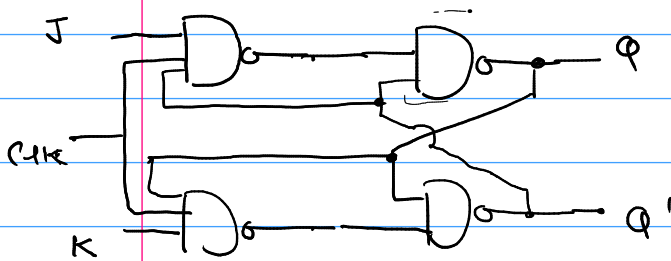


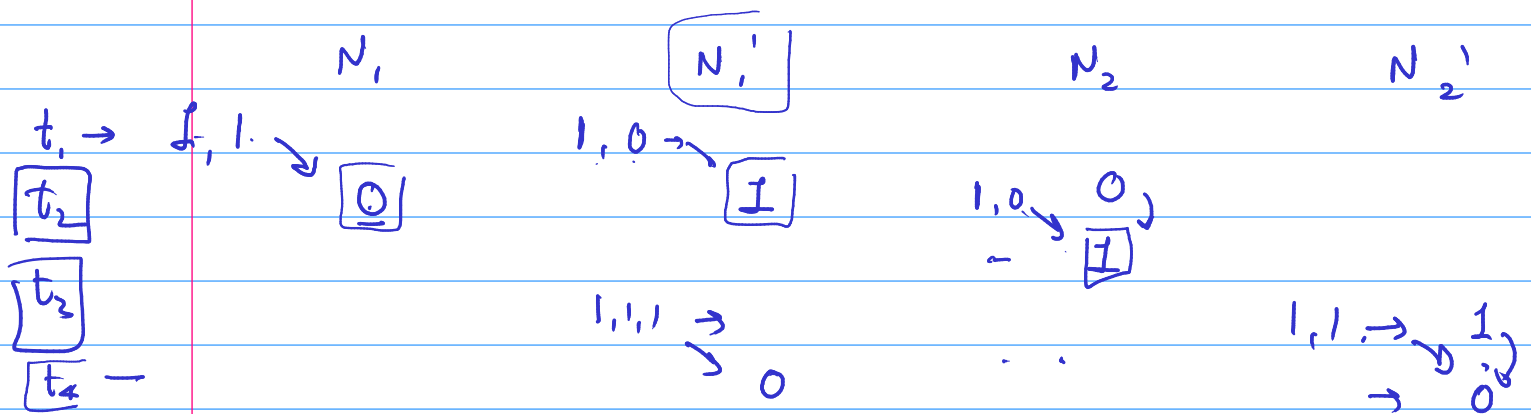
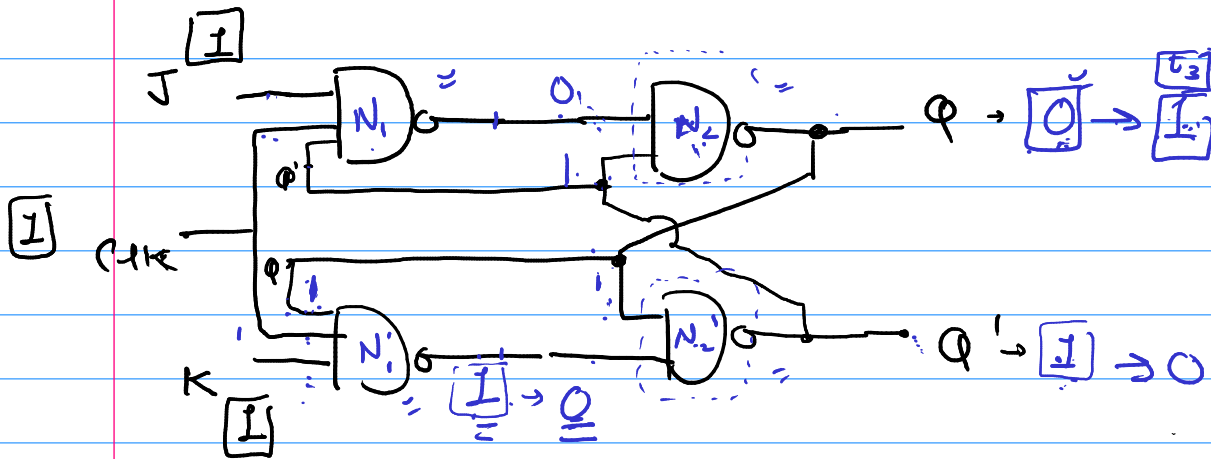
## Lecture #10

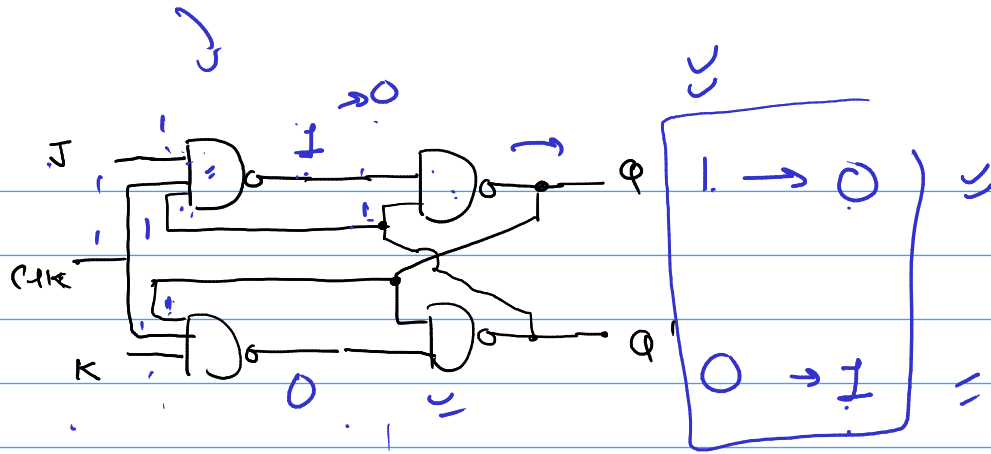
## Flip\_Flops / LATCHES

$$(AB)' = \text{NAND}$$

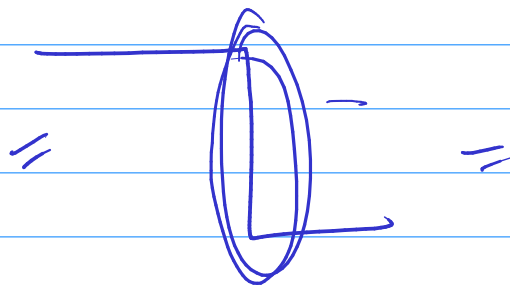


J	K	CLK	$Q_n$	$Q_{n+1}$
X	X	0		No Change
0	0	1		No Change
0	1	1	X	0
1	0	1	X	1

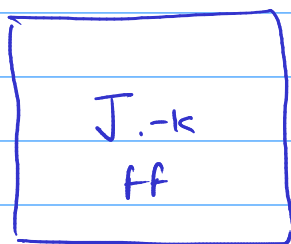




RACE AROUND Condition



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

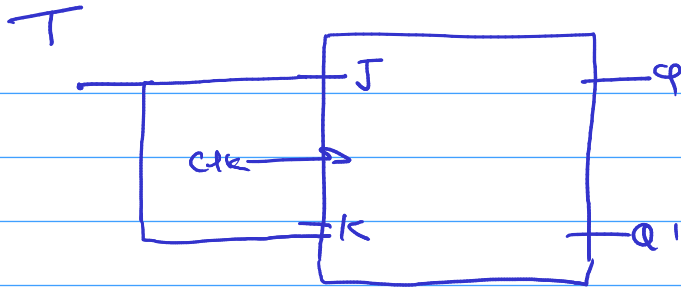


ff

J	K	clk	$Q_{n+1}$
0	0	$\uparrow$	No Change
0	1	$\uparrow$	0 writing '0'
1	0	$\uparrow$	1 writing '1'
1	1	$\uparrow$	$Q_n'$ [toggled]



#



T	J	K	clk	$Q_{n+1}$
<u>0</u>	0	0	↓	No Change
<u>1</u>	1	1	↓	$Q_n'$ [toggled]



## SR flip flop

S	R	clk →	$Q_n$	$Q_{n+1}$
0	0	↓	0	0
0	0	↓	1	1
0	1	↓	0	0
0	1	↓	1	0
1	0	↓	1	1
1	0	↓	0	1
1	1	↓	0	1
1	1	↓	1	1

	$R$			
$\bar{S}$	000	001	011	010
$S$	100	101	111	110

$Q_n$

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

## JK flip flop

J	K	clk →	$Q_n$	$Q_{n+1}$
0	0	↓	0	0
0	0	↓	1	1
0	1	↓	0	0
0	1	↓	1	0
1	0	↓	1	1
1	0	↓	0	1
1	1	↓	0	1
1	1	↓	1	0

	$K$			
$J'$	0	1	0	0
$J$	1	1	0	1

$Q_n$

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

T-flip

$$\Rightarrow Q_{n+1} = T Q_n' + T' Q_n \Rightarrow \boxed{T \oplus Q}$$

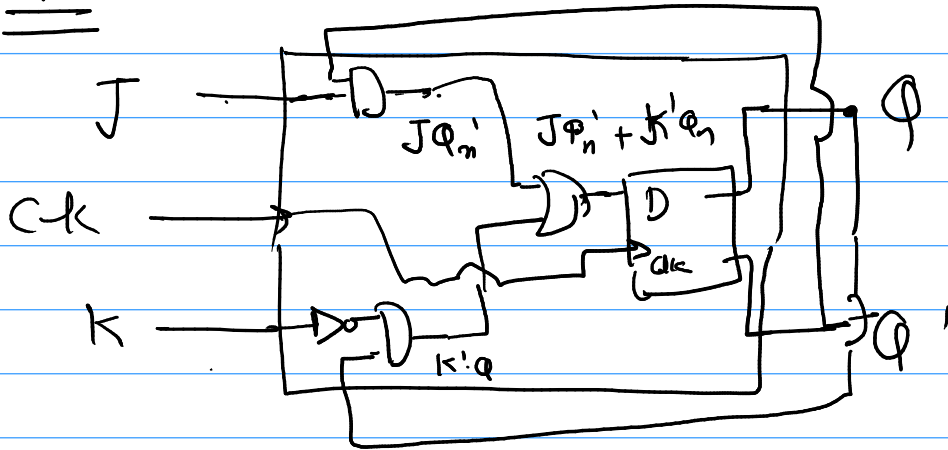
D. ff

$\Rightarrow$

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

#

D. ff

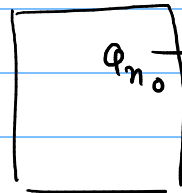
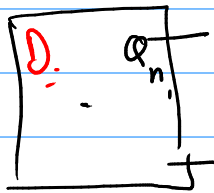
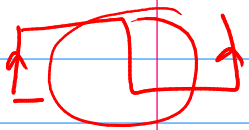


$$Q_{n+1} = JQ_n' + K'Q_n$$

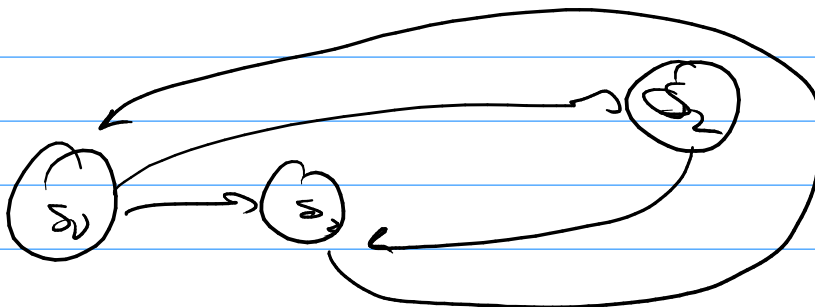
	$Q_n$	$Q_{n+1}$	D.	T
↓	0	→ 0	0	0
↓	0	→ 1	1	1
↓	1	→ 0	0	1
↓	1	→ 1	1	0

	$Q_n$	$Q_{n+1}$	J	K
↓	0	0	0	X
↓	0	1	1	X
↓	1	0	X	1
↓	1	1	X	0

J	K	clk → en	$Q_n$	$Q_{n+1}$
0	0	↓	0	0
0	0	↓	1	1
0	1	↓	0	0
0	1	↓	1	0
1	0	↓	1	1
1	0	↓	0	1
1	1	↓	0	1
1	1	↓	1	0



	$Q_{n+1}$	$Q_{n+0}$
$S_0$	0	0
$S_1$	0	1
$S_2$	1	0
$S_3$	1	1



$\begin{array}{cccc} \downarrow & \downarrow & \downarrow & \downarrow \\ 1 & 1 & 0 & 0 \end{array} \rightarrow \underline{\underline{Yes}} \quad \boxed{X} \checkmark$

Y

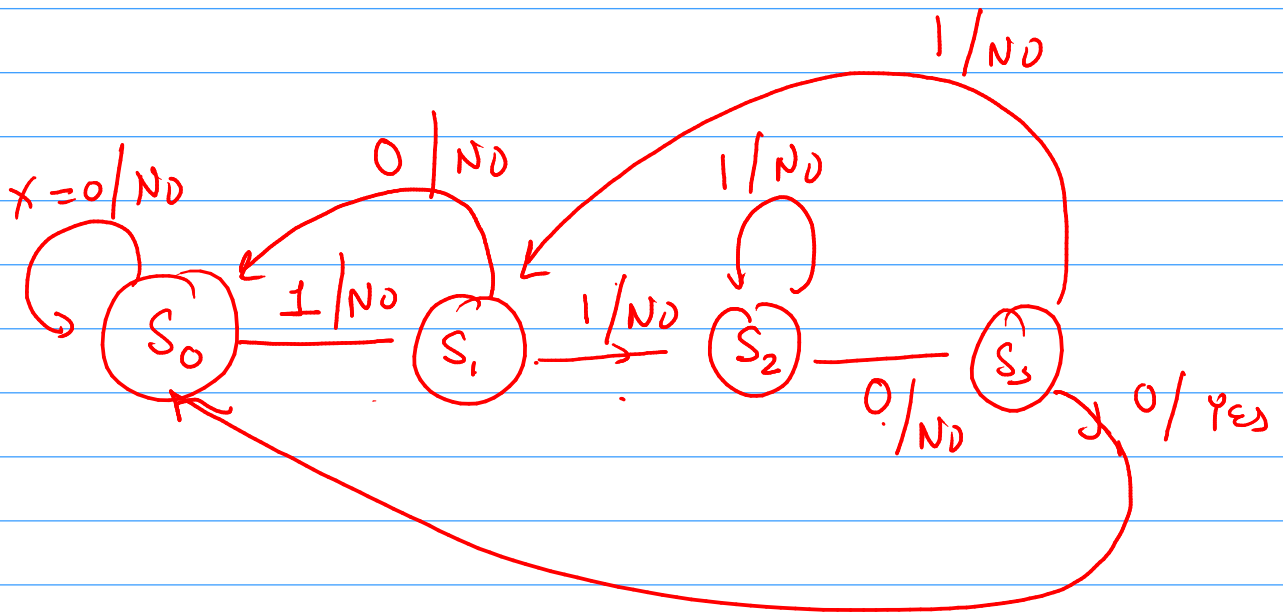
$\rightarrow$   
 $\begin{array}{c} 1 \\ 1 \\ 0 \\ 0 \end{array}$

$X = \begin{array}{c} S_0 \\ 0 \end{array}$  (NOT even began)

00000

$S_1$	$S_2$	$S_3$
1	1 1	1 1 0

$X = 0$



1010

00000000

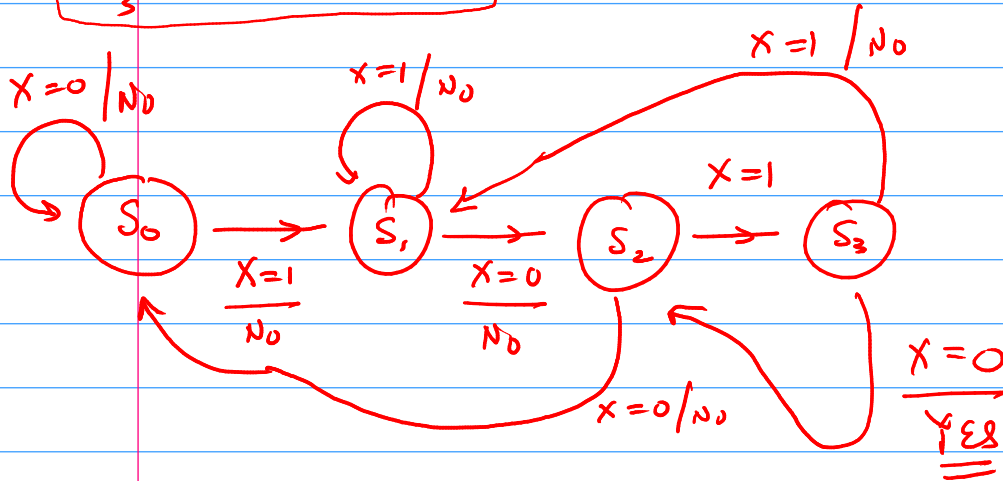
$S_0 \rightarrow \text{Reset} \rightarrow \text{No Part of the sequence}$

$S_1 \rightarrow 1$

$S_2 \rightarrow \underline{10}$

$S_3 \rightarrow \underline{101}$

1011,  
101010  
1



~~1000~~

→ 1111

1011

1011

0100 1's Comp.

+ 1

0101

2's Comp

1	0	1	-3
1	0	0	-2
1	1	1	-1
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3

001 111  
110 001  
110 110  
+ 1  
-1 111



$$\begin{array}{r}
 999 - \\
 000069 \\
 \hline
 \boxed{9}30 \\
 \rightarrow \quad +1 \\
 \hline
 931 \rightarrow
 \end{array}$$

$0 \rightarrow \text{true}$   
 $9 \rightarrow \text{true}$

$-69$

$$\begin{array}{r}
 048 \rightarrow \\
 -032 \\
 \hline
 16
 \end{array}$$

$$\begin{array}{r}
 048 \\
 968 \\
 \hline
 -016
 \end{array}$$

$$\begin{array}{r}
 \begin{array}{ccc}
 0000 & 0100 & 1000 \\
 1001 & 0110 & 1000 \rightarrow
 \end{array} \\
 \hline
 \begin{array}{ccc}
 1010 & 1011 & 0000 \\
 110 & 110 & 110 \\
 \hline
 0000 & 0001 & 0110
 \end{array} \\
 \hline
 \begin{array}{ccc}
 0 & 1 & 6
 \end{array}
 \end{array}$$