**Nand gate as Universal gate**

**(A.B)’  = A’+B’**

NAND gate is actually a combination of two logic gates i.e. AND gate followed by NOT gate. its output is complement of the output of an AND gate.

This gate can have minimum two inputs.

By using only NAND gates, we can realize all logic functions: AND, OR, NOT, Ex-OR, Ex-NOR, NOR.

this gate is also called as universal gate.

#### **NAND gates as OR gate**

From DeMorgan’s theorems:  
(A.B)’ = A’ + B’  
(A’.B’)’ = A’’ + B’’ = A + B  
So, give the inverted inputs to a NAND gate, obtain OR operation at output.

A diagram of a network

Description automatically generated with medium confidence

A white grid with black letters and numbers

Description automatically generated

#### **NAND gates as AND gate**

A NAND produces complement of AND gate. So, if the output of a NAND gate is inverted, overall output will be that of an AND gate.

**Y = ((A.B)’)’**  
**Y = (A.B)**

A black and white image of a computer

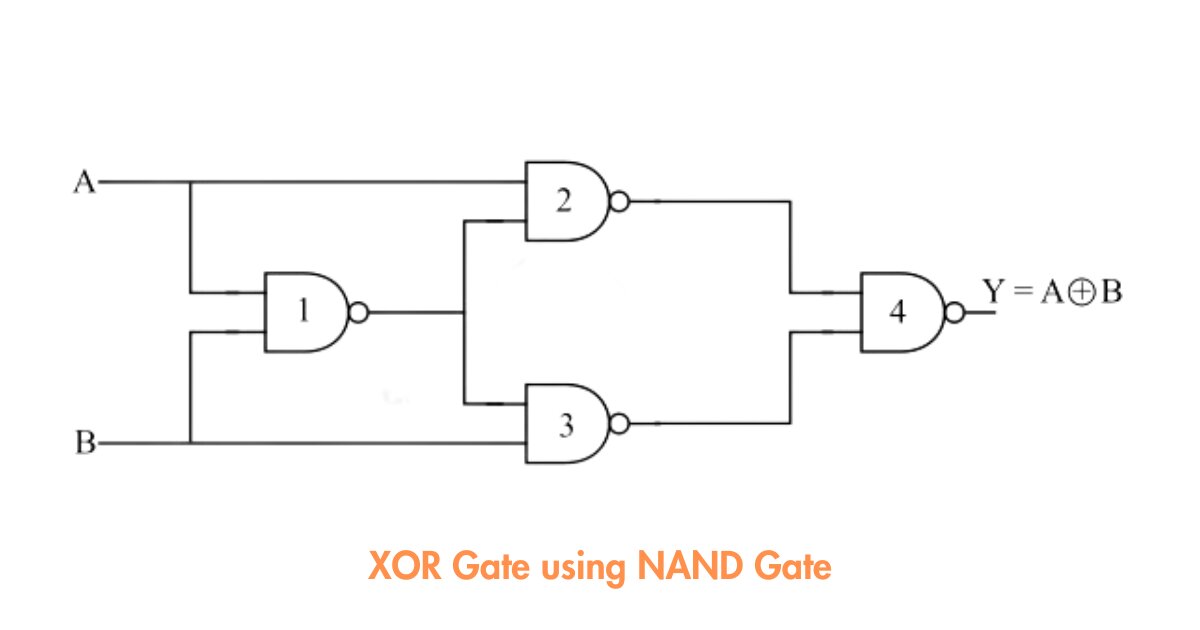
Description automatically generated

A screenshot of a computer program

Description automatically generated

#### **NAND gates as Ex-OR gate :**

The output of a two input Ex-OR gate is shown by: Y = A’B + AB’. This can be achieved with the logic diagram shown in the left side.



A screenshot of a computer

Description automatically generated

#### **NAND gates as Ex-NOR gate**

Ex-NOR gate is actually Ex-OR gate followed by NOT gate. So give the output of Ex-OR gate to a NOT gate, overall output is that of an Ex-NOR gate.

**Y = AB+ A’B’**

A diagram of a block diagram

Description automatically generated

A screenshot of a computer screen

Description automatically generated

### Nor gate as Universal Gate

### NOR gate is actually a combination of two logic gates: OR gate followed by NOT gate. So its output is complement of the output of an OR gate.This gate can have minimum two inputs, output is always one. By using only NOR gates, we can realize all logic functions: AND, OR, NOT, Ex-OR, Ex-NOR, NAND. So this gate is also called universal gate.

#### **NOR gates as OR gate**

A NOR produces complement of OR gate. So, if the output of a NOR gate is inverted, overall output will be that of an OR gate.

**Y = ((A+B)’)’  
Y = (A+B)**

A black background with white text

Description automatically generated

A white grid with black letters and numbers

Description automatically generated

#### **NOR gates as AND gate**

From DeMorgan’s theorems:  
(A+B)’ = A’B’  
(A’+B’)’ = A’’B’’ = AB  
So, give the inverted inputs to a NOR gate, obtain AND operation at output.

A black and white diagram

Description automatically generated

A screenshot of a computer program

Description automatically generated

#### **)NOR gates as Ex-OR gate**

Ex-OR gate is actually Ex-NOR gate followed by NOT gate. So give the output of Ex-NOR gate to a NOT gate, overall output is that of an Ex-OR gate.  
Y = A’B+ AB’

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Description automatically generated

#### **NOR gates as Ex-NOR gate**

The output of a two input Ex-NOR gate is shown by: Y = AB + A’B’.

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Description automatically generated

**Nand gate to implement half adder**



**Implementation of Half Adder using NOR gates :** Total 5 NOR gates are required to implement half adder.

A diagram of a green object

Description automatically generated with medium confidence

**Implementation of Half Subtractor using NAND gates :** Total 5 NAND gates are required to implement half subtractor.

A diagram of a network

Description automatically generated

**Implementation of Half Subtractor using NOR gates :** Total 5 NOR gates are required to implement half subtractor.

A diagram of a diagram

Description automatically generated

**For other logic equations ; To implement any Boolean logic using NAND GATES**

1. Convert equation into SOP FORM
2. Draw a logic diagram based on sop
3. Convert AND into Nand & OR into Bubbled OR
4. Balance out the bubbles or inverter

**For other logic equations ; To implement any Boolean logic using NOR GATES**

1. Convert equation into POS FORM
2. Draw a logic diagram based on POS
3. Convert AND into BUBBLED AND & OR into NOR
4. Balance out the bubbles or inverter