THE OHIO STATE UNIVERSITY

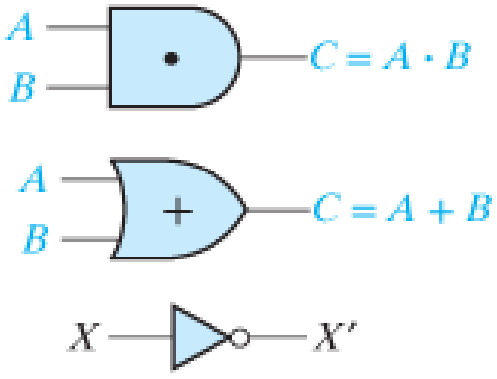
COLLEGE OF ENGINEERING

ECE 3561
Advanced Digital Design
Class 01: Review: Logic Gates and De Morgan's Laws

Drew Phillips

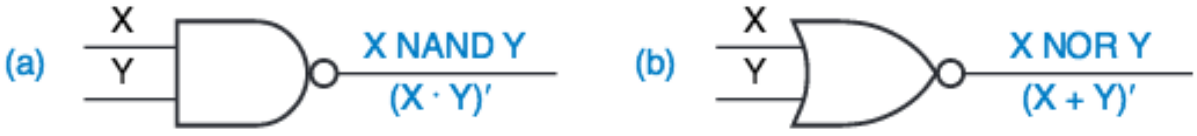
Spring 2024

Review: AND, OR, and NOT Gates

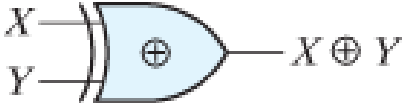


$X' = \bar{X}$ means the inverse of X

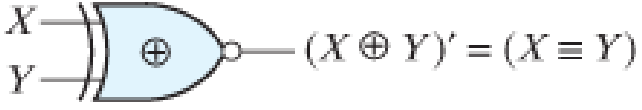
Review: NAND and NOR Gates



Review: XOR and XNOR Gates



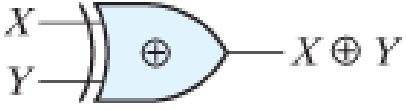
$$A \oplus B = A\overline{B} + \overline{A}B$$



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

Review: More About XOR Gate

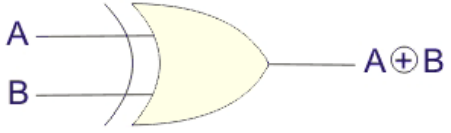
XOR (Exclusive OR)



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

Inputs		Output
A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

Modulo-2 sum of two Boolean variables A, B



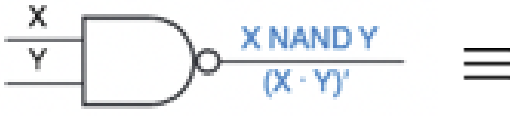
$$0 + 0 = 0$$
$$0 + 1 = 1$$
$$1 + 0 = 1$$
$$1 + 1 = 0 \dashrightarrow Carry\ 1$$

How can the logic of an inverter be implemented by using an XOR gate?

Review: De Morgan's Laws

$$(X + Y)' = X'Y' \qquad (XY)' = X' + Y'$$

Move the inversion bubble around:



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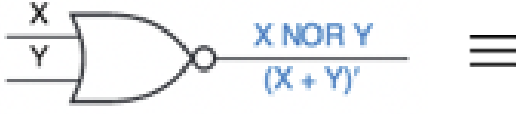

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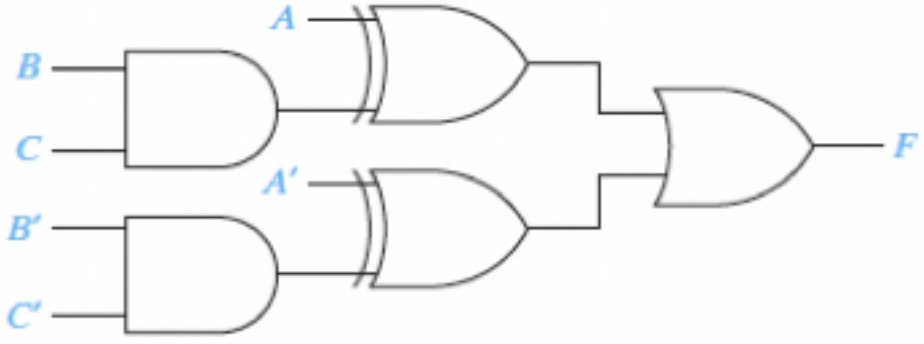
How can Boolean functions be realized by 2-input NAND gates? (Example on next slide.)

Example 1

1.1 Realize the following functions, using only two-input NAND gates.

$$F=A'BC'+BD+AC+B'CD'$$

1.2 Use gate conversions to convert the circuit below into one containing NAND and XOR gates.



1.1 Solution

1.2 Solution

Questions?