Missing 7?

Morgan Saville

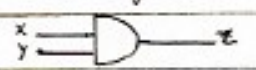
Supervision 1 Questions

1 i) A variable which can exist in one of two possible states 0 or 1. On or Off. High or low

ii) A function which accepts one or more boolean values as inputs, and outputs a boolean value

iii) A function, usually defined in terms of logic gates, which accepts one or more boolean values as inputs, and outputs one or more boolean values

2 3 fundamental gates:

AND 

$z = x * y$

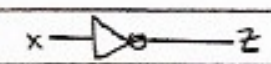
$= xy$

X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

OR 

$z = x + y$

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	1

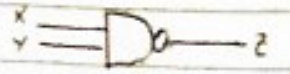
NOT 

$z = \bar{x}$

X	Z
0	1
1	0

4 compound gates

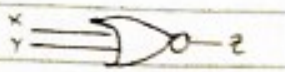
NAND



$Z = \overline{XY}$

X	Y	Z
0	0	1
0	1	1
1	0	1
1	1	0

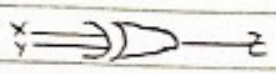
NOR



$Z = \overline{X+Y}$

X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	0

XOR



$Z = X\bar{Y} + \bar{X}Y$

$= X \oplus Y$

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0

XNOR

$Z = XY + \bar{X}\bar{Y}$

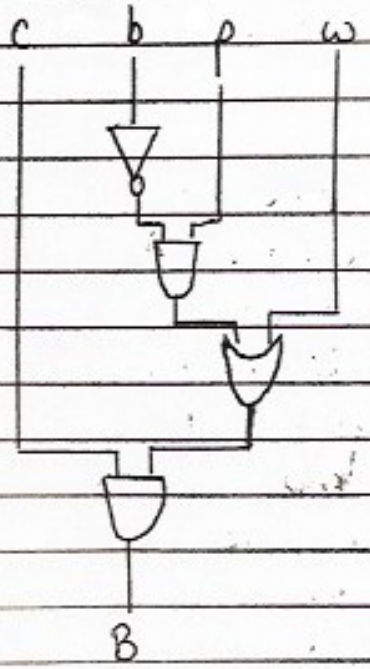
X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	1

3 Suppose there is a beeper in a car which should beep when either (or both)

- The car is moving, the passenger's seat has a person in it, and the passenger's seat belt is not done up
- The car is moving and there is an object near it.

Let c = the car is moving
p = someone is in the passenger's seat
b = the passenger's seat belt is done up
ω = there is an object near the car
(lowercase omega used because o for object looks too much like 0)
B = beeper is beeping

$B = c(\bar{b}p + \omega)$



c	p	b	ω	B
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

4. 1.

a	b	$\bar{a}$	$\overline{\bar{a}\cdot b}$	$\bar{b}$	$\overline{a\bar{b}}$	x
0	0	1	1	1	1	0
0	1	1	0	0	1	1
1	0	0	1	1	0	1
1	1	0	1	0	1	0

a	b	$\bar{a}$	$\overline{\bar{a}+b}$	$\bar{b}$	$\overline{a+\bar{b}}$	a
0	0	1	0	1	0	1
0	1	1	0	0	1	0
1	0	0	1	1	0	0
1	1	0	0	0	0	1

2. i) $abc + ab\bar{c} = ab(c+\bar{c}) = ab(1) = ab$

ii) $a(\bar{a}+b) = a\bar{a} + ab = 0 + ab = ab$

iii) $ab + \bar{a}c =$

$= (ab+\bar{a})(ab+c)$

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

$= (1)(\bar{a}+b)(a+c)(b+c)$

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

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

$= (a+c)(b(\bar{a}+1) + \bar{a}c)$

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

$= a\bar{a}c + ab + \bar{a}cc + bc$

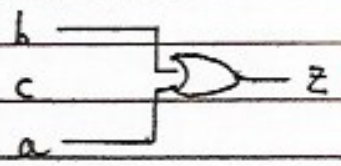
$= 0 + \bar{a}c + ab + bc$

$= a\bar{a} + \bar{a}c + ab + bc$

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

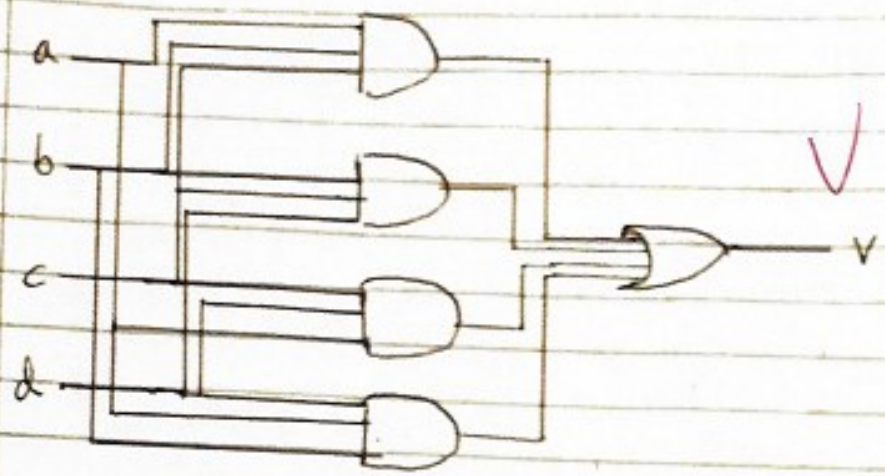
ii) $(a+c)(a+d)(b+c)(b+d)$
$= (a+cd)(b+cd)$ ✓
$= ab + cd$

3 $z = \overline{b + (abc + \bar{a})}$
$= b + (\overline{abc} \cdot a)$
~~$= b + (\bar{a} + \bar{b} + \bar{c}) a$~~
$= b + a(\bar{a} + \bar{b} + \bar{c})$
$= b + a\bar{a} + a\bar{b} + a\bar{c}$
$= b + 0 + a(\bar{b} + \bar{c})$
$= b + a(\bar{b} + \bar{c})$
~~$= b + a(b\bar{b} + b\bar{c} + \bar{b}\bar{b} + \bar{b}\bar{c})$~~
~~$= b + a(0 + b\bar{c} + \bar{b} + \bar{b}\bar{c})$~~
~~$= b + a(\bar{b} + \bar{c}(b+\bar{b}))$~~
$= abc + ab\bar{c} + \bar{a}bc + \bar{a}b\bar{c} + a\bar{b}c + a\bar{b}\bar{c} + ab\bar{c} + a\bar{b}\bar{c}$
$= abc + ab\bar{c} + \bar{a}bc + \bar{a}b\bar{c} + a\bar{b}c + a\bar{b}\bar{c}$
$= a(bc + b\bar{c} + \bar{b}c + \bar{b}\bar{c}) + \bar{a}(b\bar{c} + bc)$
$= a + \bar{a}b$
$= (a+\bar{a})(a+b)$
$= a + b$ ✓



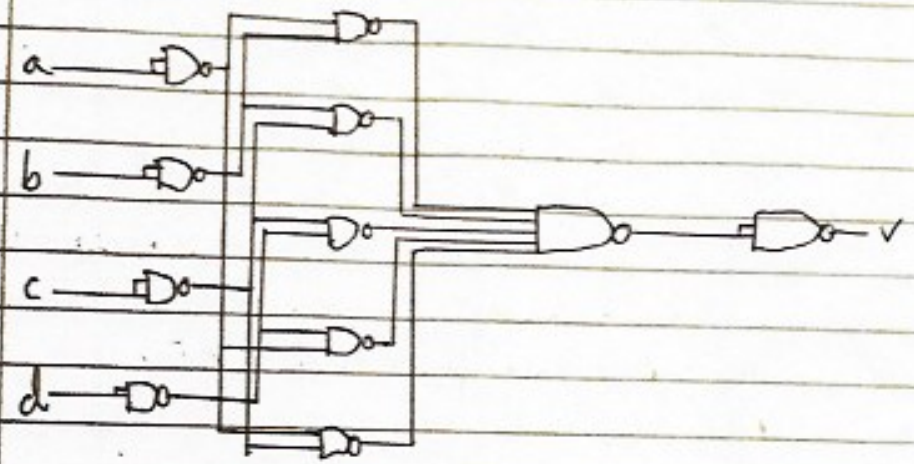
✓

4 $y = abc + abd + a\bar{c}d + bcd$ ✓

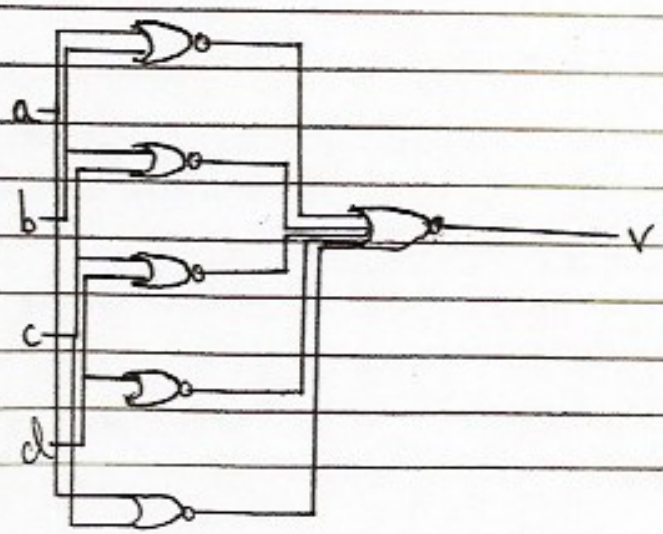


✓

5a $V = \overline{(\bar{a}b)}\,\overline{(\bar{a}c)}\,\overline{(\bar{a}d)}\,\overline{(\bar{b}c)}\,\overline{(\bar{c}d)}$



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



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6. $f = \bar a \bar d + b \bar c + \bar a b \bar c d$

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

we don't need to include X

$f = \bar a \bar c + \bar a \bar d + \bar b \bar c$ ✓

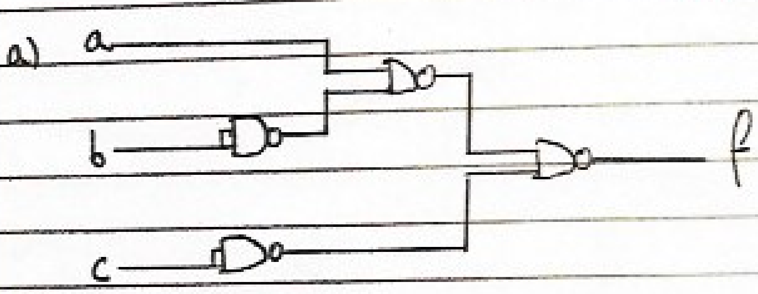
$\bar f = ab + cd + ac \Rightarrow f = \overline{\overline{\bar c + \bar d} + \overline{\bar a + \bar b}}$

7.

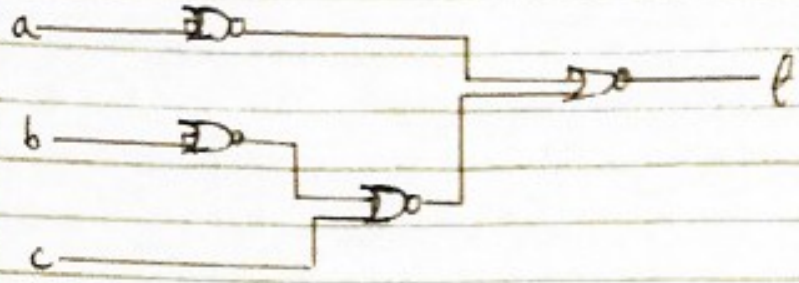
c \ ab	00	01	11	10
0	0	0	0	1
1	0	0	1	1

$f = a\bar b + ac = (a\bar b)c \Rightarrow \overline{\overline{a\bar b} \cdot \overline{ac}}$

a)



$\bar f = \bar a + b\bar c \Leftrightarrow f = \overline{\bar a + b\bar c} = \bar a + \overline{(\bar b + c)}$ ✓



5. a) i) $BD + AC + AB$ ✓ canonical = $\bar{a}b\bar{c}d + \bar{a}bcd +$ $+ abc\bar{d} + \ldots$

ii) ~~$A(B+C)+BD$~~

b) i) $BD + AB + A\bar{C}\bar{D}$

ii) ~~$B(A+D)$~~

c) i) ~~$\bar{B}\bar{D} + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C} + \bar{A}\bar{C}D$~~

$\bar{B}D + A\bar{C}\bar{D} + \bar{A}\bar{B}C + \bar{A}\bar{C}D$ ✓

ii) ~~$\bar{C}(A\bar{D} + D\bar{A}) + \bar{B}(\bar{A}C + D)$~~

$= \bar{C}(A \oplus D) + \bar{B}(\bar{A}C + D)$

d) i) $BD + \bar{B}\bar{D}$ ✓

ii) ~~$\overline{B \oplus D}$~~

iii) $\bar{f} = AB + CD + \bar{B}\bar{D}$ ok ✓

$\therefore f = \overline{AB + CD + \bar{B}\bar{D}}$

$= \overline{(AB)}\,\overline{(CD)}\,\overline{(\bar{B}\bar{D})}$

$= (\bar{A} + \bar{B})(\bar{C} + \bar{D})(B + \bar{D})$ ok

6.

index	ABCD		
0	0000	00x0	x0x0
		x000	[illegible]
2	0010		
8	1000	0x10	xx10
		x010	1xx0
5	0101	10x0	
6	0110	1x00	x1x1
			x11x
10	1010		11xx
12	1100	01x1	
		x101	
7	0111	011x	
13	1101	x110	
14	1110	1x10	
		110x	
15	1111	11x0	
		x111	
		11x1	
		111x	

∴ Prime implicants : $\bar{A}BD$, $AC\bar{D}$, $\bar{B}\bar{D}$, $C\bar{D}$, $A\bar{D}$, BD, BC, AB

	0	2	5	6	7	8	10	12	13	14	15
$\bar{A}BD$			✓		✓						
$AC\bar{D}$							✓			✓	
$\bar{B}\bar{D}$	✓	✓				✓	✓				
$C\bar{D}$		✓		✓			✓			✓	
$A\bar{D}$						✓	✓	✓		✓	
BD			✓		✓				✓		✓
BC				✓	✓					✓	✓
AB								✓	✓	✓	✓