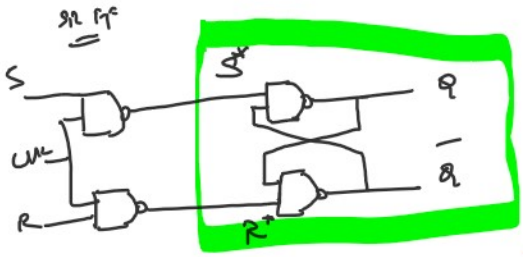
SEQ DAY 2 - FLIP FLOPS

Thursday, April 21, 2022 6:53 AM

SR FF



S^*	R^*	Q	$\bar{Q}$
0	0	Invalid	
0	1	1	0
1	0	0	1
1	1	memory	

NAND

0	0	1
0	1	1
1	0	1
1	1	0

i) $S^* = \overline{S \cdot clk} = \bar{S} + \overline{clk}$

$R^* = \overline{R \cdot clk} = \bar{R} + \overline{clk}$

If $clk = 0$, $\overline{clk} = 1$

$S^* = \bar{S} + 1 = 1$

$R^* = \bar{R} + 1 = 1$

$S^* = R^* = 1$ = memory

$clk = 1$

$S^* = \bar{S} + \overline{clk} = \bar{S} + 0 = \bar{S}$

$R^* = \bar{R} + \overline{clk} = \bar{R} + 0 = \bar{R}$

$S^* = \bar{S}$ $R^* = \bar{R}$

(i) $clk = 1$ $S = 0$, $R = 0$ | $S^* = 1$, $R^* = 1$ (memory)

(ii) $clk = 1$ $S = 0$, $R = 1$ | $S^* = 1$, $R^* = 0$ $Q = 0$, $\bar{Q} = 1$

(iii) $clk = 1$ $S = 1$, $R = 0$ | $S^* = 0$, $R^* = 1$ $Q = 1$, $\bar{Q} = 0$

(iv) $clk = 1$ $S = 1$, $R = 1$ | $S^* = 0$, $R^* = 0$ Invalid

Truth Table of SR FF

clk	S	R	Q	$\bar{Q}$	Q_{n+1}
0	x	x	memory		Q_n
1	0	0	memory		Q_n
1	0	1	0	1	0
1	1	0	1	0	1
1	1	1	invalid		Invalid.

→ NS

Q_n → S

Truth Table of 1 FF

Clk	S	R	Q	$\bar{Q}$	Q_{n+1}
0	X	X	memory		Q_n
1	0	0	memory		Q_n
1	0	1	0	1	0
1	1	0	1	0	1
1	1	1	invalid		Invalid.

Characteristic Table

Assume Clk: 1

Q_n	S	R	Q_{n+1}
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	X
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	X

$\bar{R}Q_n$

Excitation Table.

Q_n	Q_{n+1}	S	R
0	0	0	X
0	1	1	0
1	0	0	1
1	1	X	0

Char. Equation.

Q_n \ SR	00	01	11	10
0	0	0	X	1
1	1	0	X	1

$\bar{R} = S$

$\bar{R}$

$$\boxed{Q_{n+1} = S + Q_n\bar{R}}$$

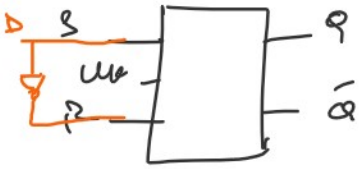
D Flip-Flop

D: Delay

↳ SR FF

S = 0 R = 1

S = 1 R = 0



Truth Table.

Clk	D	Q_{n+1}
0	X	Q_n (memory)
1 (S=0, R=1)	0	0
1 (S=1, R=0)	1	1

Ch. Table

Q_n	D	Q_{n+1}
0	0	0
0	1	1
1	0	0
1	1	1

$Q_{n+1} = D$

Excitation Table

Q_n	Q_{n+1}	D
0	0	0
0	1	1
1	0	0
1	1	1