

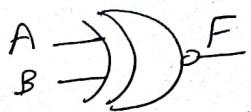
Logic Diagrams

XOR



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

XNOR



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

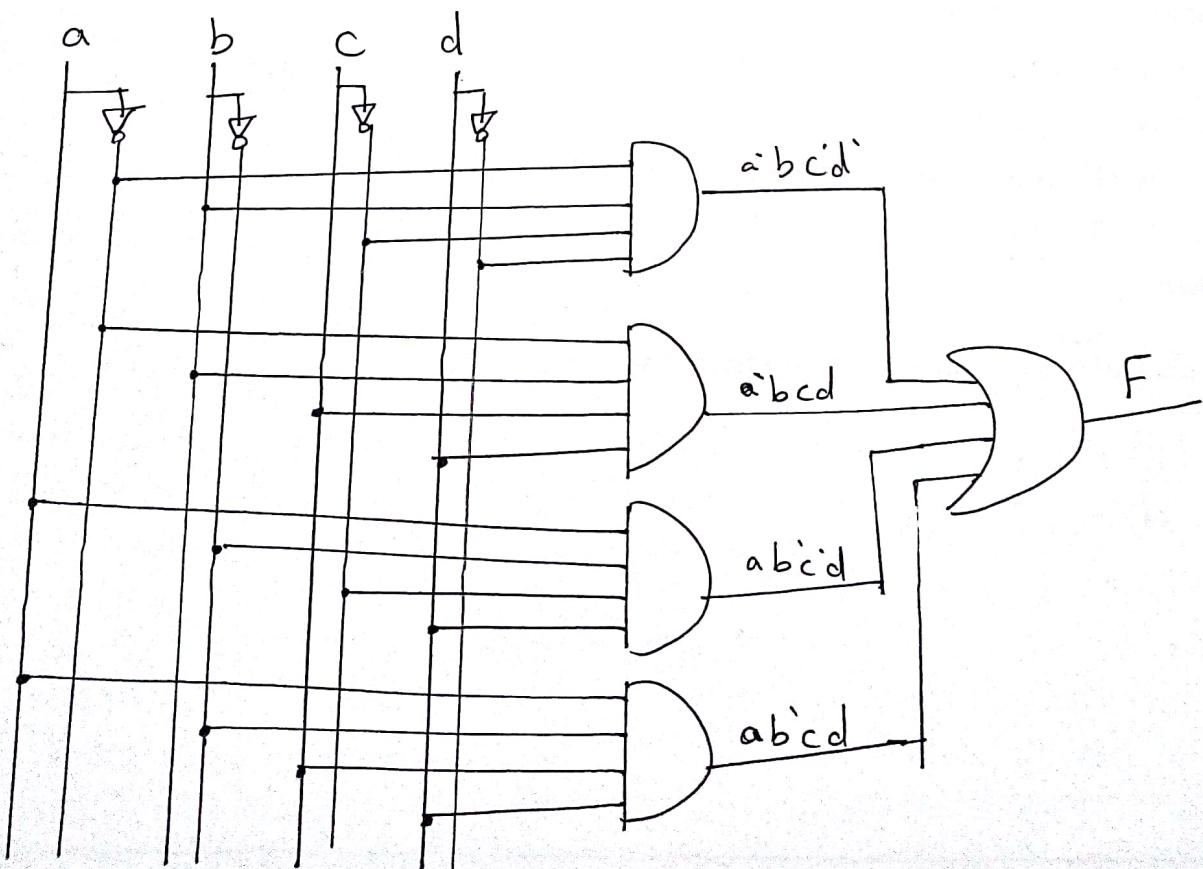
Ex.: Draw the logic diagram of "F" in AND, OR, inverter

$$F = (a \oplus b)(c \oplus d)$$

Ans.

$$\begin{aligned} F &= (a \oplus b)(c \oplus d)' \\ &= (a'b + ab')(c'd' + cd) \\ &= a'b c'd' + a'b cd + ab' c'd' + ab' cd \end{aligned}$$

Then draw it using AND, OR, inverter
(NOT)



Q3.30 P.118

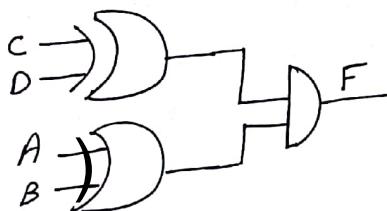
XOR

* Implement the following Boolean expression with Exclusive-or and AND gates..

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

Ans.

$$\begin{aligned} F &= A \bar{B} \underline{C (\bar{C} \bar{D} + \bar{C} D)} + \bar{A} \bar{B} \underline{(\bar{C} \bar{D} + \bar{C} D)} \\ &= (\bar{C} \bar{D} + \bar{C} D)(A \bar{B} + \bar{A} \bar{B}) \\ &= (C \oplus D)(A \oplus B) \end{aligned}$$

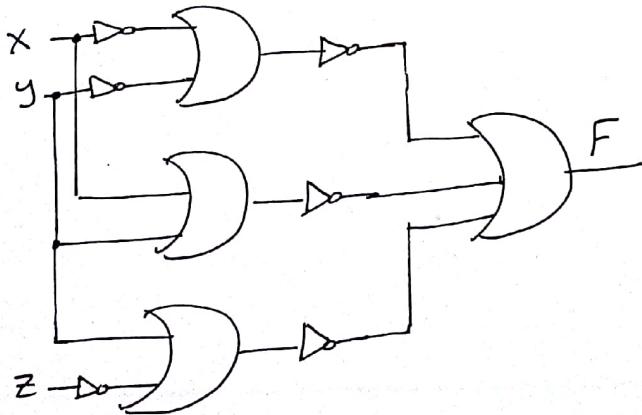


Ex-* using "only" OR and NOT gates: draw a schematic for this function:

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

You must manipulate the function to draw it using OR, NOT gates only.
That by complementing the function twice:

$$\begin{aligned} (F')' &= [(xy + x\bar{y} + \bar{y}z)]' \\ &= [(xy)'(x\bar{y})'(\bar{y}z)']' \\ &= [(x+y)(x+y)(y+z)]' \\ &= (x+y)' + (x+y)' + (y+z)' \end{aligned}$$



②

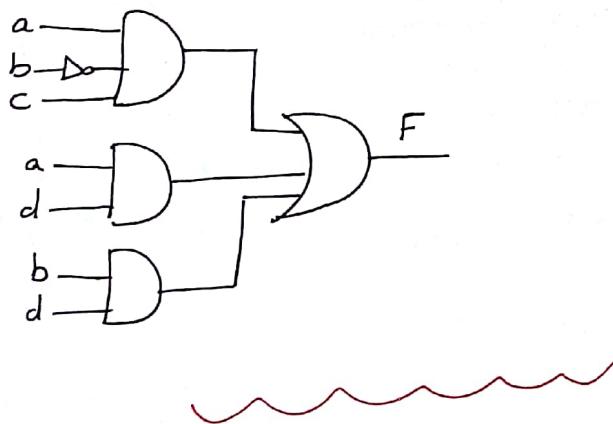
Ex. * $F = a'b'c + ad + bd$

- a) Show a block diagram by using AND, OR, gates.
b) Show a block diagram by using 2 inputs AND, OR gates

Ans.

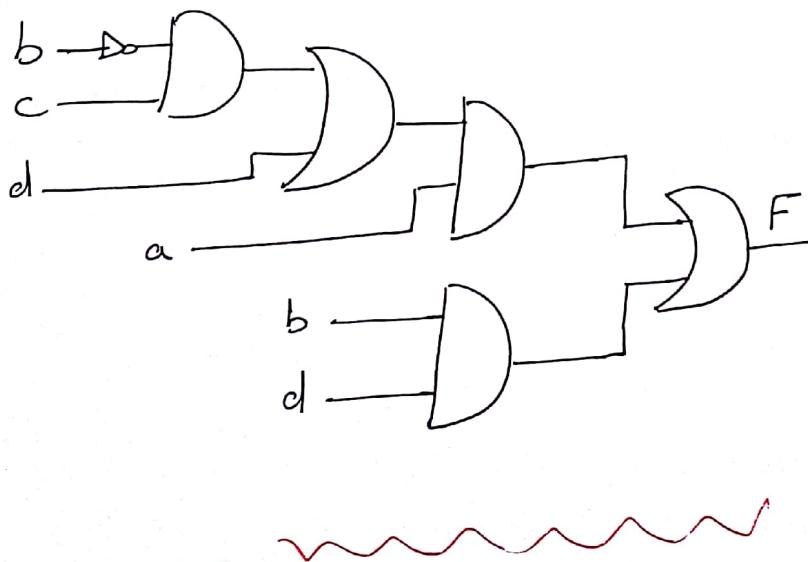
a) using AND, OR gates.

$$F = a'b'c + ad + bd$$



b) using 2 inputs AND, OR gates.

$$\begin{aligned} F &= a'b'c + ad + bd \\ &= a(b'c + d) + bd \end{aligned}$$



* Multilevel NAND

(SOP) \Rightarrow مدخلات متعددة في (Multilevel NAND) هي A, B, C, D

Ex.

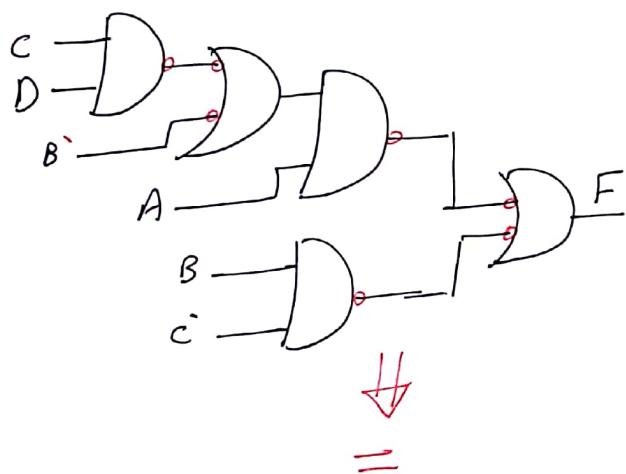
- Draw the multilevel NAND circuit for the following expressions

a) $F = A(CD + B) + BC$

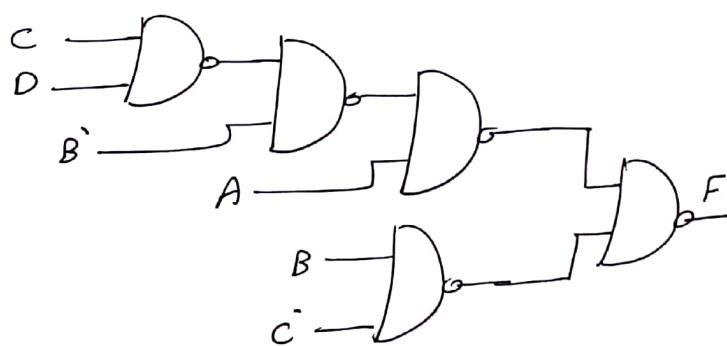
\Rightarrow Assuming all variables are available (Complemented and Uncomplemented)

- ⇒ OR, AND \rightarrow ①
- ⇒ NAND (I gate) \rightarrow ②
- ⇒ NOT (I gate) \rightarrow ③
- ⇒ Do not use multiple gates \rightarrow ④

A NS-



\Downarrow
=



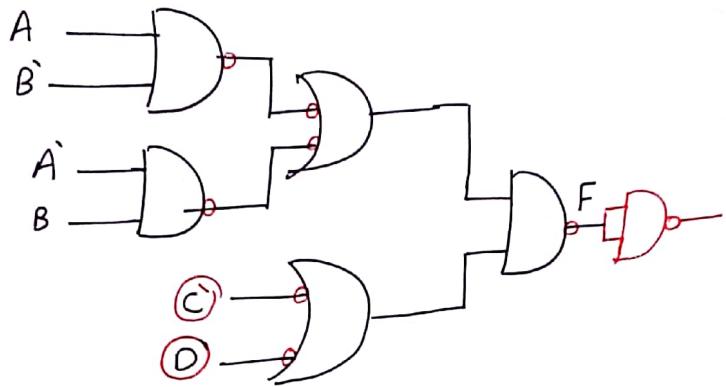
Ex.

→ Draw the Multilevel NAND circuit for the following expressions:

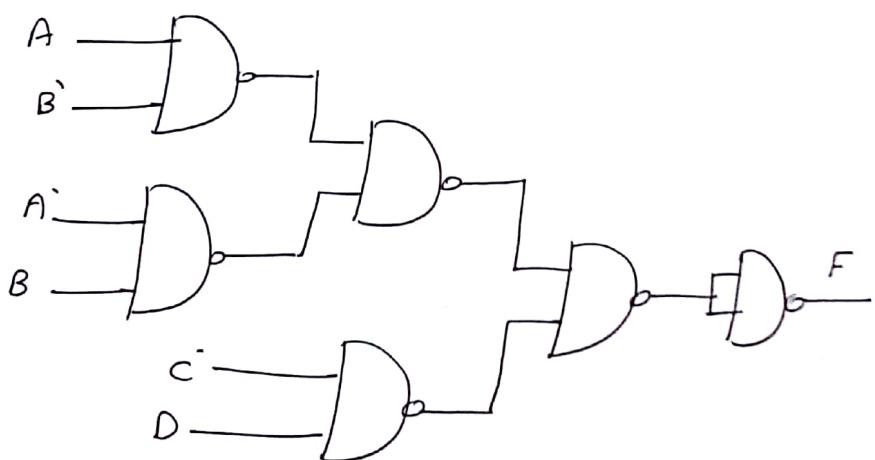
$$F = (A\bar{B} + \bar{A}B)(C + D)$$

→ Assuming all variables are available:

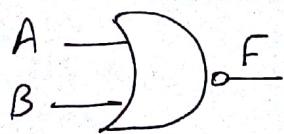
Ans.



↓
=



No R gates

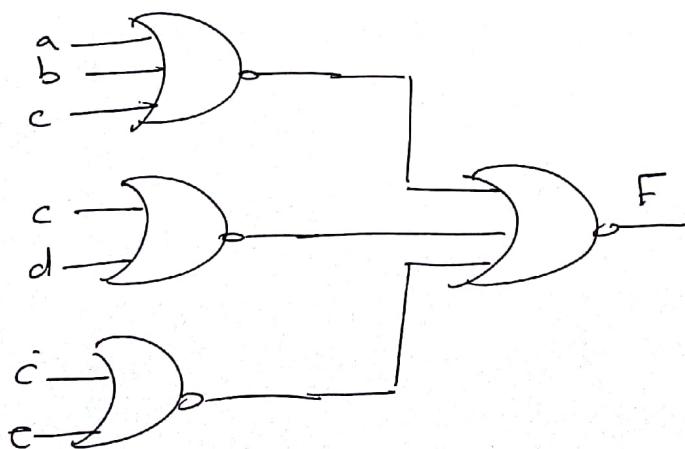
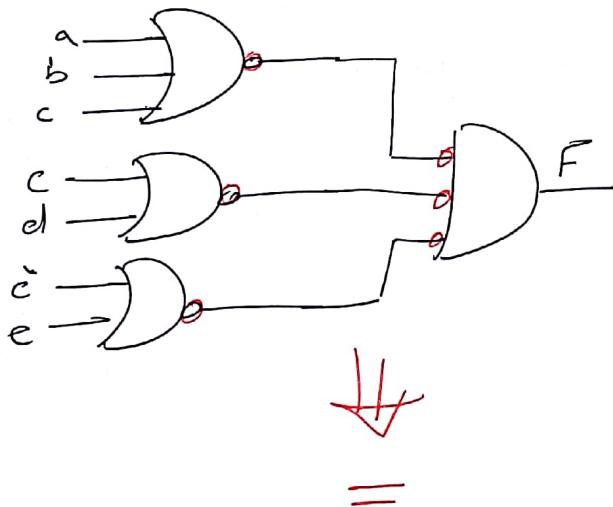


$$F = (A + B)^{\sim}$$

$$= \bar{A} \cdot \bar{B}$$

* two level NOR
 ↳ "Pos" Form

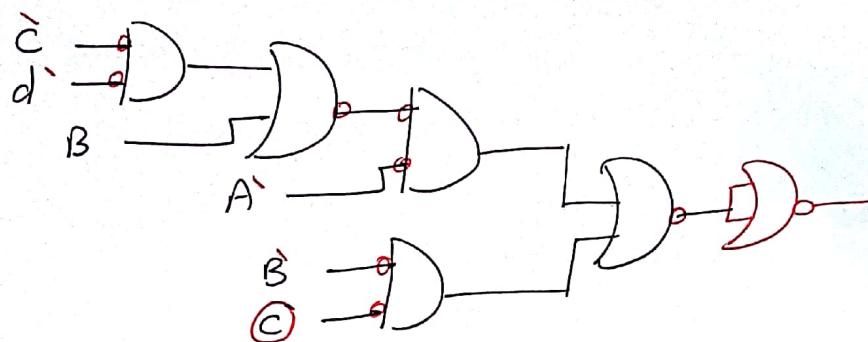
Ex. $F = (a+b+c)(c+d)(\bar{c} + e)$



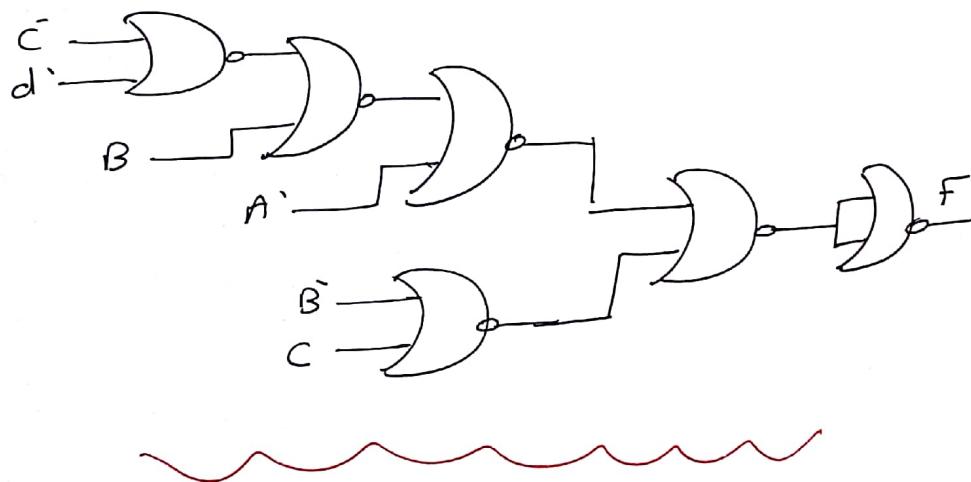
* Multilevel NOR.

(Pos) ~~inverted output~~

Ex. $F = A(CD + B) + BC$



~~=~~



*Examples on two level NOR

→ Simplify the following functions & implement them with Two-level NOR gate circuits:

a) $F = w\bar{x} + \bar{y}\bar{z} + \bar{w}\bar{y}\bar{z}$

(Two-level NOR) → pos. soln.

b) $F(w, x, y, z) = \Sigma(1, 2, 13, 14)$

"Pos. Lstn" & don't care

c) $F(x, y, z) = [(x+y)(\bar{x}+\bar{z})]$

(K-map) → 1st line soln.

d) $F(A, B, C, D) = \Sigma(2, 4, 6, 10, 12)$

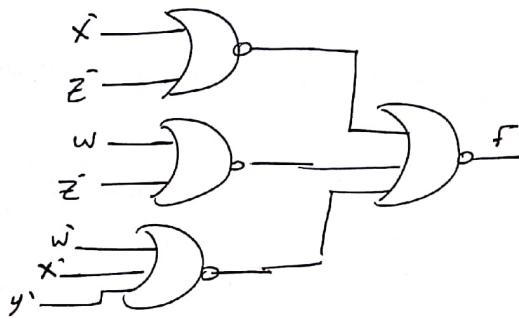
d) $F(A, B, C, D) = \Sigma(0, 8, 9, 13)$

Ans.

a) $F = w\bar{x} + \bar{y}\bar{z} + \bar{w}\bar{y}\bar{z}$

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

From zeros
 $\Rightarrow F = \bar{x}z + \bar{w}\bar{z} + wx\bar{y}$
 $\therefore F = (\bar{x} + \bar{z})(w + \bar{z})(\bar{w}\bar{x} + \bar{y})$
 Then draw it.



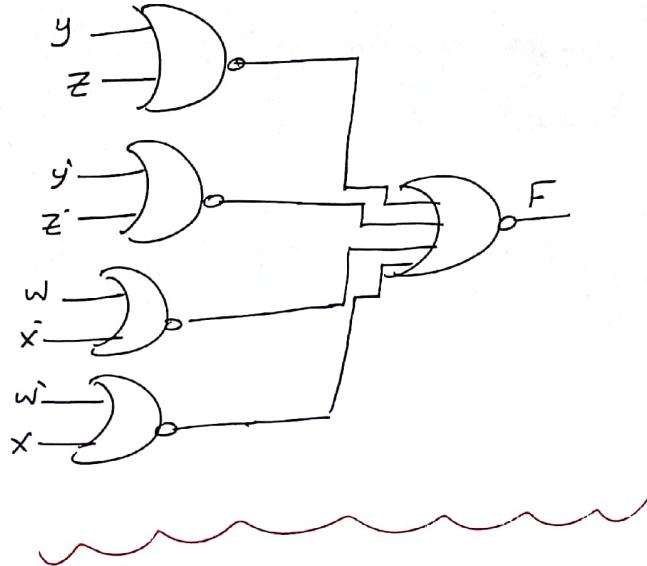
$$b) F(w, x, y, z) = \Sigma(1, 2, 13, 14)$$

W X w̄ x̄ w̄ x w x̄ w x

y z̄ 0 1 0 0 0
y z̄ 1 0 1 0 0
y z 0 0 0 0 0
y z 1 0 1 0 0

$\bar{F} = y\bar{z} + yz + \bar{w}x + \bar{w}x̄$
 $F = (y+z)(y+\bar{z})(w+x)(w+x̄)$

Then draw it.



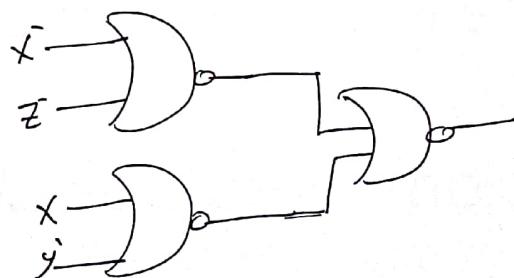
$$\begin{aligned} c) F(x, y, z) &= [(x+y)(x+z)] \\ &= (x+y) + (x+z) \\ &= x'y + xz \end{aligned}$$

3 variables x

x y x̄ y x y z̄ x̄ y x̄ y z̄

z z̄ 1 2 0 6 1 4 1
z z̄ 1 1 3 0 7 0 5 0

$\bar{F} = xz + \bar{x}y$
 $F = (x + \bar{z})(x + y)$



$$d) F(A, B, C, D) = \Sigma(2, 4, 6, 10, 12)$$

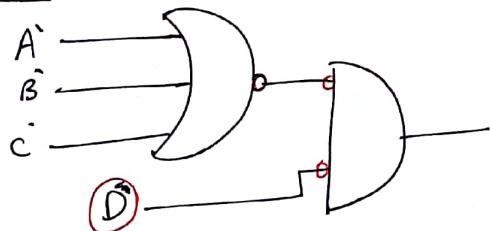
$$d(A, B, C, D) = \Sigma(0, 8, 9, 13)$$

Ans.

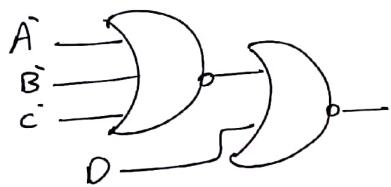
	$A\bar{B}$	$\bar{A}B$	AB	$A\bar{B}$
$\bar{C}D$	X	1	12	8 X
$\bar{C}D$	0	0	X	X
$\bar{C}D$	0	0	0	0
$C\bar{D}$	1	1	0	1

$$\Rightarrow f = D + ABC$$

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



\Downarrow
=



Ex. (Assume All inputs are available), show two level implementation of:

$$F = Wx + Wz + \bar{W}\bar{x} + \bar{W}\bar{y}\bar{z}$$

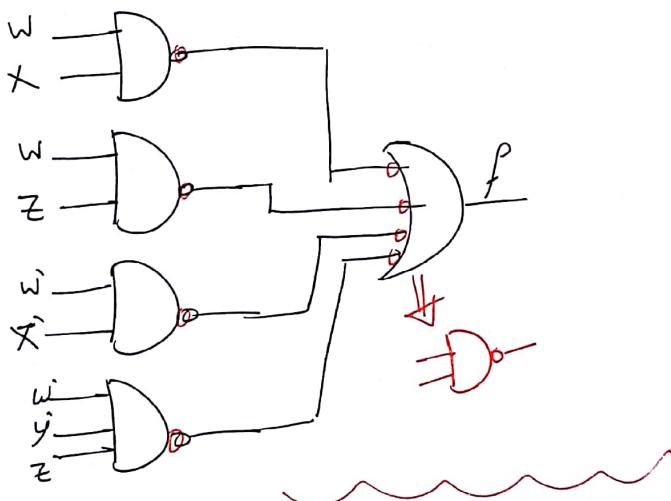
$$= (W + x + z)(W + \bar{x} + y)(W + \bar{x} + \bar{z})$$

- a) by using NAND.
 - b) by using NOR.
 - c) by using 2 inputs NAND.
-

Ans.

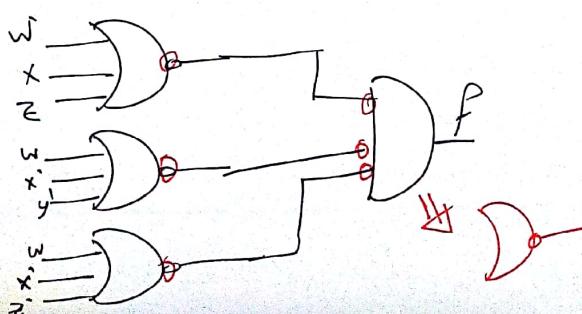
- a) by using NAND \Rightarrow two level NAND.
 \Rightarrow we will use "Sop" form

$$F = Wx + Wz + \bar{W}\bar{x} + \bar{W}\bar{y}\bar{z}$$



- b) by using NOR \Rightarrow two level NOR:
 \Rightarrow we will use "Pos" form.

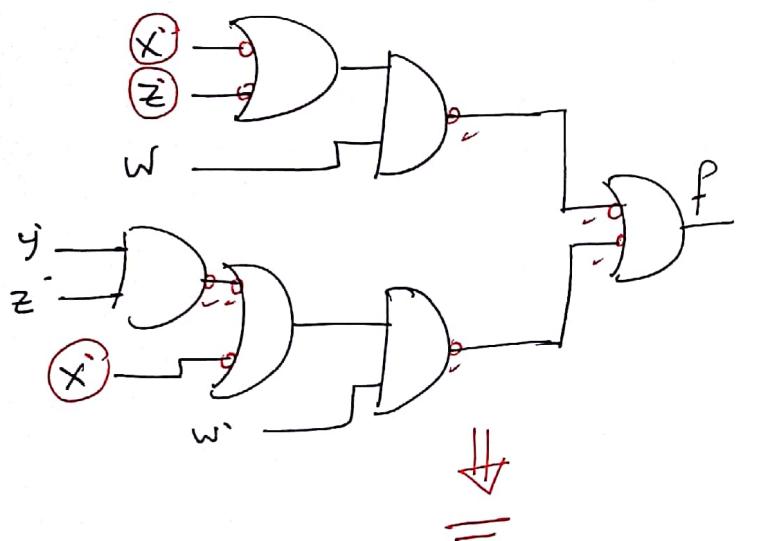
$$F = (W + x + z)(W + \bar{x} + y)(W + \bar{x} + \bar{z})$$



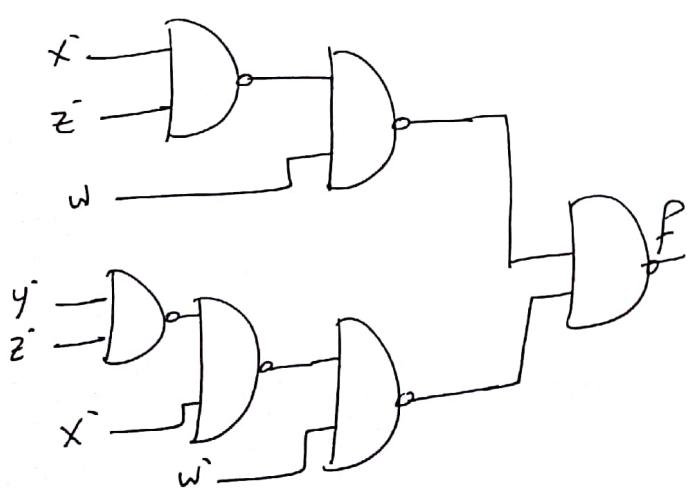
15/3/2016
week
c) To use 2 inputs NAND, we must manipulate the function.
 $f \rightarrow$ to be 2 inputs for each gate.

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

$$= w(x+z) + \bar{w}(x+\bar{y}\bar{z})$$



\Downarrow



AND-OR-inverter

$$F = (AB + CD + EF)'$$

$(SOP)'$

AND - OR - inverter

====

AND - NOR

$$\begin{aligned} F &= (AB + CD + EF)' \\ &= (AB)' (CD)' (EF)' \\ &\quad \uparrow \\ &NAND - \boxed{AND} \end{aligned}$$

لما يكتب المضلع F في الـ "SOP"

$$\bar{F} = AB + CD + EF$$

فهي تكتب بالـ "K-map" على الشكل التالي

مما يعادل $\bar{F} = \overline{ABC} \cdot \overline{DEF} + \overline{ACD} \cdot \overline{BFE} + \overline{BCE} \cdot \overline{AFD}$

AND - OR - inverter

AND - NOR

NAND - AND

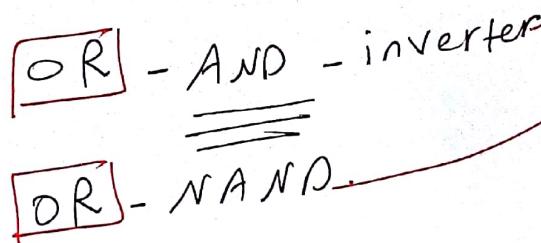
OR - AND - inverter

$$F = [(A+B)(C+D)(E+F)]'$$

$$\hat{F} = (A+B)(C+D)(F+F)$$

\hat{F} in Pos.

(Pos)



$$F = (A+B) + (C+D) + (E+F)$$

NOR - OR

لعمق حكم الحصول على \hat{F} من "Pos"

ناتج بار (\hat{f}) (طريق المعاكسة) \Leftrightarrow لو المعاكسة المخطأ على مدخل ①

الخطوة ② \Rightarrow الحصول على المعاكسة المخطأ

$$F = (A+B)(C+D)(E+F) \quad \text{أو } \hat{F} \text{ (Pos)}$$

$$F = \Pi(0, 2, 3) \quad \text{أو } \hat{F}$$

$$F = \Sigma(1, 4, 5) \quad \text{أو } \hat{F}$$

④

نفع المعاكسة بـ ①

SOP. $\Sigma(\hat{f})$ الحصول على المعاكسة بـ ②

ناتج بار (\hat{f}) (طريق المعاكسة بـ ③) \Leftrightarrow المعاكسة المخطأ

OR - AND - inverter

OR - NAND

NOR - OR

Q 3.24

P.118

* Implement the following Boolean Function F . using the two level forms of logic.

$$F(A, B, C, D) = \Sigma(0, 4, 8, 9, 10, 11, 12, 14)$$

- a) using NAND - AND : $\xrightarrow{\text{From } F \text{ in SOP} \rightarrow \text{From (Zeros) on K-map.}}$
- b) using $\text{AND} - \text{NOR}$ $\xrightarrow{\text{From } F \text{ in SOP} \rightarrow \text{From (1's) on K-map.}}$
- c) $\text{OR} - \text{NAND}$ $\xrightarrow{\text{From } F \text{ in SOP} \rightarrow \text{From (1's) on K-map.}}$
- d) $\text{NOR} - \text{OR}$ $\xrightarrow{\text{Then use DeMorgan for } F.}$

		ANS.			
		A	B	C	D
AB		$A\bar{B}$	$\bar{A}B$	AB	$A\bar{B}$
C	0	1	4	1	12
D	1	0	5	0	9
C	0	0	7	0	15
C	1	0	6	0	11
D	2	0	6	0	14
D	3	1	1	1	10

$*f = \bar{C}\bar{D} + A\bar{B} + ACD$

$*f = BD + \bar{A}D + \bar{A}C$

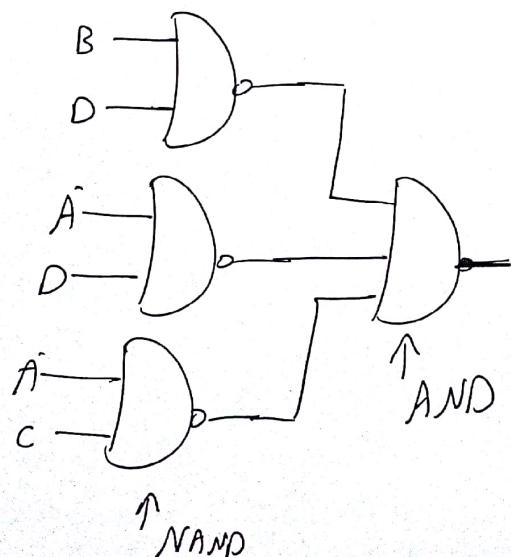
$f = (BD + \bar{A}D + \bar{A}C)$

a) To draw using NAND - AND:

$$\bar{f} = BD + \bar{A}D + \bar{A}C$$

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

$$= (BD)\bar{(A\bar{D})}\bar{(A\bar{C})}$$

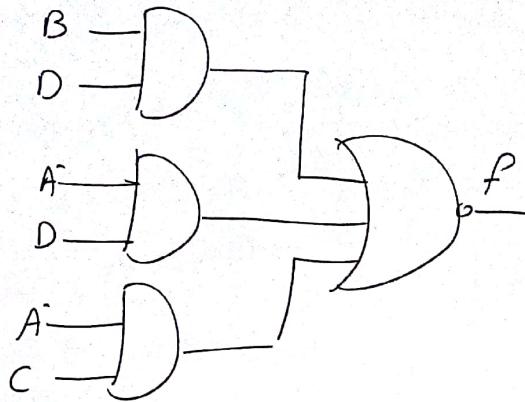


16

b) To draw using AND - NOR

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

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

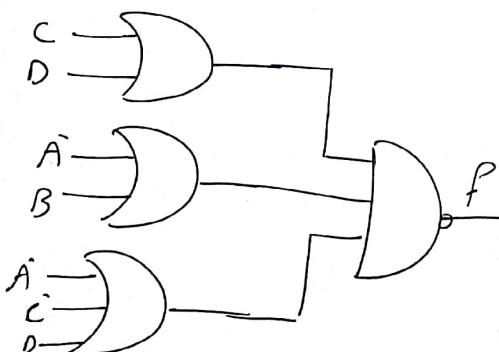


c) To draw using OR - NAND

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

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

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



d) To draw using NOR - OR

$$\begin{aligned} F &= [(C+D)(\bar{A}+\bar{B})(\bar{A}+\bar{C}+D)]' \\ &= (C+D)' + (\bar{A}+\bar{B})' + (\bar{A}+\bar{C}+D)' \end{aligned}$$

