Counters:

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

- Asynchronous or Ripple Counters
- Synchronous Counters

➢ Classification of Counters:

Depending on the way in which the counting progresses, the synchronous or asynchronous counters are classified as follows −

- Up Counters
- Down Counters
- Up/Down Counters

➢ UP/DOWN Counter:

Up counter and down counter is combined together to obtain an UP/DOWN counter. A mode control (M) input is also provided to select either up or down mode. A combinational circuit is required to be designed and used between each pair of flip-flop in order to achieve the up/down operation.
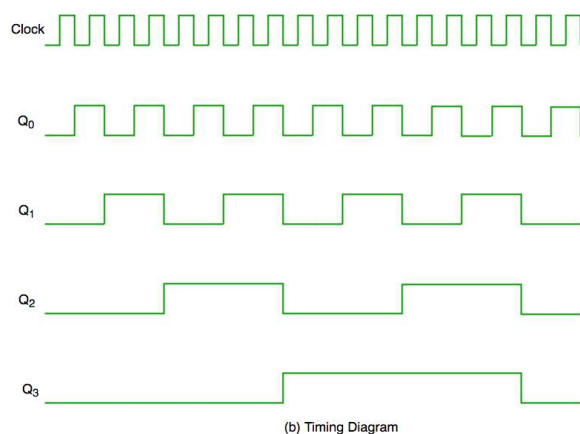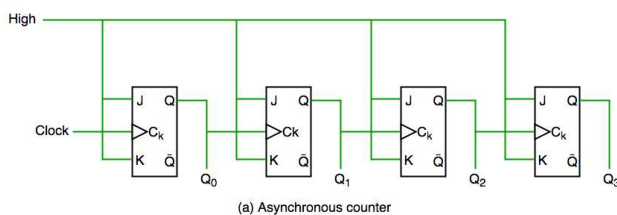
➢ Type of Up/Down Counters:

There are two types of up/down counters −

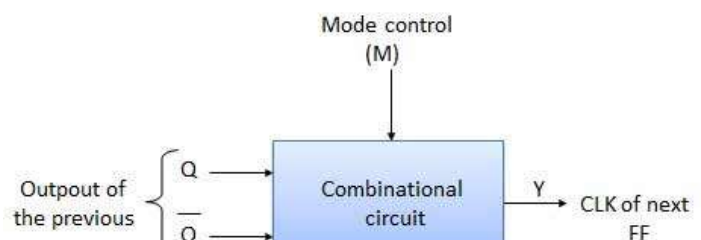- UP/DOWN Ripple Counters
- UP/DOWN Synchronous Counter

➢ UP/DOWN Ripple Counters:

In the UP/DOWN ripple counter all the FFs operate in the toggle mode. So either T flip-flops or JK flip-flops are to be used. The LSB flip-flop receives clock directly. But the clock to every other FF is obtained from (Q = Q bar) output of the previous FF.

- **UP counting mode (M=0)** − The Q output of the preceding FF is connected to the clock of the next stage if up counting is to be achieved. For this mode, the mode select input M is at logic 0 (M=0).

- **DOWN counting mode (M=1)** − If M = 1, then the Q bar output of the preceding FF is connected to the next FF. This will operate the counter in the counting mode.

Asynchronous Counter

Block Diagram

Inputs			Outputs	
M	Q	$\overline{Q}$	Y	
0	0	0	0	Y = Q for up counter
0	0	1	0	
0	1	0	1	
0	1	1	1	
1	0	0	0	Y = $\overline{Q}$ for up counter
1	0	1	1	
1	1	0	0	
1	1	1	1	

Truth Table

Simulation Waveforms:

Schematic: