EGC220 Class Notes 2/10/2023

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1. Prove by means of truth table that (AB)’ = A’ + B’

A	B	A·B	$\overline{AB}$	$\overline{A}$	$\overline{B}$	$\overline{A}+\overline{B}$
0	0	0	1	1	1	1
0	1	0	1	1	0	1
1	0	0	1	0	1	1
1	1	1	0	0	0	0

= ✓

Proved

TABLE 2-6
Basic Identities of Boolean Algebra

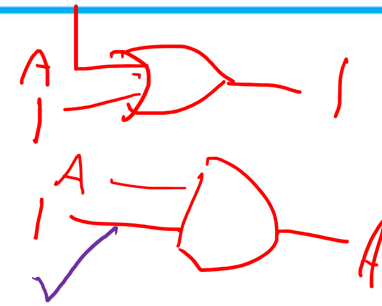
1.	$X + 0 = X$	2.	$X \cdot 1 = X$	
3.	$X + 1 = 1$	4.	$X \cdot 0 = 0$	
5.	$X + X = X$	6.	$X \cdot X = X$	
7.	$X + \overline{X} = 1$	8.	$X \cdot \overline{X} = 0$	
9.	$\overline{\overline{X}} = X$			
10.	$X + Y = Y + X$	11.	$XY = YX$	Commutative
12.	$X + (Y + Z) = (X + Y) + Z$	13.	$X(YZ) = (XY)Z$	Associative
14.	$X(Y + Z) = XY + XZ$	15.	$X + YZ = (X + Y)(X + Z)$	Distributive
16.	$\overline{X + Y} = \overline{X} \cdot \overline{Y}$	17.	$\overline{X \cdot Y} = \overline{X} + \overline{Y}$	DeMorgan's

X	X+0
0	0
1	1

Dual

$0 \leftrightarrow 1$

$\cdot \leftrightarrow +$



A B C A B A C

$$\overline{A}+\overline{B} \neq A+B$$

2. Circle T (true) or F (false) for each of these Boolean equations.

$$\overline{A}\,\overline{B} \neq A\,B$$

$$(A+B)(A+C)$$

A B	$A \oplus B$	$\overline{A}$ $\overline{B}$	$\overline{A} \oplus \overline{B}$
0 0	0	1 1	0
0 1	1	1 0	1
1 0	1	0 1	1
1 1	0	0 0	0

(a). T F 3 $A + 1 \neq \cancel{A}\ 1$

(b). T F $A + BC \neq (A + B)(B + C)$

(c). T F $\overline{A} \oplus \overline{B} = A \oplus B$

(d). T F $A(BC) = (AB)C$

(e). T F $A + B + C = \underbrace{A \cdot B \cdot C}$

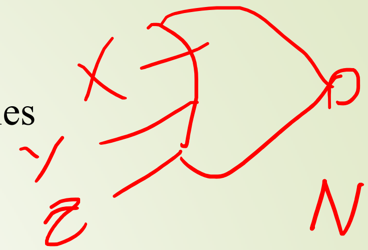
$$\overline{A+B+C} = \overline{A} \cdot \overline{B} \cdot \overline{C}$$

$$\to \overline{A} \cdot \overline{(B+C)} \to \overline{B} \cdot \overline{C}$$

3. Demonstrate by means of truth tables the validity of the following identities

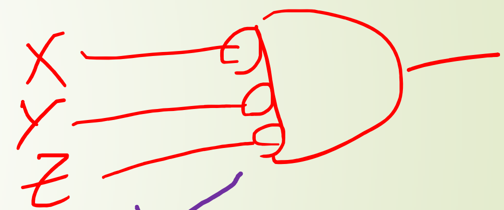
a. DeMorgan's law for three variables: (X+Y+Z)' = X'Y'Z' and (XYZ)' = X' + Y' + Z'

X	Y	Z	$\overline{X+Y+Z}$	$\overline{X}$	$\overline{Y}$	$\overline{Z}$	$\overline{X}\cdot\overline{Y}\cdot\overline{Z}$
0	0	0	1	1	1	1	1
0	0	1	0	1	1	0	0
0	1	0	0	1	0	1	0
0	1	1	0	1	0	0	0
1	0	0	0	0	1	1	0
1	0	1	0	0	1	0	0
1	1	0	0	0	0	1	0
1	1	1	0	0	0	0	0



NOR

$A \cdot \emptyset = \emptyset$



proven

Same

$$\overline{(xyz)} = \bar{x} + \bar{y} + \bar{z} \quad \checkmark$$

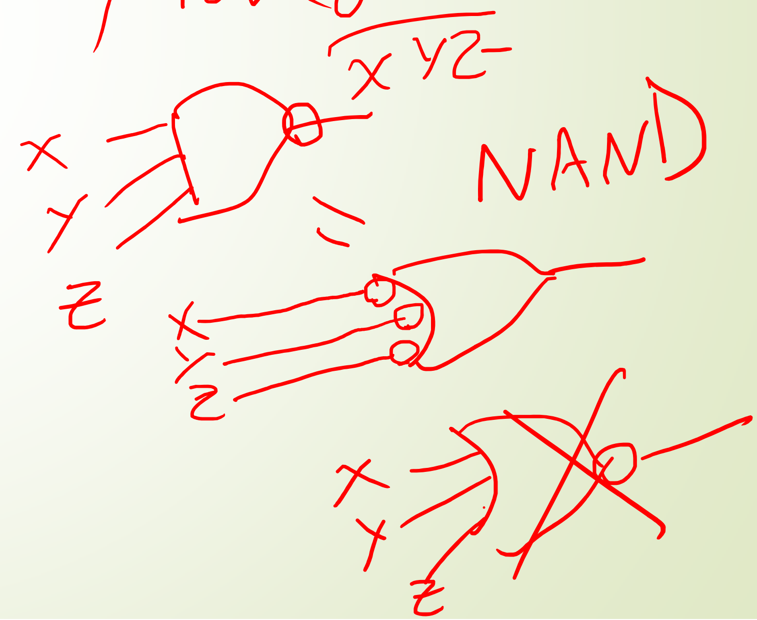
x	y	z	$\overline{xyz}$	$\bar{x} + \bar{y} + \bar{z}$
0	0	0	1	1
0	0	1	1	1
0	1	0	1	1
0	1	1	1	1
1	0	0	1	1
1	0	1	1	1
1	1	0	1	1
1	1	1	0	0

=

$$\overline{xyz} \neq \overline{(x+y+z)}$$

Dual

Proved.



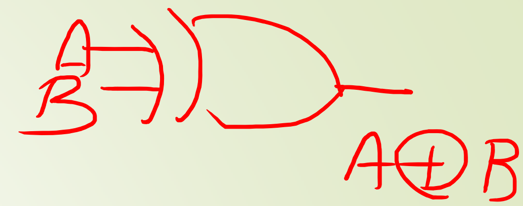
(X+Y) X = X

X	Y	X+Y	X(X+Y)
0	0	0	0
0	1	1	0
1	0	1	1
1	1	1	1

same

$x \cdot 1 + x y = x\underbrace{(1+y)}_{1} = x$

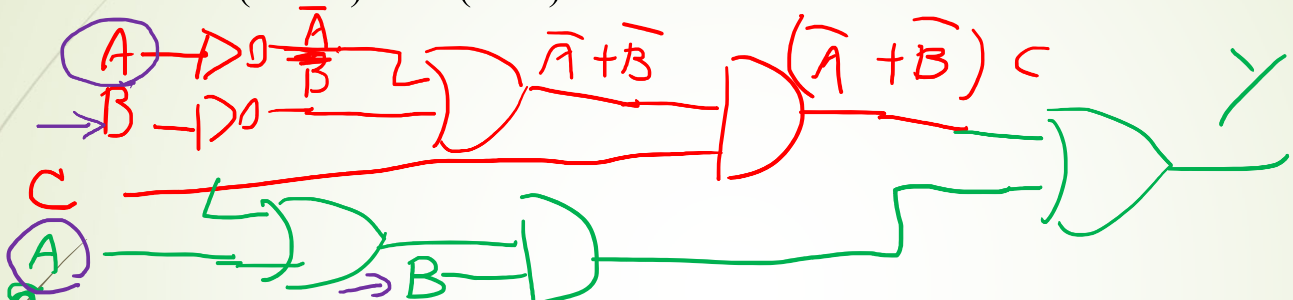
$x \cdot x + y \cdot y =$



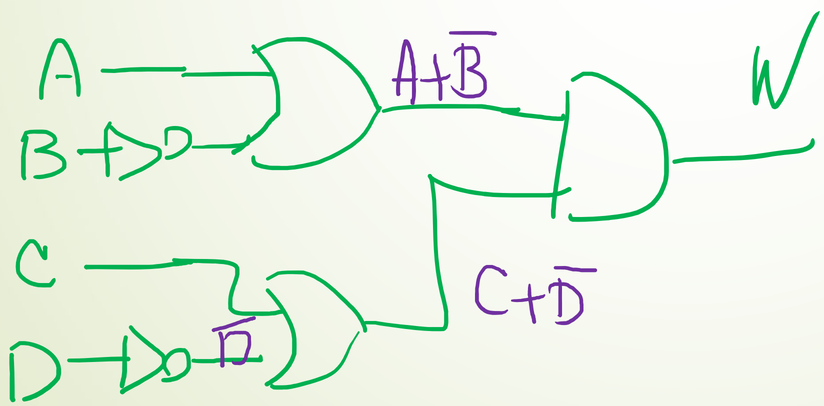
A	B	A⊕B
0	0	0
0	1	1
1	0	1
1	1	0

4. Using AND and OR gates, draw the logic diagrams for the following Boolean expressions without expanding or simplifying them.

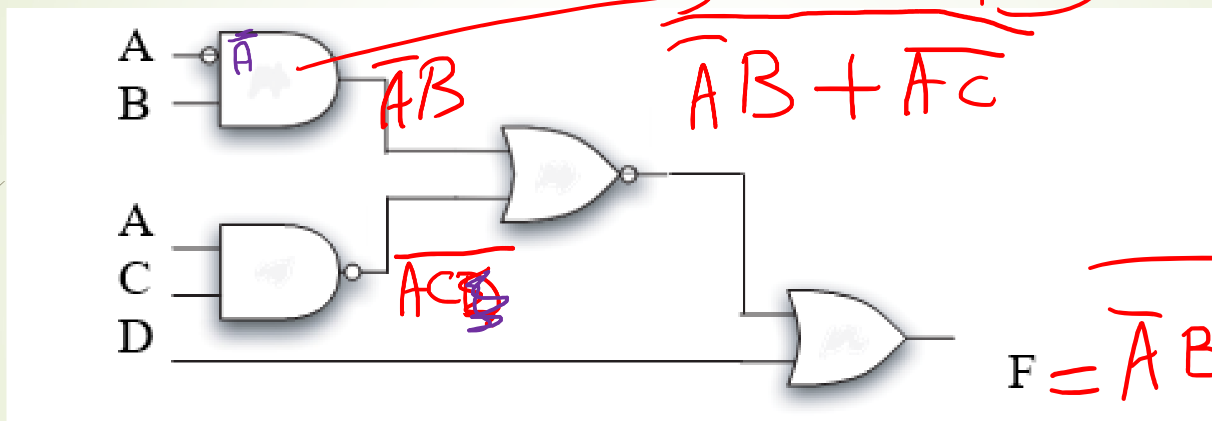
a. Y = (A’+B’)C + B(A+C)



b. W= (A+B’)(C+D’)

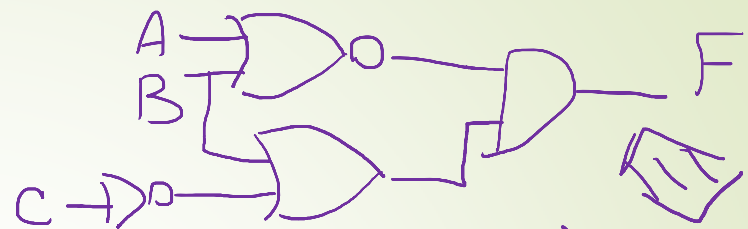


5. Write the Boolean expression equivalent to the following logic circuit. Do not simplify! Hint: Each bubble has the same effect as an invertor.



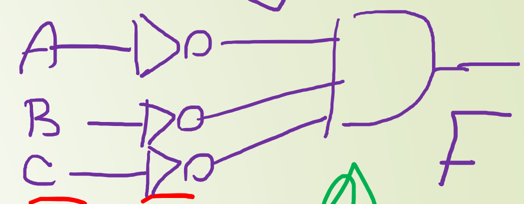
$$F = \overline{\bar{A}B + \overline{AC}} + D$$

$\overline{A}\cdot\overline{B}$



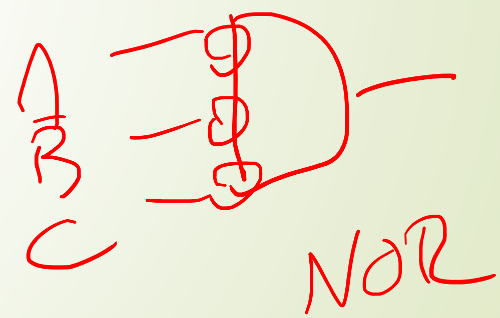
6. Write a truth table for

$$F(A, B, C) = (\overline{A + B})(B + \overline{C})$$



A	B	C	$\overline{A+B}$	$\overline{B}C$	$B+\overline{C}$	F
0	0	0	1	1	1	1
0	0	1	1	0	0	0
0	1	0	0	1	1	0
0	1	1	0	0	1	0
1	0	0	0	1	1	0
1	0	1	0	0	0	0
1	1	0	0	1	1	0
1	1	1	0	0	1	0

$F = \overline{A}\cdot\overline{B}\cdot C$



7. Find the dual of

a. $F = (A'B) + (B'C') + (D')$

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

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

b. $F(A, B, C) = (A + B)(B + \bar{C})$

$F \neq F_d$

8. ~~Find the complement of~~

$F_d = \overline{A \cdot B} + B \cdot \bar{C}$

Dual

AND $\Leftrightarrow$ OR

OR $\Leftrightarrow$ AND

0 $\Leftrightarrow$ 1

1 $\Leftrightarrow$ 0

$A' \Leftrightarrow \bar{A}$

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

$$(A + \overline{B} + C) \cdot D$$

8. Find the complement of

a. F = A'B + B'C' + D'

b. $F(A, B, C) = (\overline{A + B})(B + \overline{C})$

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

$$= \overline{\overline{(A+B)}} + \overline{(B+\overline{C})}$$

$$(A+B)+(\overline{B}\cdot C)$$

$$= A+B+\overline{B}\cdot C$$

$$= A+B+\overline{B}C$$

a. $$\overline{F} = \overline{\overline{A}B + \overline{B}\,\overline{C} + \overline{D}}$$

$$\overline{F} = (\overline{\overline{A}B})(\overline{\overline{B}\,\overline{C}})(\overline{\overline{D}})$$

$$(\overline{\overline{A}} + \overline{B})(\overline{\overline{B}} + \overline{\overline{C}})(\overline{\overline{D}})$$

$$(A + \overline{B})(B + C)(D)$$

$$\overline{\overline{x}+y} = \overline{\overline{x}} \cdot \overline{y} = x\overline{y}$$

$$\overline{x \cdot \overline{y}} = \overline{x} + \overline{\overline{y}} = \overline{x} + y$$

$$\overline{F} = \overline{A\overline{B} + \overline{A}CD + \{B + \overline{C}D\}}$$

$$= \overline{(A\overline{B})}\;\overline{(\overline{A}CD)}\;\overline{(B)}\;\overline{(\overline{C}D)}$$

$$(\overline{A}+\overline{\overline{B}})(\overline{\overline{A}}+\overline{C}+\overline{D})(\overline{B})(\overline{\overline{C}}+\overline{D})$$

$$(\overline{A}+B)(A+\overline{C}+\overline{D})(\overline{B})(C+\overline{D})$$