Experiment No: 2

Realization of logic functions with the help of universal gates-NAND Gate & NOR Gate.

Apparatus: logic trainer kit, NAND gates (IC 7400), NOR gates(IC 7402) wires.

Theory:

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

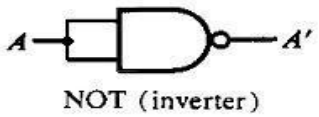
This gate can have a minimum of two inputs, output is always one. By using only NAND gates, we can realize all logic functions: AND, OR, NOT, X-OR, X-NOR, NOR. So this gate is also called the universal gate.

NAND gates as NOT gate

A NOT produces a 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)'

Y = (A)'



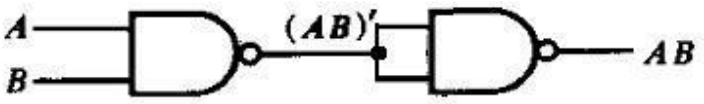
NOT (inverter)

NAND gates as AND gate

A NAND produces a 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)



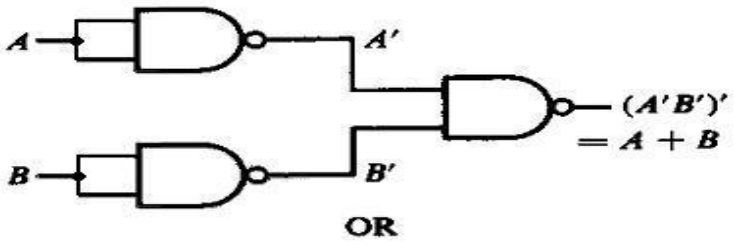
AND

NAND gates as OR gate

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

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

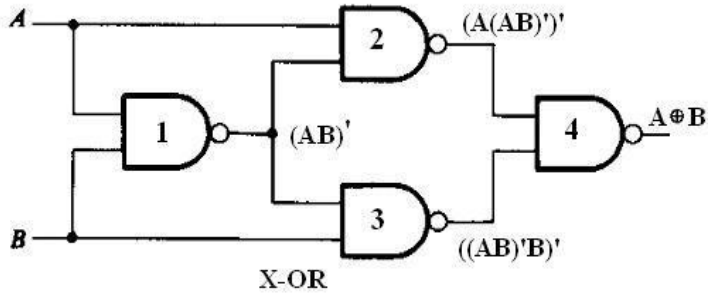
So, give the inverted inputs to a NAND gate, obtain OR operation at output.



OR

NAND gates as X-OR gate

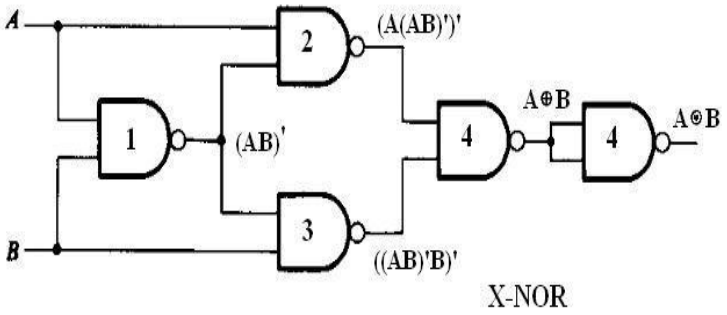
The output of a to input X-OR gate is shown by: Y = A'B + AB'. This can be achieved with the logic diagram shown in the left side.



NAND gates as X-NOR gate

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

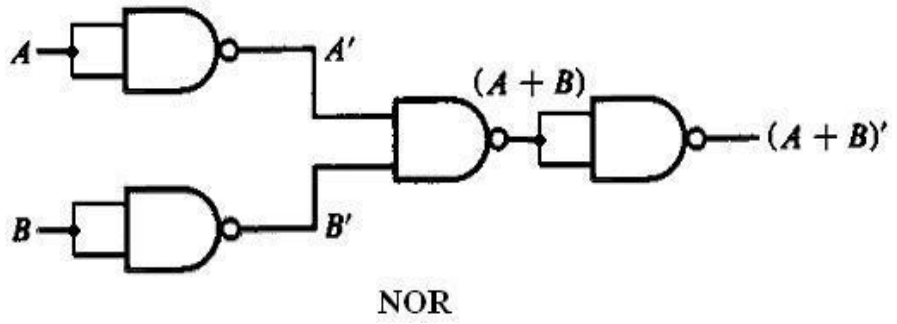
Y = AB+ A'B'



NAND gates as NOR gate

A NOR gate is an OR gate followed by a NOT gate. So connect the output of OR gate to a NOT gate, overall output is that of a NOR gate.

Y = (A + B)'



Theory:

NOR gate is actually a combination of two logic gates: OR gate followed by NOT gate. So its output is a complement of the output of an OR gate.

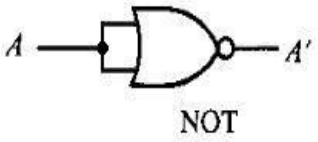
This gate can have a minimum of two inputs, output is always one. By using only NOR gates, we can realize all logic functions: AND, OR, NOT, X-OR, X-NOR, NAND. So this gate is also called the universal gate.

NOR gates as NOT gate

A NOT produces a 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)'

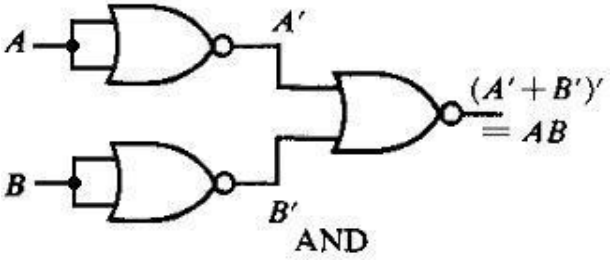
Y = (A)'



NOR gates as AND gate

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

(A'+B')' = A''B'' = AB

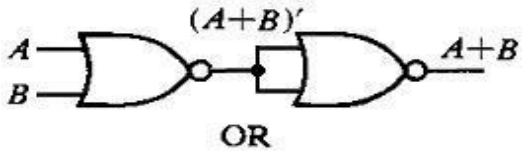


NOR gates as OR gate

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

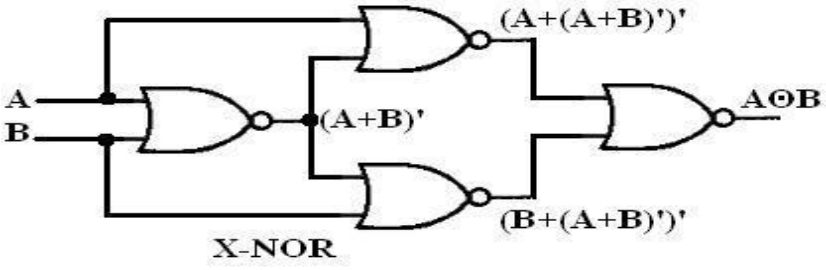
Y = ((A+B)')'

Y = (A+B)



NOR gates as X-NOR gate

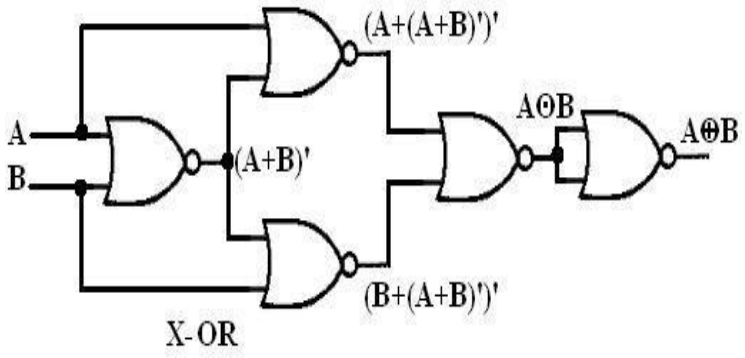
The output of a two input X-NOR gate is shown by: Y = AB + A'B'. This can be achieved with the logic diagram shown on the left side.



NOR gates as X-OR gate

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

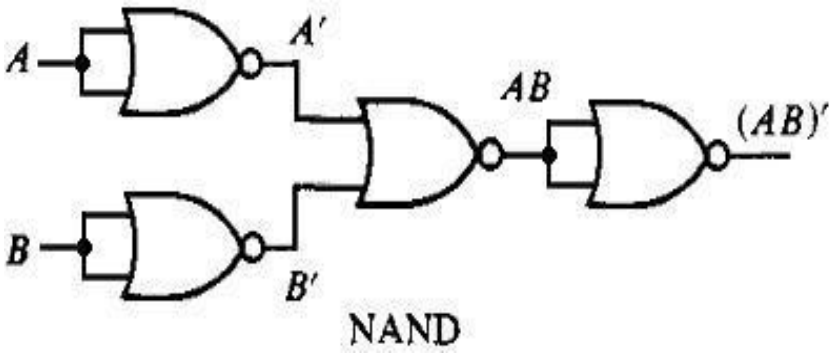
Y = A'B AB’



NOR gates as NAND gate

A NAND gate is an AND gate followed by a NOT gate. So connect the output of AND gate to a NOT gate, overall output is that of a NAND gate.

Y = (AB)’



<u>Procedure:</u>

1. Connect the trainer kit to a power supply.
2. Connect the NOR gates for any of the logic functions to be realised.
3. Connect the inputs of the first stage to logic sources and output of the last gate to the logic indicator.
4. Apply various input combinations and observe output for each one.
5. Verify the truth table for each input/ output combination.
6. Repeat the process for all logic functions.
7. Switch off the ac power supply.