DIGITAL ELECTRONICS -2317

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LOGIC FUNCTIONS-I

LOGIC GATES

Logic Gates

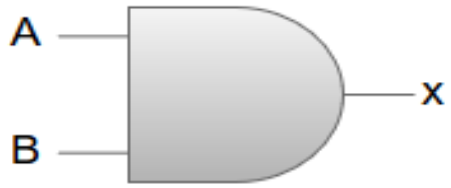
- The logic gates are the main structural part of a digital system.
- Logic Gates are a block of hardware that produces signals of binary 1 or 0 when input logic requirements are satisfied.
- Each gate has a distinct graphic symbol, and its operation can be described by means of algebraic expressions.
- The seven basic logic gates includes: AND, OR, XOR, NOT, NAND, NOR, and XNOR.

LOGIC GATES

❑AND GATE:

- The AND gate is an electronic circuit which gives a high output only if all its inputs are high. The AND operation is represented by a dot (.) sign.

AND Gate:



Algebraic Function: x = AB

Truth Table:

A	B	x
0	0	0
0	1	0
1	0	0
1	1	1

LOGIC GATES

❑OR GATE:

- The OR gate is an electronic circuit which gives a high output if one or more of its inputs are high. The operation performed by an OR gate is represented by a plus (+) sign.

OR Gate:

Algebraic Function: x = A + B

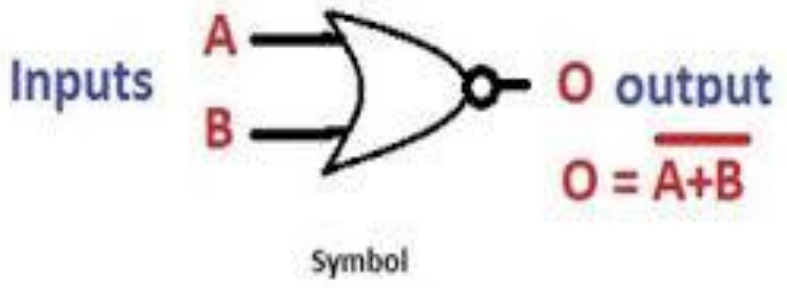
Truth Table:

A	B	x
0	0	0
0	1	1
1	0	1
1	1	1

LOGIC GATES

❑NOT GATE:

- The NOT gate is an electronic circuit which produces an inverted version of the input at its output. It is also known as an **Inverter**.



Symbol

Inputs		Output
A	B	O
0	0	1
0	1	0
1	0	0
1	1	0

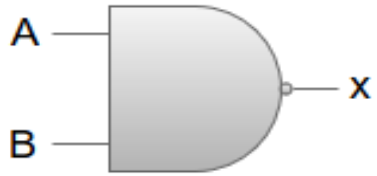
Truth table

LOGIC GATES

❑NAND GATE(Universal Gate):

- The NOT-AND (NAND) gate which is equal to an AND gate followed by a NOT gate. The NAND gate gives a high output if any of the inputs are low. The NAND gate is represented by a AND gate with a small circle on the output. The small circle represents inversion.

NAND Gate:



Algebraic Function: x = (AB)'

Truth Table:

A	B	x
0	0	1
0	1	1
1	0	1
1	1	0

LOGIC GATES

❑NOR GATE(Universal Gate):

- The NOT-OR (NOR) gate which is equal to an OR gate followed by a NOT gate. The NOR gate gives a low output if any of the inputs are high. The NOR gate is represented by an OR gate with a small circle on the output. The small circle represents inversion.

NOR Gate:

Algebraic Function: x = (A+B)'

Truth Table:

A	B	x
0	0	1
0	1	0
1	0	0
1	1	0

LOGIC GATES

❑Exclusive-OR/ XOR GATE:

- The 'Exclusive-OR' gate is a circuit which will give a high output if one of its inputs is high but not both of them. The XOR operation is represented by an encircled plus sign.

XOR Gate:

Algebraic Function: $x = A \oplus B$

or

$x = A'B + AB'$

Truth Table:

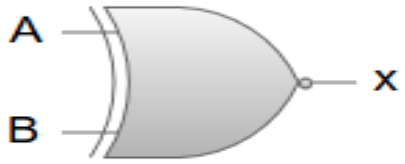
A	B	x
0	0	0
0	1	1
1	0	1
1	1	0

LOGIC GATES

❑EXCLUSIVE-NOR/Equivalence GATE:

- The 'Exclusive-NOR' gate is a circuit that does the inverse operation to the XOR gate. It will give a low output if one of its inputs is high but not both of them. The small circle represents inversion.

Exclusive-NOR Gate:



Algebraic Function: $x = (A \oplus B)'$

or

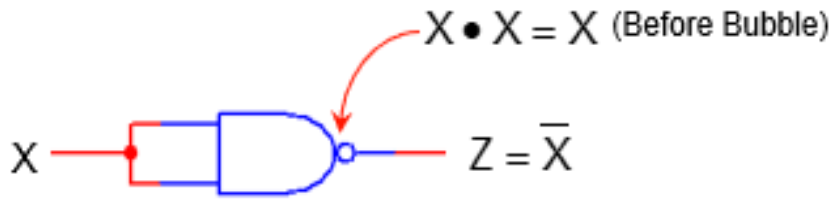
$x = A'B' + AB$

Truth Table:

A	B	x
0	0	1
0	1	0
1	0	0
1	1	1

NAND GATE AS UNIVERSAL GATE

- NAND Gate as NOT gate

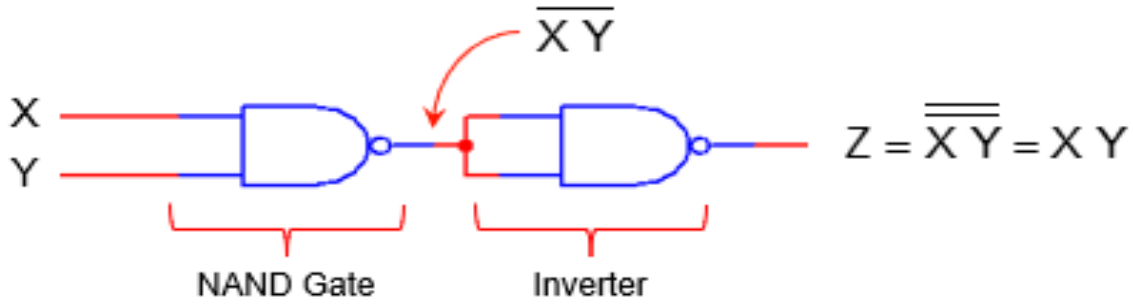


X	Z
0	1
1	0

Equivalent to Inverter

NAND GATE AS UNIVERSAL GATE

- NAND Gate as AND gate

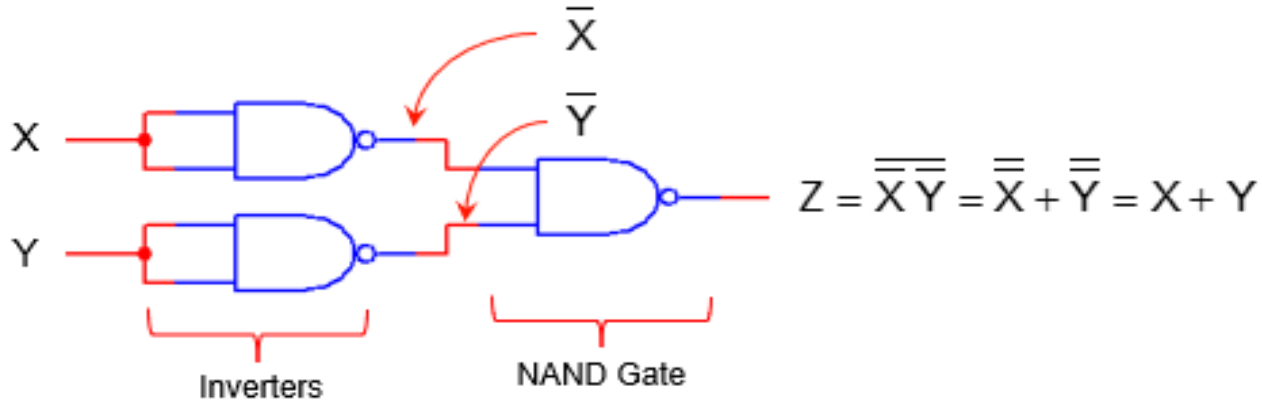


X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

Equivalent to AND Gate

NAND GATE AS UNIVERSAL GATE

- NAND Gate as OR gate

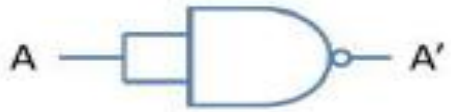


X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	1

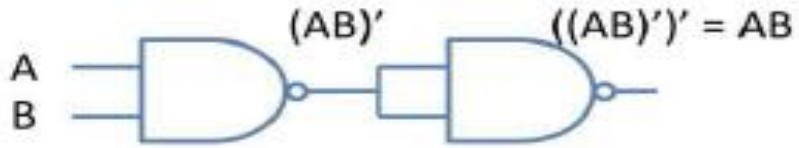
Equivalent to OR Gate

NAND GATE AS UNIVERSAL GATE

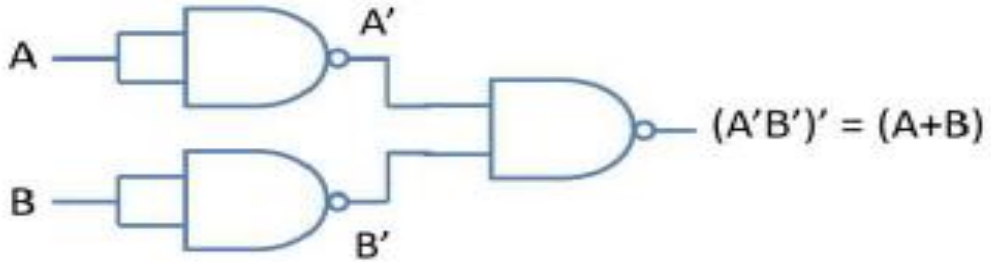
1. NOT using NAND gate
   - A NAND gate can also be used as an inverter by tying all its input terminals together and applying the signal to be inverted to the common terminal.



2. AND using NAND gate
   - NAND means NOT AND, i.e. the AND output is NOTed.
   - So, a NAND gate is combination of an AND gate and a NOT gate.



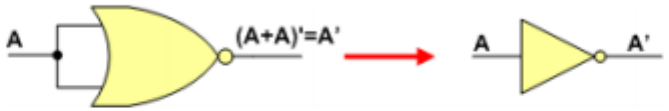
3. OR using NAND gate
   - By inverting inputs in NAND gate, a OR gate is constructed via De Morgan's theorem.
   - $\overline{\bar{A}\,\bar{B}} = \bar{\bar{A}} + \bar{\bar{B}} = A + B$



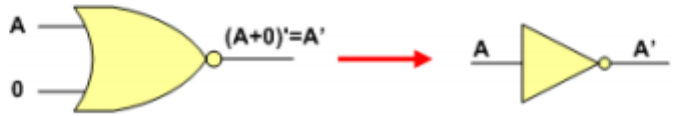
NOR GATE AS UNIVERSAL GATE

- NOR Gate as NOT gate

1. All NOR input pins connect to the input signal **A** gives an output **A'**.



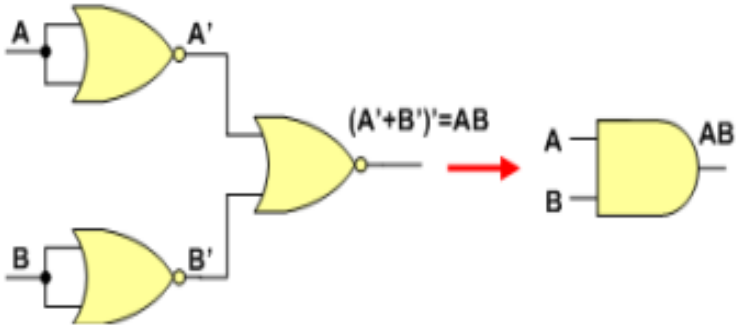
2. One NOR input pin is connected to the input signal **A** while all other input pins are connected to logic **0**. The output will be **A'**.



NOR GATE AS UNIVERSAL GATE

- NOR Gate as AND gate

An AND gate can be replaced by NOR gates as shown in the figure (The AND gate is replaced by a NOR gate with all its inputs complemented by NOR gate inverters)



NOR GATE AS UNIVERSAL GATE

- NOR Gate as OR gate

An OR gate can be replaced by NOR gates as shown in the figure (The OR is replaced by a NOR gate with its output complemented by a NOR gate inverter)