BCD Adder :

what is BCD ?

BCD → Binary Coded Decimal

10

Decimal number	Binary code
0 →	0000
1 →	0001
2 →	0010
3 →	0011
4 →	0100
5 →	0101
6 →	0110
7 →	0111
8 →	1000
9 →	1001

10 → 00010000

BCD Addition

43	→	0100	0011
+ 25	→	0010	0101
68	←	0110	1000

78	→		0111	1000
53	→		0101	0011
? ?	←		1100	1011
			0110	0110
131	←	0001	0011	0001

Error ?

$\boxed{\text{If SUM > 9}}$

Error correction

If SUM > 9
Then Add 6

$A_3 A_2 A_1 A_0$
$B_3 B_2 B_1 B_0$

S_4	S_3	S_2	S_1	S_0	
0	0	0	0	0	Add 0 (0000)
0	0	0	0	1	
0	0	0	1	0	
0	0	0	1	1	
0	0	1	0	0	
0	0	1	0	1	
0	0	1	1	0	
0	0	1	1	1	
0	1	0	0	0	
0	1	0	0	1	
0	1	0	1	0	Add 6 (0110)
0	1	0	1	1	
0	1	1	0	0	
0	1	1	0	1	
0	1	1	1	0	
0	1	1	1	1	
1	0	0	0	0	
1	0	0	0	1	
1	0	0	1	0	

If SUM ≤ 9 Then add 0
If SUM > 9 Then add 6

B_3	B_2	B_1	B_0
0	0	0	0
0	1	1	0

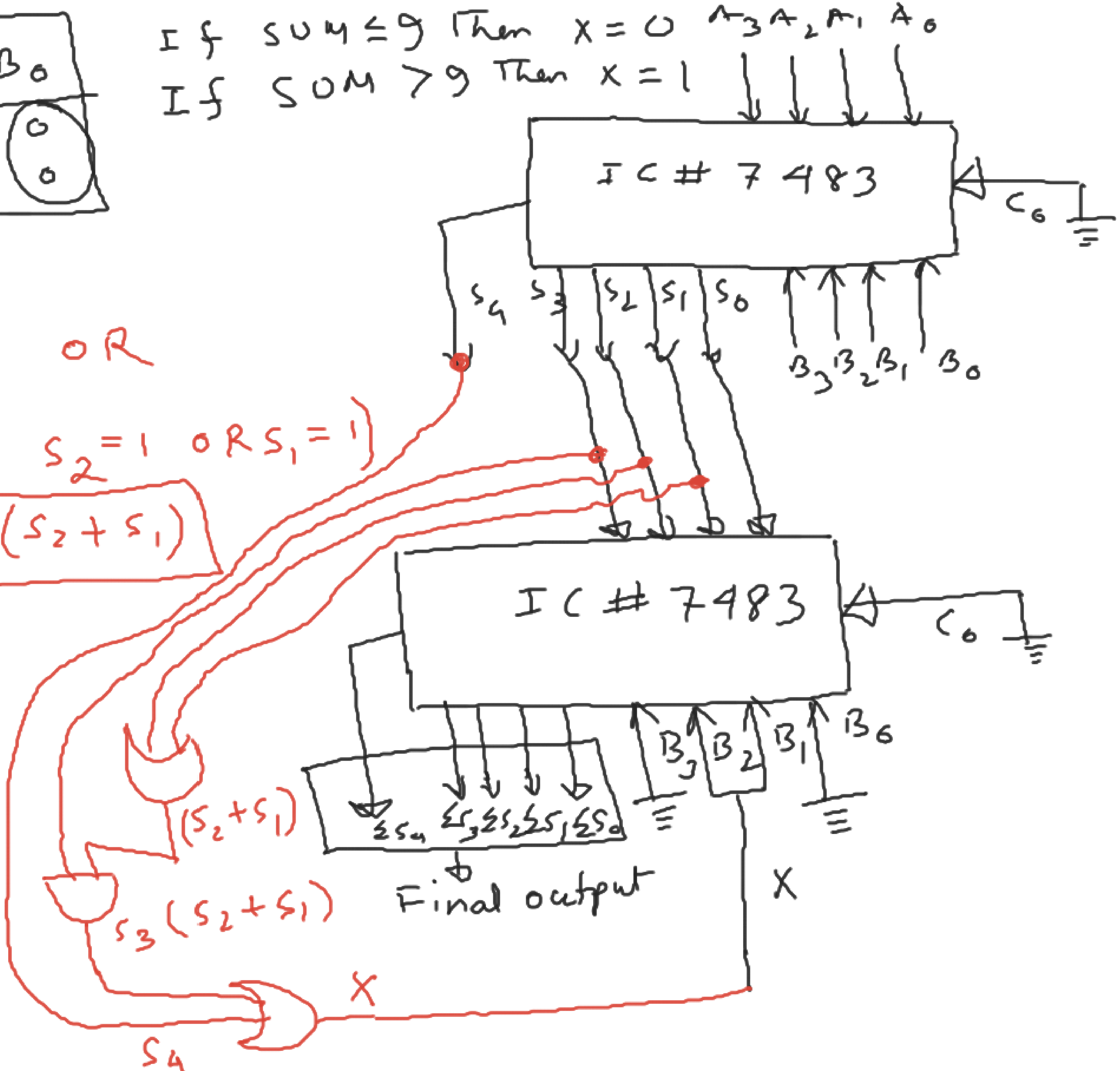
If SUM ≤ 9 Then X = 0
If SUM > 9 Then X = 1

For X = 1

$(S_4 = 1)$ OR

$(S_3 = 1$ AND $S_2 = 1$ OR $S_1 = 1)$

$$\boxed{X = S_4 + S_3 \cdot (S_2 + S_1)}$$



Chapter 5 : Flip Flop and Related Devices

What is Flip Flop?

Assignment 1 : Write a $\boxed{\text{short note}}$ on Flip Flop.

Google ⇒ 3 to 4 pages ; 12 font size
single space

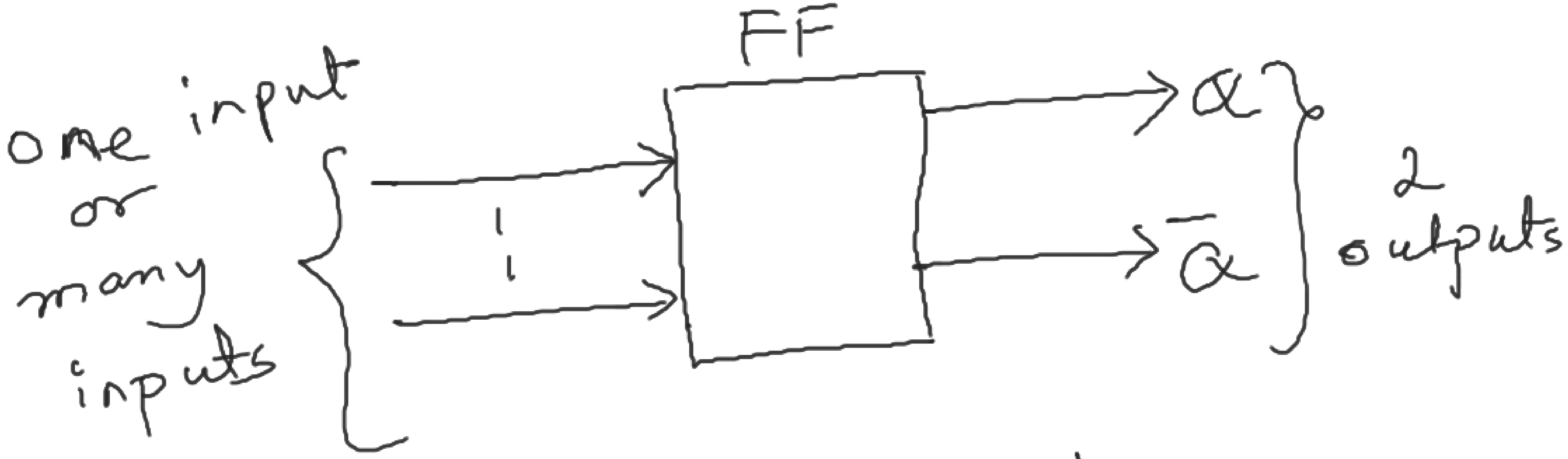
$\boxed{\text{copy}}$ →

cover page ⇒ Not needed

$\boxed{\text{Reg \#}}$ ← (Each page)

Date of submission ⇒ 04.02.2021
11 AM

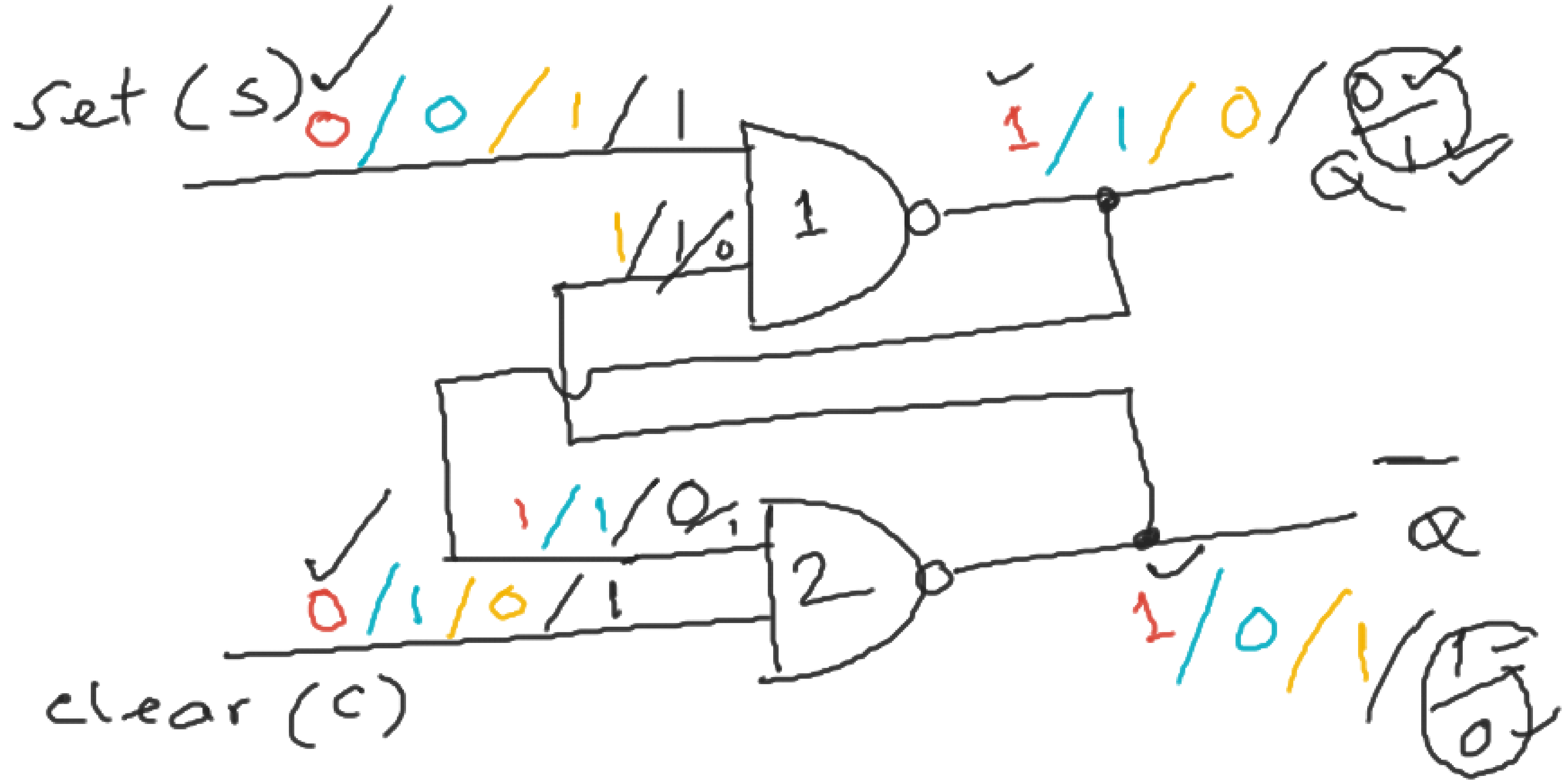
what is Flip Flop?



Flip Flop is a device where There is one input or are many input, but exactly have two outputs. One output is opposite of other output.

NAND Latch:

Internal circuit



Truth Table

S	C	Q
0	0	Invalid
0	1	1
1	0	0
1	1	No change

$(1,1) \Rightarrow$

If initially $Q = 0$ then finally $Q = 0$

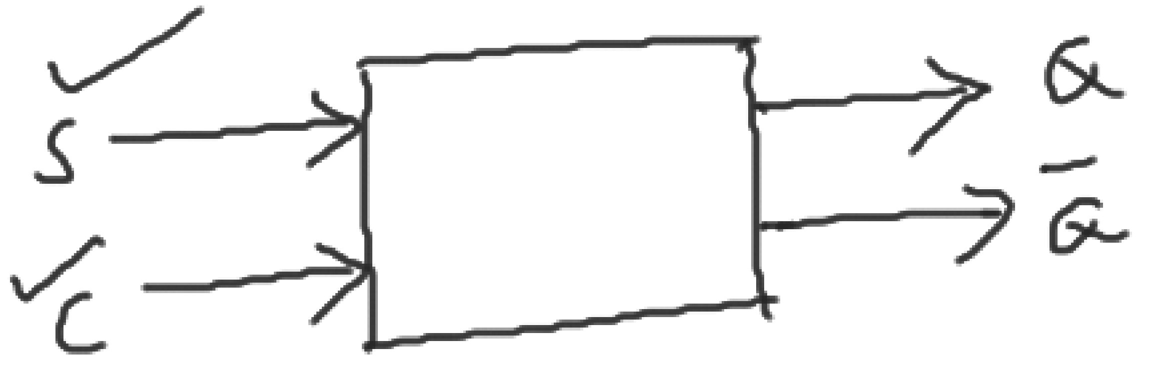
" " $Q = 1$ " " $Q = 1$

No change

NAND gate

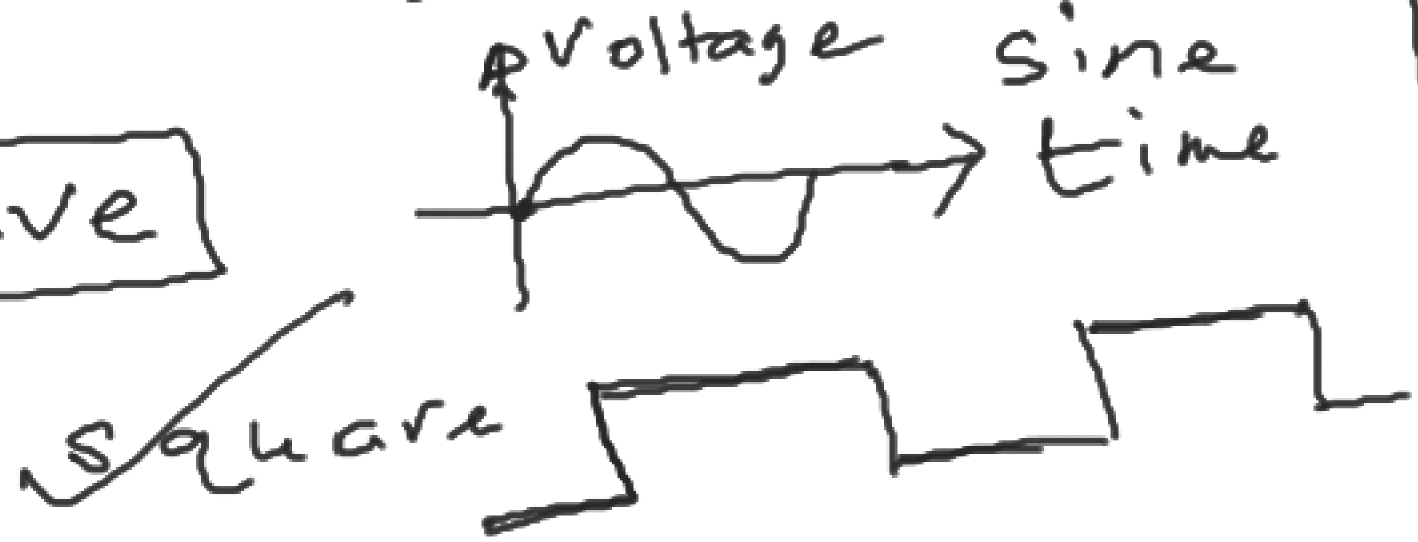
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Block diagram



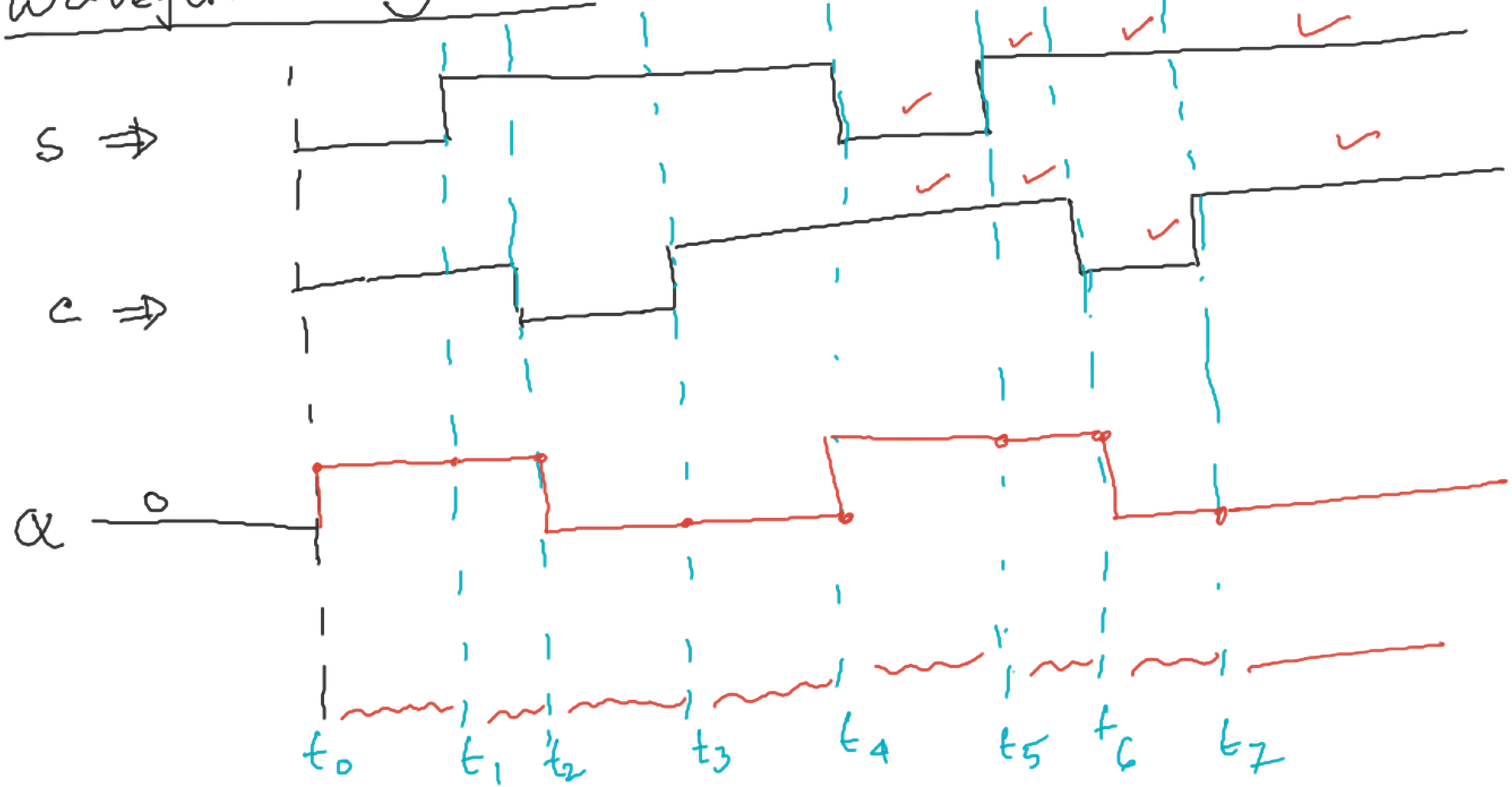
Wave

Truth Table



S	C	Q
0	0	Invalid
0	1	1
1	0	0
1	1	No change

Waveform diagram:



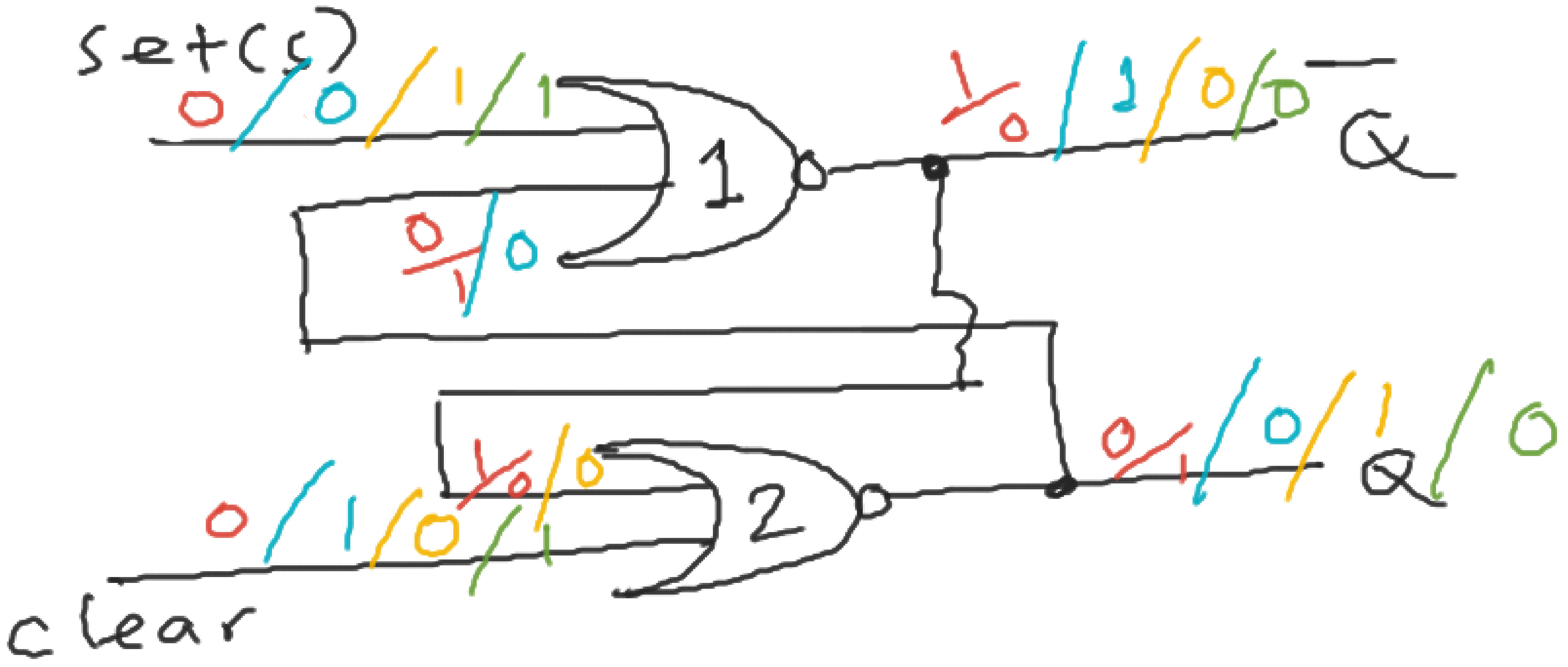
Initially

$Q = 0$

Draw The wave form of Q

NOR Latch:

Internal circuit



Truth Table

S	C	Q
0	0	No change
0	1	0
1	0	1
1	1	Invalid

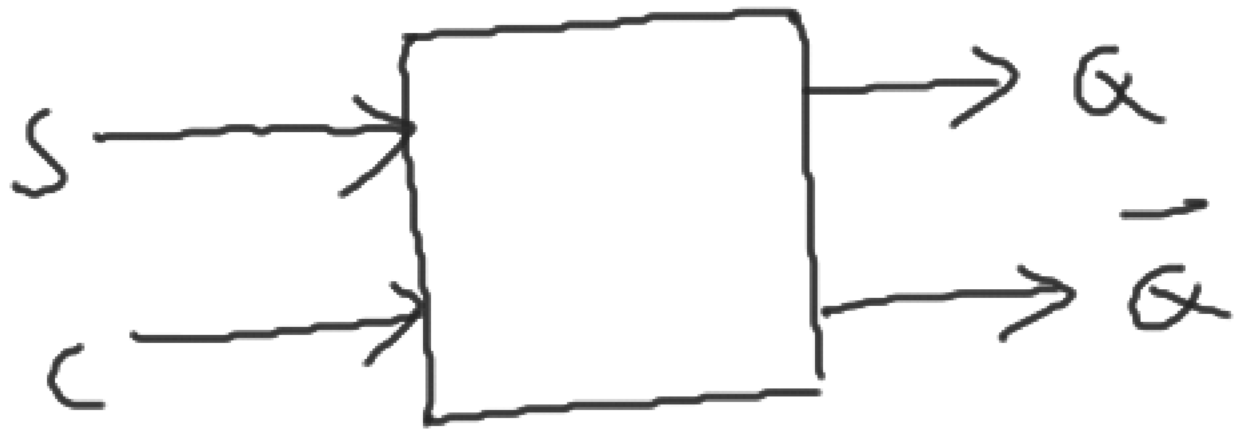
(0, 0)

If initially Q = 0, Then finally Q = 0
" " Q = 1, " " Q = 1
No change

NOR gate

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

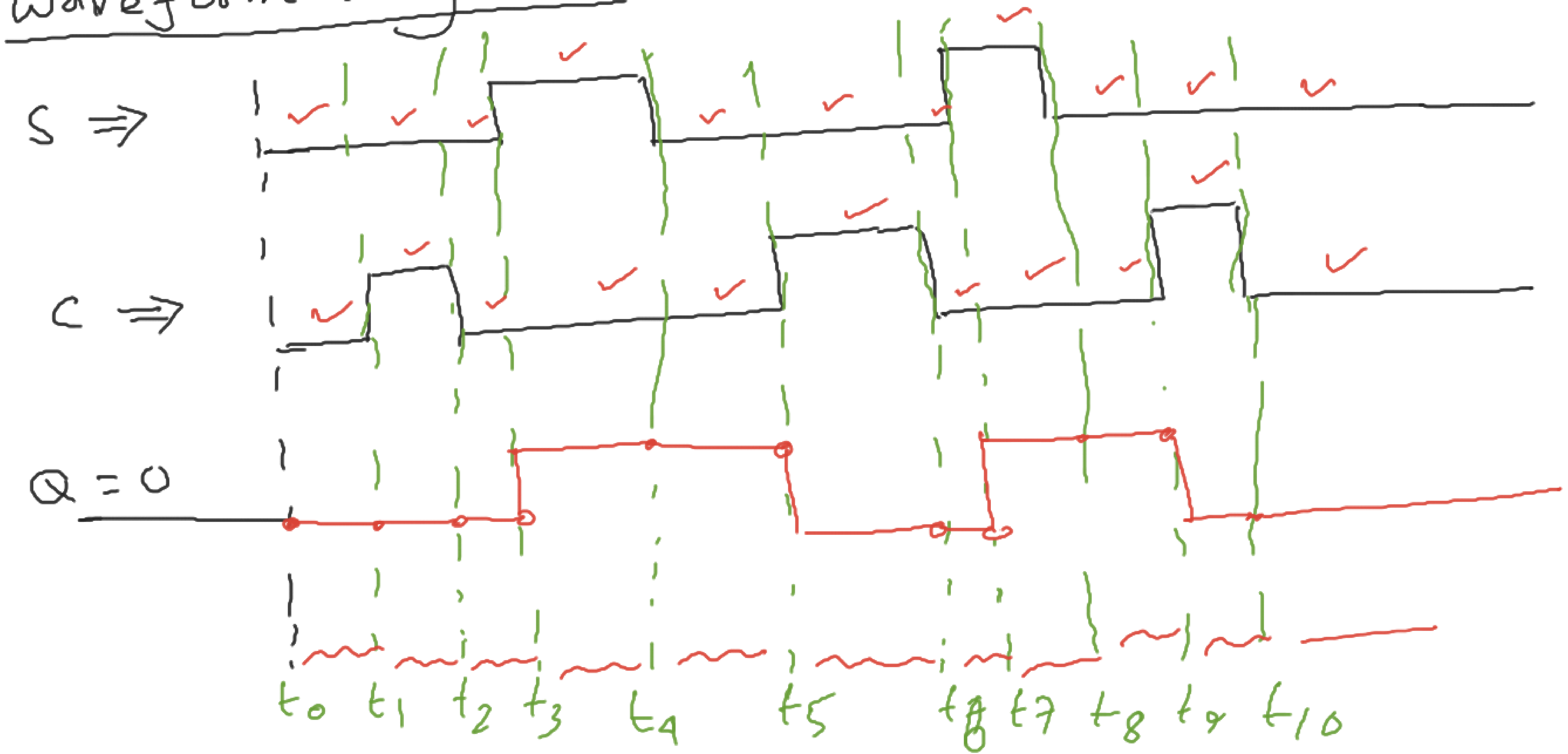
Block diagram



Truth Table

S	C	Q
0	0	No change
0	1	0
1	0	1
1	1	Invalid

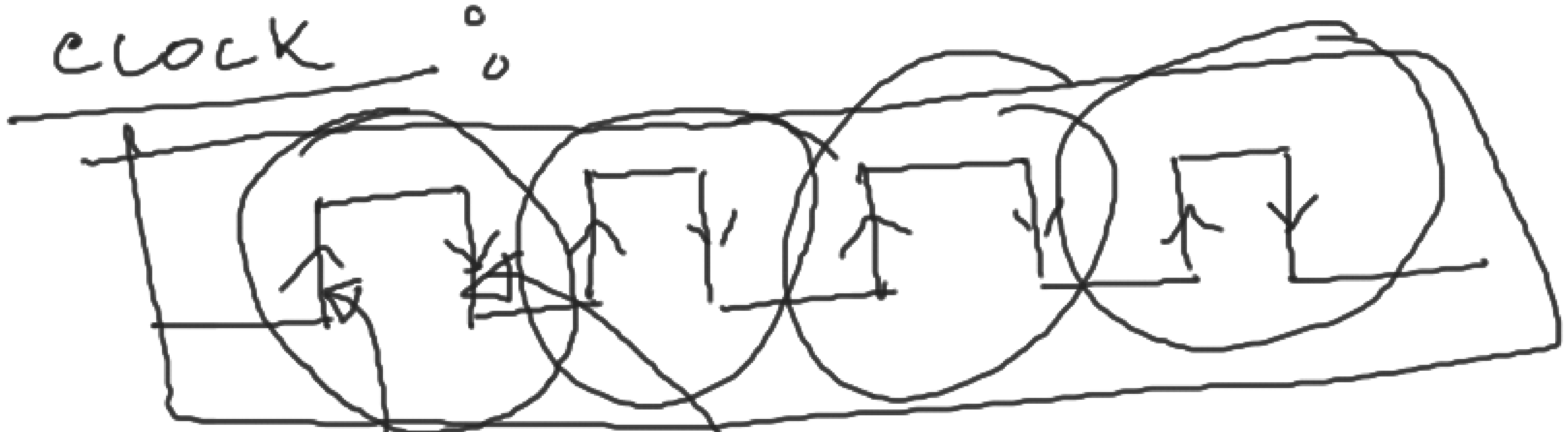
Waveform diagram :



Initially $Q = 0$.

Draw the waveform of Q

clock :

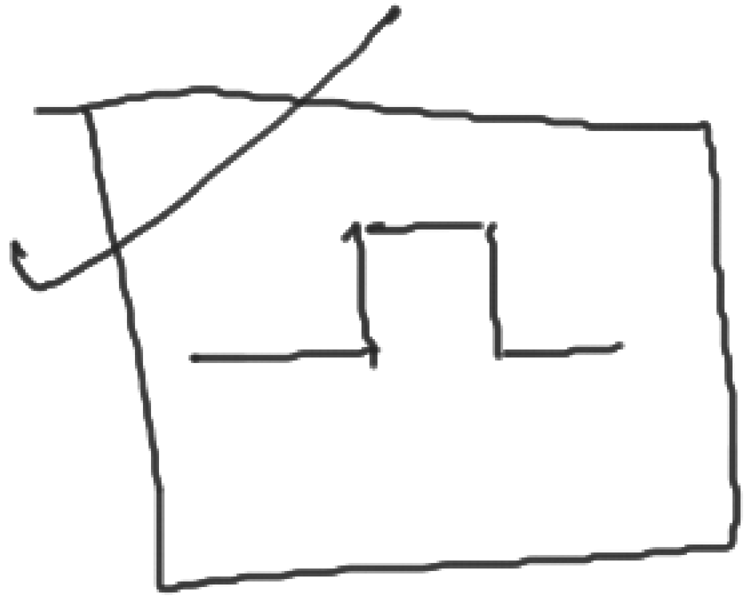


Positive Going Transition (PGT)

$\boxed{0 \text{ to } 1}$

Negative Going Transition (NGT)

$\boxed{1 \text{ to } 0}$



PGT

NGT

$\boxed{\text{Frequency}}$ → Number of oscillation / cycles per second.

1 Hz → 1 cycle/sec

10 Hz → 10 cycles/sec

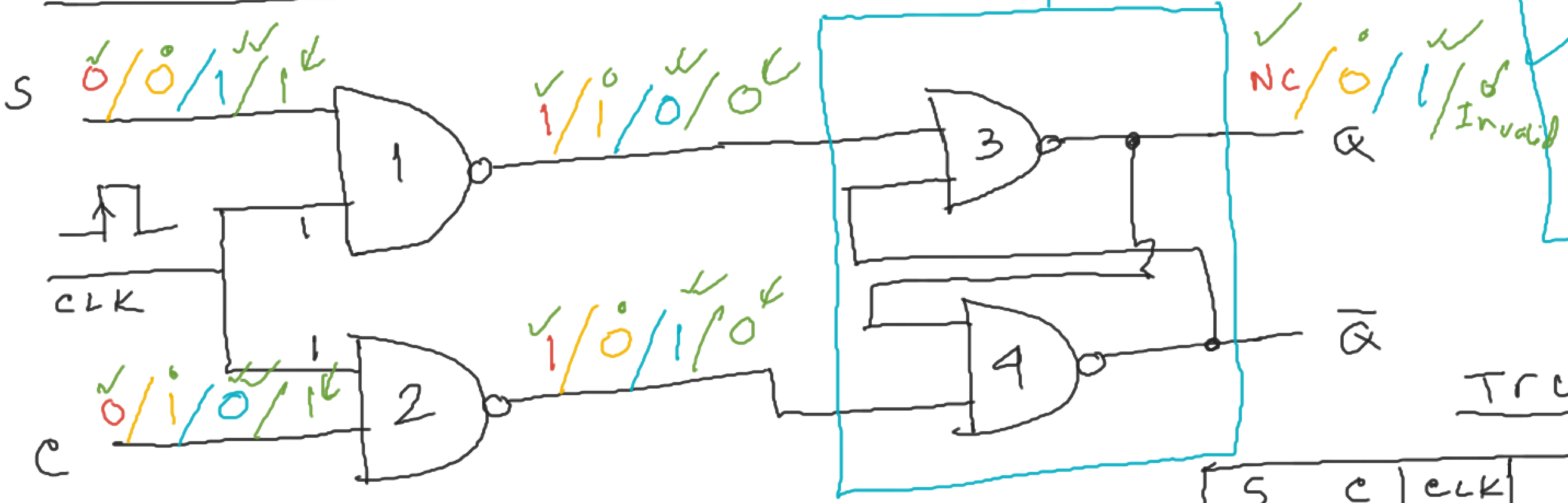
1 KHz → 1000 " /sec

1 MHz → 10^6 "

1 GHz → 10^9 "

Clocked SC Flip Flop:

Internal circuit



NAND Latch

S	C	Q
0	0	Invalid
0	1	1
1	0	0
1	1	N.C.

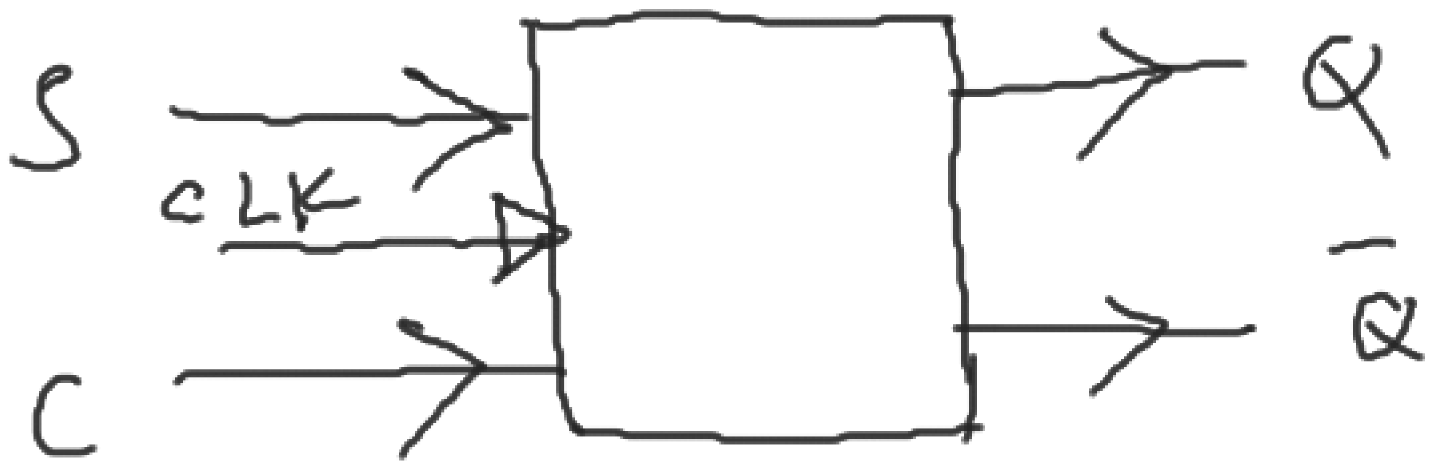
Operation:

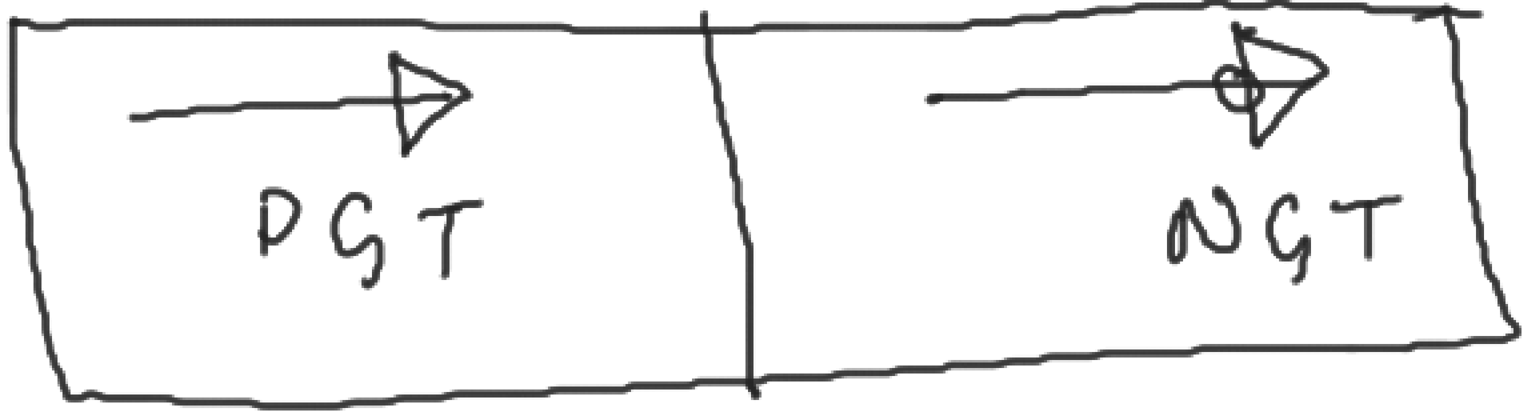
↓	NGT
↑	PGT

Truth Table:

S	C	CLK	Q
0	0	↑	No change
0	1	↑	0
1	0	↑	1
1	1	↑	Invalid

Block Diagram:



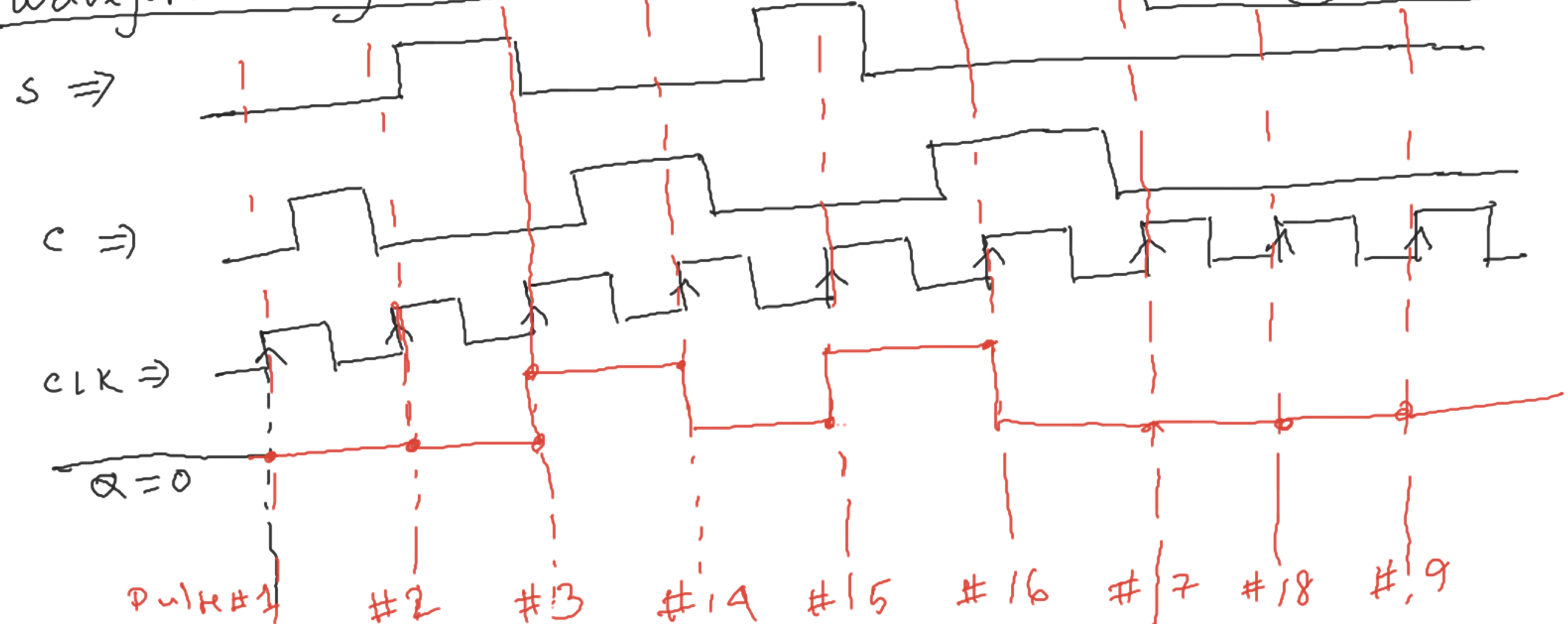


Truth Table

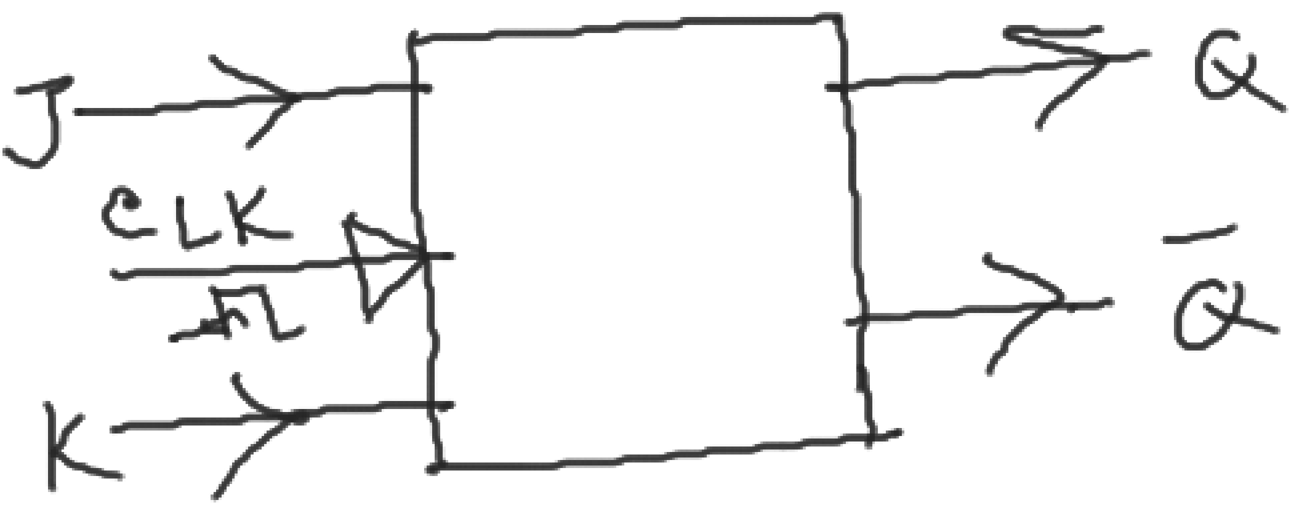
S	C	CLK	Q
0	0	↑	No change
0	1	↑	0
1	0	↑	1
1	1	↑	Invalid

waveform diagram:

Initially $Q = 0$



Block diagram:

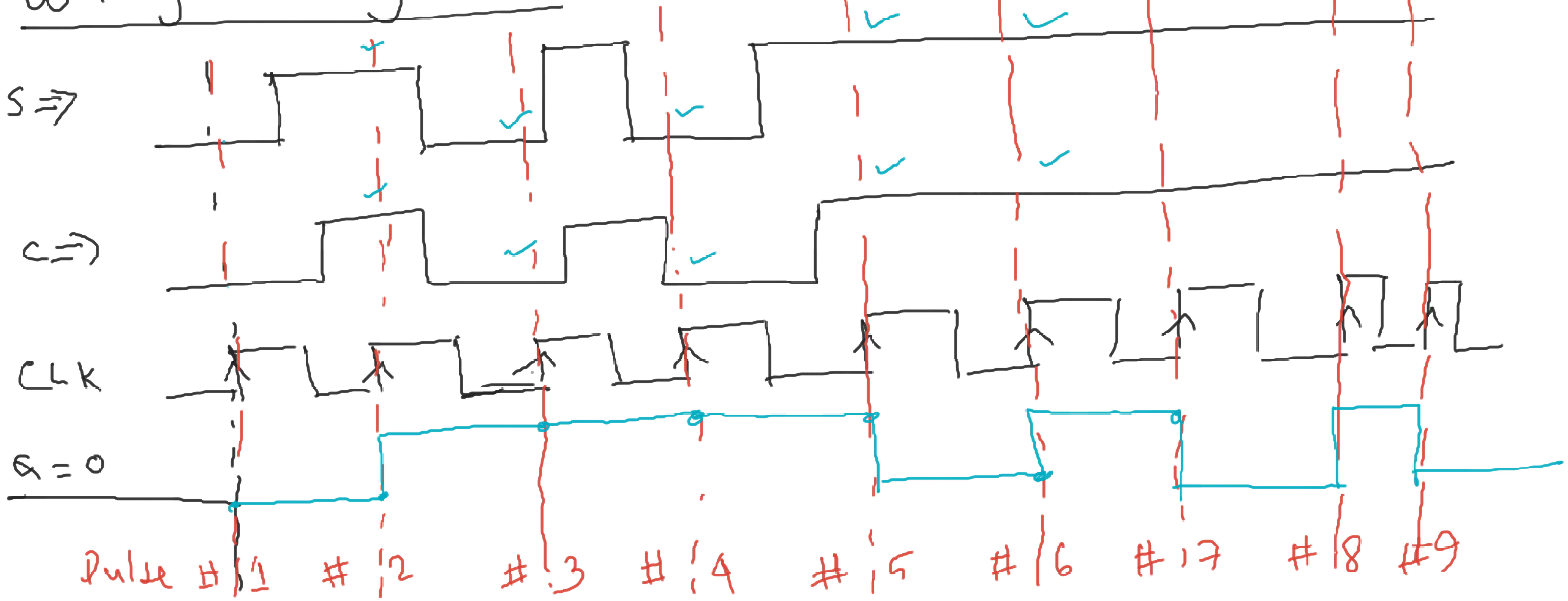


Truth Table

J	K	CLK	Q
0	0	↑	N.C.
0	1	↑	0
1	0	↑	1
1	1	↑	Toggle

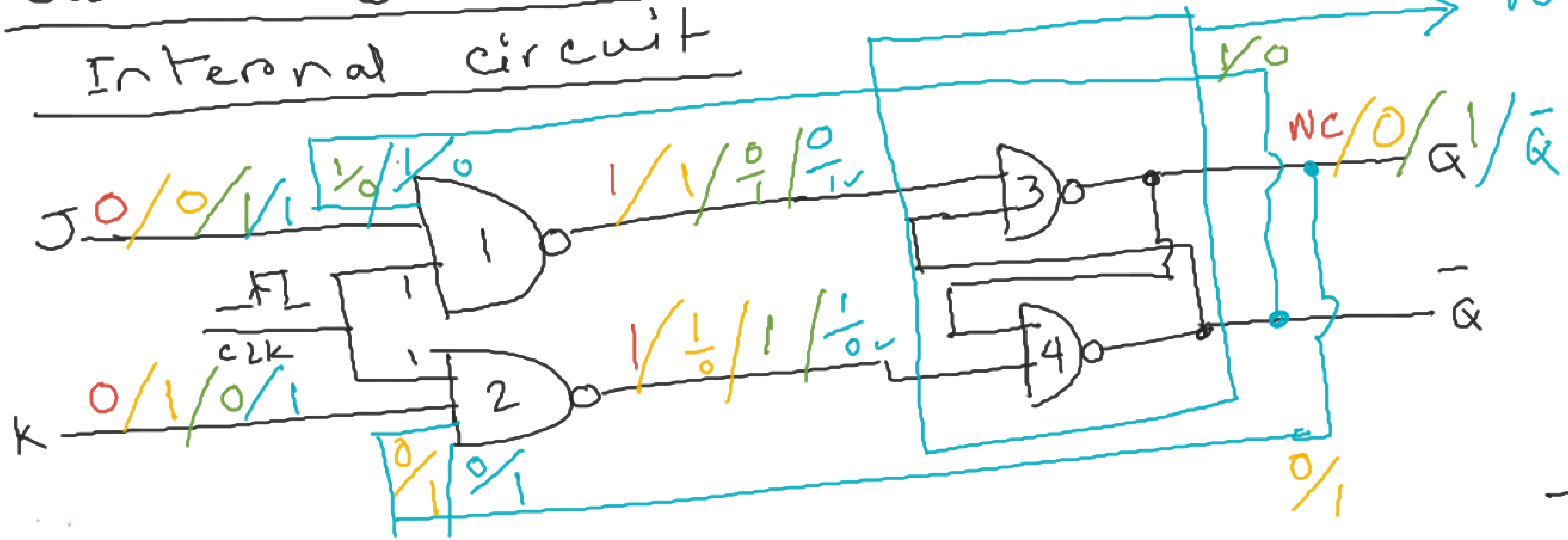
Initially Q=0

Waveform diagram



Clocked JK Flip Flop:

Internal circuit



NAND Latch

S	C	Q
0	0	Invalid
0	1	1
1	0	0
1	1	No change

Truth Table:

J	K	clk	Q
0	0	↑	No change
0	1	↑	0
1	0	↑	1
1	1	↑	Toggle

operation:

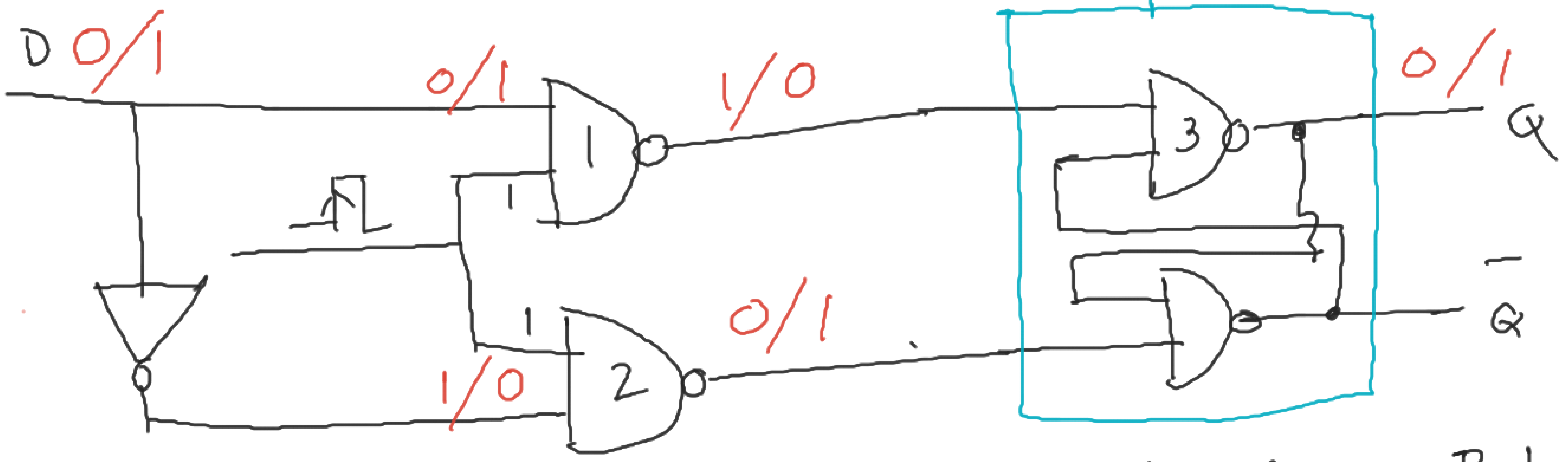
(0, 1) ⇒ If initially Q = 0 ; finally Q = 0 } Q = 0
" " Q = 1 ; " Q = 0

(1, 0) ⇒ " " Q = 0 ; " Q = 1 } Q = 1
" " Q = 1 ; " Q = 1

(1, 1) ⇒ " " Q = 0 ; " Q = 1 } $\bar{Q}$
" " Q = 1 ; " Q = 0

Clocked D Flip Flop :

Internal circuit



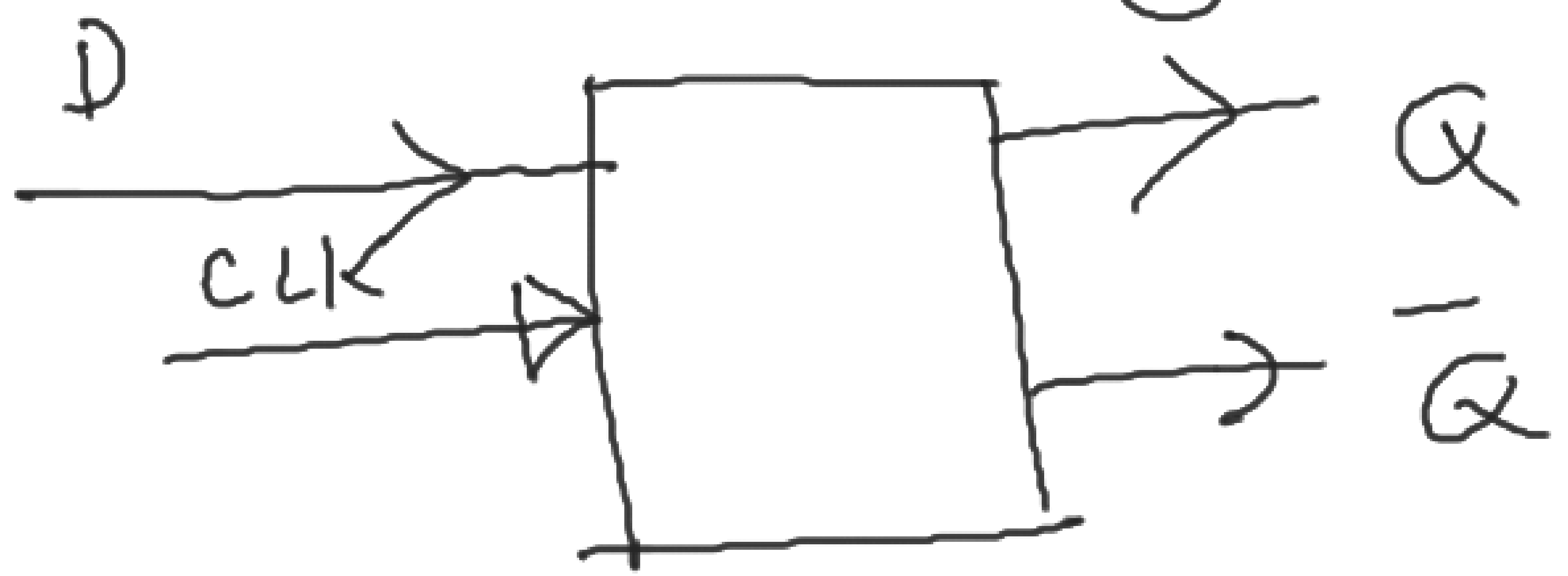
NAND Latch

S	C	Q
0	0	Invalid
0	1	1
1	0	0
1	1	N.C.

Operation and Truth Table :

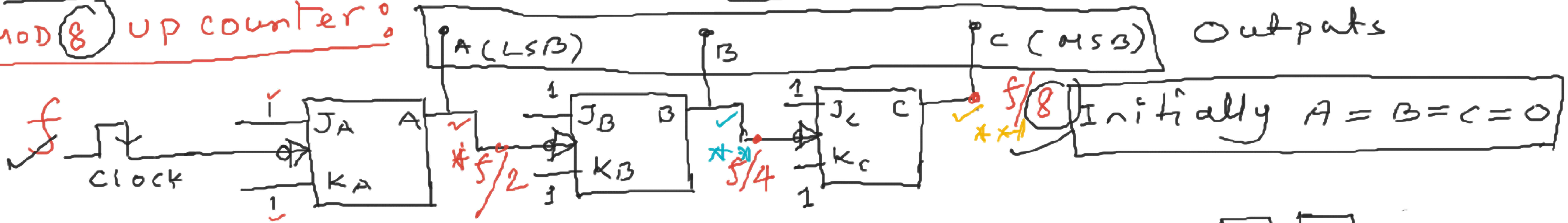
D	CLK	Q
0	↑	0
1	↑	1

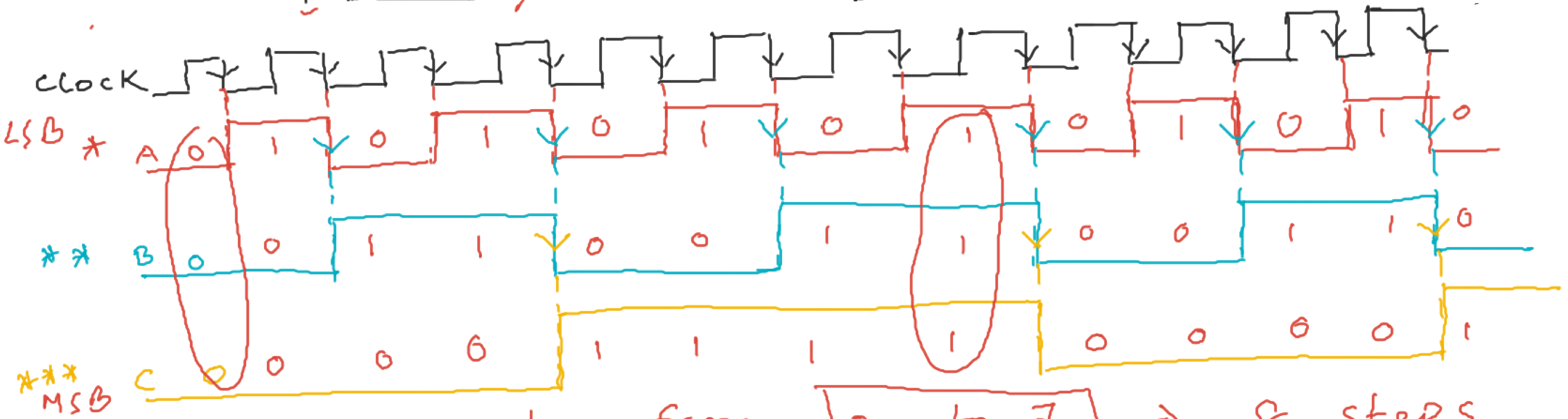
Block Diagram



Application of Flip Flop: Frequency division and counting

MOD 8 up counter:





It counts from 0 to 7 → 8 steps

Mod number: Number of different steps of the counter is called mod number.

Number of FF	Mod number
2	$4 = 2^{2}$
3	$8 = 2^{3}$ → 0 to 7
4	$16 = 2^{4}$ → 0 to 15
5	$32 = 2^{5}$ → 0 to 31
6	$64 = 2^{6}$

Mod number of counter $= 2^{\text{No. of FF}}$

output frequency $= \dfrac{\text{Input frequency}}{\text{Mod number}}$

Range of counter = 0 to (Mod number − 1)

= 0 to $(2^{\text{No. of FF}} - 1)$

8 FFs Input frequency is 2 MHz.

1) find Mod number.

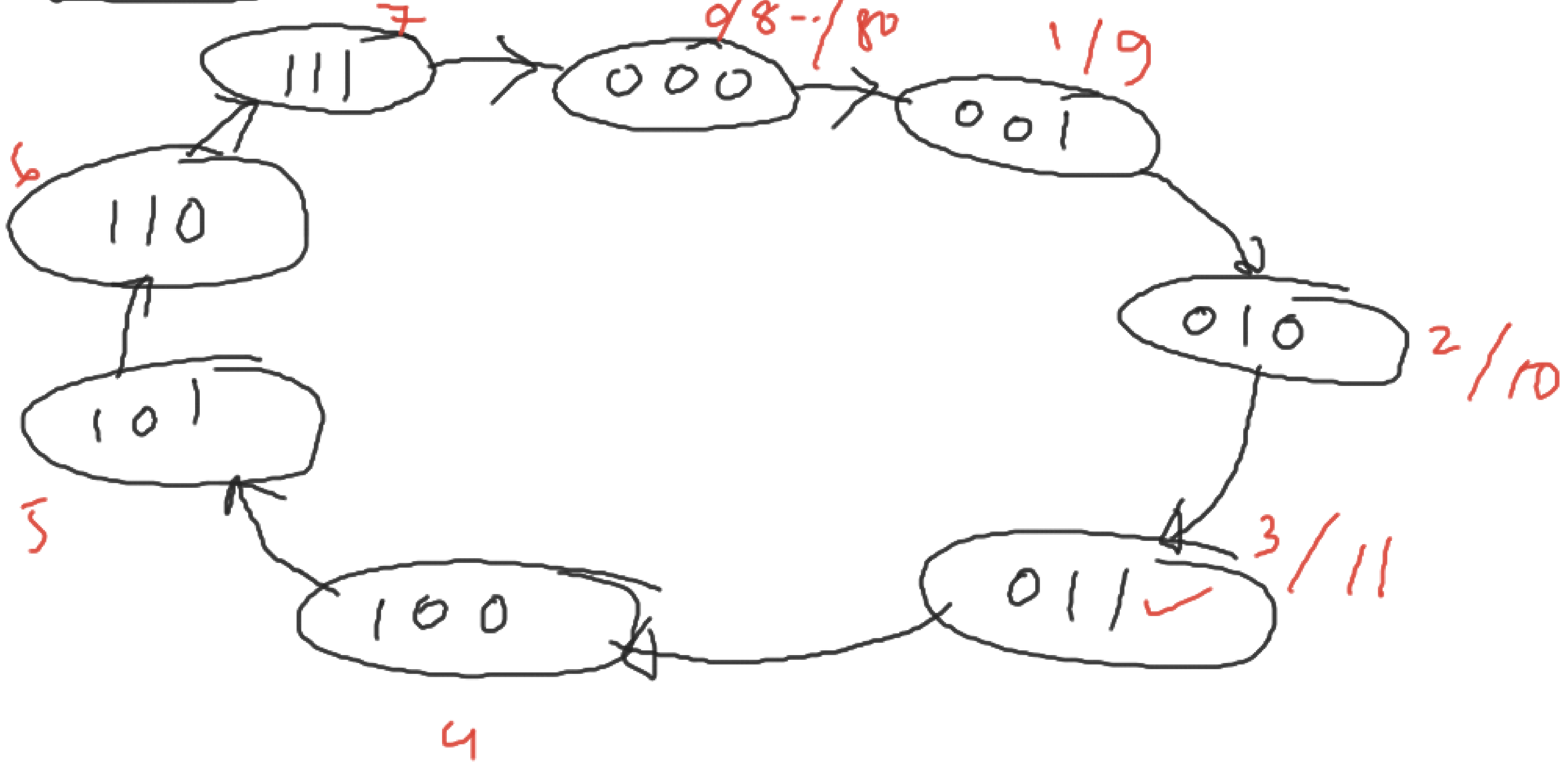
2) find output frequency in KHz.

1) Mod number $= 2^{8} = 256$

2) output frequency $= \dfrac{2 \times 10^{3}}{256}$

$= 7.8125$ KHz

Draw the state transition diagram of MOD 8 up counter



Given that initial state of the counter is 000. Find the counting state after 11 pulses.

→ $\boxed{011}$

→ After 85 pulses what is the counting states?

$\boxed{85 \% 8 = 5}$

$8 \,|\, 85 \,|\, 10$
80
5

$\boxed{5_{10} = 101_2}$

mod
↓

$\boxed{\text{Counting state} = (\text{Number of pulses}) \,\%\, (\text{Mod number})}$

If Initial state is $\boxed{101}$ find the counting state after 105 pulses?

$\Rightarrow$ $101_2 = 5_{10}$

$5 + 105$

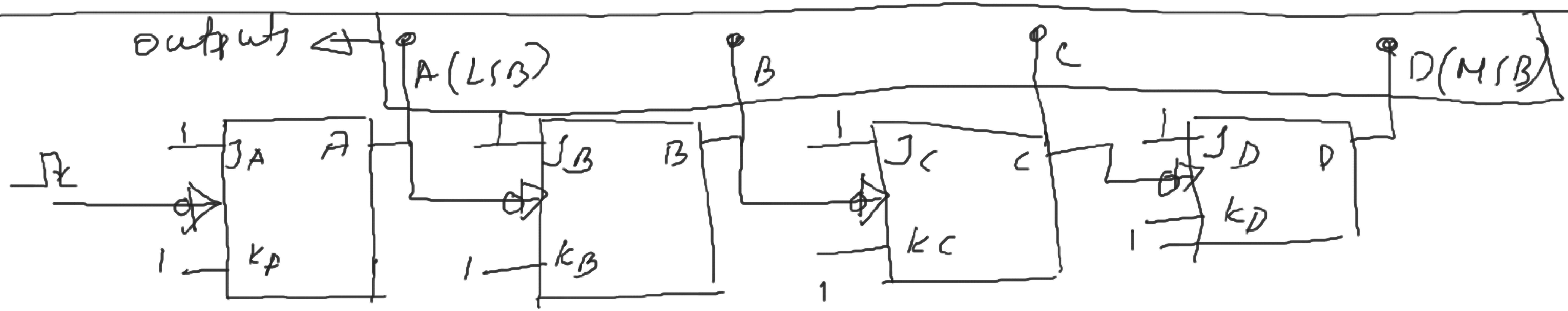
$= 110$

$$
\begin{array}{r|l}
8 & 110 \quad 13 \\
 & \underline{8} \\
 & 30 \\
 & \underline{24} \\
 & 6
\end{array}
$$

$110 \% 8 = 6_{10}$

$\boxed{110}$

Draw The internal circuit of MOD 16 up counter



Initially A = B = C = D = 0

Q 1) a) Mod number $= 2^6 = 64$

b) output frequency $= \dfrac{1 \times 10^3}{64} = 15.625$ KHz

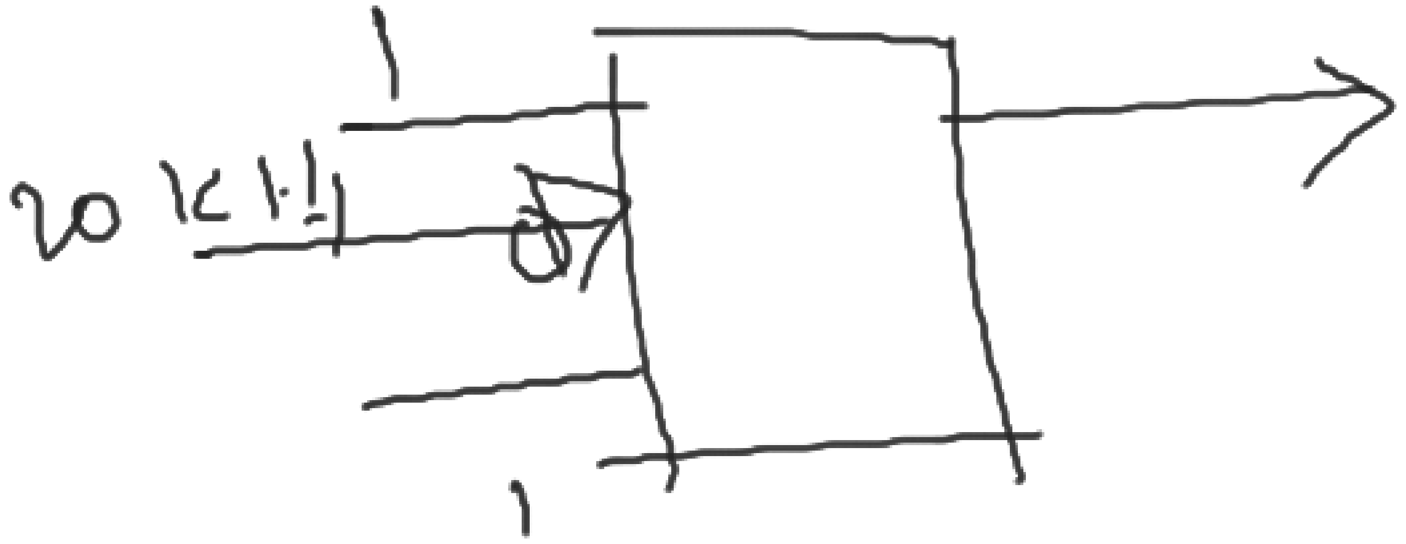
c) 0 to 63

d) $9 + 129 = 138$

$$64 \,\big|\, \begin{array}{r} 138 \\ 128 \\ \hline 10 \end{array} \,\big|\, 2$$

$\boxed{001010}$

Q 2)



$\frac{20}{2} = \boxed{10\ \text{KHz}}$

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1
0	0	1	0	0	0	0	1

Q 3) 0 - 255

Mod number = 256

$2^8 = 256$

a) $\boxed{8\ \text{FFs}}$

b) $\boxed{\text{MOD } 256}$

Q4) a) out frequency $= \frac{512\ \text{kHz}}{2^8} = \frac{512}{256} = 2\ \text{KHz}$

b) $00011001_2 = 25 + 520 = 545 \% 256$

$$\begin{array}{r|r|l} 256 & 545 & 2 \\ & 512 & \\ \hline & 33 & \end{array}$$

$= 33_{10}$

$\boxed{0\,0\,1\,0\,0\,0\,0\,1}$ ✓