Dated:　　　DLD Assignment # 4

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Q1)
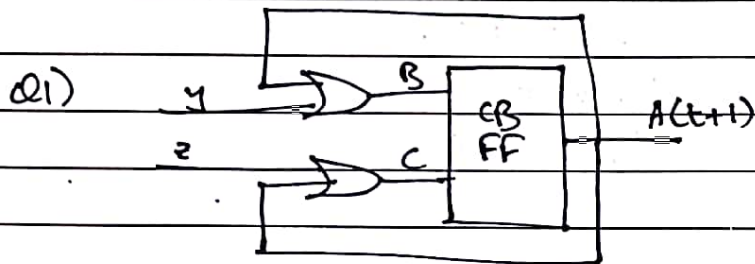
i) $BC = 11$, 0

ii) $BC = 10$, Comp

iii) $BC = 01$, 1

iv) $BC = 00$; No change

(a) Characteristic Table

B	C	A(t+1)
1	1	0
1	0	$A'(t)$
0	1	1
0	0	$A(t)$

(b)

A(t)	B	C	A(t+1)
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

B

A(t) \ BC	00	01	11	10
0	0	1	0	1
1	1	1	0	0

$$A(t+1) = A(t)B' + B'C + A(t)'BC'$$

(c) Excitation Table

A(t)	A(t+1)	B	C
0	0	x	x
0	1	x	x
1	0	1	x
1	1	0	x

* $A(t) = 0$ & $A(t+1) = 0$, $B = 0$ & 1, $C = 0$ & 1

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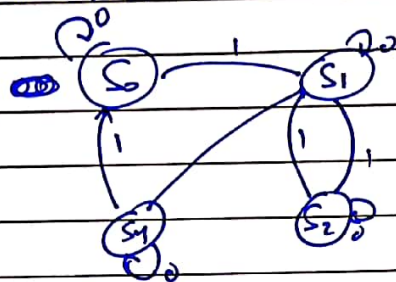* $A(t) = 1$ & $A(t+1) = 1$, $B = 0$, $C = 0$ & 1

Dated:

d) State Transition Table

Present State A(t)	Inputs		Next State A(t+1)	Output	
	y	z		B	C
0	0	0	0	0	0
0	0	1	1	0	1
0	1	0	1	1	0
0	1	1	0	1	1
1	0	0	0	1	1
1	0	1	0	1	1
1	1	0	0	1	1
1	1	1	0	1	1

Dated:

(Q2) id: aia07674

(a)

$S_0 = 000$
$S_1 = 111$
$S_2 = 110$ } Same $(S_1 \& S_3)$
$S_3 = 111$
$S_4 = 010$

(b)

Present State $A_3 \bullet A_2\ A_1\ A_0$	Input I	Next State $A_3\ A_2\ A_1\ A_0\ (t+1)$
0 0 0 0	0	0 0 0 0
0 0 0 0	1	0 1 1 1
0 1 1 1	1	0 1 1 0
0 1 1 0	1	0 1 1 1
0 1 1 1	1	0 0 1 0
0 0 1 0	1	0 0 0 0
0		

(c) $A_2(t+1)$:

$A_3 A_2 \backslash A_1 A_0$

	00	01	11	10
00	1	X	X	0
01	X	X	X	1
11	X	X	X	X
10	X	X	X	X

A_3 is always 0

$A_2(t+1) = A_1' + A_2$

$A_0(t+1)$

$A_3 A_2 \backslash A_1 A_0$

	00	01	11	10
00	1	X	X	0
01	0	0	0	1
11	0	X	X	X
10	X	X	X	X

$A_0(t+1) = A_1' + A_2 A_0'$

$A_1(t+1)$

$A_3 A_2 \backslash A_1 A_0$

	00	01	11	10
00	1	X	X	0
01	0	0	1	1
11	0	0	X	X
10	X	X	X	X

$A_1(t+1) = A_1' + A_2$

Dated:

Q3)
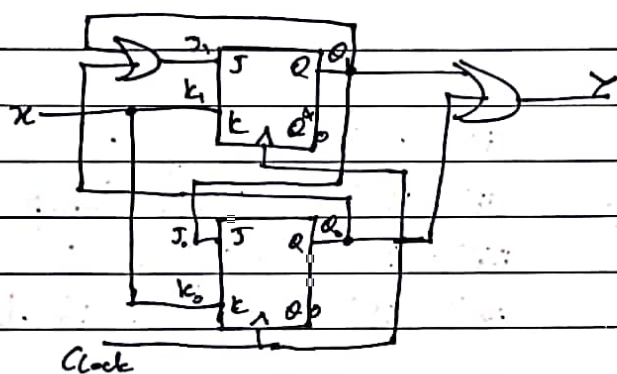
$J_0 = Q_1$
$K_0 = x$
$J_1 = Q_0 + Q_1$
$K_1 = x$
$Y = Q_0 + Q_1$

Clock

(a) Excitation Equations:

$J_2 = Q_1$, $K_0 = x$, $J_1 = Q_0 + Q_1$, $K_1 = x$

$Y = Q_0 + Q_1 \rightarrow$ Output Equation.

&

Transition Equation:

$$Q_1(t+1) = J_1 Q_1{}^0(t)' + K_1' Q(t)$$

$$\Leftrightarrow \Rightarrow J_1 = Q_0 + Q_1 , \quad K_1 = x$$

$$Q_1(t+1) = (Q_0 + Q_1) Q_1(t)' + x' Q(t)$$

$$= Q_0 Q_1(t)' + Q_1 Q_1(t)' + x' Q(t)$$

$$Q_1(t+1) = Q_0 Q_1(t)' + x' Q(t)$$

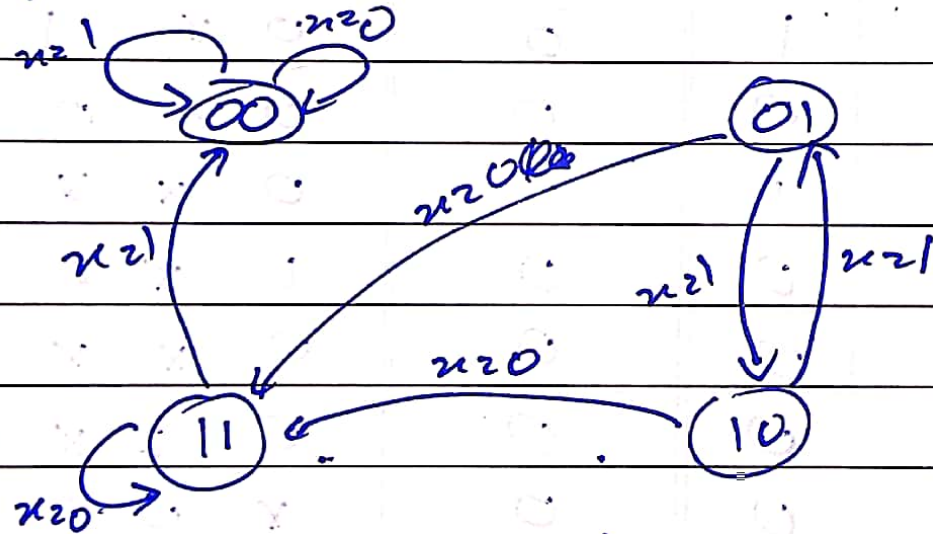$$Q_0(t+1) = Q_0(t)' J_0 + K_0' Q_0 \qquad [J_0 = Q_1 , K_0 = x]$$

$$Q_0(t+1) = Q_0(t)' Q_1 + x' Q_0$$

(b)

Present State		Input	Next State		Flip Flop Input				Output
Q_1	Q_0	x	Q_1	Q_0	J_1	K_1	J_0	K_0	Y
0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0	1	0
0	1	0	1	1	1	0	1	0	1
0	1	1	1	1	1	1	1	1	1
1	0	0	1	1	1	0	1	0	1
1	0	1	0	1	1	1	1	1	1
1	1	0	1	1	1	0	1	0	1
1	1	1	0	0	1	1	1	1	1

Q3

(c) State Diagram:

& 2 Inputs define state ⇒ 2 bits, 4 states

This is clearly a Moore Machine as output is only dependent on the present state.

4a.

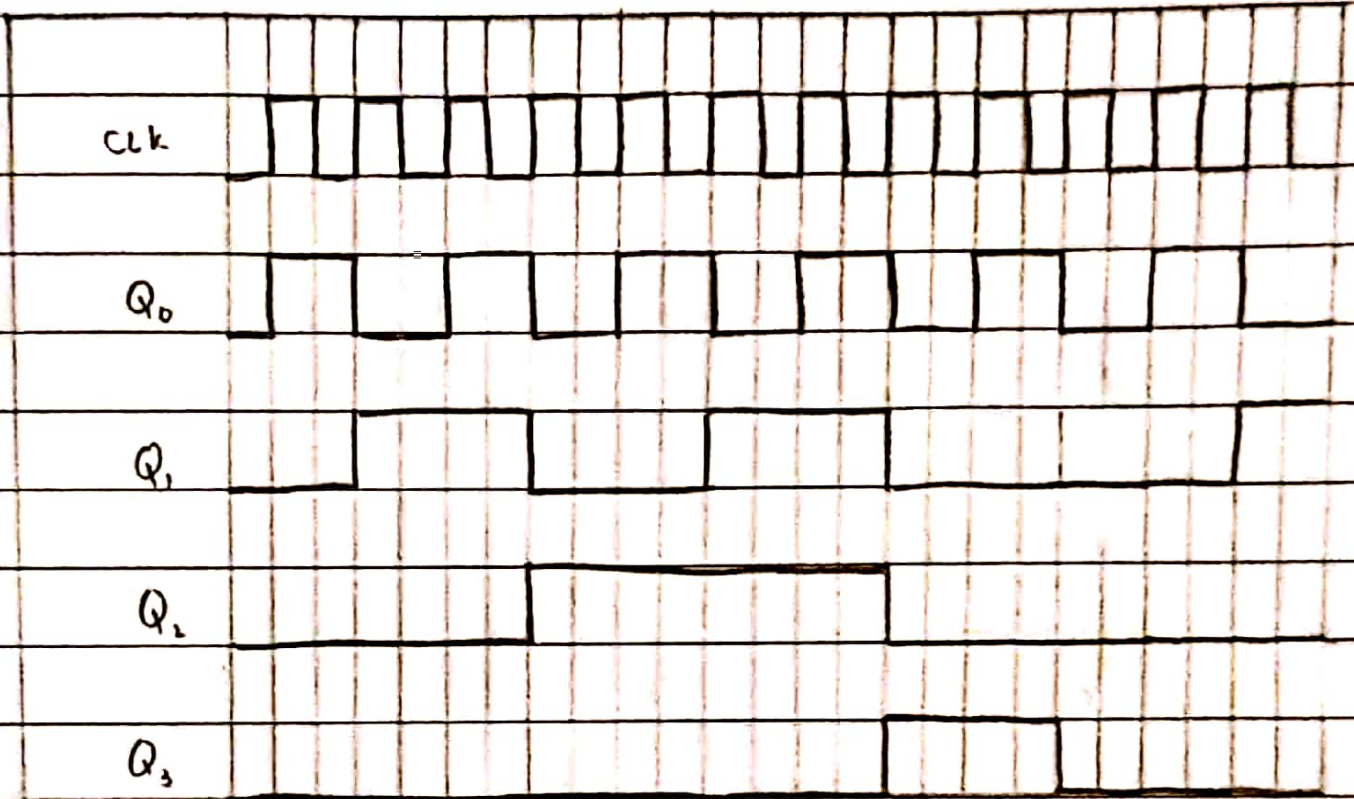Timing diagram showing CLK, J, K, and Q waveforms.

4b.

Timing diagram showing S, R, and Q waveforms.

4c.

	CLK
	Q_0
	Q_1
	Q_2
	Q_3

Asynchronous BCD counter

5.

a.

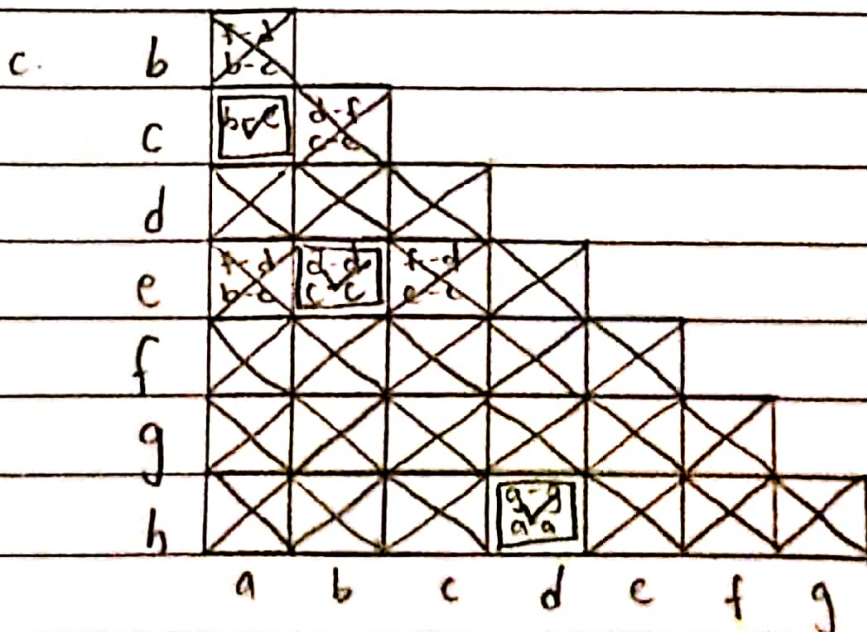| Present State	Next State		Output	
	$x = 0$	$x = 1$	$x = 0$	$x = 1$
a	f	b	0	0
b	d	c	0	0
c	f	e	0	0
d	g	a	1	0
e	d	c	0	0
f	f	b	1	1
g	g	h	0	1
h	g	a	1	0

b.   b and e are equivalent
d and h are equivalent
because same output and next state as shown in table
table

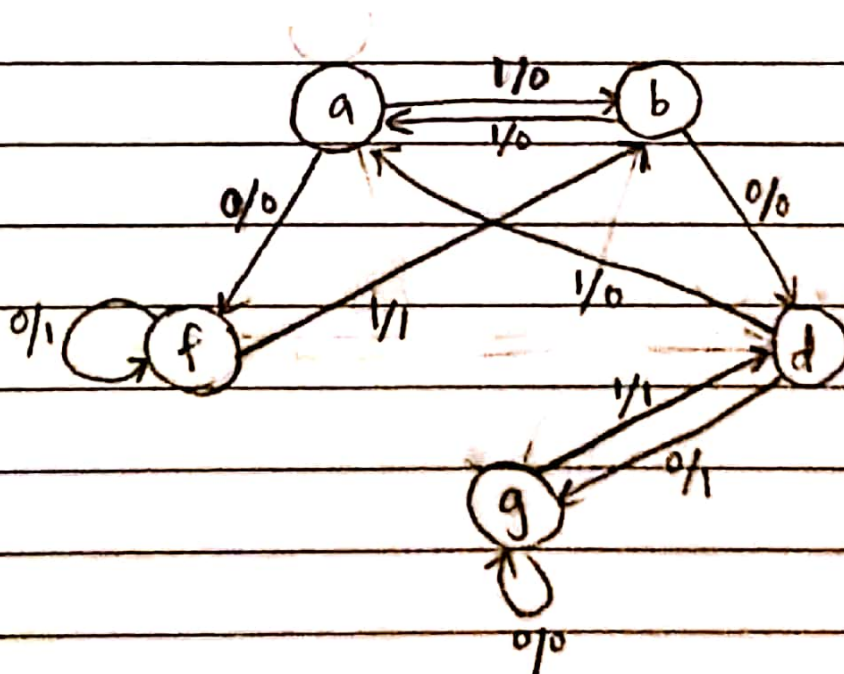| Present State	Next State		Output		
	$x=0$	$x=1$	$x=0$	$x=1$	
a	f	b	0	0	
b	d	c	0	0	
c	f	b	0	0	
d	g	a	1	0	
f	f	b	1	1	
g	g	d	0	1	

a and c are equivalent so one can be removed from table (updated table shown in next page).

c.

b (contd)

Present State	Next State		Output	
	$n=0$	$x=1$	$n=0$	$n=1$
a	f	b	0	0
b	d	a	0	0
d	g	a	1	0
f	f	b	1	1
g	g	d	0	1

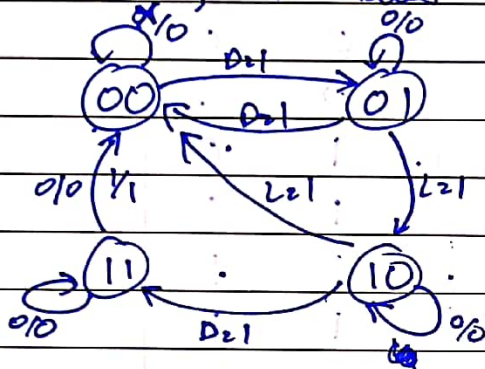No more equivalent states can be deduced from table

d.

Q6) ✗ JK FF   ✗ 'DLD' → input → pins lock.
 ✗ Inputs: D & L , output x
  2 bits , 4 States

$S_0 = 00$: Idle
$S_1 = 01$: D
$S_2 = 10$: L
$S_3 = 11$: D

State Table:

Present State		Inputs		Next State		Output	JK Flip Flop			
A	B	D	L	A(t+1)	B(t+1)	X	J_A	K_A	J_B	K_B
0	0	0	0	0	0	0	0	x	0	x
0	0	0	1	0	0	0	0	x	0	x
0	0	1	0	0	1	0	0	x	1	x
0	0	1	1	0	0	0	0	x	0	x
0	1	0	0	0	1	0	0	x	x	0
0	1	0	1	1	0	0	1	x	x	1
0	1	1	0	0	0	0	0	x	x	1
0	1	1	1	0	0	0	0	x	x	0
1	0	0	0	1	0	0	x	0	0	x
1	0	0	1	0	0	0	x	1	0	x
1	0	1	0	1	1	0	x	0	1	x
1	0	1	1	0	0	0	x	0	⊗	⊗
1	1	0	0	1	1	1	x	0	x	0
1	1	0	1	0	0	1	x	1	x	1
1	1	1	0	0	0	1	x	1	x	1
1	1	1	1	0	0	1	x	1	x	1

Dated:

J_A:

	D			
AB\DL	00	01	11	10
00	0	0	0	0
01	0	1	0	0
11	X	X	X	X
10	X	X	X	X

A { 11, 10 }   } B

$J_A = B D' L$

K_A:

	D			
AB\DL	00	01	11	10
00	X	X	X	X
01	X	X	X	X
11	0	1	1	1
10	0	1	0	0

A { 11, 10 }   } B

$K_A = BD + D' L$

J_B:

	D			
AB\DL	00	01	11	10
00				1
01	X	X	X	X
11	X	X	X	X
10			0	1

A { 11, 10 }   } B

$J_B = D L'$

K_B:

	D			
AB\DL	00	01	11	10
00	X	X	X	X
01			1	1
11	1	1	1	1
10	X	X	X	X

A { 11, 10 }   } B

$K_B = D' L + D L' + A L$

$K_B = (D \oplus L) + A L$

X:

	D			
AB\DL	00	01	11	10
00				
01				
11	1	1	1	1
10				

A { 11, 10 }   } B

$X = AB$

$J_A = B D' L$ $K_A = BD + D' L$

$J_B = D L'$ $K_B = (D \oplus L) + A L$

$X = AB$

Dated:

$J_A = BD'L$ $K_A = BD + D'L$

$J_B = DL'$ $K_B = (D \oplus L) + AL$

Output: $X = AB$