Digital Electronics Paper

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dg681

1.

a)

ab	$\bar a$	$\overline{\bar a \cdot b}$	$\bar b$	$\overline{\bar b \cdot a}$	x
00	1	1	1	1	0
01	1	0	0	1	1
10	0	1	1	0	1
11	0	1	0	1	0

b)

ab	$\bar a$	$\overline{\bar a + b}$	$\bar b$	$\overline{\bar b + a}$	x
00	1	0	1	0	1
01	1	0	0	1	0
10	0	1	1	0	0
11	0	0	0	0	1

2.

a) $a.b.c + a.b.\bar c$

$= a.b.(c + \bar c)$

$= a.b.1$

$= \underline{\underline{a.b}}$

b) $a.(\bar a + b)$

$= a.\bar a + a.b$

$= 0 + a.b$

$= a.b$

c) $\cancel{a.b + \bar a.c}$

$\cancel{= (a.\bar a + a.b)} + (a.\bar a + a.c)$

$\cancel{=}$

$(a + c).(\bar a + b)$

$= a.\bar a + a.b + \bar a.c + c.b$

$= 0 + c.b + a.b + \bar a.c$

→ Consensus:

$= a.b + \bar a.c$

②

d) $(a+c)\cdot(a+d)\cdot(b+c)\cdot(b+d)$

$= (a.a + a.d + c.a + c.d)\cdot(b.b + b.d + c.b + c.d)$

$\cancel{= (a + a.d + a.c)\cdot(b + b.d + b.c)}$

$\cancel{= (a.d + a.c)\cdot(b.d + b.c)}$

$\cancel{= a.d.d.b + a.d.b.c + a.d.b.c + a.c.c.b}$

$\cancel{= a.b + a.c}$

$= (a + a.d + a.c + c.d)\cdot(b + b.d + b.c + c.d)$

$= [a.(1+d+c) + c.d]\cdot[b.(1+d+c) + c.d]$

$= (a.1 + c.d)\cdot(b.1 + c.d)$

$= (a + c.d)\cdot(b + c.d)$

$= \cancel{a.b + c.d} \; a.b + a.c.d + b.c.d + c.c.d.d$

$= a.b + c.d + a.\cancel{c}.d + b.\cancel{c}.d$

Consensus:

$= \underline{a.b + c.d}$

3

$$z = b + \overline{\overline{a.a} + a.b.c}$$

$$\cancel{= b + \overline{\overline{a.a}}}$$

$$= b + \overline{\overline{a} + a.b.c}$$

$$= b + (a.(\bar{a} + \bar{b} + \bar{c}))$$

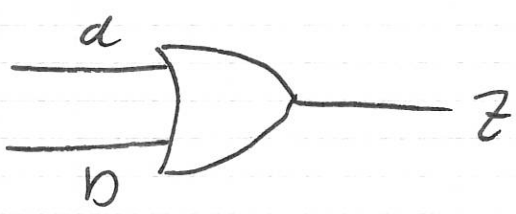
$$= b + a.\bar{a} + a.\bar{b} + a.\bar{c}$$

$$= b + 0 + a.\bar{b} + a.\bar{c}$$

$$= b + a.\bar{b} + a.\bar{c}$$

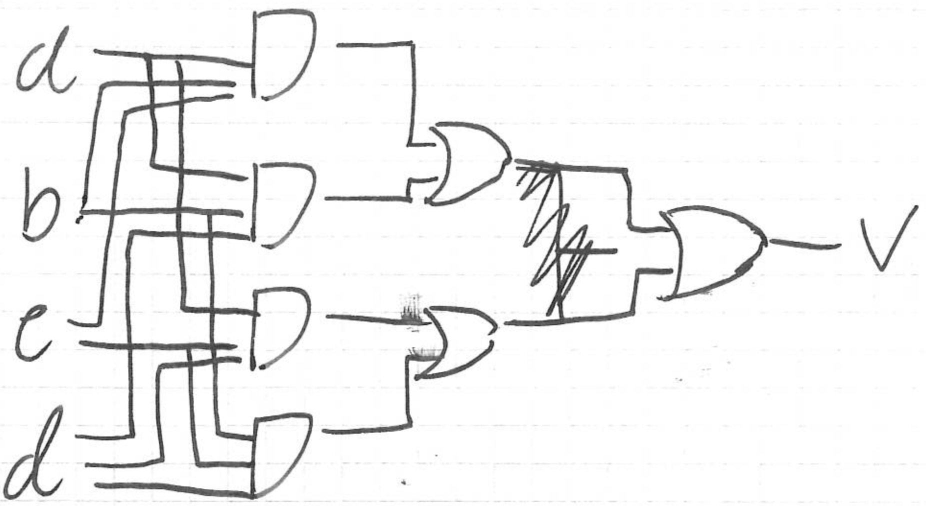
$$= b + a + a.\bar{c}$$

$$= a + b$$

→ 

4

$$V = a.b.c + a.b.d + a.c.d + b.c.d + \cancel{a.b.c.d}$$



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a) Currently in SoP form $\overline{a.b} = \bar{a} + \bar{b}$

$$\rightarrow V = \overline{(\bar{a} + \bar{b} + \bar{c})} + \overline{(\bar{a} + \bar{b} + \bar{d})} + \overline{(\bar{a} + \bar{c} + \bar{d})}$$

$$+ \overline{(\bar{b} + \bar{c} + \bar{d})}$$

$$= \overline{a.b.c} + \overline{a.b.d} + \overline{a.c.d} + \overline{b.c.d}$$

$$= \overline{\cancel{a}.\cancel{b}.c.\cancel{a}.\cancel{b}.d} + \overline{a.\cancel{c}.d.b.\cancel{c}.d}$$

$$= \overline{c.d} + \overline{a.d}$$

$$= \overline{a.b.c.d} = \overline{a.b} \cdot \overline{c.d}$$

b) Get $\bar V$ in SoP

$cd \backslash ab$	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	1	1	1	1
10	0	0	1	0

$$\bar V = \bar a \cdot \bar b + \bar c \cdot \bar d + \bar a \cdot \bar c + \bar a \cdot \bar d + \bar b + \bar d + \bar b \cdot \bar c$$

$$\Rightarrow \bar V = \overline{a+b} + \overline{c+d} + \overline{a+c} + \overline{a+d} + \overline{b+d} + \overline{b+c}$$

$$\bar V = \overline{(a+b)\cdot(c+d)\cdot(a+c)\cdot(a+d)\cdot(b+d)\cdot(b+c)}$$

$$\Rightarrow V = (a+b)\cdot(c+d)\cdot(a+c)\cdot(a+d)\cdot(b+d)\cdot(b+c)$$

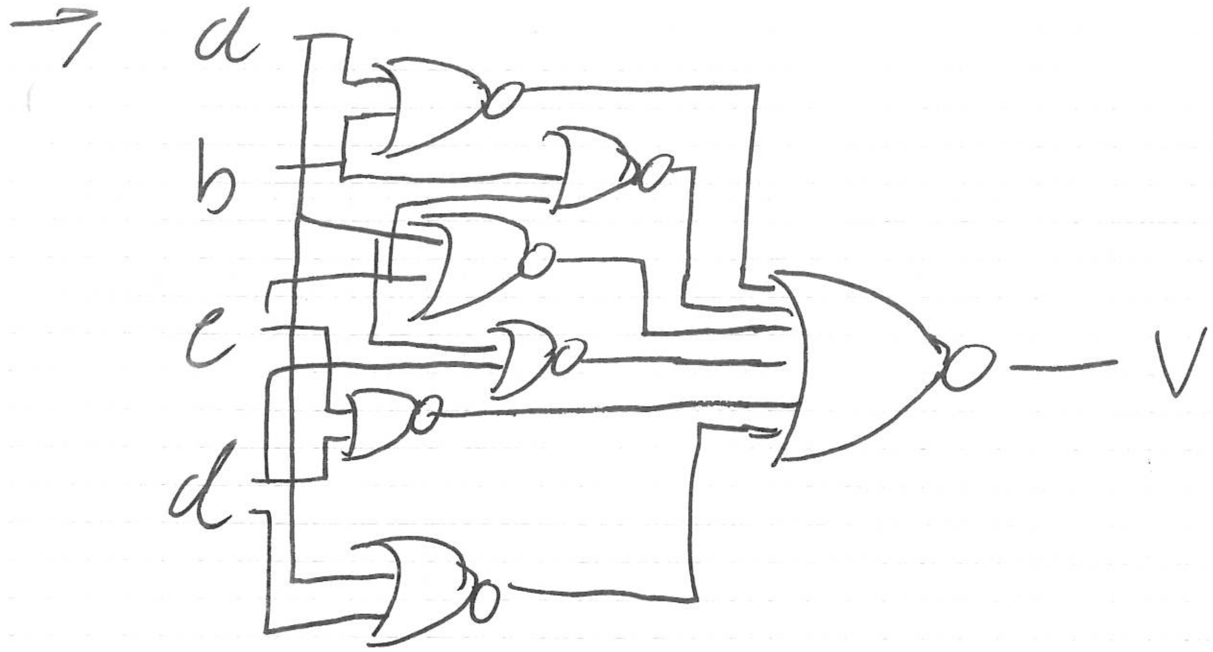
Into circuit:

$$(a+b)\cdot(c+d) = \overline{\overline{a+b} + \overline{c+d}}$$

$$\Rightarrow V = \overline{\overline{a+b} + \overline{c+d}} \cdot \overline{\overline{a+c} + \overline{a+d}} \cdot \overline{\overline{b+d} + \overline{b+c}}$$

$$= \overline{\overline{a+b} + \overline{c+d} + \overline{a+c} + \overline{a+d}} \cdot \overline{\overline{b+d} + \overline{b+c}}$$

$$= \overline{\overline{a+b} + \overline{c+d} + \overline{a+c} + \overline{a+d} + \overline{b+d} + \overline{b+c}}$$



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cd \ ab	00	01	11	10
00	1	1	0	1
01	1	1	0	1
11	0	0	0	0
10	1	1	0	X

$$f = \bar{a}\cdot\bar{c} + \bar{b}\cdot\bar{c} + \bar{a}\cdot\bar{d}$$

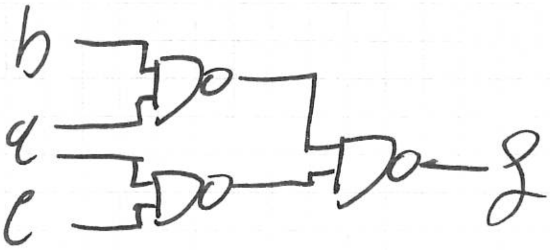
$$\bar{f} = a\cdot b + c\cdot d$$

c \ ab	00	01	11	10
0	0	0	1	0
1	0	0	1	1

$$g = a \cdot b + a \cdot c \quad (= a \cdot (b + c))$$

$$\bar{g} = \bar{a} + \bar{c} \cdot \bar{b}$$

a) $g = \overline{\overline{a \cdot b} \cdot \overline{a \cdot c}}$

→ 

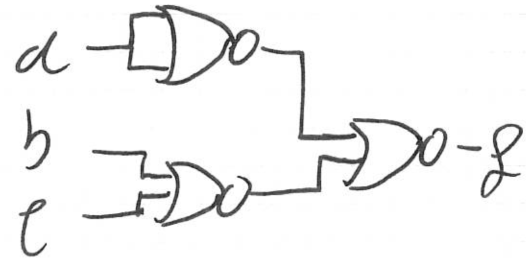
b) $\bar{g} = \bar{a} + (\bar{c} \cdot \bar{b})$

$\bar{g} = \bar{a} + \overline{c + b}$

$\bar{g} = \overline{(a) \cdot (c + b)}$

$g = (a) \cdot (c + b)$

→ $g = \overline{\bar{a} + \overline{c+b}}$

→ 

1000

8 Q-M method

0101, 0110, 0111, 1000, 1010, 1011, 1100,
1101, 1110, 1111

1	2	3	4
1000 ✓	10-0 ✓	1--0	
	1-00 ✓		
0101 ✓			
	01-1 ✓	-1-1	
0110 ✓	-101 ✓		
1010 ✓	011- ✓	-11-	
1100 ✓	-110 ✓	1-1-	
	101- ✓	11--	
0111 ✓	1-10 ✓		
1011 ✓	11[illegible] ✓		
1101 ✓	11-0 ✓		
1110 ✓			
	-111 ✓		
1111 ✓	1-11 ✓		
	11-1 ✓		
	111- ✓		

	5	6	7	8
8, 10, 12, 14 1--0				X
5, 7, 13, 15 -1-1	X		X	
6, 7, 14, 15 -11-		X	X	
10, 11, 14, 15 1-1-				
12, 13, 14, 15 11--				

$\rightarrow \boxed{g = a \cdot \bar{d} + b \cdot d + b \cdot c}$

a

Jan, Feb, Mar, April, Sep, Oct, Nov, Dec

$\rightarrow$ 0001, 0010, 0011, 0100, 1001, 1010, 1011, 1100

$A_1A_0 \backslash A_3A_2$	00	01	11	10
00	X	1	1	0
01	1	0	X	1
11	1	0	X	1
10	1	0	X	1

$\rightarrow m = \bar{A}_3 \cdot \bar{A}_2 + A_2 \cdot \bar{A}_1 \cdot \bar{A}_0 + A_3 \cdot A_1 + A_3 \cdot \bar{A}_1 \cdot A_0$

10

b) 0000, 0001, 0010, 0011, 1000, 1001, 1010, 1011

$A_1A_0 \backslash A_3A_2$	00	01	11	10
00	1	0	X	1
01	1	0	X	1
11	1	0	X	1
10	1	0	X	1

$\rightarrow m = \bar{A_2}$

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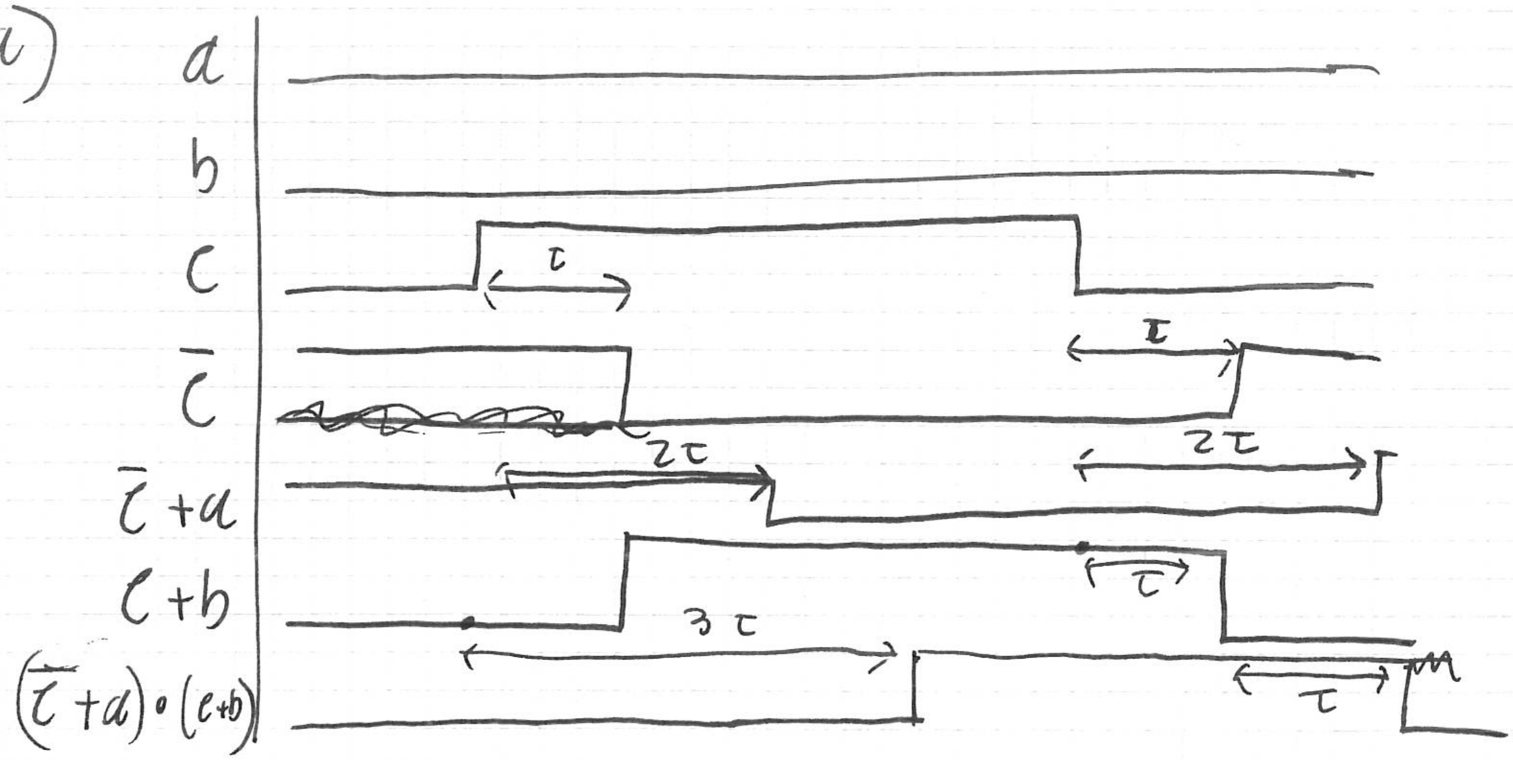
a)



b) There may be a static 0 hazard becase $(\bar{c}+a)\cdot(c+b)$ may not change to 1 if c changes before 3τ, even though the output should've changed

b) $z = (\bar{c} + a)\cdot(c + b)$

$z = \overline{c\cdot\bar{a}} + \overline{\bar{c}\cdot\bar{b}}$

$\bar{z} = (c\cdot\bar{a}) + (\bar{c}\cdot\bar{b})$

c)

c \ ab	00	01	11	10
0	1	0	0	1
1	1	1	0	0

← Protection

Ans: An or gate should be added to "connect" the essential prime implicants, so

$\bar{z} = c\cdot\bar{a} + \bar{c}\cdot\bar{b} + \boxed{\bar{a}\cdot\bar{b}}$

$\overline{\bar{a}\cdot\bar{b}} \rightarrow (a + b)$

→ z should become: