Digital Logic and Design
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Term Project

Design a MOD-12 asynchronous counter using JK ffs.

Counters: A counter is a device that stores the number of times a particular event or process has occurred, often in relationship to a clock signal. Counters are used in digital electronics for counting purpose, they can count specific event happening in the circuit. They can be designed with the help of flip flops.

Counters are broadly divided into two types:

- Asynchronous or ripple counter
- Synchronous counter

Synchronous counter

1) In synchronous counter, all flip flops are triggered with same clock simultaneously
2) It is comparatively faster.
3) Design and implementation is complex due to increase in number of states.
4) Example: Ring counter, Johnson counter.

Asynchronous counter

1) In Asynchronous counter, different flip flops are triggered with different clock, not simultaneously.
2) It is comparatively slower.
3) Designing and implementation is very easy.
4) Example: Ripple UP counter, Ripple DOWN counter.

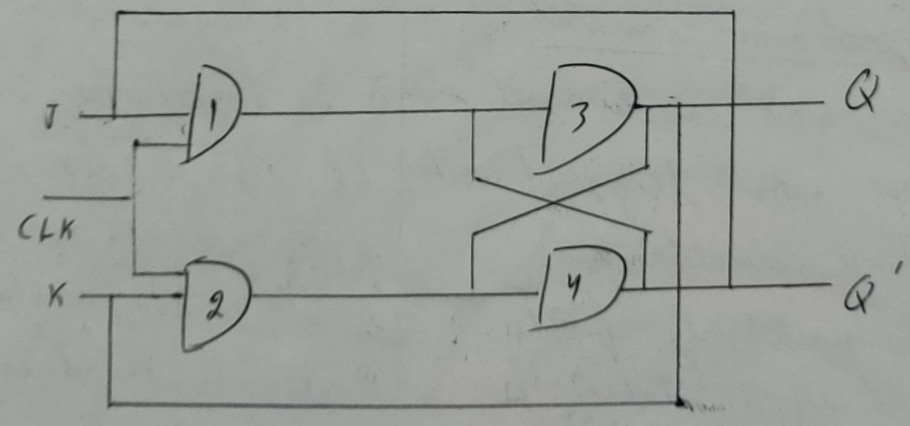
Flip Flops:

A flip flop is an electronic circuit with two stable state that can be changed by applying varying inputs. Flip flops and latches are fundamental building blocks of digital electronics systems used in computers, communications and many other types of systems.

There are majorly four types of flip flops

- SR flip flop
- JK flip flop
- D flip flop
- T flip flop

JK flip flop: JK flip flop is an improvement for SR flip flop as SR flip flop has an undefined state.

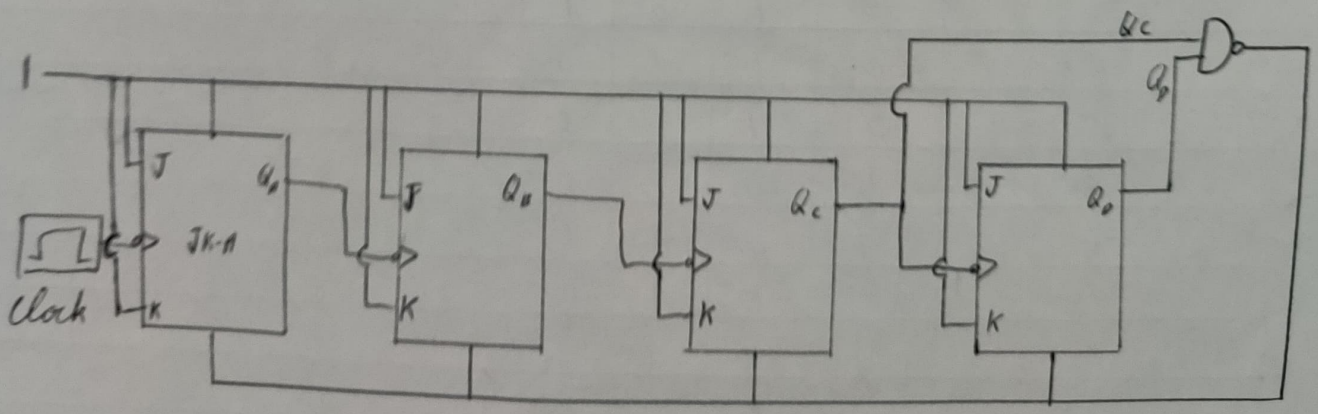


Truth Table:

CLK	J	K	Q(n+1)	Comments
↓	0	0	Q(n)	Initial Stage
↓	1	0	1	Set
↓	0	1	0	Ret
↓	1	1	Q'(n)	Toggle

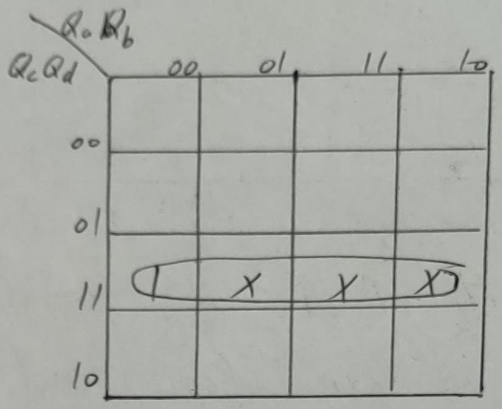
MOD-12 counter: A MOD-12 counter will be created using 4 JK-flip flops but four flip flops can count to 16 i.e. 16 states so we will add a clear condition which resets after 12. As it is an asynchronous counter. So, ~~all~~ ~~out~~ clock of pr a flip flop will be a output of the previous flip flop. The 1 clock will be connected to the first flip flop. J & K of all flip flops will be set to 1 to experience toggle.

Circuit:



K-Map of Clear:

$$C = \Sigma m(12) + \Sigma d(13, 14, 15)$$



$$C = Q_c Q_d$$

Input will be cleared at $Q_c Q_d$ i.e. 12

Truth Table:

Clock Pulse	Q_d	Q_c	Q_b	Q_a	Decimal Equivalent	Clear	
0	0	0	0	0	0	0	
1	0	0	0	1	1	0	
2	0	0	1	0	2	0	
3	0	0	1	1	3	0	
4	0	1	0	0	4	0	
5	0	1	0	1	5	0	12
6	0	1	1	0	6	0	State
7	0	1	1	1	7	0	
8	1	0	0	0	8	0	
9	1	0	0	1	9	0	
10	1	0	1	0	10	0	
11	1	0	1	1	11	0	
12	0	0	0	0	0	1	

Reset State

The counter resets after 12.

Uses :- Counters are the crucial hard ware components are defined as " The digital circuit which is used to count the number of pulses ". Counters are well known to us as " Timers ". Counters are not only used for counting but also for measuring frequency and time ; increment memory addresses.