Digital Electronics

Unit 2.1.5 – DeMorgan's Theorems

DeMorgan's Theorems are ______ additional _________________ techniques that can be used to simplify Boolean expressions. Again, the simpler the Boolean expression, the __________ the resulting logic.

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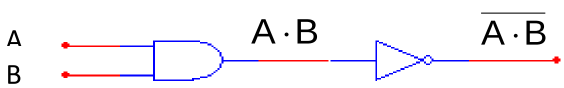
Augustus DeMorgan

Augustus DeMorgan, an Englishman, born in India in 1806. He was instrumental in the advancement of mathematics and is best known for the ____________ _______________ that bear his name.

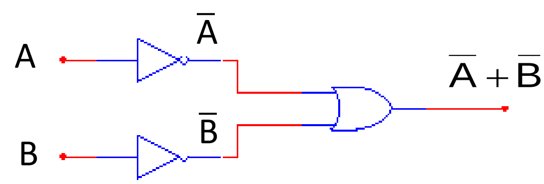
DeMorgan's Theorem #1: ________________________

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



A	B	A·B	$\overline{A \cdot B}$
0	0	0	
0	1	0	
1	0	0	
1	1	1	

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

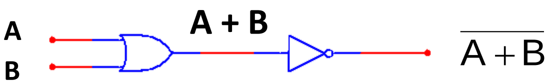


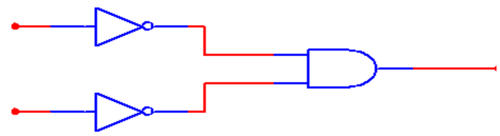
A	B	$\overline{A}$	$\overline{B}$	$\overline{A} + \overline{B}$
0	0	1	1	
0	1	1	0	
1	0	0	1	
1	1	0	0	

The truth-tables are __________; therefore, the Boolean equations must be __________!

DeMorgan's Theorem #2: ________________________

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





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

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

The truth-tables are __________; therefore, the Boolean equations must be ___________!

DeMorgan Shortcut

BREAK THE __________, CHANGE THE __________!

Break the LINE over the two variables, and change the SIGN directly under the line.

$\overline{A\cdot B}=\overline{A}+\overline{B}$ For Theorem #______, break the line, and change the _______ function to an ______ function. *Be sure to keep the lines over the variables.*

$\overline{A+B}=\overline{A}\cdot\overline{B}$ For Theorem #______, break the line, and change the _____ function to an _______ function. Be sure to keep the lines over the variables.

DeMorgan’s: Example #1

Simplify the following Boolean expression and note the Boolean or DeMorgan’s theorem used at each step. Put the answer in SOP form.

$$F_1=\overline{(\overline{X\cdot\overline{Y}})\cdot(\overline{Y}+Z)}$$

$$F_1 = \overline{\overline{(\mathrm{X}\cdot\overline{\mathrm{Y}})}\cdot(\overline{Y}+Z)}$$

____

___________________________________ Theorem #14A

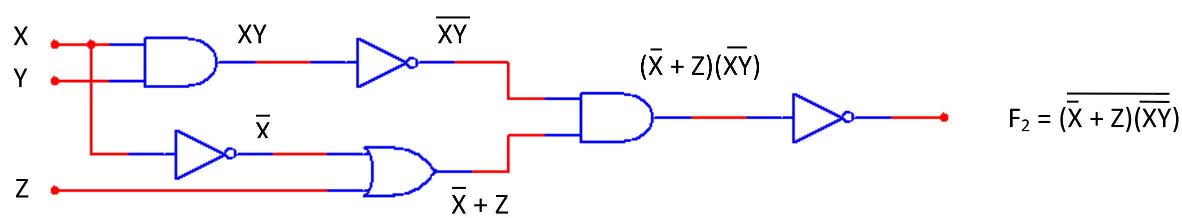
___________________________________ Theorem #9 & #14B

___________________________________ Theorem #9

___________________________________ Rewritten without AND symbols and parentheses

<u>DeMorgan's: Example #2</u>

Take a look at the VERY poorly designed logic circuit shown below. If you were to analyze this circuit to determine the output function F_2, you would obtain the results shown.



Simplify the output function F_2. Be sure to note the Boolean or DeMorgan's theorem used at each step. Put the answer in SOP form.

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___________________________________ Theorem #14A

___________________________________ Theorem #9

___________________________________ Theorem #14B

___________________________________ Theorem #9

___________________________________ Rewritten without AND symbols and parentheses