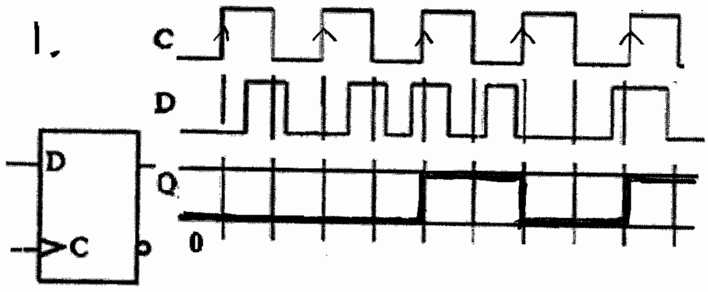
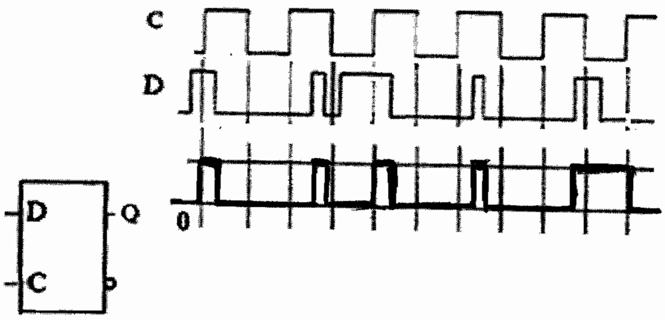
1.



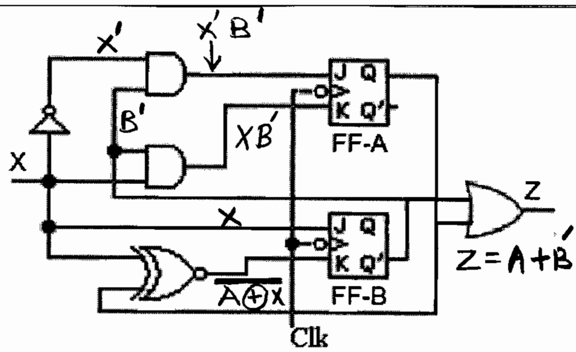
D FF



Clocked D
Transparent Latch

2. a. $Z = A + B'$

→ cct is Moore since external o/p depends on the state only (not affected by the external I/p).



b. $J_A = x'B'$, $J_B = xB'$

$J_B = X$, $J_B = \overline{A \oplus X}$,

(i.) present state → Through CT Table; Through CT; Next state

1-D state Table

	A	B	X	J_A	K_A	J_B	K_B	A^+	B^+	Ext. o/p Z
0	0	0	0	1	0	0	1	1	0	1
1	0	0	1	0	1	1	0	0	1	1
2	0	1	0	0	0	0	1	0	0	0
3	0	1	1	0	0	1	0	0	1	0
4	1	0	0	1	0	0	0	1	0	1
5	1	0	1	0	1	1	1	0	1	1
6	1	1	0	0	0	0	0	1	1	1
7	1	1	1	0	0	1	1	1	0	1

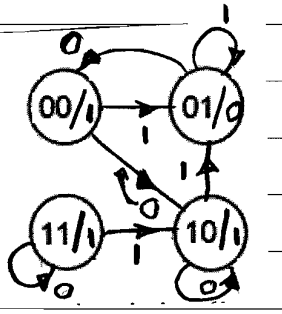
Characteristic Table (CT) of JK FF

JK	Q(t+1)
0 0	Q(t)
0 1	0
1 0	1
1 1	Q'(t)

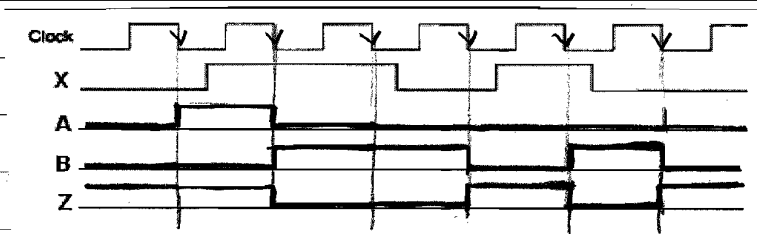
ii. 2-D state Table

Present state AB	Next state A^+B^+ x=0	Next state A^+B^+ x=1	o/p Z
0 0	1 0	0 1	1
0 1	0 0	0 1	0
1 0	1 0	0 1	1
1 1	1 1	1 0	1

iii. State Diagram



c.

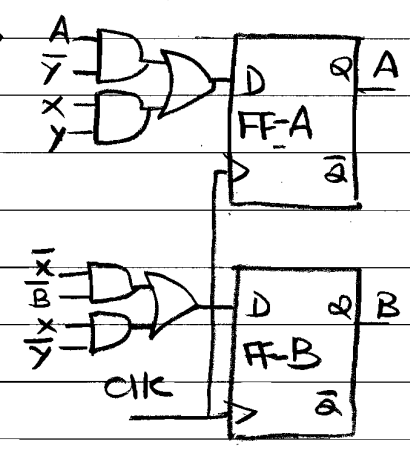


4. $A(t+1) = Ay' + xy$, $B(t+1) = B'x' + xy'$, $Z = A'(x+y)$

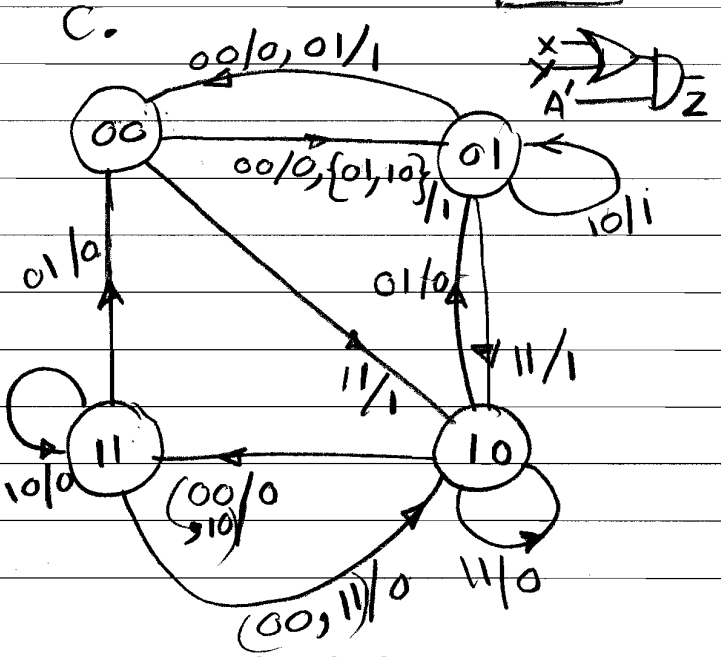
a. Mealy cct, o/p depends on external I/ps

pres. state A B	I/ps x y	$D_A = A^+$	$D_B = B^+$	x+y	Z = A'(x+y)
0 0	0 0	0	1	0	0
0 0	0 1	0	1	1	1
0 0	1 0	0	1	1	1
0 0	1 1	1	0	1	1
0 1	0 0	0	0	0	0
0 1	0 1	0	0	1	1
0 1	1 0	0	1	1	1
0 1	1 1	1	0	1	1
1 0	0 0	1	1	0	0
1 0	0 1	0	1	1	0
1 0	1 0	1	1	1	0
1 0	1 1	1	0	1	0
1 1	0 0	1	0	0	0
1 1	0 1	0	0	1	0
1 1	1 0	1	1	1	0
1 1	1 1	1	0	1	0

b.

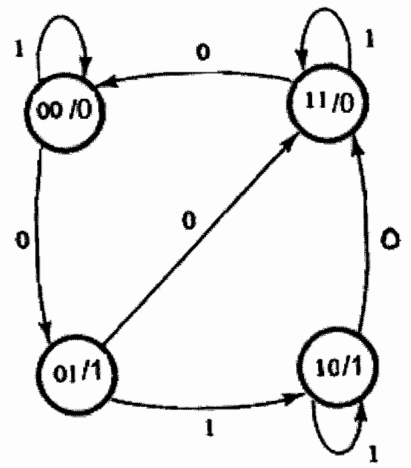


c.



4.

a. Moore, 1 external I/p, 1 external o/p, 2 state variables, 2 FFs.



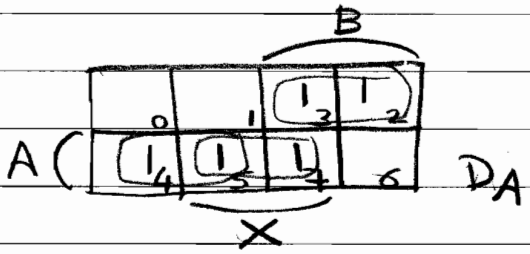
b. 2-D Table

Present state A B	Next state X=0 A^+B^+	Next state X=1 A^+B^+	output Z
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

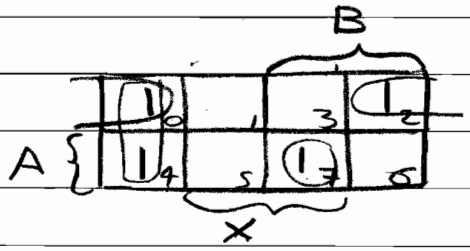
1-D Table

	A B X	$A^+ = D_A$	$B^+ = D_B$	Z
0	0 0 0	0	1	0
1	0 0 1	0	0	0
2	0 1 0	1	1	1
3	0 1 1	1	0	1
4	1 0 0	1	1	1
5	1 0 1	1	0	1
6	1 1 0	0	0	0
7	1 1 1	1	1	0

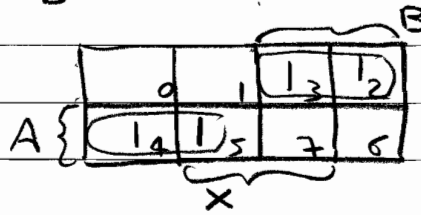
c.



$D_A = \bar{A}B + AX + A\bar{B}$

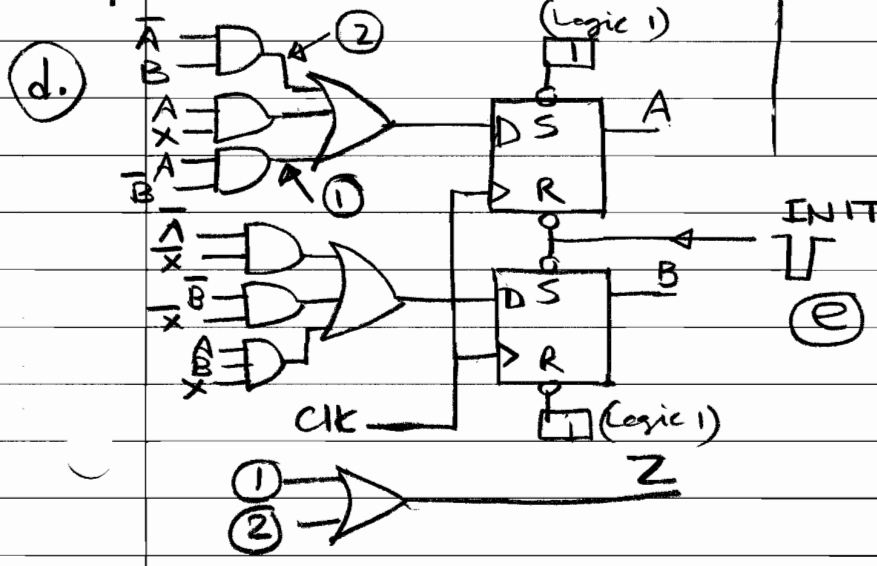


$D_B = \bar{A}\bar{X} + \bar{B}\bar{X} + ABX$



$Z = A\bar{B} + \bar{A}B$

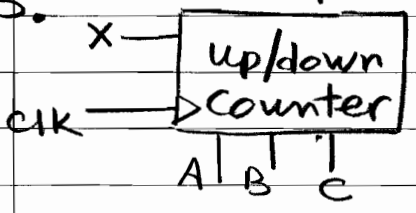
d.



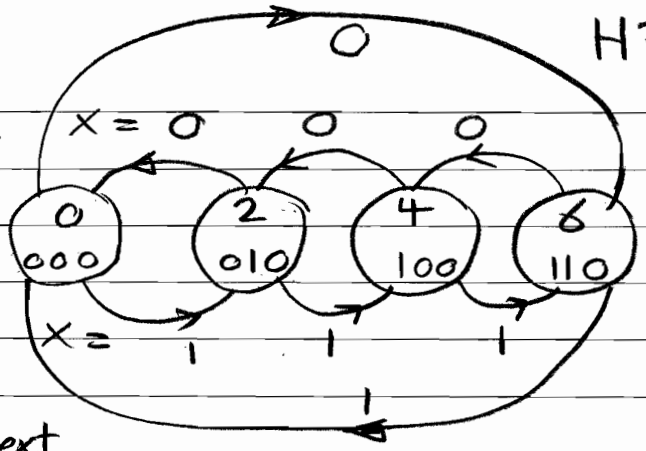
e.

F. From the state diagram we need 3 clock pulses to return to state 00.

5. $\begin{cases} X=0 & \text{Down} \\ X=1 & \text{Up} \end{cases}$



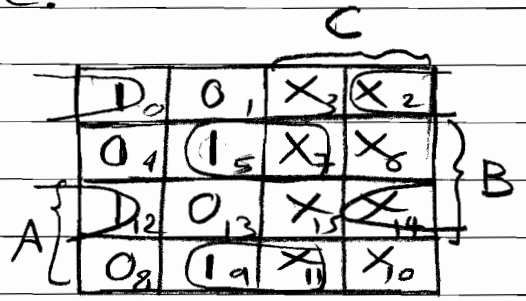
a.



b.

	Present State A B C	I/p X	Next State $A^+ B^+ C^+$ (D_A) (D_B) D_C
0	0 0 0	0	1 1 0
1	0 0 0	1	0 1 0
2	0 0 1	0	X X X
3	0 0 1	1	X X X
4	0 1 0	0	0 0 0
5	0 1 0	1	1 0 0
6	0 1 1	0	X X X
7	0 1 1	1	X X X
8	1 0 0	0	0 1 0
9	1 0 0	1	1 1 0
10	1 0 1	0	X X X
11	1 0 1	1	X X X
12	1 1 0	0	1 0 0
13	1 1 0	1	0 0 0
14	1 1 1	0	X X X
15	1 1 1	1	X X X

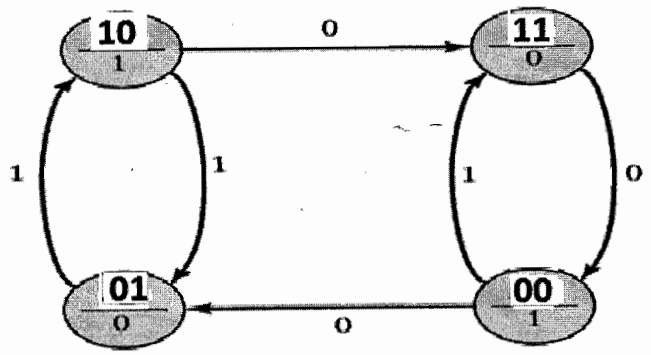
c.



$$D_A = \bar{A}\bar{B}\bar{X} + \bar{A}BX + AB\bar{X} + A\bar{B}X$$

6. JK FF 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



6, contd.

	Present A	B	X	Next A^+	B^+	Z	J_A	K_A	J_B	K_B
0	0	0	0	0	1	1	0	X	1	X
1	0	0	1	1	1	1	1	X	1	X
2	0	1	0	X	X	0	X	X	X	X
3	0	1	1	1	0	0	1	X	X	1
4	1	0	0	1	1	1	X	0	1	X
5	1	0	1	0	1	1	X	1	1	X
6	1	1	0	0	0	0	X	1	X	1
7	1	1	1	X	X	0	X	X	X	X

J_A

A \ B	0	1	1	X
0	0	1	3	2
1	4	5	7	6

$J_A = X$

K_A

A \ B	X	X	X	X
0	0	1	3	2
1	4	5	7	6

$K_A = X = J_A$

J_B

A \ B	1	1	X	X
0	0	1	3	2
1	4	5	7	6

$J_B = \overline{B}$

K_B

A \ B	X	X	1	X
0	0	1	3	2
1	4	5	7	6

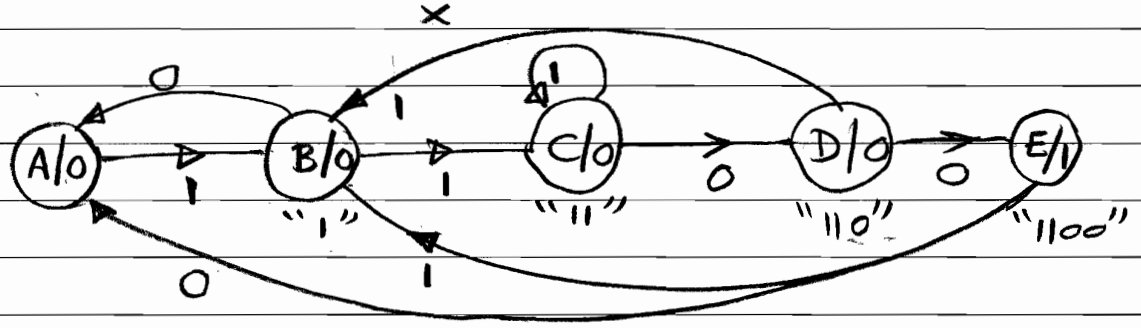
$K_B = B$

Z

A \ B	1	1	0	0
0	0	1	3	2
1	4	5	7	6

$Z = \overline{B}$

7. a.



b. 5 states
3 state variables
3 FFs
$2^3 - 5 = 3$ unused states