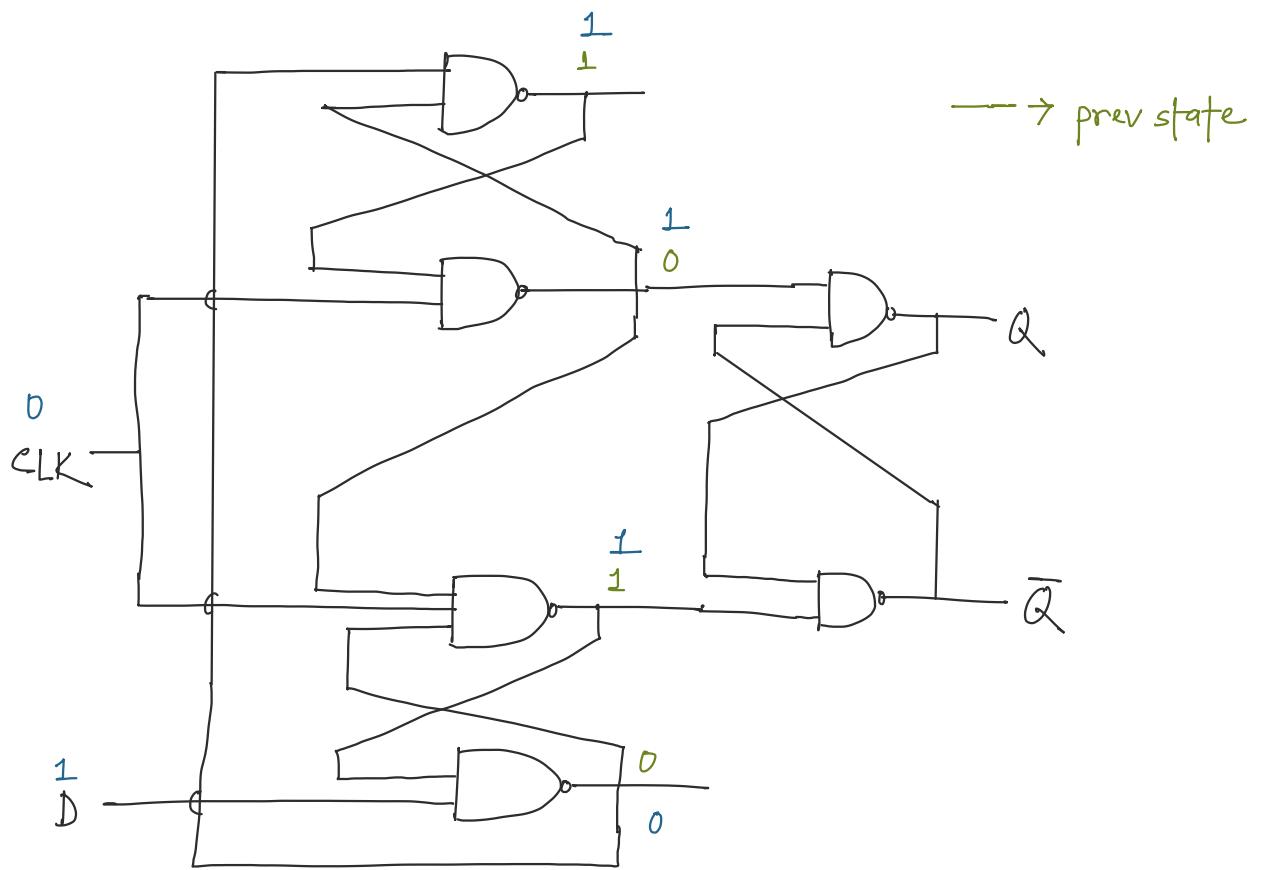




যদির value change করবো তার corresponding gate  
থেকে start করবো।







$0 \rightarrow 1 \rightarrow$  তার বিচ্ছুলন আগে থেকে

$1 \rightarrow 0 \rightarrow$  তার বিচ্ছুলন পরে D chng রচে  
দিয়ে না,

JK Flip Flops:  
↔ 2 input

## T Flip Flop

$D \rightarrow \text{set, reset}$

$JK \rightarrow \text{reset, set, no change, complement}$

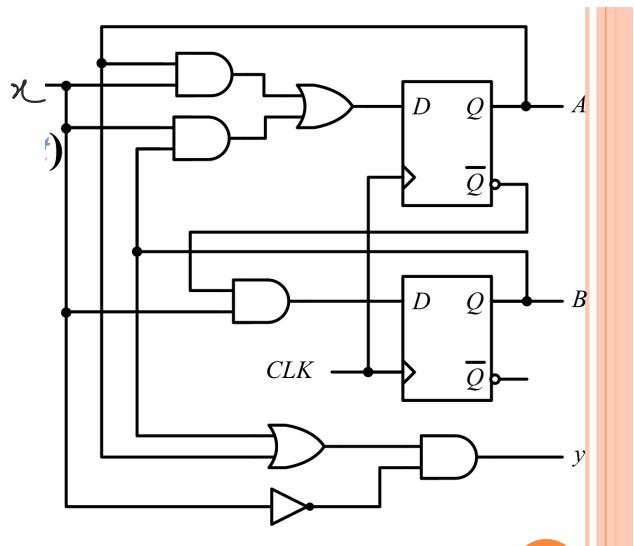
$T \rightarrow \text{no change, complement}$   
 1 input

State equations:

$$\begin{aligned} A(t+1) &= x(t)B(t) \\ &\quad + x(t)A(t) \\ &= xB + xA \end{aligned}$$

$$B(t+1) = xA'(t) = xA'$$

$$y(t) = [A(t) + B(t)] \bar{x}(t)$$



prev state  $\rightarrow$  2 bit  $A, B$

next state  $\rightarrow$  2 bit  $A, B$

output  $\rightarrow$   $y$

## state table

previous state		input $x$	next state		output $y$
A	B		A	B	
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	0	0	1
0	1	1	1	1	0
1	0	0	0	0	1
1	0	1	1	0	0
1	1	0	0	0	1
1	1	1	1	0	0

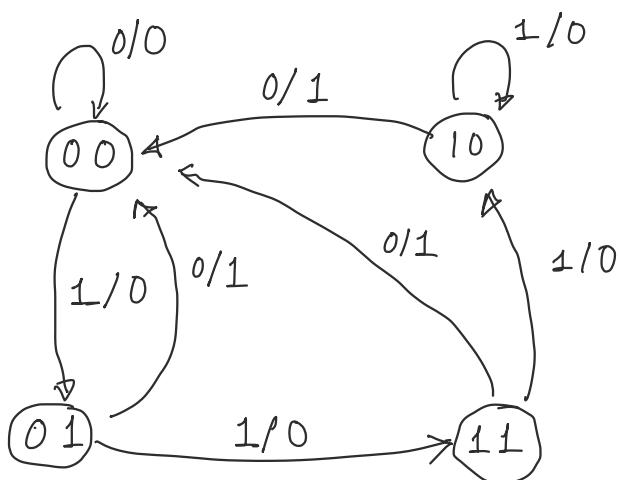
$$A(t+1) = x(t)B(t) + x(t)A(t)$$

$$= x_B + x_A$$

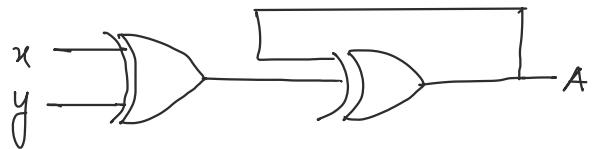
$$B(t+1) = x A'(t) = x A'$$

$$y(t) = [A(t) + B(t)] \bar{x}(t)$$

## state diagram:



State table :



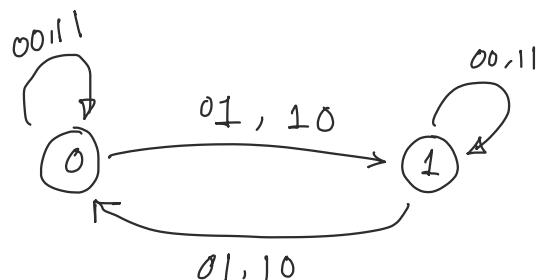
previous state	input	next state
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A	x	y	A
---	---	---	---

0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

$$A(t+1) = A \oplus x \oplus y$$

state diagram:



$$\begin{aligned} A(t+1) &= T_A \oplus Q \\ &= BxQ' + (Bx)'Q \end{aligned}$$

$$\begin{aligned} TA &= Bx \\ TB &= x \end{aligned}$$

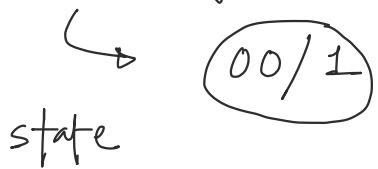
$$B(t) = x$$

$$y = AB$$

output slash ফিল্টার দ্বারা নির্ণয় কৰা হবে

input এবং উপর নির্ভর না হলো

(only state dependent)



diagram

CT syllabus — chapter 5

chapter 9.5

} 11th week  
Saturday