# Boolean Algebra

**Logic Gate Review** 

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A	В	NOT A	A AND B	A NAND B	A OR B	A NOR B	A XOR B	A XNOR B

# Logical Equivalence

If the truth table for two circuits are the same, they are \_\_\_\_\_

#### **Boolean Identities and Laws**

Logical Inverse	0' =	1' =
Involution Law	A'' =	
Dominance	A + 1 =	A · 0 =
Identity	A + 0 =	A · 1 =

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Idempotent Law	A + A =	A · A =
Law of Complementarity	A + A' =	A · A' =
Commutative Law	A + B = B + A	A · B = B · A
Associative Law	(A + B) + C = A + (B + C)	(A · B) · C = A · (B · C)
Distributive Law	$A + (B \cdot C) = (A + B) \cdot (A + C)$	$A \cdot (B + C) = (A \cdot B) + (A \cdot C)$
Absorption	A + (AB) = A	A (A + B) = A
De Morgan's Law	A + B = (A'·B')'	A · B = (A' + B')'

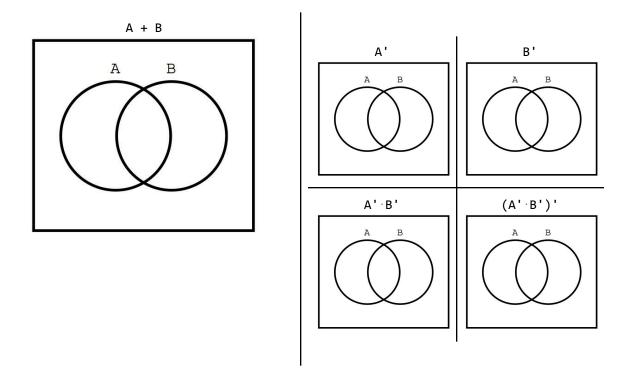
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## De Morgan's Law

1) \_\_\_\_\_\_ the inputs, 2) \_\_\_\_\_, 3) \_\_\_\_ the output

"Break the \_\_\_\_\_\_, change the \_\_\_\_\_"

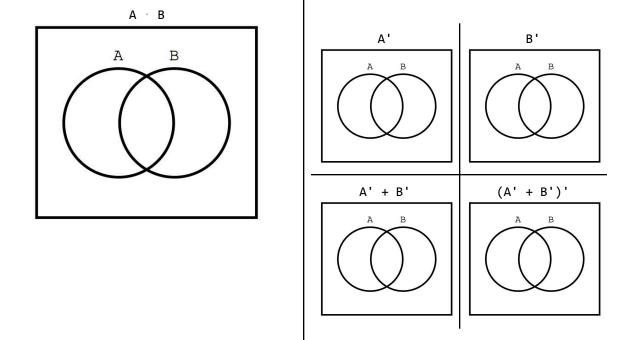
Α	$A + B = (A' \cdot B')'$									
	A + B			_	(A'·I	3')'				
	A	В	A + B		A	В	A'	B'	A' · B'	(A'·B')'
	0	0			0	0				
	0	1			0	1				
	1	0			1	0				
	1	1		ĺ	1	1				
				[	Do t	he tr	ruth	tabl	es match?	



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 $A \cdot B = (A' + B')'$ 

A · B				(A' + B')'					
A	В	A · B	A	A	В	A'	B'	A' + B'	(A' + B')'
0	0		6	0	0				
0	1		6	o	1				
1	0		1	1	0				
1	1		1	1	1				
Do the truth tables match?									

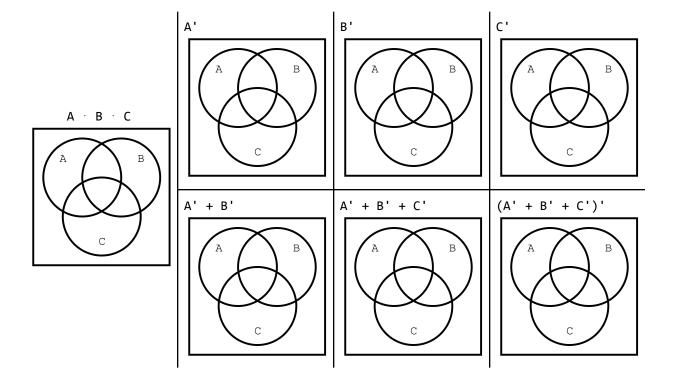


Example

Show how (A · B')' = A' + B

 $A \cdot B \cdot C = (A' + B' + C')'$ 

Α ·	В .	C			(A'	+ B'	+ C'	)'				
Α	В	С	A · B	A · B · C	Α	В	С	A'	B'	C'	A' + B' + C'	(A' + B' + C')'
0	0	0			0	0	0					
0	0	1			0	0	1					
0	1	0			0	1	0					
0	1	1			0	1	1					
1	0	0			1	0	0					
1	0	1			1	0	1					
1	1	0			1	1	0					
1	1	1			1	1	1					
					Do t	he t	ruth	tabl	es m	atch	?	



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You can create a circuit for ANY truth table with only	
In addition, you can complete any truth table with only	
You can also complete any truth table with only	

## **Only NANDS**

Finish the truth table for  $(A \cdot B)$ '. What happens if both inputs are the same?

A	В	(A · B)'
0	0	
0	1	
1	0	
1	1	

 $\hbox{ Draw a NOT gate using only NAND gates } \\$ 

Draw an AND gate using only NAND gates

Draw an OR gate using only NAND gates (hint: use DeMorgan's Law)

Draw a NOR gate using only NAND gates (hint: use DeMorgan's Law)

## **Only NORS**

Finish the truth table for (A + B)'. What happens if both inputs are the same?

A	В	(A + B)'
0	0	
0	1	
1	0	
1	1	

Draw a NOT gate using only NOR gates

Draw an OR gate using only NOR gates

Draw an AND gate using only NOR gates (hint: use DeMorgan's Law)

Draw a NAND gate using only NOR gates (hint: use DeMorgan's Law)

# XOR Example

# NAND Implementation

Use DeMorgan's Law to construct an XOR gate out of only NAND gates

Draw an XOR gate and complete the truth table. Generate the SOP equation.
Draw the SOP logic circuit.
Hea DeMangan's Law to convent the OB gate to an AND gate
Use DeMorgan's Law to convert the OR gate to an AND gate.
Combine the inverter and AND gates to form NAND gates
Convert the inverters on the inputs to NAND gates

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Use DeMorgan's Law to construct an XOR gate out of only NOR gates

Draw an XOR gate and complete the truth table. Generate the POS equation.
Draw the POS logic circuit.
Use DeMorgan's Law to convert the AND gate to an OR gate.
Combine the inverters and OR gates to form NOR gates
Convert the inverters on the inputs to NOR gates

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If the truth table for two circuits are the same, they are logically equivalent.

Are	these	circuit	diagrams	logically	equal?
Are	these	circuit	diagrams	logically	equal?
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