Using NAND Gate: ← low act

S	R	Q_{t+1}
0	0	Undesired
0	1	1
1	0	0
1	1	Q_t

Using NOR Gate:

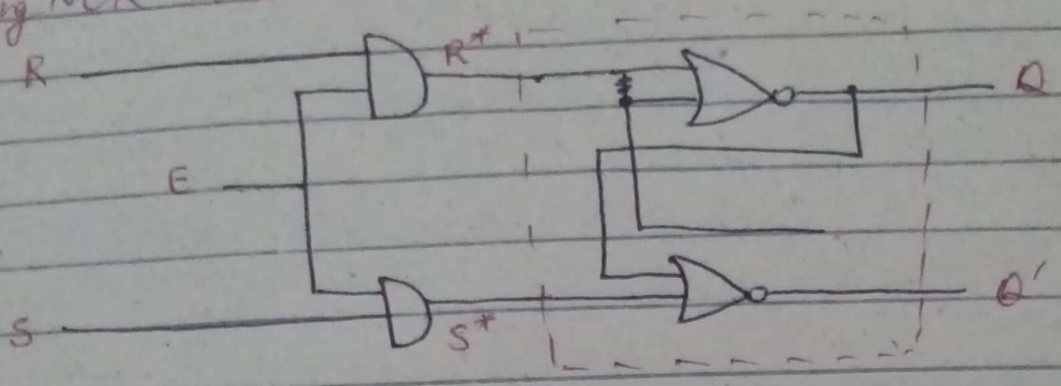
Q_t	S	R	Q_{t+1}
0	0	0	0 (Q_t)
0	0	1	0
0	1	0	1
0	1	1	x undesirable
1	0	0	1 (Q_t)
1	0	1	0
1	1	0	1
1	1	1	X

Using NAND Gate:

Q_t	S	R	Q_{t+1}
0	0	0	X
0	0	1	1
0	1	0	0
0	1	1	0 (Q_t)
1	0	0	X
1	0	1	1
1	1	0	0
1	1	1	1 (Q_t)

Gated SR-Latch: Latch with an Enable input / gated input

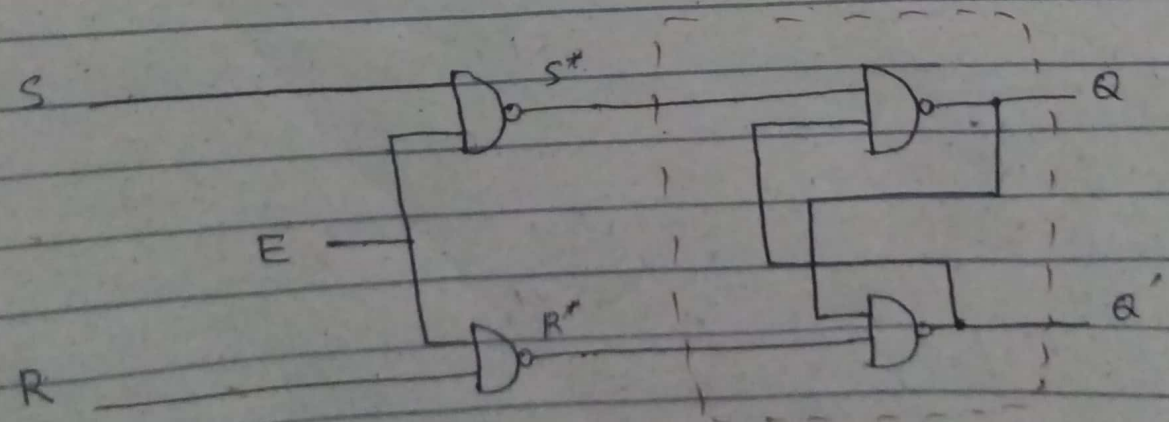
Using NOR Gate:



E	S	R	Q_{t+1}
→ 0	0	0	Q_t
→ 0	0	1	Q_t
→ 0	1	0	Q_t
→ 0	1	1	Q_t
1	0	0	Q_t
1	0	1	0
1	1	0	1
1	1	1	undesirable state

* If E is zero, no matter what input is in S, R → it retains Q_t in its new state (Q_{t+1})

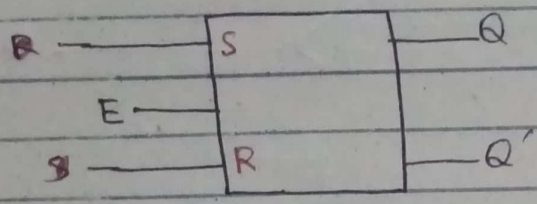
Using NAND Gate:-



E	S	R	Q_{t+1}
0	0	0	Q_t
0	0	1	Q_t
0	1	0	Q_t
0	1	1	Q_t
1	0	0	Q_t
1	0	1	0
1	1	0	1
1	1	1	X undesirable

Gated SR-Latch works the same on both active high (NOR gate) and active low (NAND gate) state.

Block Diagram:



Truth Table assuming E=1:

Q_t	S	R	Q_{t+1}
0	0	0	Q_t (0)
0	0	1	0
0	1	0	1
0	1	1	X
1	0	0	Q_t (1)
1	0	1	0
1	1	0	1
1	1	1	X

Characteristic Table:

S	R	Q_{t+1}
0	0	Q_t
0	1	0
1	0	1
1	1	X

Boolean Expression for Q_{t+1}:

$Q_{t+1} = Q_t'SR' + Q_tS'R' + Q_tS'R'$, $d = Q_t'SR + Q_tSR$

$Q_{t+1} = \Sigma(2, 4, 6)$ $d = \Sigma(3, 7)$

By K-Map:

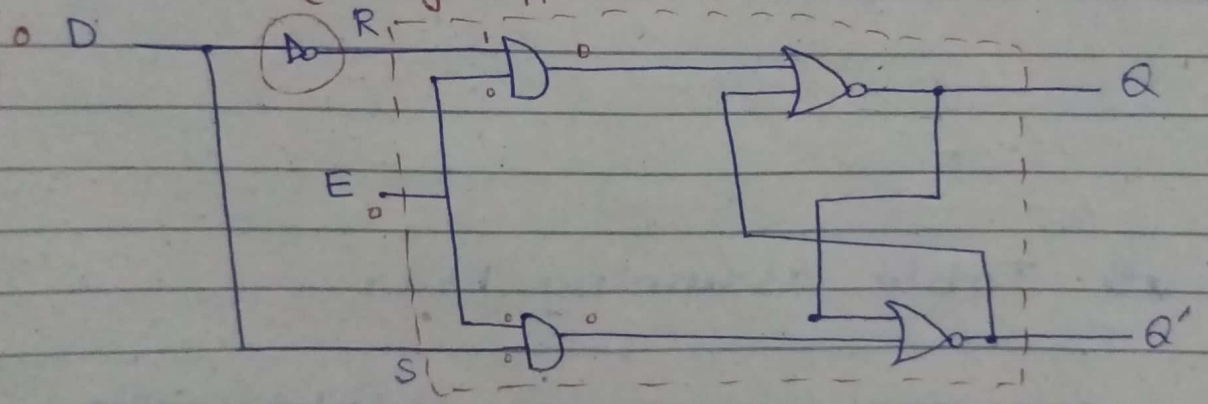
Q_t \ SR	$S'R'$	$S'R$	SR	SR'
Q_t'			X	1
Q_t	1		X	1

$$Q_{t+1} = S + R'Q_t$$

This is called characteristic equation ~~whic~~ with condition: $S.R = 0$, so that S and R don't have 1 at the same which will lead towards undesirable state.

Gated D-Latch:

only difference from Gated SR-Latch



E	D	Q_t	Q_{t+1}
0	0	0	Q_t (0)
0	0	1	Q_t (1)
0	1	0	Q_t (0)
0	1	1	Q_t (1)
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

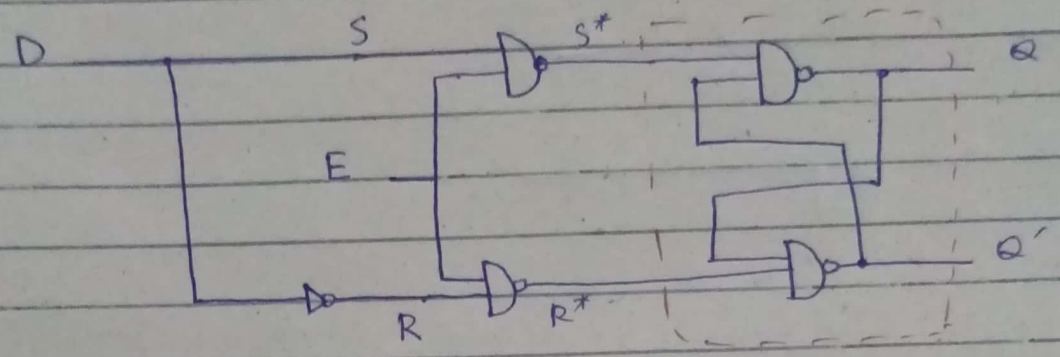
* For $E = 0$, $Q_{t+1} = Q_t$ dependent on Q_t for $E = 0$

* For $E = 1$, $Q_{t+1} = D$ independent of Q_t for $E = 1$

⇒ E = 1 :

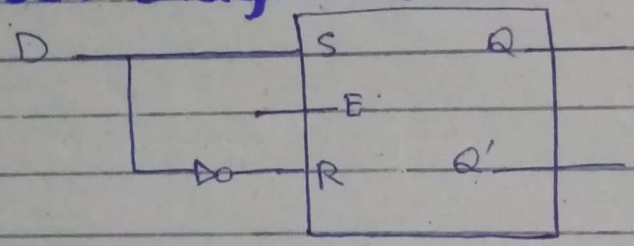
D	Q_{t+1}
0	0
1	1

D-Latch by using NAND Gate:



Same Truth Table as for D-Latch by NOR

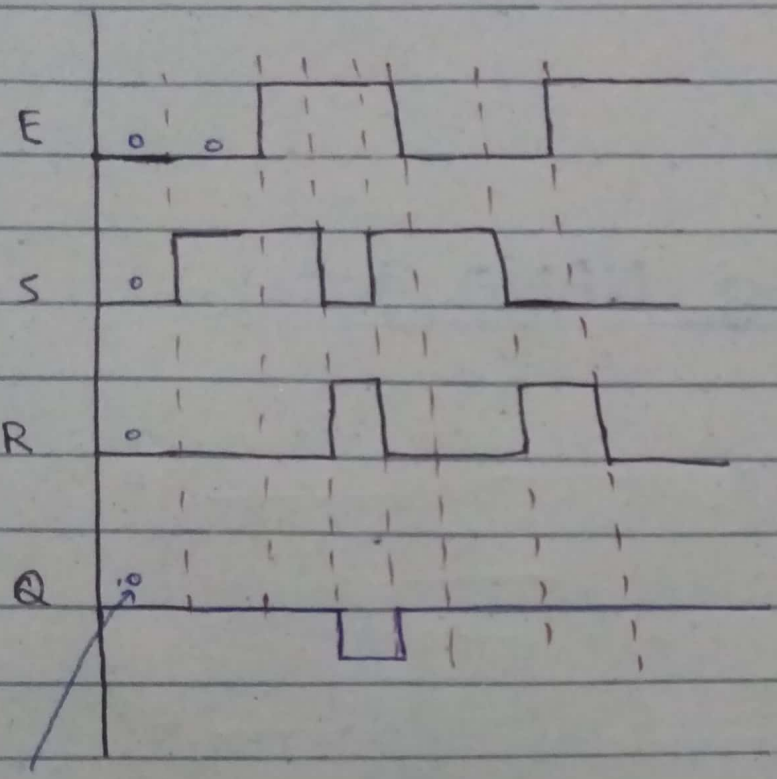
Block Diagram:



E	D	Q_{t+1}
0	X	Q_t
1	0	0
1	1	1

$Q_{t+1} = D$

When Enable is zero, any state of D don't matter in Q_{t+1}



Initially, $Q_t = 0$ due to $E = 0$.