

ENGR 101

Engineering Technology

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Victoria
UNIVERSITY OF WELLINGTON
*Te Whare Wānanga
o te Ūpoko o te Ika a Māui*



CAPITAL CITY UNIVERSITY

Week 4 Lecture 6a

- Main topics
 - Introduction to Engineering Technology
 - Number system
 - Logic Gates
 - Boolean Algebra
- Course web page:
https://ecs.wgtn.ac.nz/Courses/XMUT101_2021T1/
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Boolean Algebra Laws

	Name of Law	Properties
1.	Identity Law	$A+0=A$; $A+1=1$; $A.0=0$; $A.1=A$
2.	Commutative Law	$A.B = B.A$; $A+B = B+A$
3.	Associative Law	$A.(B.C) = A.B.C$; $A+(B+C) = A+B+C$
4.	Idempotent Law	$A.A = A$; $A+A = A$
5.	Double Negative Law	$A'' = A$
6.	Complement Law	$A.A' = 0$; $A+A' = 1$
7.	Law of Union	$A+1 = 1$; $A+0 = A$
8.	DeMorgan's Theorem	$(AB)' = A'+B'$; $(A+B)' = A'.B'$
9.	Distributive Law	$A.(B+C) = (A.B) + (A.C)$; $A+(BC) = (A+B).(A+C)$
10.	Absorption Law	$A.(A+B) = A$; $A+(A.B) = A$
11.	Common Identities Law	$A.(A'+B) = AB$; $A+(A'B) = A+B$

Example 1: Simplify the given Boolean expression.

$$C + (BC)' \rightarrow \overline{BC}$$

Example 1

Simplify the expression: $C + (BC)'$ \rightarrow \overline{BC}

Solution:

$$C + (BC)'$$

Rules Used

Apply DeMorgan's Theorem to the $(BC)'$ term

9. DeMorgan's Theorem

$$(AB)' = A'+B'; (A+B)' = A'.B'$$

Example 1

Simplify the expression: $C + (BC)'$ \rightarrow \overline{BC}

Solution:

$C + (BC)'$

Rules Used

Step 1: $C + (B' + C')$

9) DeMorgan's Law

9. DeMorgan's Theorem

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

Example 1

Simplify the expression: $C + (BC)'$ \rightarrow \overline{BC}

Solution:

$C + (BC)'$

Rules Used

Step 1: $C + (B' + C')$

8) DeMorgan's Law

Step 2: $C + (C' + B')$

2) Commutative Law

2.	Commutative Law	$A.B = B.A$; $A+B = B+A$

Example 1

Simplify the expression: $C + (BC)'$ \rightarrow \overline{BC}

Solution:

$$C + (BC)'$$

Step 1: $C + (B' + C')$

Step 2: $C + (C' + B')$

Step 3: $C + C' + B'$

Rules Used

8) DeMorgan's Law

2) Commutative

3) Associative Laws

3.	Associative Law	$A.(B.C) = A.B.C$; $A+(B+C) = A+B+C$

Example 1

Simplify the expression: $C + (BC)'$ \rightarrow \overline{BC}

Solution:

$$C + (BC)'$$

Step 1: $C + (B' + C')$

Step 2: $C + (C' + B')$

Step 3: $C + C' + B'$

Step 4: $1 + B'$

Rules Used

8) DeMorgan's Law

2) Commutative

3) Associative Laws

6) Complement Law

6. Complementary Law

$A.A' = 0$; $A+A' = 1$

Example 1

Simplify the expression: $C + (BC)'$ \rightarrow \overline{BC}

Solution:

$$C + (BC)'$$

Rules Used

Step 1: $C + (B' + C')$

8) DeMorgan's Law

Step 2: $C + (C' + B')$

2) Commutative

Step 3: $C + C' + B'$

3) Associative Laws

Step 4: $1 + B'$

6) Complement Law

Step 5: $= 1$

1) Identity Law

1. Identity Law

$A+0=A$; $A+1=1$; $A.0=0$; $A.1=A$

Example 2: Simplify the given Boolean expression.

$$(AB)'(A'+B)(B'+B)$$

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	Name of Law	Properties
1.	Identity Law	$A+0=A$; $A+1=1$; $A.0=0$; $A.1=A$
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11.	Common Identities Law	$A.(A'+B) = AB$; $A+(A'B) = A+B$

Example 2: Simplify the given Boolean expression.

$$(AB)'(A'+B)(B'+B)$$

Solution:

$$(AB)'(A'+B)(B'+B)$$

Step 1: $(AB)'(A'+B)(1)$

Rules Used

6) Complement Law

6. Complement Law

$A.A' = 0$; $A+A' = 1$

Example 2: Simplify the given Boolean expression.

$$(AB)'(A'+B)(B'+B)$$

Solution:

$$(AB)'(A'+B)(B'+B)$$

Rules Used

Step 1: $(AB)'(A'+B)(1)$

6) Complementary Law

Step 2: $(AB)'(A'+B)$

1) Identity Law

1. Identity Law

$A+0=A$; $A+1=1$; $A.0=0$; $A.1=A$

Example 2: Simplify the given Boolean expression.

$$(AB)'(A'+B)(B'+B)$$

Solution:

$$(AB)'(A'+B)(B'+B)$$

Rules Used

Step 1: $(AB)'(A'+B)(1)$

6) Complementary Law

Step 2: $(AB)'(A'+B)$

1) Identity Law

Step 3: $(A'+B')(A'+B)$

8) DeMorgan's Theorem

8. DeMorgan's Theorem

$$(AB)' = A'+B'; \quad (A+B)' = A'.B'$$

Example 2: Simplify the given Boolean expression.

$$(AB)'(A'+B)(B'+B)$$

Solution:

$$(AB)'(A'+B)(B'+B)$$

Step 1: $(AB)'(A'+B)(1)$

Step 2: $(AB)'(A'+B)$

Step 3: $(A'+B')(A'+B)$

Step 4: $A' + B'B$

Rules Used

6) Complementary Law

1) Identity Law

8) DeMorgan's Theorem

9) Distributive Law

9. Distributive Law

$$A.(B+C) = (A.B) + (A.C);$$
$$A+(BC) = (A+B).(A+C)$$

Example 2: Simplify the given Boolean expression.

$$(AB)'(A'+B)(B'+B)$$

Solution:

$$(AB)'(A'+B)(B'+B)$$

Rules Used

Step 1: $(AB)'(A'+B)(1)$

6) Complementary Law

Step 2: $(AB)'(A'+B)$

1) Identity Law

Step 3: $(A'+B')(A'+B)$

8) DeMorgan's Theorem

Step 4: $A' + \boxed{B'B}$

9) Distributive Law

Step 5: $= A'$

6) Complement Law

6. Complement Law

$$\boxed{A.A' = 0; A+A' = 1}$$

Exercise 6.1 Use the Boolean rules to simplify the following expressions:

(Note: $\bar{A} = A'$ or $\bar{C} = C'$)

(a) $X = ABC + \bar{A}B + AB\bar{C}$

(b) $X = \bar{A}B\bar{C} + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C$

(c) $AB + \bar{A}C + BC = AB + \bar{A}C$

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

Take 7 minutes for each expression!

Total = 7 x 4 = 28 minutes

Week 4 Lecture 6a

- Boolean Algebra
 - AND, OR and NOT (inverter)
 - Truth tables
 - Describing logic circuits algebraically

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