ESC 201 Assignment 10 Solutions

Ans 1.

$$f = (x \cdot y + z) \cdot (y + x \cdot z)$$

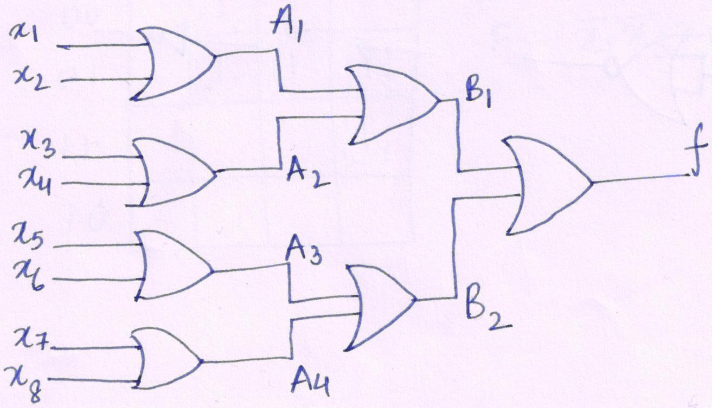
x	y	z	$(x \cdot y + z)$	$(y + x \cdot z)$	f
0	0	0	0	0	0
0	0	1	1	0	0
0	1	0	0	1	0
0	1	1	1	1	1
1	0	0	0	0	0
1	0	1	1	1	1
1	1	0	1	1	1
1	1	1	1	1	1

SOP : $f = \bar{x}yz + x\bar{y}z + xy\bar{z} + xyz$

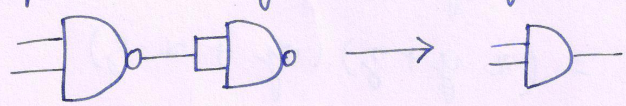
POS : $f = (x+y+z)(x+y+\bar{z})(x+\bar{y}+z)(\bar{x}+y+z)$

Ans 2.

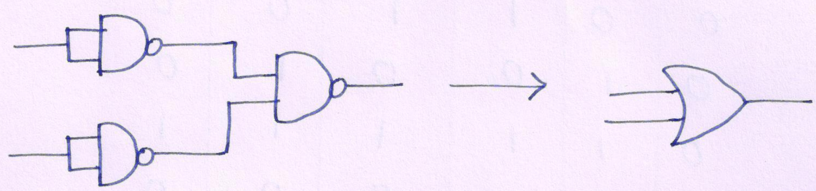
$$\begin{aligned} f &= x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 \\ &= (x_1 + x_2) + (x_3 + x_4) + (x_5 + x_6) + (x_7 + x_8) \\ &= A_1 + A_2 + A_3 + A_4 \\ &= (A_1 + A_2) + (A_3 + A_4) \\ &= B_1 + B_2 \end{aligned}$$



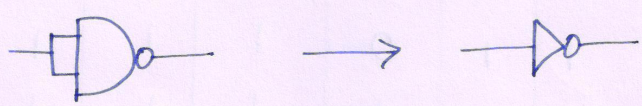
Ans 3. 2-input AND gate using 2-input NAND ga



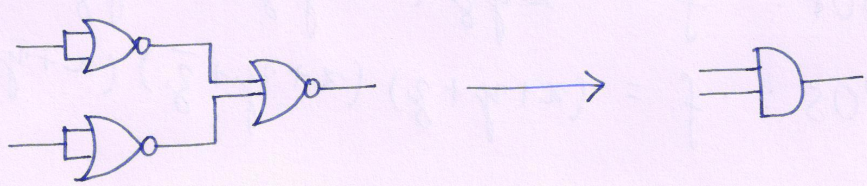
2-input OR gate using 2-input NAND gates:



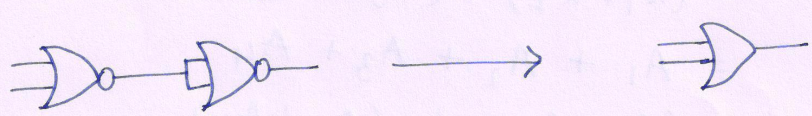
NOT gate using 2-input NAND gate:



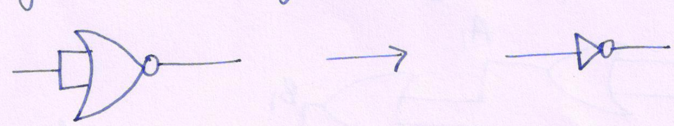
2-input AND gate using 2-input NOR gates:



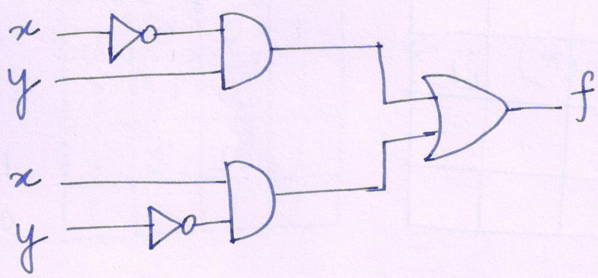
2-input OR gate using 2-input NOR gates:

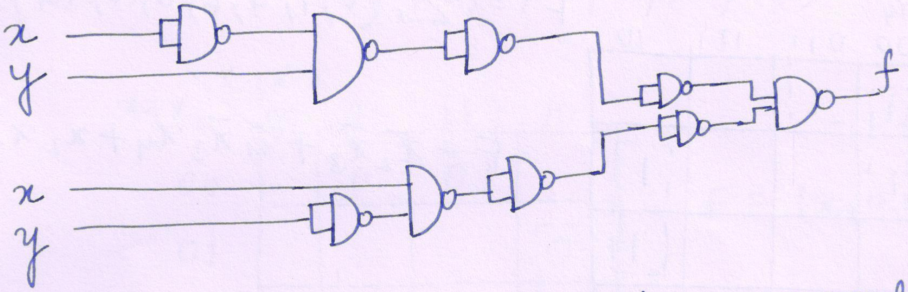


NOT gate using 2-input NOR gate:

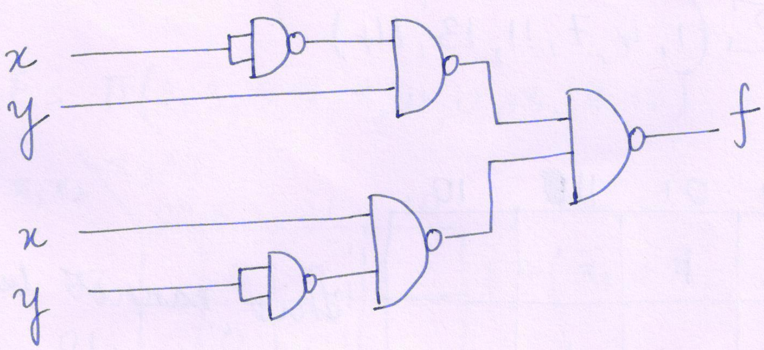


Ans 4. $f = \bar{x}y + x\bar{y}$





Two NOT gates in series cancel.



Ans 5. (a) $F = \Sigma(1, 5, 6, 7, 14)$

x_1x_2 \ x_3x_4	00	01	11	10
00		1		
01		1	1	1
11				1
10				

$F = \overline{x_1}\,\overline{x_3}\,x_4 + \overline{x_1}\,x_2 x_3 + x_2 x_3 \overline{x_4}$

(b) $F = \Sigma(0,4,6,8)$

$x_1x_2 \backslash x_3x_4$	00	01	11	10
00	1			
01	1			1
11				
10	1			

$F = \bar{x}_2 \bar{x}_3 x_4 + \bar{x}_1 x_2 \bar{x}_4$

(c) $F = \Sigma(0,1,4,6,8,9,14)$

$x_1x_2 \backslash x_3x_4$	00	01	11	10
00	1	1		
01	1			1
11				1
10	1	1		

$F = \bar{x}_2 \bar{x}_3 + \bar{x}_1 \bar{x}_3 x_4 + x_2 x_3 \bar{x}_4$

(d) $F = \Sigma(1,4,7,11,13,14)$

$x_1x_2 \backslash x_3x_4$	00	01	11	10
00		1		
01	1		1	
11		1		1
10			1	

This cannot be minimized.

Q6 (a) $F = \prod(1,3,5,7,13,15)$

$x_1x_2 \backslash x_3x_4$	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	1	0	0	1
10	1	1	1	1

$F = (x_1 + \bar{x}_4)(\bar{x}_2 + \bar{x}_4)$

(b) $F = \prod(1,3,6,9,11,12,14)$

$x_1x_2 \backslash x_3x_4$	00	01	11	10
00		0	0	
01				0
11	0			0
10		0	0	

$F = (x_2 + \bar{x}_4).(\bar{x}_1 + \bar{x}_2 + x_4).(\bar{x}_2 + \bar{x}_3 + x_4)$

(c) $F = \prod(1,3,5,7,9,11,12,13,14,15)$

$x_1x_2 \backslash x_3x_4$	00	01	11	10
00		0	0	
01		0	0	
11	0	0	0	0
10		0	0	

$F = (\bar{x}_1 + \bar{x}_2).(\bar{x}_4)$

(d) $F = (0,1,3,4,5,7,12,13,15)$

$x_1x_2 \backslash x_3x_4$	00	01	11	10
00	0	0	0	
01	0	0	0	
11	0	0	0	
10				

$F = (x_1 + x_3)(x_1 + \bar{x}_4)(\bar{x}_2 + x_3)(\bar{x}_2 + \bar{x}_4)$

Ans 7. (a) $F(A,B,C,D) = \sum(4,5,7,12,13,14)$

$d(A,B,C,D) = \sum(1,9,11,15)$

AB \ CD	00	01	11	10
00		X		
01	1	1	1	
11	1	1	X	1
10		X	X	

$F = AB + B\bar{C} + BD$

(b) $F(A,B,C,D) = \sum(1,2,12,13,14)$

$d(A,B,C,D) = \sum(8,9,10,11)$

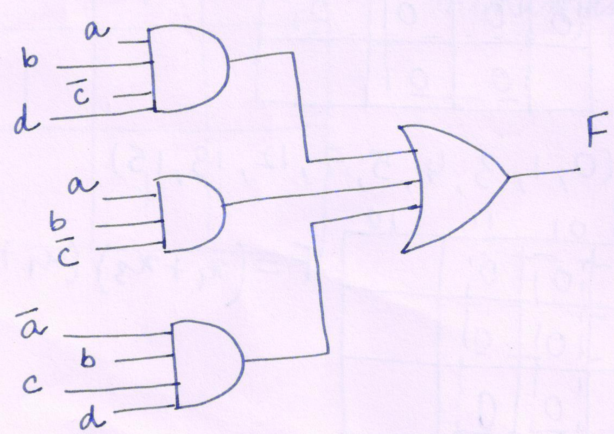
AB \ CD	00	01	11	10
00		1		1
01				
11	1	1		1
10	X	X	X	X

$F = A\bar{C} + A\bar{D} + \bar{B}\bar{C}D + \bar{B}C\bar{D}$

Ans 8. $F = (ab + cd)(\bar{a}b + \bar{c}d + a\bar{c})$

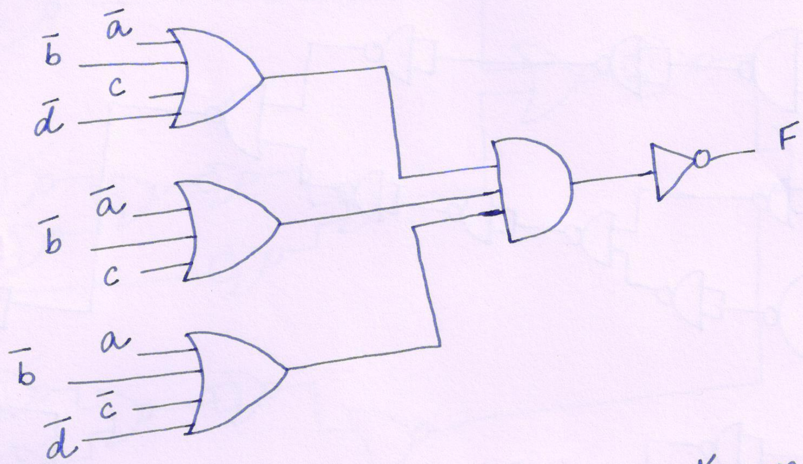
$F = ab\bar{c}d + ab\bar{c} + \bar{a}bcd$

AND - OR :



OR - AND : Implement $\bar{F}$ and then invert it:

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



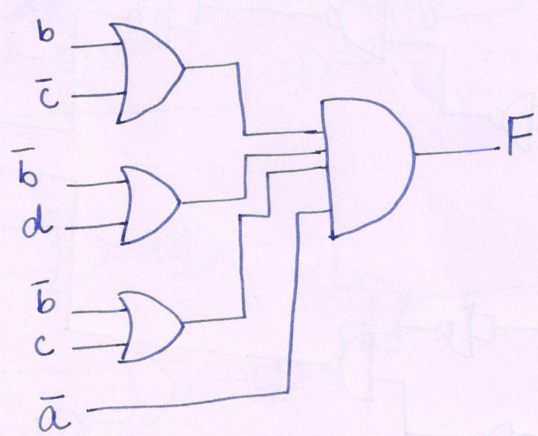
An alternate is to obtain PoS from K-map:

$$F = ab\bar{c}\bar{d} + ab\bar{c} + \bar{a}bcd$$

↳ can be minimized further.

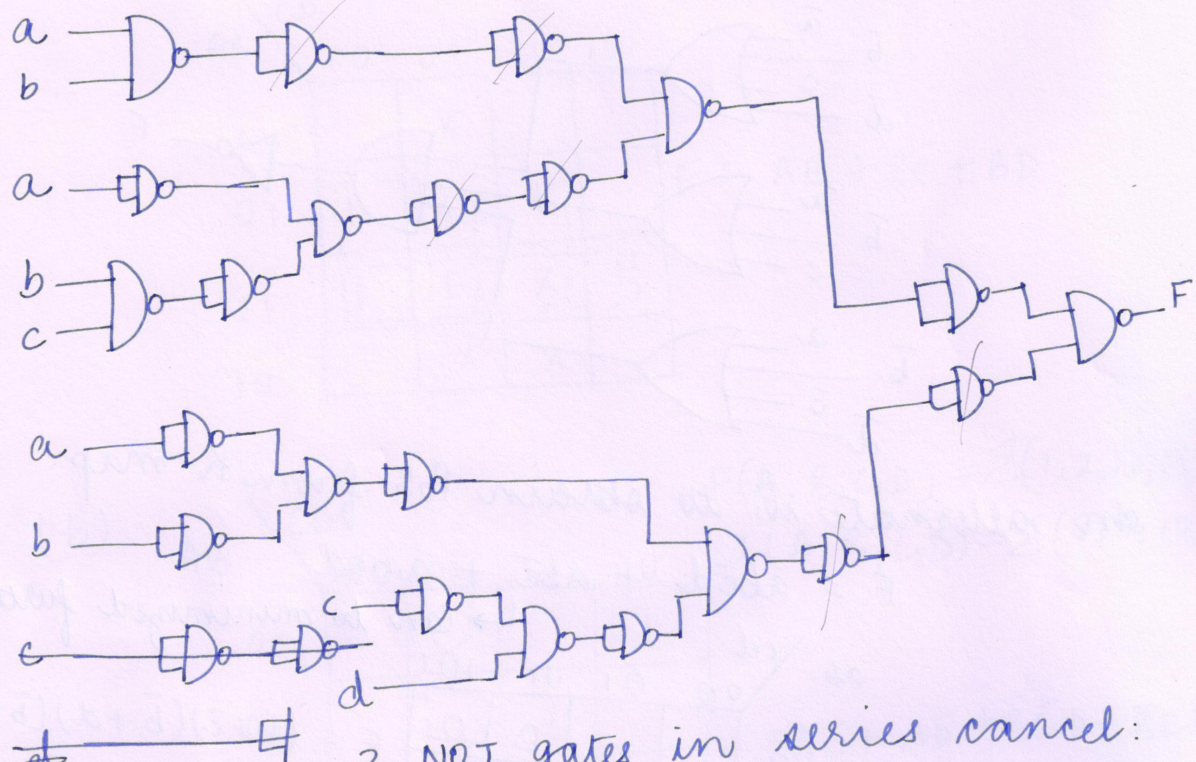
ab \ cd	00	01	11	10
00			0	0
01	0	0		0
11	0	0	0	0
10	0	0	0	0

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

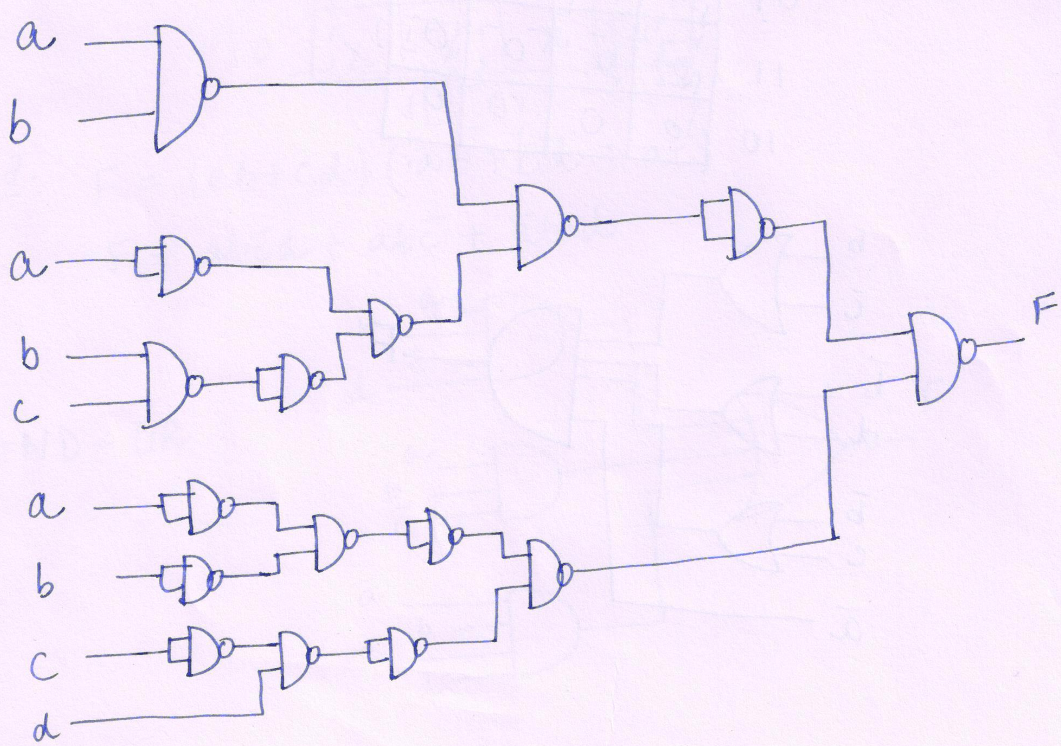


Ans 9. $F(a,b,c,d) = ab + \bar{a}bc + \bar{a}\bar{b}\bar{c}d$

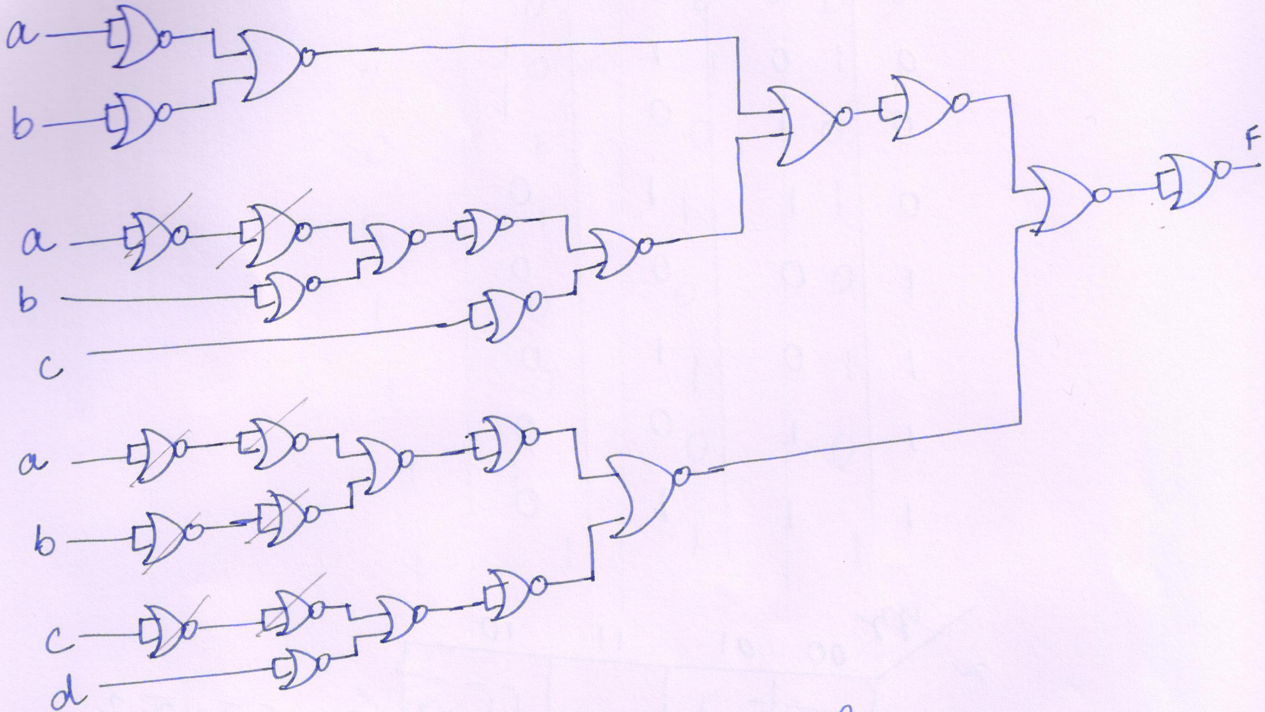
Using 2-input NAND gates:



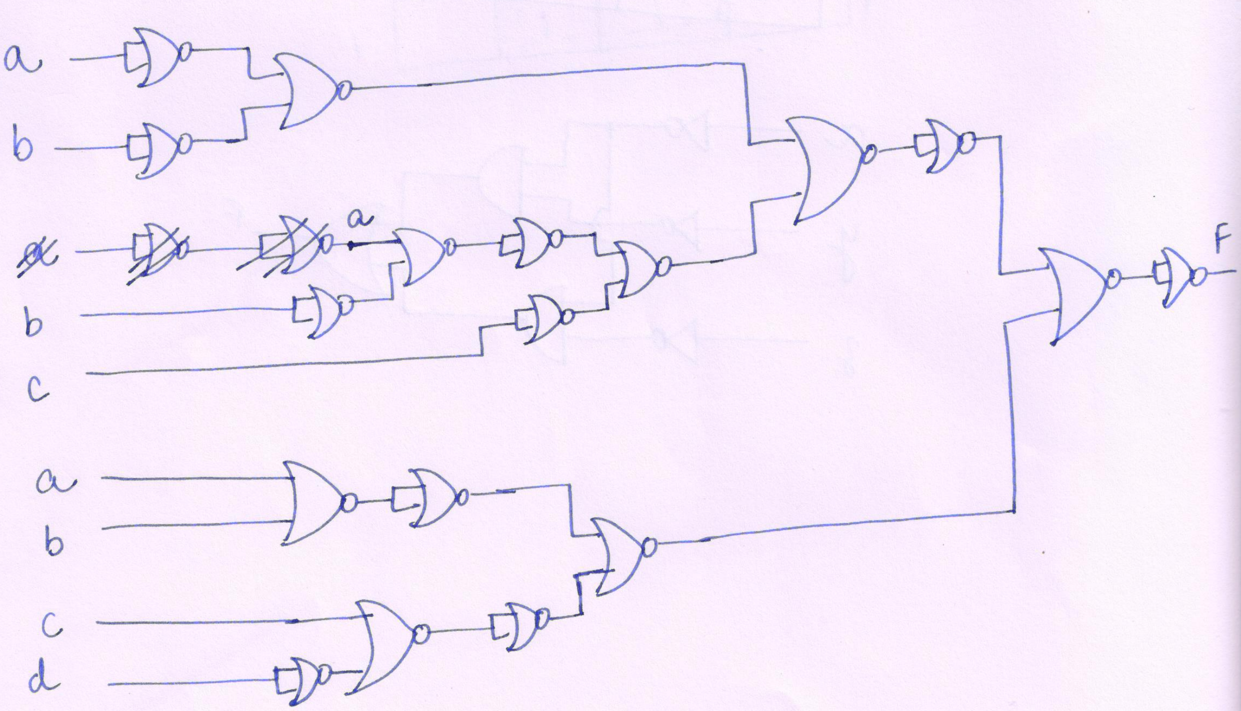
2 NOT gates in series cancel:



sing 2- input NOR gates:



2 NOT gates in series cancel:

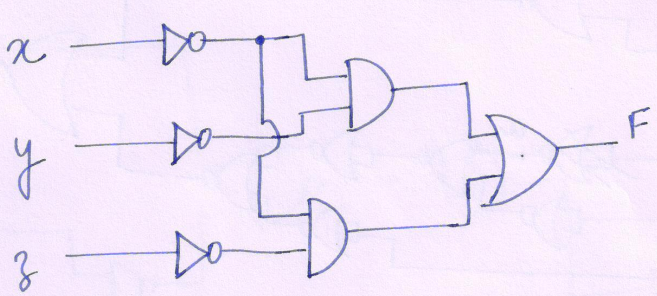


Ans 10. (a)

x	y	z	f
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

x \ yz	00	01	11	10
0	1	1		1
1				

$F = \bar{x}\bar{y} + \bar{x}\bar{z}$



(b)

x	y	z	f
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

x \ yz	00	01	11	10
0		1	1	
1		1	1	

$F = z$