ELECTRONIC PRINCIPLES AND DEVICES

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Unit-3 Digital Electronics

Other Logical Operation, Digital Logic gates (XOR and XNOR)

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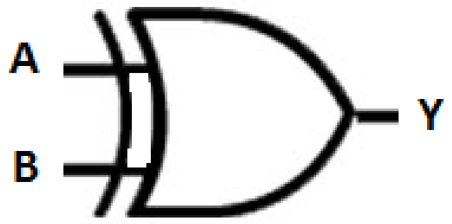
Other Logical Operation, Digital Logic gates (XOR and XNOR)

- **XOR Gate** is a digital logic Gate which has two or more inputs and only one output that performs Exclusive OR operation. Hence it is also called as Ex-OR or XOR
- For two input XOR gate output is **logic-1** only when one of its input is logic-1 (unequal input i.e..A = 0 and B = 1 or A = 1 and B = 0).
- Output of XOR gate is **logic-0** if both inputs are same (i.e.., A = 0 and B = 0 or A = 1 and B = 1)
- Truth Table of XOR Gate:

Input A	Input B	Output Y
0	0	0
0	1	1
1	0	1
1	1	0

- Symbol



$A.B' + A'.B = A \oplus B$

Other Logical Operation, Digital Logic gates (XOR and XNOR)

- XOR gate performs modulo sum operation without including carry.

i.e.., 0+0 = 0 , 0+1 = 1, 1+0 = 1, 1+1 = 0 (carry 1)

- Truth Table

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

$Y = A'.B + A.B'$

$Y = A \text{ XOR } B$

$Y = A \oplus B$

$A.B' + A'.B = A \oplus B$

LHS = $A.B' + A'.B$

Case1: If A = 0 and B = 0

$0.0' + 0'.0 = 0.1 + 1.0 = 0$

Case2: If A = 0 and B = 1

$0.1' + 0'.1 = 0.0 + 1.1 = 1$

Case3: If A = 1 and B = 0

$1.0' + 1'.0 = 1.1 + 0.0 = 1$

Case4: If A = 1 and B = 1

$1.1' + 1'.1 = 1.0 + 0.1 = 0$

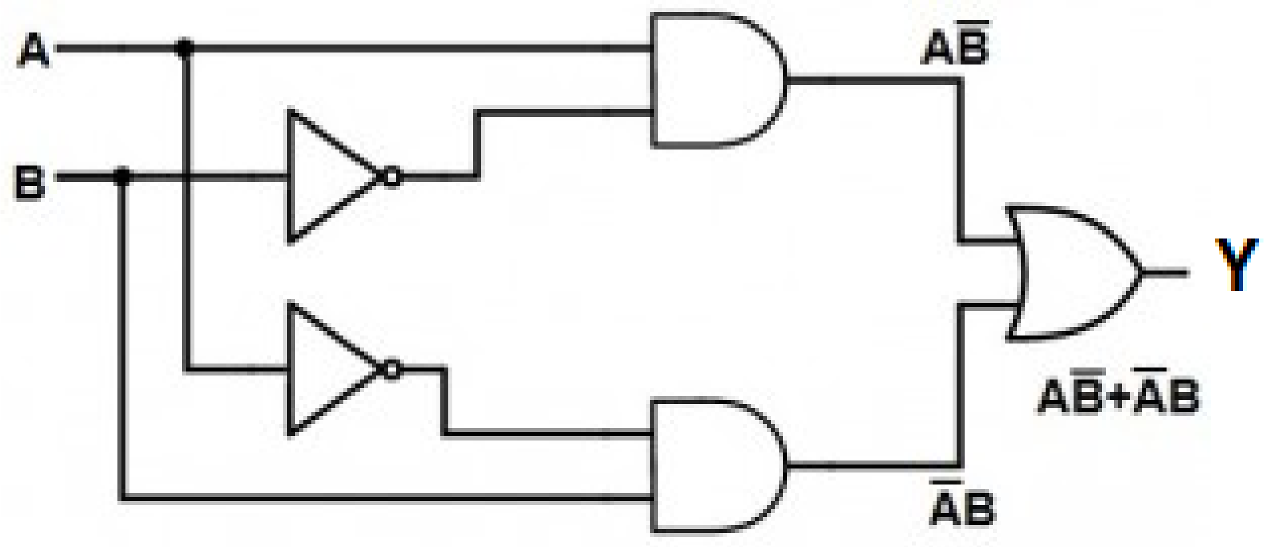
Hence **$Y = A \oplus B = A.B' + A'.B$**

Other Logical Operation, Digital Logic gates (XOR and XNOR)

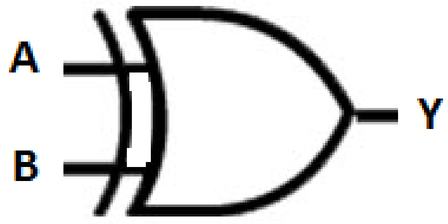
- Implementation of XOR Gate using basic gates:

  $Y = A \oplus B = A.B' + A'.B$

- Logic Diagram



- Symbol



Reference: "Digital Design with an Introduction to Verilog HDL" M Morris Mano, Michale D Ciletti

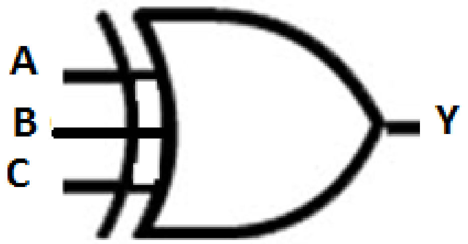
Other Logical Operation, Digital Logic gates (XOR and XNOR)

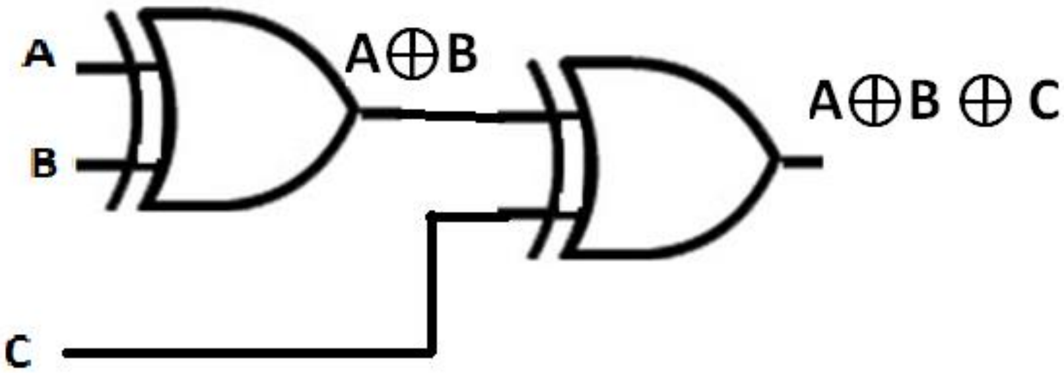
- **3 - Input XOR Gate:** $Y = A \oplus B \oplus C$

Truth Table

A	B	C	$A \oplus B$	$A \oplus B \oplus C$
0	0	0	0	0
0	0	1	0	1
0	1	0	1	1
0	1	1	1	0
1	0	0	1	1
1	0	1	1	0
1	1	0	0	0
1	1	1	0	1

Symbol





Associative Law:
$(A \oplus B) \oplus C = A \oplus (B \oplus C)$

- Even or odd Parity Bits

Other Logical Operation, Digital Logic gates (XOR and XNOR)

- **XNOR Gate**: Logical Complement of XOR Gate

- For two input XNOR Gate if both inputs are same i.e.., A = 0 and B = 0 or A = 1 and B = 1. Then output of logic gate is logic-1 (High). Output of XNOR is logic-0 if inputs are unequal.

- Equality detector

Truth Table

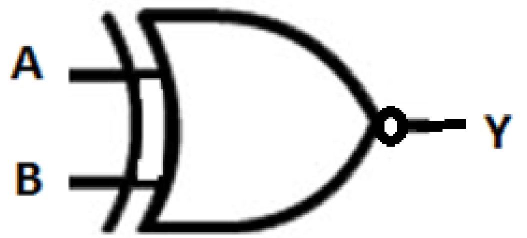
Input A	Input B	Output Y
0	0	1
0	1	0
1	0	0
1	1	1

- **Boolean Expression**

$$Y = A.B + A'.B'$$

$$Y = A \odot B$$

- **Symbol**



Other Logical Operation, Digital Logic gates (XOR and XNOR)

❖ XNOR Gate:

$Y = (A \oplus B)'$

$Y = (A.B' + A'.B)'$

De Morgan's Theorem

$Y = (A.B')' . (A'.B)'$

$Y = (A'+B) . (A + B')$

$Y = A'.A + A'.B' + A.B + B.B'$

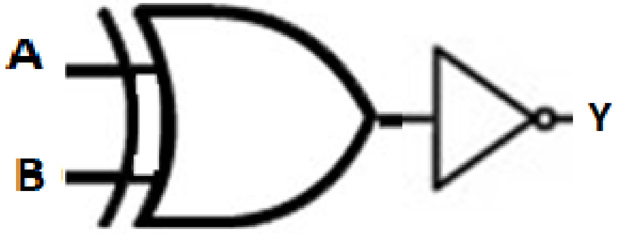
$Y = 0 + A'.B' + A.B + 0$

$Y = A'.B' + A.B$

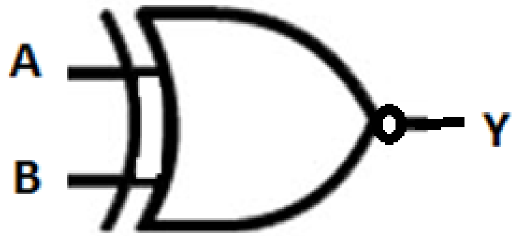
$Y = (A \oplus B)' = A \odot B$

$Y = (A \text{ XOR } B)' = (A \text{ XNOR } B)$

❖ Logic Diagram:



❖ Symbol:

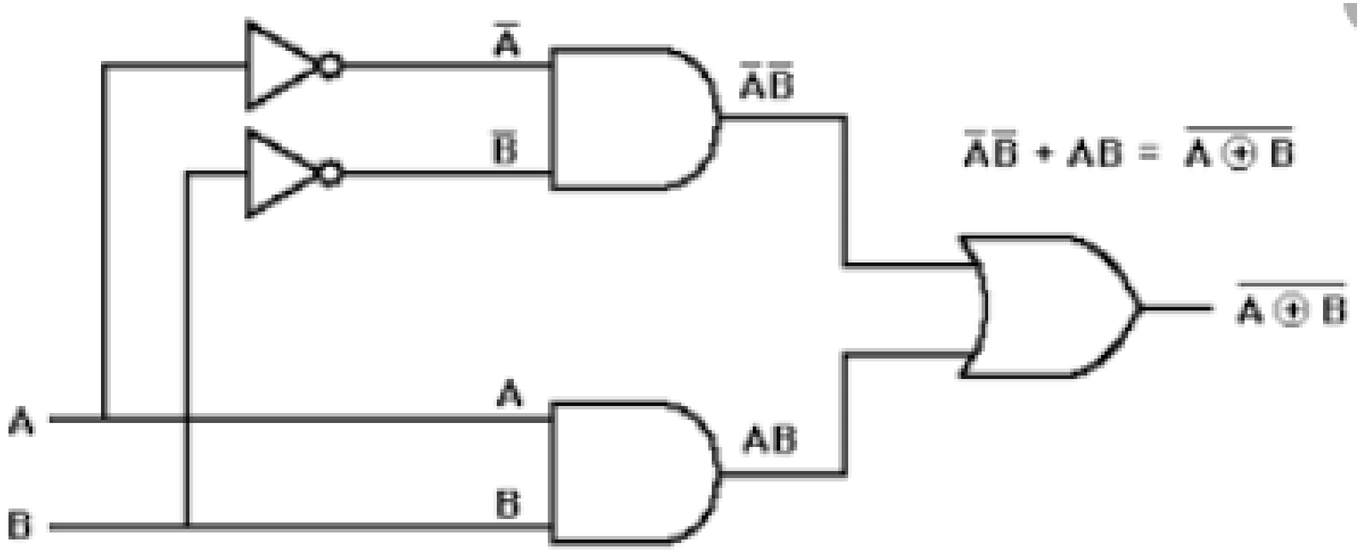


Other Logical Operation, Digital Logic gates (XOR and XNOR)

- **Implement the XNOR Gate using basic gates:**

$$Y = A'.B' + A.B$$

- **Logic Diagram:**

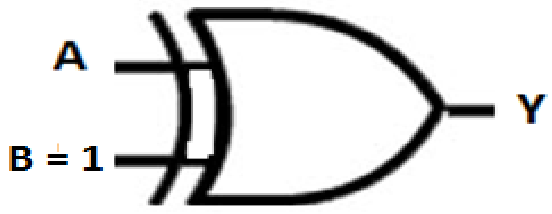


$$Y = (A \oplus B)' = A \odot B$$

Other Logical Operation, Digital Logic gates (XOR and XNOR)

❖ Properties of XOR Gate:

- Identity element: $A \oplus 0 = A$
- $A \oplus 1 = A'$
- $A \oplus A = 0$
- Commutative Law: $A \oplus B = B \oplus A$
- Associative Law : $A \oplus (B \oplus C) = (A \oplus B) \oplus C$



Input A	Input B	Output Y
0	0	0
0	1	1
1	0	1
1	1	0

Other Logical Operation, Digital Logic gates (XOR and XNOR)

❖ Applications of XOR and XNOR

- XOR gate is used in processor’s Arithmetic Logic Unit (ALU) for binary addition.
- XOR logic gate is used to generate pseudorandom numbers in hardware.
- To generate parity bits and error detection
- Equality detector

THANK YOU

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