CS & IT ENGINEERING

DIGITAL LOGIC

Sequential Circuit

Lecture No. 6

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01 Registers, Basic of Counters

02 PRACTICE

03 DISCUSSION

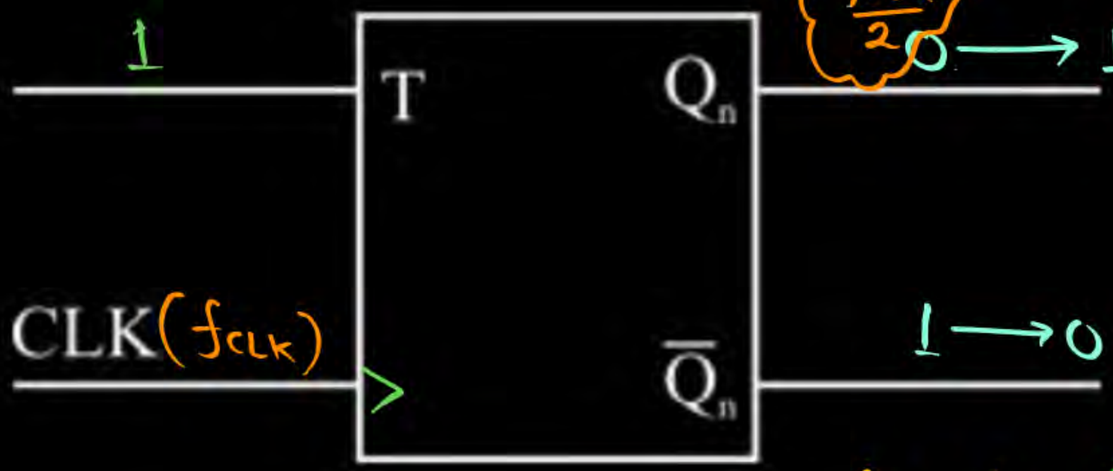
TOGGLE MODE OF FLIP FLOPS

1. Toggle mode of T Flip-Flop.

$Q_{n+1} = T \oplus Q_n$

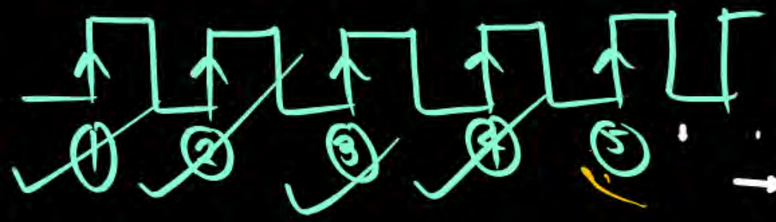
$Q_{n+1} = 1 \oplus Q_n = \bar{Q}_n \Rightarrow Q_{n+1} = \bar{Q}_n$

Toggle mode



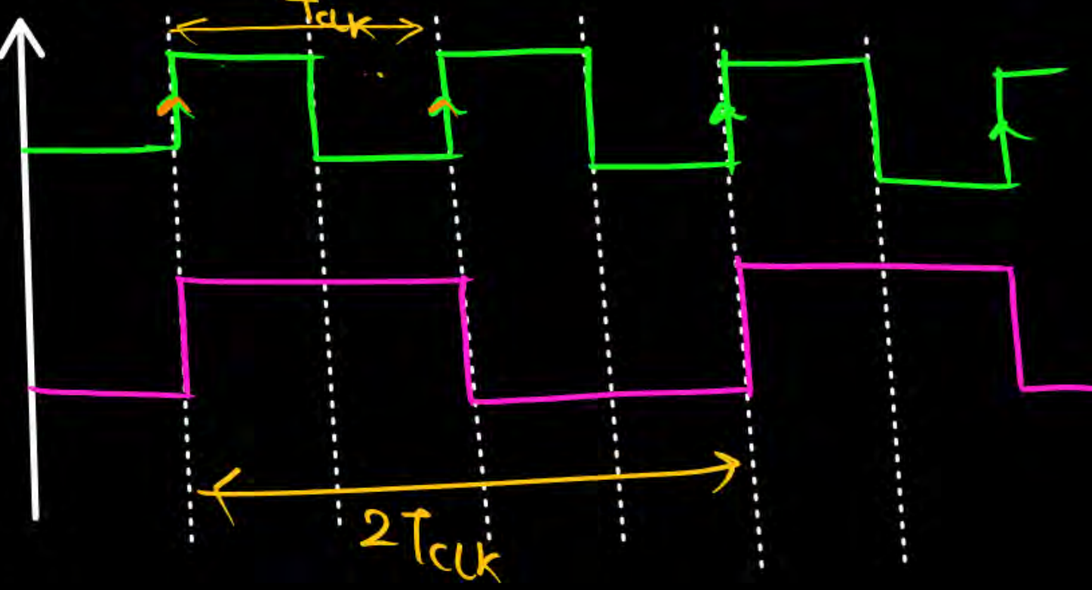
$\frac{f_{CLK}}{2}$: 0 → 1 → 0 → 1 → 0 → . . .

1 → 0 → 1 → 0 → 1 → . . .



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

$f_{Q_{n+1}} = \frac{1}{2T_{CLK}} = \frac{f_{CLK}}{2}$



TOGGLE MODE OF FLIP FLIPS

J=1 K=1

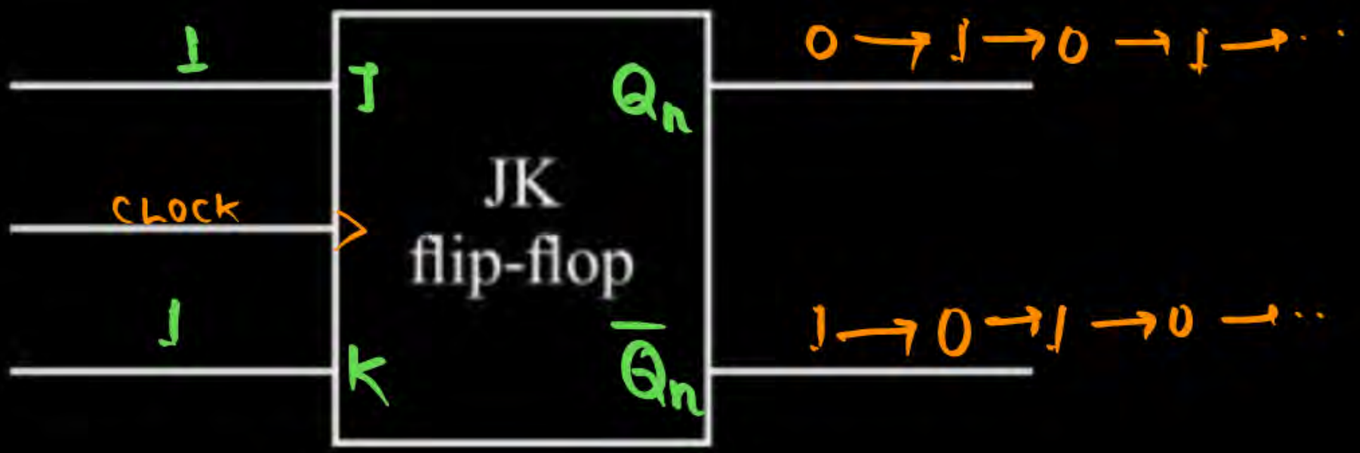
2. Toggle mode of J K Flip-Flop.

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

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

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

(i)



TOGGLE MODE OF FLIP FLIPS

2. Toggle mode of J K Flip-Flop.

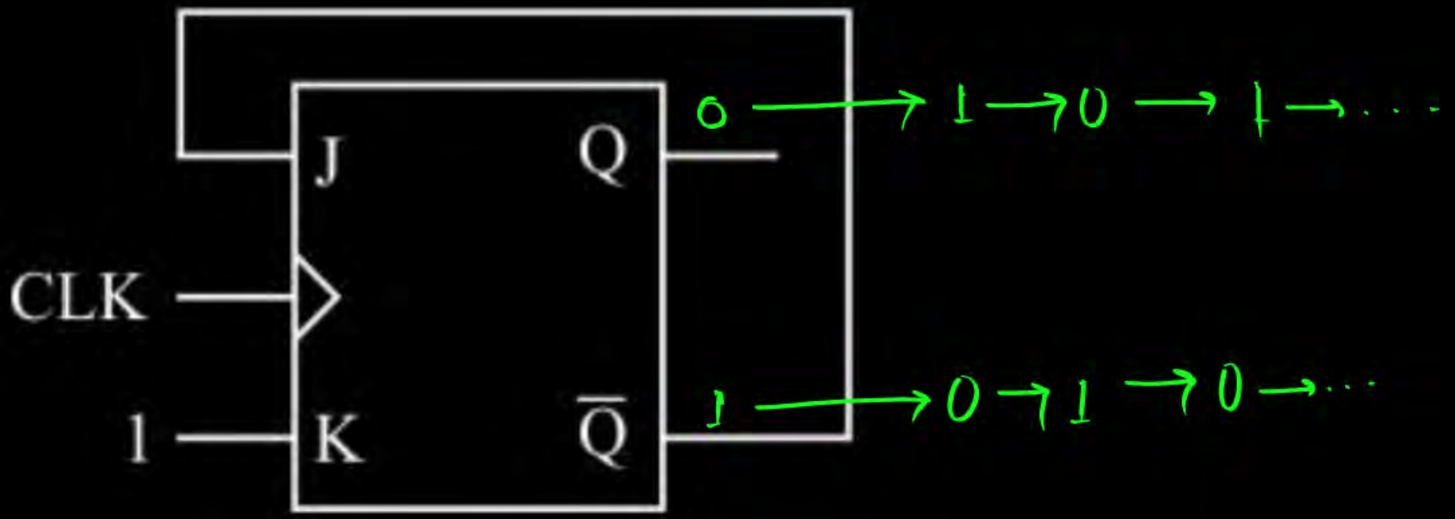
$J = \bar{Q}_n \quad K = 1$

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

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

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

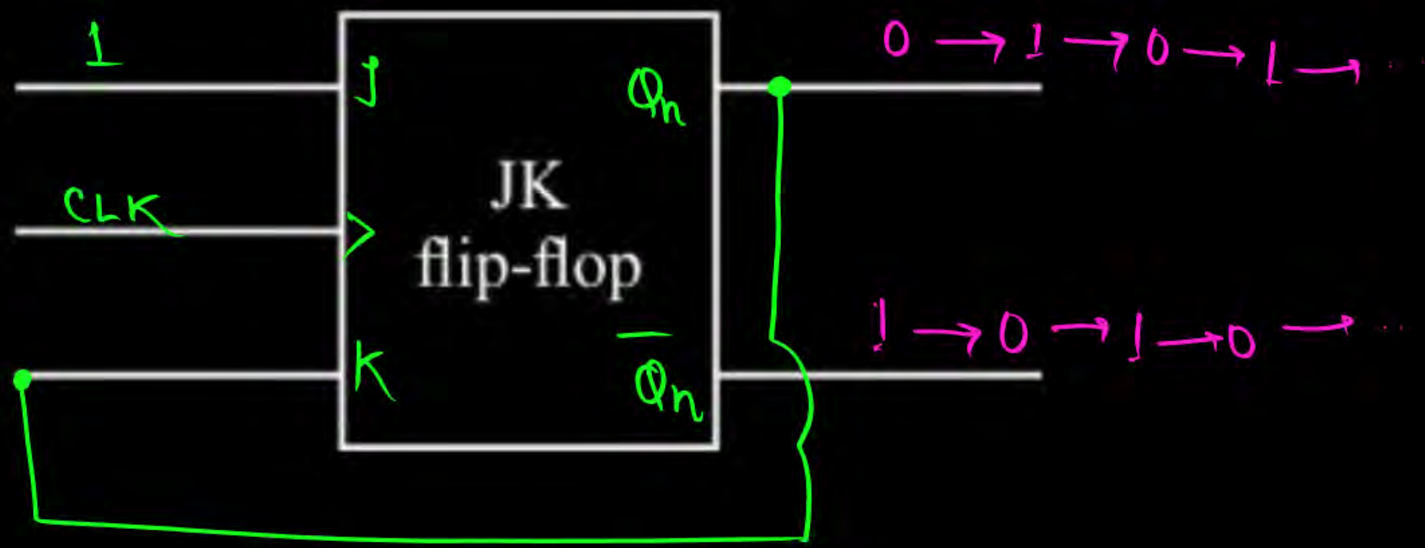
(ii)



TOGGLE MODE OF FLIP FLIPS

2. Toggle mode of J K Flip-Flop.

(iii)



$J = 1$ $\quad K = Q_n$

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

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

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

TOGGLE MODE OF FLIP FLIPS

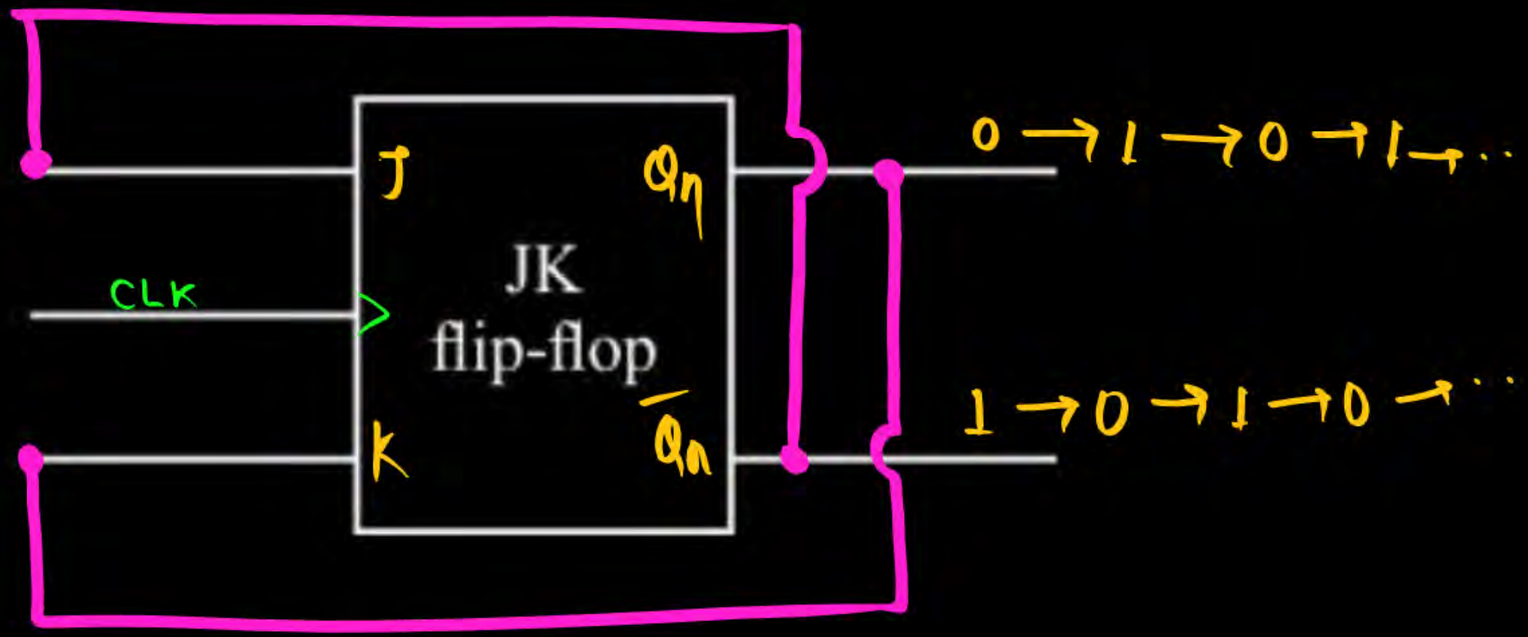
$J = \bar{Q}_n \quad K = Q_n$

2. Toggle mode of J K Flip-Flop.

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

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

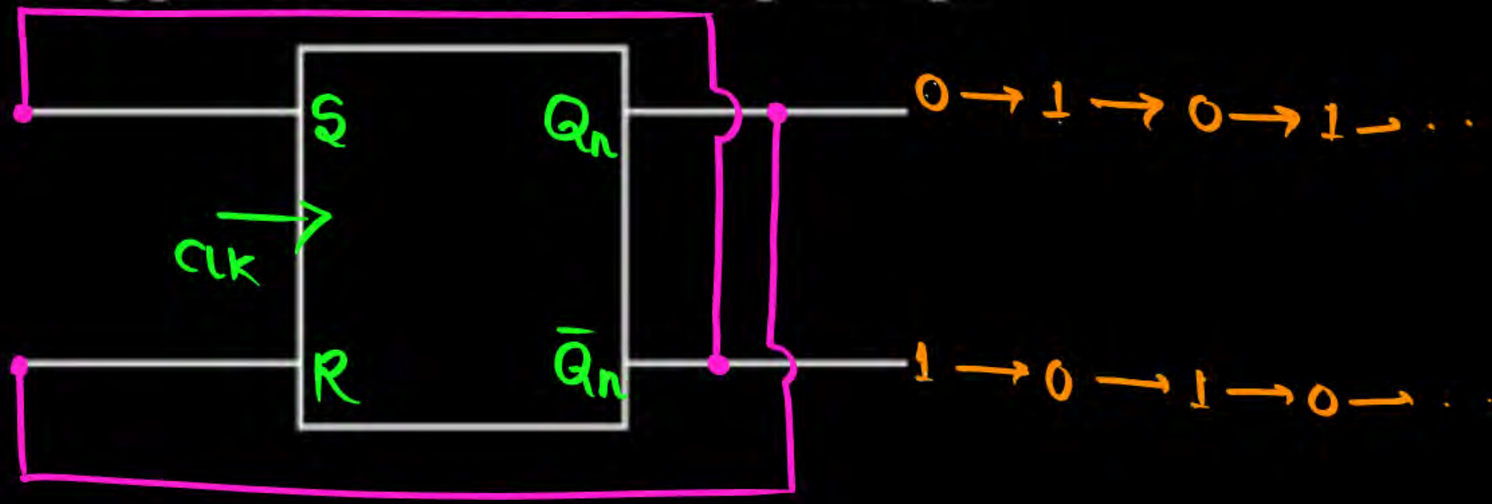
(iv)



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

TOGGLE MODE OF FLIP FLIPS

3. Toggle mode of S R Flip-Flop.



$S = \bar{Q}_n \quad R = Q_n$

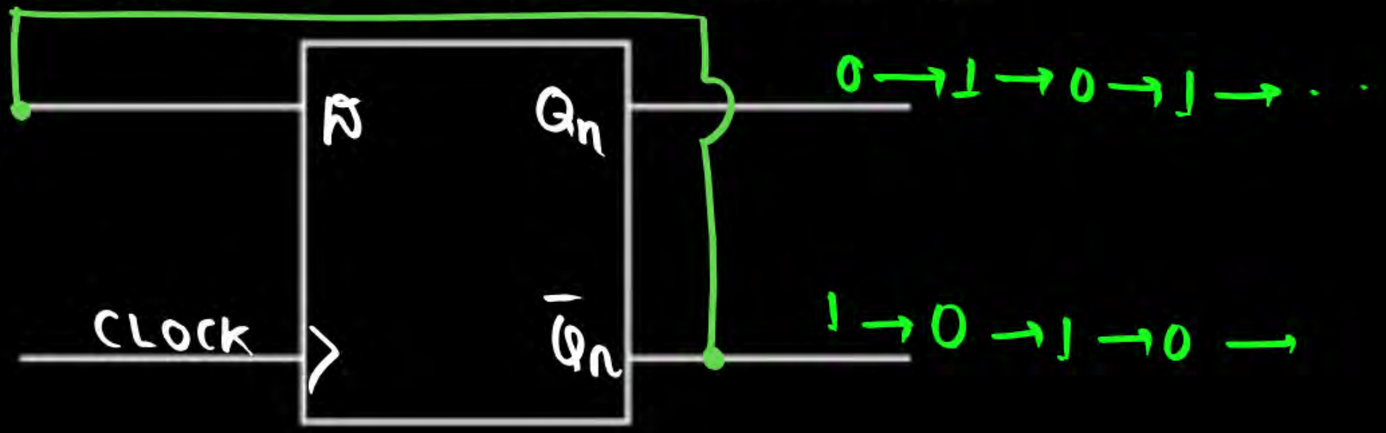
$Q_{n+1} = S + \bar{R} Q_n$

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

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

TOGGLE MODE OF FLIP FLIPS

4. Toggle mode of D Flip-Flop.



$D = \bar{Q}_n$

$Q_{n+1} = D$

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

COUNTER

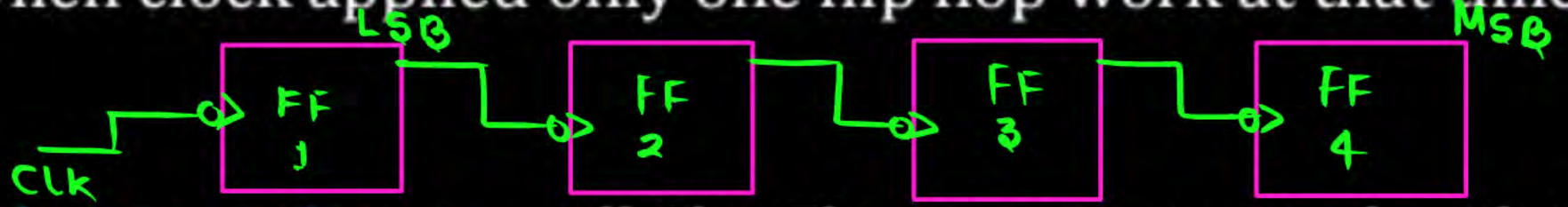
1. Counters are used to count Number of clock.
2. Counter are used as Frequency Divider Circuit.
3. Counter are also used in ADC. → Analog to Digital converter.
4. Counters are also known as pulse stretcher circuit.
5. Counters also used in RADAR for detection of Range.
   → Radio Detection & Ranging

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.



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

COUNTER

② Synchronous counter

① All the FF's are connected with the same clock.

② Faster

③ All type of counting are possible.

④ No Transition Error.

⑤ Ex. Ring counter
Johnson counter

④ Asynchronous counter

① Only one FF having external clock and o/p of that FF will be clock for the next FF.

② Slower

③ Only increasing and decreasing counting are possible.

④ Yes, Transition error.

⑤ Ex. Ripple counter.

1 2 3 4 5

5 4 3 2 1

1 3 2 5 4

Thank you

GW

Soldiers !