

## EXPERIMENT: 2 UNIVERSAL GATES

**AIM:** Realization of logic functions with the help of universal gates-NAND Gate.

**LEARNING OBJECTIVE:**

Prove NAND and NOR as Universal Gates

**COMPONENTS REQUIRED:**

- Connecting patch chords.
- NAND gates (IC 7400), NOR gates (IC 7402).

**THEORY:**

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

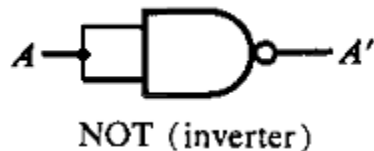
This gate can have minimum two inputs, output is always one. By using only NAND gates, we can realize basic logic functions: AND, OR, NOT. So this gate is also called universal gate.

**NAND gates as NOT gate**

A NOT produces complement of the input. It can have only one input, tie the inputs of a NAND gate together. Now it will work as a NOT gate. Its output is

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

$$\Rightarrow Y = (A)'$$

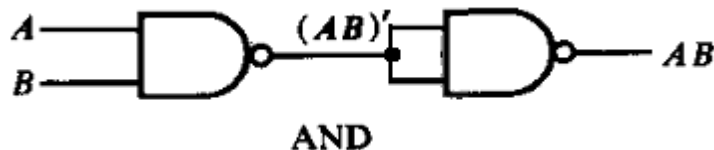


**NAND gates as AND gate**

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.

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

$$\Rightarrow Y = (A.B)$$

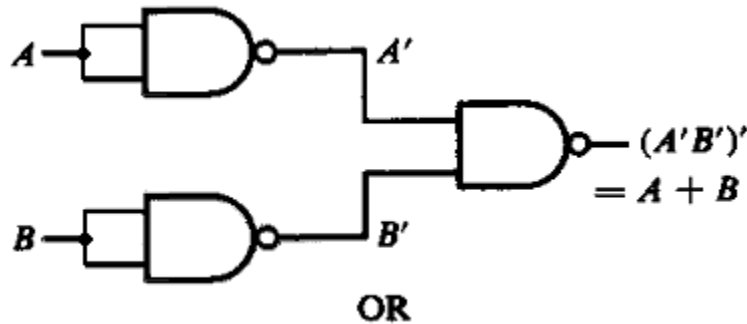


**NAND gates as OR gate**

From DeMorgan's theorems:  $(A.B)' = A' + B'$

$$\Rightarrow (A'.B')' = A'' + B'' = A + B$$

So, give the inverted inputs to a NAND gate, obtain OR operation at output

**NOR gates as NOT gate**

A NOT produces complement of the input. It can have only one input, tie the inputs of a NOR gate together. Now it will work as a NOT gate. Its output is

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

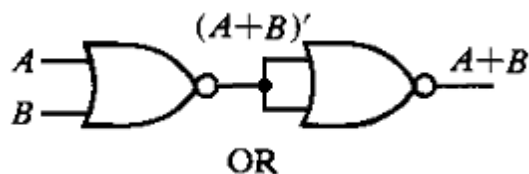
$$\Rightarrow Y = (A)'$$

**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.

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

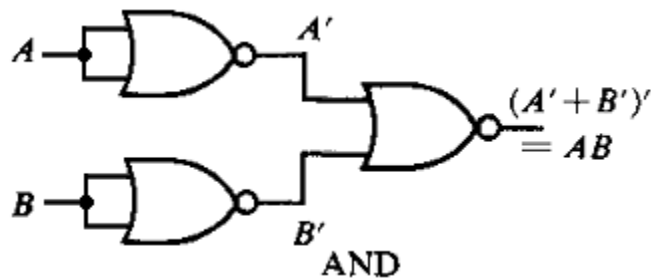
$$\Rightarrow Y = (A+B)$$

**NOR gates as AND gate**

From DeMorgan's theorems:  $(A+B)' = A'B'$

$$\Rightarrow (A'+B')' = A''B'' = AB$$

So, give the inverted inputs to a NOR gate, obtain AND operation at output.

**PROCEDURE**

1. Check the components for their working.
2. Connect the inputs of first stage to logic sources and output of the last gate to logic indicator.
3. Apply various input combinations and observe output for each one.
4. Verify the truth table for each input/ output combination.
5. Repeat the process for all logic functions.
6. Switch off the ac power supply.

**RESULT:** Realization of logic functions with the help of universal gates-NAND Gate and NOR gate is done successfully.