

# Boolean Algebra

ELEC 311

Digital Logic and Circuits

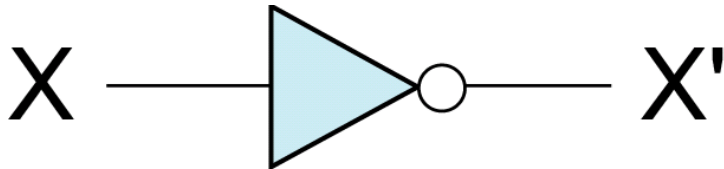
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*Images Courtesy of Cengage Learning*



# Inverter (Not Gate)

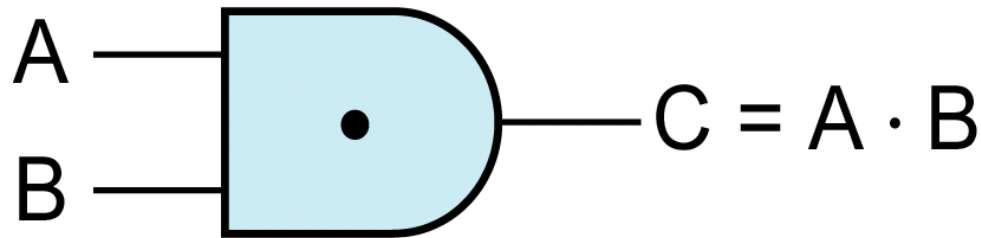
- ◆ If  $X = 0$  then  $X' = 1$
- ◆ If  $X = 1$  then  $X' = 0$



$X$	NOT $X$
0	1
1	0

# AND Gate

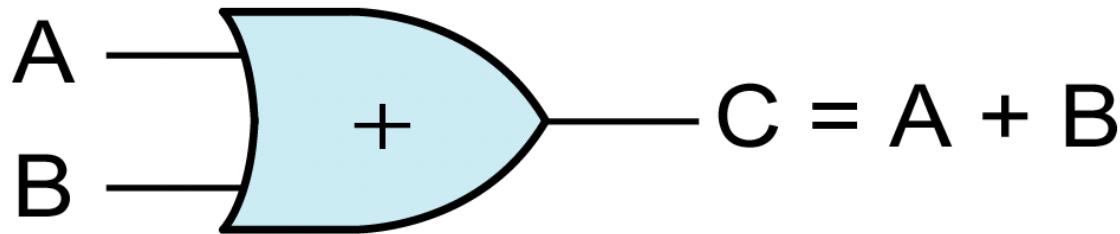
- ◆ If  $A = 1$  **and**  $B = 1$  then  $C = 1$  (else  $C = 0$ )



<u>A</u>	<u>B</u>	<u>C = A · B</u>
0	0	0
0	1	0
1	0	0
1	1	1

# OR Gate

- ♦ If  $A = 1$  **or**  $B = 1$  then  $C = 1$  (else  $C = 0$ )



A	B	C = A + B
0	0	0
0	1	1
1	0	1
1	1	1

# Boolean Algebra

## ♦ AND Operation

- $0 \cdot 0 = 0$
- $0 \cdot 1 = 0$
- $1 \cdot 0 = 0$
- $1 \cdot 1 = 1$

## ♦ OR Operation

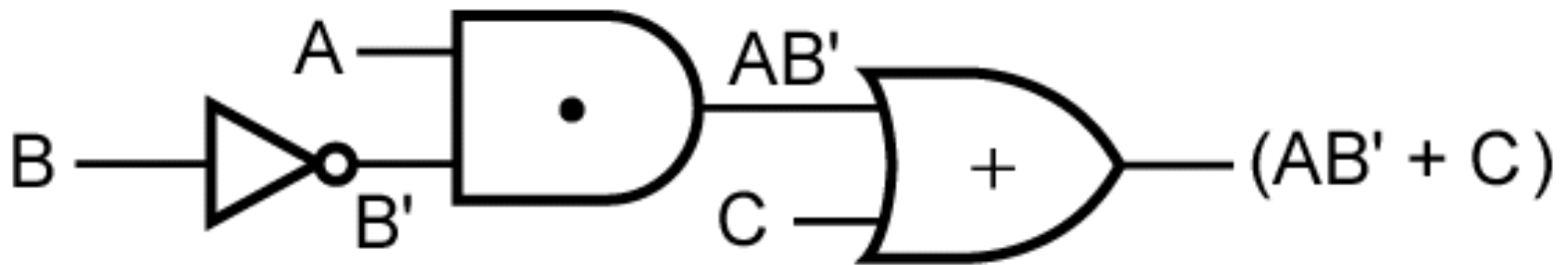
- $0 + 0 = 0$
- $0 + 1 = 1$
- $1 + 0 = 1$
- $1 + 1 = 1$

## ♦ NOT Operation (Complement)

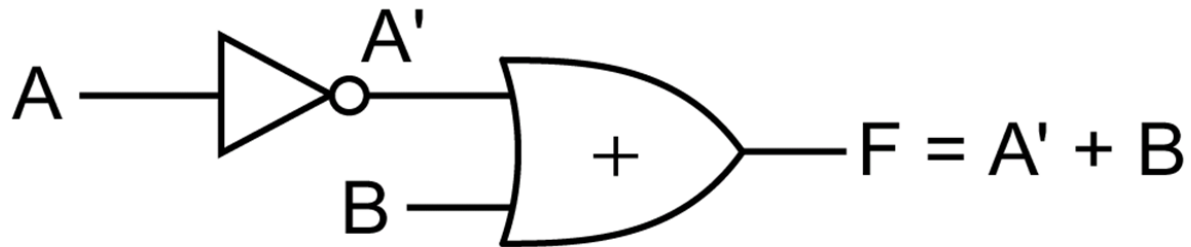
- $0' = 1$
- $1' = 0$

# Boolean Expressions

◆  $F = AB' + C$



# Truth Table



$A$	$B$	$A'$	$F = A' + B$
0	0	1	1
0	1	1	1
1	0	0	0
1	1	0	1

(b)

# Laws and Theorems (p.46)

Operations with 0 and 1:

**1.  $X + 0 = X$**

**1D.  $X \cdot 1 = X$**

**2.  $X + 1 = 1$**

**2D.  $X \cdot 0 = 0$**

Idempotent laws:

**3.  $X + X = X$**

**3D.  $X \cdot X = X$**

Involution law:

**4.  $(X')' = X$**

Laws of complements:

**5.  $X + X' = 1$**

**5D.  $X \cdot X' = 0$**



# Laws and Theorems (p.46)

Commutative laws:

$$6. X + Y = Y + X$$

$$6D. XY = YX$$

Associative laws:

$$7. (X + Y) + Z = X + (Y + Z) \quad 7D. (XY)Z = X(YZ) = XYZ$$

Distributive laws:

$$8. X(Y + Z) = XY + XZ$$

$$8D. X + YZ = (X + Y)(X + Z)$$

DeMorgan's laws:

$$9. (X + Y)' = X'Y'$$

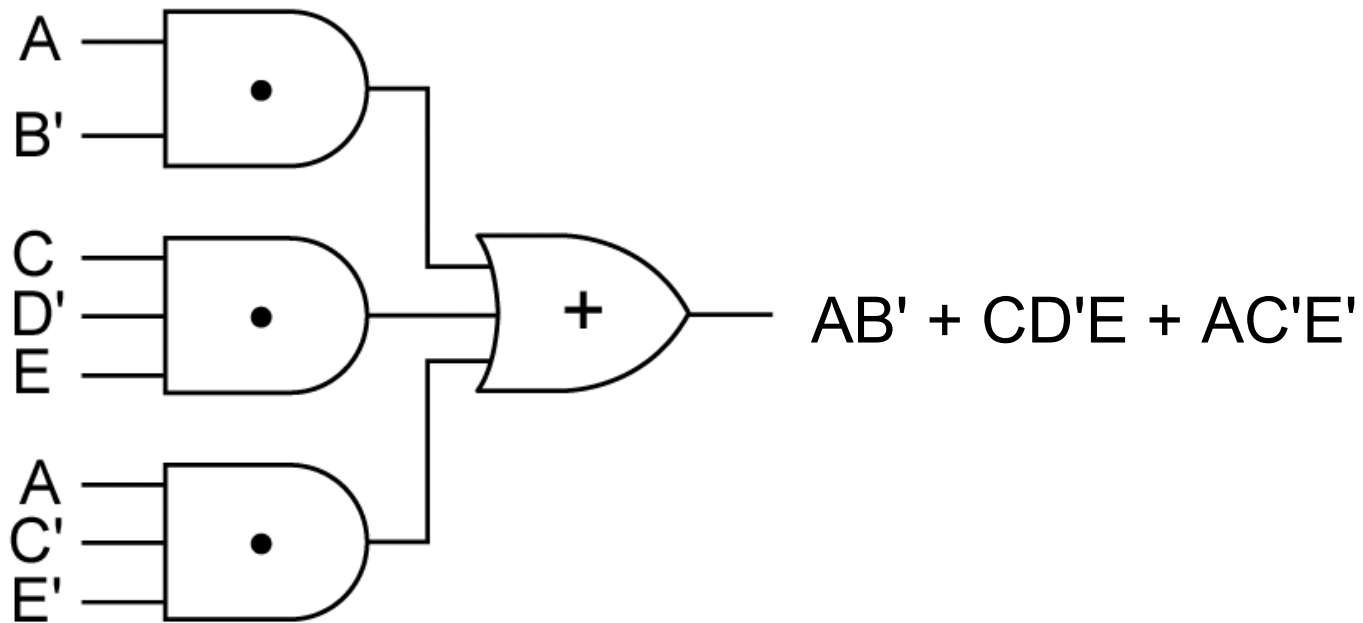
$$12D. (XY)' = X' + Y'$$

Simplification theorems:

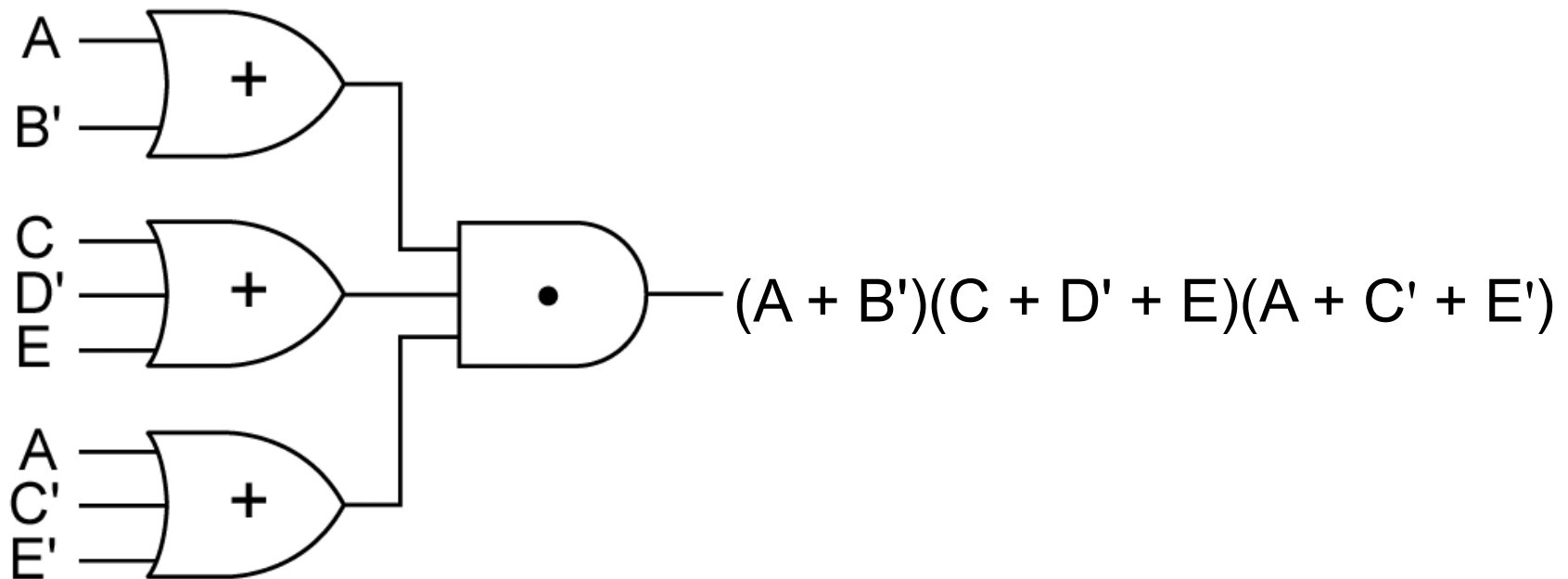
$$10. XY + XY' = X \quad (\text{Adjacency Theorem})$$

$$11. X + XY = X$$

# Sum of Products (SOP)



# Product of Sums (POS)



# Summary

- ◆ Logic Gates
- ◆ Boolean Algebra
- ◆ Truth Tables
- ◆ Laws and Theorems