DACD Assignment-3

N. Sree Dhyuti
CED19I027

(1)

Shift	Content after each shift	Serial Input
0th (initial)	1011	101101
1st	1101	10110
2nd	0110	1011
3rd	1011	101
4th	1101	10
5th	0110	1
6th	1011	0

(2) (a) t_{pd} of each FF = 50 ns

t_{pd} of each AND Gate = 20 ns

For a synchronous counter of any no of bits,

Total delay $\geq t_{pd}$(FF) + t_{pd}(AND Gate)

Total delay $\geq (50+20)$ ns

$T_{clock} \geq 70$ ns

$\frac{1}{T_{clock}} \leq \frac{1}{70\text{ns}}$

$f_{clock} \leq \frac{1}{70}\text{ns} = 14.285 \times 10^6$ Hz

$f_{clock} \leq 14.285$ MHz

$f_{max} = 14.285$ MHz

For a MOD-16 ripple counter,

$f_{max} = \frac{1}{4} \times \frac{1}{t_{pd} \text{ of FF}}$ (as it has 4 flipflops)

$f_{max} = \frac{1}{4 \times 50 \times 10^{-9}} = 5$ MHz

∴ The f_{max} of 4-bit synchronous counter is greater than the f_{max} of a MOD-16 ripple counter.

(b) To convert a MOD-16 ripple counter to a Mod-32 counter, we should add one more flip flop.
Already a MOD-16 counter will have 4 FF's.
So, adding one more will make it count from 0 to 31

(c) As all the flip flops and other gates function simultaneously or paralelly to each other, adding of FF's will not change the tpd & also the fmax,
So, fmax of MOD-32 ripple counter = fmax of MOD-16 ripple counter

fmax of MOD-32 ripple counter = 14.28 MHz

(3) STATE TABLE

	Present State			Next State			Inputs (D-FF)		
	A	B	C	A	B	C	D_A	D_B	D_C
0	0	0	0	0	0	1	0	0	1
1	0	0	1	0	1	1	0	1	1
2	0	1	0	0	0	0	0	0	0
3	0	1	1	1	0	1	1	0	1
4	1	0	0	X	X	X	X	X	X
5	1	0	1	1	1	1	1	1	1
6	1	1	0	X	X	X	X	X	X
7	1	1	1	0	1	0	0	1	0

Now, using K-maps, we find
D_A, D_B, D_C interms of present state values of A, B, C

For D_A

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

~~$D_A = A\bar{B} + \bar{A}BC + A$~~

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

$= A\bar{B} + BC$

~~$D_A = B(A+C)$~~

$D_A = A + BC$

For D_B

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

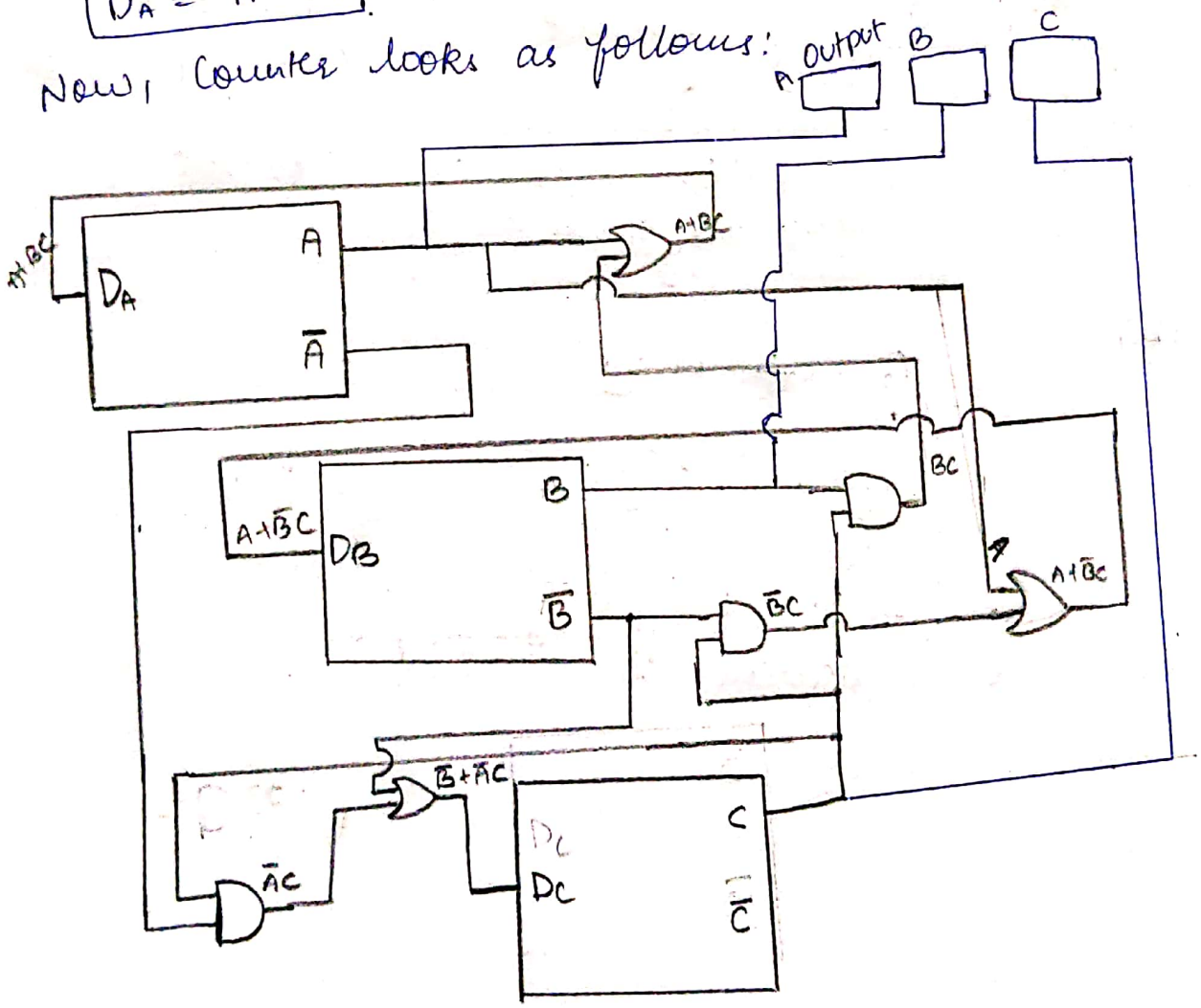
$D_B = A + \bar{B}C$

For D_C

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

$D_C = \bar{B} + \bar{A}C$

Now, Counter looks as follows:



(4) (a) Truth table of M-F flipflop

M	F	Q_n	Q_{n+1}	
0	0	0	1	} set
0	0	1	1	
0	1	0	1	} Toggles
0	1	1	0	
1	0	0	X	} Don't Care/ Not allowed
1	0	1	X	
1	1	0	0	} reset
1	1	1	0	

using Kmaps for Q_{n+1}

M \ FQ_n	00	01	11	10
0	1	1	0	1
1	X	X	0	0

$Q_{n+1} = \bar{F} + F\bar{M}\bar{Q_n}$

$Q_{n+1} = \bar{F} + \bar{M}\bar{Q_n}$

$\therefore$ $Q_{n+1} = \bar{F} + \bar{M}\bar{Q_n}$ is the characteristic equation for the given M-F flipflop

(b)

Q_n	$Q_{(t+1)}$	M	F
0	0	1	1
0	1	0	X
1	0	X	1
1	1	0	0

(5) Aim: To construct a circuit that

(5) Aim: To construct a circuit that finds the 10's complement of a BCD digit.

Sol) digit ⇒ we should construct it for 0-9

Truth table:

BCD equivalent of inputs — BCD equivalent of 10's complement

digit	I_3	I_2	I_1	I_0	10's complement	O_3	O_2	O_1	O_0
0	0	0	0	0	10	1	0	1	0
1	0	0	0	1	9	1	0	0	1
2	0	0	1	0	8	1	0	0	0
3	0	0	1	1	7	0	1	1	1
4	0	1	0	0	6	0	1	1	0
5	0	1	0	1	5	0	1	0	1
6	0	1	1	0	4	0	1	0	0
7	0	1	1	1	3	0	0	1	1
8	1	0	0	0	2	0	0	1	0
9	1	0	0	1	1	0	0	0	1

remaining all cases are dontcare cases

using Kmaps

For O_0

I_3I_2 \ I_1I_0	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	X	X	X	X
10	0	1	X	X

$O_0 = I_0$

For O_1,

I_3I_2 \ I_1I_0	00	01	11	10
00	1	0	1	0
01	1	0	1	0
11	X	X	X	X
10	1	0	X	X

$$O_1 = \bar{I}_0\bar{I}_1 + I_0I_1$$

For O_2,

I_3I_2 \ I_1I_0	00	01	11	10
00	0	0	1	0
01	1	1	0	1
11	X	X	X	X
10	0	0	X	X

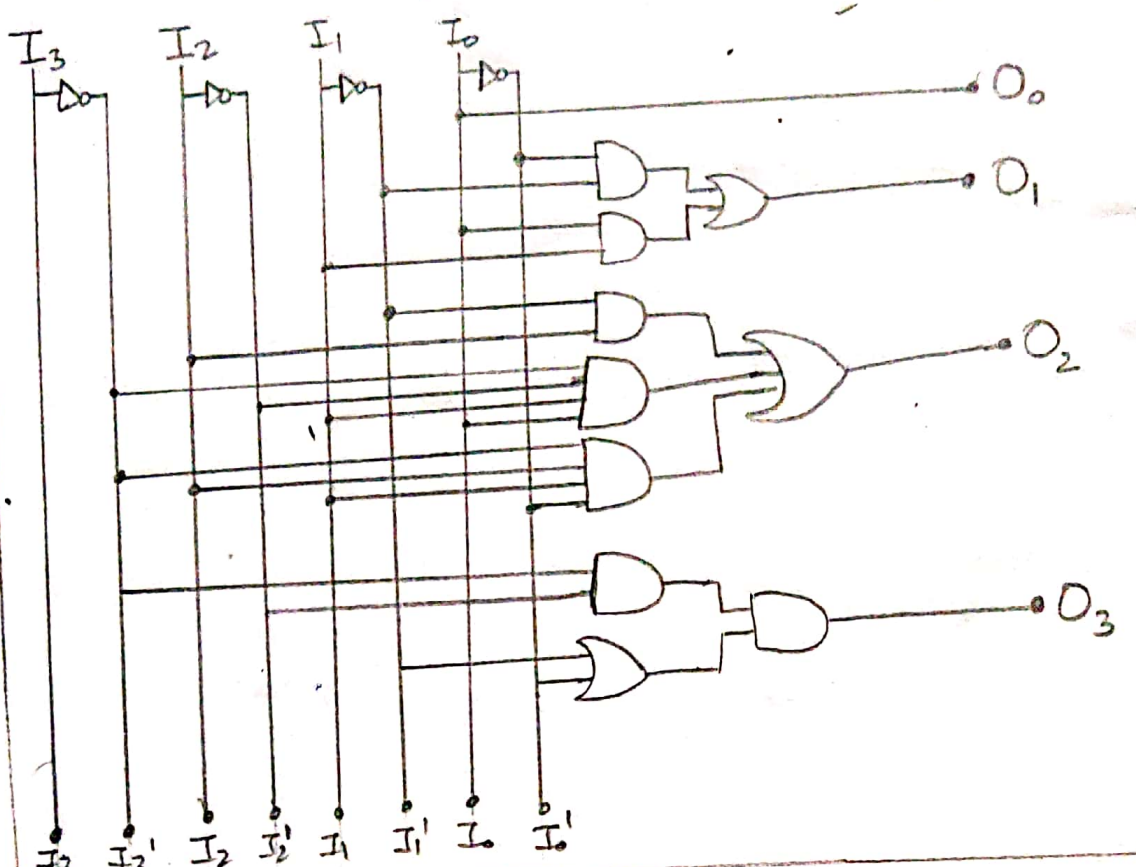
$$O_2 = I_2\bar{I}_1 + \bar{I}_3\bar{I}_2I_1I_0 + \bar{I}_3I_2I_1\bar{I}_0$$

For O_3

I_3I_2 \ I_1I_0	00	01	11	10
00	1	1	0	1
01	0	0	0	0
11	X	X	X	X
10	0	0	X	X

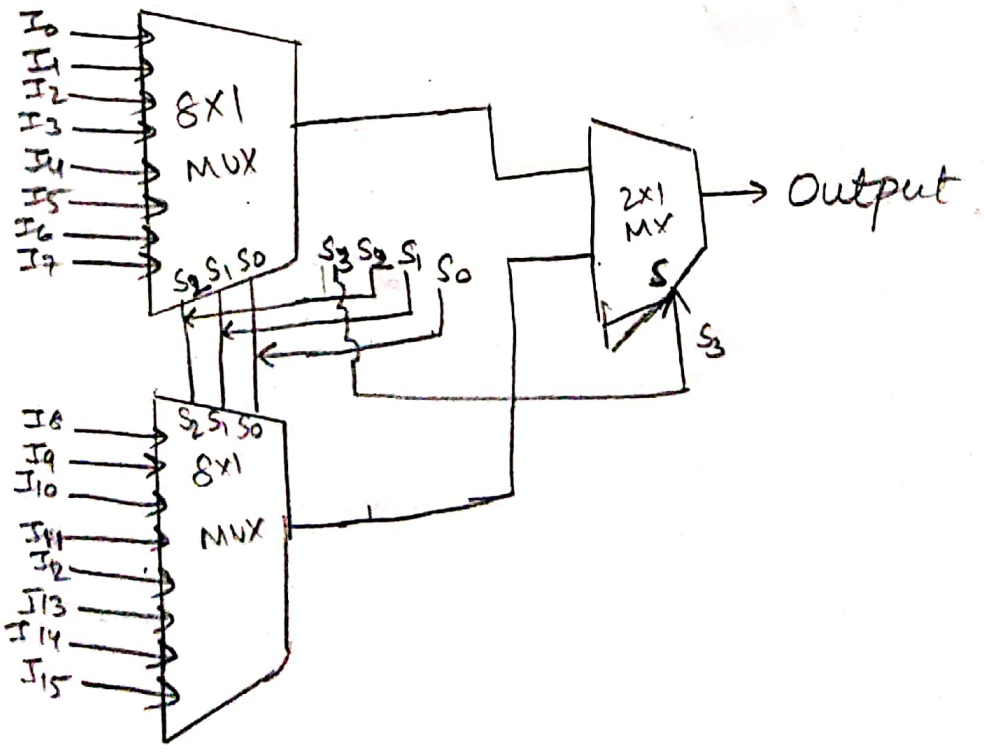
$$O_3 = \bar{I}_3\bar{I}_2\bar{I}_1 + \bar{I}_3\bar{I}_2\bar{I}_0$$
$$= \bar{I}_3\bar{I}_2(\bar{I}_1 + \bar{I}_0)$$

Now, from the eqns of O_0, O_1, O_2, O_3, we get the circuit as follows:

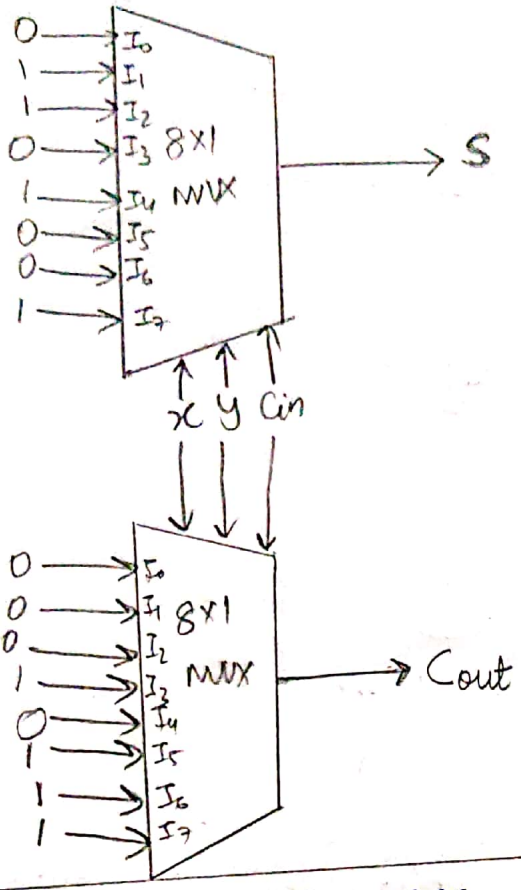


6 16×1 multiplexer using two 8×1 multiplexers & one 2×1 multiplexer

Let S_0, S_1, S_2 be the select lines



7 (a)



X	Y	Cin	S	Cout
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

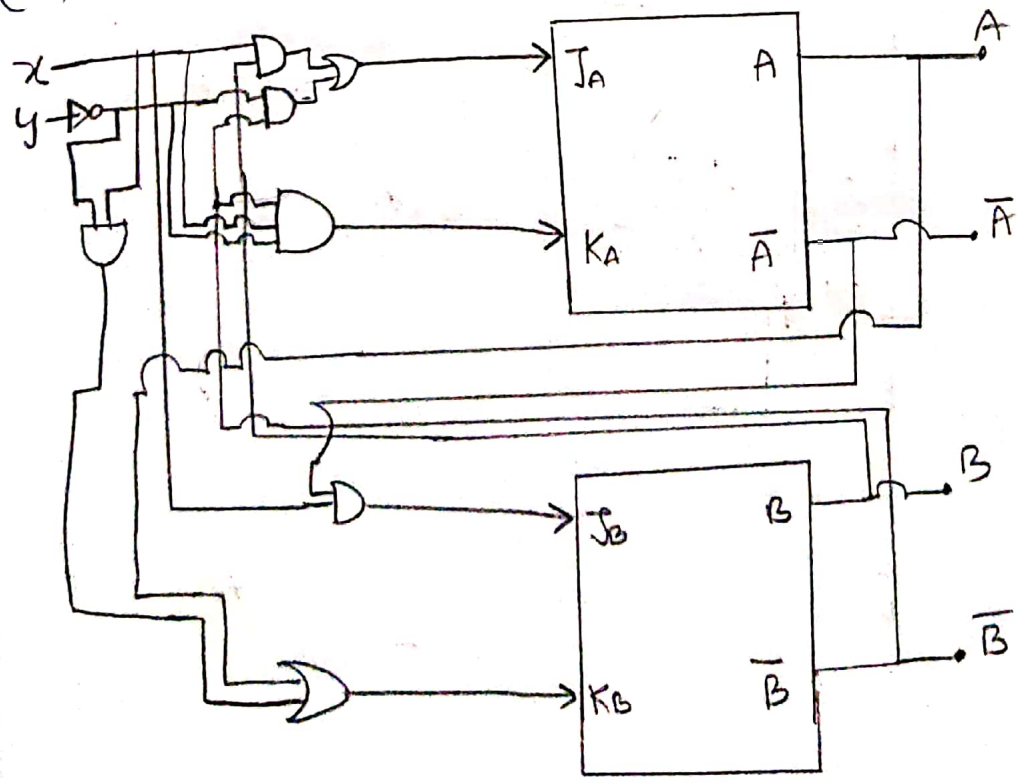
8 Input equations are

$J_A = Bx + B'y'$ & $K_A = B'xy'$

$J_B = A'x$ $K_B = A + xy'$

$Z = Ax'y' + Bxy'$

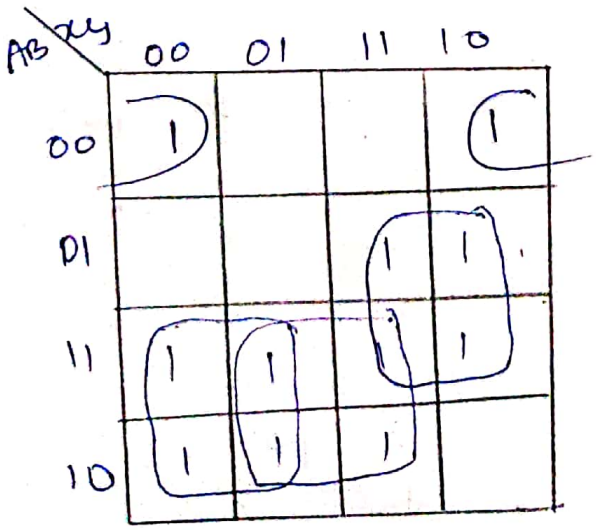
(a)



(b)

Present state		Inputs		Next state		Output	FF inputs			
A	B	x	y	A	B	Z	J_A	K_A	J_B	K_B
0	0	0	0	1	0	0	1	0	0	0
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	1	0	1	1	1	1
0	0	1	1	0	1	0	0	0	1	0
0	1	0	0	0	1	1	0	0	0	0
0	1	0	1	0	1	0	0	0	0	0
0	1	1	0	1	0	0	1	0	1	1
0	1	1	1	1	1	0	1	0	1	0
1	0	0	0	1	0	1	1	0	0	1
1	0	0	1	1	0	0	0	0	0	1
1	0	1	0	0	0	0	1	1	0	1
1	0	1	1	1	0	0	0	0	0	1
1	1	0	0	1	0	1	0	0	0	1
1	1	0	1	1	0	0	0	0	0	1
1	1	1	0	1	0	0	1	0	0	1
1	1	1	1	1	0	0	1	0	0	1

(c) K-map for next state A



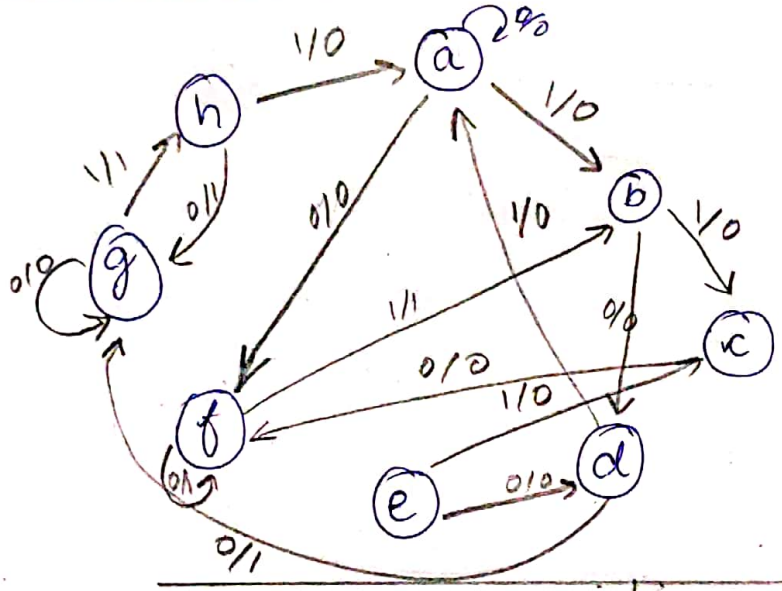
$A_{(t+1)} = A\bar{x} + Bx + Ay + \bar{A}\bar{B}\bar{y}$

For next state of B

AB \ xy	00	01	11	10
00			1	1
01	1	1	1	
11				
10				

$$B_{(t+1)} = \bar{A}\bar{B}x + \bar{A}B\bar{x} + \bar{A}By$$

(9) a)

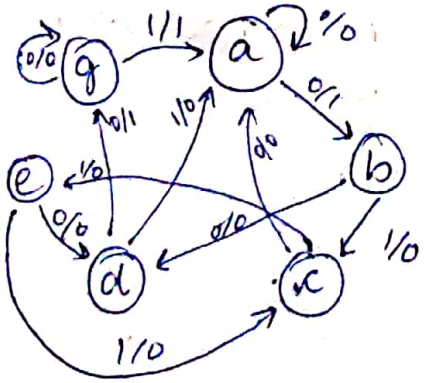


(b)

PS	NS		Output	
	x=0	x=1	x=0	x=1
a	a	b	0	0
b	d	c	0	0
c	a	e	0	0
d	g	a	1	0
e	d	c	0	0
g	g	a	0	1

(remove f & h)

(c)



(d)

PS	x	NS	output
a	0	a	0
a	1	b	0
b	1	c	0
c	1	e	0
e	0	c	0
c	0	a	0
a	1	b	0
b	0	d	0
d	0	g	1
g	1	a	1
a	1	b	0

output : 00000000110