



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB231 – DIGITAL ELECTRONICS

II YEAR/ III SEMESTER

UNIT 3 –SEQUENTIAL CIRCUITS

TOPIC - Design of Synchronous Sequential circuits : Up/Down counter



What is a Counter?

- A digital circuit which is used for counting pulses is known as counter.
- Counter is the widest application of flip-flops.
- It is a group of flip-flops with a clock signal applied.



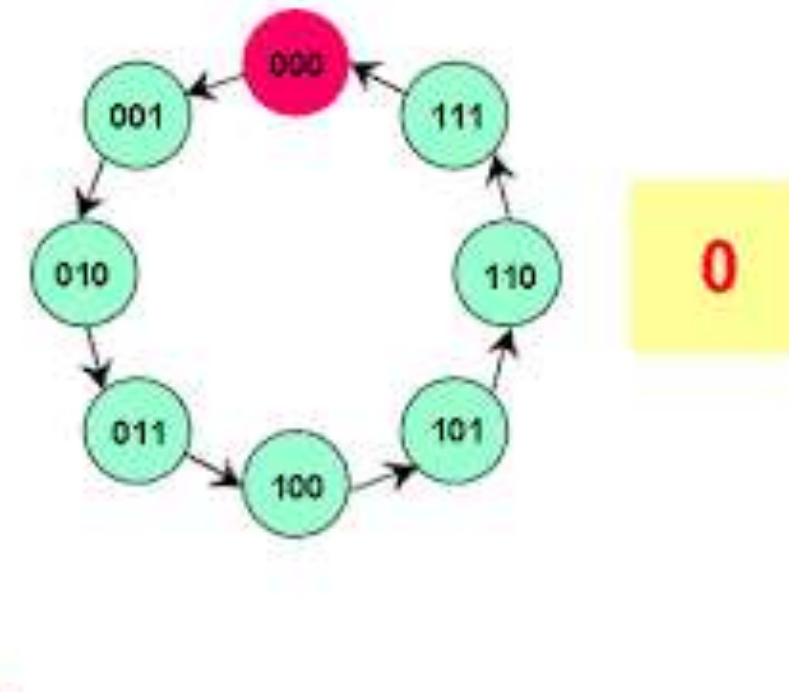


Types of counters



Two Types

1. Asynchronous Counter or Ripple Counter.
2. Synchronous Counter

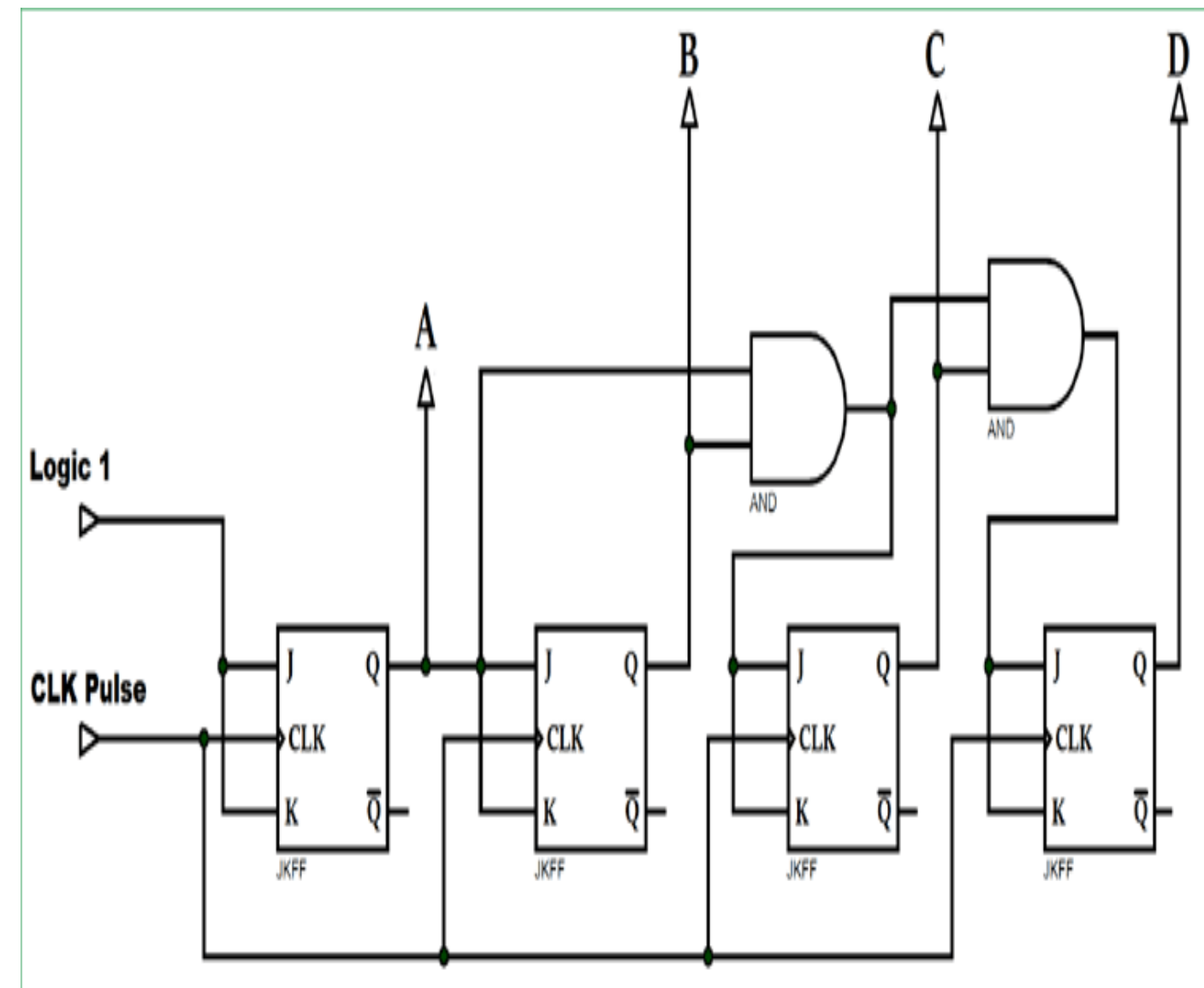




Synchronous Counter



- In **synchronous counter**, the clock input across all the flip-flops use the same source and create the same clock signal at the same time.
- A counter which is using the same clock signal from the same source at the same time is called **Synchronous counter**.

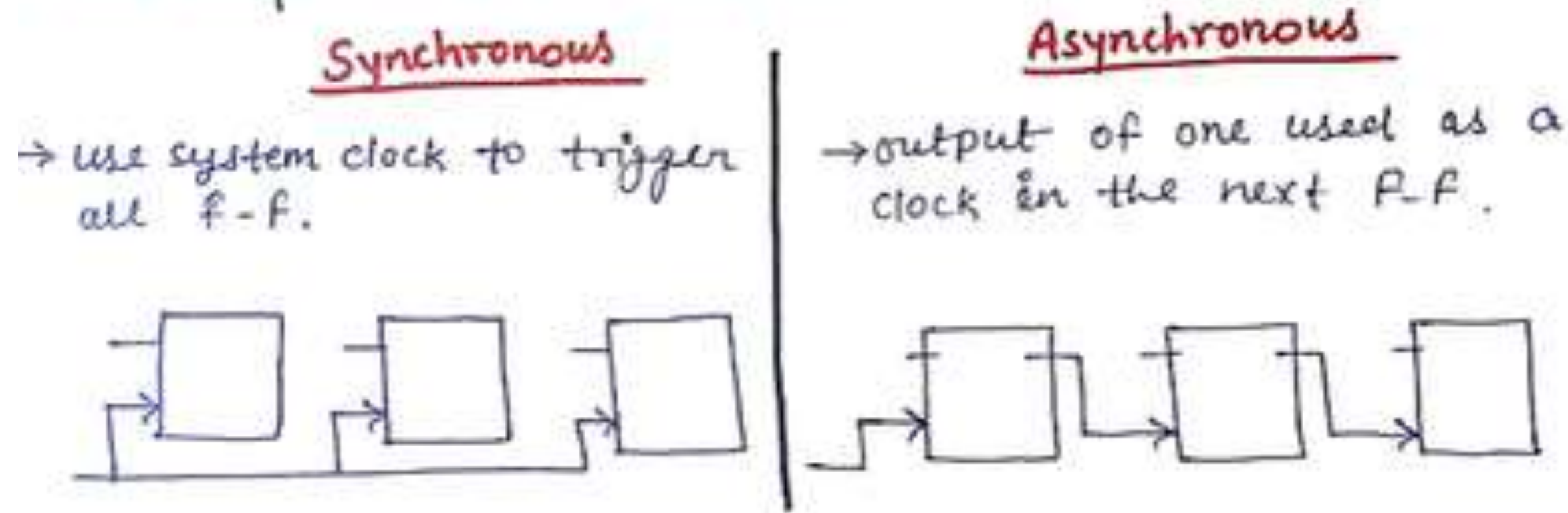




Asynchronous Counter

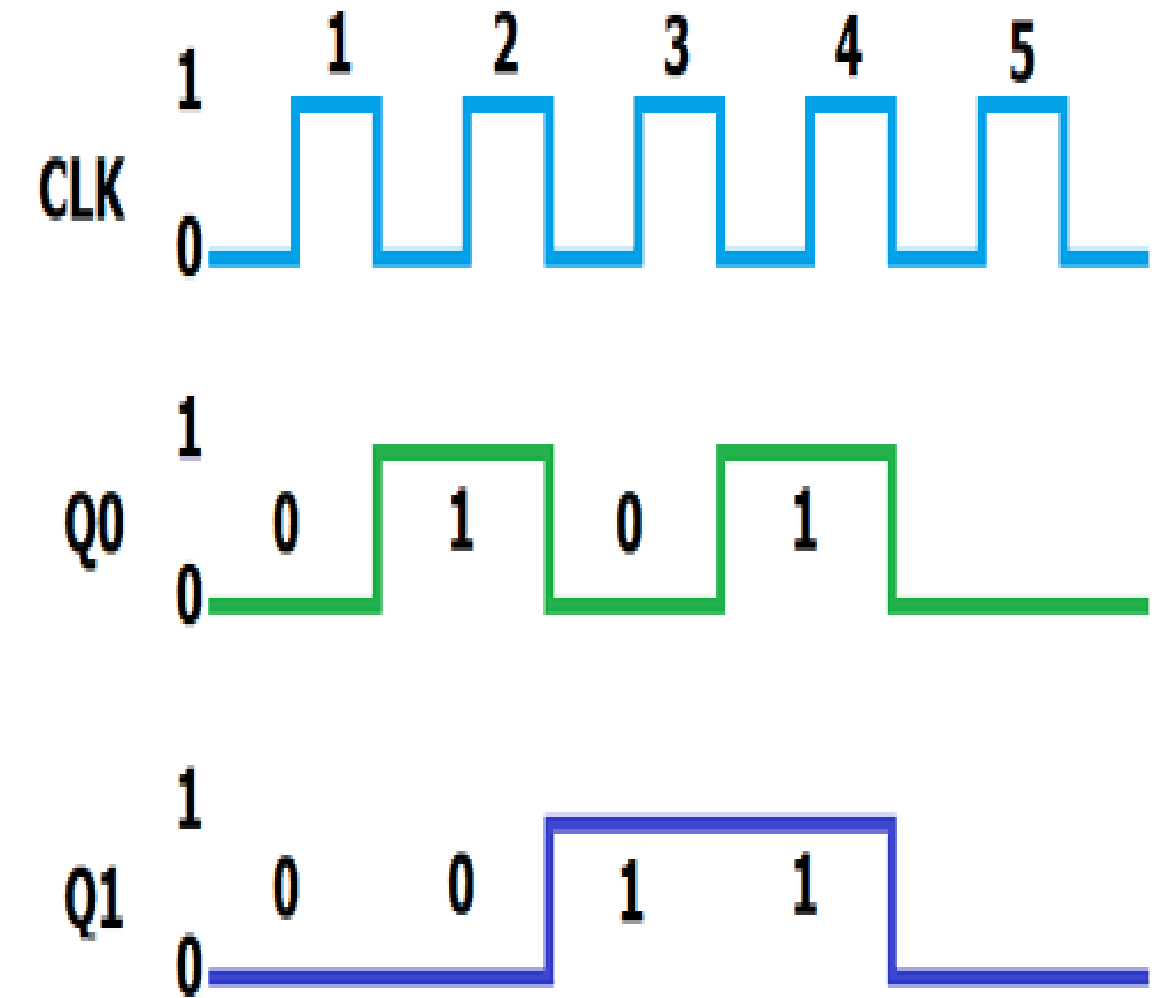
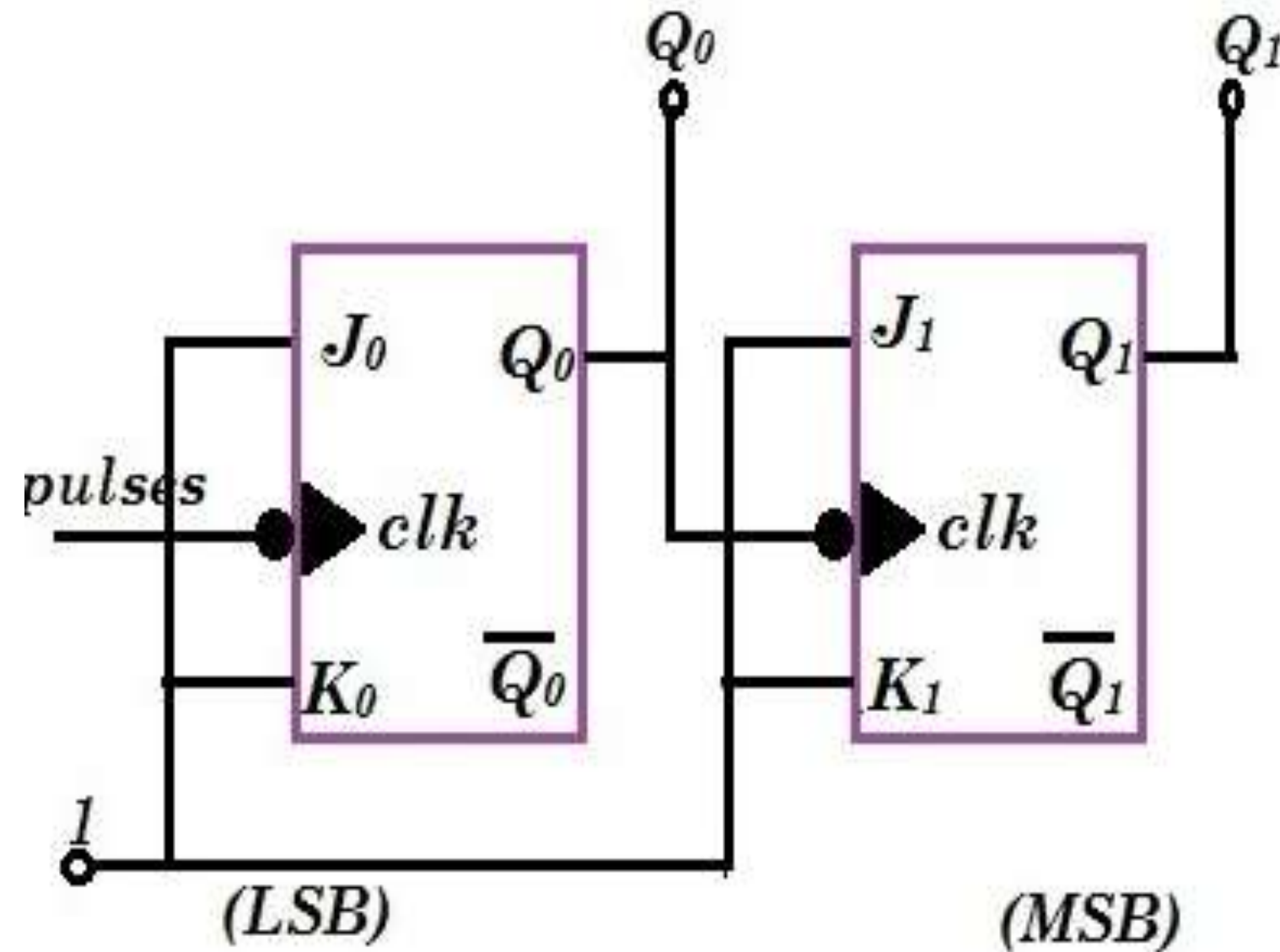
- Depending upon the manner in which the flip-flop are triggered, counters can be divided into two major categories.
 - i) Asynchronous counter (Ripple/series counter).
 - ii) Synchronous counter (parallel counter).

The comparison between synchronous and Asynchronous counter.





2-bit Asynchronous Counter





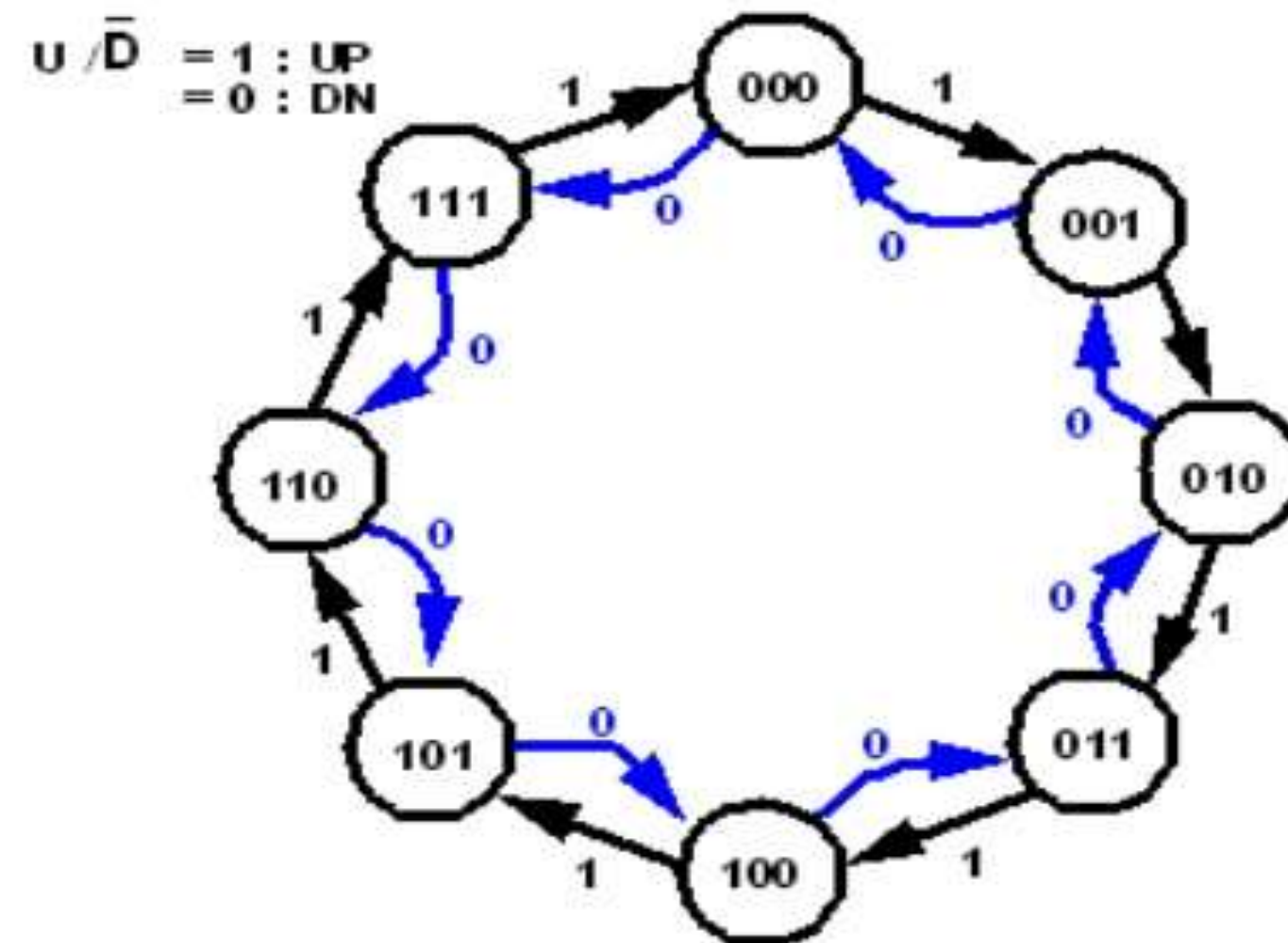
Synchronous Counter	Asynchronous Counter
All flip flops are triggered with same clock.	Different clock is applied to different flip flops.
It is faster.	It is lower
Design is complex.	I Design is relatively easy.
Decoding errors not present.	Decoding errors present.
Any required sequence can be designed	Only fixed sequence can be designed.



3-bit Synchronous Up/Down Counter

Up/Down Counters

- A 3-bit binary up/down counter (State diagram)





3-bit Synchronous Down Counter



State Table

CP	UP	Q _C	Q _B	Q _A	DOWN
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	↻



3-bit Synchronous Down Counter



Excitation table

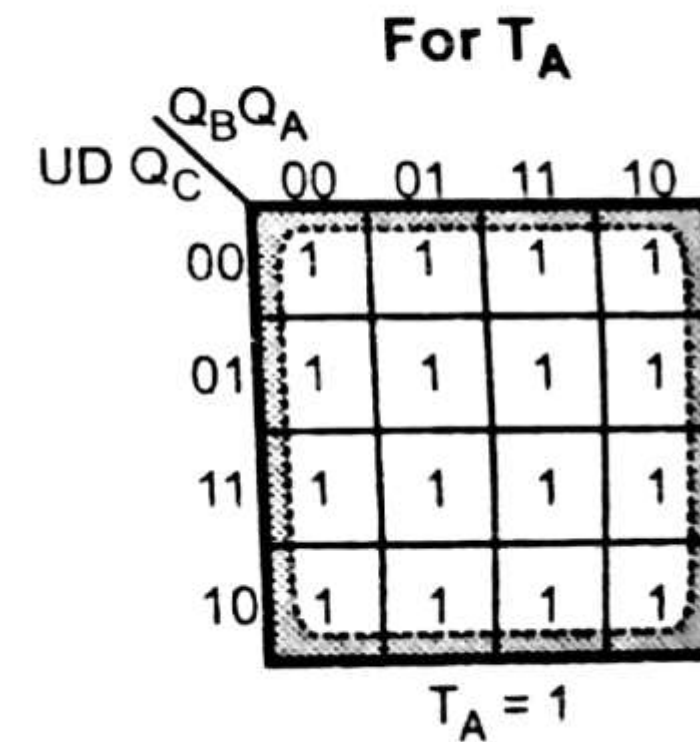
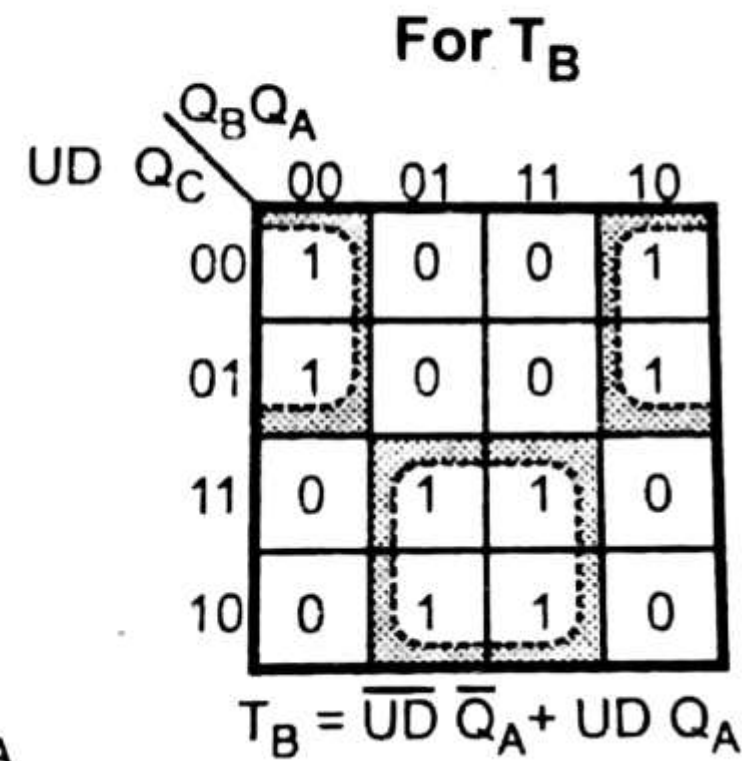
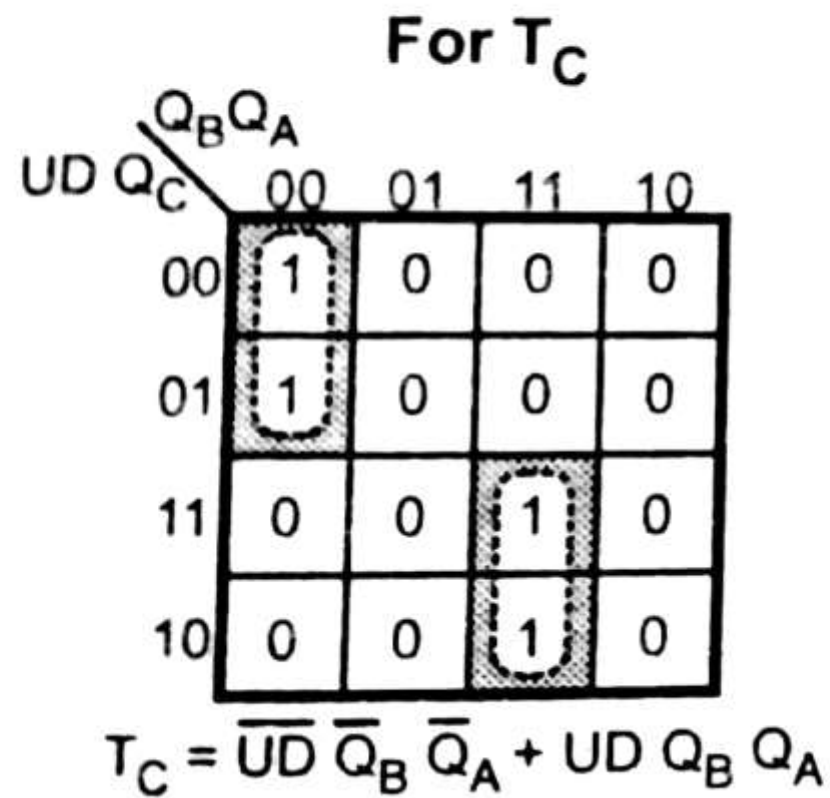
Input UP/DOWN (UD)	Present State			Next State			Flip-flop Inputs		
	Q_C	Q_B	Q_A	Q_{C+1}	Q_{B+1}	Q_{A+1}	T_C	T_B	T_A
0	0	0	0	1	1	1	1	1	1
0	0	0	1	0	0	0	0	0	1
0	0	1	0	0	0	1	0	1	1
0	0	1	1	0	1	0	0	0	1
0	1	0	0	0	1	1	1	1	1
0	1	0	1	1	0	0	0	0	1
0	1	1	0	1	0	1	0	1	1
0	1	1	1	1	1	0	0	0	1
1	0	0	0	0	0	1	0	0	1
1	0	0	1	0	1	0	0	1	1
1	0	1	0	0	1	1	0	0	1
1	0	1	1	1	0	0	1	1	1
1	1	0	0	1	0	1	0	0	1
1	1	0	1	1	1	0	0	1	1
1	1	1	0	1	1	1	0	0	1
1	1	1	1	0	0	0	1	1	1



3-bit Synchronous Down Counter



K-map simplification

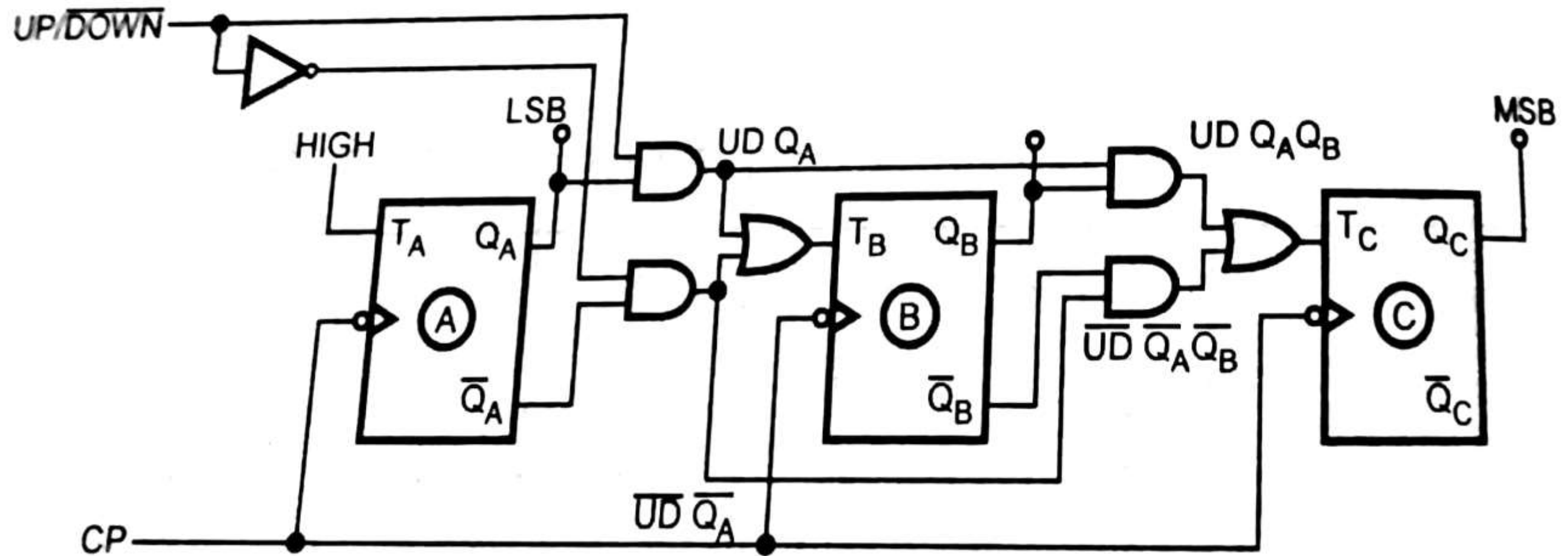




3-bit Synchronous Down Counter



Logic Diagram





Applications of Counters



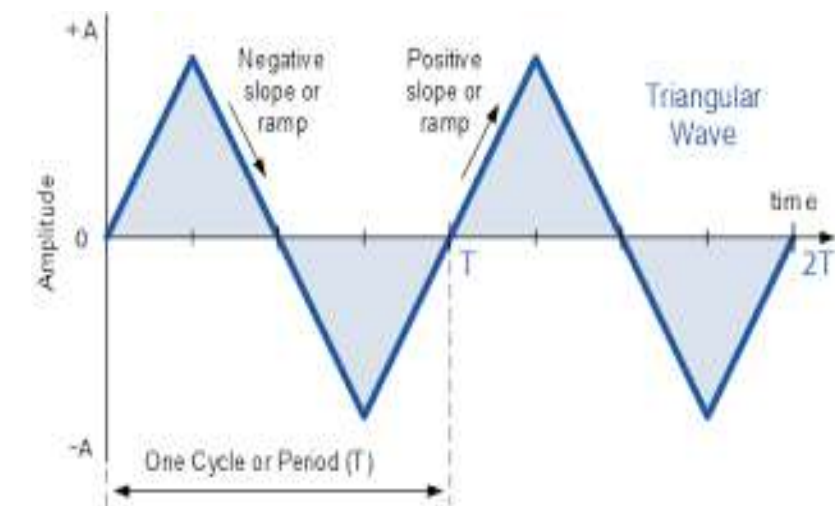
Frequency counters



Digital clocks



Digital triangular wave generator





Application for counter

- Frequency counters
- Digital clock
- Time measurement
- A to D converter
- Frequency divider circuits



ASSESSMENTS



1. How many natural states will there be in a 4-bit ripple counter?
 - a) 4
 - b) 8
 - c) **16**
 - d) 32
2. A ripple counter's speed is limited by the propagation delay of _____
 - a) **Each flip-flop**
 - b) All flip-flops and gates
 - c) The flip-flops only with gates
 - d) Only circuit gates.
3. Internal propagation delay of asynchronous counter is removed by _____
 - a) Ripple counter
 - b) Ring counter
 - c) Modulus counter
 - d) **Synchronous counter**



ASSESSMENTS



4. An asynchronous 4-bit binary down counter changes from count 2 to count 3. How many transitional states are required?

- a) 1
- b) 2
- c) 8
- d) **15**

5. A ripple counter's speed is limited by the propagation delay of

-
- a) **Each flip-flop**
 - b) All flip-flops and gates
 - c) The flip-flops only with gates
 - d) Only circuit gates



THANK YOU