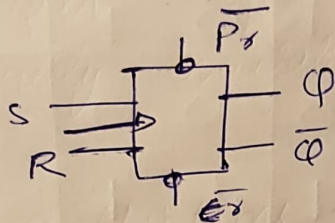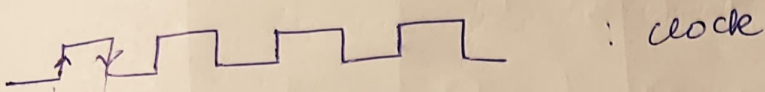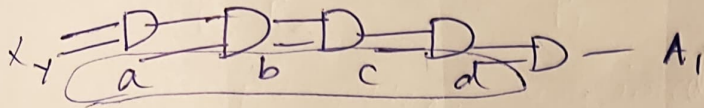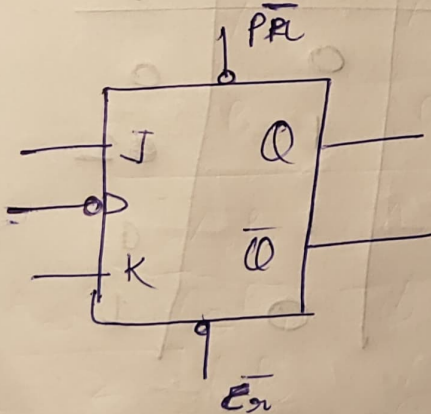# Sequential Circuit : Analysis

Any change in input gets reflected at the output at that instant.

combinational + synchronous = sequential

$$X_Y = D - D - D - D - D - A_1$$
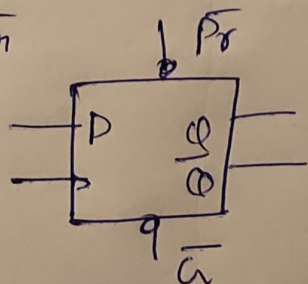$$\quad\ \ a \quad\ \ b \quad\ \ c \quad\ \ d$$

 : clock

Positive edge trigger SR flip flop

NET JK Flipflop
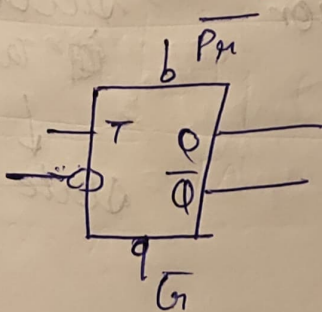
NET T F/F

PET D F/F

S	R	Q_{n+1}
0	0	Q_n
0	1	0
1	0	1
1	1	??

J	K	Q_{n+1}
0	0	Q_n
0	1	0
1	0	1
1	1	$\overline{Q_n}$

T	Q_{n+1}
0	Q_n
1	$\overline{Q_n}$

D	Q_{n+1}
0	0
1	1

Transition table

$Q_n \longrightarrow Q_{n+1}$		S R	J K	T	D
0	0	0 X	0 X	0	0
0	1	1 0	1 X	1	1
1	0	0 1	X 1	1	0
1	1	X 0	X 0	0	1

* Circuit Diagram :- state equation → state
    table
    ↓
    State diagram

clk n = input

if n flipflops : 2^n state

Z - output

eg.

MSB

P_A Q_A

$D_A = x \oplus \overline{Q_B}$
↳ state equation

$D_B = x + Q_A$ clock
↳ state equation
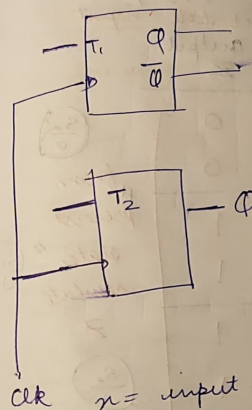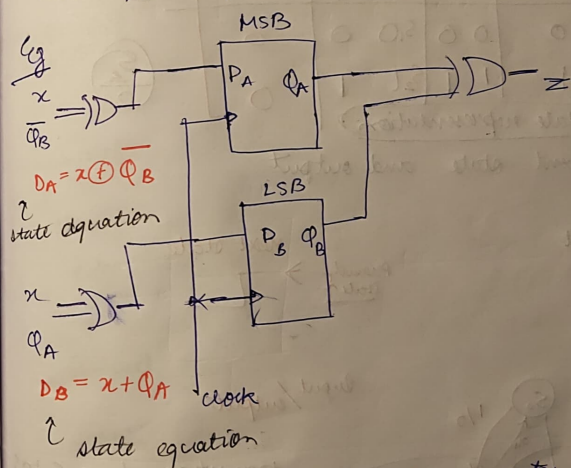
2 flipflops cascaded $\Rightarrow$ $2^2 = 4$ states

Q_2	Q_1
0	0
0	1
1	0
1	1

LSB

P_B Q_B

State table:

as it is a D flip flop
next state = input

Present states

Q_A	Q_B	input x	input to DFF D_A D_B	Next state Q_A Q_B	Output Z
S_0 0	0	0	1 0	S_2 1 0	0
0	0	1	0 1	S_1 0 1	0
S_1 0	1	0	0 0	S_0 0 0	1
0	1	1	1 1	S_3 1 1	1
S_2 1	0	0	1 0	S_3 1 0	1
1	0	1	0 1	S_1 0 1	1
S_3 1	1	0	0 0	S_1 1 0	0
1	1	1	1 1	S_2 1 1	0

$\frac{S_2}{0}$

$\frac{S_1}{1}$ from present state " calculate Z

$\frac{S_2}{1}$

$\frac{S_3}{0}$

(Straight binary state representation)

State : input , present state and output
Equation
↑ governs input

State diagram :

Present → next state
State ↗
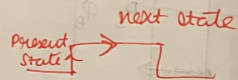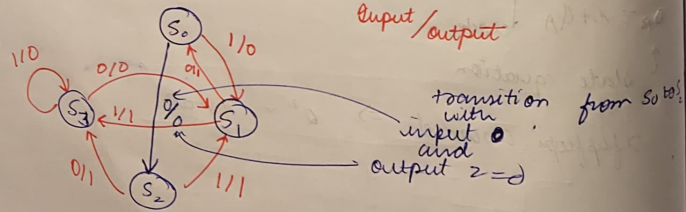
input / output

transition from S_0 to S_2
with input 0
and
output z = 0

Waveform : (wrt clock) "next state"

random input x

input ← input detected
input given then
$D_A = P_B = 0$
↓
$x \oplus Q_B$ → $x + Q_A$
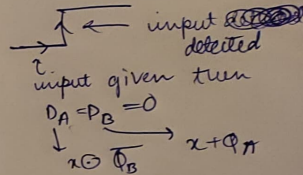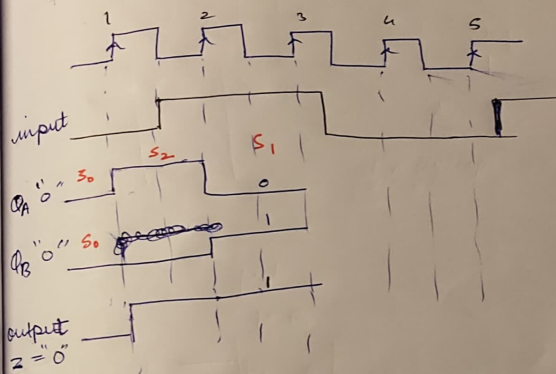
→ initially Q_A, Q_B and z are 0

oup
→ change in Q_A and Q_B will be detected at true
edge irrespective of input x given

Output depends on only state : Moore machine

Mealy machine :