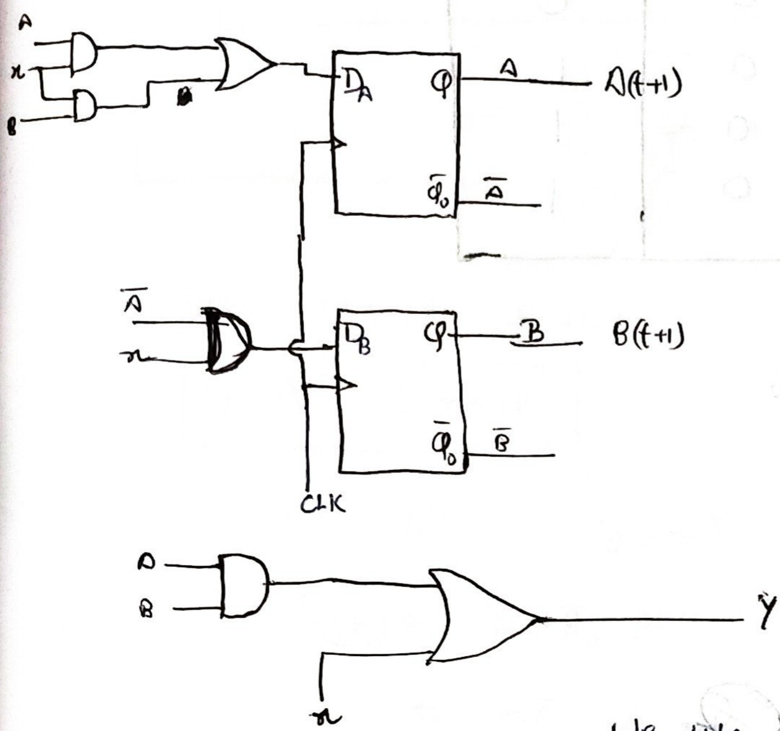
Unit-4 [Analysis of Sequential Circuit]

* In analysis of sequential circuit, 'Circuit' or state Equation given and we do analysis about various States and output of CKt.

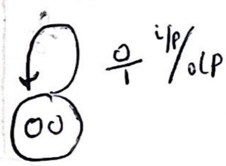
Ques:- Derive the state table & state diagram of synchronous sequential CKt?

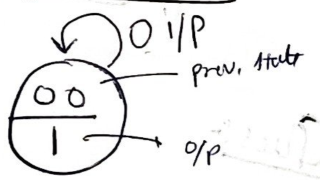


We use when:-

① Mealy Method → (output depends upon i/p)
② Moore method → (O/P depends upon Prev. state)

two methods





Ans:- State Equation :-

$$A(t+1) = D_A = Ax + Bx = x(A+B) \quad \text{— (I)}$$

$$B(t+1) = D_B = \bar{A} * x \Rightarrow \bar{A}x \quad \text{— (II)}$$

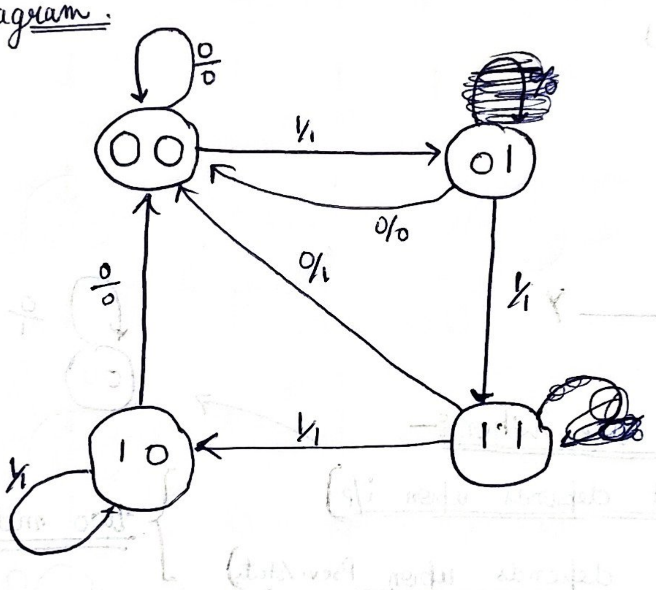
$$Y = AB + x \quad \text{— (III)}$$

now,

State table

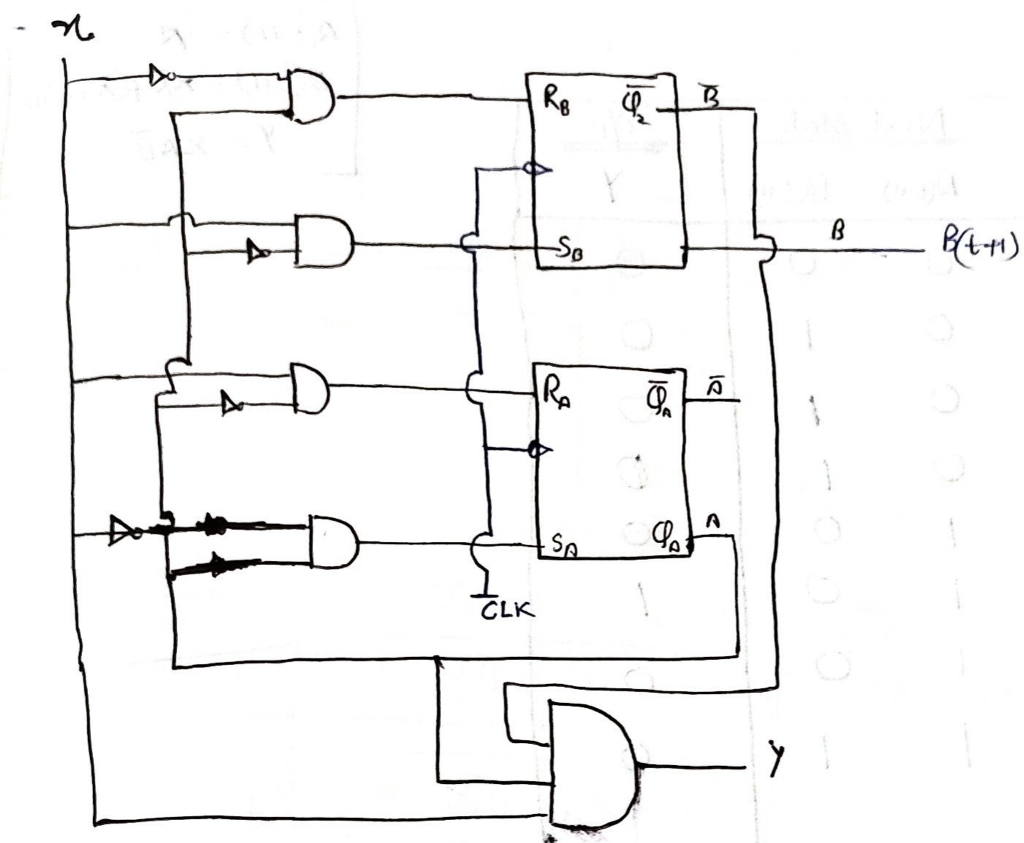
Prev. state A	Prev. state B	Input x	Next state $A_{(t+1)}$	Next state $B_{(t+1)}$	O/P
0	0	0	0	0	0
0	0	1	0	1	1
0	1	0	0	0	0
0	1	1	1	1	1
1	0	0	0	0	0
1	0	1	1	0	1
1	1	0	0	0	1
1	1	1	1	0	1

State diagram.



Ques:-

find state table & state diagram of



Characteristic eqn of SR F/F

$$\boxed{Q(t+1) = S + \bar{R}Q}$$

$R_B = A\bar{x}$, $S_B = x\bar{A}$

$$B(t+1) = S_B + \bar{R}_B \cdot B$$

$$= x\bar{A} + (\bar{A}+x)\cdot B$$

$$\Rightarrow x\bar{A} + \bar{A}B + xB$$

$R_A = x\bar{A}$ $S_A = A\bar{x}$

$$\Rightarrow \bar{A}B + x\bar{A} + xB = \boxed{x\bar{A} + (\bar{A}+x)B \Rightarrow B(t+1)}$$ — (I)

$$A(t+1) = S_A + \bar{R}_A A$$

$$= \bar{x}A + (\bar{x}+A)\cdot A$$

$$= \bar{x}A + \bar{x}A + A$$

$$\Rightarrow A(1 + \bar{x} + \bar{x})$$

$$\boxed{A(t+1) \Rightarrow A}$$ — (II)

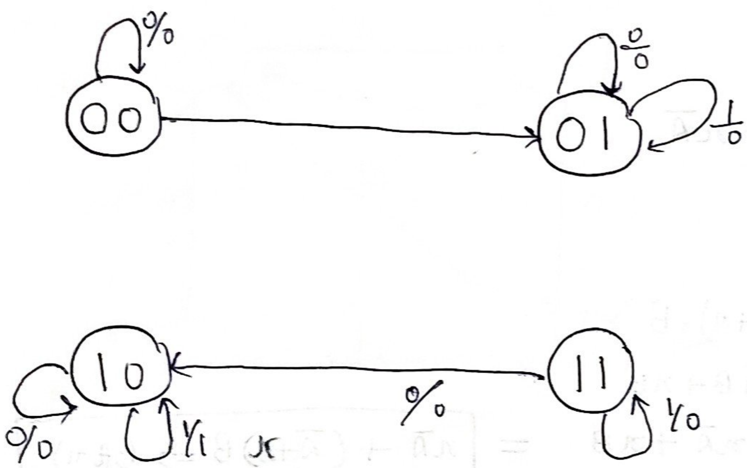
$$\boxed{Y = xA\bar{B}}$$

State table.

$$A(t+1) = A$$
$$B(t+1) = x\bar{A} + (\bar{A}+x)B$$
$$Y = xA\bar{B}$$

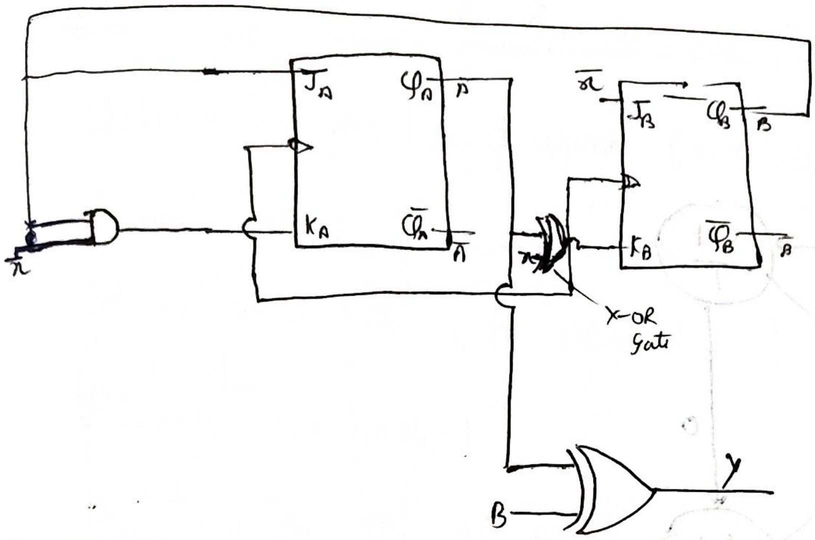
P.S		i/p	Next State		o/p
A	B	x	A(t+1)	B(t+1)	Y
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	0	1	0
0	1	1	0	1	0
1	0	0	1	0	0
1	0	1	1	0	1
1	1	0	1	0	0
1	1	1	1	1	0

State diagram



Ques :- design the state table & state diagram for the sequential circuit –

→



State eqn

$J_A = B \qquad K_A = xB \qquad J_B = \bar{x}$

$K_B = (A \oplus x)$

$$Q_{(t+1)} = \boxed{A(t+1) = J\bar{Q} + \bar{K}Q}$$

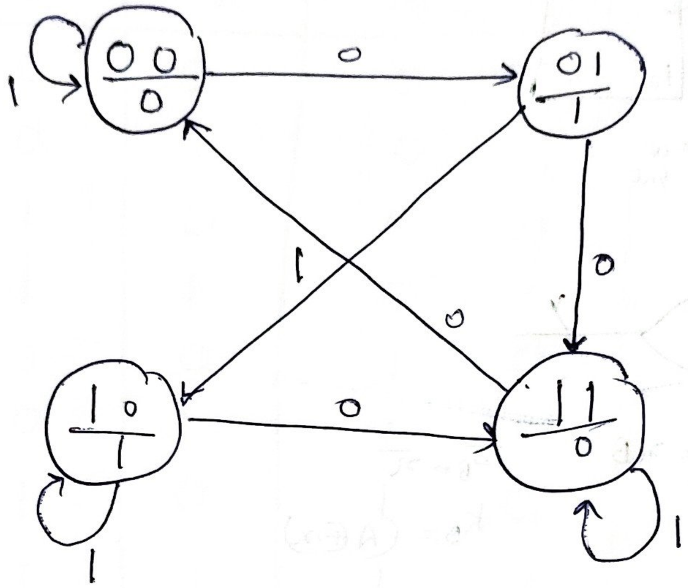
$$\boxed{B(t+1) = \overline{(A \oplus x)}\, B + \bar{x}\bar{B}}$$

$$\boxed{Y = A \oplus B}$$

State table

P.S A	P.S B	i/p x	NS A(t+1)	NS B(t+1)	Y
0	0	0	0	1	0
0	0	1	0	0	0
0	1	0	1	1	1
0	1	1	1	0	1
1	0	0	1	1	1
1	0	1	1	0	1
1	1	0	0	0	0
1	1	1	1	1	0

State diagram



State.

= Stable Simplified

P.S		NS				O/P
		x=0		x=1		
A	B	A(t+1)	B(t+1)	A(t+1)	B(t+1)	
0	0	0	1	0	0	0
0	1	1	1	1	0	1
1	0	1	1	1	0	1
1	1	0	0	1	1	0

Clocked Sequential Synchronous Ckt :-

1> Determine state diagram (normally given question)

2> from state diagram → State table

3> State reduction (If possible)

4> Binary assignment

5> By finding no. of F/F.

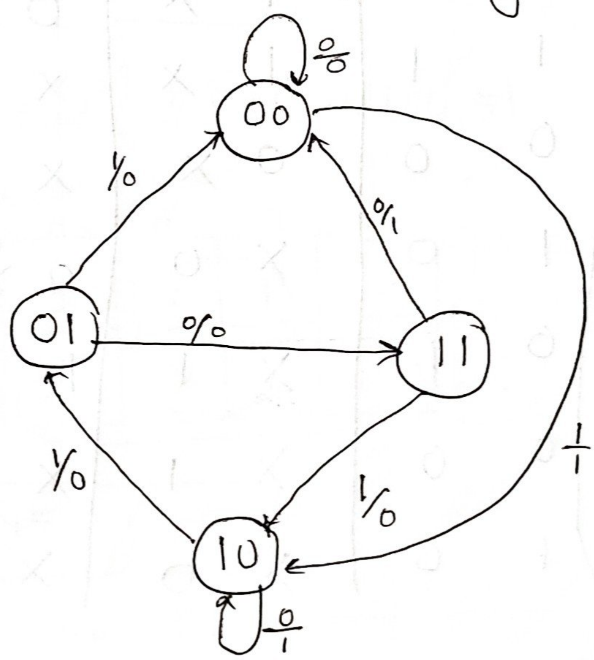
6> Choose type of F/F (SR, JK, D, T)

7> Compare excitation & state table

8> By K-map find ckt output.

9> Draw logic diagram.

Ques:- A sequential ckt has one i/p and one o/p state diagram is shown below design using J-K F/F ?



4-state

$2^{②} \Rightarrow$ f/

Ans :- Given that

State table

(2)

Prev. State A	Prev. State B	i/p x	N.S $A(t+1)$	N.S $B(t+1)$	o/p y
0	0	0	0	0	0
0	0	1	1	0	1
0	1	0	1	1	0
0	1	1	0	0	0
1	0	0	1	0	0
1	0	1	0	1	0
1	1	0	0	0	1
1	1	1	1	0	0

Excitation table (JK)

$Q(t)$	$Q(t+1)$	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

= Compare

P.S. A	P.S. B	i/p x	N.S $A(t+1)$	N.S $B(t+1)$	J_0	K_0	J_1	K_1	y
0	0	0	0	0	0	X	0	X	0
0	0	1	1	0	1	X	0	X	1
0	1	0	1	1	1	X	X	0	0
0	1	1	0	0	0	X	X	1	0
1	0	0	1	0	X	0	0	X	0
1	0	1	0	1	X	1	1	X	0
1	1	0	0	0	X	1	X	1	1
1	1	1	1	0	X	0	X	1	0

$J_0 = \Sigma m(1, 2) + \Sigma d(4, 5, 6, 7)$

A \ B x	00	01	11	10
0		1		1
1	X	X	X	X

$J_0 = \bar{x} B + x \bar{B}$

$\boxed{J_0 = \cancel{x \oplus A(t+1)}\ \ x \oplus B}$

$K_0 = \Sigma m(5,6) + \Sigma d(0,1,2,3)$

A \ Bx	00	01	11	10
0	X	X	X	X
1		1		1

$K_0 = \bar{x} B + x\bar{B}$

$\boxed{K_0 = x \oplus B}$

$J_1 = \Sigma m(5) + \Sigma d(2,3,6,7)$

A \ Bx	00	01	11	10
0			X	X
1		1	X	X

$\boxed{J_1 = Ax}$

$K_1 = \Sigma m(3,6,7) + \Sigma d(0,1,4,5)$

A \ Bx	00	01	11	10
0	X	X	1	
1	X	X	1	1

$\boxed{K_1 = A + x}$

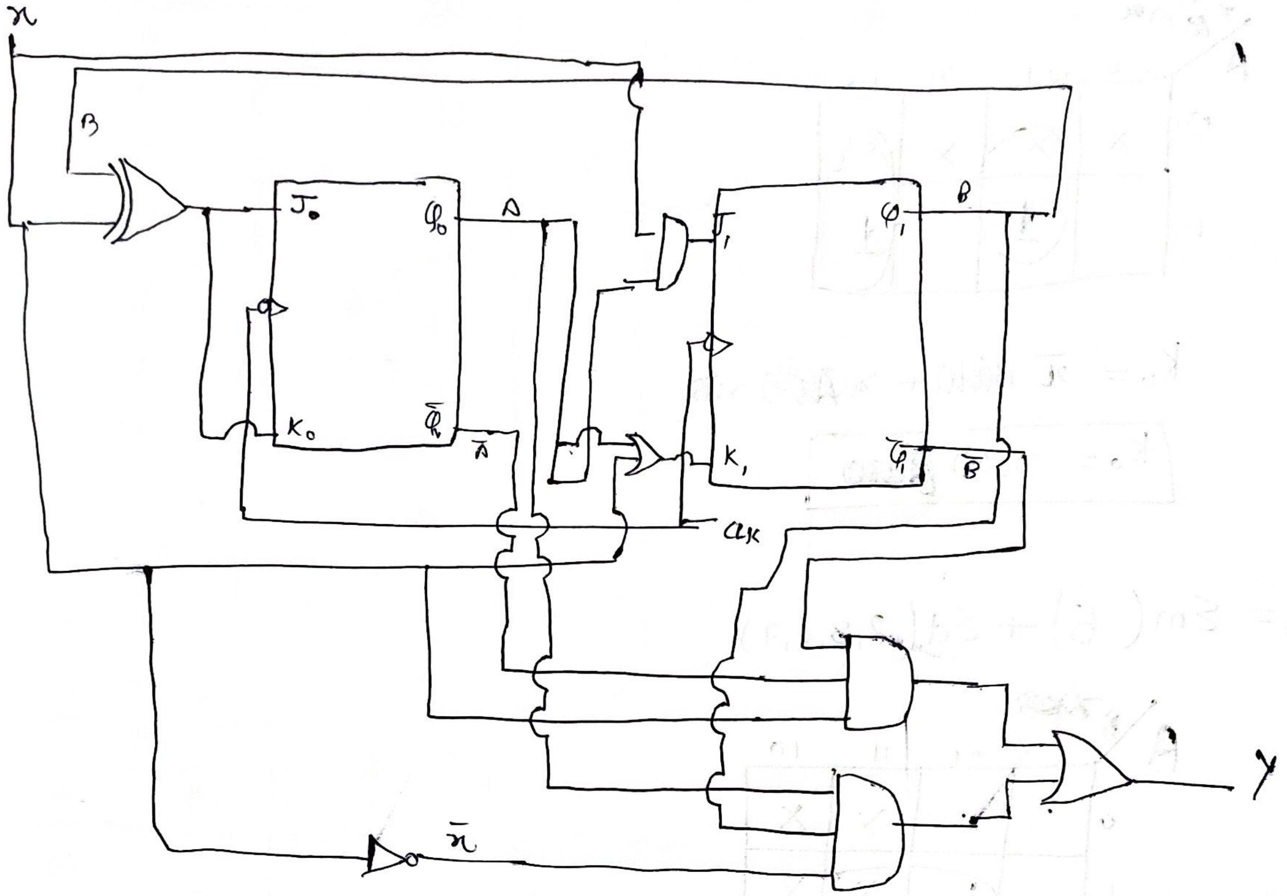
$Y = \Sigma m(1,6) + \Sigma d$

$\Rightarrow$

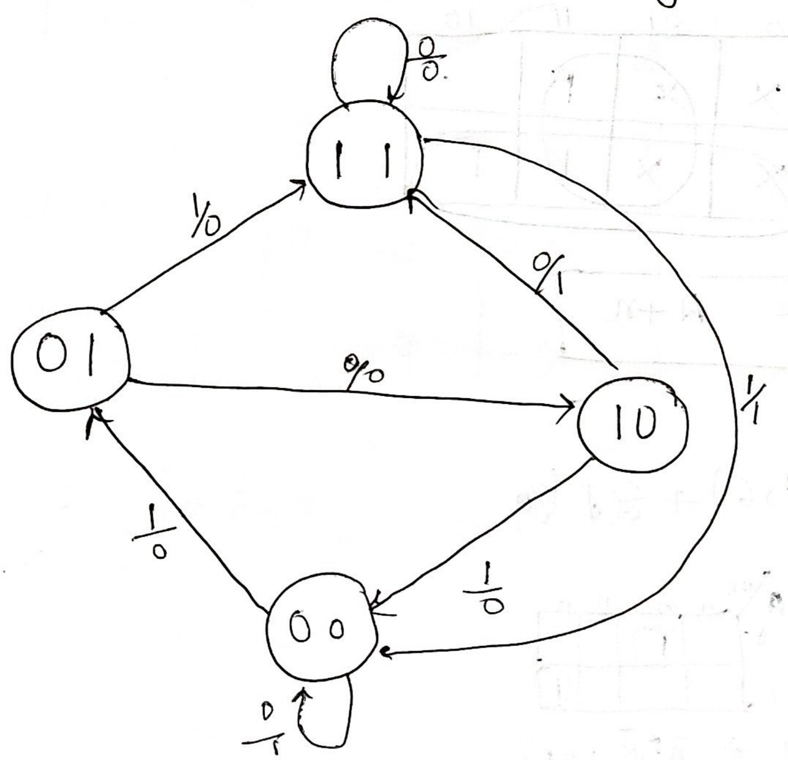
A \ Bx	00	01	11	10
0		1		
1				1

$Y \Rightarrow \bar{A}x\bar{B} + AB\bar{x}$

now, CKt diagram

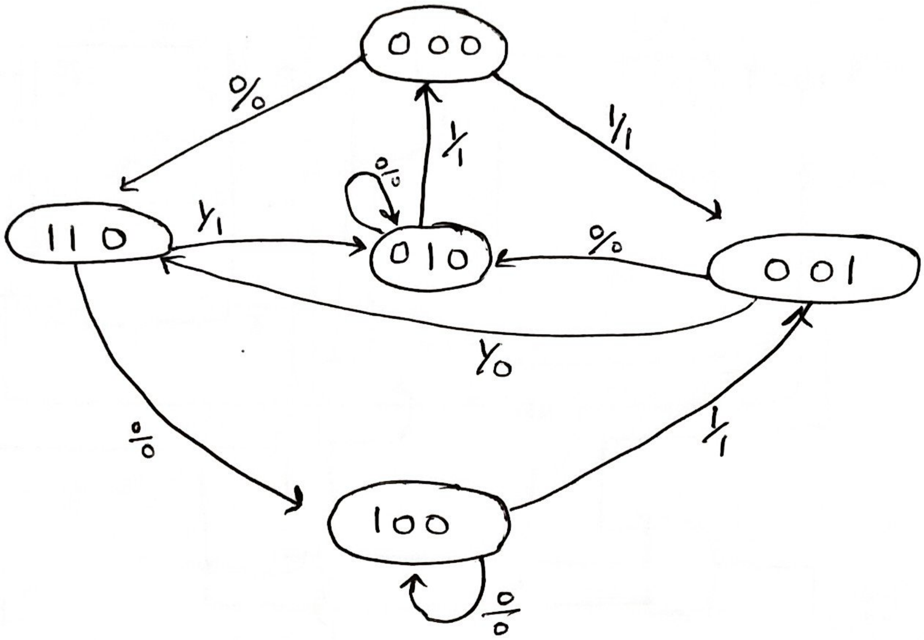


Ques:- A sequential CKt has one i/p and one o/p. State diagram is shown below design using, J-K F/F?



Ques:- for the state diagram shown in fig. design the ckt using –

(a) T F/F (b) S-R F/F (c) J-K F/F



Solⁿ: (a)

State table

Prev. State A	B	C	i/p x	Next state A(t+1)	B(t+1)	C(t+1)	o/p Y
0	0	0	0	1	1	0	0
0	0	0	1	0	0	1	1
0	0	1	0	0	1	0	0
0	0	1	1	1	1	0	0
1	0	0	0	1	0	0	0
1	0	0	1	0	0	1	1
1	1	0	0	1	0	0	0
1	1	0	1	0	1	0	1
0	1	0	1	0	0	0	1
0	1	0	0	0	1	0	0

Excitation table of T-F/F

$Q_{(t)}$	$Q_{(t+1)}$	T
0	0	0
0	1	1
1	0	1
1	1	0

than

A	B	C	x	$A_{(t+1)}$	$B_{(t+1)}$	$C_{(t+1)}$	T_A	T_B	T_C	Y
0	0	0	0	1	1	0	1	1	0	0
0	0	0	1	0	0	1	0	0	1	1
0	0	1	0	0	1	0	0	1	1	0
0	0	1	1	1	1	0	1	1	1	0
1	0	0	0	1	0	0	0	0	0	0
1	0	0	1	0	0	1	1	0	1	1
1	1	0	0	1	0	0	0	1	0	0
1	1	0	1	0	1	0	1	0	0	1
0	1	0	1	0	0	0	0	1	0	1
0	1	0	0	0	1	0	0	0	0	0

$$T_A = \Sigma m(0, 3, 9, 13)$$

$$T_B = \Sigma m(0, 2, 3, 5, 12)$$

$$T_C = \Sigma m(1, 2, 3, 9)$$

$$Y = \Sigma m(1, 5, 9, 13)$$

K-Map

for T_A -

AB \ Cx	$\bar{C}\bar{x}$ 00	$\bar{C}x$ 01	Cx 11	$C\bar{x}$ 10
$\bar{A}\bar{B}$ 00	1		1	
$\bar{A}B$ 01				
AB 11		1		
$A\bar{B}$ 10		1		

$$\boxed{T_A = \bar{A}\bar{B}\bar{C}\bar{x} + \bar{A}\bar{B}Cx + A\bar{C}x}$$

for T_B.

AB \ Cx	00	01	11	10
00	1		1	1
01		1		
11	1			
10				

$$\boxed{T_B = \bar{A}\bar{B}\bar{x} + AB\bar{C}\bar{x} + \bar{A}B\bar{C}x + \bar{A}\bar{B}C}$$

for the T_C

AB \ Cx	00	01	11	10
00		1	1	1
01				
11				
10		1		

$$\boxed{T_C = \bar{B}\bar{C}x + \bar{A}\bar{B}C}$$

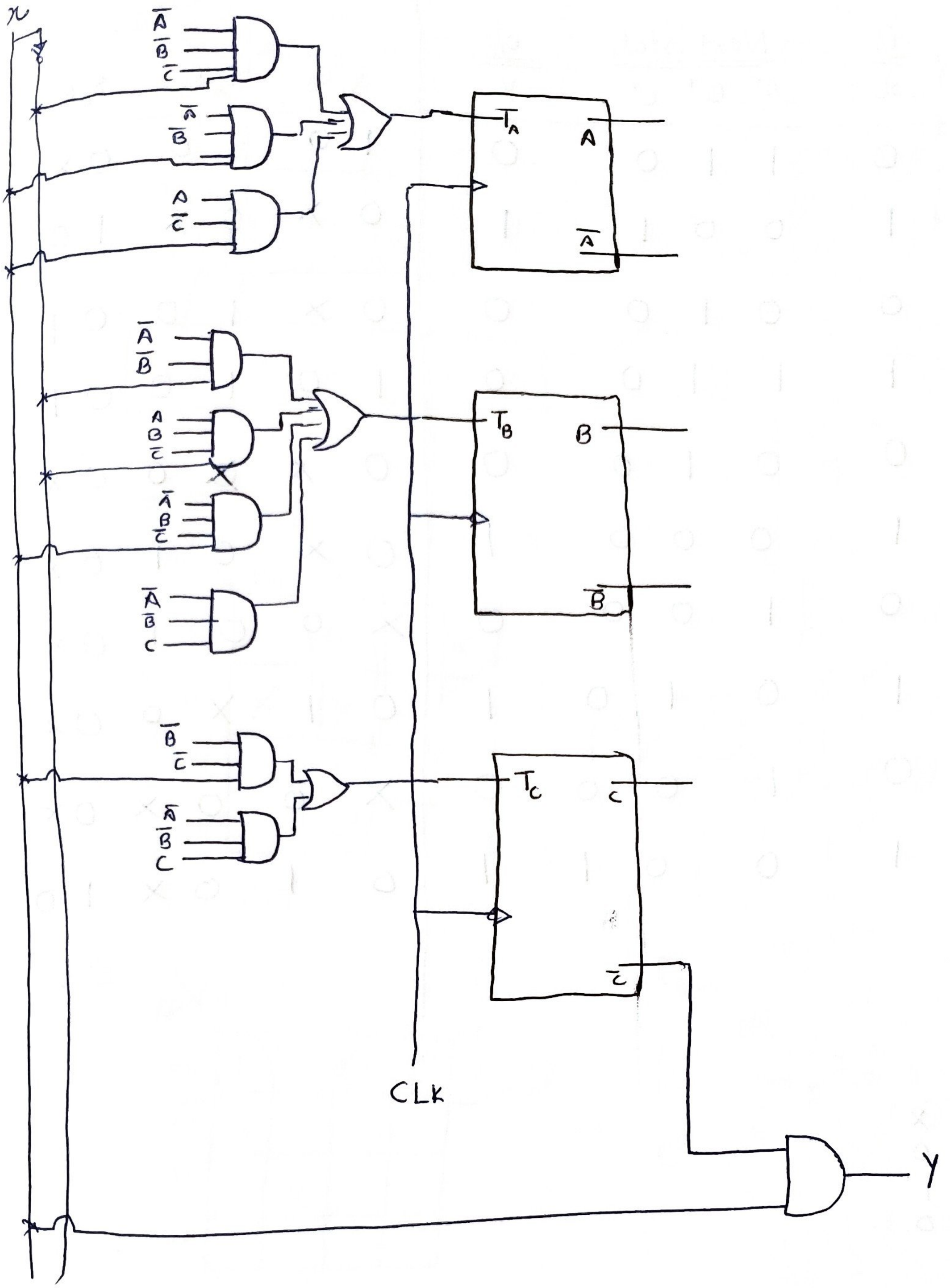
for Y

AB \ Cx	00	01	11	10
00		1		
01		1		
11		1		
10		1		

$$\boxed{Y = \bar{C}x}$$

Ckt diagram $\rightarrow$

Ckt diagram


x
y
$\bar{A}$
$\bar{B}$
$\bar{C}$
A
$\bar{B}$
A
$\bar{C}$
T_A
A
$\bar{A}$
$\bar{A}$
$\bar{B}$
A
B
$\bar{C}$
$\bar{A}$
B
$\bar{C}$
$\bar{A}$
$\bar{B}$
C
T_B
B
$\bar{B}$
$\bar{B}$
$\bar{C}$
$\bar{A}$
$\bar{B}$
C
T_C
C
$\bar{C}$
CLK
Y

Using S-R

State table

Table . 1 | Table . 2

Prev. state A	B	C	i/p x	Next state A^+	B^+	C^+	o/p y	S_A	R_A	S_B	R_B	S_C	R_C
0	0	0	0	1	1	0	0	1	0	1	0	0	X
0	0	0	1	0	0	1	1	0	X	0	X	1	0
0	0	1	0	0	1	0	0	0	X	1	0	0	1
0	0	1	1	1	1	0	0	1	0	1	0	0	1
0	1	0	0	0	1	0	0	0	X	X	0	0	X
0	1	0	1	0	0	0	1	0	X	0	1	0	X
1	1	0	0	1	0	0	0	X	0	0	1	0	X
1	1	0	1	0	1	0	1	0	1	X	0	0	X
1	0	0	0	1	0	0	0	X	0	0	X	0	X
1	0	0	1	0	0	1	1	0	1	0	X	1	0

Characteristic of S-R

$Q(t)$	$Q(t+1)$	S	R
0	0	0	X
0	1	1	0
1	0	0	1
1	1	X	0

min terms —

$$S_A = \Sigma m(0,3) + \Sigma d(12,8)$$

$$R_A = \Sigma m(13,9) + \Sigma d(1,2,4,5)$$

$$Y = \Sigma m(1,5,13,9)$$

$$S_B = \Sigma m(0,2,3) + \Sigma d(4,13)$$

$$R_B = \Sigma m(5,12) + \Sigma d(1,8,9)$$

$$S_C = \Sigma m(1,9)$$

$$R_C = \Sigma m(2,3) + \Sigma d(0,4,5,8,12,13)$$

for S_A

AB \ Cx	00	01	11	10
00	1		1	
01				
11	X			
10	1			

$$\boxed{S_A = \bar{B}\bar{C}\bar{x} + \bar{A}\bar{B}\,Cx}$$

for R_A

AB \ Cx	00	01	11	10
00		X		X
01	X	X		
11		1		
10				

$$\boxed{R_A = \bar{C}x}$$

S_B

AB \ Cx	00	01	11	10
00	1		1	1
01	X			
11		X		
10				

$$\boxed{S_B = \bar{A}\bar{B}\bar{x} + \bar{A}\bar{B}C}$$

$R_B =$

AB \ Cx	00	01	11	10
00		X		
01		1		
11	1			
10	X	X		

$$\boxed{R_B = A\bar{C}\bar{x} + \bar{A}\bar{C}x}$$

$S_C =$

AB \ Cx	00	01	11	10
00		1		
01				
11				
10		1		

$$\boxed{S_C = \bar{B}\bar{C}x}$$

AB \ Cx	00	01	11	10
00	X		1	1
01	X	X		
11	X	X		
10	X			

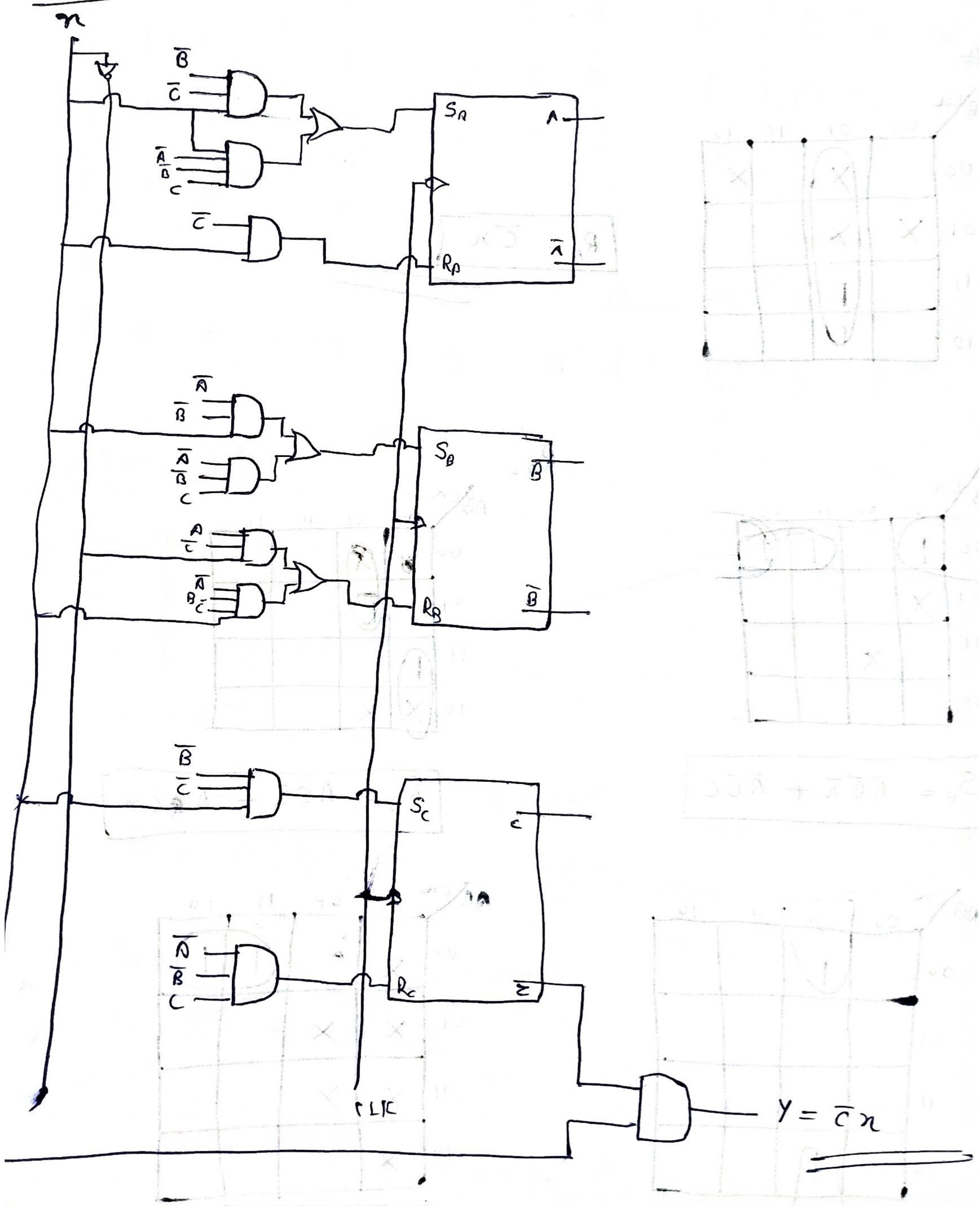
$$\boxed{R_C = \bar{A}\bar{B}C}$$

$Y =$

AB \ Cx	00	01	11	10
00		1		
01		1		
11		1		
10		1		

$$\boxed{Y = \bar{C}x}$$

Ckt diagram



(iii) By J-K F/F.

J-K Excitation table

Q_t	Q_{t+1}	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

State table

Prev. state			i/p	Next state			o/p						
A	B	C	x	A^+	B^+	C^+	y	J_A	K_A	J_B	K_B	J_C	K
0	0	0	0	1	1	0	0	1	X	1	X	0	X
0	0	0	1	0	0	1	1	0	X	0	X	1	X
0	0	1	0	0	1	0	0	0	X	1	X	X	1
0	0	1	1	1	1	0	0	1	X	1	X	X	1
0	1	0	0	0	1	0	0	0	X	X	0	0	X
0	1	0	1	0	0	0	1	0	X	X	1	0	X
1	1	0	0	1	0	0	0	X	0	X	1	0	X
1	1	0	1	0	1	0	1	X	1	X	0	0	X
1	0	0	0	1	0	0	0	X	0	0	X	0	X
1	0	0	1	0	0	1	1	X	1	0	X	1	X

$J_A = \Sigma m(0,3) + \Sigma d(12,13,8,9)$

$K_A = \Sigma m(9,13) + \Sigma d(0,1,2,3,4,5)$

$J_B = \Sigma m(0,2,3) + \Sigma d(4,5,12,13)$

$K_B = \Sigma m(5,12) + \Sigma d(0,1,2,3,8,9)$

$J_C = \Sigma m(1,9) + \Sigma d(2,3)$

$K_C = \Sigma m(2,3) + \Sigma d(0,1,4,5,12,13,8,9)$

$Y = \Sigma m(1,5,9,13)$

now,

K-map for —

J_A

AB \ Cx	00	01	11	10
00	1		1	
01				
11	X	X		
10	X	X		

$$\boxed{J_A = \bar{B}\bar{C}\bar{x} + \bar{A}\bar{B}Cx}$$

K_A

AB \ Cx	00	01	11	10
00	X	X	X	X
01	X	X		
11		1		
10		1		

$$\boxed{K_A = \bar{C}x}$$

J_B

AB \ Cx	00	01	11	10
00	1		1	1
01	X	X		
11	X	X		
10				

$$\boxed{J_B = \bar{A}\bar{B}\bar{x} + \bar{A}\bar{B}C}$$

K_B

AB \ Cx	00	01	11	10
00	X	X	X	X
01		1		
11	1			
10	X	X		

$$\boxed{K_B = \bar{A}\bar{C}x + A\bar{C}\bar{x}}$$

J_C

AB \ Cx	00	01	11	10
00		1	X	X
01				
11				
10		1		

$$\boxed{J_C = \bar{B}\bar{C}x}$$

K_C

AB \ Cx	00	01	11	10
00	X	X	1	1
01	X	X		
11	X	X		
10	X	X		

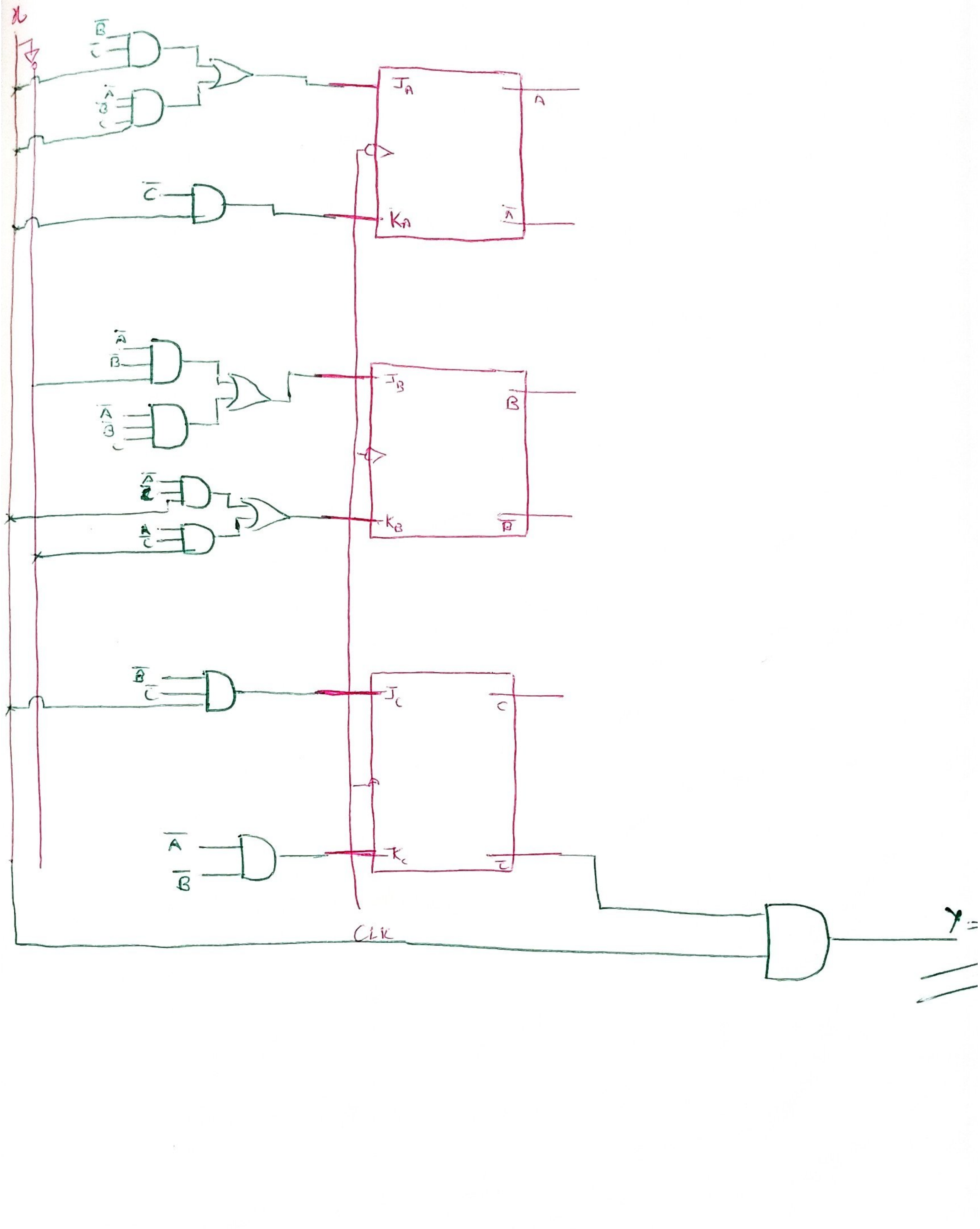
$$\boxed{K_C = \bar{A}\bar{B}}$$

Y

AB \ Cx	00	01	11	10
00		1		
01		1		
11		1		
10		1		

$$\boxed{Y = \bar{C}x}$$

Ckt diagram



Analysis of Asynchronous sequential circuit

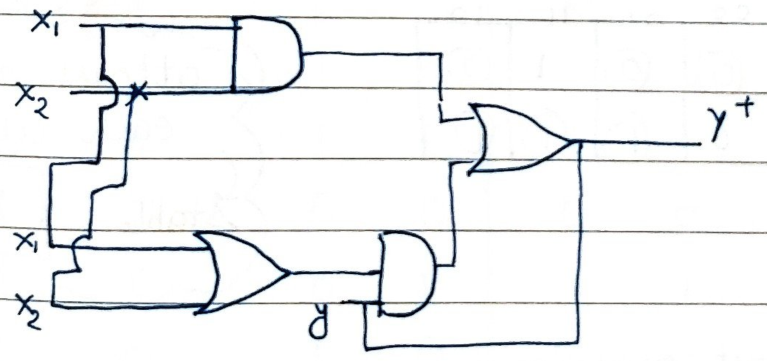
Steps :- 1> determine the next secondary state & output equations from given sequential ckt.
2> Construct the state table
3> Construct transition table
4> Construct the output map.

Ques :- An Asynchronous sequential ckt is design by the following excitation output f^n —

$$y^+ = x_1x_2 + (x_1+x_2)y$$
$$Z = y^+$$

(i) Draw logic diagram of ckt?
(ii) Derive transition table & output map?

Ans. (i)



(ii) now,
We construct the ~~ex~~ state table first —

N.S = y^+

Prev. state = y

O/P = Z

i/P = x_1, x_2

State table

Prev. S. y	i/p x_1	i/p x_2	N.S y^+	o/p Z
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	1	1
1	0	0	0	0
1	0	1	1	1
1	1	0	1	1
1	1	1	1	1

transition table

x_1x_2 (i/p) →

y (P.S) ↓

$y \backslash x_1x_2$	00	01	11	10
0	0	0	1	0
1	0	1	1	1

(atleast one circle in each coloumn)

Stable $\boxed{Y_i = Y_i^+}$

Output mapping -

$y \backslash x_1x_2$	00	01	11	10
0	0	0	–	0
1	–	1	1	1

Ques :- An asynchronous sequential ckt has two internal states & one o/p. The excitation and o/p function describing the ckt as follows —

$$Y_1 = X_1X_2 + X_1y_2 + X_2y_1$$
$$Y_2 = X_2 + X_1y_1y_2 + X_1y_1$$
$$Z = X_2 + y_1$$

y. State table —

Prev. state y_1	y_2	i/p X_1	X_2	N.S Y_1	Y_2	o/p Z
0	0	0	0	0	0	0
0	0	0	1	0	1	1
0	0	1	0	0	0	0
0	0	1	1	1	1	1
0	1	0	0	0	0	0
0	1	0	1	0	1	1
0	1	1	0	1	0	0
0	1	1	1	1	1	1
1	0	0	0	0	0	1
1	0	0	1	1	1	1
1	0	1	0	0	1	1
1	0	1	1	1	1	1
1	1	0	0	0	0	1
1	1	0	1	1	1	1
1	1	1	0	1	1	1
1	1	1	1	1	1	1

transition table

y_1y_2 \ x_1x_2	00	01	11	10
00	00	01	11	00
01	00	01	11	10
11	00	11	11	11
10	00	11	11	01

Output mapping

y_1y_2 \ x_1x_2	00	01	11	10
00	0	–	–	0
01	–	1	–	–
11	–	1	1	1
10	–	–	–	–

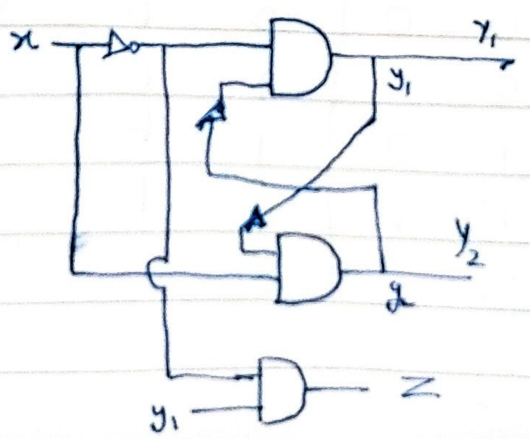
Ques. Draw the logic diagram and check Stability of following expression –

$Y_1 = \bar{x}\bar{y}_2$

$Y_2 = x\bar{y}_1$

$Z = \bar{x}y_1$

Ans :-



State table

P.S y_1	y_2	i/p X	Next State Y_1	Y_2	o/p Z
0	0	0	1	0	0
0	0	1	0	1	0
0	1	0	0	0	0
0	1	1	0	1	0
1	0	0	1	0	1
1	0	1	0	0	0
1	1	0	0	0	1
1	1	1	0	0	0

→ transition table

X \ y_1y_2	00	01	11	10
0				
1				

y_1y_2 \ X	0	1
00	10	01
01	00	01
11	00	00
10	10	00

It is stable

→ Output mapping

y_1y_2 \ X	0	1
00	–	–
01	–	0
11	–	–
10	1	–

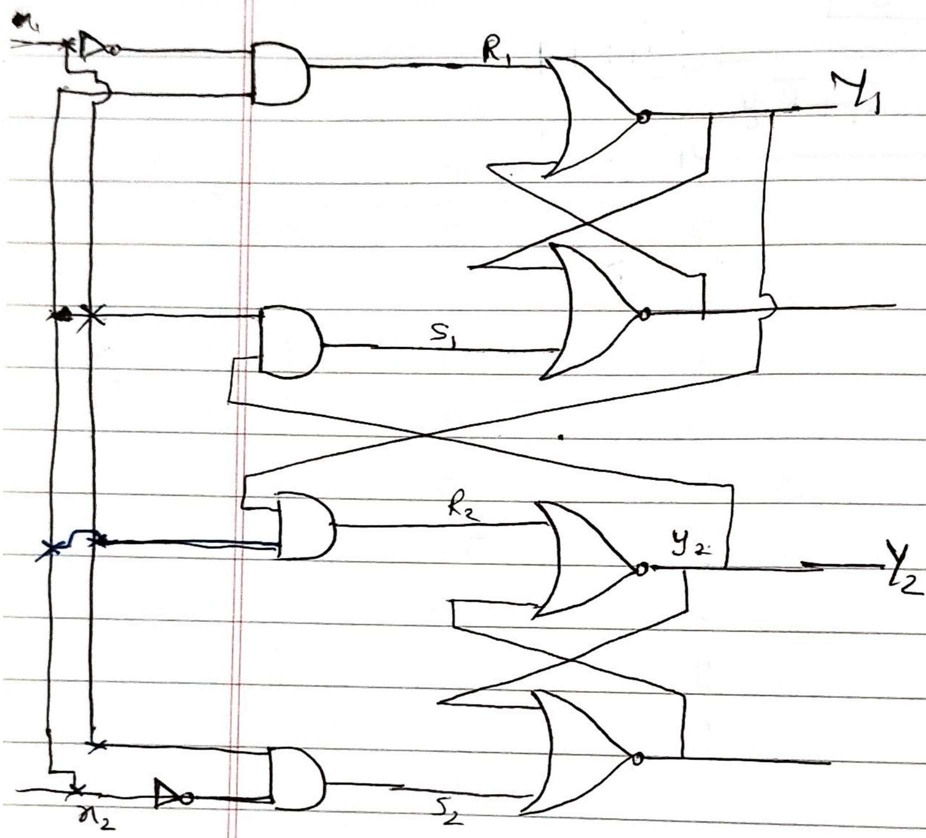
classmate

Date

Page

★

Ques :- find the flow table and transition table using S-R latch.



Ans

Characteristic Eqn of S-R latch

$$\boxed{Y = S + \overline{R}y}$$

$$\boxed{Y_1 = S_1 + \overline{R_1}y_1}$$

$$\boxed{Y_2 = S_2 + \overline{R_2}y_2}$$

$S_1 = x_1 y_2$, $R_1 = \overline{x_1}\, x_2$

$$Y_1 = x_1 y_2 + (\overline{\overline{x_1}\, x_2})\, y_1$$

$$\Rightarrow \boxed{Y_1 = x_1 y_2 + x_1 y_1 + \overline{x_2} y_1}$$

$$\boxed{Y_2 = S_2 + \overline{R_2}\, y_2}$$

$$S_2 = x_1 \bar{x}_2, \qquad R_2 = x_2 y_1$$

$$Y_2 = x_1 \bar{x}_2 + (\overline{x_2 y_1})\, y_2$$

$$Y_2 = x_1 \bar{x}_2 + (\bar{x}_2 + \bar{y}_1)\, y_2$$

$$\boxed{Y_2 = x_1 \bar{x}_2 + \bar{x}_2 y_2 + \bar{y}_1 y_2}$$

State table

Prev. State		i/p		N.S	
y_1	y_2	x_1	x_2	Y_1	Y_2
0	0	0	0	0	0
0	0	0	1	0	0
0	0	1	0	0	1
0	0	1	1	0	0
0	1	0	0	0	1
0	1	0	1	0	1
0	1	1	0	1	1
0	1	1	1	1	1
1	0	0	0	1	0
1	0	0	1	0	0
1	0	1	0	1	1
1	0	1	1	1	0
1	1	0	0	1	1
1	1	0	1	0	0
1	1	1	0	1	1
1	1	1	1	1	0

» transition table

y_1y_2 \ x_1x_2	00	01	11	10
00	00	00	00	01
01	01	01	11	11
11	01	00	10	11
10	10	00	10	11

= stable

Reverse Engineering

for Y_2

y_1y_2 \ x_1x_2	00	01	11	10
00	1	0	1	1
01	1	0	0	0
11	1	0	0	0
10	0	0	0	0

for Y_1

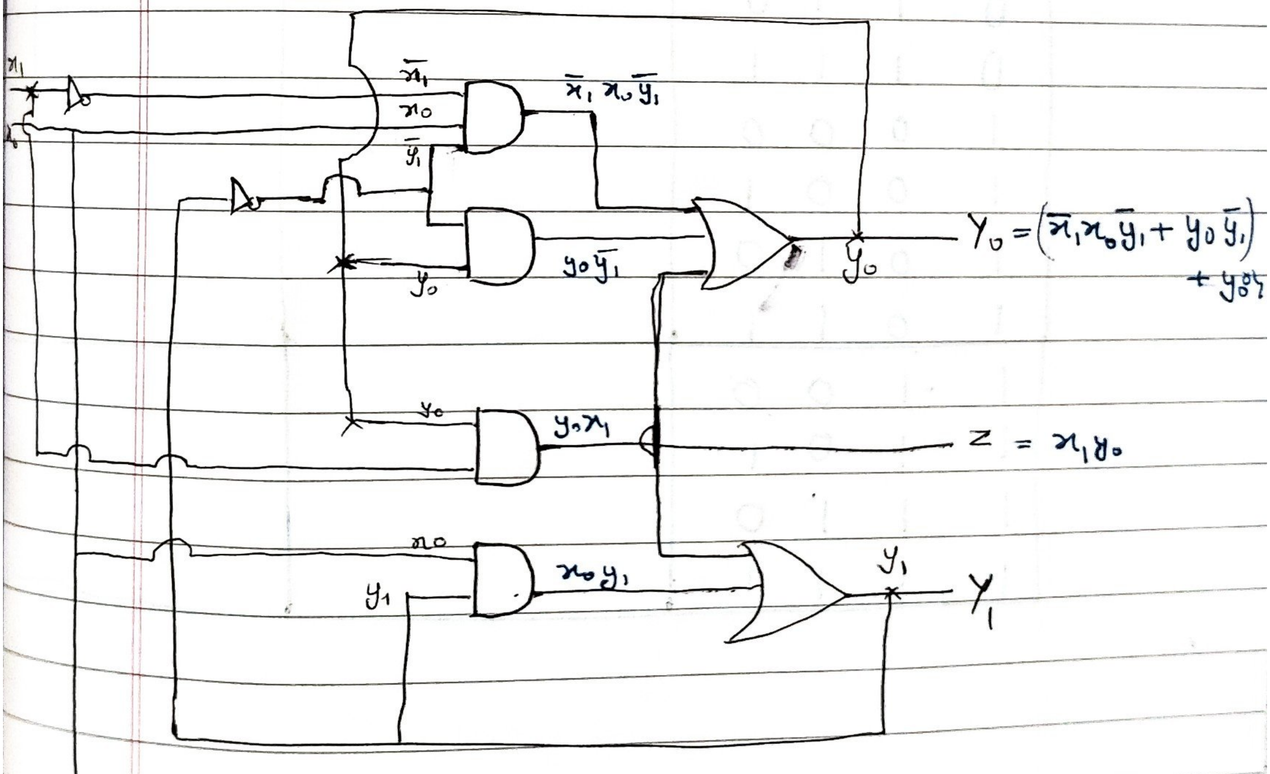
y_1y_2 \ x_1x_2	00	01	11	10
00	0	0	0	0
01	0	0	1	1
11	1	0	0	1
10	0	0	0	1

≃ now, flow table →

Let P.S ⇒ { 00 = a, 01 = b, 11 = c, 10 = d }

y_1y_2 \ x_1x_2	00	01	11	10
a	a	a	a	b
b	b	b	c	c
c	c	a	d	c
d	d	a	d	c

Ques:- for the following CKt find out present total states, next total states, stable State, O/P, transition table & flow table ?



$$\boxed{Y_0 = \bar{x}_1 x_0 \bar{y}_1 + y_0 \bar{y}_1 + y_0 x_1}$$

$$\boxed{Z = x_1 y_0}$$

$$\boxed{Y_1 = y_0 x_1 + x_0 y_1}$$

Asynchronous sequential ckt design

Problem of Element

↓

Premitive flow table

↓

flow table

↓

Transition table

↓

Logic diagram (combination of S-R- latches).

Ques:- Design asynchronous S.C in gated latch with two i/p A&B and output Q whenever B is 1, A is transfered to Q when B is '0' output remains in same state even if A changes its value?

Ans.

$B = 1$, $Q = A$

$B = 0$, $Q =$ Prev. o/p

State	A	B	φ
a	0	1	0
b	0	0	0
c	1	0	0
d	1	1	1
e	1	0	1
f	0	0	1

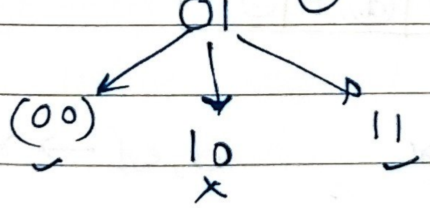
» Primitive flow table

AB	00	01	11	10
a	b,–	a,0	d,–	~~–,–~~
b	b,0	a,–	–,–	c,–
c	b,–	–,–	d,–	c,0
d	–,–	a,–	d,1	e,–
e	f,–	–,–	d,–	e,1
f	f,1	a,–	–,–	e,–

[stable state नहीं है तो –]

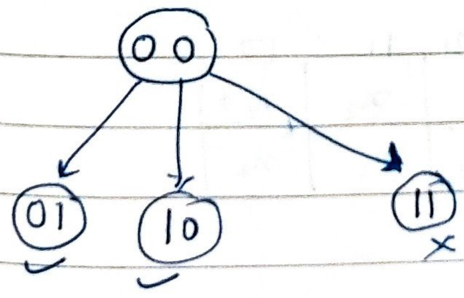
fundamental ~~table~~ mode

a

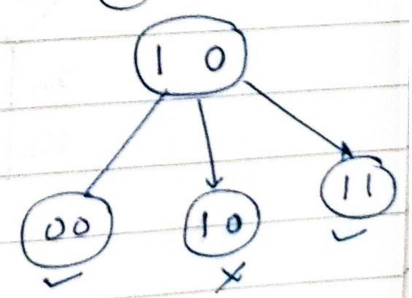


(find 1-bit difference)

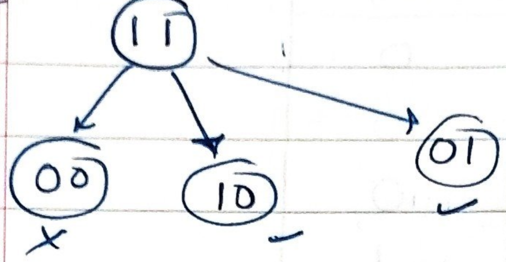
b.



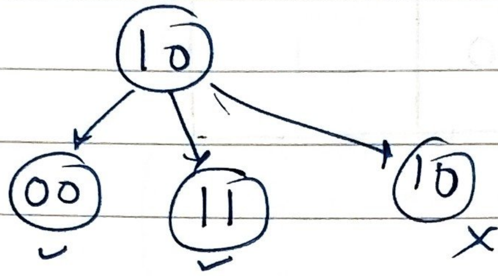
c



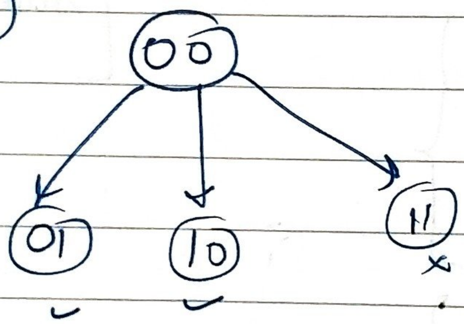
d



e



f



» Reduce table

AB	00	01	11	10
a, b, c	b, 0	a, 0	d, -	c, 0
d, e, f	f, 1	a, -	d, 1	e, 1

a, b, c $\rightarrow x_1$ d, e, f $\rightarrow x_2$

AB	00	01	11	10
x_1	x_1	x_1	x_2	x_1
x_2	x_2	x_1	x_2	x_2

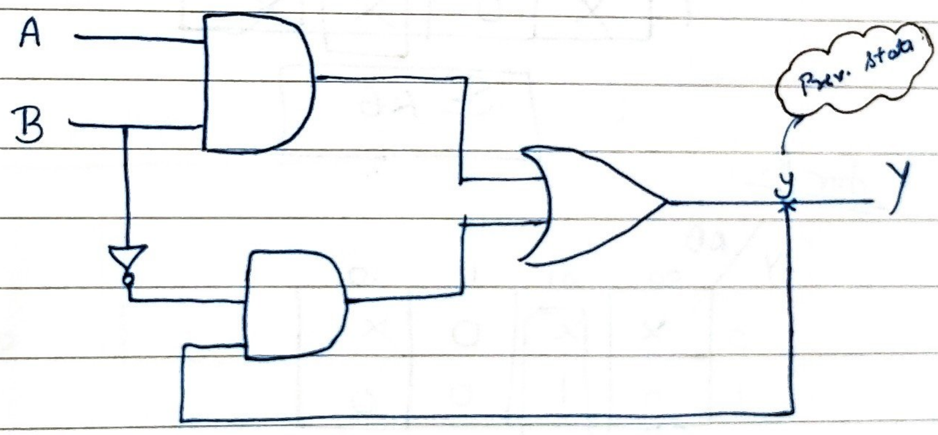
» transition table

$x_1 = 0$, $x_2 = 1$ (let)

y \ AB	00	01	11	10
0	0	0	1	0
1	1	0	1	1

$$\boxed{Y = AB + y\bar{B}}$$

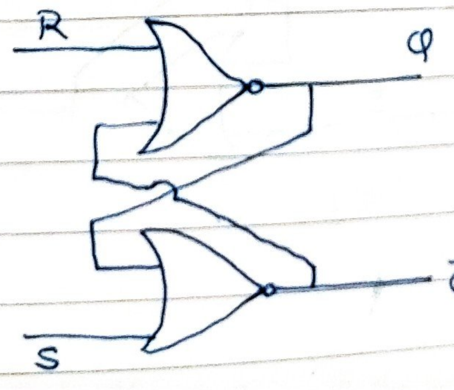
→ CKt diagram



→ Asynchronous sequential ckt by S-R-latch

↳ by using ~~nor~~ NOR - Gate.

S.R. Latch



Excitation table

P.S	N.S	S	R
0	0	0	X
0	1	1	0
0	0	0	1
0	1	X	0

y \ AB	00	01	11	1…
0	0	0	1	0
1	1	0	1	1

» K-map for S

y \ AB	00	01	11	10
0	0	0	1	0
1	X	0	X	X

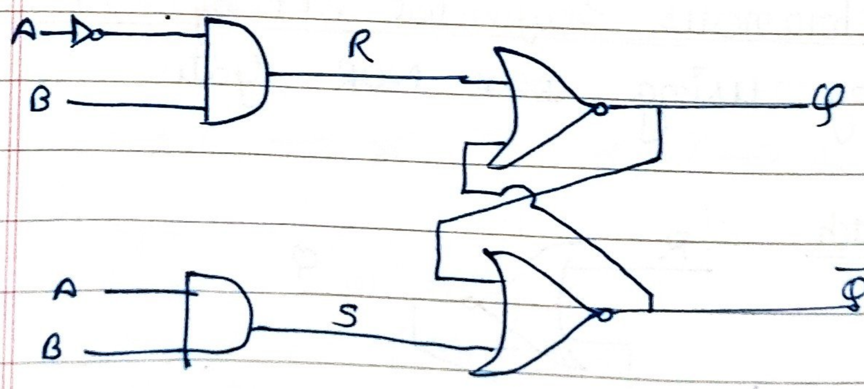
$\boxed{S = AB}$

for R,

y \ AB	00	01	11	10
0	X	X	0	X
1	0	1	0	0

$\boxed{R = \bar{A}B}$

Ckt.



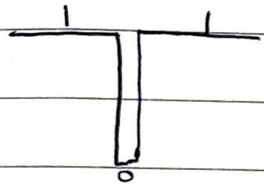
2 or 5 Marks imp.

HAZARDS

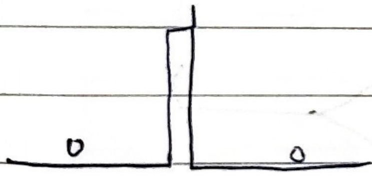
» Hazards are unwanted switching transien that may appear at the o/p of a ckt because of different path exhibit differen propagation delay.

» Types of Hazards –

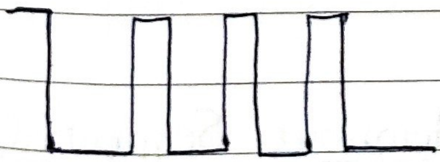
(1) Static 1 (one) Hazard –



(2) Static '0' Hazard –

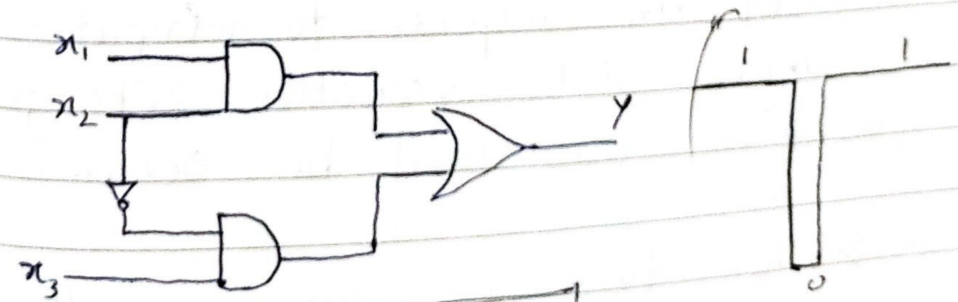


(3) Dynamic Hazard



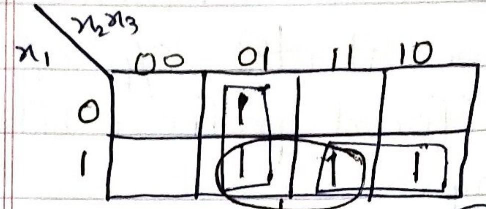
(4) Essential Hazard –

Eg.



$\boxed{Y = x_1 x_2 + \bar{x}_2 x_3}$

using
reverse K-map

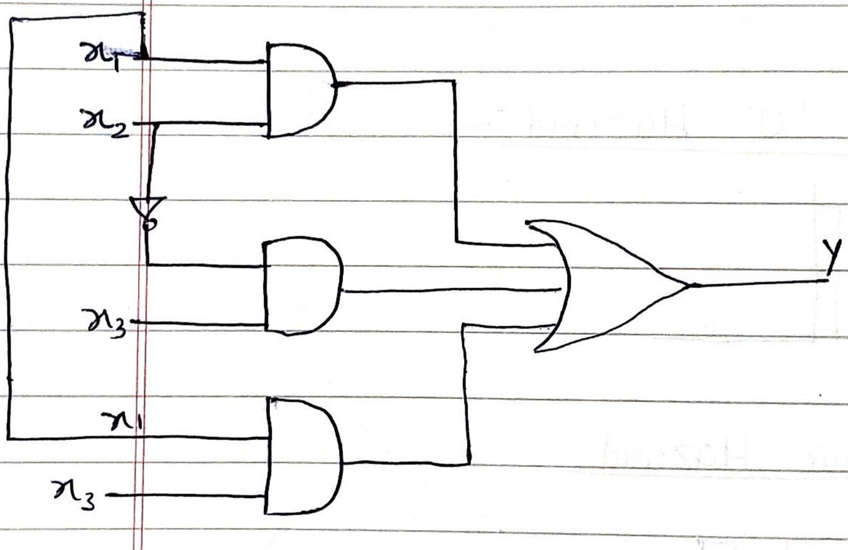


we add this group for remove (Hazard)

$$\boxed{Y = x_1 x_2 + \bar{x}_2 x_3 + x_1 x_3}$$ (Hazard free eqn)

now,

CKt diagram



Races in Asynchronous Sequential CKt

» When input is applied to asynchronous CKt in response to input two or more state variables change simultane than race will be occur.

» When two or more feedback variabl

classmate
Date
Page

changes value in response to a change in input variable with unequal propagation delay than a race condition exists in an asynchronous sequential ckt.

Eg: Transition table

y_1y_2 \ x	0	1
00	11	00
01	00	11
11	00	11
10	00	11

2bit difference

00 → 11 → race condⁿ
01 → 00 → (x)
01 → 11 → (x)
11 → 00 → ✓ (race condⁿ exists)

Types of race condition

(1) Critical race (2) Non-critical race

* Critical race-
• If there is a race in a circuit and ckt reaches in different final, final stable state depending upon the order of change of state variable than race is called critical race.

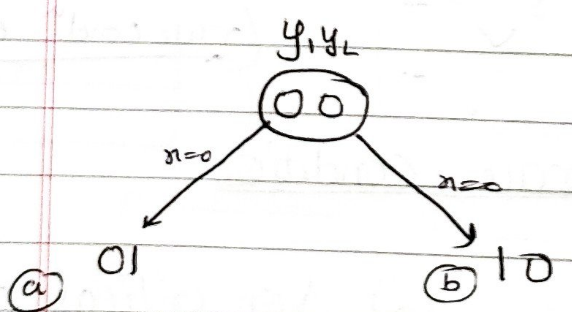
- Critical race may always go to some wrong state
- It is due to different propagation delay.
- Identical ckt with different propagation delay may go to different wrong state.

Eg.: Transition table

y_1y_2 \ x	0	1
00	11	00
01	01	00
11	11	01
10	10	00

race condition exists

P.S, N.S: $11 \rightarrow 00$



a) $00 \xrightarrow{x=0} 01 \xrightarrow{x=0} 01$ (stable state)

b) $00 \xrightarrow{x=0} 10 \xrightarrow{x=0} 10$ (stable state)

★ In all transition final stable state are different, so the race is critical.

* non-critical race –

- The final stable state will be same in non-critical race.
- In non-critical race may always go to the correct final state after it's transition through unstable states.
- It is also due to different propagation delay.

Eg. Transition table

y_1y_2 \ x	0	1
00	00	01
01	00	11
11	00	11
10	00	11

[(P.S) 11 $\longrightarrow$ (N.S) 00 race condn exist]

y_1y_2

$\boxed{11}$

$x=0$ ↙ ↘ $x=0$

(a) 01 (b) 10

(a) $11 \xrightarrow{x=0} 01 \xrightarrow{x=0} 00 \xrightarrow{x=0} 00$

(b) $11 \xrightarrow{x=0} 10 \xrightarrow{x=0} 00 \xrightarrow{x=0} 00$

} Stable state.

Hence, both states are same so, this is non-critical race condn.