UNIT - IV FLIP FLOPS

CLASSIFICATION OF DIGITAL CIRCUITS

- Digital circuits are divided into two types. They are

a) Combinational circuits.

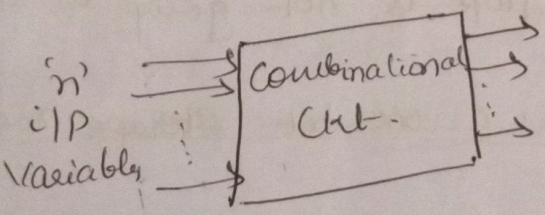
b) Sequential circuits.

COMBINATIONAL CIRCUITS

→ [A logic ckt designed to produce a specified o/p for certain combination of i/p variables without storage facility]

* A combinational logic is achieved by logic gates AND, OR, NOT, X-OR, NOR, NAND and X-NOR.
* Does not contain any memory Element.
* In combinational logic, the present o/p is depends only on present i/p combinations.
* the behaviour of combinational circuit is described by the set of o/p functions.

Ex: Adders, Encoders, decoders, multiplexers, Demultiplexers.

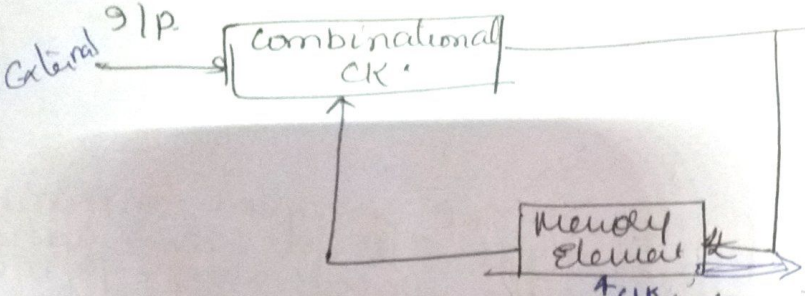


SEQUENTIAL CIRCUITS

* A sequential logic is achieved by a memory Element called flip flop. flip flops are synchronous to each other
* In sequential logic, the present o/p not only depends on present i/p but also depends on previous o/p of a sequential ckt.
* the behaviour of sequential ckts described by the set of next-state fun^ns & set of o/p fun^n.

o/p's can be controlled irrespective of change in i/p's.

③ CKT

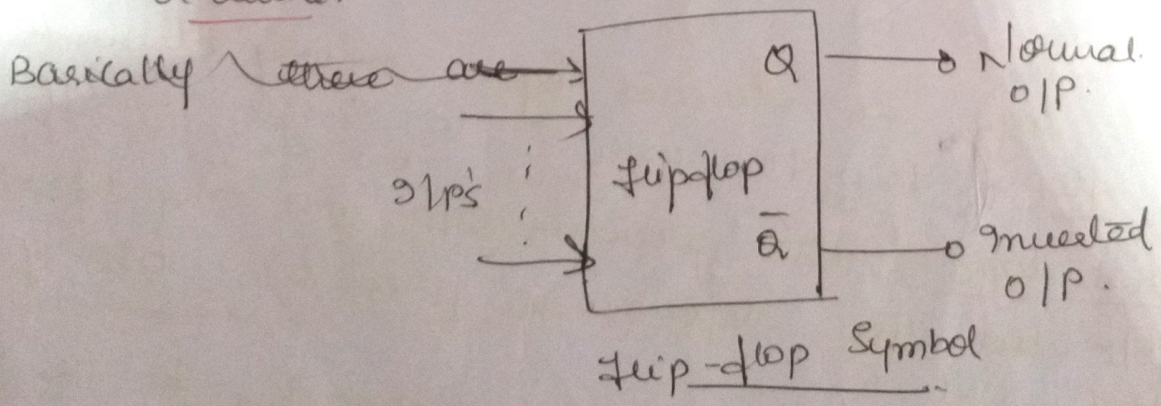


- The sequential CKTs are classified as
  - Synchronous sequential CKTs → depends on clocks (eg: latches) → signals can affect the memory Element only at discrete instants of time
  - Asynchronous sequential CKTs → eg: latches → it does not have clk. → I/P signals can affect memory Element at any instant of time.

- The memory Element used in sequential CKTs are flip-flops

FLIP-FLOPS → O/P changes only when we apply clk & exists these states

- flip flop has two possible stable states & these states are identified as logic '1' and logic '0'
- The O/P of flip-flop is not going to change Even after removal of I/P.
- Hence flip-flop is a one-bit storage memory Element & device.



Flip-flop Symbol

- Basically there are four flip-flops, they are
1) SR flip flop
2) JK flip flop
3) D flip flop
4) T flip-flop.

LATCH → O/P changes for a small change in the I/P

A CKT which can indefinitely store a logic '1' or a logic '0' is called the basic - bi stable Element.

* A latch is an Example of basic - bi stable Element.

- The latch means the information is locked (or) latched in the CKT

- A latch is the most basic type of flip flop CKT

- It can be constructed using NAND or NOR gates.

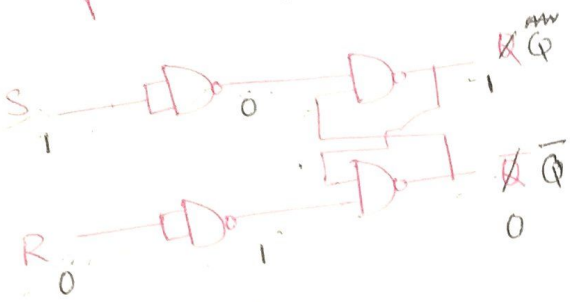
- According the latch are of 2 types.

1) NAND gate latch.
2) NOR gate latch.

S - SET
R - RESET

→ start always i/p is '0'

b) using NAND gates

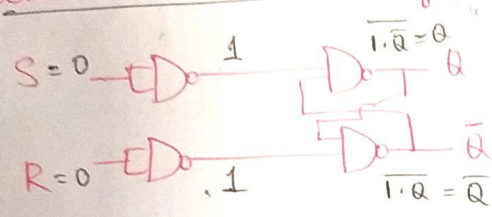


Truth table

Inputs		Outputs	
S	R	Q	$\bar{Q}$
0	0	No change	
0	1	reset 0	1
1	0	set 1	0
1	1	Not allowed	

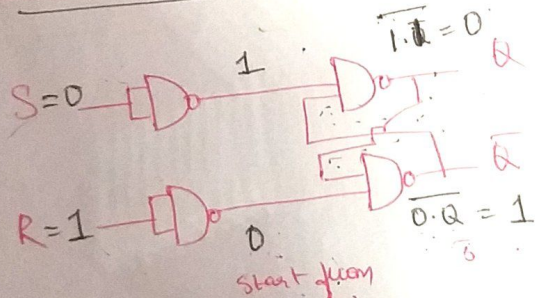
SET

Case i) when S=0 and R=0



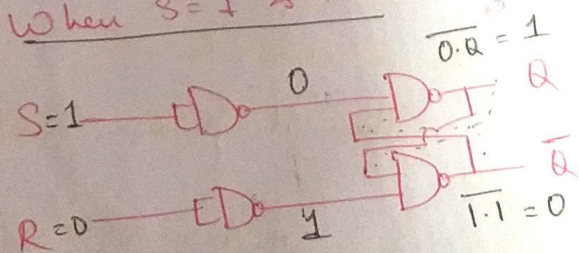
∴ When S=0 & R=0, then Q = Q and $\bar{Q}=\bar{Q}$.

Case ii) when S=0 and R=1

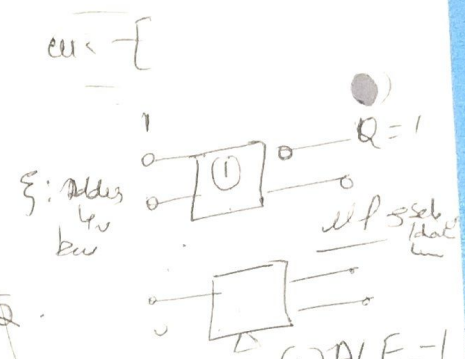


∴ When S=0 & R=1, then Q=0 & $\bar{Q}=1$

Case iii) when S=1 & R=0



∴ When S=1 & R=0, then Q=1 and $\bar{Q}=0$

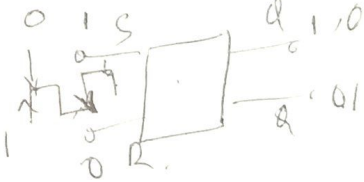


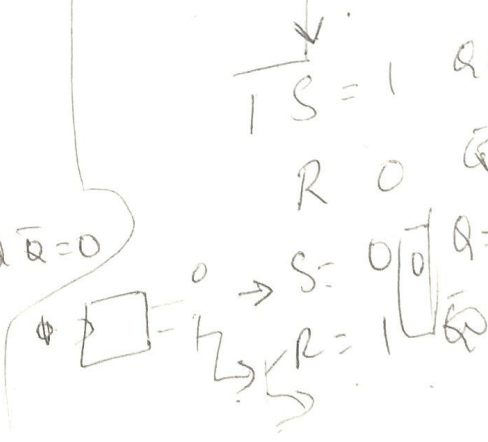
SOH

1000 0000

0000 0001

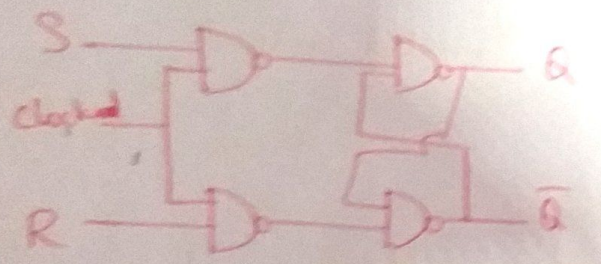
A/D Multi





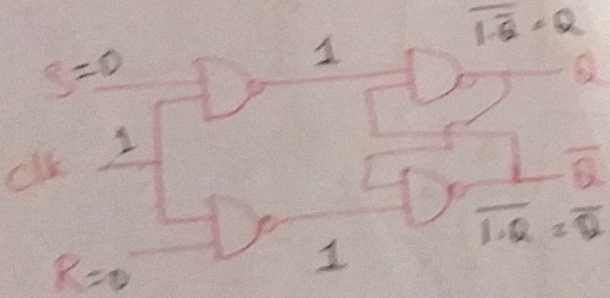
∴ When S=1 & R=1, then Output is invalid

SR Flipflop: with positive edge triggered clock



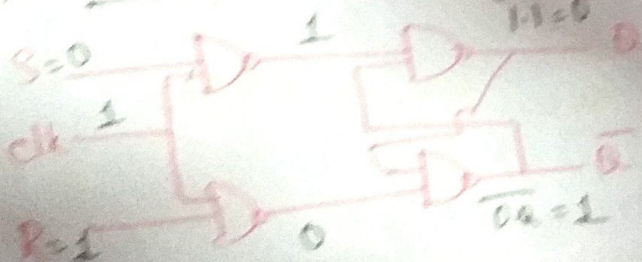
Inputs			Outputs	
clk	S	R	Q	$\overline{Q}$
↑	0	0	Q	$\overline{Q}$
↑	0	1	0	1
↑	1	0	1	0
↑	1	1	Invalid	

Case i) When S=0 & R=0,



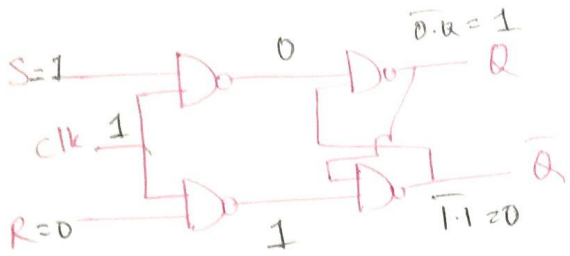
∴ When S=0 & R=0, Then Q=Q and $\overline{Q} = \overline{Q}$

Case ii) When S=0 & R=1,



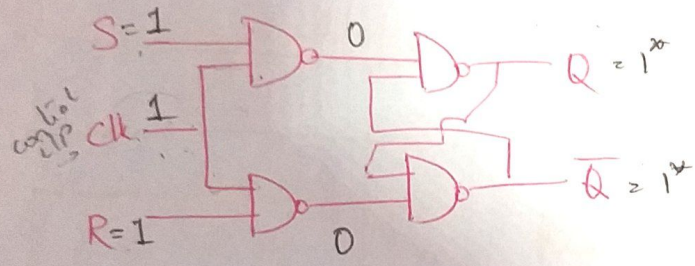
∴ When S=0 & R=1,
Then Q=0 & $\overline{Q}$ = 1

Case iii> When S = 1 & R = 0,

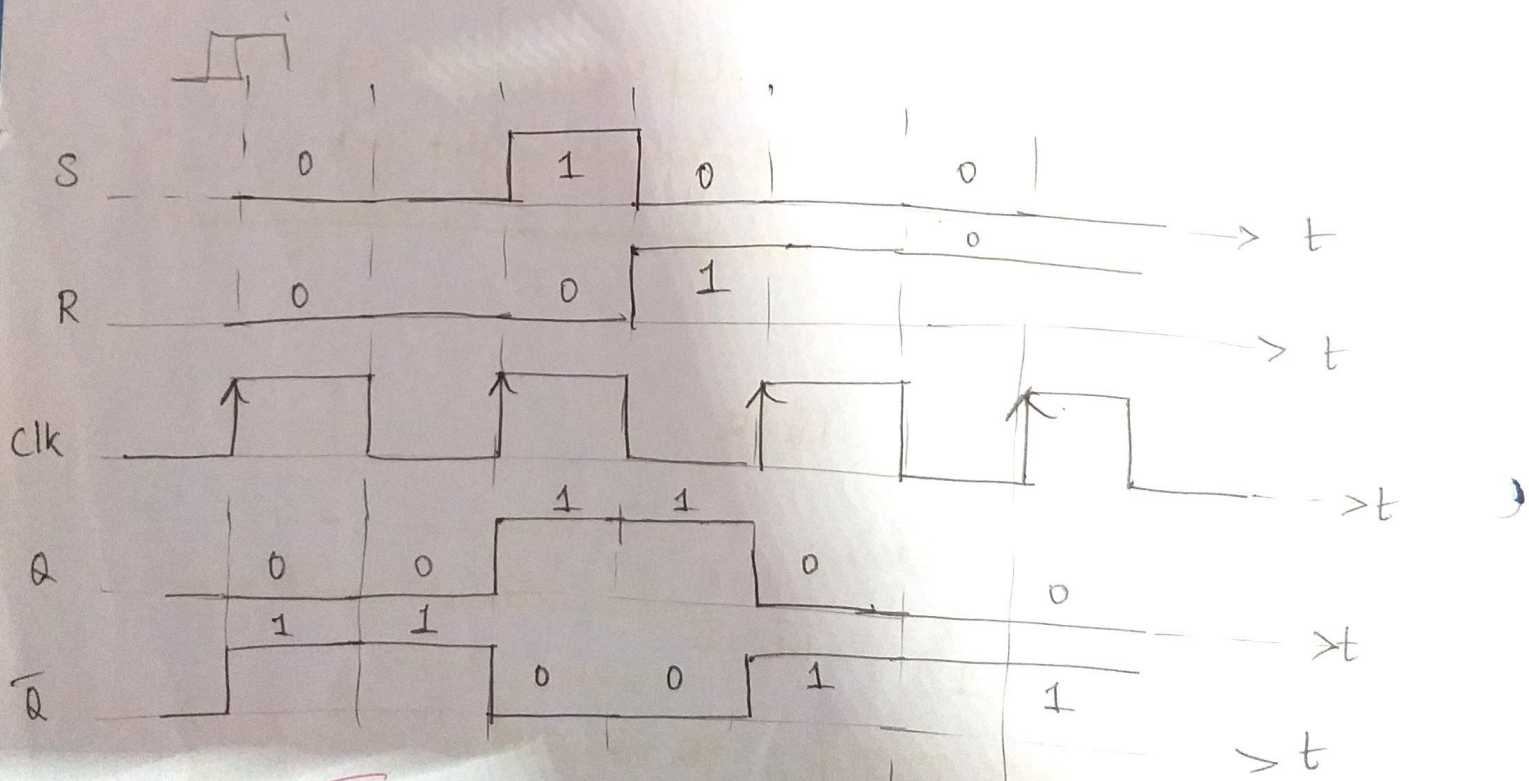


∴ When S = 1 & R = 0, then Q = 1 & $\overline{Q}$ = 0.

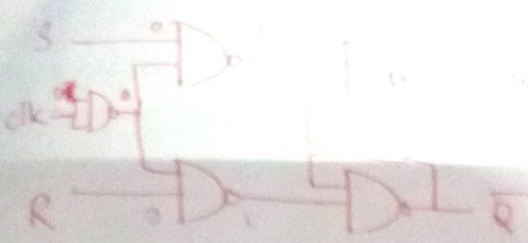
Case iv> When S = 1 & R = 1

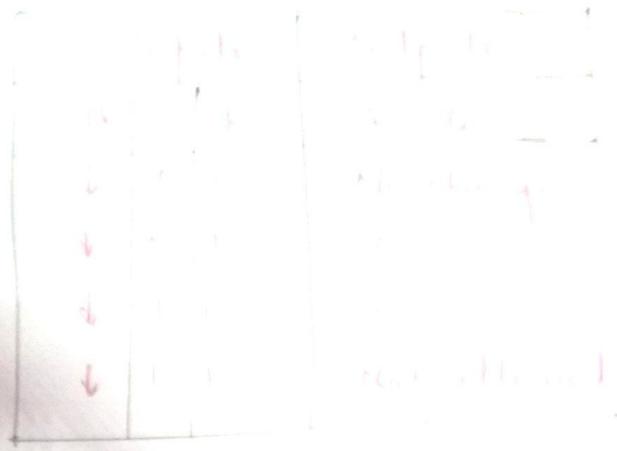


Invalid output



Timing diagram





Applications of flip-flops:

1. It is used as a memory element
2. In digital circuits flipflop is used to eliminate key debounce
3. Counters & registers are constructed using flip flop
4. In digital logic flip-flop can be used as a delay element

Comparison bwt combinational & Sequential circuits

Combinational circuits	Sequential circuits
1. Only logic gates	combinational circuit and a memory device
2. It depends only on present inputs	It depends on present and previous inputs outputs
3. Is used to realize boolean expression	It is used to record number of events
4. ex. half adder, full adder, decoders, encoders	counters, shift registers etc

The sequential circuits are classified as,

- Synchronous sequential circuits – signals can affect the element only at discrete instants of time
- Asynchronous sequential circuits
  - ↳ change in input signals can affect memory element at any instant of time

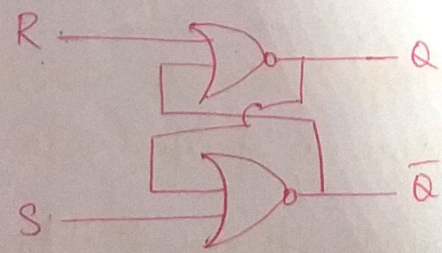
The memory element used in sequential circuits are flip-flops which is capable of storing one bit binary information.

Basically there are four flip-flops :

1) SR flipflop
2) JK flipflop
3) D flipflop
4) T flipflop

R-S latch

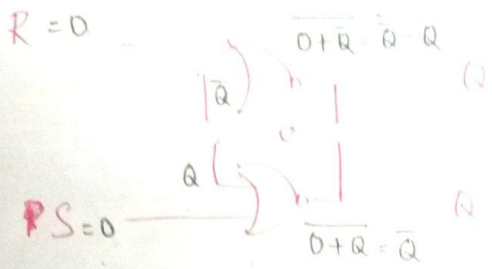
a) R-S latch using NOR gates



Truth table

Inputs		Outputs	
S	R	Q	$\bar{Q}$
0	0	No change	
0	1	0	1
1	0	1	0
1	1	Not allowed	

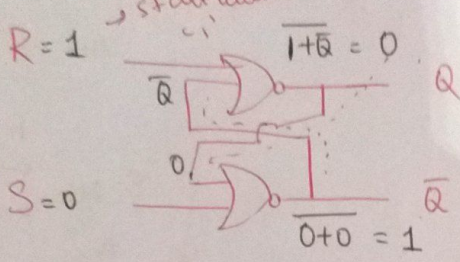
When both R & S = 0, then



i.e. When R=0 & S=0, the output of flipflop remains same

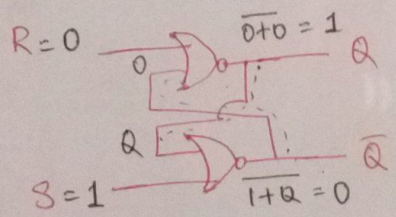
latch

Case ii) When R=1 & S=0, then



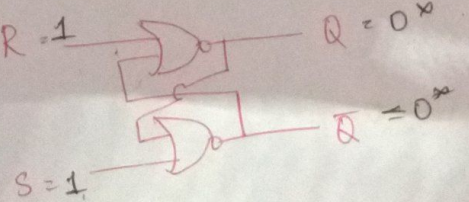
i.e. when R=1 and S=0, the output Q = zero & $\bar{Q}$ is one

Case iii) When R=0 & S=1, then



i.e. when R=0 and S=1, the output Q = one and $\bar{Q}$ is zero.

Case iv) When R=1 and S=1, then



Then it is an invalid state.