

Sequential Circuit



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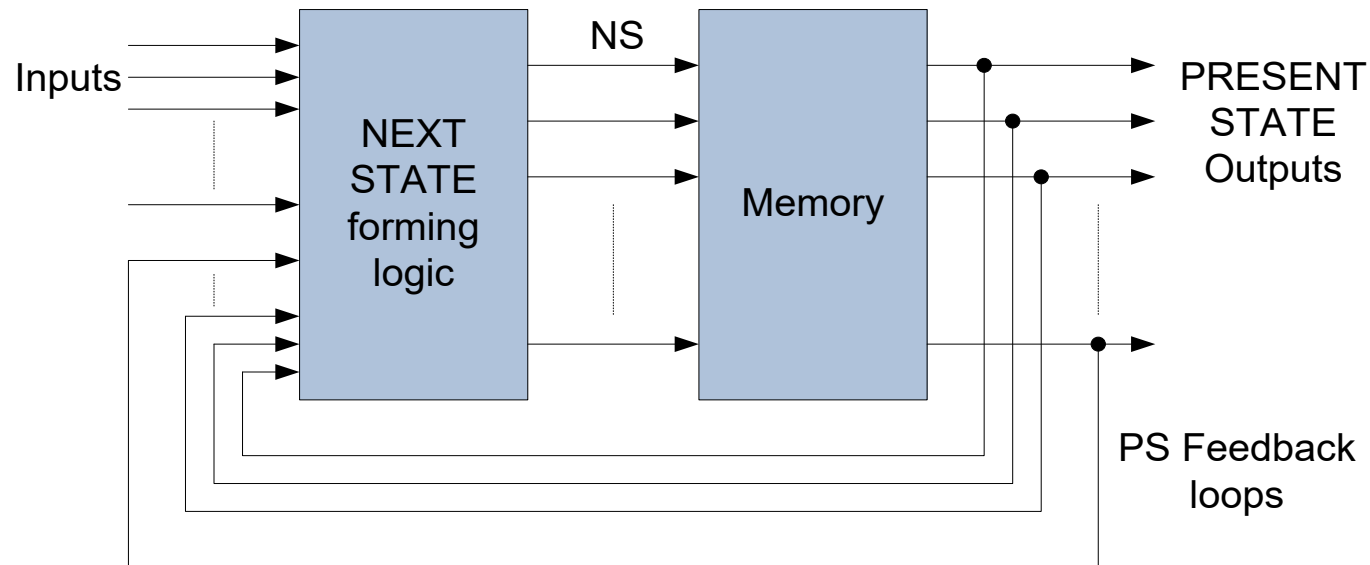
TE.141323 Rangkaian Digital

Teknik Multimedia dan Jaringan, Teknik Elektro

FTI - ITS

Sequential Circuit

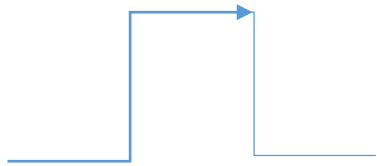
Type of Digital circuit which the output is produced depended on input combination at the certain time and the output at the previous time.



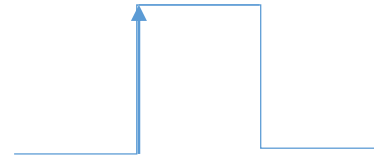
Basic Memory Cell

- SR Flip Flop
- JK Flip Flop
- D Flip Flop
- T Flip Flop

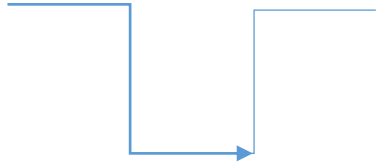
Clock Pulse Triggered



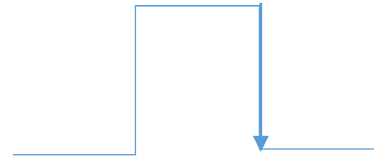
Positive Pulse Triggered



Positive Edge Pulse Triggered (Rising Edge)



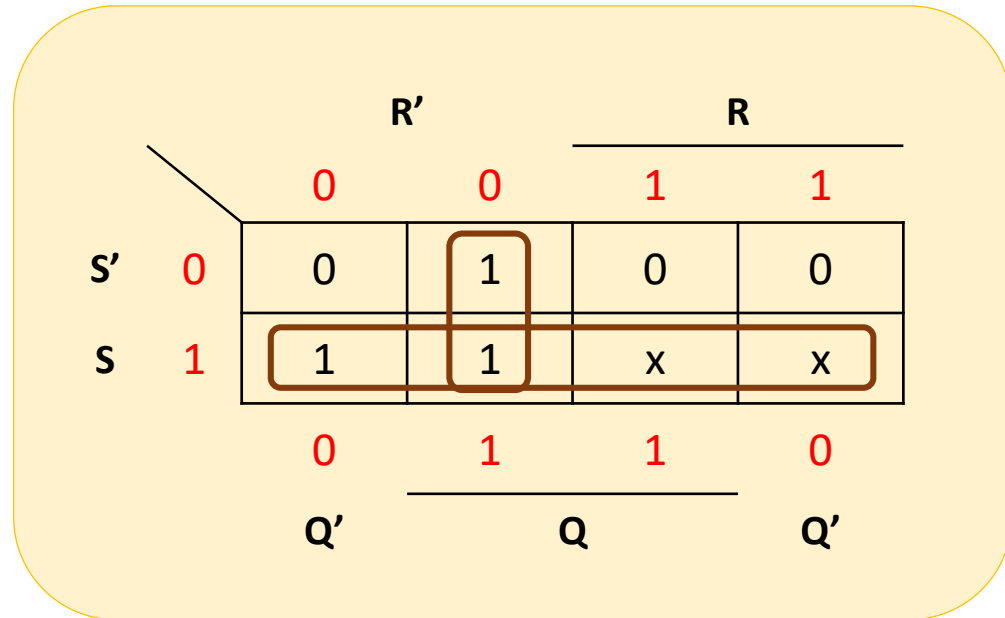
Negative Pulse Triggered



Negative Edge Pulse Triggered (Falling Edge)

Set Reset Flip Flop

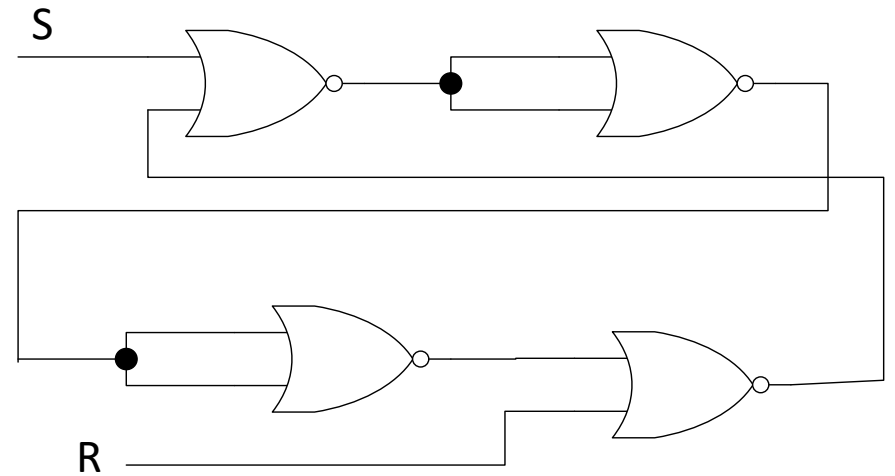
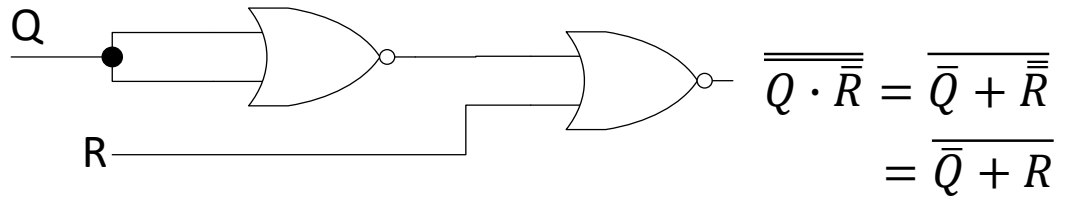
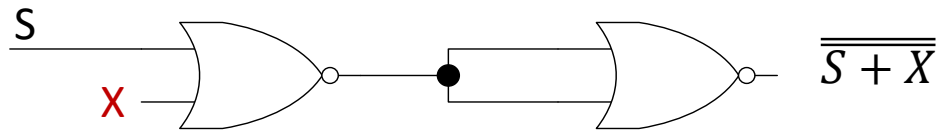
S	R	$Q(t)$	$Q(t+1)$
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	X
1	1	1	X



$$Q(t + 1) = S + \bar{R}Q$$

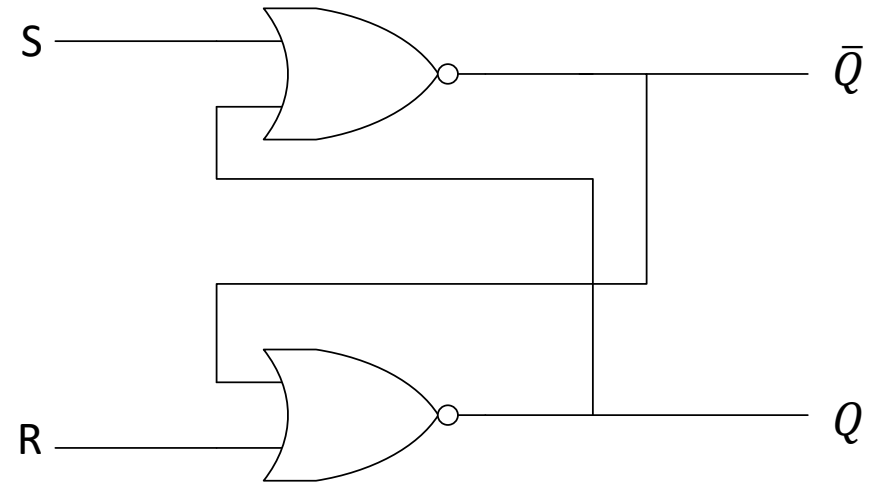
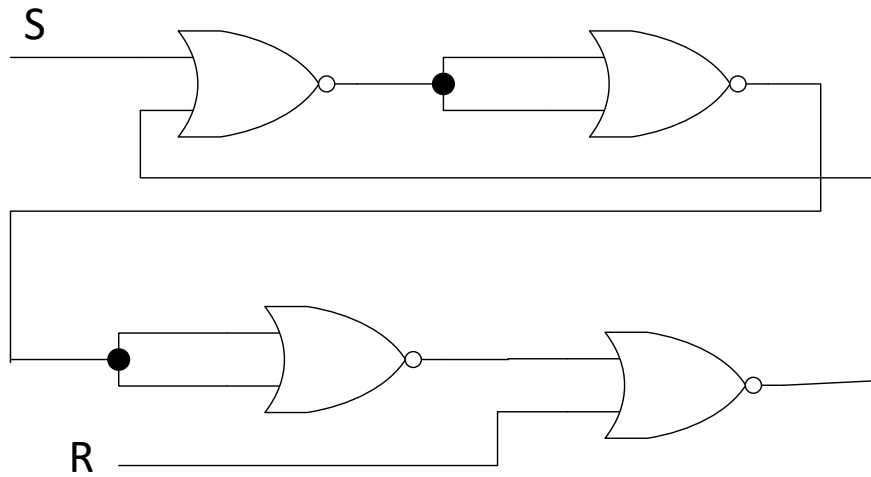
Set Reset Flip Flop

$$Q(t + 1) = S + \bar{R}Q$$



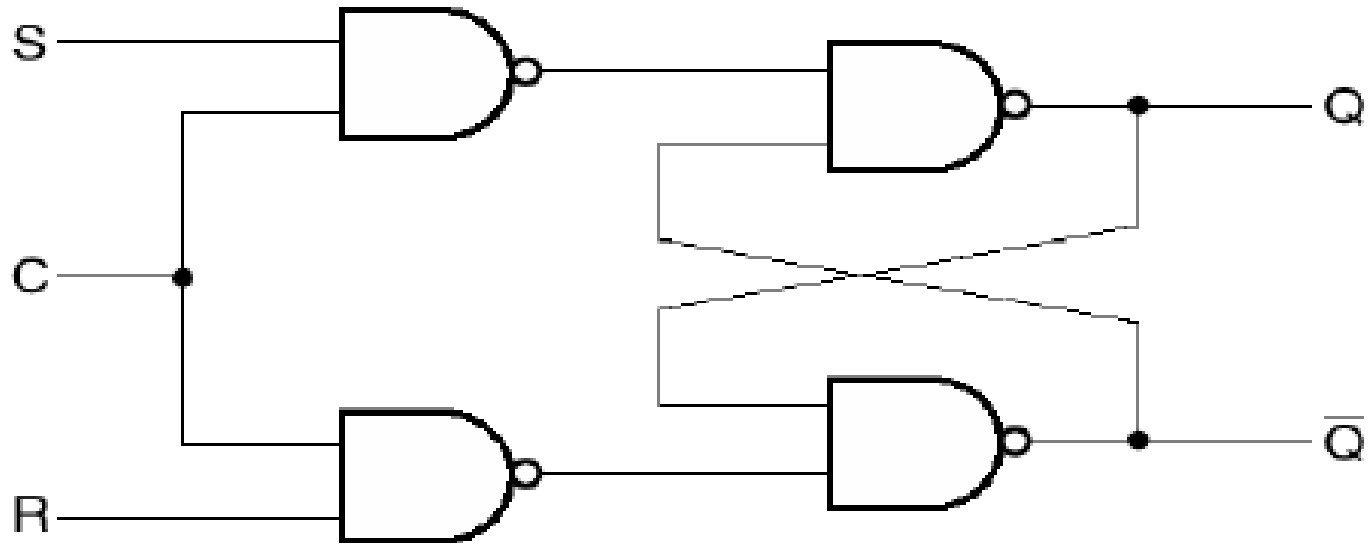
Set Reset Flip Flop

$$Q(t + 1) = S + \bar{R}Q$$



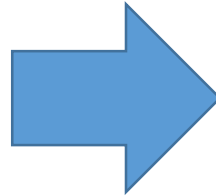
Set Reset Flip Flop

$$Q(t + 1) = S + \bar{R}Q$$



Set Reset Flip Flop Transition Table

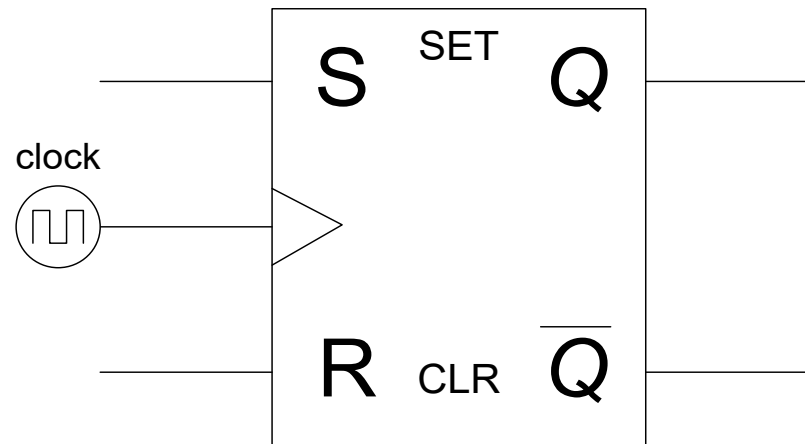
S	R	$Q(t)$	$Q(t+1)$
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	X
1	1	1	X



Q	$Q(t+1)$	S	R
0	0	0	X
0	1	1	0
1	0	0	1
1	1	X	0

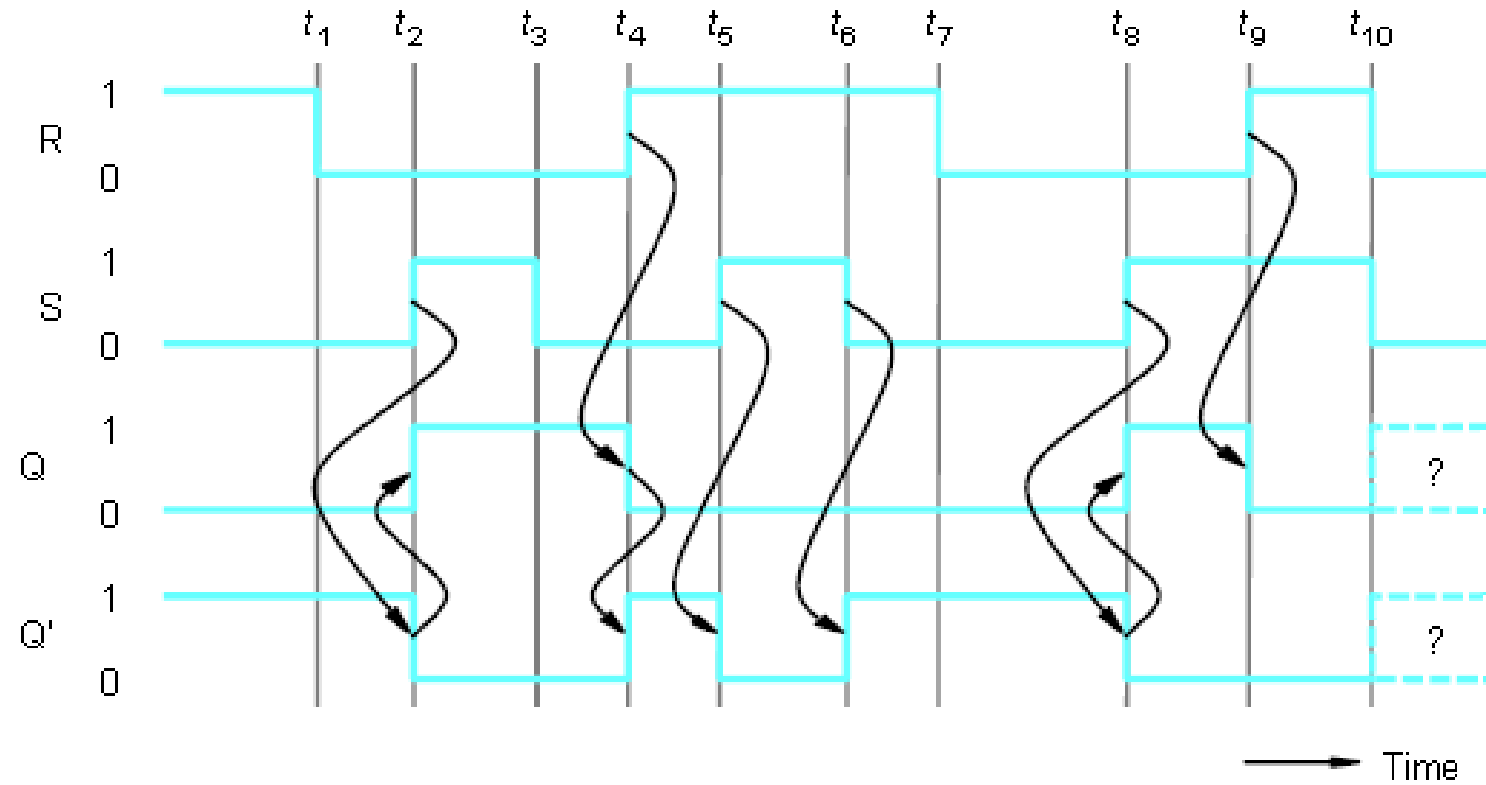
Set Reset Flip Flop

$$Q(t + 1) = S + \bar{R}Q$$



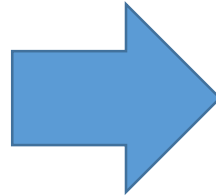
Set Reset Flip Flop

$$Q(t+1) = S + \bar{R}Q$$



JK Flip Flop Transition Table

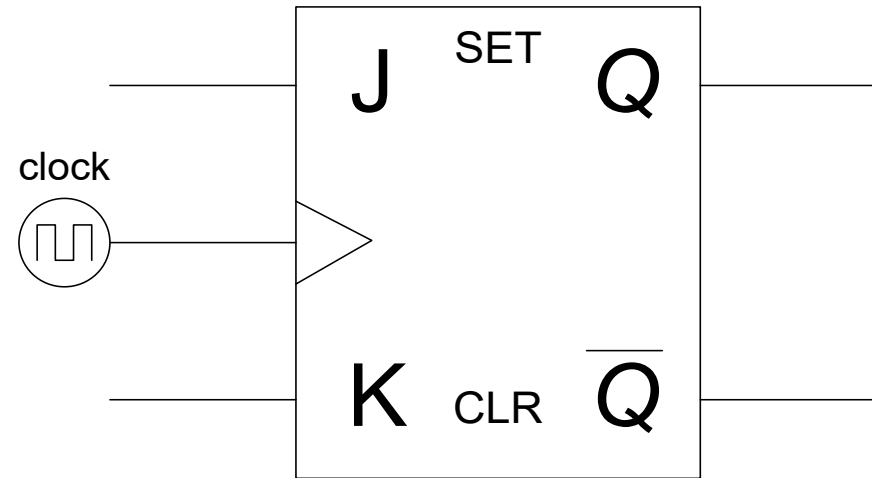
J	K	$Q(t)$	$Q(t+1)$
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0



Q	$Q(t+1)$	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

$$Q(t + 1) = J \cdot \overline{Q(t)} + \bar{K} \cdot Q(t)$$

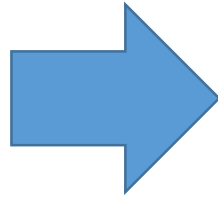
JK Flip Flop



$$Q(t + 1) = J \cdot \overline{Q(t)} + \overline{K} \cdot Q(t)$$

D Flip Flop Transition Table

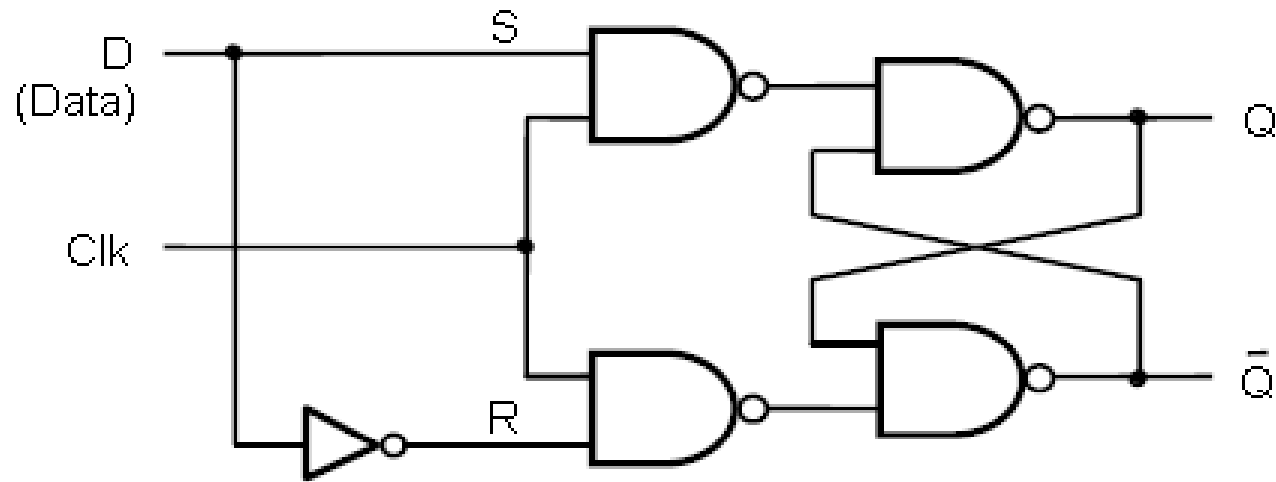
D	$Q(t)$	$Q(t+1)$
0	0	0
0	1	0
1	0	1
1	1	1



Q	$Q(t+1)$	D
0	0	0
0	1	1
1	0	0
1	1	1

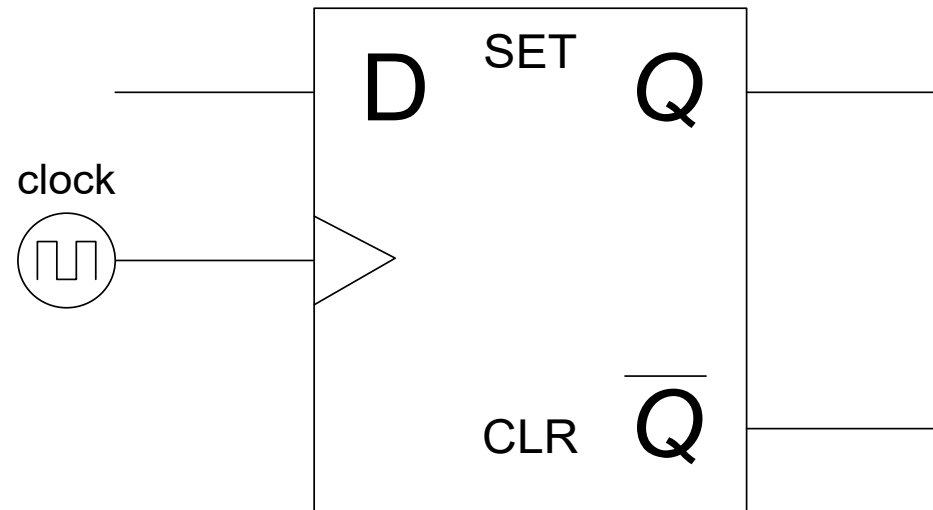
$$Q(t + 1) = D(t)$$

D Flip Flop



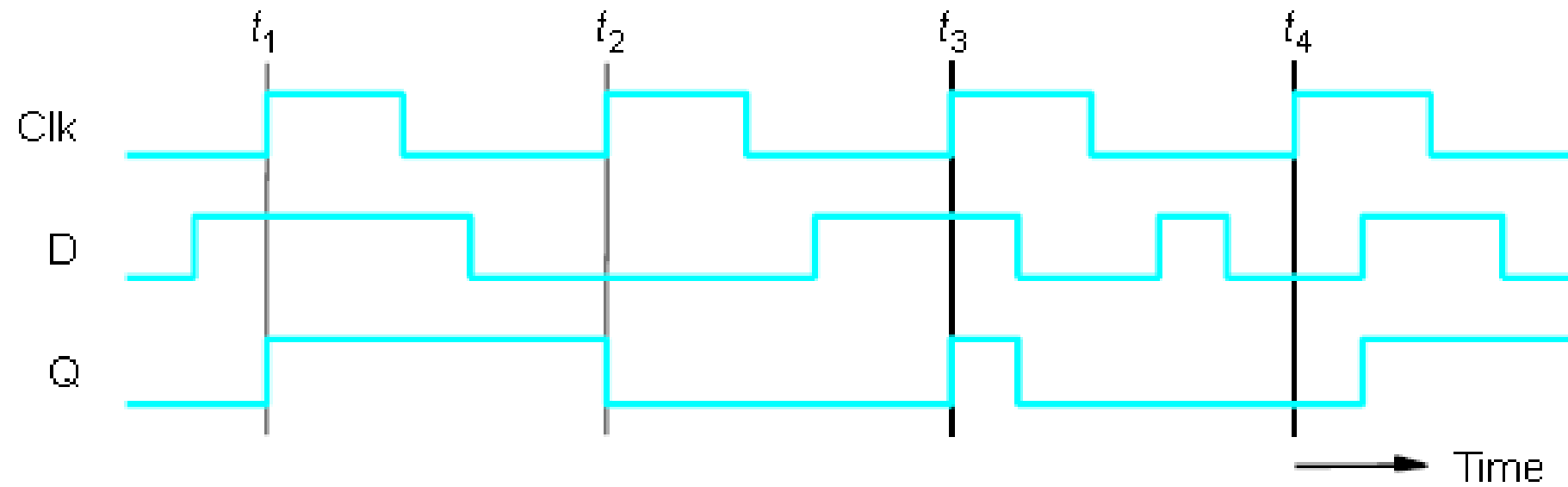
$$Q(t + 1) = D(t)$$

D Flip Flop



$$Q(t + 1) = D(t)$$

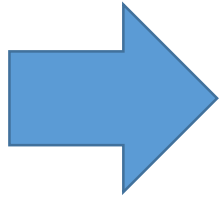
D Flip Flop



$$Q(t + 1) = D(t)$$

T Flip Flop Transition Table

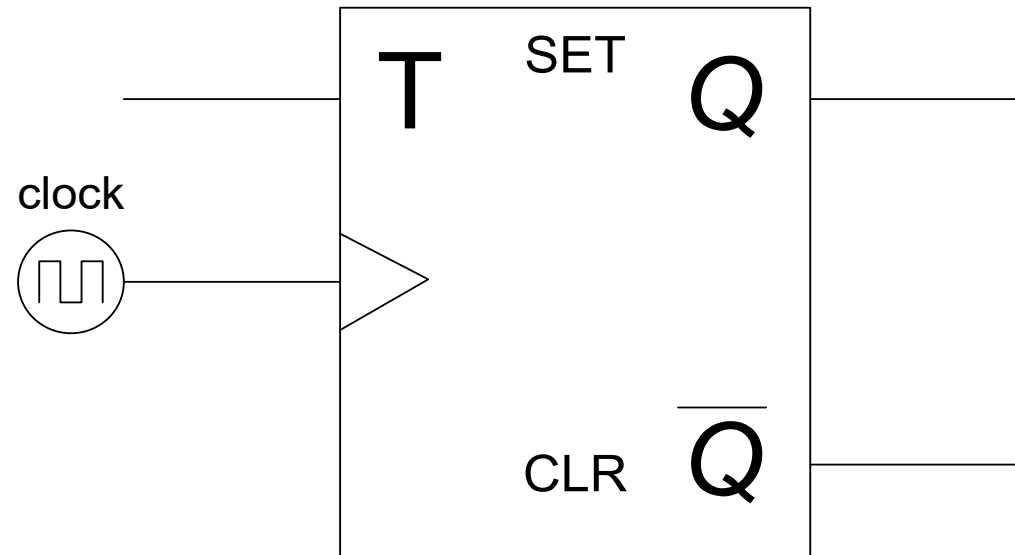
T	$Q(t)$	$Q(t+1)$
0	0	0
0	1	1
1	0	1
1	1	0



Q	$Q(t+1)$	T
0	0	0
0	1	1
1	0	1
1	1	0

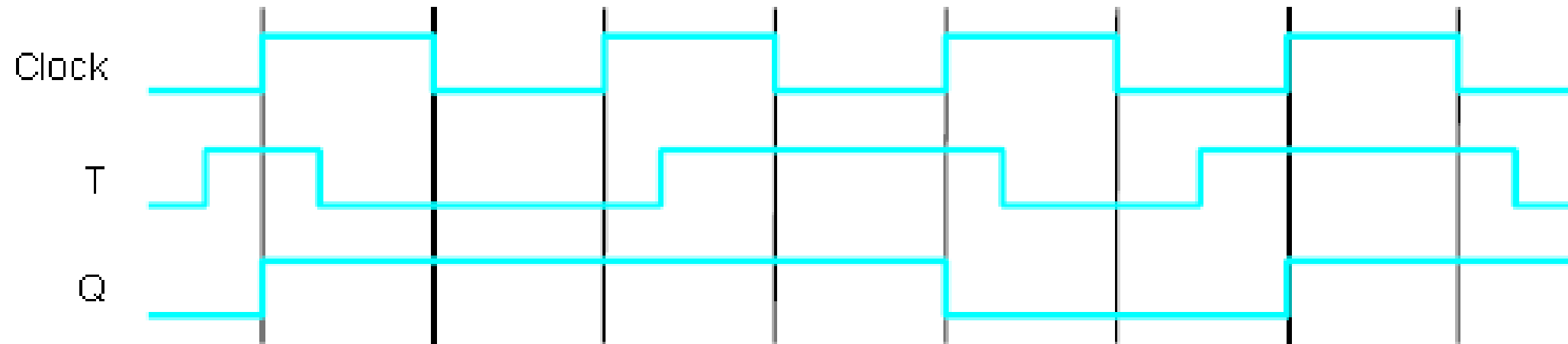
$$Q(t + 1) = \bar{T} \cdot Q(t) + T \cdot \overline{Q(t)}$$

T Flip Flop



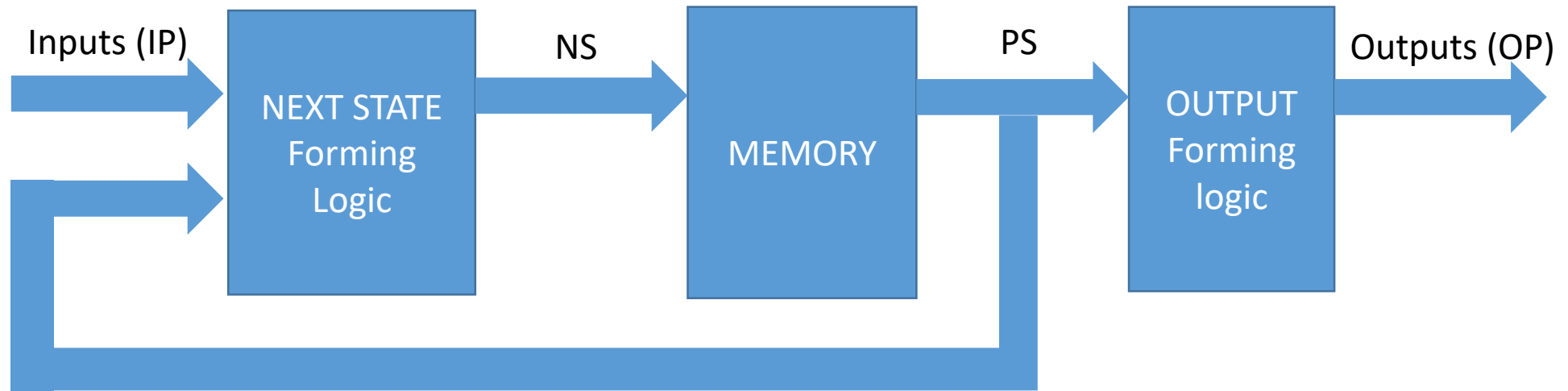
$$Q(t + 1) = \overline{T} \cdot Q(t) + T \cdot \overline{Q(t)}$$

T Flip Flop



$$Q(t + 1) = \bar{T} \cdot Q(t) + T \cdot \overline{Q(t)}$$

Moore Machine/Model

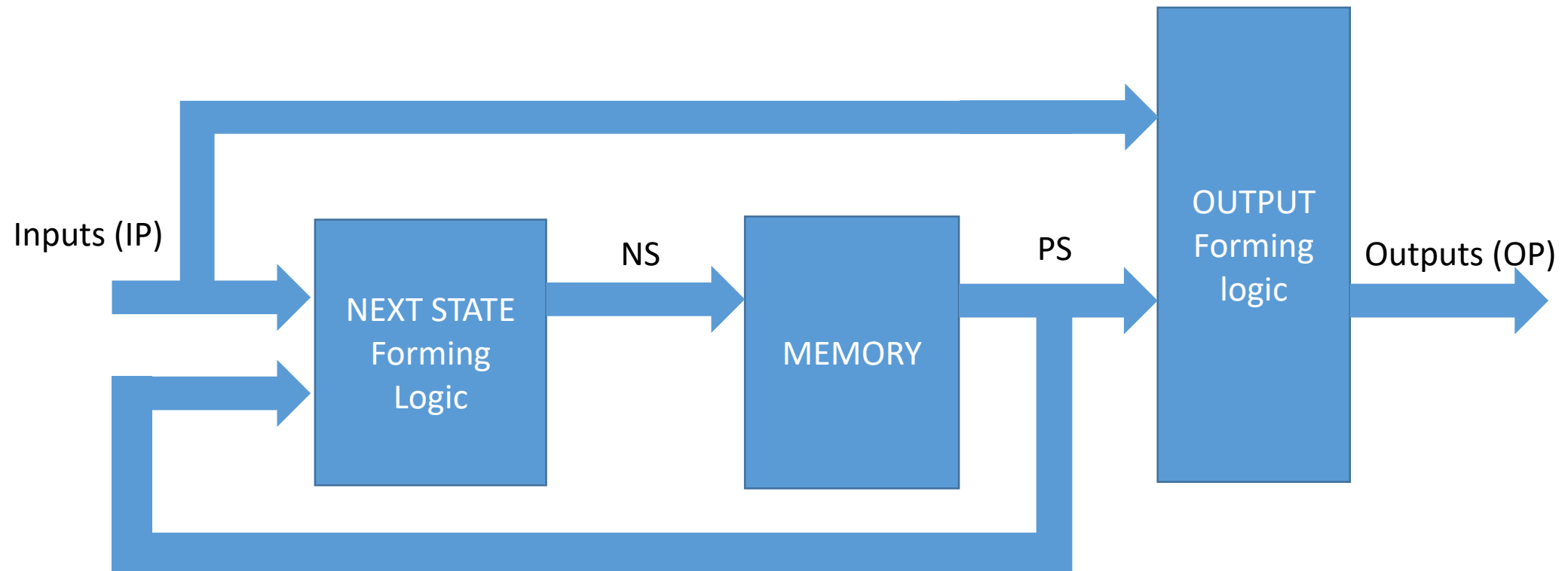


$$PS = f(NS)$$

$$NS = g(PS, IP)$$

$$OP = h(PS)$$

Mealy Machine/Model



$$PS = f(NS)$$

$$NS = g(PS, IP)$$

$$OP = h(PS, IP)$$

Finite State Machine (FSM)

