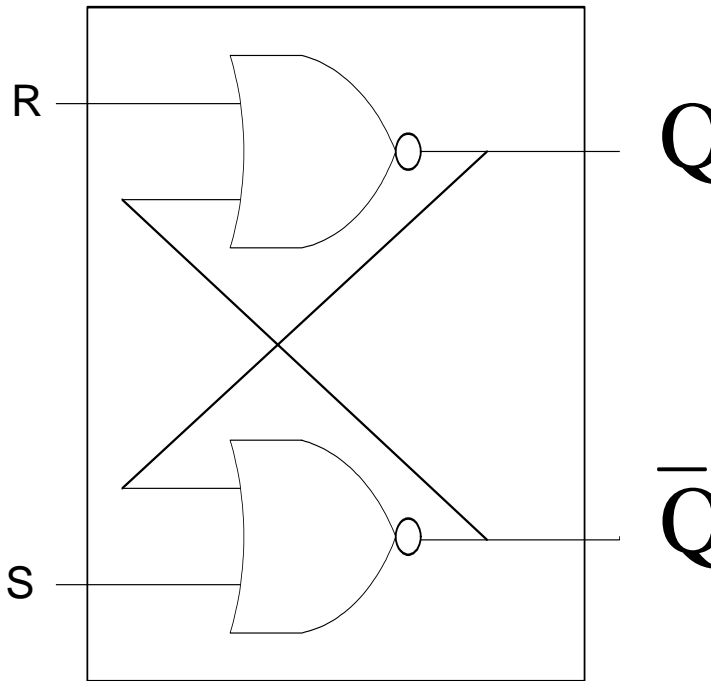


RS Latch

$$Q_+ = S + R' Q$$

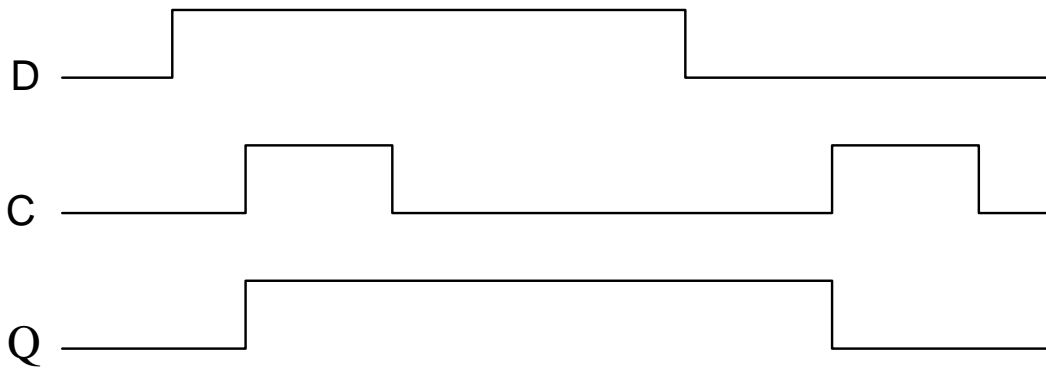
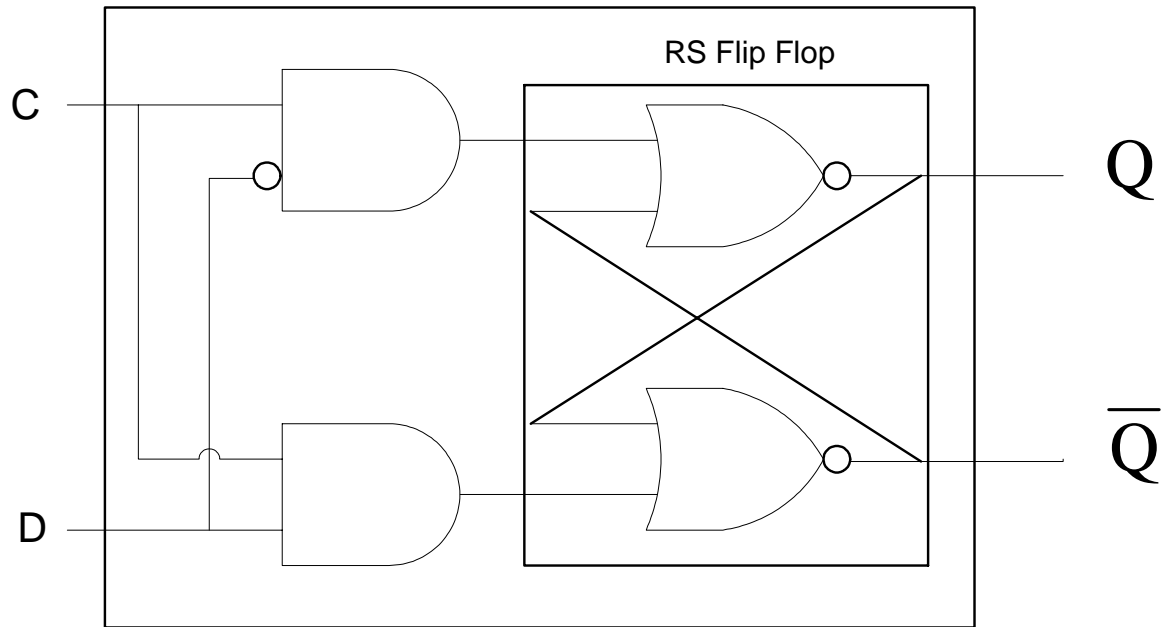


R	S	Q_{t+1}
0	0	\bar{q}_t
0	1	1
1	0	0
1	1	—

Two Problems:

R=S= 1 Not allowed, Data is transparent

The D Latch

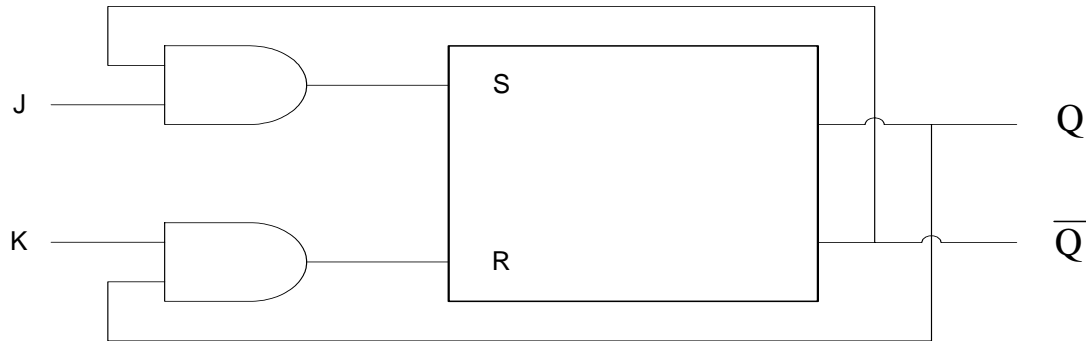


Problem: Level sensitive

JK Latch : Universal, Level sensitive,

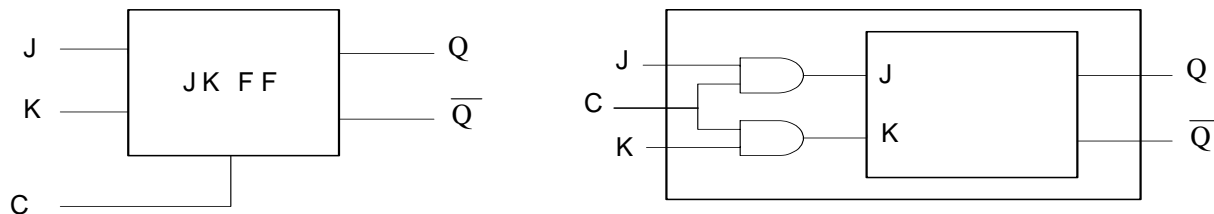
Timing Constraints due to feed back.

JK Flip Flop:



$$Q_{t+1} = J \overline{Q}_t + \overline{K} Q_t$$

JK Flip Flop with a rising-edge :

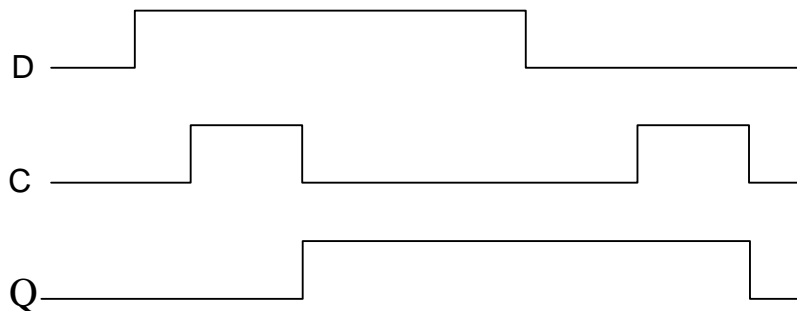
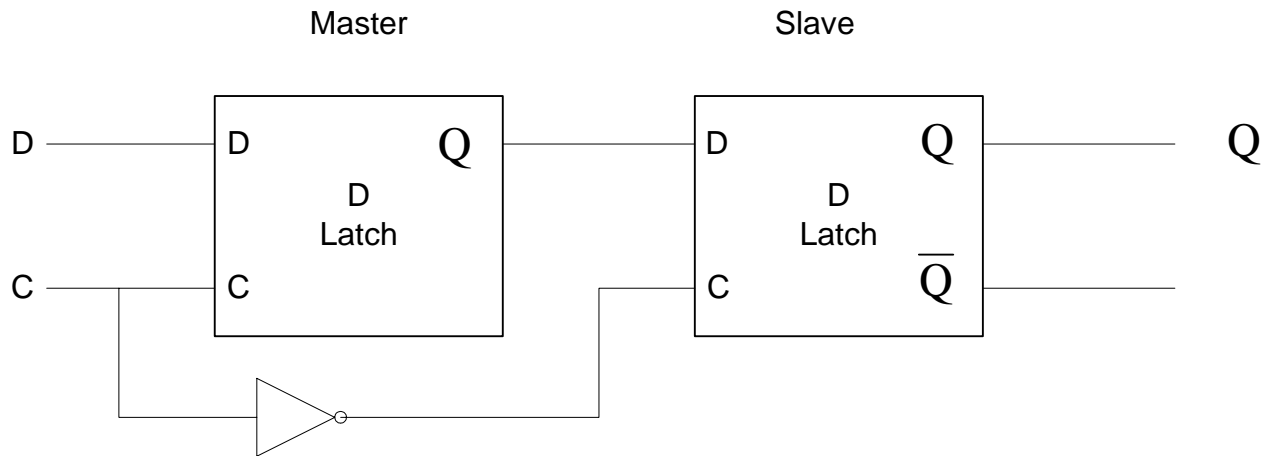


Master Slave Flip Flop

Edge sensitive, Set up and Hold time

Master and Slave Flip Flop :

A D Flip Flop with a falling-edge trigger.



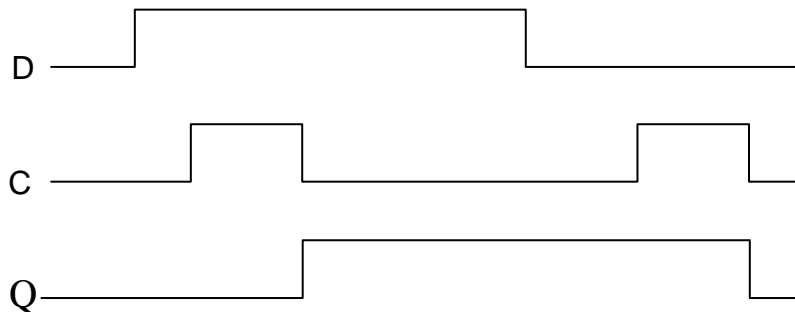
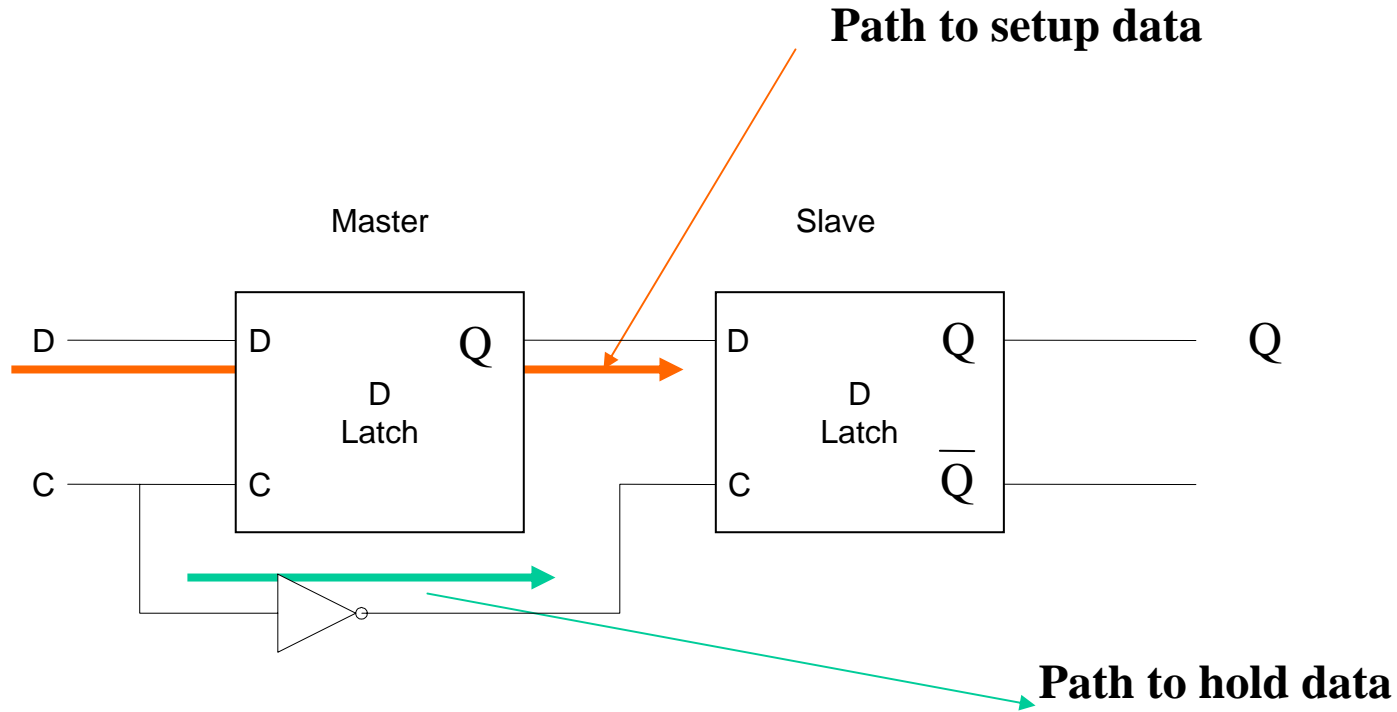
Master Slave Flip Flop Edge sensitive,-Falling Edge

Set Up and Hold Time constraints

Concordia

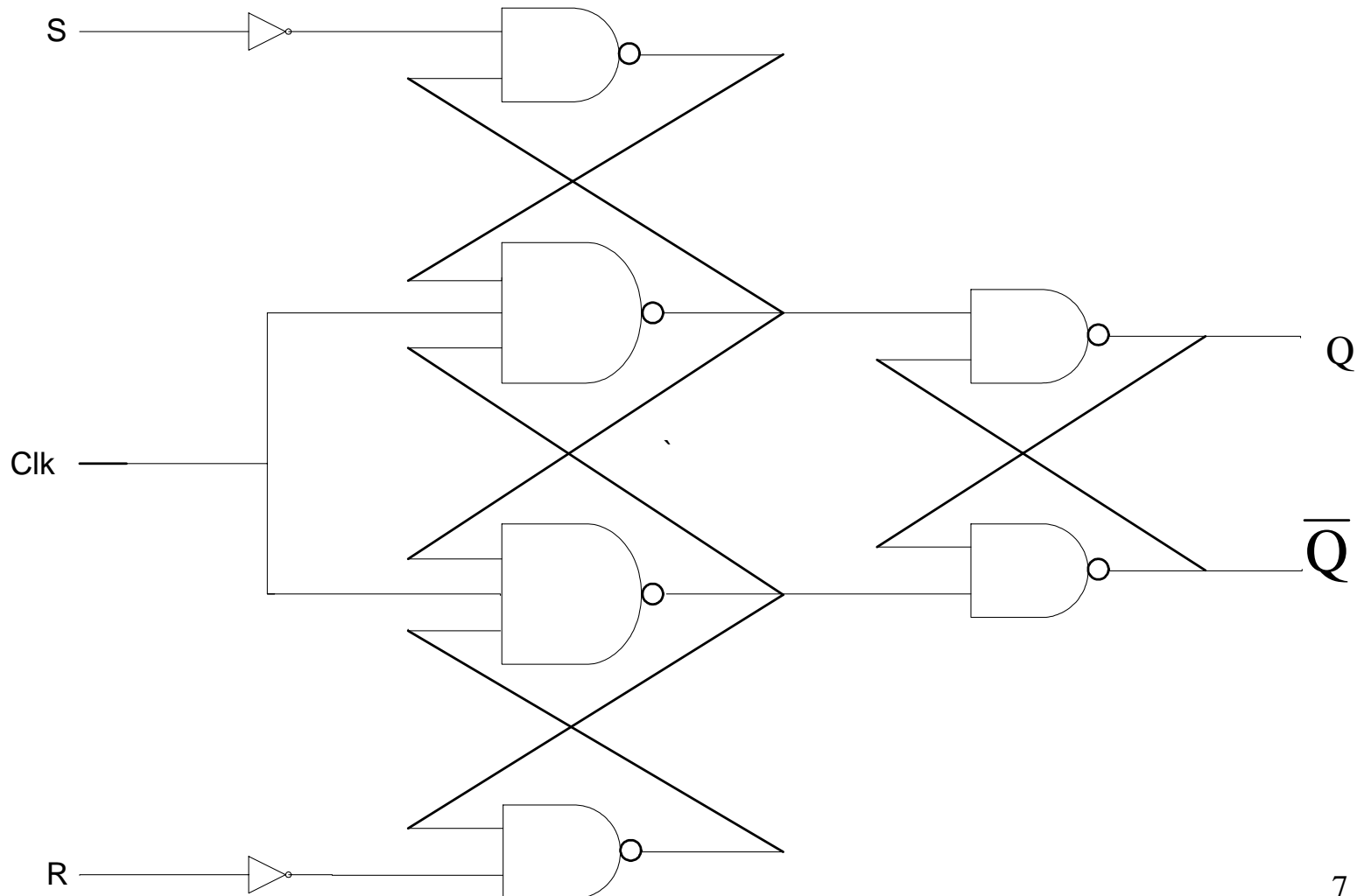


University

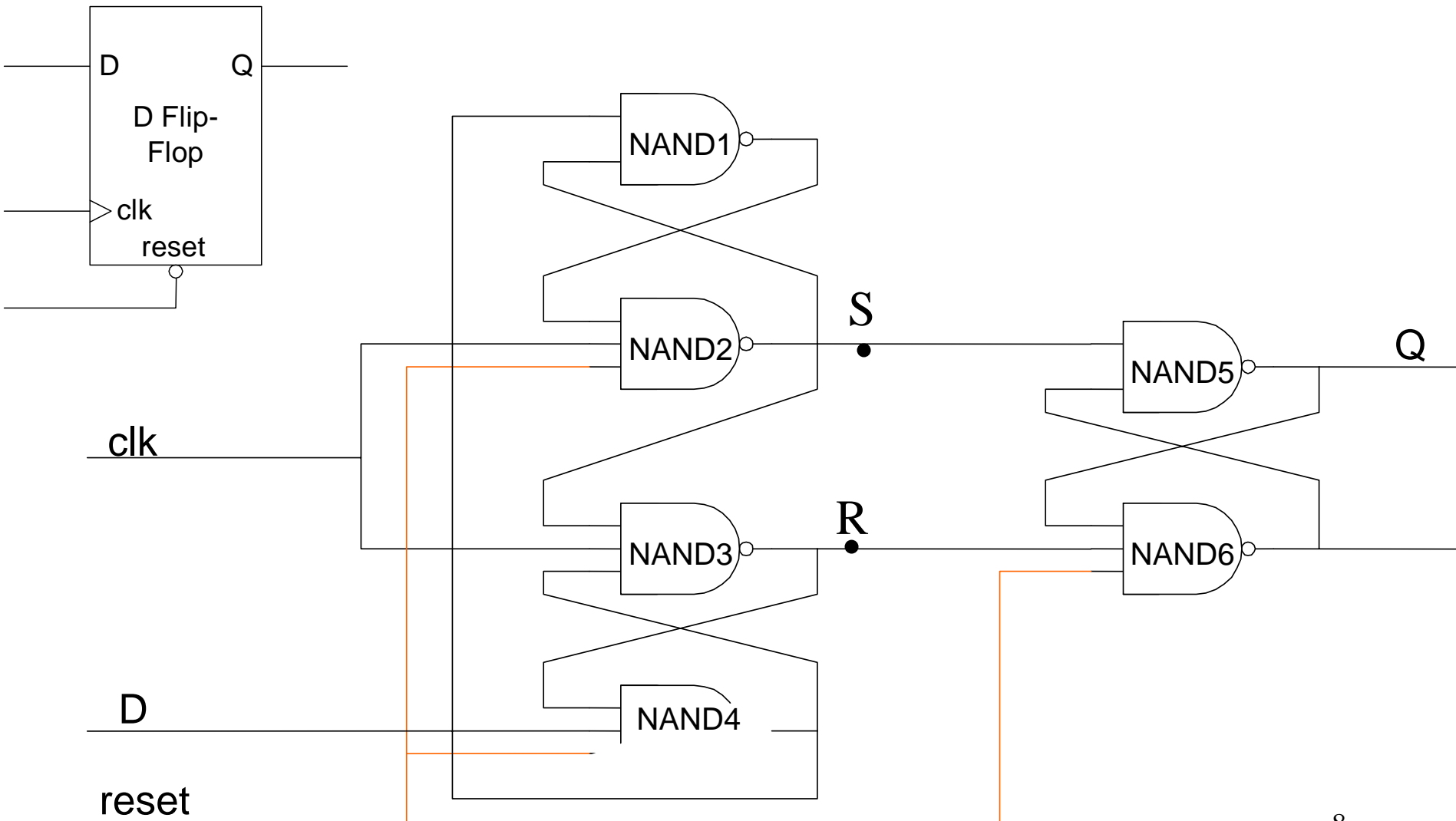


Edge triggered Flip Flop:

Set up and Hold time Constraints



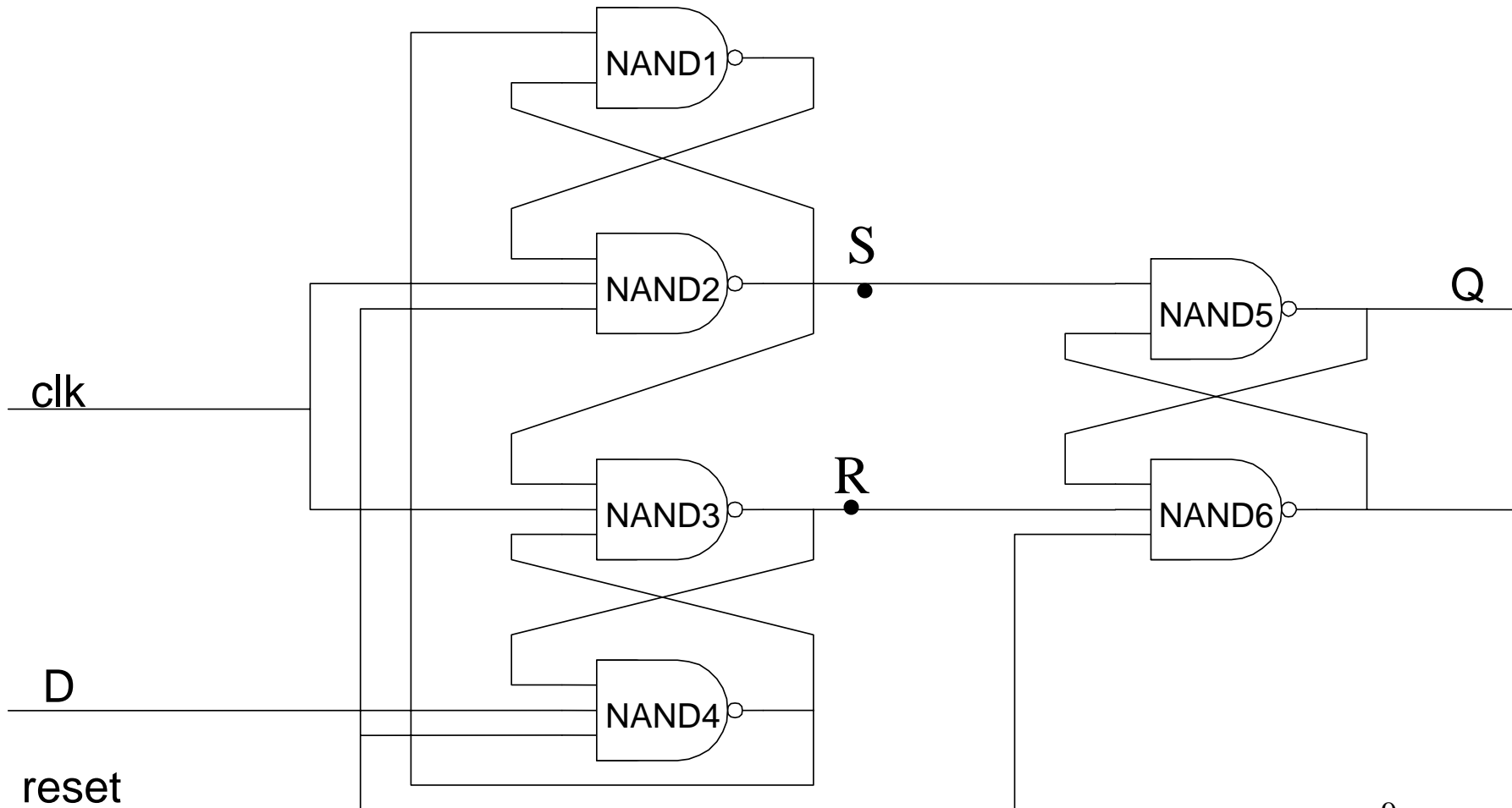
Edge Triggered, D Flip Flop



When CLK changes from 0 to 1

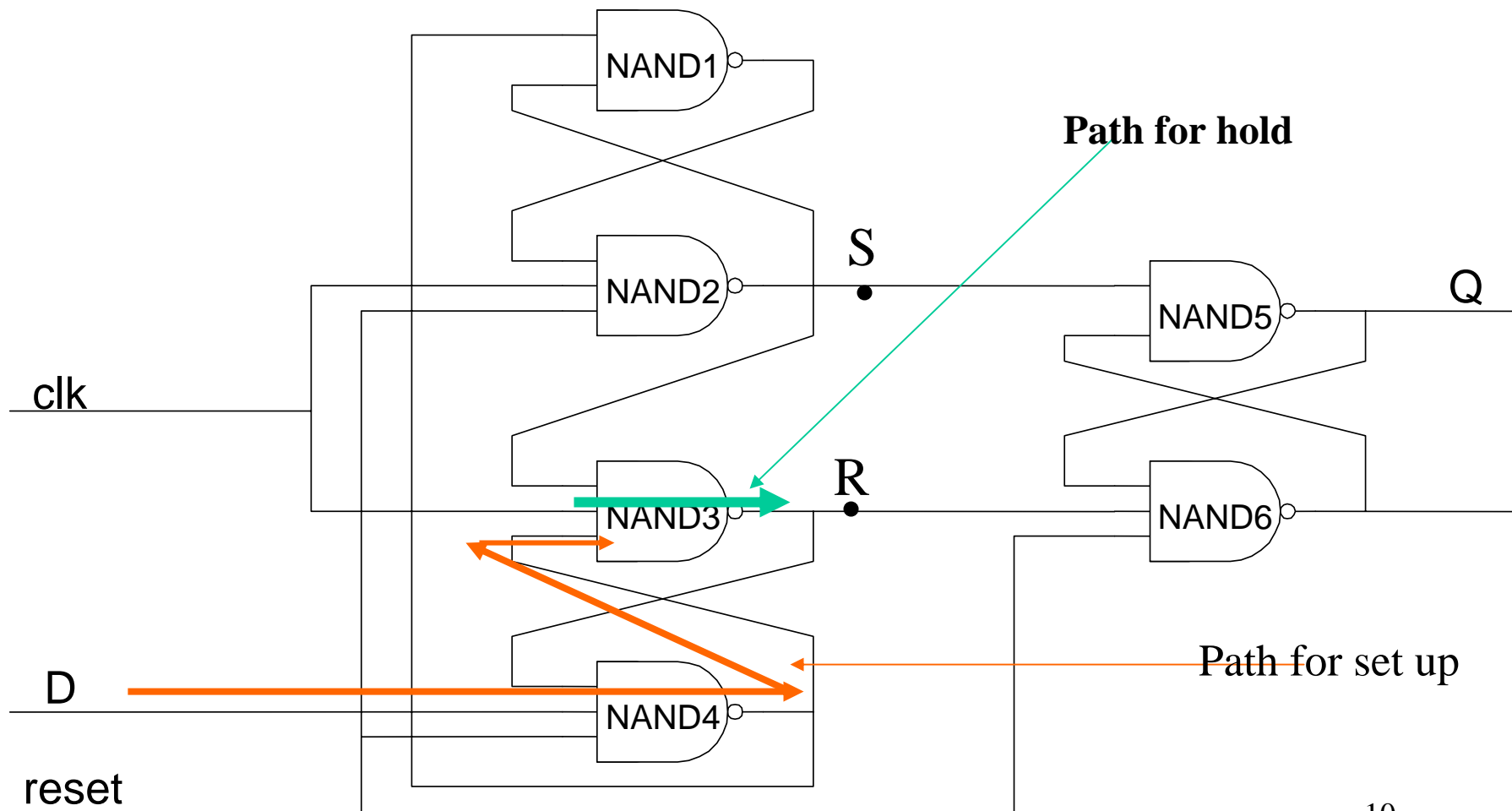
Case1, D=0: $t_{\text{setup}} = t_4$, $t_{\text{hold}} = t_3$

Case2, D=1 $t_{\text{setup}} = t_4 + t_1$ $t_{\text{hold}} = t_2$



When CLK changes from 0 to 1

Case1, D=0: $t_{\text{setup}} = t_4$, $t_{\text{hold}} = t_3$



When CLK changes from 0 to 1

Case2, D=1 $t_{\text{setup}} = t_4 + t_1$ $t_{\text{hold}} = t_2$

Path to set up

Path to hold

