CS & IT ENGINEERING

DIGITAL LOGIC

Sequential circuit

Lecture No. 7

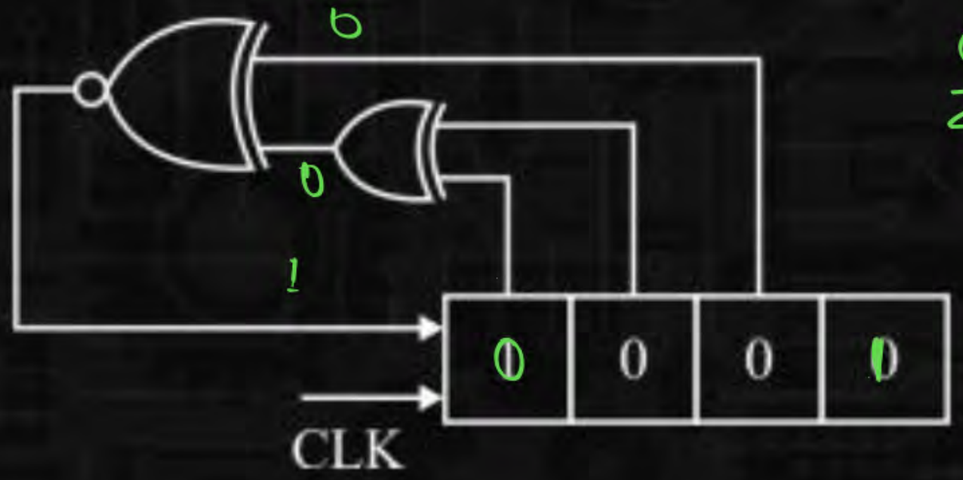
By- CHANDAN SIR

01 Counter Basic

02 Practice

03 Discussion

Q. After 97th clock the output ill be?



$\frac{97}{4} \Rightarrow R = 1$

0100

Clock	Q_3	Q_2	Q_1	Q_0
0	1	0	0	0
1	0	1	0	0
2	0	0	1	0
3	0	0	0	1
4	1	0	0	0
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

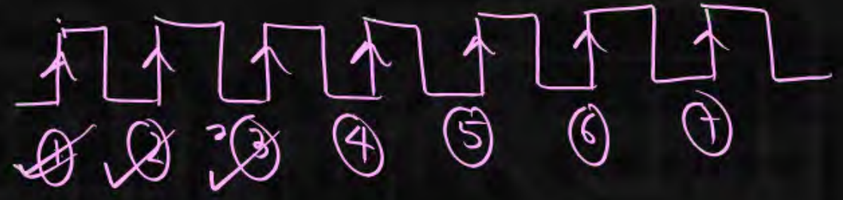
TOGGLE MODE OF FLIP FLIPS

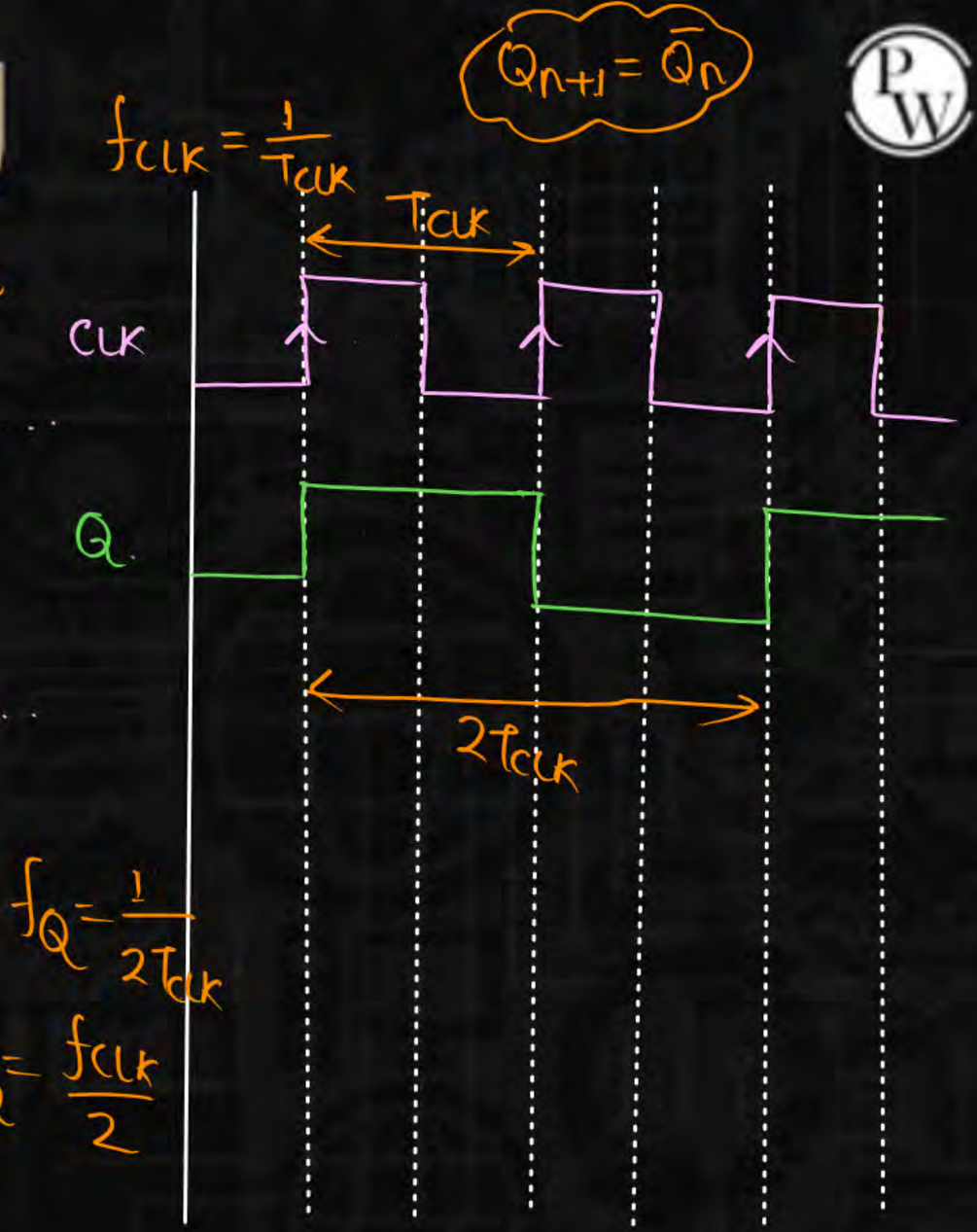
$Q_{n+1} = T \oplus Q_n \Rightarrow 1 \oplus Q_n = \bar{Q}_n$

1. Toggle mode of T Flip Flop

$Q_{n+1} = \bar{Q}_n$

Figure 6: Toggling Mode of T Flip Flop





TOGGLE MODE OF FLIP FLIPS

2. Toggle mode of J K Flip Flop.

(i)

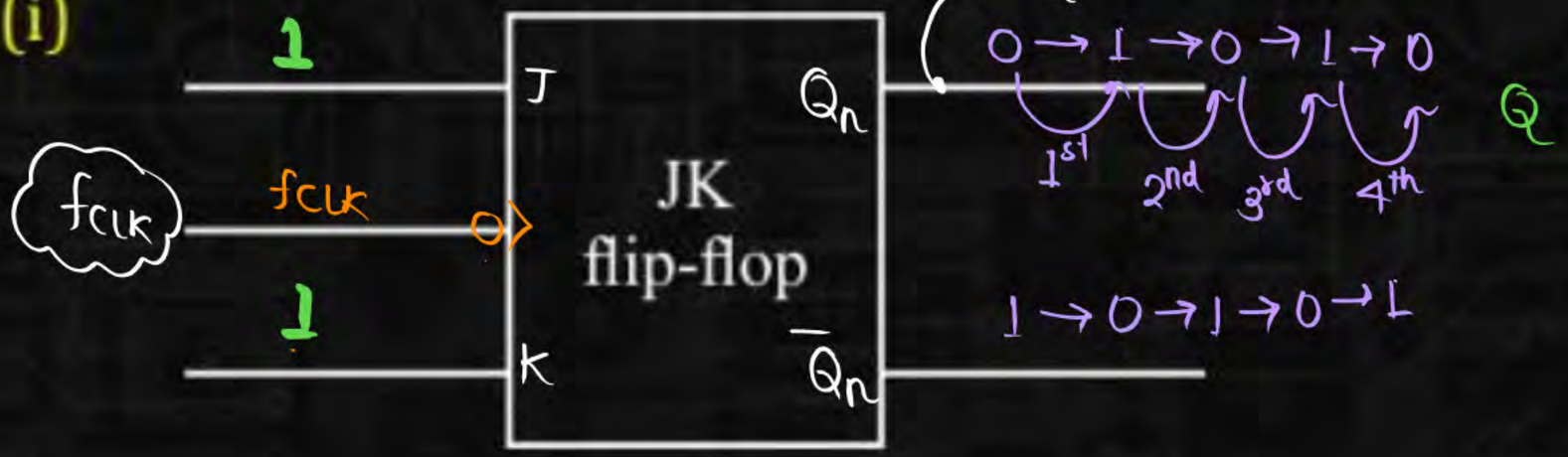


Figure 7: Toggling Mode of JK Flip Flop

$$Q_{n+1} = J\bar{Q}_n + \bar{K}Q_n$$

$$= 1\cdot\bar{Q}_n + 0\cdot Q_n$$

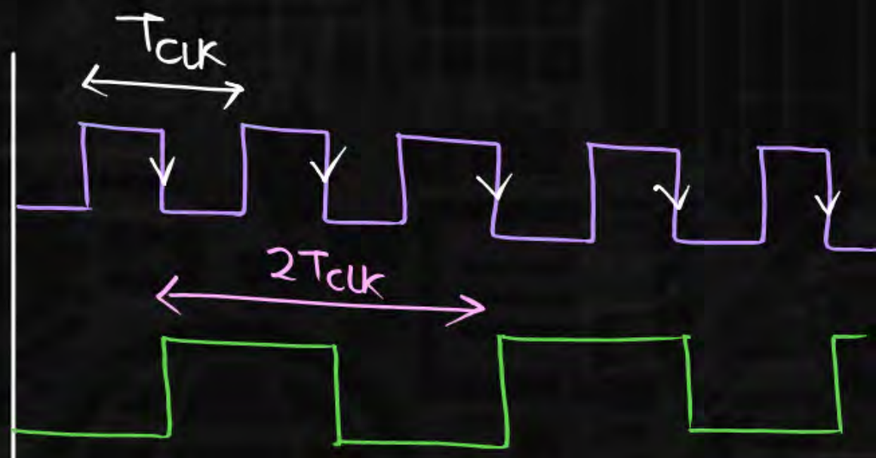
$$Q_{n+1} = \bar{Q}_n$$

$f_{clk} = \frac{1}{T_{clk}}$

$\frac{f_{clk}}{2}$: 0 → 1 → 0 → 1 → 0

1st 2nd 3rd 4th

1 → 0 → 1 → 0 → 1



$$f_Q = \frac{1}{2T_{clk}} = \frac{\left(\frac{1}{T_{clk}}\right)}{2} = \frac{f_{clk}}{2}$$

$$f_Q = \frac{f_{clk}}{2}$$

TOGGLE MODE OF FLIP FLIPS

2. Toggle mode of J K Flip Flop.

(ii)

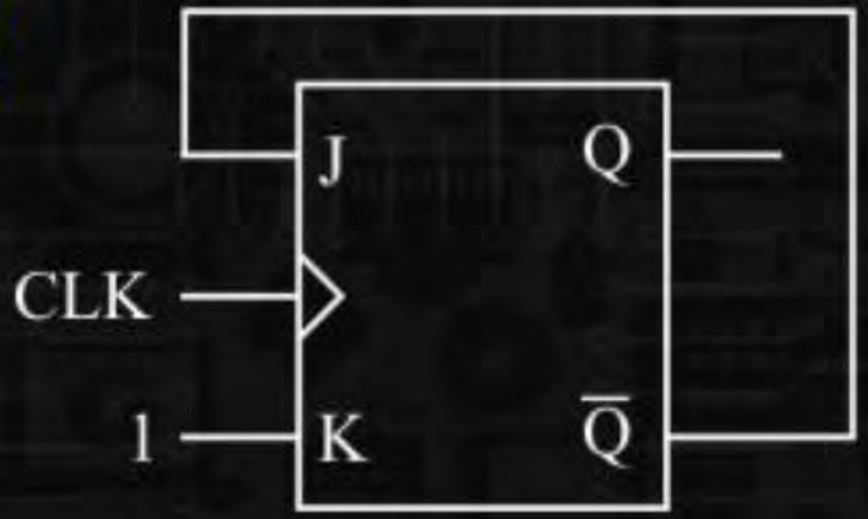


Figure 8: Toggling Mode of modified JK Flip Flop

$Q_{n+1} = J\bar{Q}_n + \bar{K}Q_n$

$= \bar{Q}_n \cdot \bar{Q}_n + 0 \cdot Q_n$

$Q_{n+1} = \bar{Q}_n$

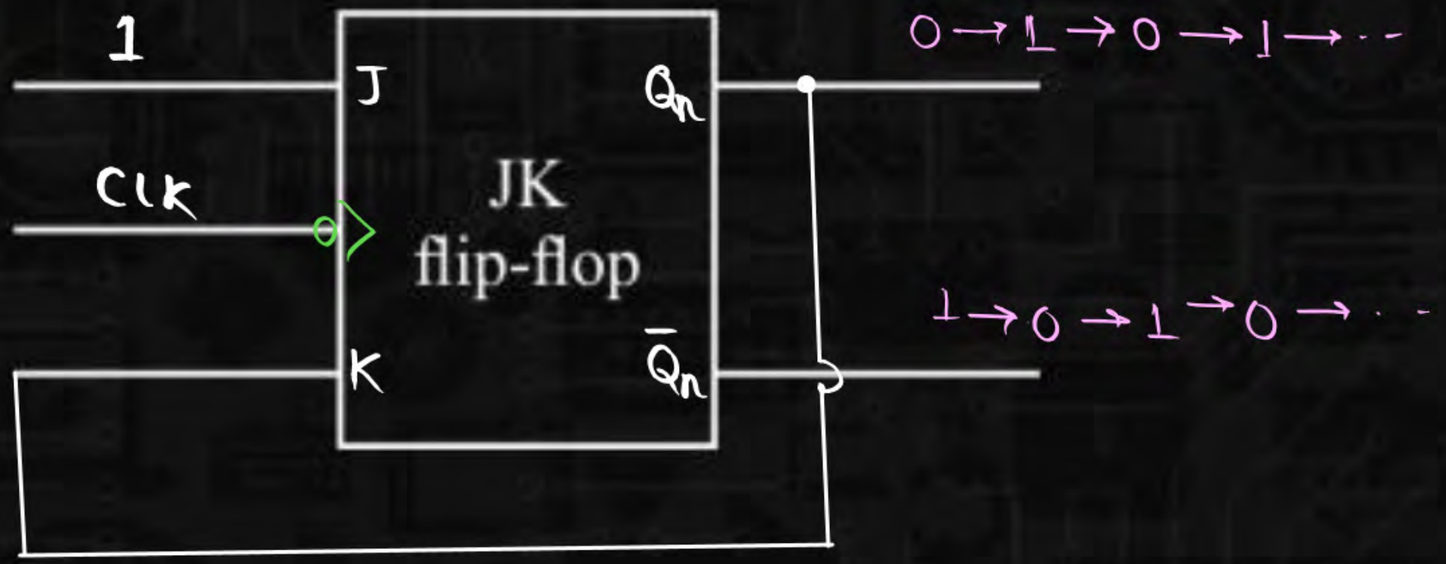
$Q = 0 \rightarrow 1 \rightarrow 0 \rightarrow 1 \rightarrow 0 \rightarrow \ldots$

$\bar{Q} = 1 \rightarrow 0 \rightarrow 1 \rightarrow 0 \rightarrow 1 \rightarrow \ldots$

TOGGLE MODE OF FLIP FLIPS

2. Toggle mode of J K Flip Flop.

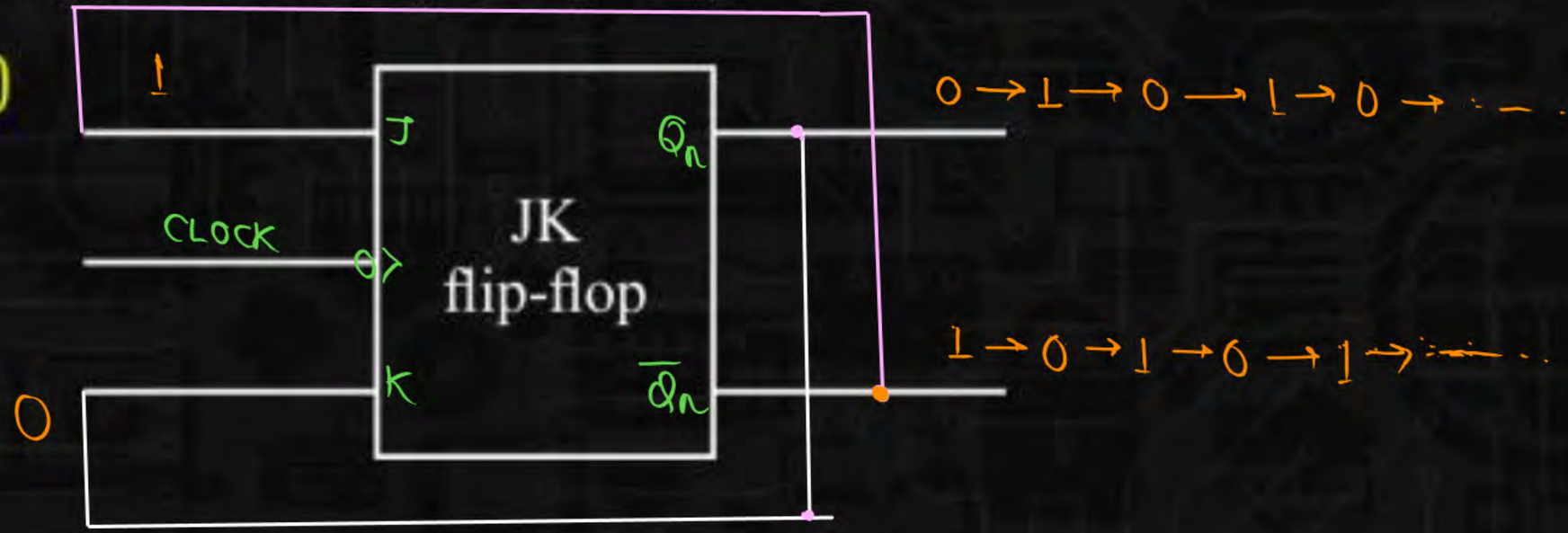
(iii)



TOGGLE MODE OF FLIP FLIPS

2. Toggle mode of J K Flip Flop.

(iv)

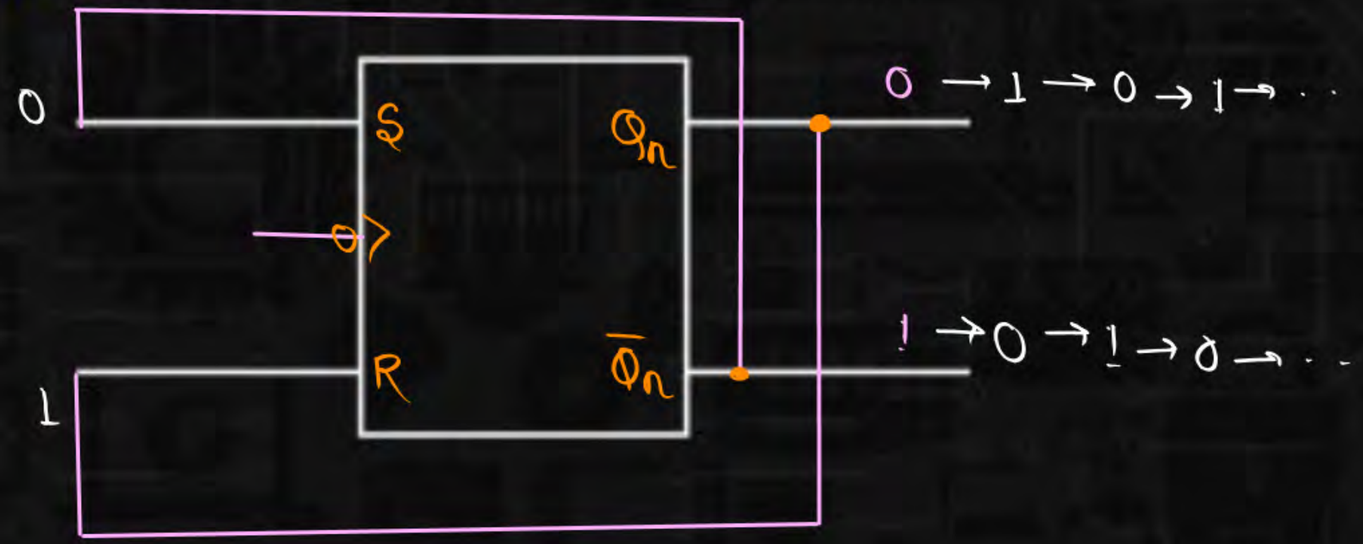


TOGGLE MODE OF FLIP FLIPS

$S = \bar{Q}_n$

$R = Q_n \rightarrow \bar{R} = \bar{Q}_n$

3. Toggle mode of S R Flip Flop.



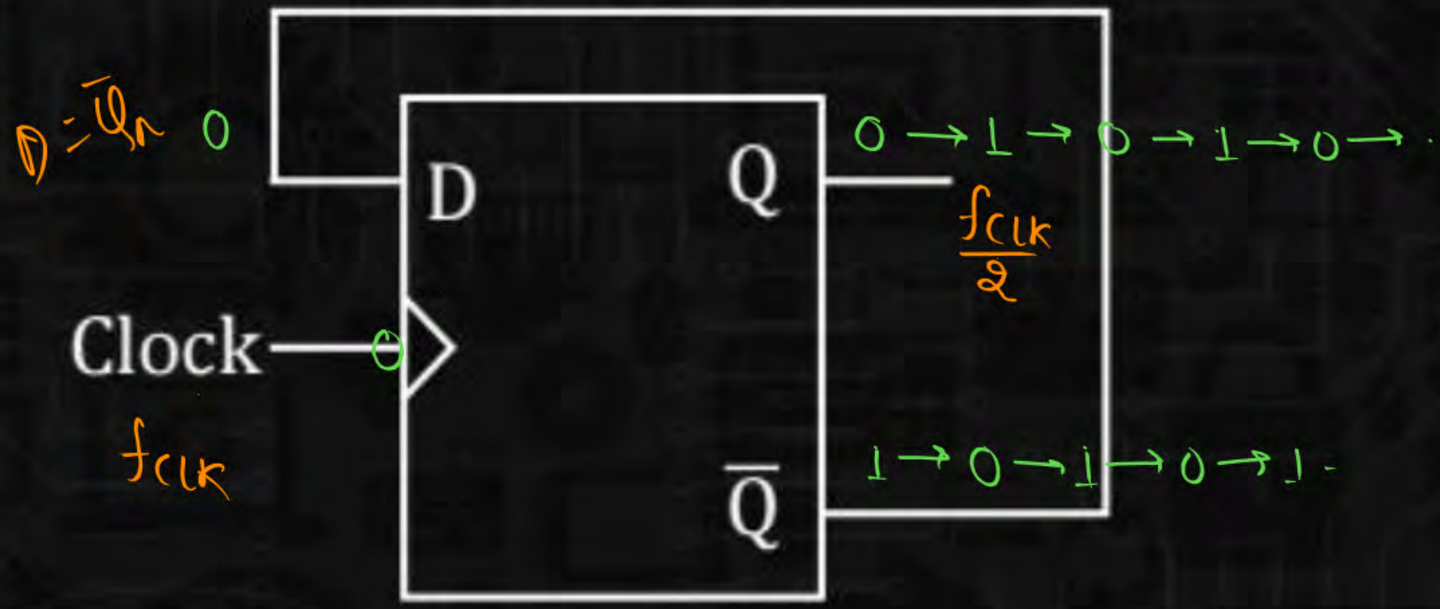
$Q_{n+1} = S + \bar{R} Q_n$

$= \bar{Q}_n + \bar{Q}_n \cdot Q_n$

$Q_{n+1} = \bar{Q}_n$

TOGGLE MODE OF FLIP FLOPS

4. Toggle mode of D Flip Flop.



$Q_{n+1} = D$

$Q_{n+1} = \bar{Q}_n$

COUNTER

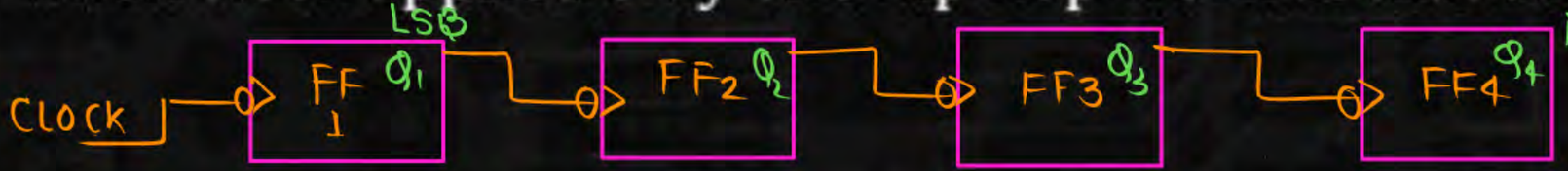
1. Counters are used to count Number of clocks.
2. Counter are used as Frequency Divider Circuit.
3. Counter are also used in ADC.
4. Counters are also known as pulse stretcher circuit.
5. Counters also used in RADAR for detection of Range.

TYPES OF COUNTER

1. Asynchronous Counter
2. Synchronous Counter

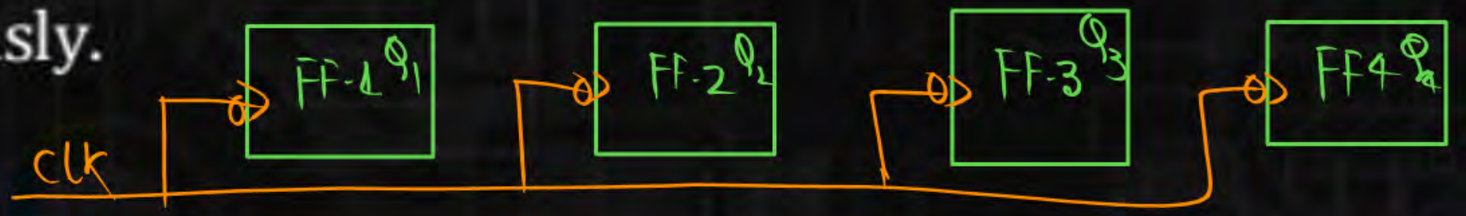
TYPES OF COUNTER

1. Asynchronous Counter: Only one flip flop having external clock and output of that flip flop will become clock for the next flip flop. So when clock applied only one flip flop work at that time.



MSB ↓ LSB ↓ $Q_4 Q_3 Q_2 Q_1$

2. Synchronous Counter: All Flip Flops are connected with the same clock. Hence when clock is applied all the flip flops work simultaneously.



$Q_1 Q_2 Q_3 Q_4$

COUNTER

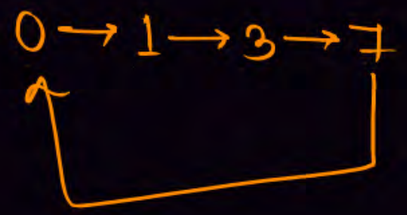
Synchronous counter	Asynchronous counter
① All the FF's are synchronized with same clock.	① Only one FF having external clock and o/p of that FF will be clock for the next FF.
② Faster	② Slower
③ All type of counting are possible.	③ Only increasing or decreasing counting are possible.
④ No Transition error	④ Transition error occures
⑤ Ex. Ring counter, Johnson counter	⑤ Ex. Ripple counter.

COUNTER MAXIMUM STATE

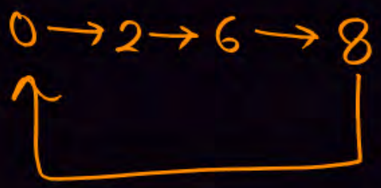
Maximum number of states $= 2^n$

$n \rightarrow$ no. of FF's

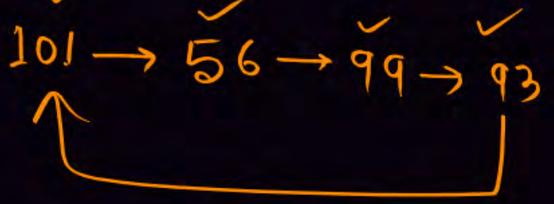
0 0
0 1
1 0
1 1
} 4



(MOD) MODULUS = 4



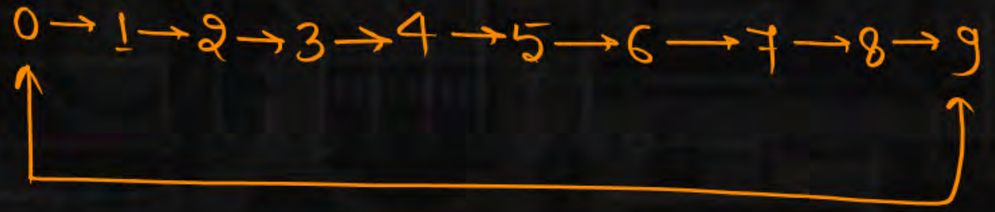
MOD = 4



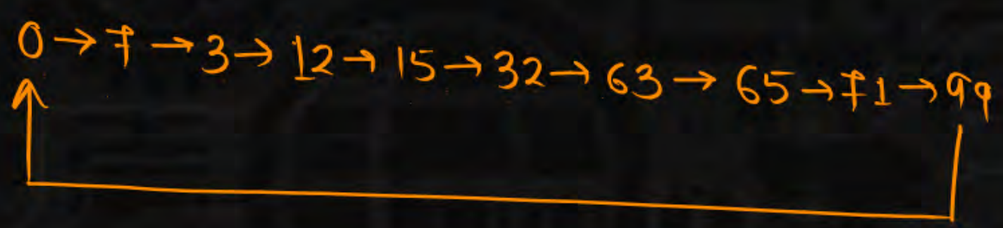
MOD = 4

MODULUS OF THE COUNTER

Number of states that can be used by the counters are called Modulus(MOD) of the Counter.



MOD = 10



MOD = 10

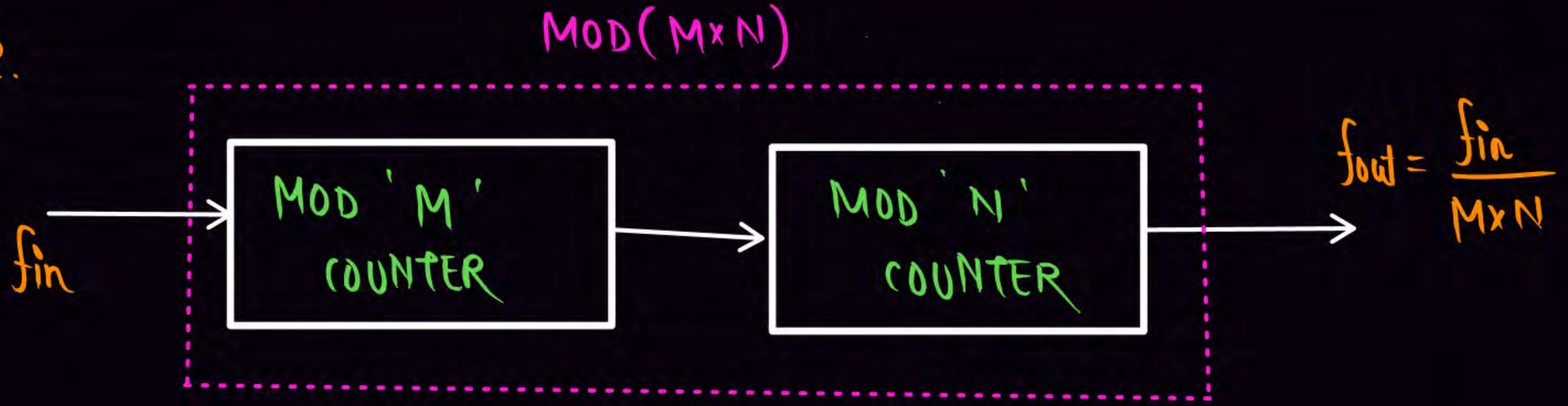
$$\text{MOD}(M) \leq 2^n$$

$$n \geq \log_2 M$$

NOTE 1.


fin
MOD 'M' COUNTER
fout = fin / M

2.


MOD (M×N)
fin
MOD 'M' COUNTER
MOD 'N' COUNTER
fout = fin / M×N

0000
0001
0010
0011
0100
0101
0110
0111
1000
1001

BCD

BCD Counter

MOD-10 Counter

→ BCD ✗

↳ not neccessarily

Q. If mode-5 counter is cascaded with mod-2 counter, then it will become?

$5 \times 2 = \text{MOD}-10$

A. Mod 10 counter ✓

B. BCD Counter ✗

C. Both A and B ✗

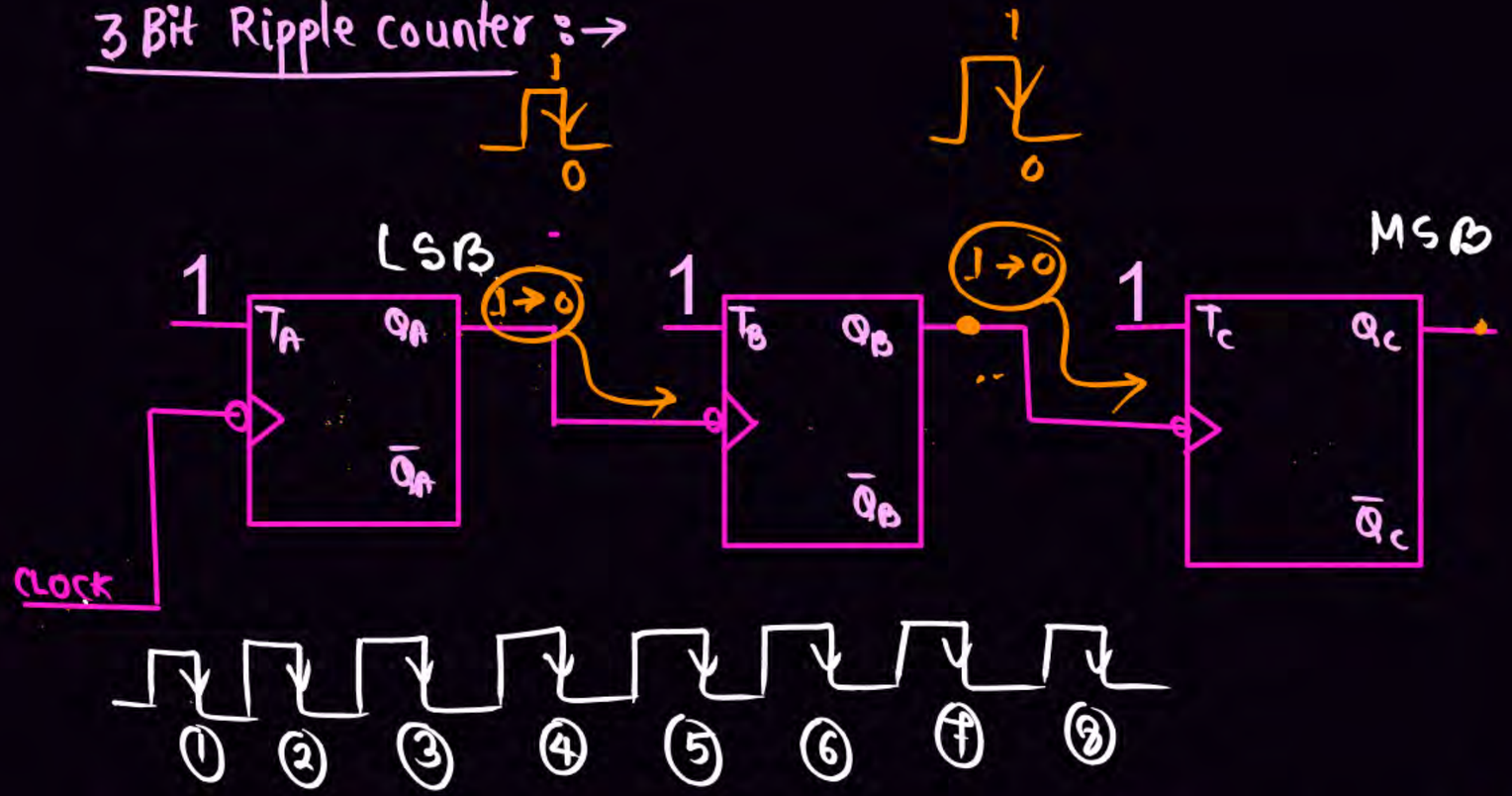
D. None ✗

Asynchronous counter :→

RIPPLE COUNTER

- All the FF's are used in toggle mode.

3 Bit Ripple counter :→



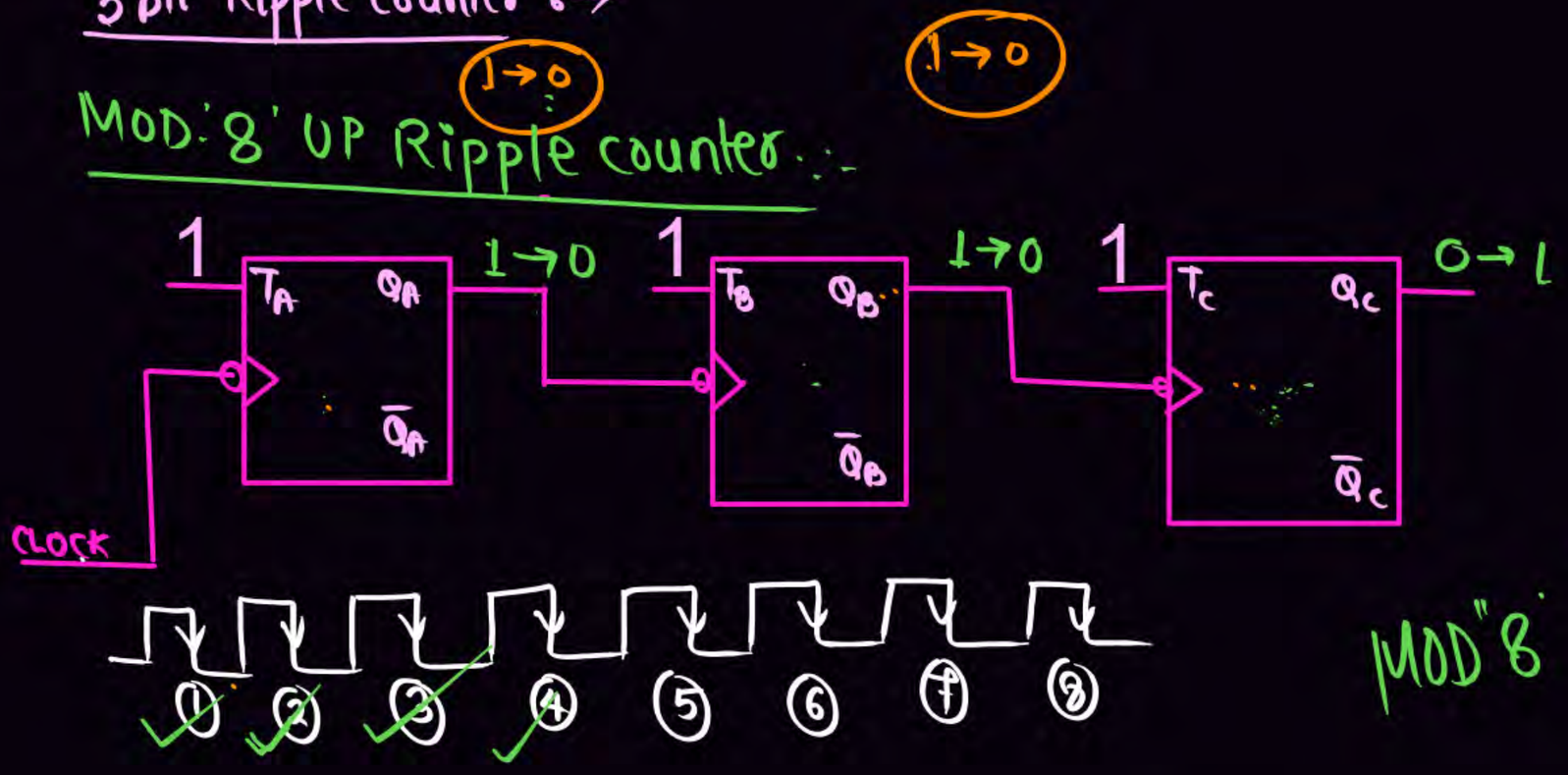
① Q_A will toggle for every -ve edge of external clock.

② Q_B will toggle when Q_A goes from 1 to 0.

③ Q_C will toggle when Q_B goes from 1 to 0.

3 Bit Ripple counter :→

MOD '8' UP Ripple counter :-



MOD "8"

Clock	Q_C	Q_B	Q_A
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1
8	0	0	0
9	0	0	1
10			


THANK YOU GW
SOLDIERS !