



**EC/EE/CS & IT/IN**

**Digital Electronics**

**Asynchronous  
Counter**



**LECTURE NO. 9**

**Chandan Jha Sir (CJ Sir)**



ज़िंदगी कि असली उड़ान बाकी है  
जिंदगी के कई इम्तेहान अभी बाकी है  
अभी तो नापी है मुट्ठी भर ज़मीन हमने  
अभी तो सारा आसमान बाकी है



# Design a CJ by using SR FF?

C	J	$Q_{n+1}$
0	0	1
0	1	0
1	0	$Q_n$
1	1	$Q_n$

Step-1 & step 2.



C	J	$Q_n$	$Q_{n+1}$	S	R
0	0	0	1	1	0
0	0	1	1	X	0
0	1	0	0	0	X
0	1	1	0	0	1
1	0	0	1	1	0
1	0	1	0	0	1
1	1	0	0	0	X
1	1	1	1	X	0

C	J	$Q_{n+1}$
0	0	1
0	1	0
1	0	$Q_n$
1	1	$Q_n$

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



Step 3  
Step 4

$$S(c, J, Q_n) = \sum m(0, 4) + \sum d(1, 7)$$

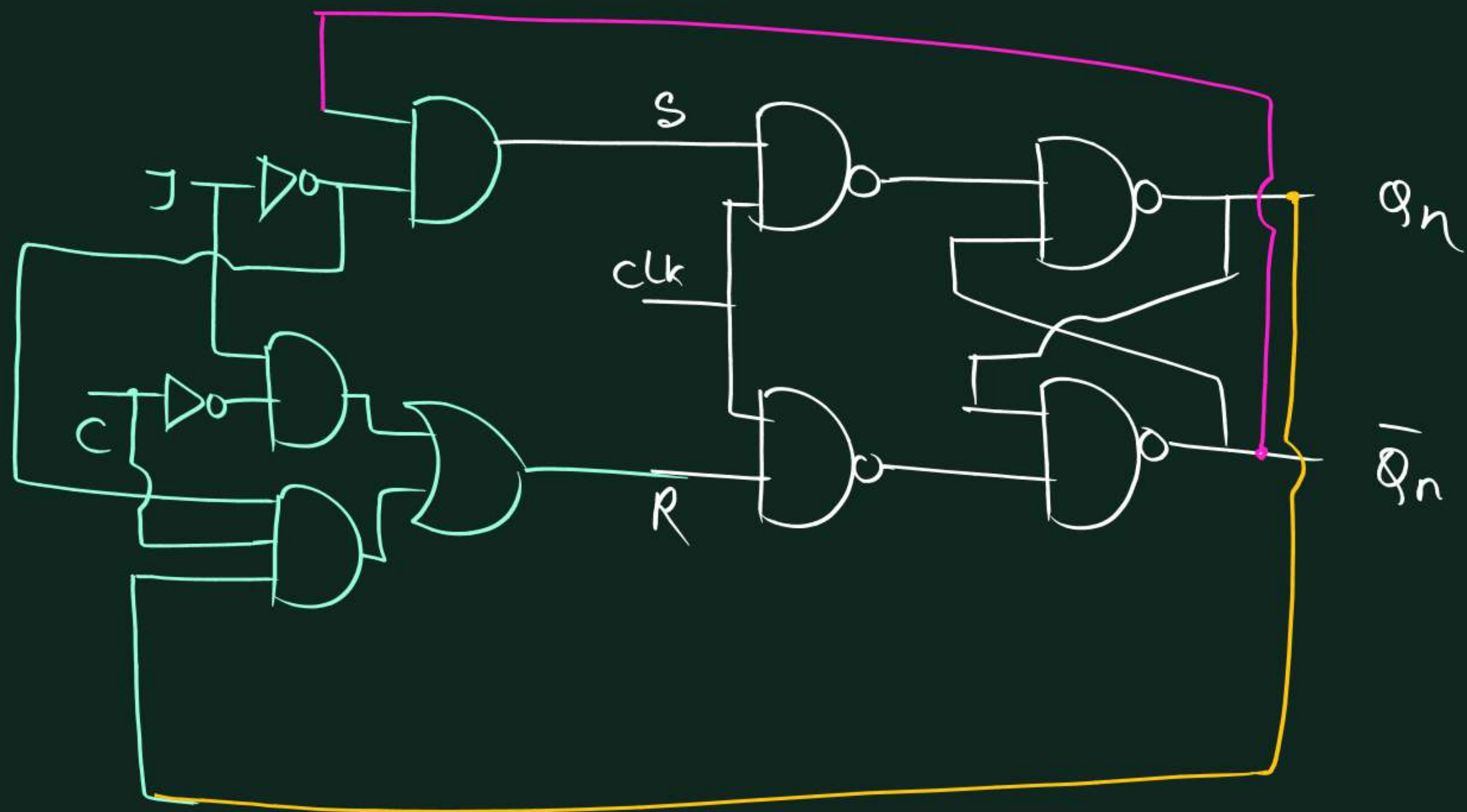
$c \backslash JQ_n$	00	01	11	10
0	1	X		
1	1		X	

$$S = \bar{J} \bar{Q}_n$$

$$R(c, J, Q_n) = \sum m(3, 5) + \sum d(2, 6)$$

$c \backslash JQ_n$	00	01	11	10
0			1	X
1		1		X

$$R = c \bar{J} \bar{Q}_n + \bar{c} J$$

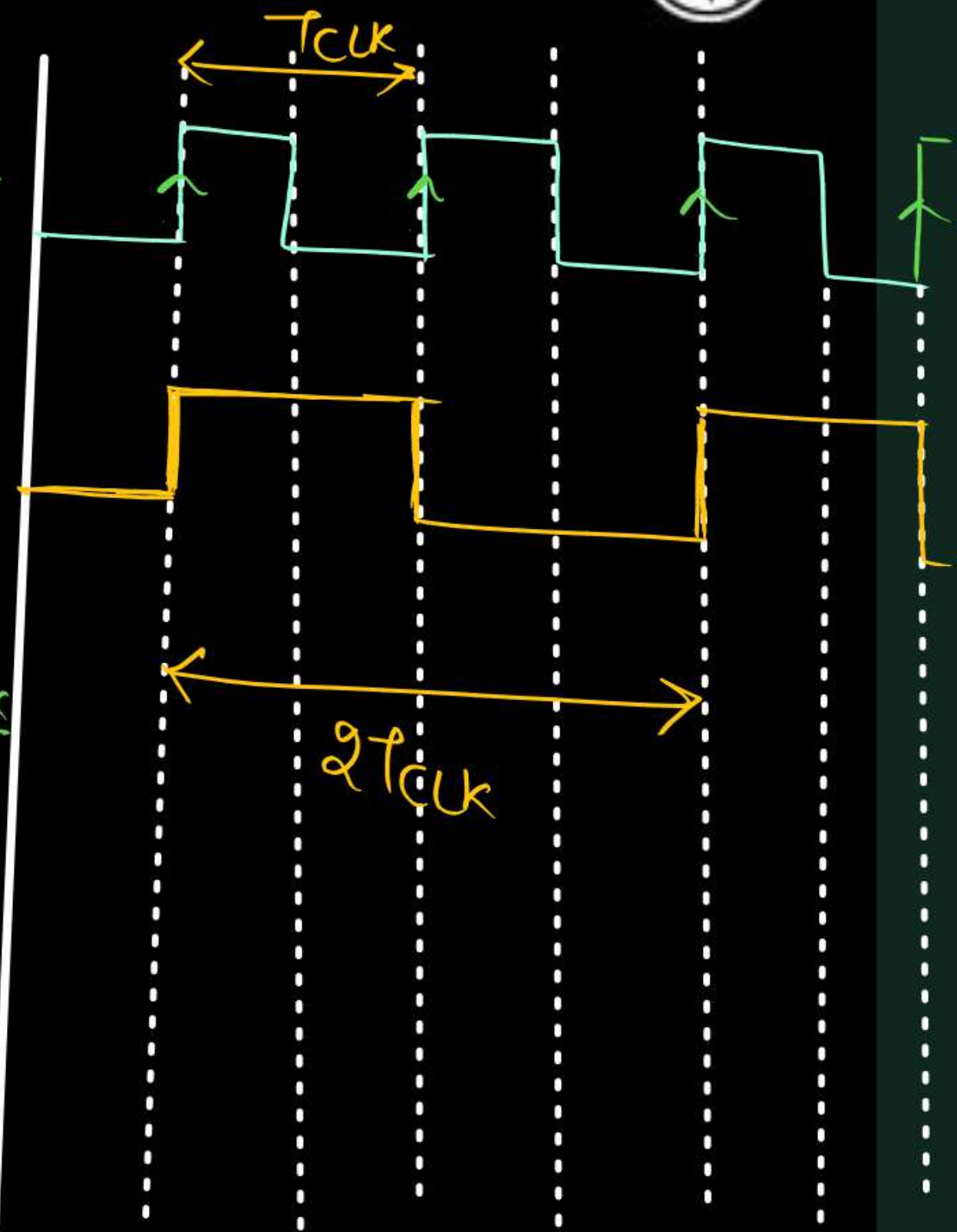
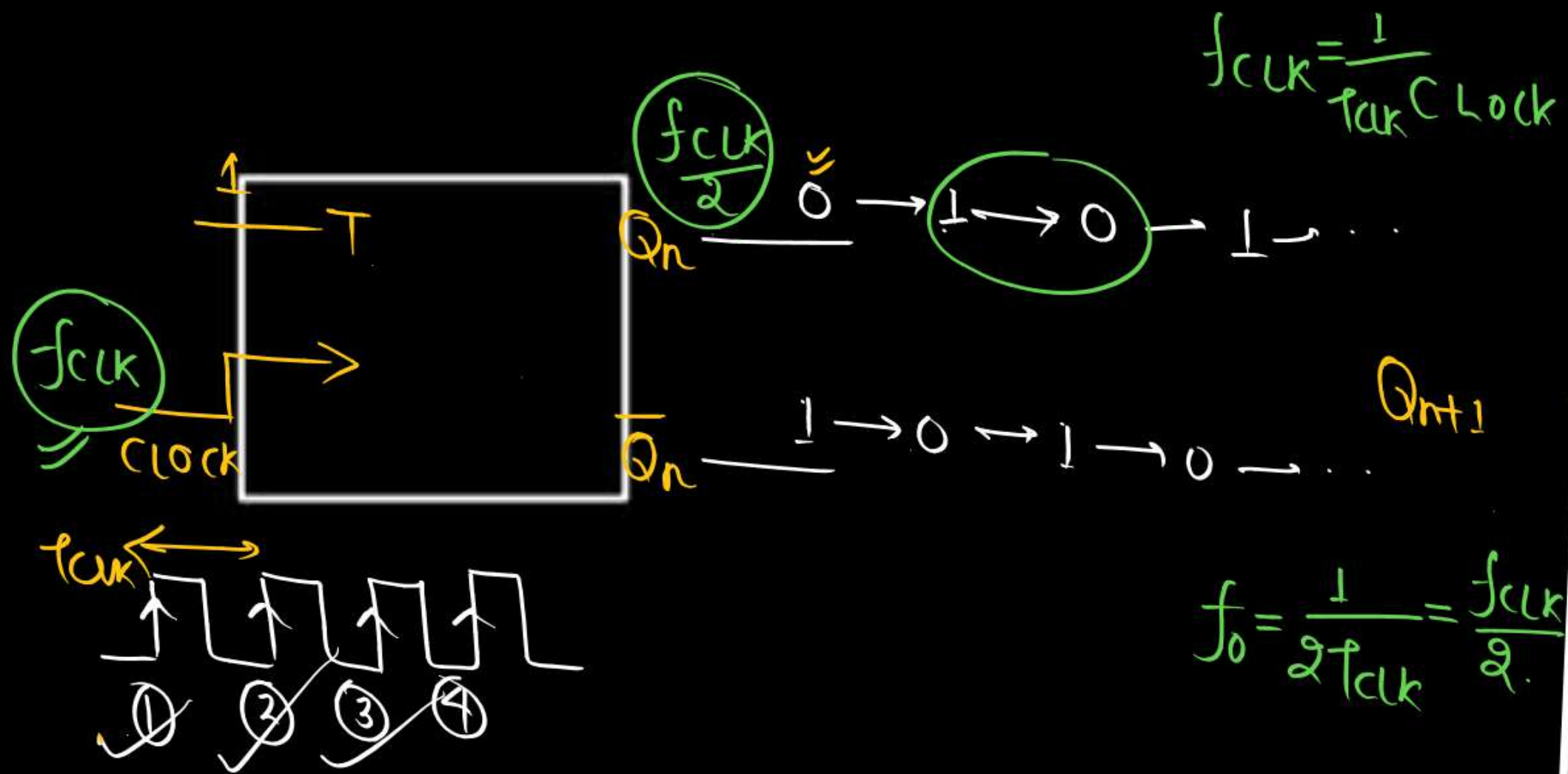


Design a JK FF by using SR FF FF?

J	K	$Q_n$	$Q_{n+1}$	S	R
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

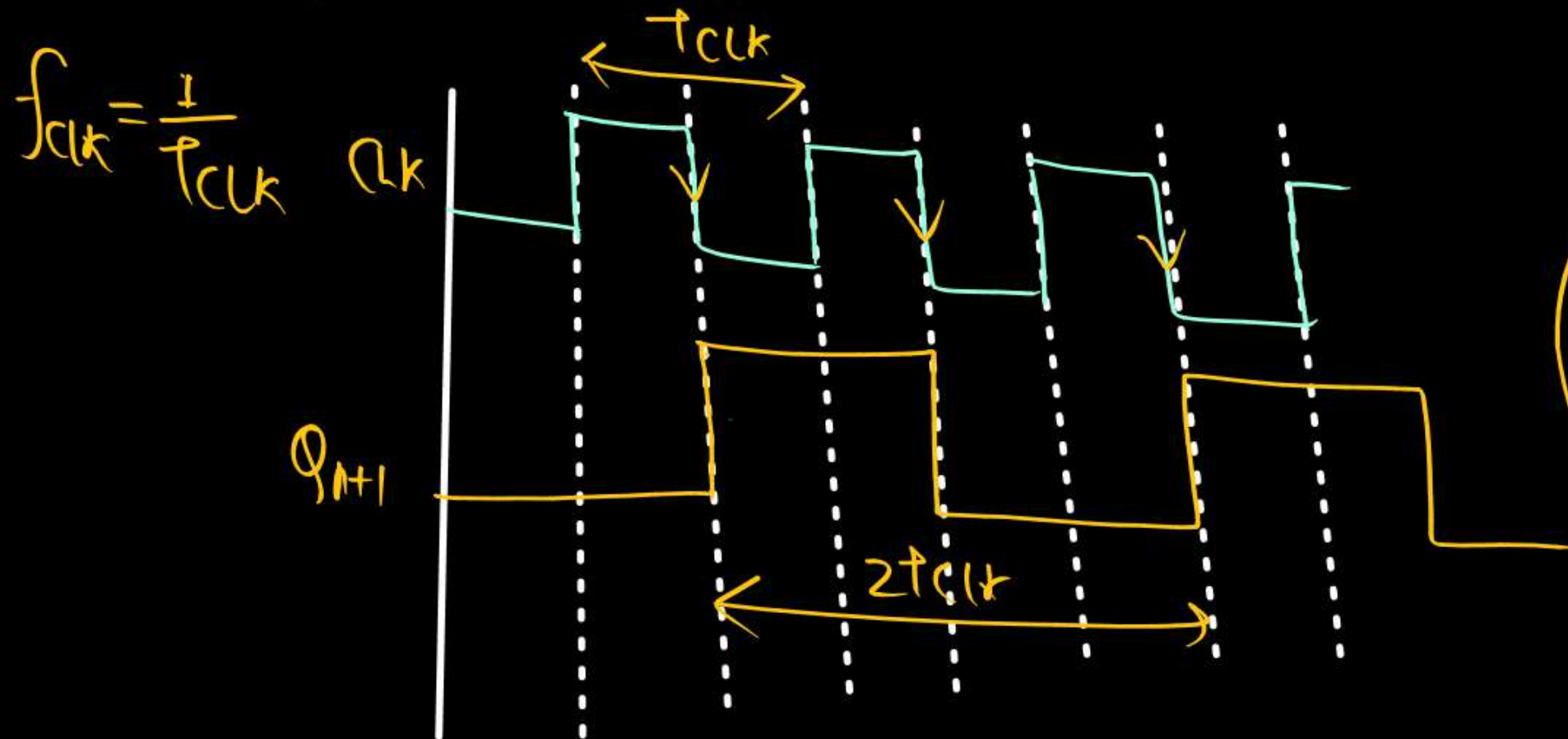
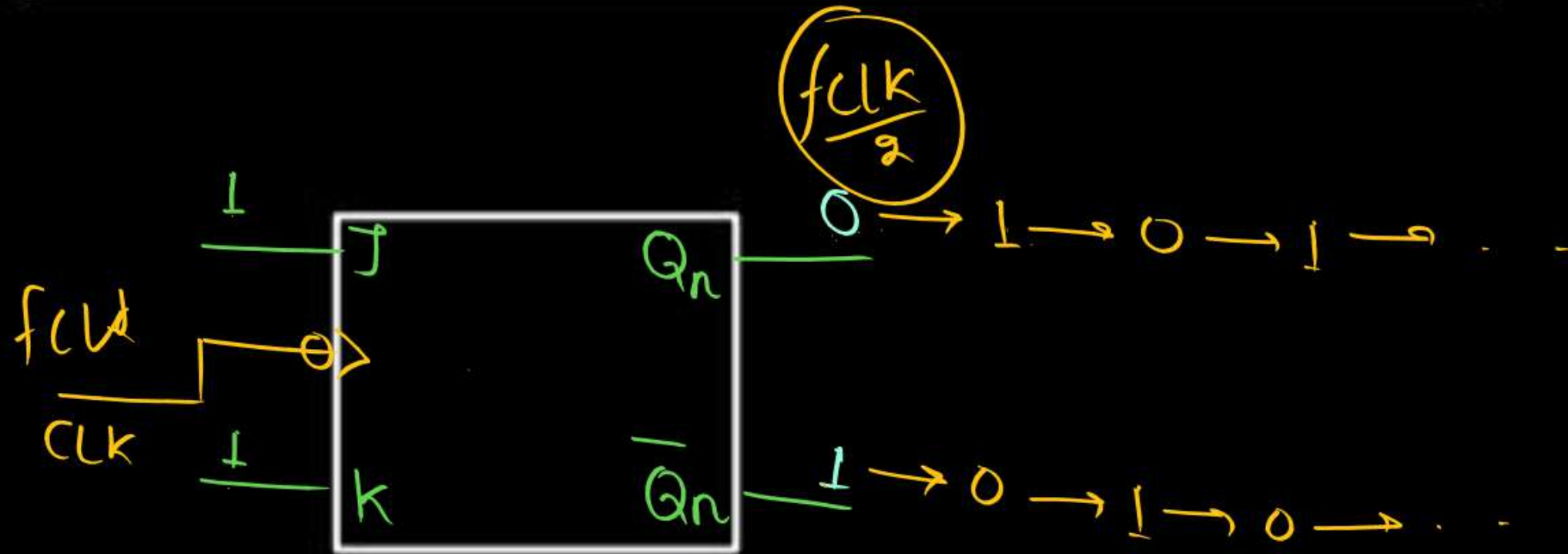


# TOGGLE MODE OF THE FLIP FLOP



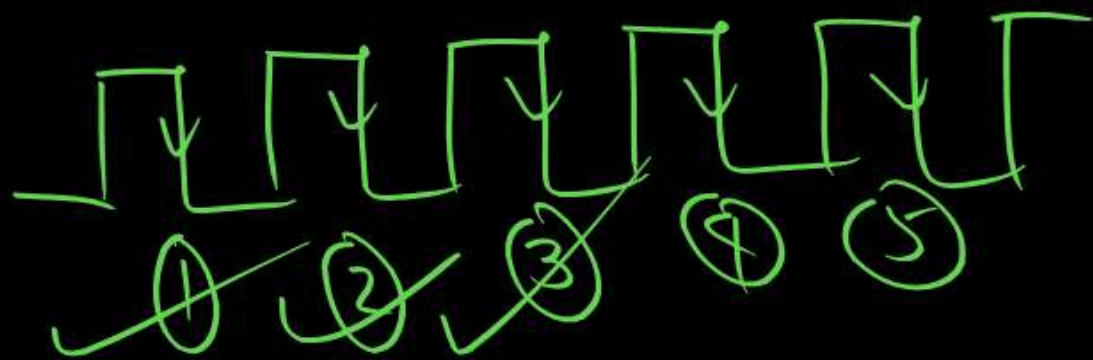
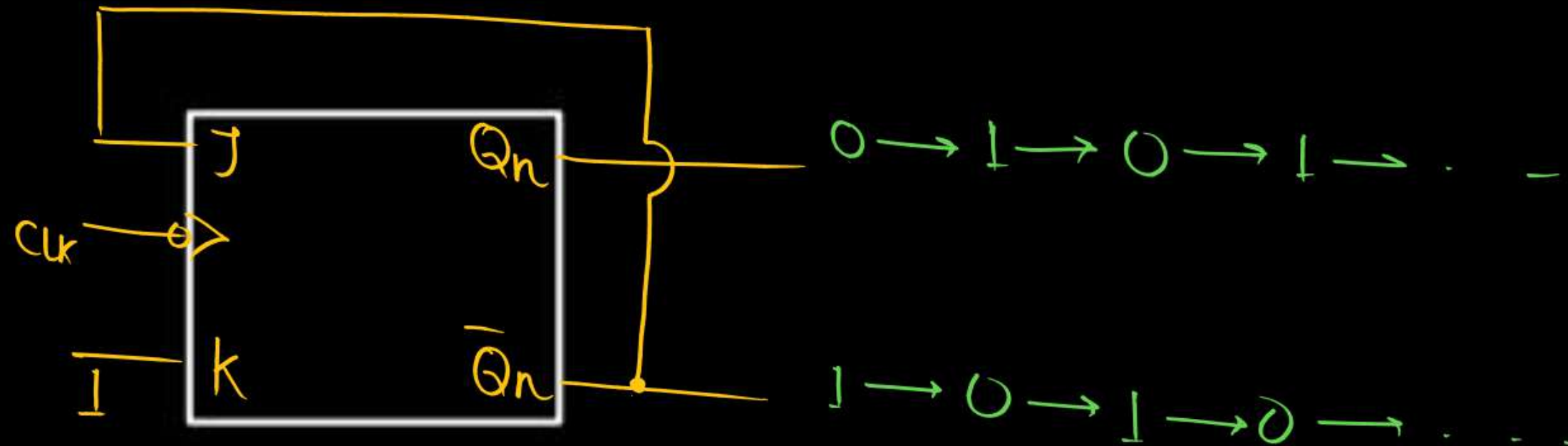


# TOGGLE MODE OF THE FLIP FLOP

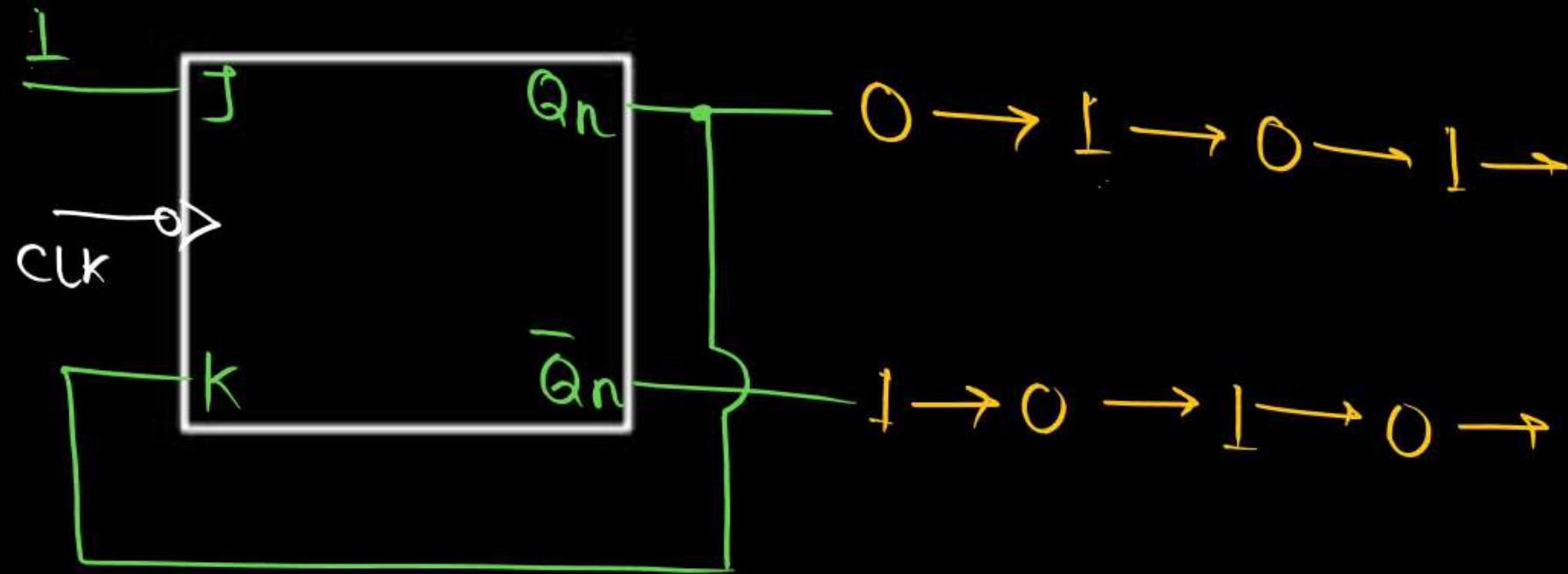


$$f_o = \frac{f_{clk}}{2}$$

# TOGGLE MODE OF THE FLIP FLOP

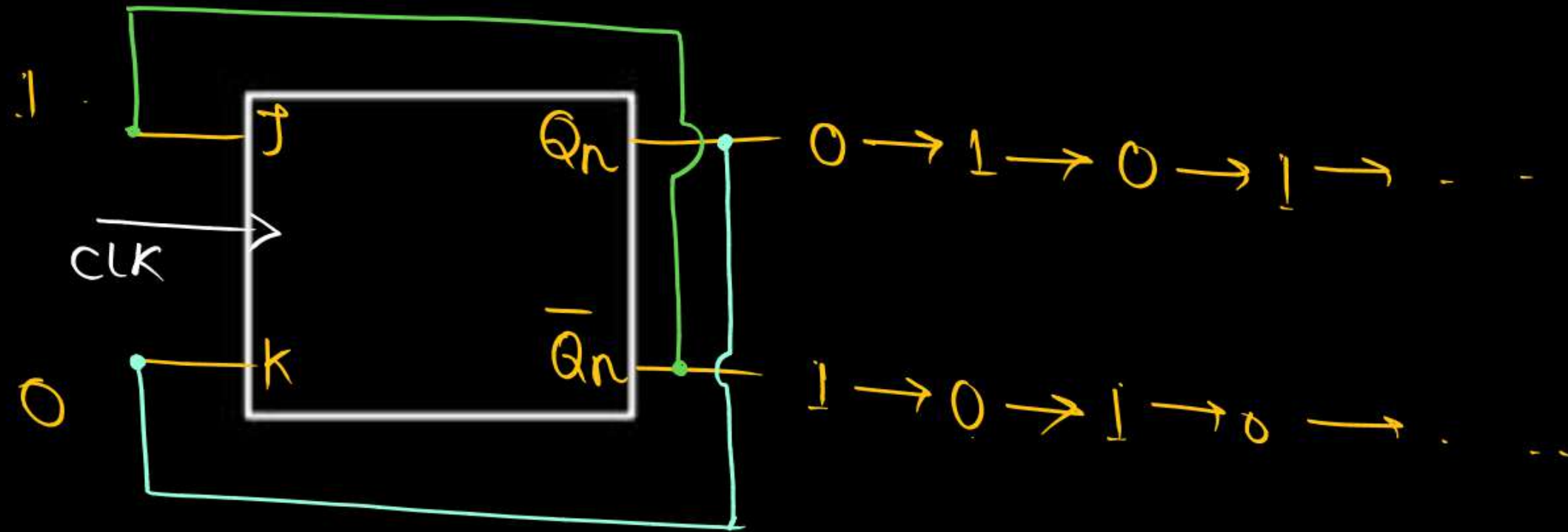


# TOGGLE MODE OF THE FLIP FLOP

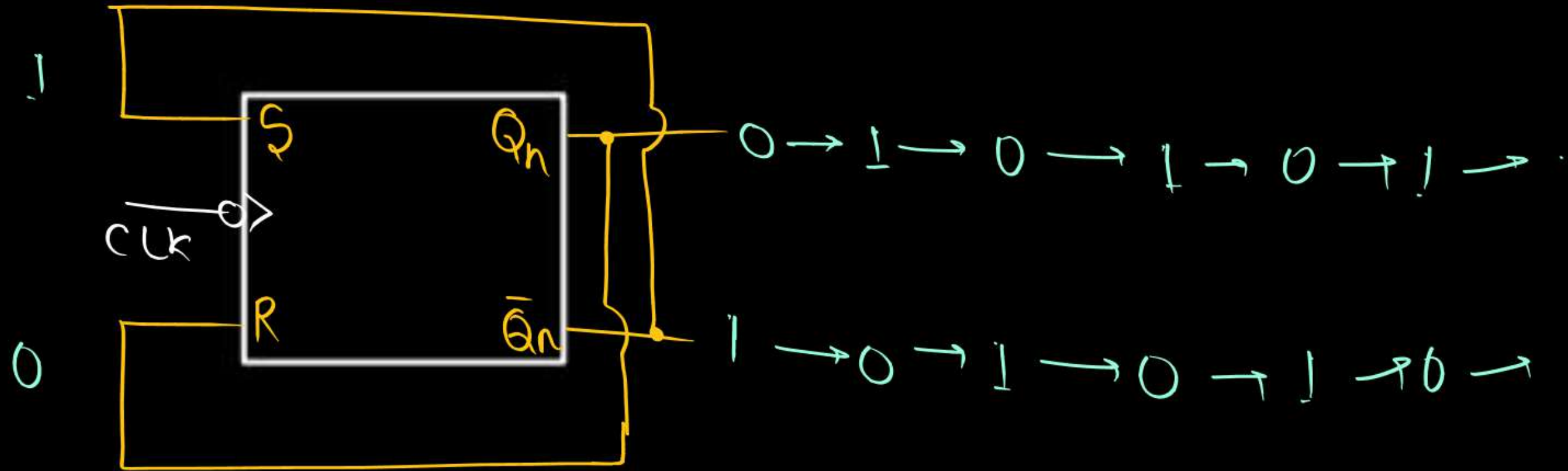




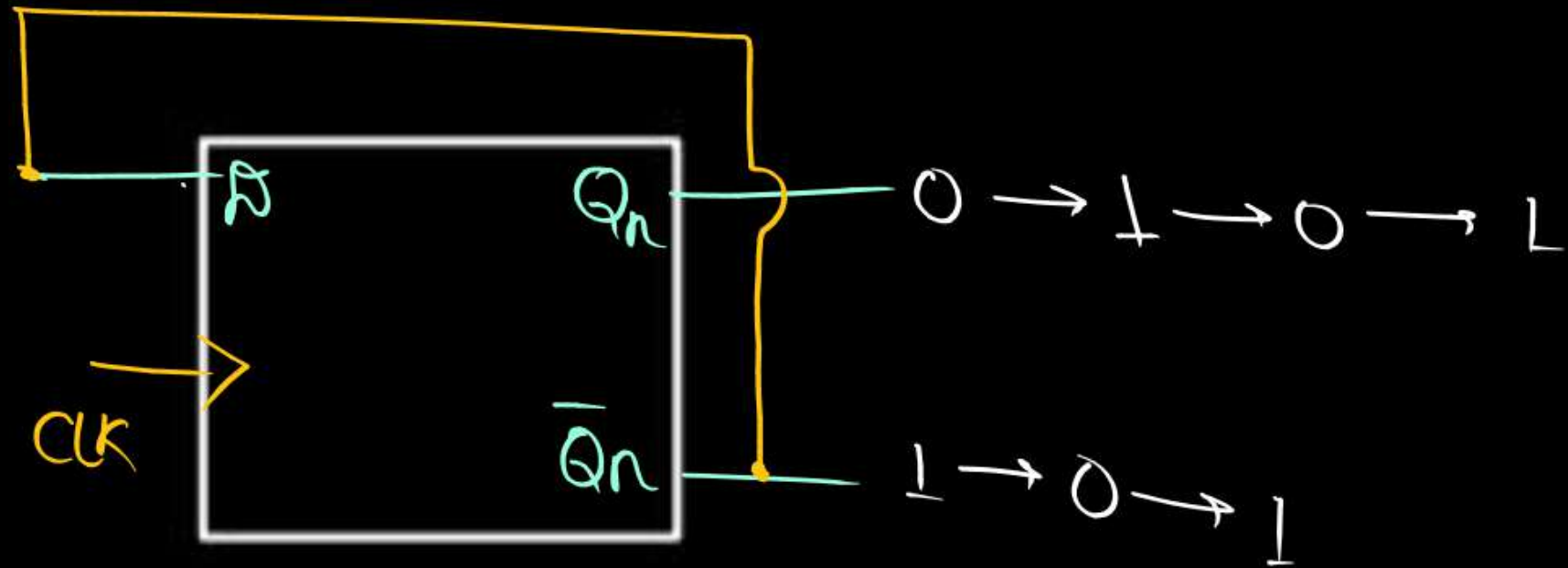
# TOGGLE MODE OF THE FLIP FLOP



# TOGGLE MODE OF THE FLIP FLOP



# TOGGLE MODE OF THE FLIP FLOP





1. Counter are used to count number of clock.
2. Counters are also known as frequency divider circuit.

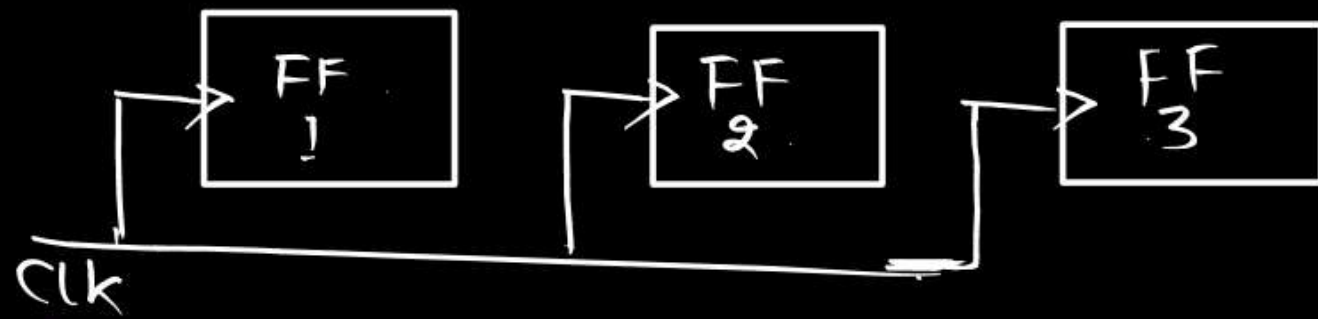
① Synchronous counter

② Asynchronous counter

UP	DOWN	RANDOM
1	5	1
2	4	3
3	3	2
4	2	5
5	1	4

## Synchronous Counters

1. All the flip flops are connected with same clock.



② fast

③ All type of counting are possible.

④ Ex. Ring, Johnson counter

## Asynchronous Counters

1. Only one Flip Flop having External clock and the outputs of that flip flop will be clock for the next flip flop

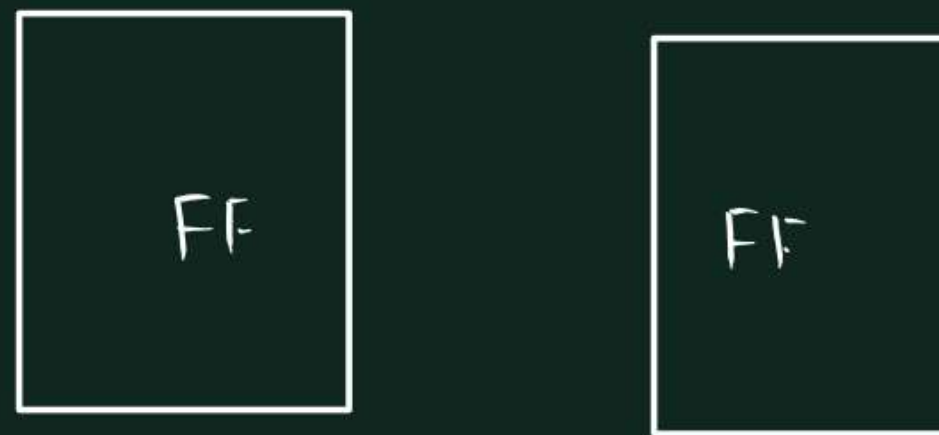
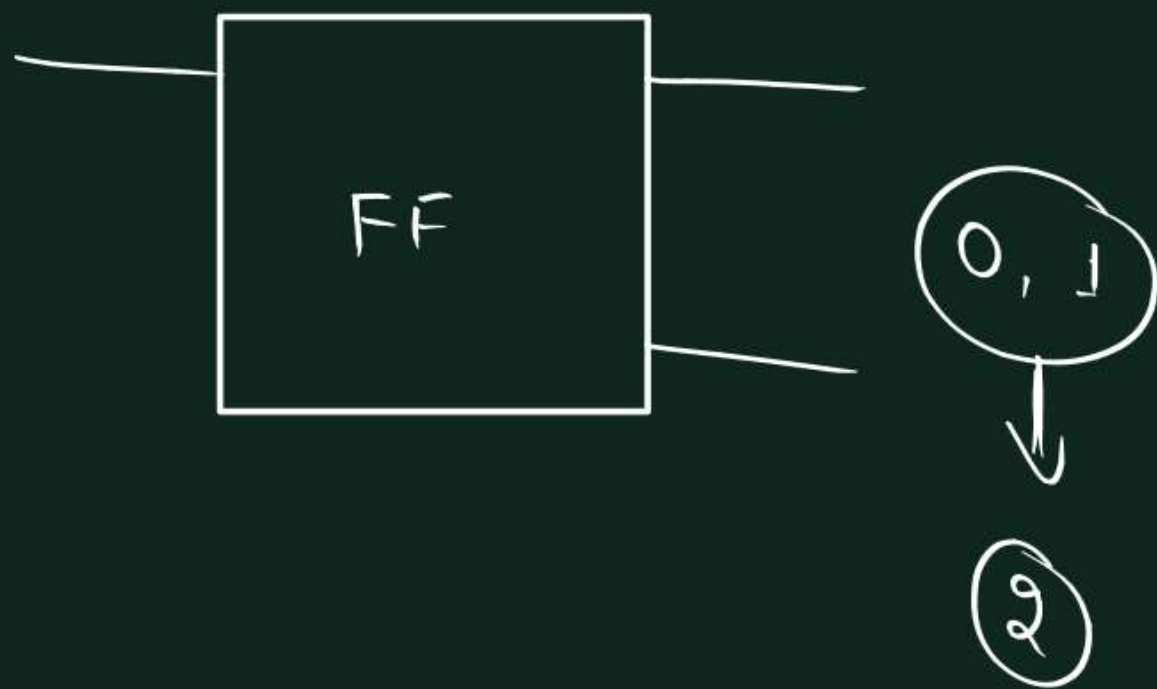


② slow

③ Generally UP & DOWN counting are possible.

④ Ex. Ripple counter





$$\left\{ \begin{array}{cc} 0 & 0 \\ 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{array} \right\}$$

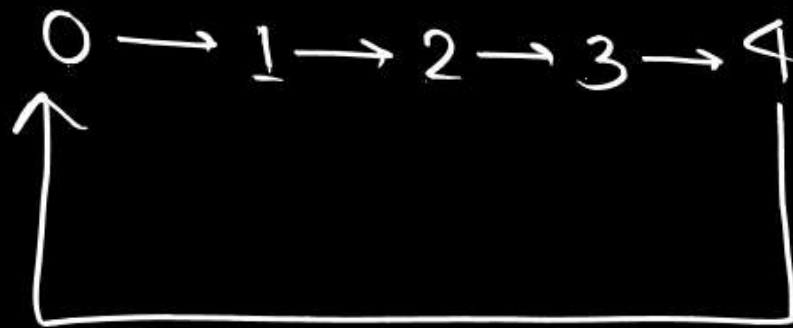
Maximum number of states =  $2^n$

$n \rightarrow$  Number of FF

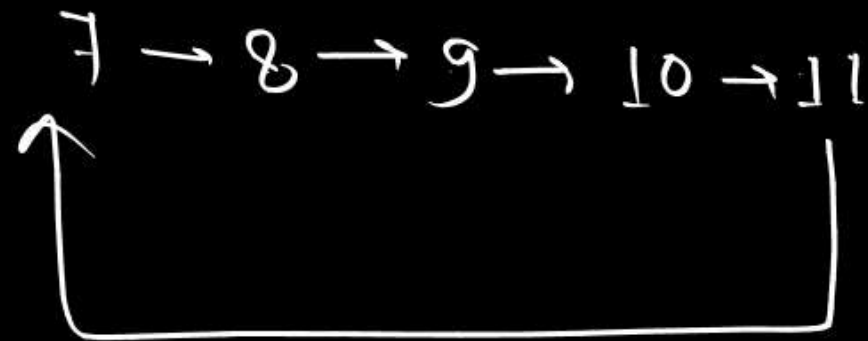
**MOD**



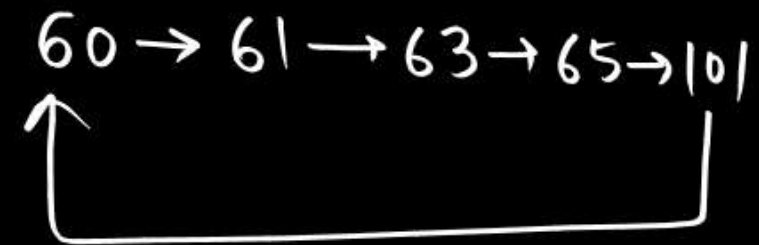
Number of states used by the counter.



MOD=5



MOD=5



MOD=5



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

$$M \leq 2^n$$

$$n \geq \log_2 M$$

Q <sup>3</sup> MOD-10 counter.

no. of FF?

$$M \leq 2^n$$

$$n \geq \log_2 M$$

$$n \geq \log_2 10$$

$$n \geq 3 \cdot \text{something}$$

$$n \approx 4$$

NOTE

1.

$f_{in}$



$f_{out} = \frac{f_{in}}{M}$

MOD (MxN)

2.

$f_{in}$



$f_{out} = \frac{f_{in}}{M \times N}$

BCD

→ Binary coded decimal

→ Every decimal number are represented by 4 bit.

BCD

100  
101  
102  
103  
104  
105  
105  
107  
106  
109

MOD-10

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

BCD



Q When MOD'5' counter is cascaded by MOD'2' counter  
Then it will become.

~~(A) MOD-10 counter~~

(B) BCD counter

~~(C) Both (A) & B~~

(D) MOD'7' counter

(E) Sir, Mujhe qta to hai par mai batunga nahi.

$$5 \times 2 = \textcircled{10}$$

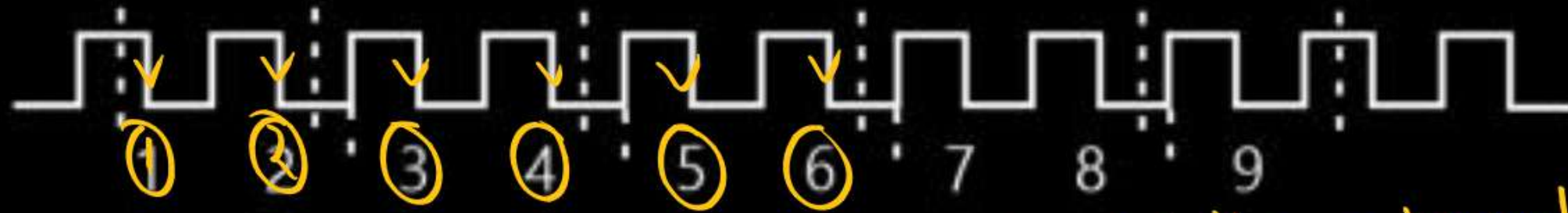
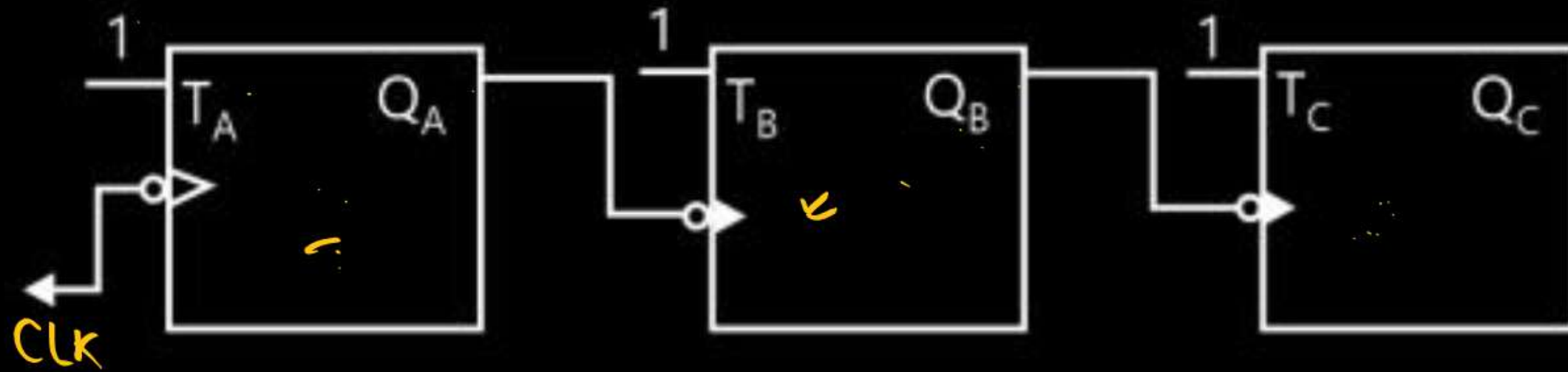
MOD



काम करो ऐसा कि एक पहचान बन जाए, ✓  
हर कदम ऐसा चलो कि निशान बन जाए,  
यहां जिंदगी तो हर कोई काट लेता है,  
जिंदगी जियो इस कदर कि मिसाल बन जाए।

ASYNCHRONOUS COUNTER → All the FF's are used in toggle Mod.

Ripple counter → 3 bit

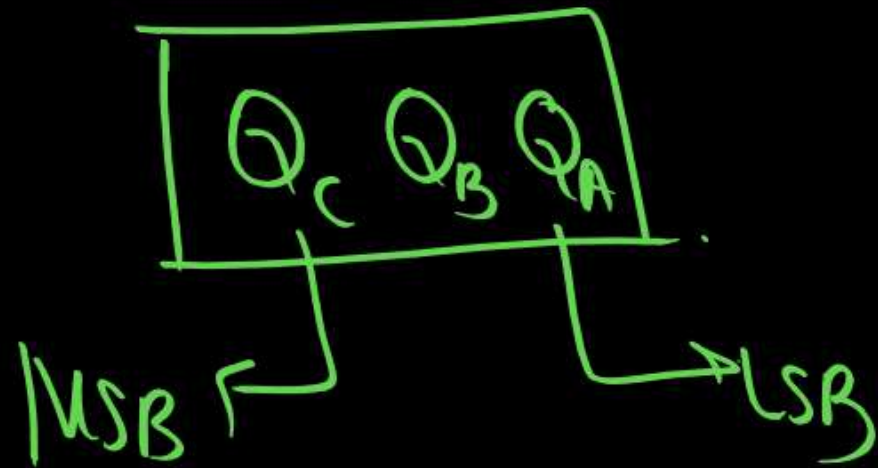
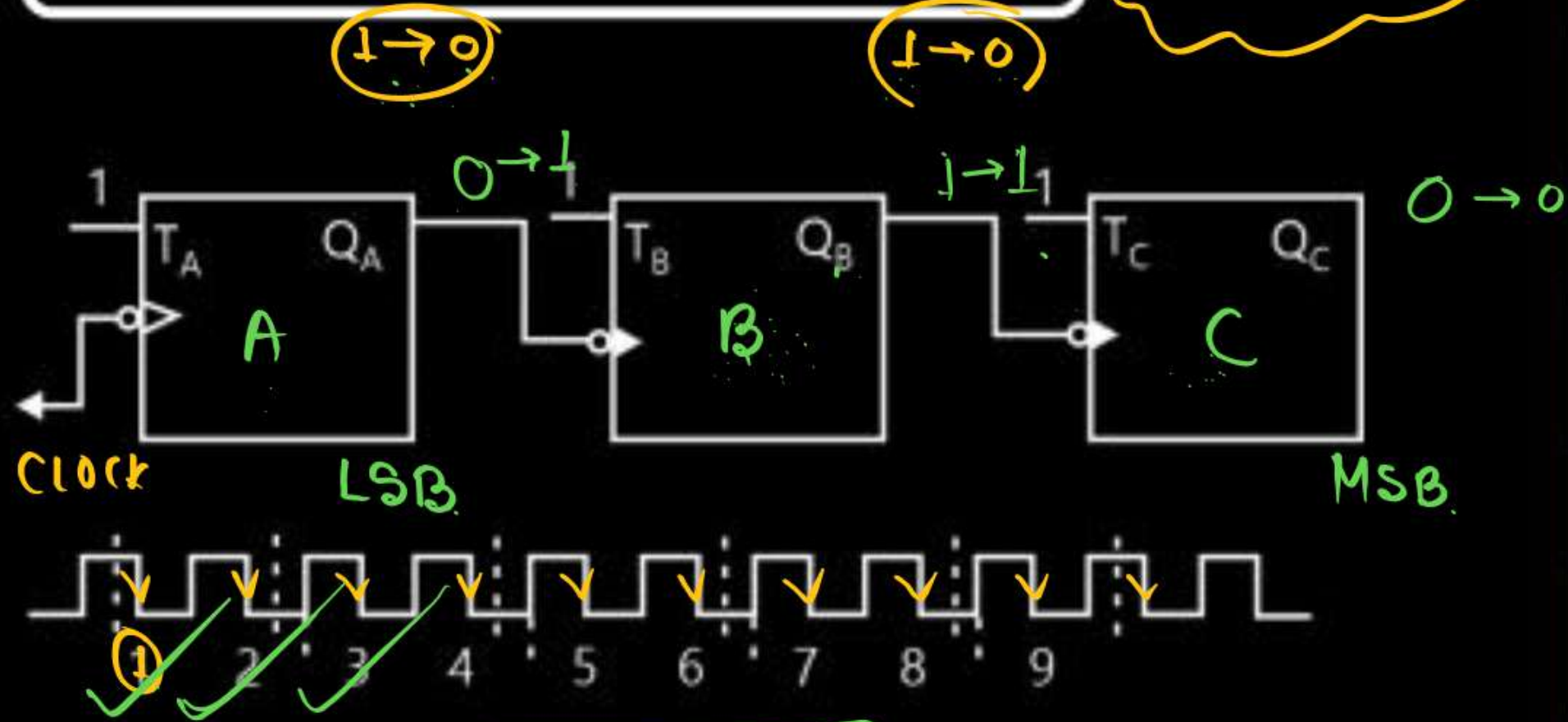


- ✓  $Q_A$  will toggle for every -ve edge of the external clock.
- ✓  $Q_B$  will toggle when  $Q_A$  goes from 1 → 0.
- ✓  $Q_C$  will toggle when  $Q_B$  goes from 1 → 0.



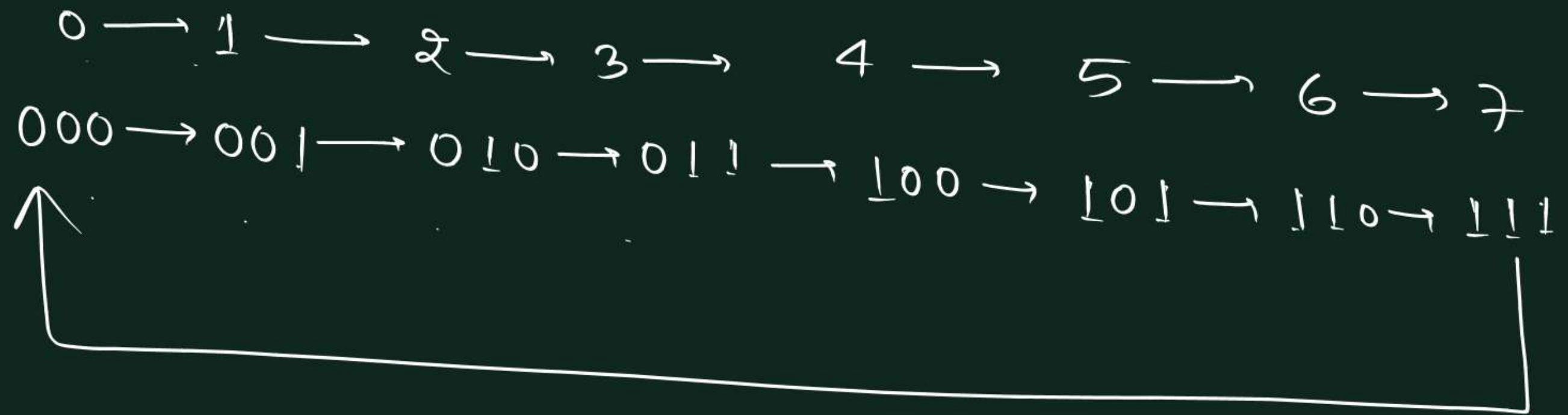
# Asynchronous Counter

3 bit Ripple counter



clock	QC	QB	QA
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

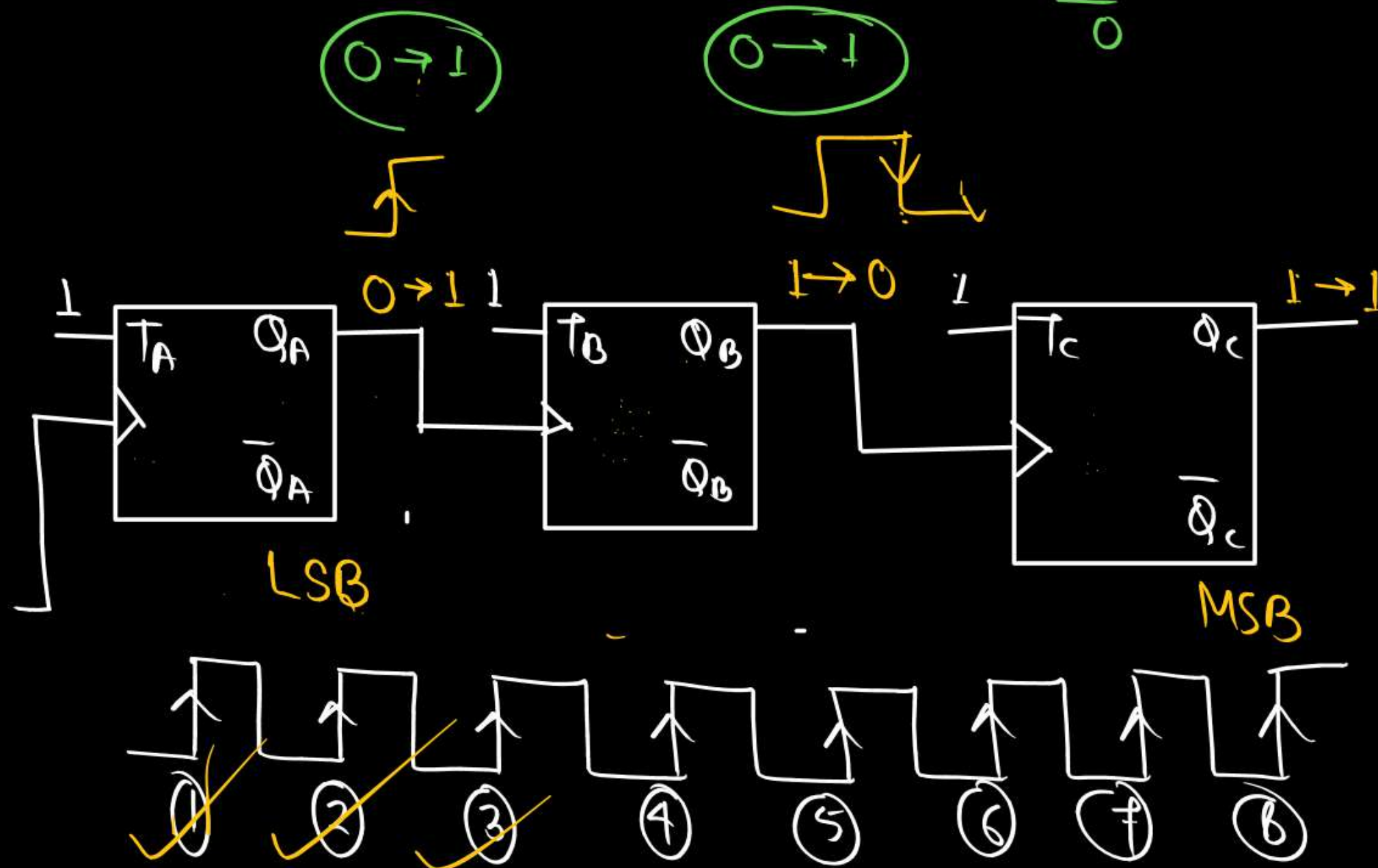




MOD-8 UP RIPPLE COUNTER

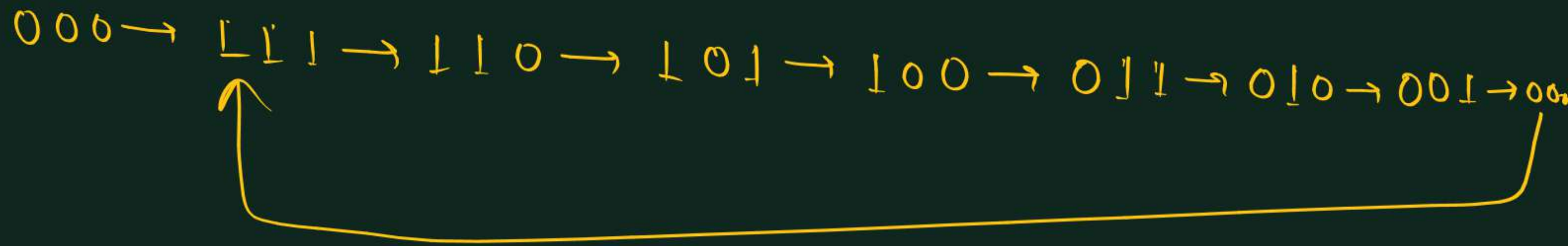


# Asynchronous Counter



clock	$Q_C$	$Q_B$	$Q_A$
0	0	0	0
1	1	1	1
✓ 2	1	1	0
3	1	0	1
✓ 4	1	0	0
✓ 5	0	1	1
✓ 6	0	1	0
✓ 7	0	0	1
✓ 8	0	0	0





MOD-8 DOWN RIPPLE COUNTER

# Asynchronous Counter



clock	$Q_C$	$Q_B$	$Q_C$
0			
1			
2			
3			
4			
5			
6			
7			
8			

# Asynchronous Counter



clock	$Q_C$	$Q_B$	$Q_C$
0			
1			
2			
3			
4			
5			
6			
7			
8			



# Asynchronous Counter



Bubble  
↓  
{ 0 → -ve.  
   $\overline{Q}$  → -ve

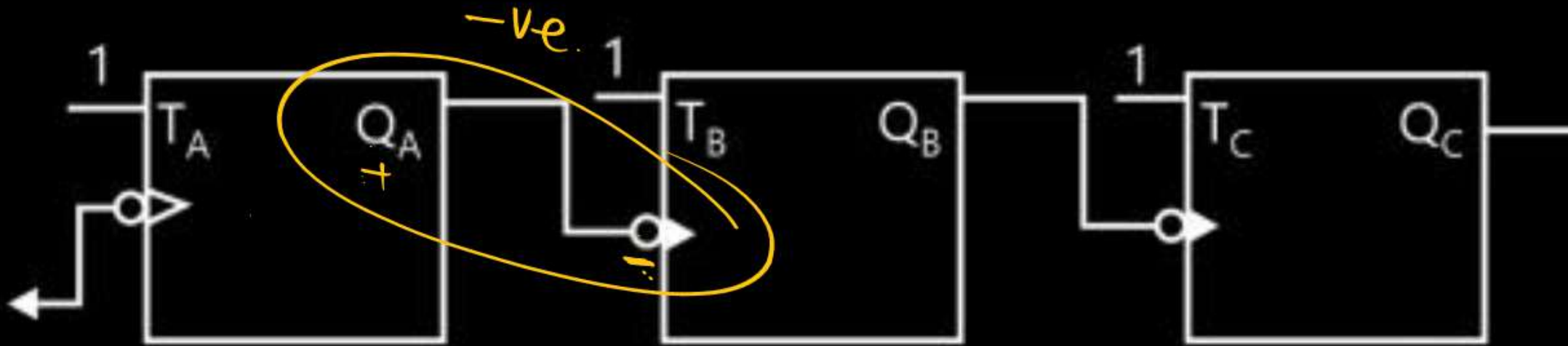
-ve → UP  
+ve → DOWN

clock	$Q_C$	$Q_B$	$Q_C$
0			
1			
2			
3			
4			
5			
6			
7			
8			

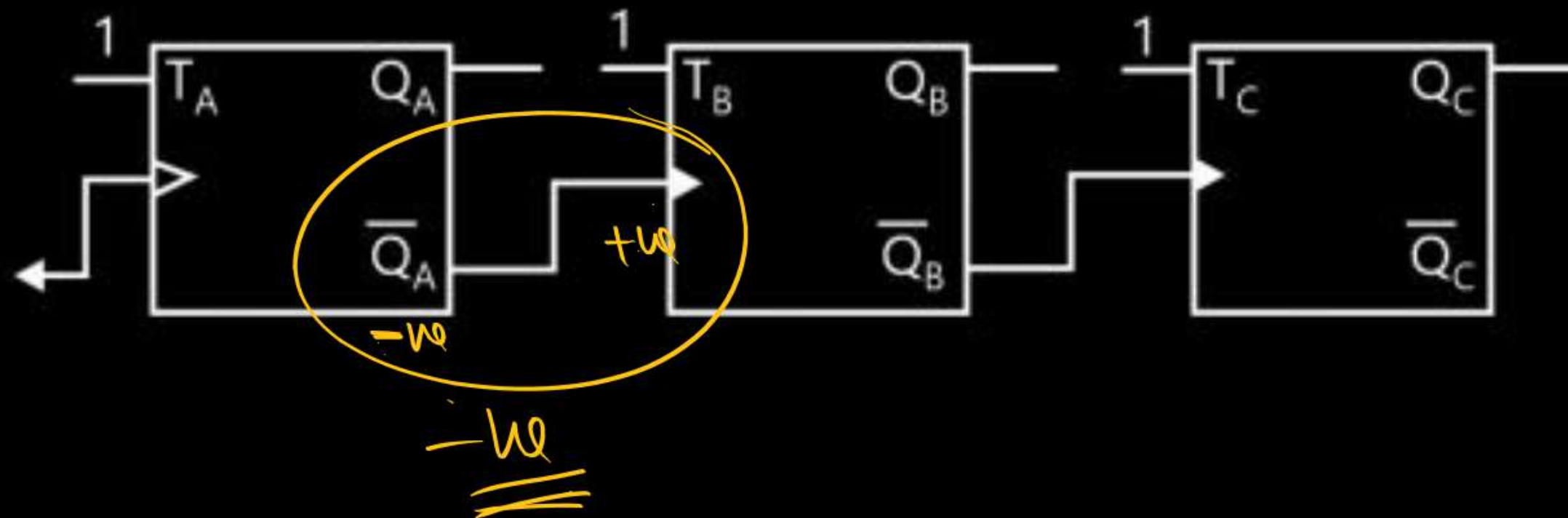
# Asynchronous Counter



-ve  $\rightarrow$  UP  
+ve  $\rightarrow$  DOWN



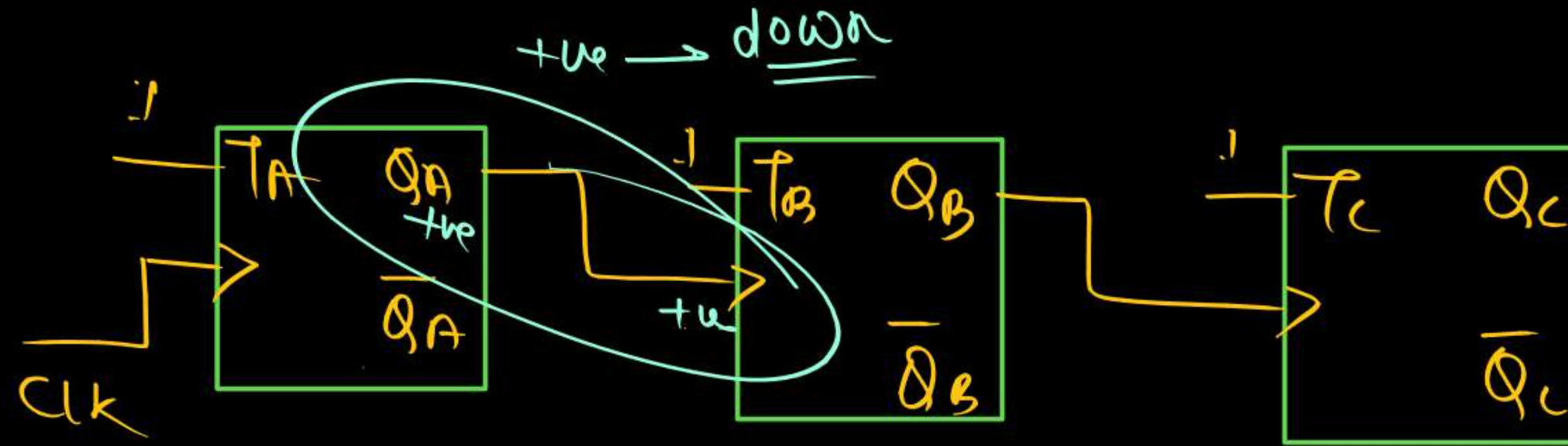
UP



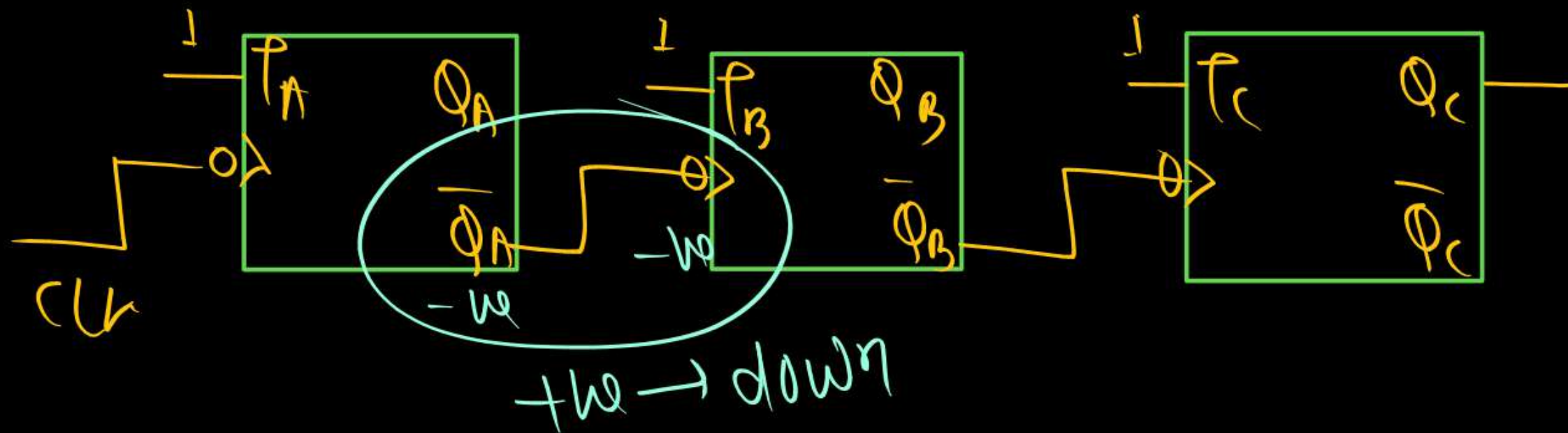
# Asynchronous Counter



$$n \rightarrow 2^n$$



DOWN

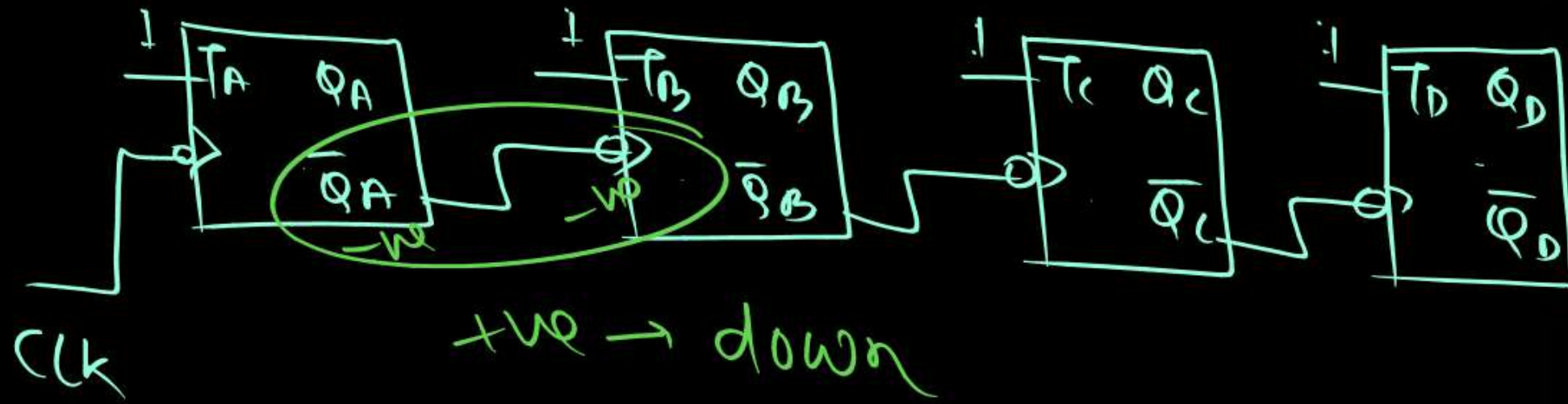


Down counter



## Asynchronous Counter

$$\text{MOD} = 2^4 = 16$$



## MOD 16- down Ripple counter

clock	$Q_C$	$Q_B$	$Q_C$	Clr
0				
1				
2				
3				
4				
5				
6				
7				
8				



# Asynchronous Counter



LDL

# 11PM

1000

500

200

100

50

20

10

5

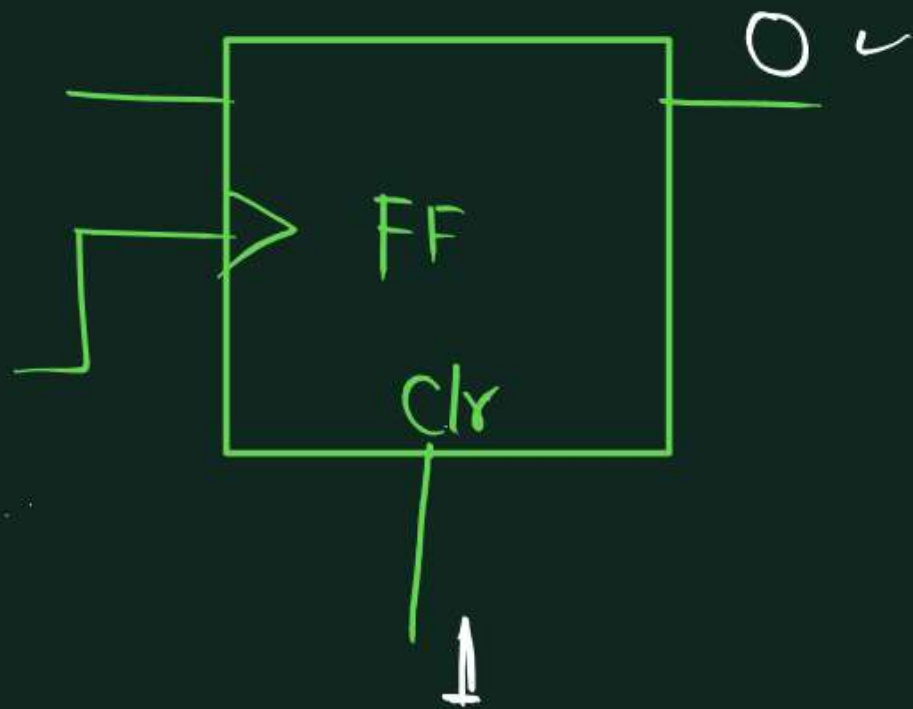
2

0

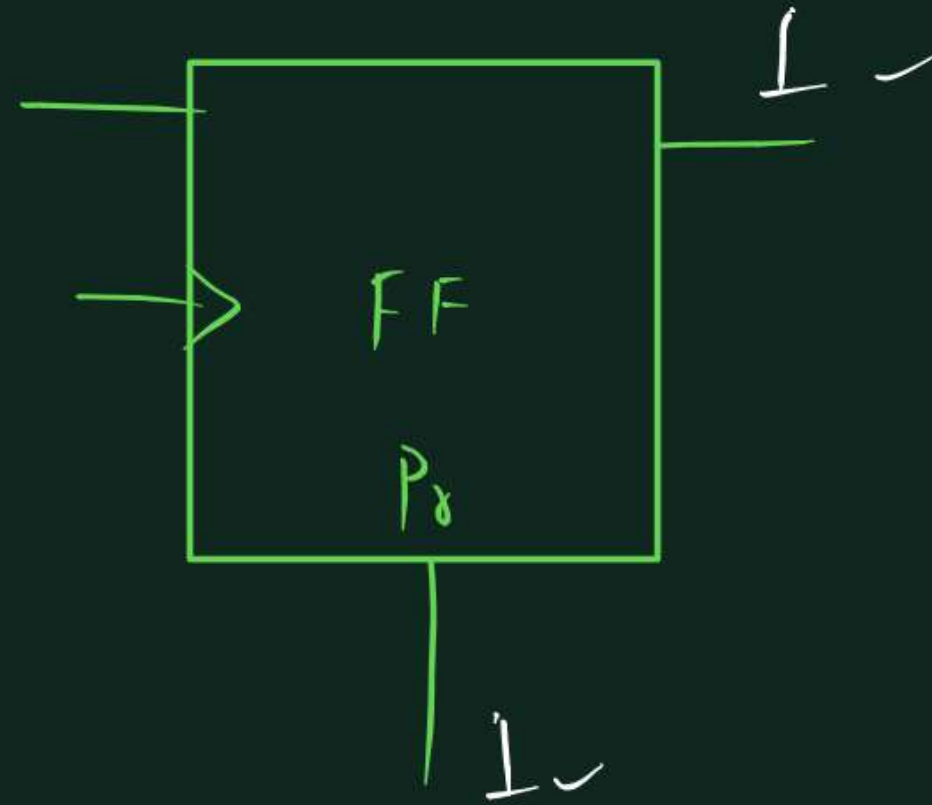


clock	Q <sub>C</sub>	Q <sub>B</sub>	Q <sub>C</sub>	Clr
0				
1				
2				
3				
4				
5				
6				
7				
8				

Reset (clr)



Preset

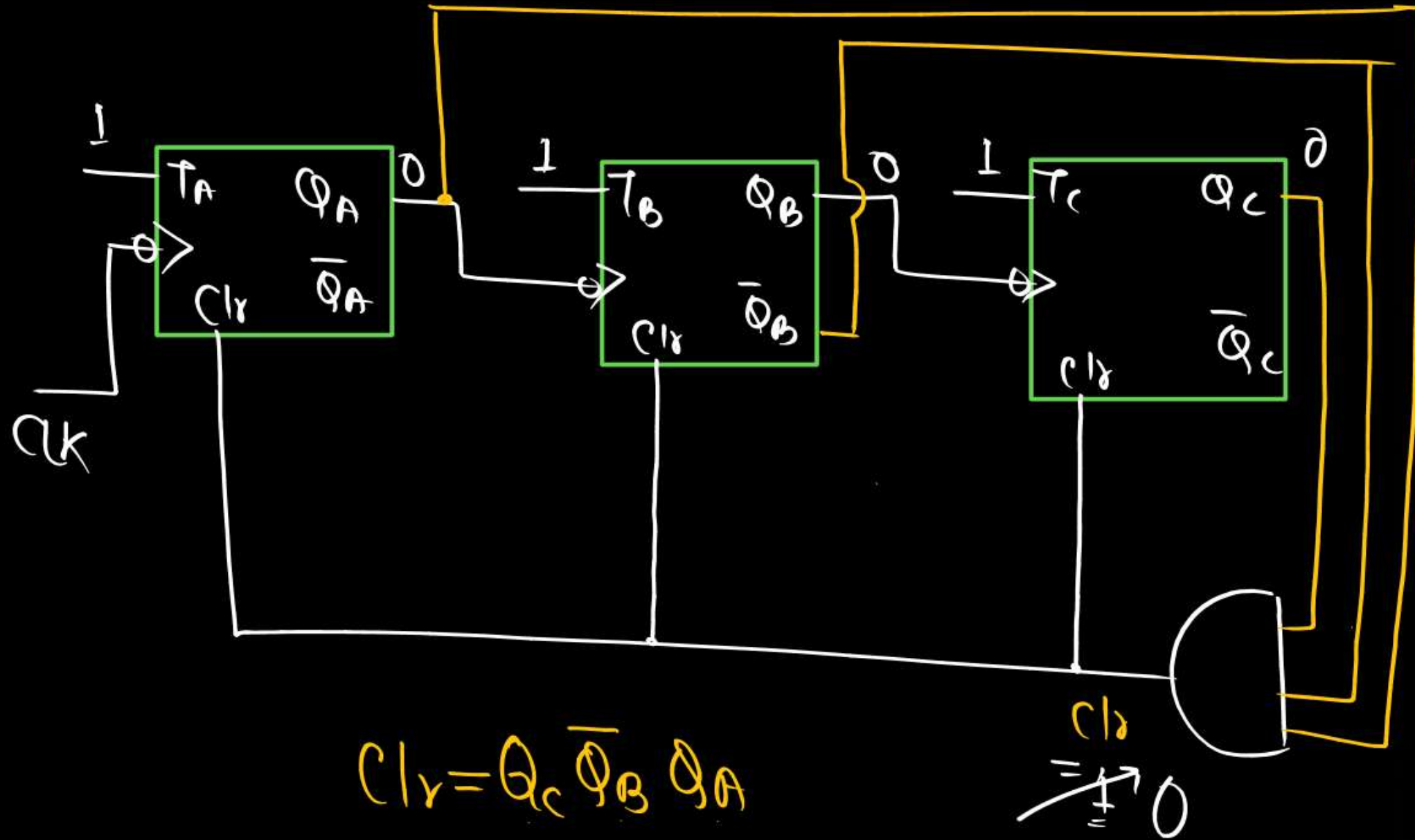


# Asynchronous Counter



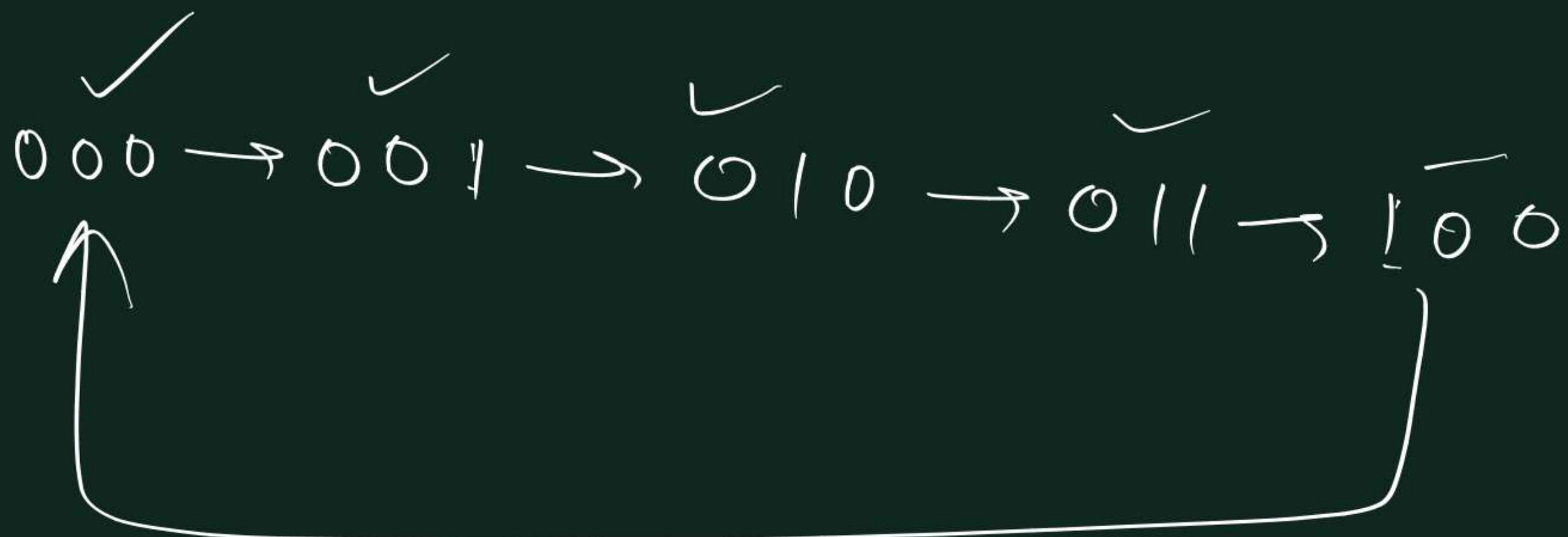
UP  $Clr = Q_C \bar{Q}_B Q_A \rightarrow 5 \text{ MOD}$   
 1 0 1

MOD-5 UP COUNTER



$Clr = Q_C \bar{Q}_B Q_A$   
 1 0 1

clock	$Q_C$	$Q_B$	$Q_A$	$Clr = Q_C \bar{Q}_B Q_A$
0	0	0	0	0
1	0	0	1	0
2	0	1	0	0
3	0	1	1	0
4	1	0	0	0
5	<del>1</del> 0	<del>0</del> 1	<del>1</del> 0	<del>1</del> 0
6	0	0	1	0
7	0	1	0	0
8	0	1	1	0



$\text{MOD} = 5$



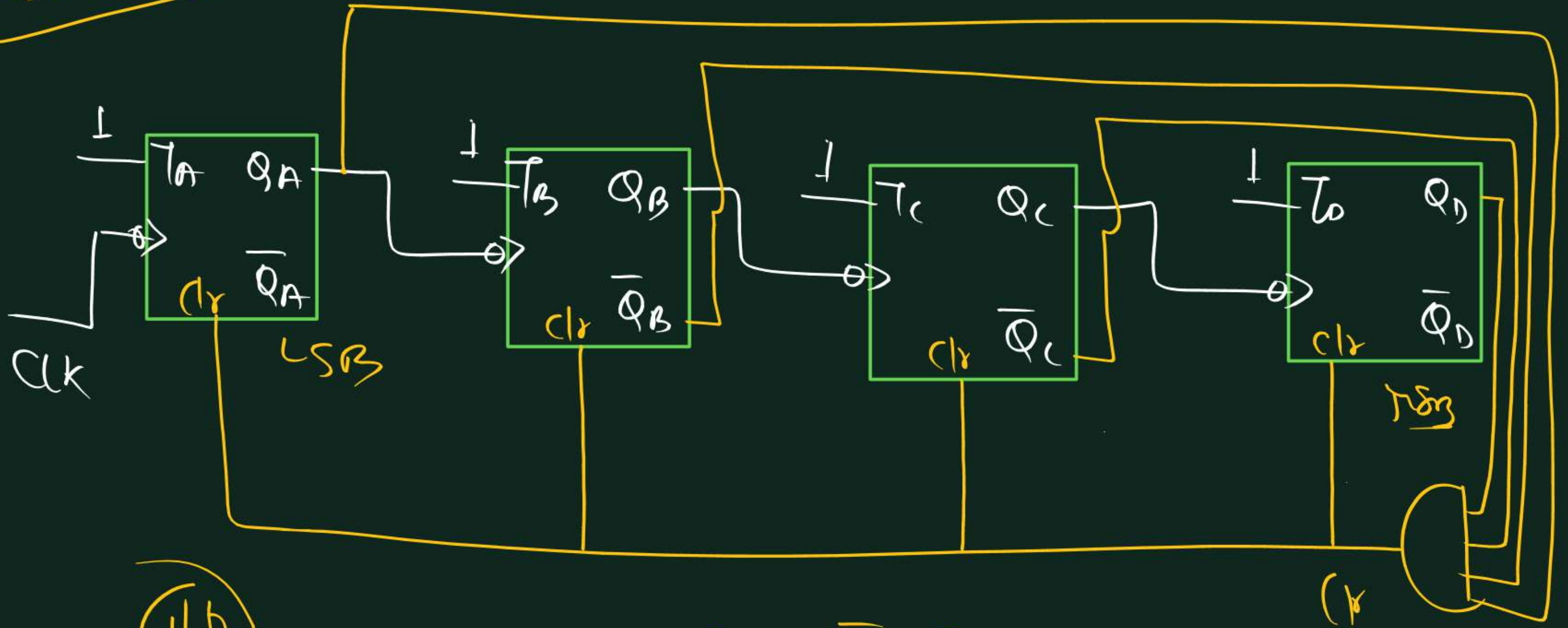
जीत की खातिर बस जूनून चाहिए,  
जिसमें उबाल हो ऐसा खून चाहिए,  
ये आसमान भी आ जाएगा ज़मीन पर,  
बस इरादों में जीत की गूँज चाहिए।

# Asynchronous Counter



clock	$Q_C$	$Q_B$	$Q_C$	Clr
0				
1				
2				
3				
4				
5				
6				
7				
8				

# SHANDAR ♡



VP

$$clr = Q_D \bar{Q}_C \bar{Q}_B Q_A$$

1 0 0 1 → 9

MOD-9 UP  
Ripple counter

# Asynchronous Counter



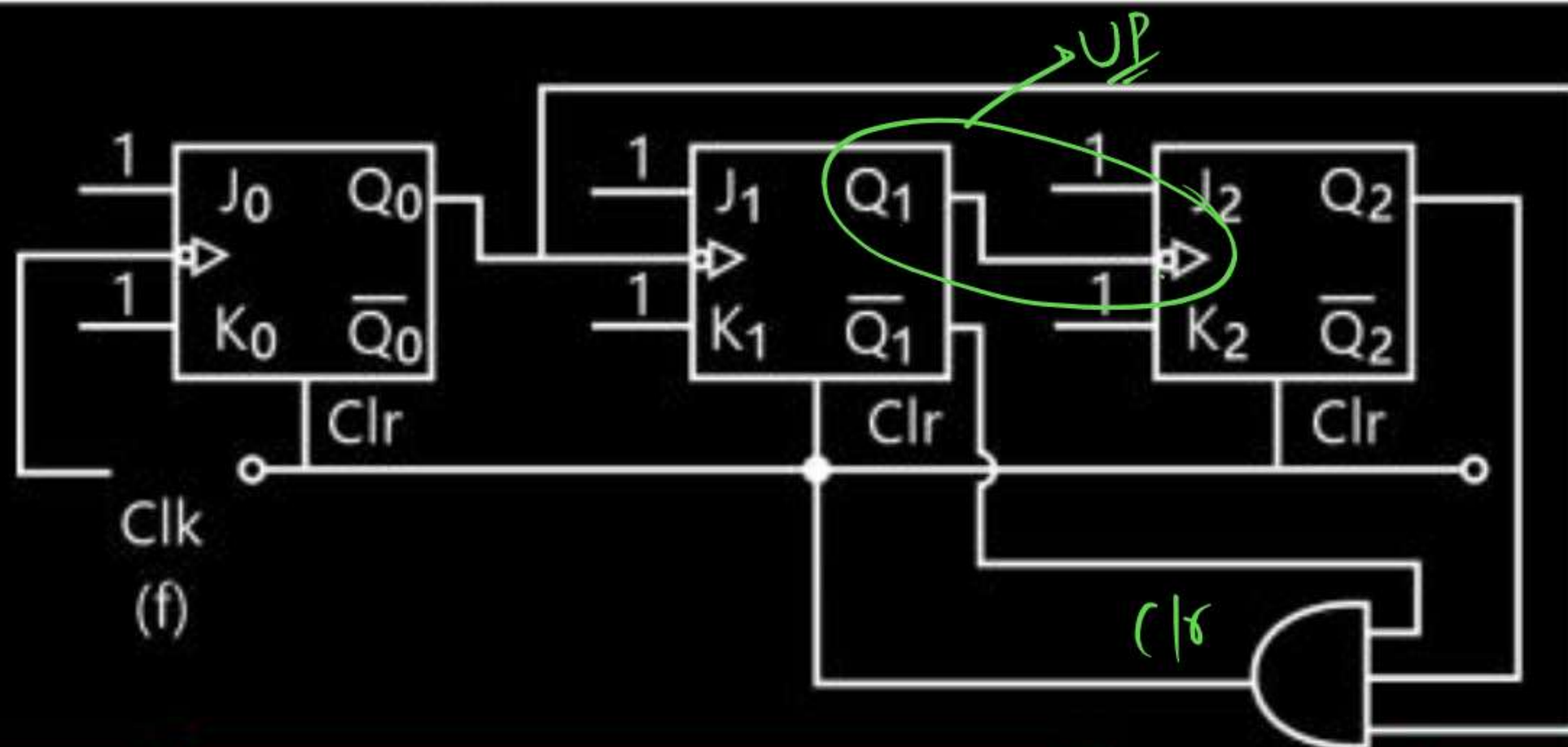
$Q_b Q_c Q_d Q_n$

Q Design a BCD counter

Clr =



Q. Which type of counter is shown below?



**A**

mod 5 down counter

**B**

mod 5 up counter

**C**

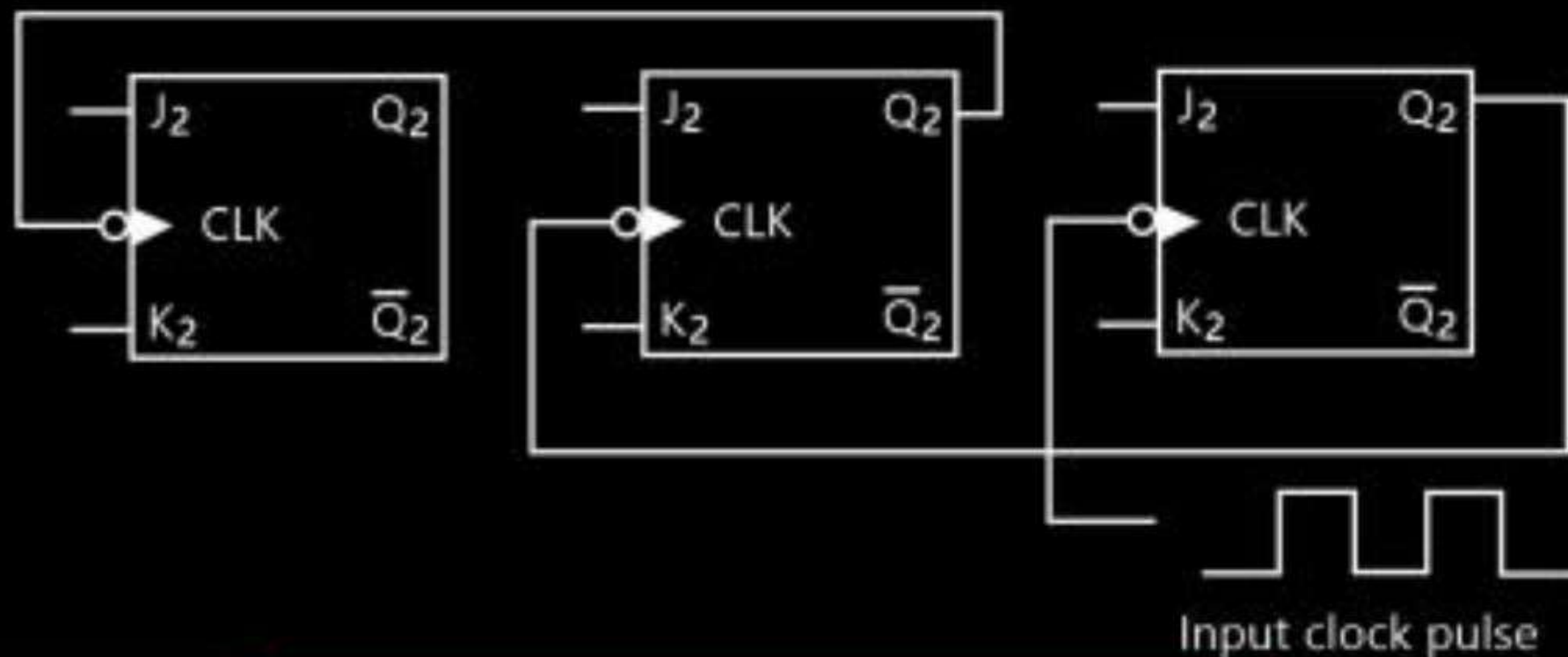
mod 6 up counter

**D**

mod 6 down counter

Q. Consider the following counter

If counter starts at 000, what will be the count after 13 clock pulses?



HPW

Comment

**A**

**100**

**B**

**101**

**C**

**110**

**D**

**111**



सपने उनके सच होते हैं,  
जिनके सपनों में जान होती है,  
पंखों से कुछ नहीं होता,  
होंसलों से उड़ान होती है।



