

Date: / /

Subject: Digital Logic

K-map

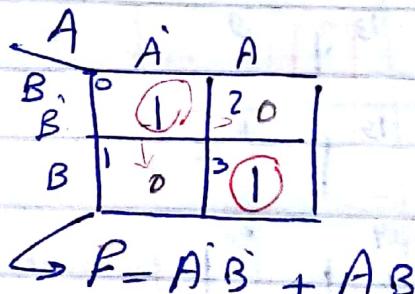
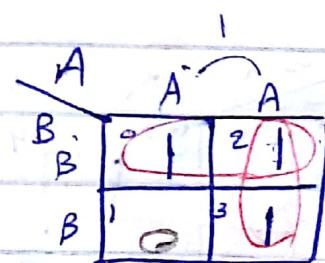
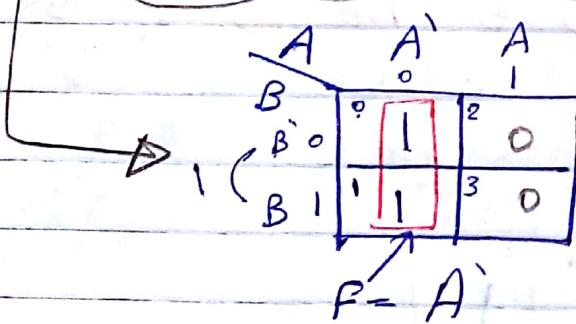
2 Variable $\rightarrow 2^2 \rightarrow 4$ Prob.

Truth table

A	B	f
0	0	1
1	0	1
0	1	0
1	1	0

$$\begin{aligned}f &= m(0, 1) \cup f = \overline{m}(2, 3) \\&= A'B + A'B \\&= A'(B' + B) \\&= A'\end{aligned}$$

K-map For 2 Var. $\rightarrow 4$ Prob.



$$\begin{aligned}F &= B' + AB \\&= B' + A\end{aligned}$$



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 $\frac{A \oplus B}{W \oplus Z}$

16

 $\begin{matrix} X \\ 8 \\ 4 \\ 2 \end{matrix}$

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3 variable $\rightarrow 2^3 \rightarrow 8$ Prob. $\rightarrow o = 7$

 A, B, C $F = \{m(0, 1, 4, 5, 6, 7)\}$

	A	B	A	B'
C	AB	$\bar{A}\bar{B}$	$\bar{A}B$	AB
\bar{C}	1	2	6	4
C	1	3	7	5

$$F = A + B'$$

	A	B	$\bar{A}\bar{B}$	$\bar{A}B$	AB	AB'
C	AB	$\bar{A}\bar{B}$	$\bar{A}B$	AB	AB'	
\bar{C}	1	2	6	1	4	
C	1	3	7	1	5	

$$F = \bar{A}\bar{B}\bar{C} + BC + AB$$

* 4 variables $\rightarrow 2^4 \rightarrow 16$ Prob. $\rightarrow o = 15$

	w	x	y	z	wx	$w\bar{x}$	$\bar{w}x$	$w\bar{x}$	$\bar{w}\bar{x}$
\bar{y}	0	1	0	1	0	1	0	1	0
y	1	0	1	0	1	0	1	0	1
\bar{z}	0	1	1	0	0	1	1	0	1
z	1	0	0	1	1	0	0	1	0
\bar{w}	1	0	1	0	0	1	0	1	0
w	0	1	0	1	1	0	1	0	1

$$F = \bar{x}\bar{z} + \bar{x}z + w\bar{x}/wz \leftarrow SOP$$

$$F_1 = \bar{x}\bar{z} + xz + w\bar{x}$$

$$F_2 = \bar{x}\bar{z} + xz + wz$$

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Ex.: Simplify: $F(a, b, c, d) = \sum m(0, 3, 7, 11, 12, 13, 15)$

to the minimum S.O.P & P.O.S:-

ab	cd	$a'b'$	ab'	ab	ab'	
$a'b'c'd'$	$c'd'$	1	0	1	0	abc
c	$c'd$	1	0	1	0	
cd	3	1	1	1	1	cd
cd'	2	0	0	0	0	

$$\Rightarrow F_1 = cd + ab\bar{c} + a'b'cd'$$

S.O.P: \rightarrow * in P.O.S

$$F = cd' + a'b\bar{c} + b'\bar{c}d + ab\bar{c}\bar{d}/ab\bar{d}'$$

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

$$\rightarrow F_2 = (\bar{c} + d)(\bar{a} + b + c)(b + c + d')(a' + b + c)$$

$$\rightarrow F_3 = (\bar{c} + d)(a + b + c)(b + c + d')(a' + b + d)$$



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(٤) المعاذنة

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Ex: Simplify: $f(A, B, C, D) = \prod (1, 3, 5, 7, 13, 15)$

To the minimum SOP & the minimum POS.

of Var. $\rightarrow A, B, C, D$

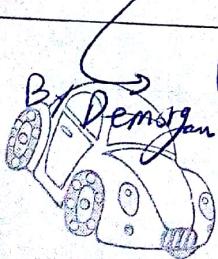
	A	B	A'	B'
D	AB	$\bar{A}\bar{B}$	$\bar{A}B$	AB'
\bar{D}	$\bar{C}D$	1	4	12
C	$\bar{C}D$	5	13	9
\bar{C}	$\bar{C}D$	0	0	1
D	$\bar{C}D$	0	0	15
\bar{D}	$\bar{C}D$	0	0	11
C	$\bar{C}D$	2	6	14
\bar{C}	$\bar{C}D$	1	1	10

* The minimum SOP:-

$$\hookrightarrow f = \bar{D} + AB' = (\bar{D} + AB)(\bar{D} + B')$$

* The minimum POS:-

$$\hookrightarrow f' = \bar{A}\bar{D} + BD$$



$$(f')' = (\bar{A}\bar{D} + BD)'$$

$$f = (A + D)(B' + D')$$

Subject:

Engineering

Ex:

Simplify:

(3)' 12 + JS'

SOP \rightarrow 12

$$F(A, B, C, D) = \underline{ACD} + \underline{CD} + A\bar{B} + ABCD$$

To the minimum SOP form & POS form:-

	A'B	A'B	AB	AB
D'	0	0	0	1
C'	1	1	1	1
D	3	7	15	11
C	2	6	14	10
	0	0	1	1

* SOP: $\square^{\circ}S$

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

* POS: $\rightarrow \square^{\circ}S$

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

$$\hookrightarrow (F')' = (\bar{A}\bar{C} + \bar{A}\bar{D} + B\bar{C}\bar{D})'$$

$$\hookrightarrow F = (A + C)(A + D)(B + C + D)$$

Ex: Simplify:

$$f(A, B, C, D) = \text{مخرج المدخلات}$$

$$(A' + B + D')(A' + B' + C')(A' + B' + C)$$

$$\xrightarrow{\text{POS}} (B' + C + D') \rightarrow T \quad S = P \wedge P = S$$

ANS.

$$f' = ABD + ABC + ABC' + BCD$$

OR

	A	B	A'	B'
D'	AB	AB'	AB	A'B'
C'	CD	CD	CD	CD
D	CD	CD	CD	CD
C	CD	CD	CD	CD

The Karnaugh map shows the following minterms marked with circles: M₀, M₁, M₂, M₃, M₄, M₅, M₆, M₇, M₁₀, M₁₁, M₁₂, M₁₃, M₁₄, M₁₅. Red circles highlight groups of 2 or 4 minterms, while purple circles highlight groups of 1 or 2 minterms.

* SOP:

$$\rightarrow f = A'B + A'C + B'D + A'CD'$$

* POS:

$$\rightarrow f = AB + AD + BCD$$

$$\rightarrow (f')' = (A' + B')(A' + D')(B' + C' + D')$$

if f in POS.

$$\textcircled{1} \Rightarrow f = \sum m (\dots, \dots) \leftarrow \boxed{1's} \text{ on K-map}$$

$$\textcircled{2} \Rightarrow f = \prod (\dots, \dots) \leftarrow \boxed{0's} \text{ on K-map.}$$

$$\textcircled{3} \Rightarrow f = \underline{\quad} + \underline{\quad} + \underline{\quad} + \underline{\quad}$$

$\boxed{1's}$ on K-map.

$$\textcircled{4} \Rightarrow f = (+ +)(+ +)(+ +)$$

$\swarrow P = \underline{\quad} + \underline{\quad} + \underline{\quad}$
 $\swarrow \boxed{0's} \text{ on K-map.}$

⇒ Find the minterms of the following Boolean expressions by first plotting each function in a map, then simplify them.

$$f = \dots$$

⇒ Simplify the following function to SOP (OR) POS

⇒ Convert the following Boolean function from SOP form to a simplified POS form.

$$f = \underline{\quad} + \underline{\quad} + \underline{\quad}$$



K-map with don't Cares.

Ex 1)

Simplify: $F(x, y, z) = \Sigma(0, 1, 4, 5, 6) \rightarrow \text{SOP}$
 $d(x, y, z) = \Sigma(2, 3, 7) \rightarrow \text{POS}$

	xy	xy	xy	xy	xy
z̄	0	1	2	x	6
z	1	3	x	7	5

$$\Rightarrow F = 1$$

Ex 2)

Simplify: $F(A, B, C, D) = \Sigma(2, 4, 7, 10, 12)$

$d(A, B, C, D) = \Sigma(6, 8)$

to SOP Form

to POS Form

	AB	ĀB	ĀB	AB	ĀB̄
CD	0	X	4	1	12
C̄D	1	5		13	9
CD	3	7	1	15	11
C̄D	2	1	X	14	10

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

h/
n/

	AB	ĀB	ĀB	AB	ĀB̄
CD	X				
C̄D	0	0	0	0	0
CD	0				
C̄D		X	0	0	

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

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

$$(\bar{A} + B + \bar{C})$$

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Ex 3:

Simplify:

$$F(W, X, Y, Z) = \sum m(4, 6, 11, 12, 13) + \sum d(3, 5, 7, 9, 10)$$

	W'X'	W'X	WX'	WX	
Y'Z'	0	4	11	12	13
Y'Z	5	X	13	1	9
YZ'	3	X	7	X	15
YZ	2	6	14	10	X

SOP.

$$\rightarrow F = W'X + X'Y + W'X'Z / W'X'Y / X'Y'Z$$

$$SF_1 = W'X + X'Y + W'X'Z$$

$$P_2 = W'X + X'Y + W'X'Y$$

$$P_3 = W'X + X'Y + X'Y'Z$$

	W'X'	W'X	WX'	WX	
Y'Z'	0			0	
Y'Z	0	X		X	
YZ'	X	X	0		
YZ	0		0	X	

P/S

$$\rightarrow P = W'X + X'Y + W'X'Y$$

$$\rightarrow SF = (W + X)(X'Y)(W' + X' + Y)$$



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* two level NAND must be SOP.

* two level NOR must be POS

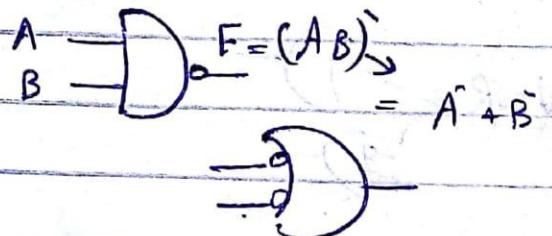
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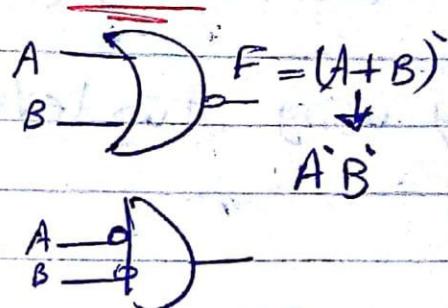
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* logic Diagrams ..

NAND:



NOR:

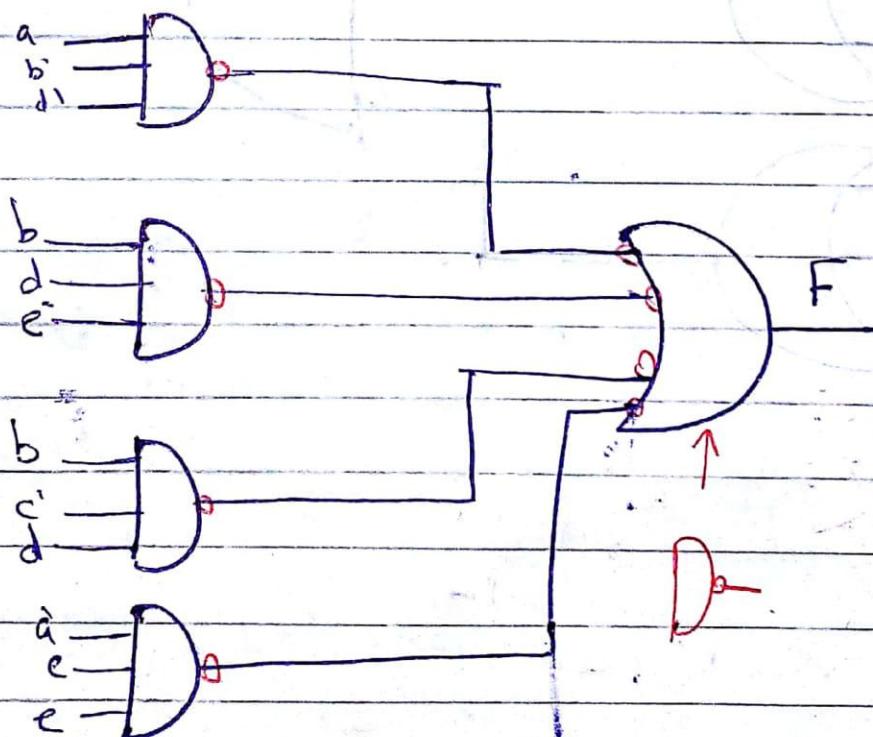


EX1 ..

↳ Show the block diagram of:

$$F = ab'd' + bde' + b'cd + ace$$

by using two level NAND

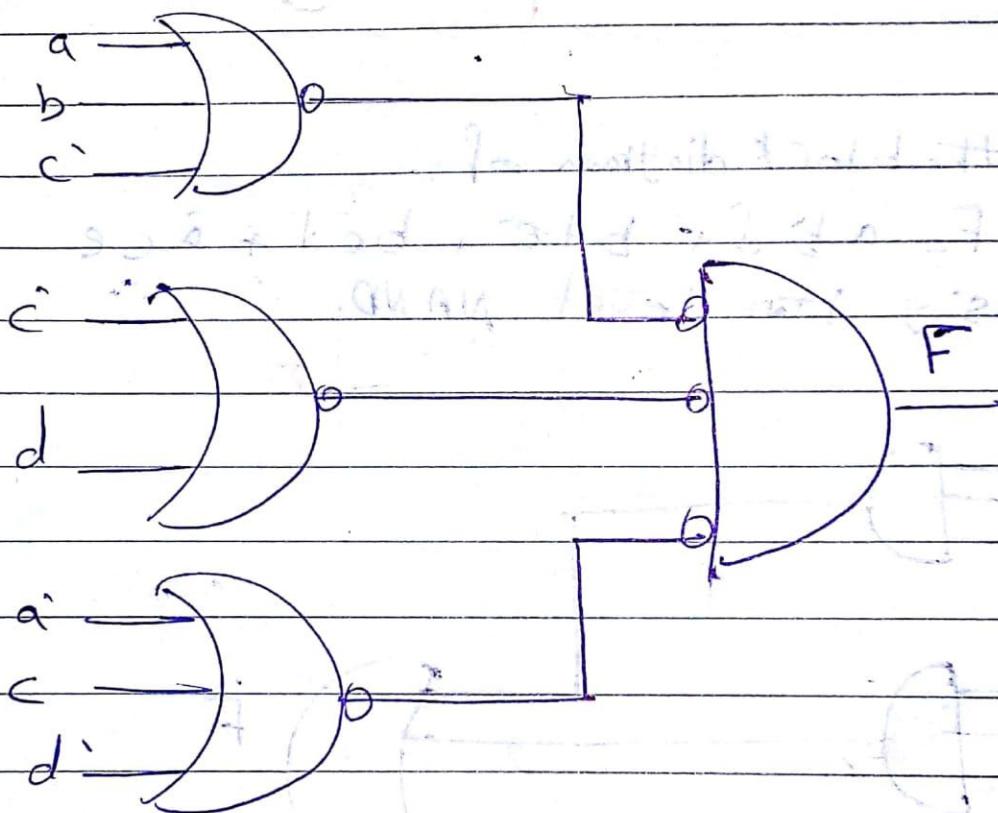


Ex2

↳ Show the block diagram of:

$$F = (a+b+c)(c+d)(a+c+d') \leftarrow \text{pos.}$$

↳ by using Two level NOR



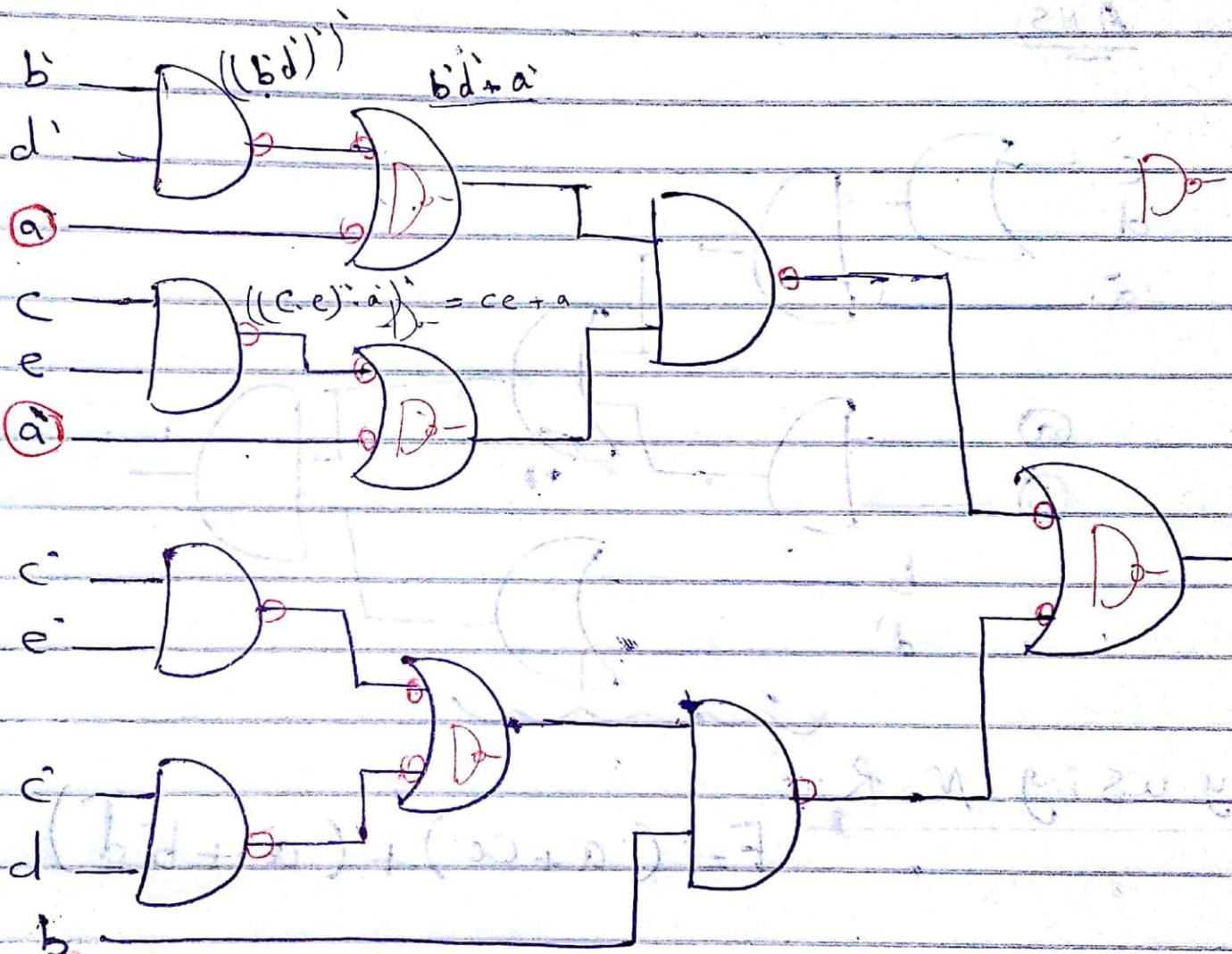
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 $b \rightarrow b$ (All Variable available)
 a, a', b, b' / / :
: world's largest

Ex 3:

Show the block diagram of.

$$F = b(c'd + c'e') + (a + ce)(a' + b'd')$$

→ Using Multilevel NAND.



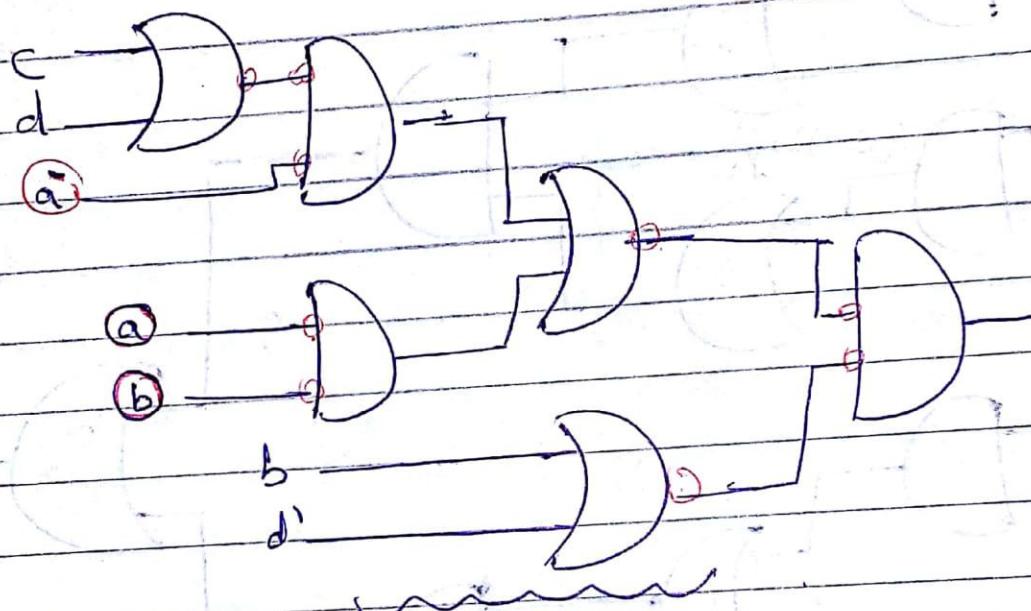
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EX4:

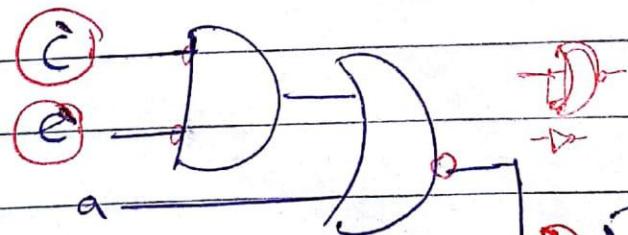
By using multi level NOR

$$F = [a'b' + a(c+c'd)] \cdot (b+d)$$

ANS:

by using NOR:

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



$\times - J \times$
not



Ex:

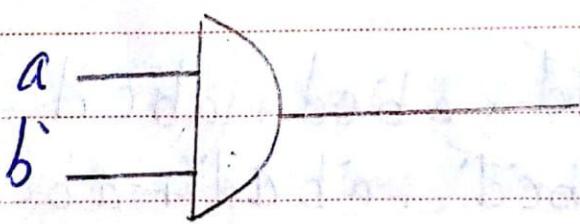
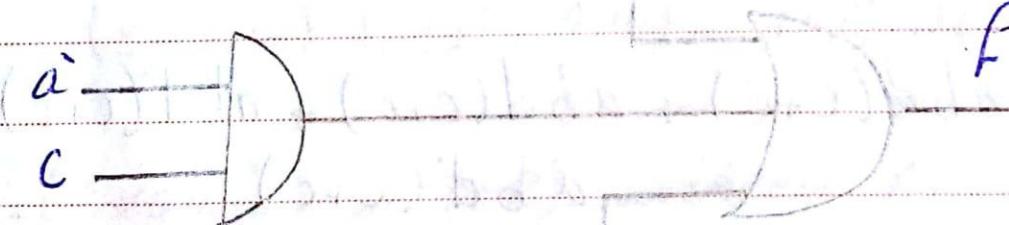
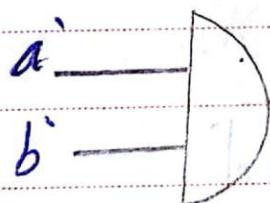
Given the function, (assume all variables are available)
both complemented and uncomplemented)

$$F = \bar{a}'\bar{b}' + \bar{a}\bar{c} + ab$$

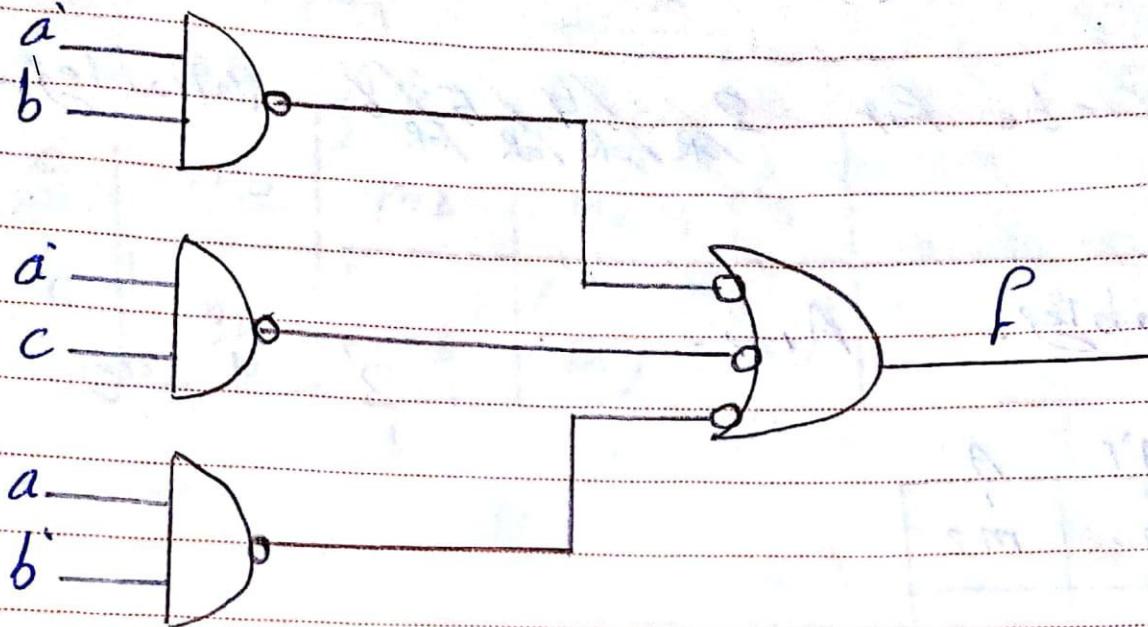
- a) Show a block diagram for a two-level implementation of F using AND and OR gates.
- b) Show a block diagram for an implementation of F using only NAND gates.
- c) Expand F to sum of minterms, eliminate any duplication.

Solutions:

a) The Block diagram by AND, OR.



b) The Block diagram by NAND:



c) The EXPanding of $f = \bar{a}\bar{b} + \bar{a}\bar{c} + \bar{a}\bar{b}$

$$\begin{aligned}
 f &= \bar{a}\bar{b}(c+c') + \bar{a}\bar{c}(b+b') + \bar{a}\bar{b}(c+c') \\
 &= \bar{a}\bar{b}c + \bar{a}\bar{b}\bar{c} + \bar{a}bc + \bar{a}\bar{b}c + \bar{a}\bar{b}c + \bar{a}\bar{b}\bar{c} \\
 &= \bar{a}\bar{b}c + \bar{a}\bar{b}\bar{c} + \bar{a}bc + \bar{a}\bar{b}c + \bar{a}\bar{b}\bar{c}
 \end{aligned}$$