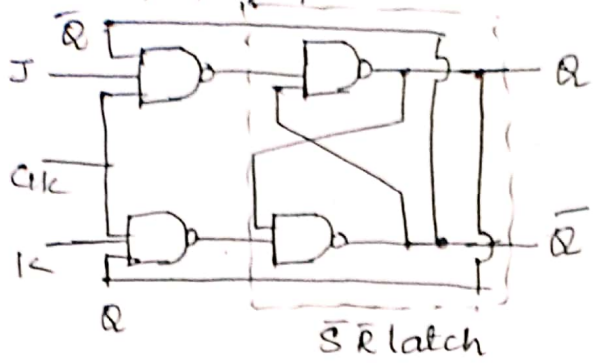
JK flip flop



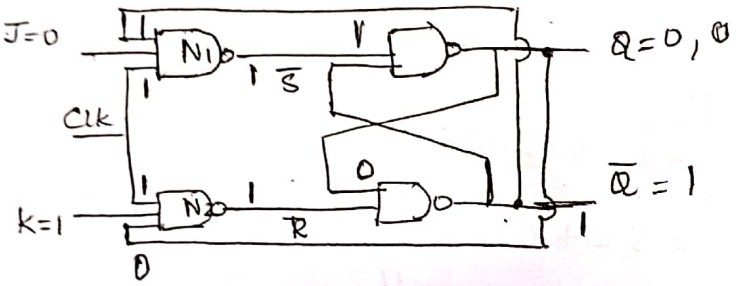
State table of $\bar{S}\bar{R}$ Latch.

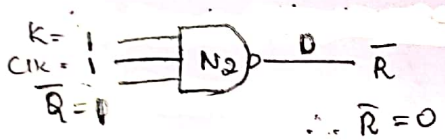
$\bar{S}$	$\bar{R}$	Q	$\bar{Q}$	
0	0	1*	1*	invalid / not used.
0	1	1	0	
1	0	0	1	
1	1	Q	$\bar{Q}$	memory / NC.

Case 1 :- When ~~J = 0, K = 0~~ Clk = 0 ; When clk = 0, the flip flop retains its previous output irrespective of the i/p values at J and K.

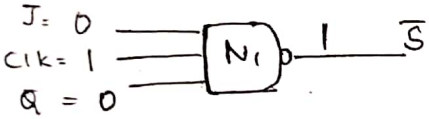
Case 2 :- When Clk = 1, J = 0, K = 1 let Q = 0

a) let Q = 0.





$\therefore \bar{R} = 0$

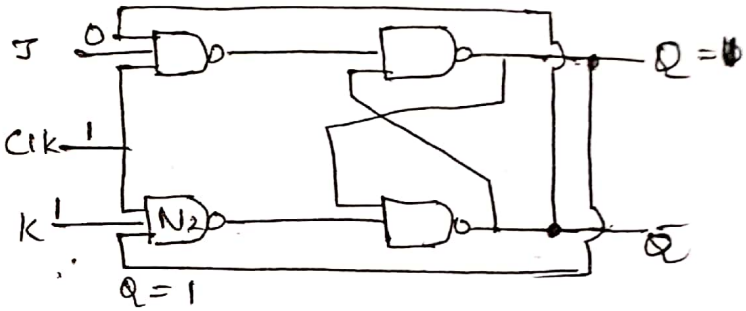


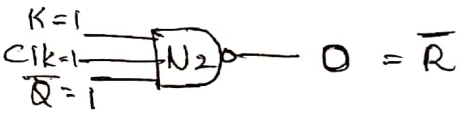
$\bar{S} = 1$

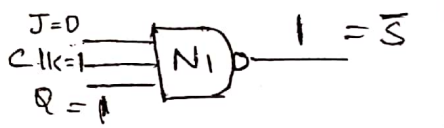
$\therefore \bar{S}\bar{R} = 1, 0$

$\therefore$ from $\bar{S}\bar{R}$ latch state table $Q_{t+1} = 0$, $\bar{Q}_{t+1} = 1$

b) let Q = 1







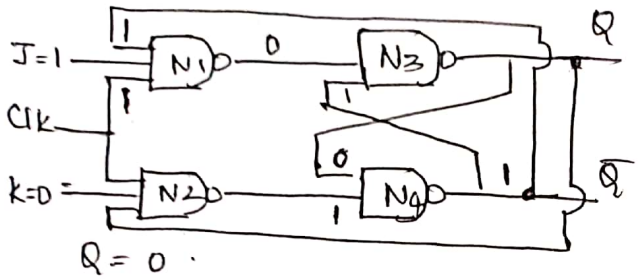
[o/p of NAND = 1 if any one i/p = 0]

$\therefore \bar{S}, \bar{R} = 1, 0$

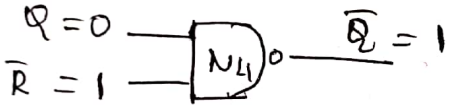
hence from state table of $\bar{S}\bar{R}$ latch $Q_{t+1} = 0$, $\bar{Q}_{t+1} = 1$

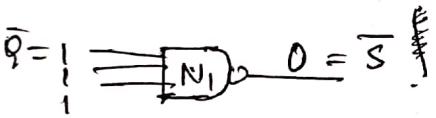
Case 2:- When J=1, K=0 and Clk = 1

a) Q = 0.



[∵ o/p of NAND = 1 if any one i/p = 0]





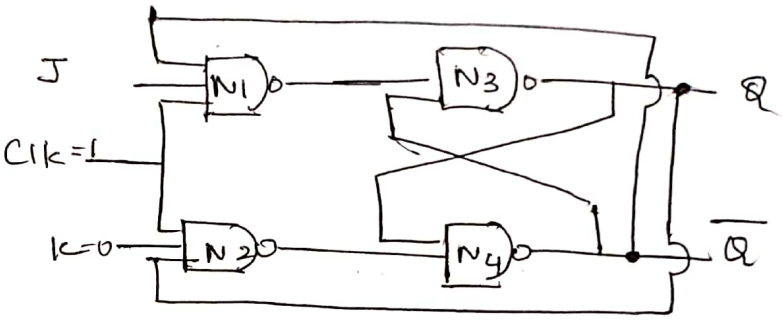
∴ $\bar{S}$ = 0 and $\bar{R}$ = 1

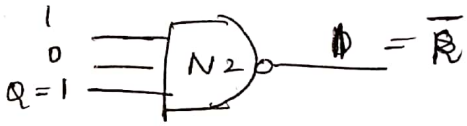
from $\bar{S}$ $\bar{R}$ latch o/p

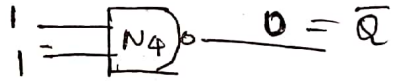
Q = 1

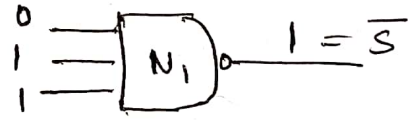
$\bar{Q}$ = 0

b) Q = 1









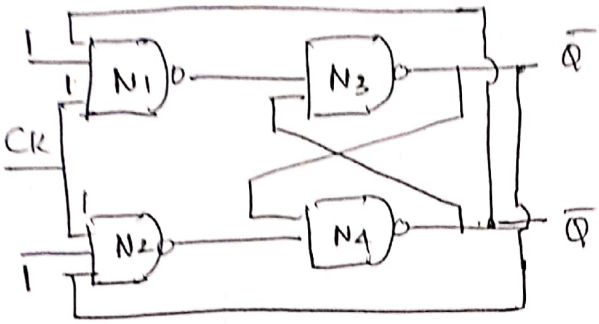
∴ $\bar{S}$ = 1, $\bar{R}$ = 0 from $\bar{S}$ $\bar{R}$ latch o/p Q = 1 and $\bar{Q}$ = 0.

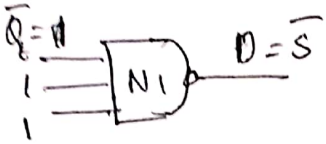
∴ when J = 1, K = 0 ⇒ Q_{t+1} = 1 $\overline{Q_{t+1}}$ = 0.

Case 3

$J = 1, K = 1$ Clk = ↓

assume $Q = 0$ and $\bar{Q} = 1$

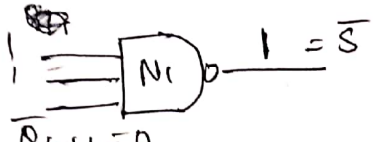




$\therefore \bar{S} = 0 \quad \bar{R} = 1$

$\therefore Q_{t+1} = 1$

$\bar{Q}_{t+1} = 0$



$\therefore \bar{S} = 0 \quad \bar{R} = 0$

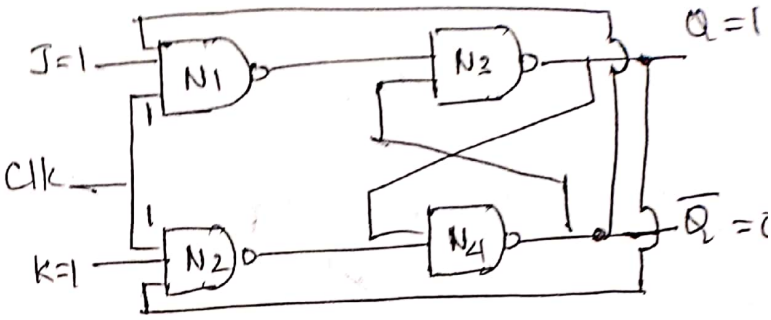
$\therefore Q_{t+2} = 0 \quad \bar{Q}_{t+2} = 1$

$\therefore$ the o/p switches as follow

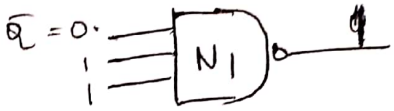
$Q_{t+1} = 1\ 0\ 1\ 0 \cdots$

$\bar{Q}_{t+1} = 0\ 1\ 0\ 1 \cdots$

assume $Q = 1$ and $\bar{Q} = 0$

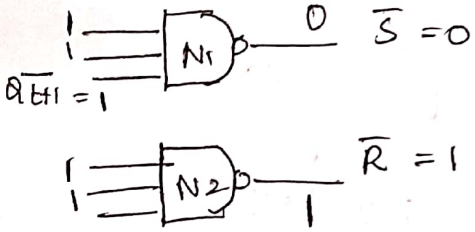


$Q_t = 1$ and $\bar{Q}_t = 0$.



$\therefore \bar{S} = 1, \quad \bar{R} = 0 \quad Q_{t+1} = 0$

$\bar{Q}_{t+1} = 1$



$\therefore \bar{S}\ \bar{R} = 0\ 1$

$\Rightarrow Q_{t+2} = 1, \quad \bar{Q}_{t+2} = 0$

$\therefore$ the o/p switches as follows

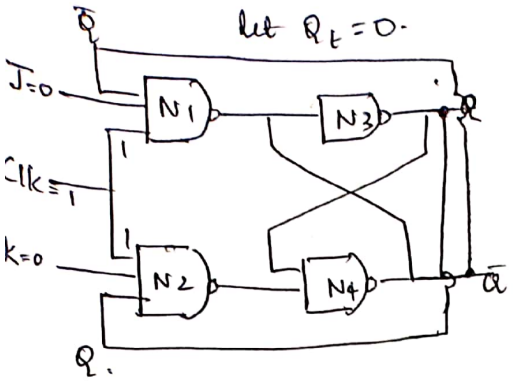
$Q_{t+1} = 0\ 1\ 0\ 1 \ldots$

$\bar{Q}_{t+1} = 1\ 0\ 1\ 0 \ldots$

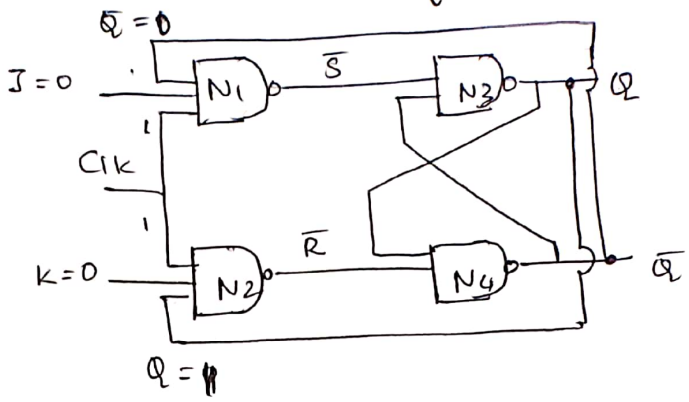
$\therefore$ for the condition $J = 1, K = 1$, Clk = ↓ Q_{t+1} and $\bar{Q}_{t+1}$ switches alternately bhw 0 & 1, This state is known as toggle.

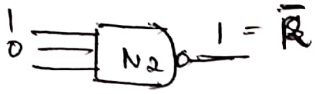
Case 4:- When J=0, K=0 and Clk=1.

let $Q_t = 0$

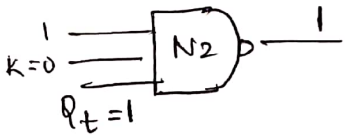


let $Q_t = 1$

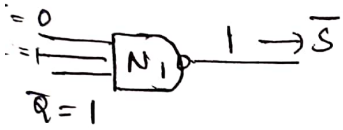




$Q = 0$



$\bar{R} = 1$



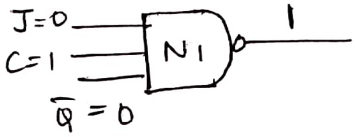
$\bar{S} = 1$

$\therefore \bar{S}\bar{R} = 11$

from state table of $\bar{S}\bar{R}$ latch

$\bar{Q}_{t+1} = \bar{Q}_t$ NC

$Q_{t+1} = Q_t$ NC



$\therefore \bar{S}\bar{R} = 11$

from state table of $\bar{S}\bar{R}$ latch

$Q_{t+1} = Q_t$ NC

$\bar{Q}_{t+1} = \bar{Q}_t$ NC.

The above state is known as memory or no change.

State transition table of JK flip flop

Clk	J	K	Q_t	Q_{t+1}	$\bar{Q}_{t+1}$	
x	•	–	–	Q_t	$\bar{Q}_t$	→ Memory / NC.
↑	0	0	0	NC	NC	memory.
			1	NC	NC	
↑	0	1	0	0	1	
			1	0	1	
↑	1	0	0	1	0	
			1	1	0	
↑	1	1	0	Toggle state.		
			1			