DATE

TUTORIAL ON SYNCHRONOUS & ASYNCHRONOUS CIRCUITS.

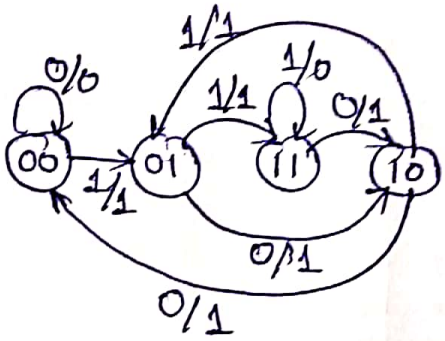
SHEET NO.

9.1.

State table

PS	NS $x=0$	NS $x=1$	Z $x=0$	Z $x=1$
00	00	01	0	1
01	10	11	1	1
~~00~~				
11	10	11	1	0
10	00	01	1	1

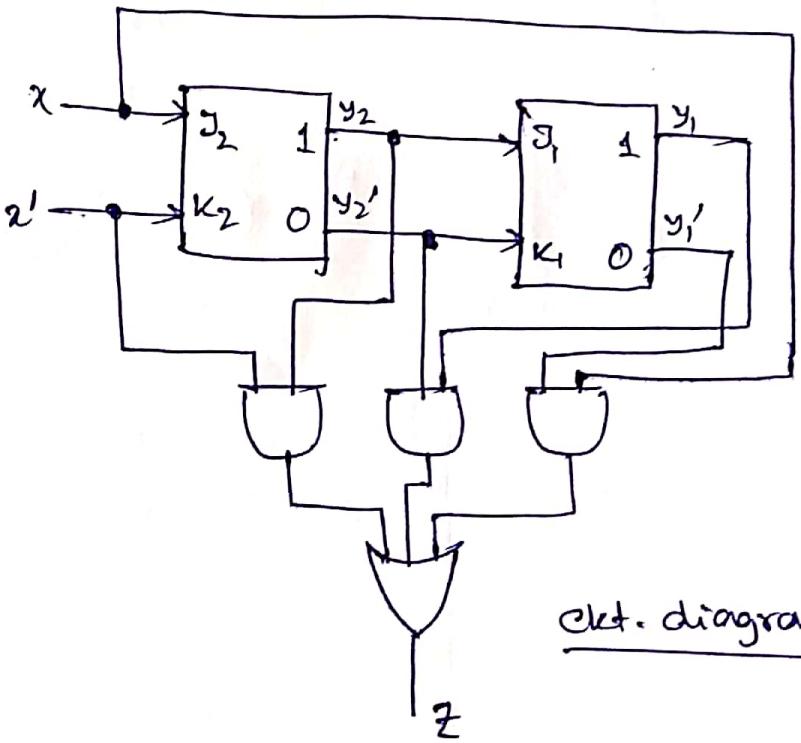
State Diagram



$Z = x'y_2 + y_1y_2' + xy_1'$ output function

$J_1 = y_2$	$J_2 = x$
$K_1 = y_2'$	$K_2 = x'$

excitation function



ckt. diagram.

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Excitation table.

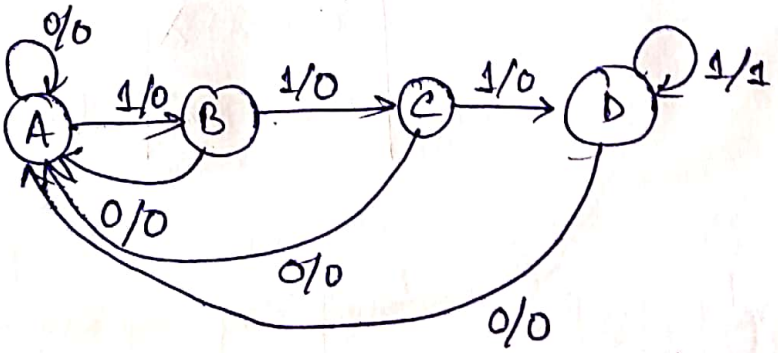
y_1y_2	$x=0$ J_1K_1	$x=0$ J_2K_2	$x=1$ J_1K_1	$x=1$ J_2K_2	Z $x=0$	Z $x=1$
0 0	0 1	0 1	0 1	1 0	0	1
0 1	1 0	0 1	1 0	1 0	1	1
1 1	1 0	0 1	1 0	1 0	1	0
1 0	0 1	0 1	0 1	1 0	1	1

ex. table for J-K

	J K
0 → 0	0 x
0 → 1	1 x
1 → 0	x 1
1 → 1	x 0

* The circuit produces 0 output only if xy_1y_2 is 000 or 111. J-K f/f's are acting as D- f/fs ; so whatever input it's taking, producing the same output after one clock pulse.

Q.2.



State Diagram

State Assignment-

A → 00
B → 01
C → 10
D → 11

Excitation table

State table.

	PS $y_1 y_2$	NS $x=0$ $Y_1 Y_2$	NS $x=1$ $Y_1 Y_2$	output z $x=0$	output z $x=1$
A	0 0	0 0	0 1	0	0
B	0 1	0 0	1 0	0	0
C	1 0	0 0	1 1	0	0
D	1 1	0 0	1 1	0	1

Y_1

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

$Y_1 = xy_2 + xy_1$

$Z = xy_1y_2$

Y_2

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

$Y_2 = xy_1 + x\bar{y}_2$

excitation table.

PS	NS $x=0$ S_1R_1	NS $x=0$ S_2R_2	NS $x=1$ S_1R_1	NS $x=1$ S_2R_2
0 0	0X	0X	0X	10
0 1	0X	01	10	01
1 0	01	0X	00	10
1 1	01	01	00	00

S	R
0→0	0 X
0→1	1 0
1→0	0 1
1→1	X 0

S_1

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

$S_1 = xy_2$

S_2

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

$S_2 = x\bar{y}_2$

R_1

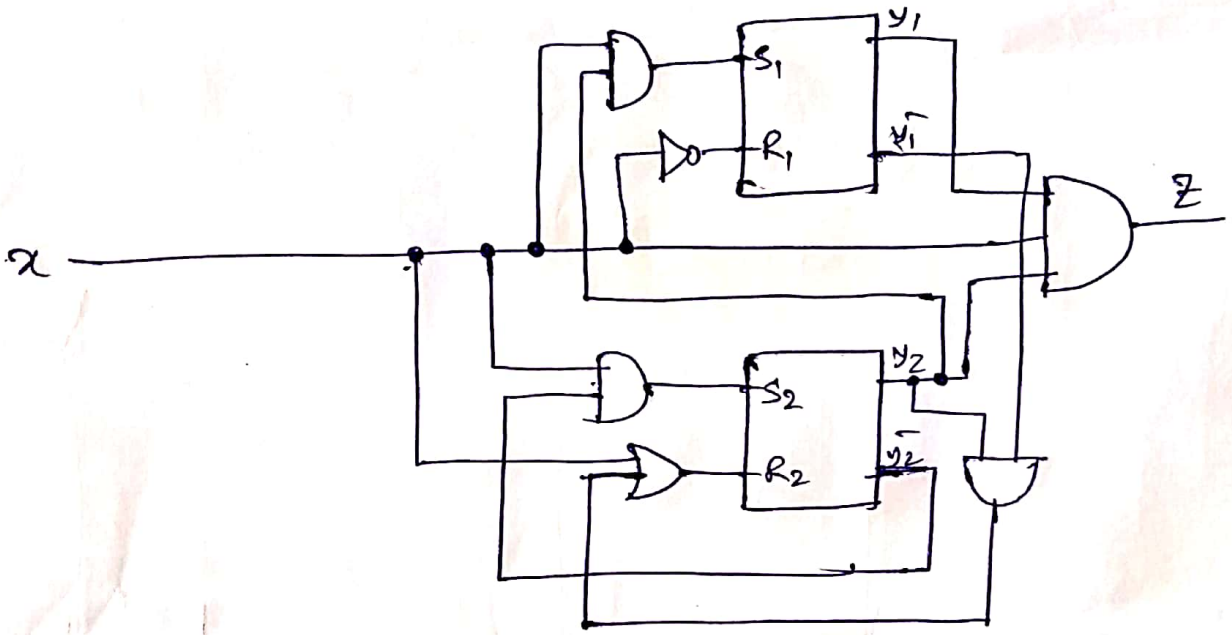
x \ y_1y_2	00	01	11	10
0	X	X	1	1
1	X	0	0	0

$R_1 = \bar{x}$

R_2

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

$R_2 = \bar{x} + \bar{y}_1y_2$



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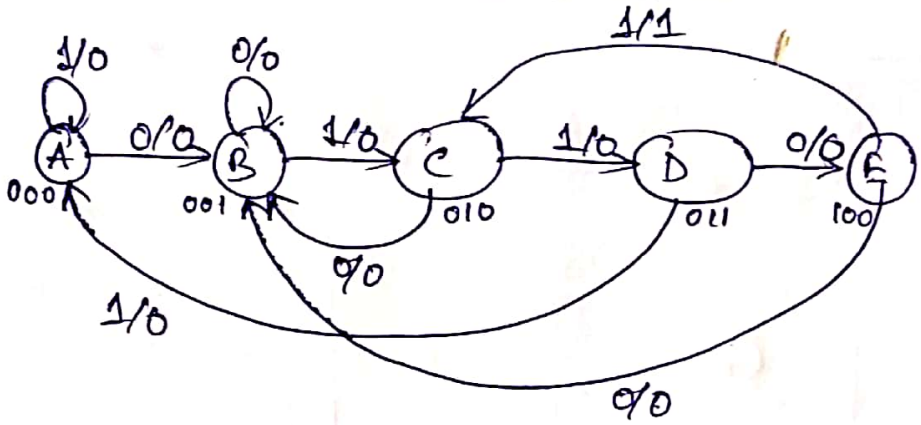
9.3.



State assignment-

A → 000
B → 001
C → 010
D → 011
E → 100

State table

PS $y_1y_2y_3$	NS $x=0$ $Y_1Y_2Y_3$	NS $x=1$ $Y_1Y_2Y_3$	Z $x=0$	Z $x=1$
000	001	000	0	0
001	010	010	0	0
010	001	011	0	0
011	100	000	0	0
100	001	010	0	1

$Z = x y_1 y_2' y_3'$

$T_1 = y_1 + \bar{x} y_2 y_3$

xy_1 \ y_2y_3	00	01	11	10
00	0	0	1	0
01	1	x	x	x
11	1	x	x	x
10	0	0	0	0

Excitation table.

PS $y_1y_2y_3$	NS $x=0$ $T_1T_2T_3$	NS $x=1$ $T_1T_2T_3$
000	001	000
001	000	011
010	011	001
011	111	011
100	101	110

$T_2 = x'y_2 + xy_1 + xy_3$

xy_1 \ y_2y_3	00	01	11	10
00	0	0	1	0
01	0	x	x	x
11	1	x	x	x
10	0	1	1	0

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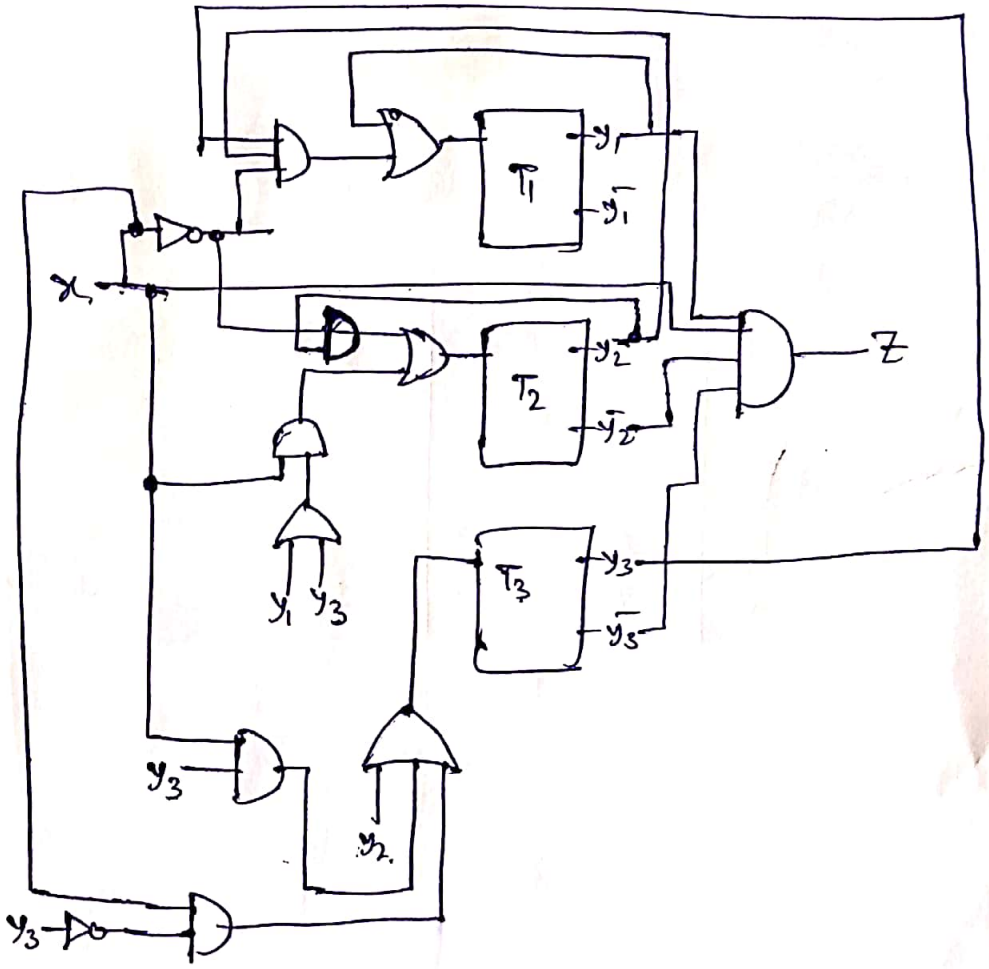
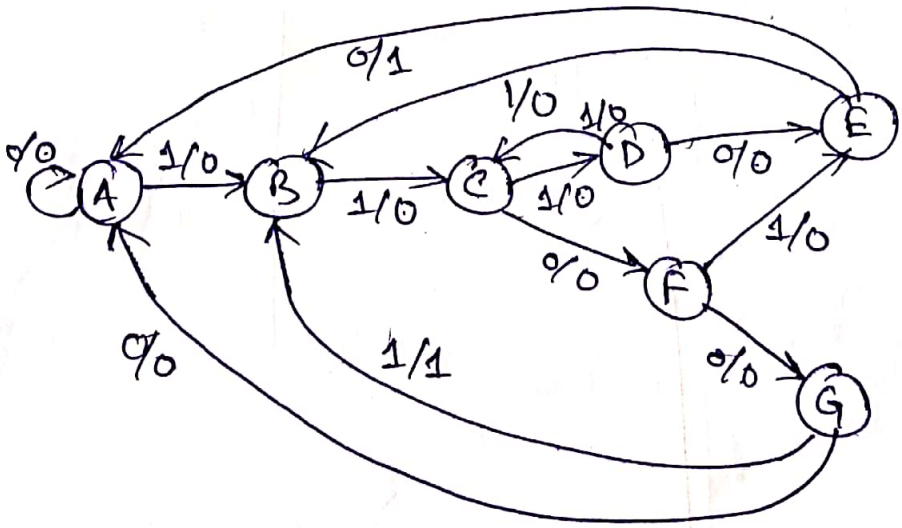
$T_3 = y_2 + xy_3 + x'y_3'$

xy_1 \ y_2y_3	00	01	11	10
00	1	0	1	1
01	1	x	x	x
11	0	x	x	x
10	0	1	1	1



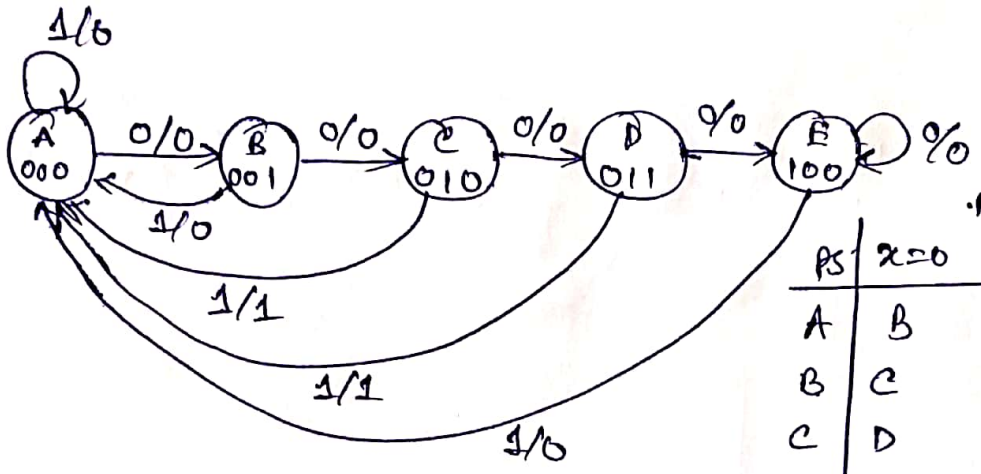
Q.4.



Possible in 7 states.

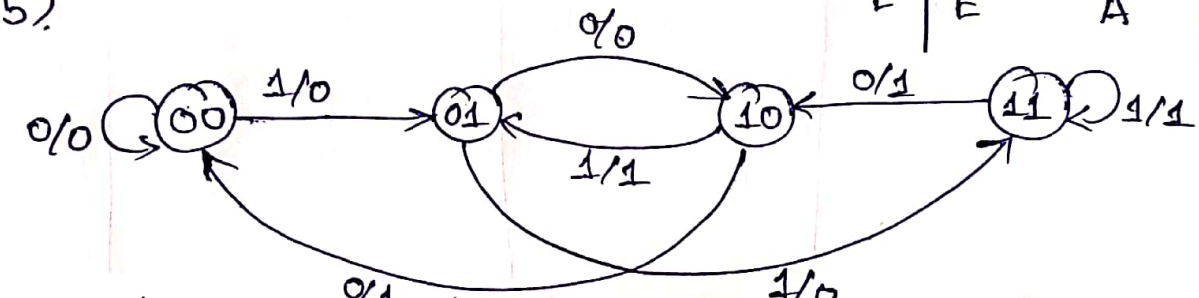
Q.5.

a)



PS	NS x=0	NS x=1	Z x=0	Z x=1
A	B	A	0	0
B	C	A	0	0
C	D	A	0	1
D	E	A	0	1
E	E	A	0	0

b)



NS	PS x=0	PS x=1	Z x=0	Z x=1
00	0	0		
01	0	0		
10	01	1		
11	1	1		

PS	NS x=0	NS x=1	Z x=0	Z x=1
00	00	01	0	0
01	10	11	0	0
10	00	01	1	1
11	10	11	1	1

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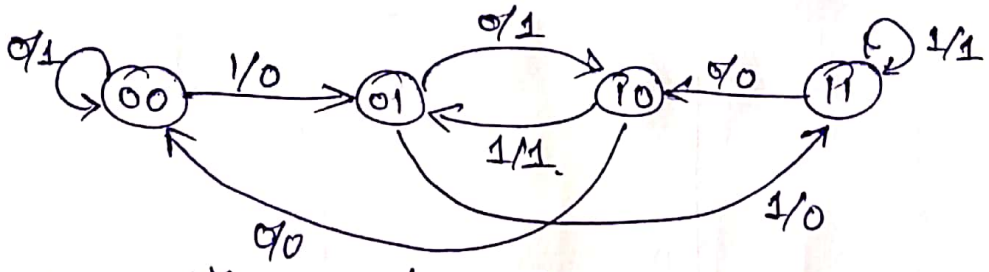
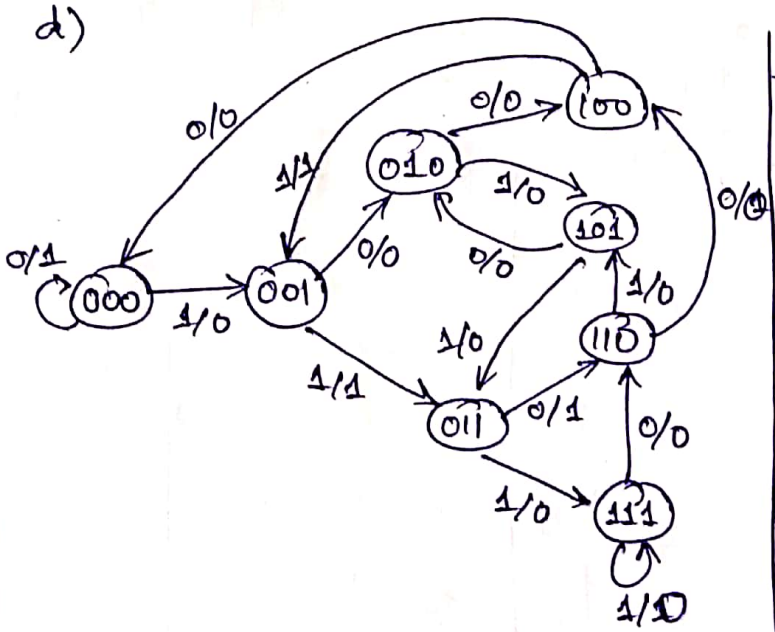
c)



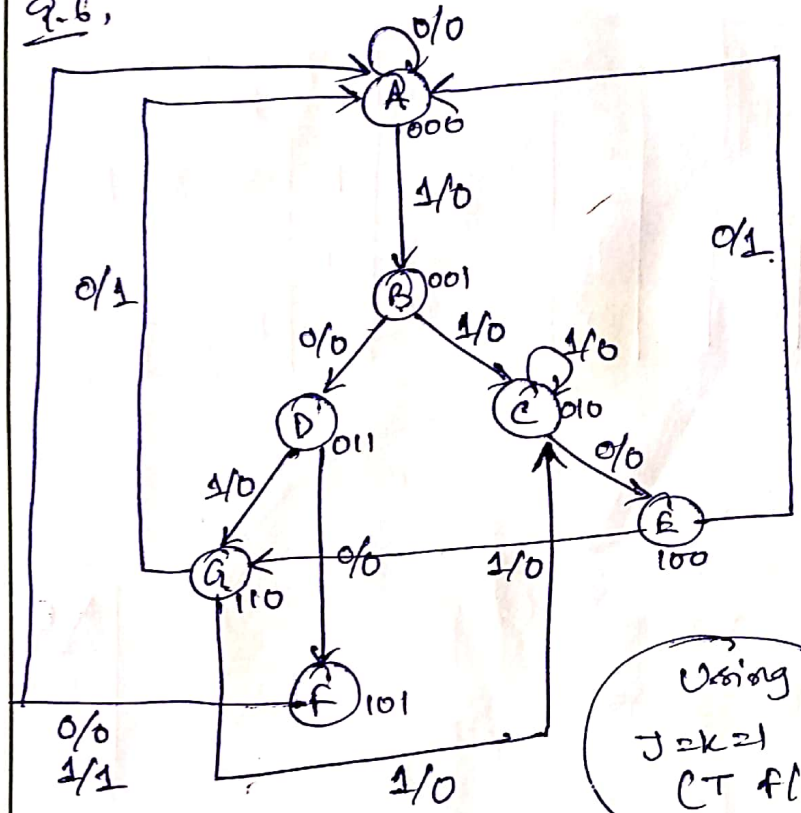
PS	NS x=0	NS x=1	Z x=0	Z x=1
00	00	01	1	0
01	10	11	1	0
10	00	01	0	1
11	10	11	0	1

d)



PS	NS x=0	NS x=1	Z x=0	Z x=1
000	000	001	1	0
001	010	011	0	1
010	100	101	0	0
011	110	111	1	0
100	000	001	0	1
101	010	011	0	0
110	100	101	1	0
111	110	111	0	1

Q.6,



State diagram.

State Assignment:

A → 000
B → 001
C → 010
D → 011
E → 100
f → 101
G → 110

Using J=K=1 CT f(f)

excitation table.

PS	NS x=0	NS x=1	Z x=0	Z x=1	x=0 $T_1\ T_2\ T_3$	x=1 $T_1\ T_2\ T_3$
000	000	001	0	0	0 0 0	0 0 1
001	011	010	0	0	0 1 0	0 1 1
010	100	010	0	0	1 1 0	0 0 0
011	101	110	0	0	1 1 0	1 0 1
100	000	110	1	0	1 0 0	0 1 0
101	000	000	0	1	1 0 1	1 0 1
110	000	010	1	0	1 1 0	1 0 0

State table

$T_1 = x'y_1 + y_2y_3 + xy_2 + y_1y_3 + y_1y_2$

xy_1 \ y_2y_3	00	01	11	10
00	0	0	1	1
01	1	1	X	1
11	0	1	X	1
10	0	0	1	0

$T_2 = x'y_2 + y_1y_2'y_3 + xy_1y_2'y_3'$

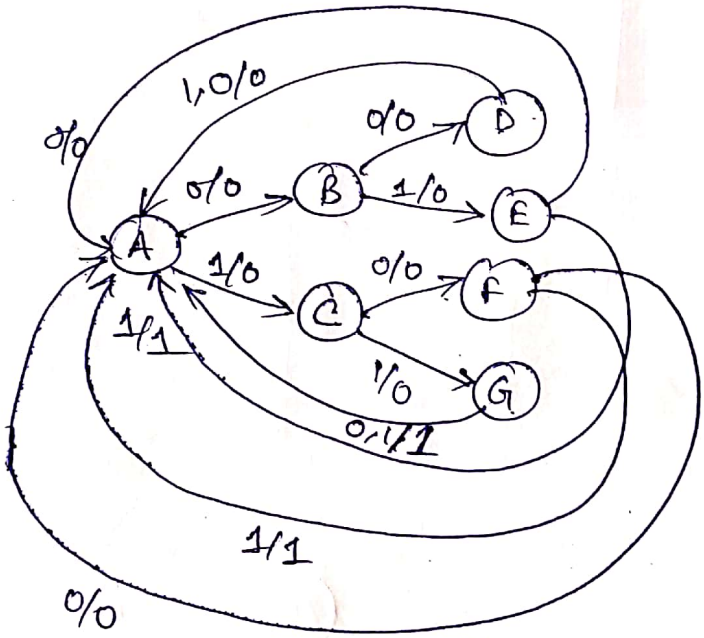
xy_1 \ y_2y_3	00	01	11	10
00	0	1	1	1
01	0	0	X	1
11	1	0	X	0
10	0	1	0	0

$T_3 = xy_3 + xy_1y_3 + xy_1'y_2'$

xy_1 \ y_2y_3	00	01	11	10
00	0	0	0	0
01	0	1	X	0
11	0	1	X	0
10	1	1		0

Q.7.

	S	R
0→0	0	X
0→1	1	0
1→0	0	1
1→1	X	0



State Assignment.

A → 000
B → 001
C → 010
D → 011
E → 100
F → 101
G → 110

NS (excitation Table)

PS $y_1y_2y_3$	NS $x=0$ $Y_1Y_2Y_3$	NS $x=1$ $Y_1Y_2Y_3$	Z $x=0$	Z $x=1$	$x=0$ S_1R_1	S_2R_2	S_3R_3	$x=1$ S_1R_1	S_2R_2	S_3R_3
A 000	001	010	0	0	0X	0X	10	0X	10	0X
B 001	011	100	0	0	0X	10	X0	10	0X	01
C 010	101	110	0	0	10	01	10	10	X0	0X
D 011	000	000	0	0	0X	01	01	0X	01	01
E 100	000	000	0	1	01	0X	0X	01	0X	0X
F 101	000	000	0	1	01	0X	01	01	0X	01
G 110	000	000	1	1	01	01	0X	01	01	0X

$S_1 = y_1' y_2 y_3' + x y_1' y_2' y_3$

$R_1 = y_1$

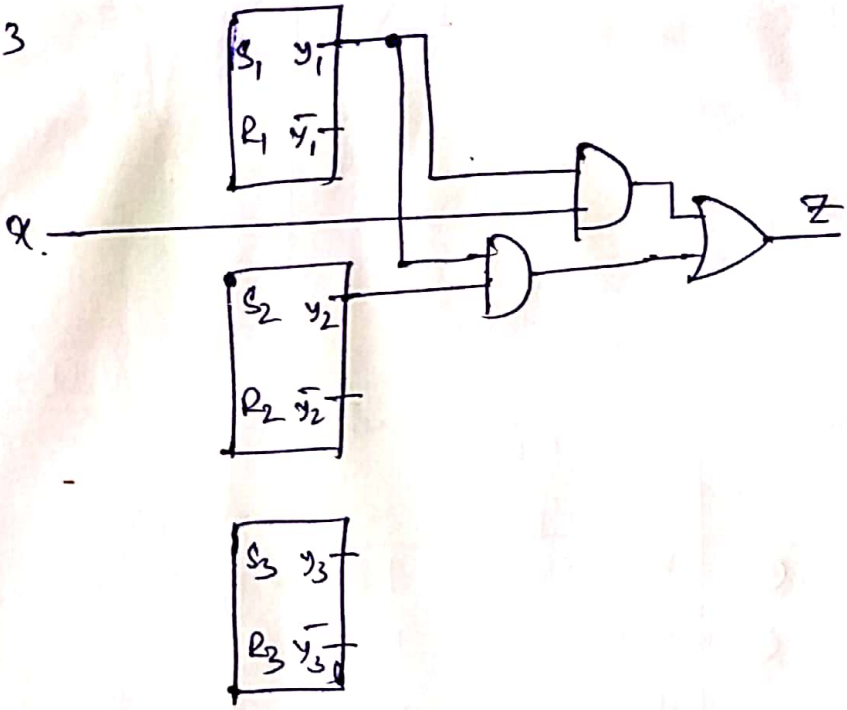
$S_2 = x y_1' y_3' + x' y_1' y_2' y_3$

$R_2 = y_1 + x' y_3' + y_2 y_3$

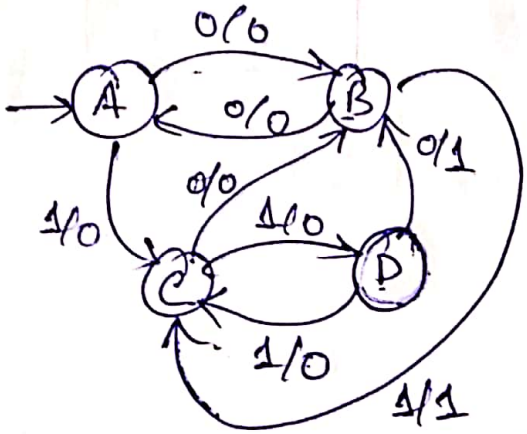
$S_3 = x' y_1' y_2$

$R_3 = y_1 + x + y_2 y_3$

$Z = y_1 y_2 + x y_1$



9.10.



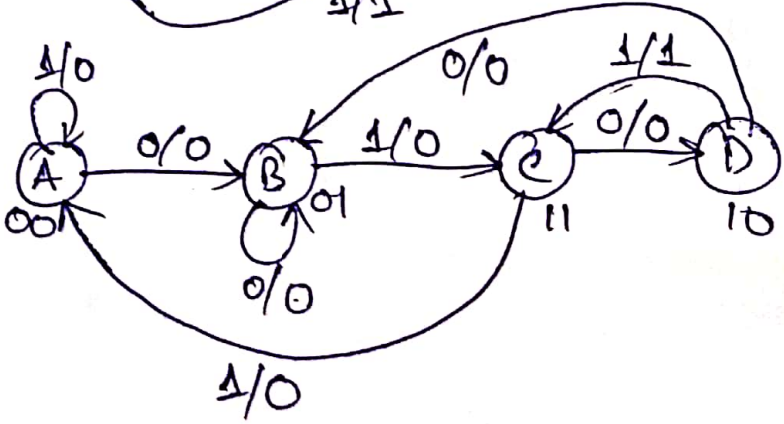
A: even no. of 0's

B: odd no. of 0's

C: odd no. of 1's

D: even no. of 1's.

9.11.



State table :-

PS y_1y_2	NS $x=0$ Y_1Y_2	NS $x=1$ Y_1Y_2	Z $x=0$	Z $x=1$
A 00	01	00	0	0
B 01	01	11	0	0
C 11	10	00	0	0
D 10	01	11	0	1

State assignment

Excitation table for U, V.

$U = S$, $V = R \oplus S$

	U	V
0 → 0	0	x
0 → 1	1	1
1 → 0	0	1
1 → 1	0 1	0 1

PS y_1y_2	NS $x=0$ U_1V_1 U_2V_2	NS $x=1$ U_1V_1	U_2V_2	Z $x=0$	Z $x=1$
00	0x 11	0x	0x	0	0
01	0x 11	11	11	0	0
11	11 01	01	01	0	0
10	01 11	11	11	0	1

$U_1 = x'y_1y_2 + x y_1'y_2 + x y_1y_2'$

$V_1 = 1$

$U_2 = y_1'y_2 + y_1y_2' + x'y_1'$

$V_2 = 1$

9.12.

(a)

PS	NS	excitation
0	0	0
0	1	1
1	0	x
1	1	Not possible

Given State table.

PS	NS, Z	
	x=0	x=1
A	B, 0	B, 0
B	C, 0	A, 1
C	B, 0	D, 0
D	C, 0	B, 1

Excitation

PS Y_1Y_2	NS Y_1Y_2, Z	
	x=0	x=1
11	XX, 0	XX, 0
00	10, 0	11, 1
10	X0, 0	X1, 0
01	1X, 0	0X, 1

* Assignment should be done in such a way that there's no 1→1 transition. One such possible assignment is —

A → 11
B → 00
C → 10
D → 01

$Y_1 = x' + Y_2'$

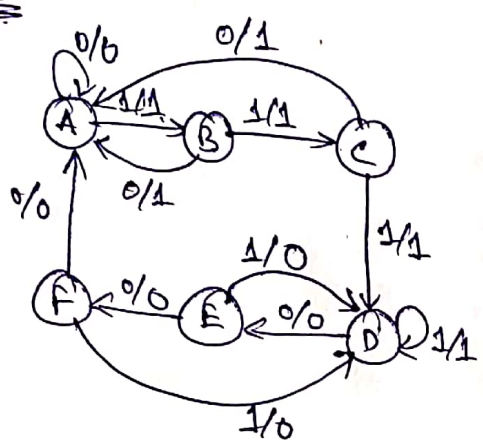
$Y_2 = x$

$Z = x Y_1'$

(b) The constraint that no memory element can have a transition 1→1 means not all state tables can be realized with log(n) no. of memory element where n = no. of states. An n-state table can be always realized by an n-state n memory elements in which each state is represented by a 'one of n' coding. Such assignments are not necessarily the best, in general it would be difficult to realize by min. no. of state variables.

P.R.E.

Q.13.



State diagram

State table -

PS	NS, z	
	x=0	x=1
A	A, 0	B, 1
B	A, 1	C, 1
C	A, 1	D, 1
D	E, 0	D, 1
E	F, 0	D, 0
F	A, 0	D, 0

Q.14.

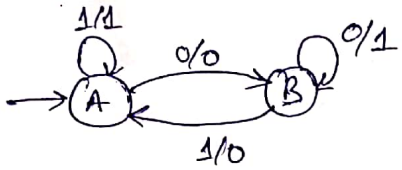
x_1	x_2	x_3	x_4	z
1	1	0	0	1
1	0	0	1	0
0	0	1	0	1
0	1	0	1	0
1	0	1	0	0
0	1	0	0	0
1	0	0	0	1
0	0	0	1	1
0	0	1	1	0
0	1	1	0	0

Solving K-map & considering other inputs to be don't care, we get,

$$f(x_1, x_2, x_3, x_4) = x_1 x_3' x_4' + x_1' x_2' x_3' + x_1' x_2' x_4'$$

Q.05.

(a)



(b) An output of 0 ~~from~~ from ~~N~~ N identifies the final state as B, while an o/p of 1 identifies the final state as A. Once the state of N is known, it's straightforward to determine the i/p to N and state to which N goes by observing its o/p. Consequently except for the first bit, each of subsequent bits can be decoded.

Q.16.

PS	-#	NS, write, shift: 0	1	2	3
A	B,#,R	A,0,R	A,1,R	A,0,R	A,1,R
B		C,2,R	D,3,R	I,2,L	I,3,L
C	E,#,L	C,0,R	C,1,R	E,2,L	E,3,L
D	F,#,L	D,0,R	D,1,R	F,2,L	F,3,L
E		G,2,L	H,1,L	I,2,L	
F		H,0,L	G,3,L		I,3,L
G		G,0,L	G,1,L	B,2,R	B,3,R
H	A,#,R	H,0,L	H,1,L	H,2,L	H,3,L
I	J,#,R	J,0,L	I,1,L	I,2,L	I,3,L
J	Halt	J,0,R	J,1,R	J,0,R	J,1,R
Halt	Halt	Halt	Halt		

State A: Starting state, the m/c restores the original symbols of the present block and moves ~~the~~ to test the next block.

State B:

col. (0,1): The head checks the leftmost original symbol of the block.

col (2,3): A palindrome detected.

State C & D:

(#,1,2,3): The head searches for the rightmost original symbol of the block. State C is for the case that the leftmost symbol is a 0 and D for the case that it is a 1.

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States E & F: (0,1): The head checks the rightmost symbol and compares it with the leftmost symbol. (E is for 0 and F for 1)

(2,3): At this point, the m/c knows that the current symbol is the middle of an odd-length palindrome.

State G: The symbols that were checked so far can be members of a palindrome.

(0,1,2,3): The head searches for the leftmost original symbol of the block.

State H: At this point, the m/c knows that the block is not a palindrome.

(0,1,2,3): The head goes to the beginning of the block, so that it will be ready to restore the original symbols (as indicated in state A)

State I:

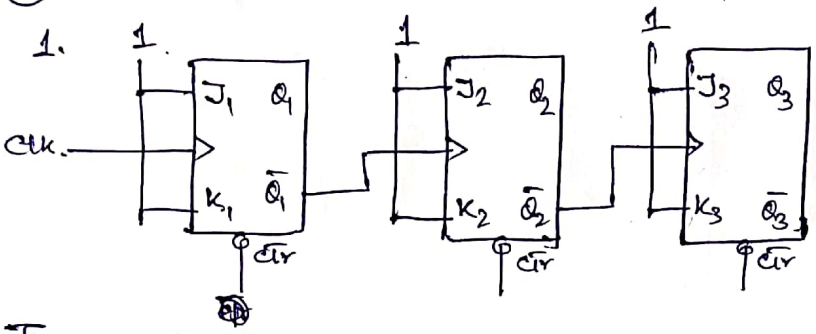
The m/c now knows that the block is a palindrome. Therefore the head goes to the beginning of the block, so that it will be ready to restore the original symbols (as indicated in state J)

States J and Halt:

The original symbols are restored and the m/c stops at the first # to the right of the block.

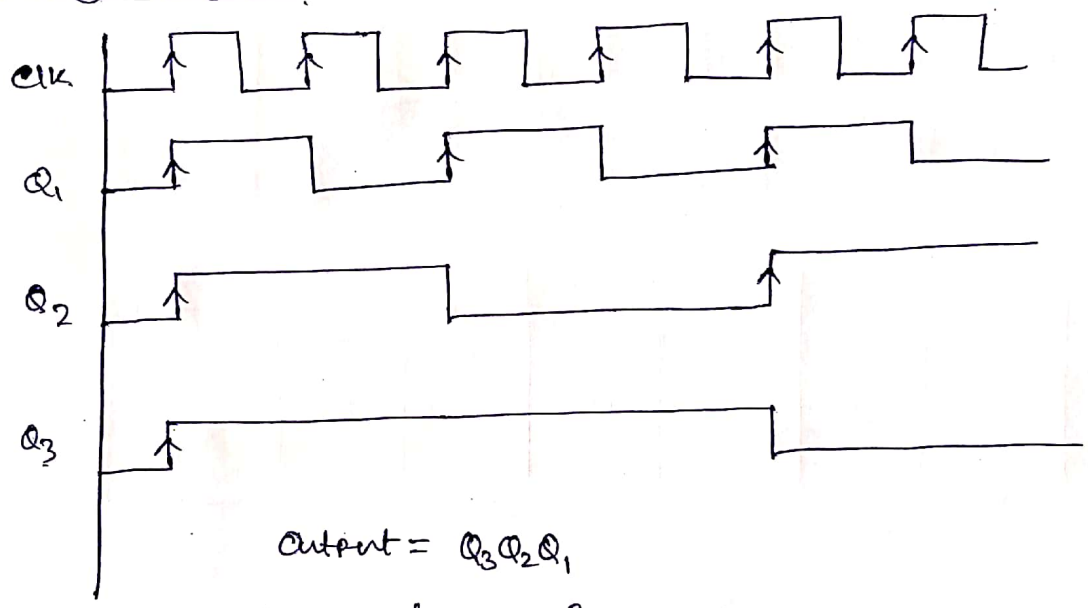
(B)

1.



clk is -ve edge triggered.

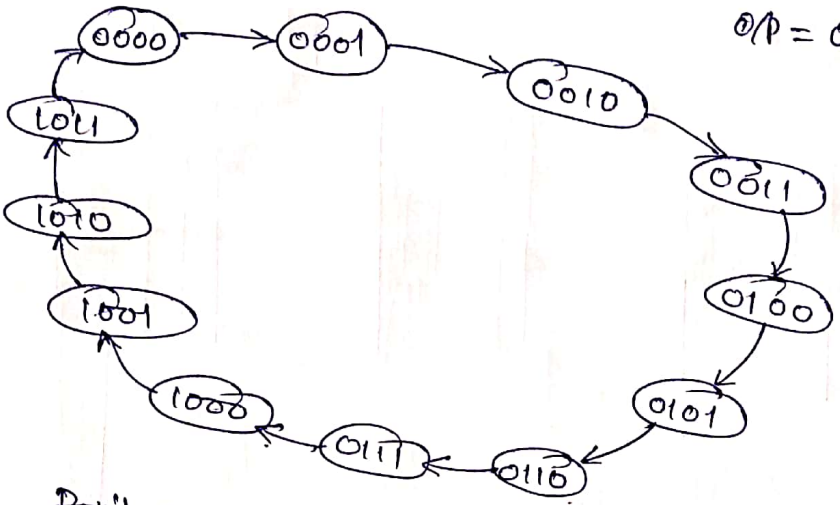
Timing Diagram.



Output = $Q_3Q_2Q_1$

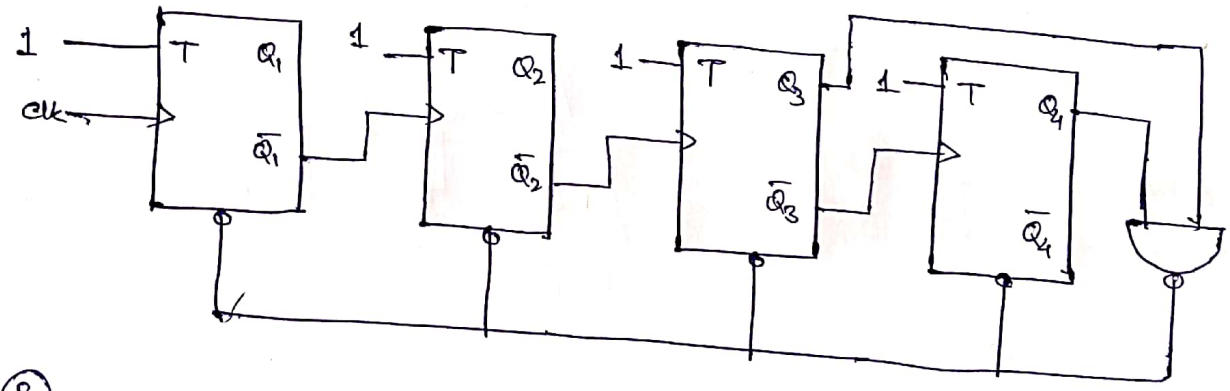
Input freq = 2^3 x O/P freq.

(2)



O/P = $Q_4 Q_3 Q_2 Q_1$

Don't cares (12, 13, 14, 15) = $Q_4 Q_3$



(3)

Don't cares (10, 11, 12, 13, 14, 15) = $Q_4 Q_2 + Q_4 Q_3$

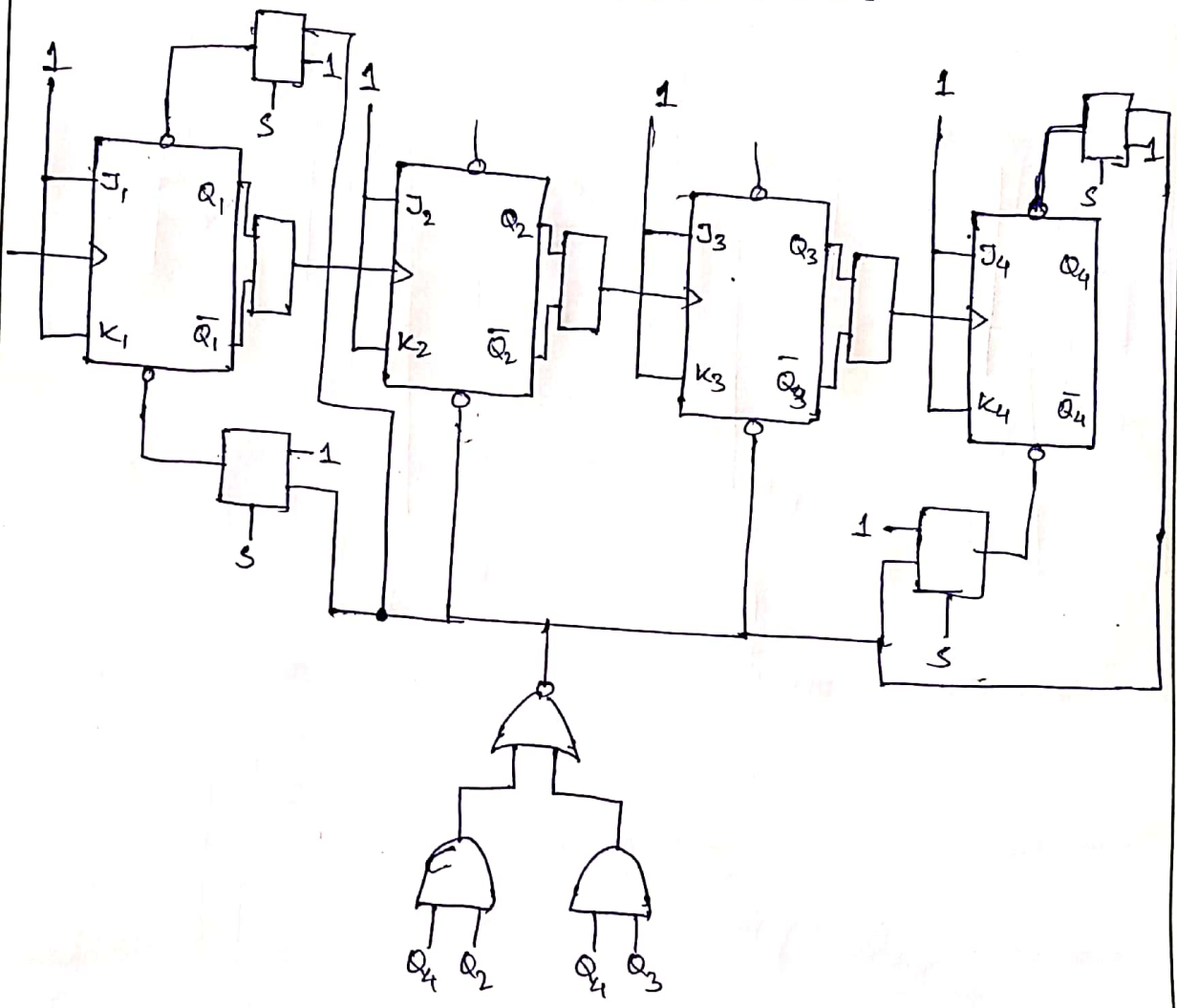
O/P → $Q_4 Q_3 Q_2 Q_1$

DATE

SHEET NO.

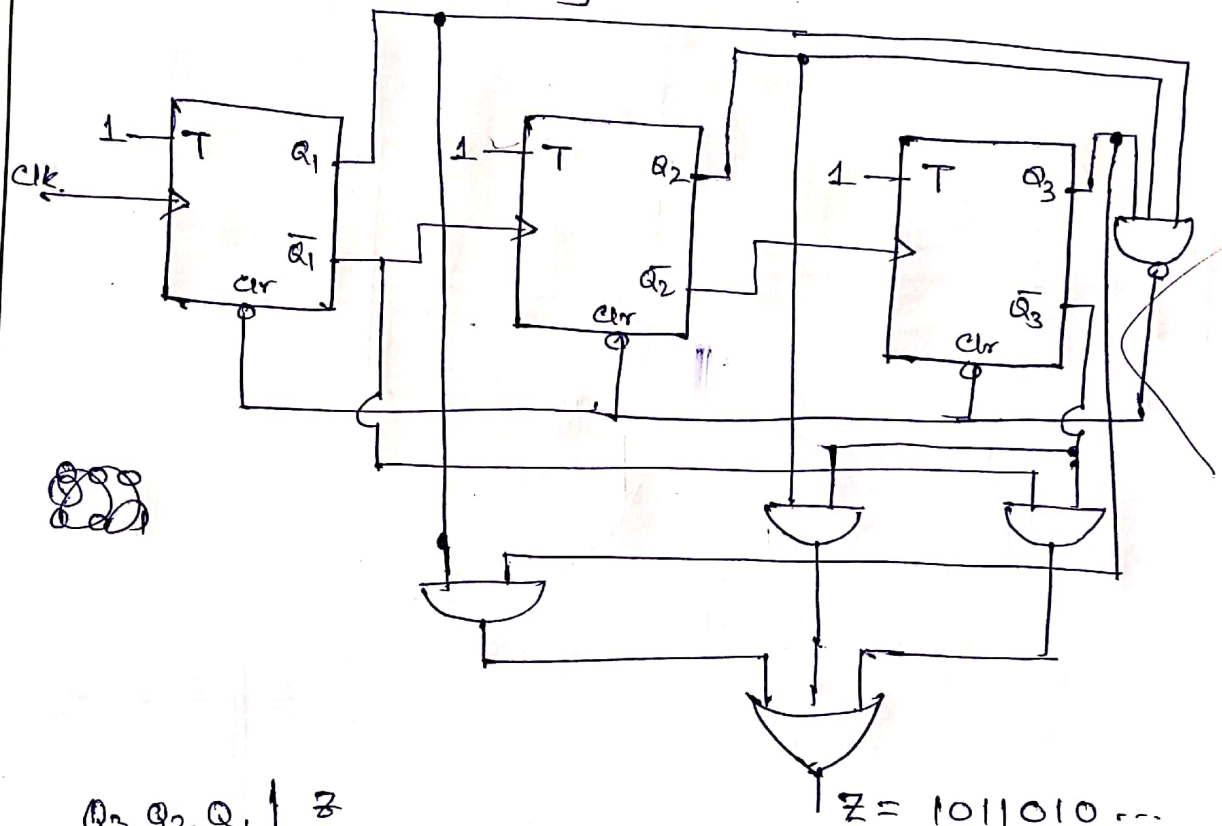
S = 1 : Up counter.

S = 0 : Down counter.



SHEET NO.

(5) Sequence generator to generate the sequence 1011010 [using T F/F's and +ve edge triggered clock]



$Z = 1011010\ldots$

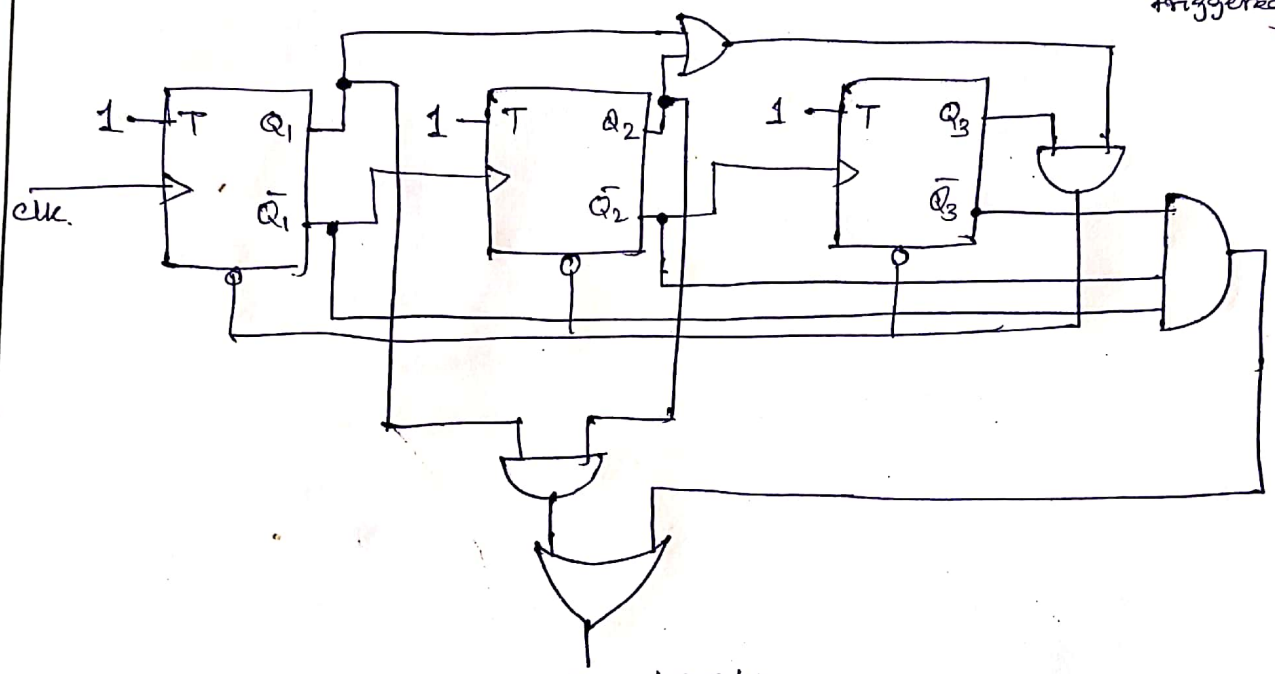
Q_3	Q_2	Q_1	Z
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0

$$Z = \bar{Q}_1\bar{Q}_3 + Q_3Q_1 + \bar{Q}_3Q_2$$

DATE

SHEET NO.

⑥ Pulse train generator of 10010 [T F/F & clk +ve edge triggered]



Z = 10010 ---

Q_3	Q_2	Q_1	Z
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
~~+0~~	~~1~~		
~~+1~~	~~0~~		

$Z = Q_1 Q_2 + \bar{Q}_1 \bar{Q}_2 \bar{Q}_3$

$clr = Q_3 (Q_1 + Q_2)$