COMPUTER SCIENCE & IT

DIGITAL LOGIC

Lecture No. 04

BOOLEAN THEOREMS AND GATES

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Basic gates

Arithematic gates

[XOR GATE] 'Exclusive OR'

$\overline{1}\cdot 0 + 1\cdot\overline{0} = 0+1 = 1$

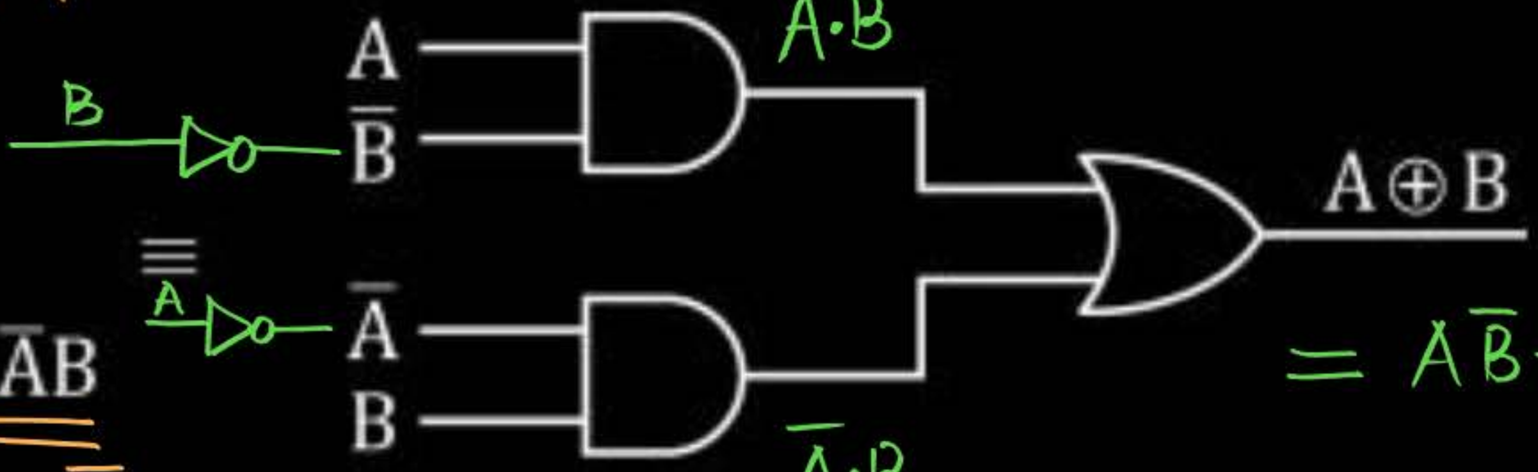
$\overline{1}\cdot 1 + 1\cdot\overline{1} = 0$

Representation :

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

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

$\equiv$



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

$\overline{0}\cdot 0 + 0\cdot\overline{0} = 0$, $\overline{0}\cdot 1 + 0\cdot\overline{1} = 1$

	A	B	$y = A\oplus B$
0	0	0	$0\oplus 0 = 0$
1	0	1	$0\oplus 1 = 1$
2	1	0	$1\oplus 0 = 1$
3	1	1	$1\oplus 1 = 0$

$y(A,B) = \Sigma(1,2)$

$= \pi(0,3)$

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

$= (A+B)\cdot(\overline{A}+\overline{B})$ ✓

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

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

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

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

- $x \oplus xy = \overline{x} \cdot xy + x \cdot \overline{xy} = 0 + x \cdot (\overline{x} + \overline{y}) = 0 + x\overline{y} = x\overline{y}$

- $xy \oplus yz = \overline{xy}\, yz + xy \cdot \overline{yz} = (\overline{x} + \overline{y}) \cdot yz + xy(\overline{y} + \overline{z})$

$$= \overline{x}yz + xy\overline{z}$$

$$= y[\overline{x}z + x\overline{z}] = y[x \oplus z]$$

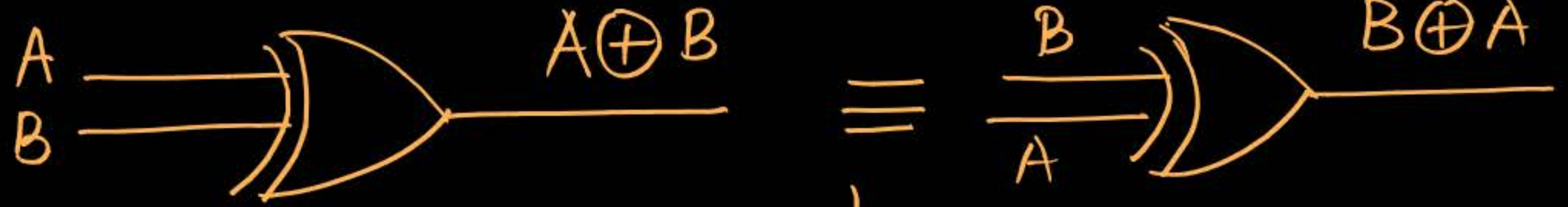
-

$3 + 7 + 8 = 10 + 8 = 18$

$3 + 15 = 18$

$\underbrace{1 \oplus 0} \oplus 1 = 1 \oplus 1 = 0$

- Commutative Law :



$$\boxed{B \oplus A = A \oplus B}$$

→ It holds Commutative law.

→ Position of variables is irrelevant

- Associative Law :

- It holds associative law → meaning is that multi i/P XOR can be calculated using 2-i/P XOR operation.

$$A \oplus B \oplus C \Rightarrow (A \oplus B) \longrightarrow (A \oplus B) \oplus C$$

$$\Rightarrow (B \oplus C) \longrightarrow (B \oplus C) \oplus A = A \oplus B \oplus C$$

- Multi i/P XOR can be designed using 2-i/P XOR gate.

- Properties of XOR GATE :

- $A \oplus A = \bar{A} \cdot A + A \cdot \bar{A} = 0 \implies \bar{A} \oplus \bar{A} = 0$

- $A \oplus \bar{A} = \bar{A} \cdot \bar{A} + A \cdot \bar{\bar{A}} = \bar{A} + A = 1$, $\bar{A} \oplus A = 1$

- $A \oplus A = 0 \Rightarrow A \oplus 0 = A = \bar{A} \cdot 0 + A \cdot \bar{0}$

  $= A$

  $\bar{A} \oplus 0 = \bar{A}$

  $AB \oplus 0 = AB$

- $A \oplus \bar{A} = 1 \Rightarrow A \oplus 1 = \bar{A} = \bar{A} \cdot 1 + A \cdot \bar{1} = \bar{A}$

  $\bar{A} \oplus 1 = A$

  $AB \oplus 1 = \overline{AB}$

- Exchange properties of XOR GATE :

- $A \oplus B = C \rightarrow$ Given $\Rightarrow B \oplus A = C$

$A \oplus C = B \longrightarrow$ true

$\Rightarrow A \oplus C = A \oplus A \oplus B = 0 \oplus B = B$

$\Rightarrow B \oplus C = A \longrightarrow$ true

$B \oplus C = B \oplus A \oplus B = B \oplus B \oplus A = 0 \oplus A = A$

- $A \oplus A \oplus A \oplus A$ ....n times [n - represents no. of A]

then o/p $= 0$ for n-even

$= A$ for n-odd

$A \oplus A = 0$

$\underbrace{A \oplus A} \oplus \underbrace{A \oplus A}$

$= 0 \oplus 0 = 0$

$\underbrace{A \oplus A} \oplus A = 0 \oplus A = A$

- **Buffer and inverting buffer using XOR :**

$A \oplus 0 = A \longrightarrow$ buffer

$A \oplus 1 = \bar{A} \longrightarrow$ inverting buffer

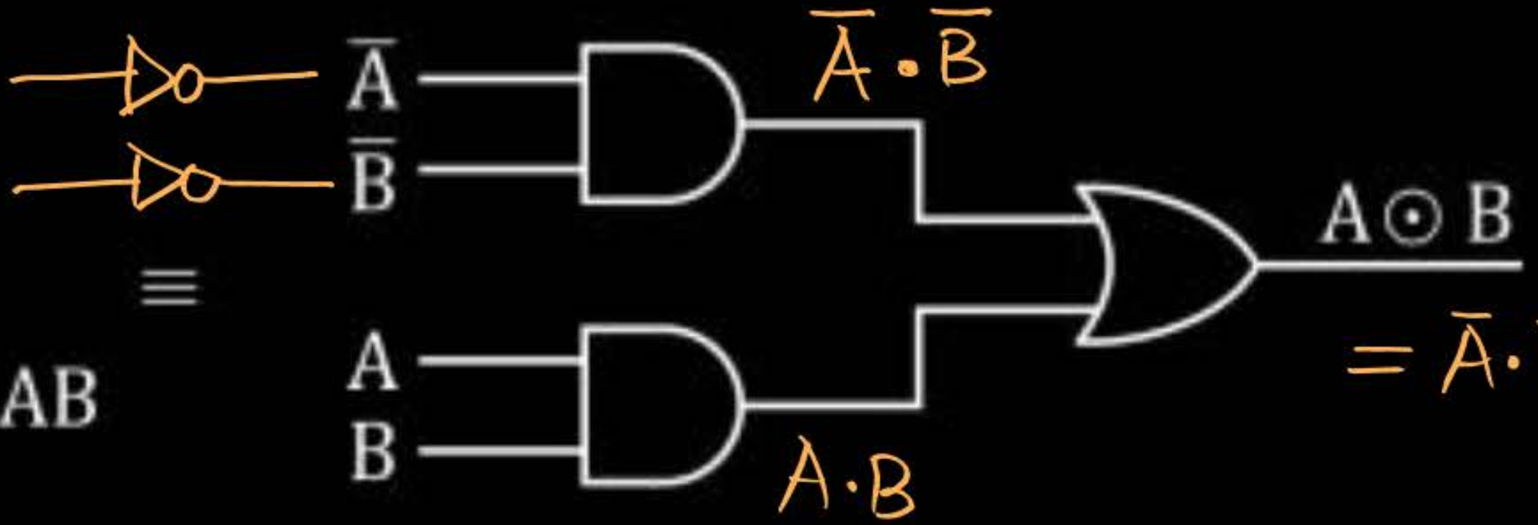
Control $= 0$
$= 1$ $\Big\} \longrightarrow$ enable

[XNOR GATE] 'Exclusive NOR'

Representation :

$= \overline{A}\,\overline{B} + AB$

$\equiv$



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

$y_1 = \overline{y} \Rightarrow A\oplus B = \overline{A\odot B}$

$\overline{A\oplus B} = A\odot B$

$A\oplus B$

	A	B	$y = A\odot B$	y_1
0	0	0	$0\odot 0 = 1$	0
1	0	1	$0\odot 1 = 0$	1
2	1	0	$1\odot 0 = 0$	1
3	1	1	$1\odot 1 = 1$	0

$A\odot B \;\; y(A,B) = \Sigma(0,3) = \Pi(1,2)$

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

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

$A\oplus B = \Sigma(1,2) = \Pi(0,3)$

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

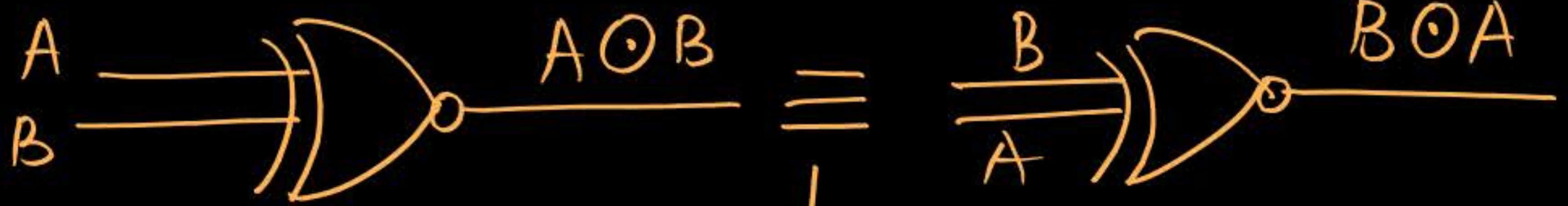
$\overline{x}\odot y = \overline{\overline{x}}\cdot\overline{y} + \overline{x}\cdot y$

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

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

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

- Commutative Law :



$$\boxed{A \odot B = B \odot A}$$

It holds commutative law.

Position of variable is irrelevant.

- Associative Law :

- It holds associative law → meaning is that we can calculate multi i/p XNOR using 2-i/p XNOR operation.

$$A \odot B \odot C \Rightarrow (A \odot B) \Longrightarrow (A \odot B) \odot C$$

$$\Rightarrow (B \odot C) \Longrightarrow (B \odot C) \odot A = A \odot (B \odot C)$$

- That means, we can design multi i/p XNOR gate using 2-i/p XNOR gate.

2 Minute Summary

→ XOR & XNOR gates

Thank you

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Soldiers !