Table of Contents

Objectives

- To study the realization of basic gates using universal gates (NAND & NOR).

Apparatus

- Power Supply
- Breadboard

Components

- ICs 7400 (quad 2-input NAND gate),
- 7402 (quad 2-input NOR gate),
- DIP Switch,
- LED

Theory

Universal Gates:

A universal gate is a gate which can implement any Boolean function without need to use any other gate type. The NAND and NOR gates are universal gates. In practice, this is advantageous since NAND and NOR gates are economical and easier to fabricate and are the basic gates used in all IC digital logic families. In fact, an AND gate is typically implemented as a NAND gate followed by an inverter not the other way around!! Likewise, an OR gate is typically implemented as a NOR gate followed by an inverter not the other way around!! . The **NOR gate and NAND gate** are universal gates. This means that you can create any logical Boolean expression using only NOR gates or only NAND gates.

NAND and NOR Gate as Universal Gate:

AND, OR, NOT are called basic gates as their logical operation cannot be simplified further To prove that any Boolean function can be implemented using only NAND and NOR gates, we will show that the AND, OR, and NOT operations can be performed using only these gates. Using NAND and NOR gates and De-Morgan's Theorems different basic gates & EX-OR gates are realized.

- ## Implementing an Inverter Using only NOR Gate

The figure shows two ways in which a NOR gate can be used as an inverter (NOT gate).

Figure NOT Implementation

- ## Implementing OR Using only NOR Gates

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)

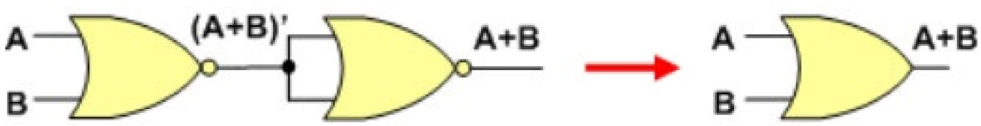


Figure : OR Implementation

- ## Implementing AND Using only NOR Gates

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)

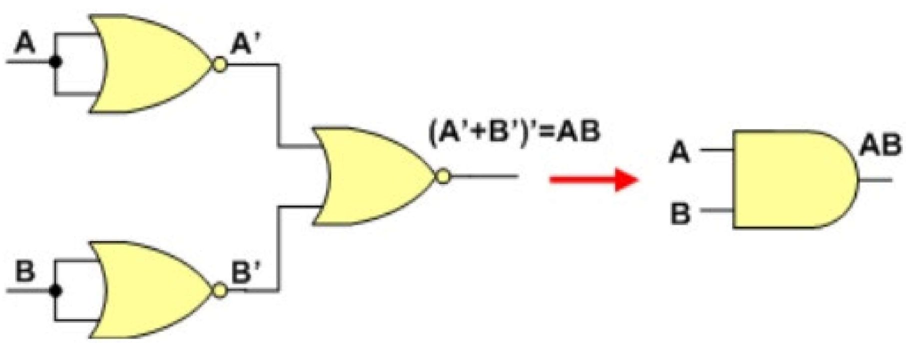


Figure : AND Implementation

Circuit Diagram

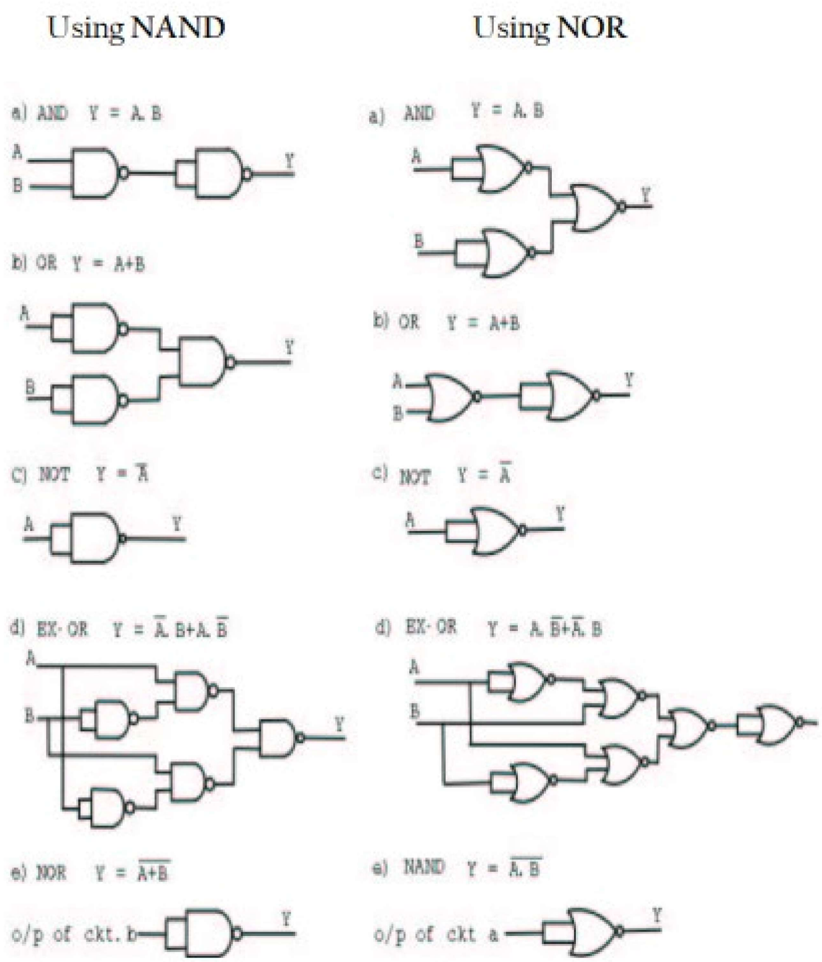


Figure: Circuit Diagram

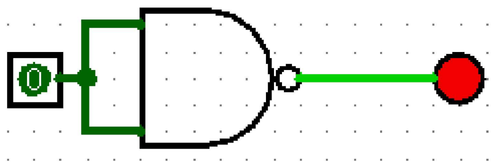
Procedure

1. Give biasing to the IC and do necessary connections as shown in the circuit diagram.
2. Give various combinations of inputs and note down output using LED.
3. Repeat the procedure for all gates.

Experiment

1) Implementation of Basic Gates Using only NAND Gates:

i) NOT

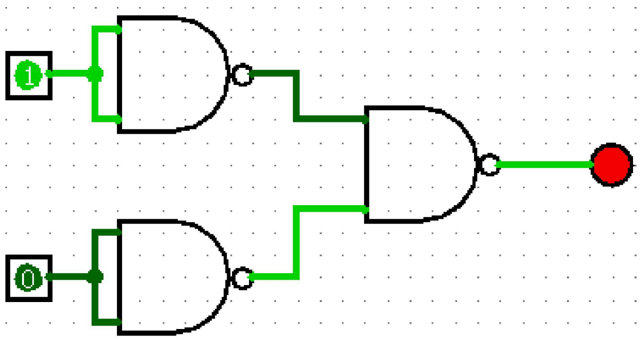


Truth Table

A	Y	Y Exp
1	0	0
0	1	1

Figure 1: NOT Gate

ii) OR

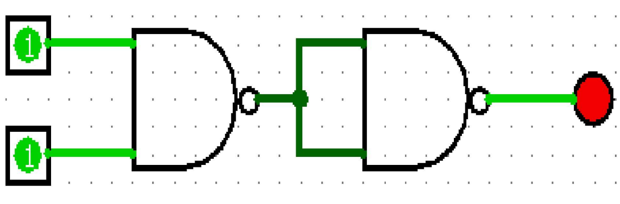


Truth Table

A	B	Y	Y_{Exp}
0	0	0	0
0	1	1	1
1	0	1	1
1	1	1	1

Figure 2: OR Gate

iii) AND



Truth Table

A	B	Y	Y_{Exp}
0	0	0	0
0	1	0	0
1	0	0	0
1	1	1	1

Figure 3: AND Gate

iv) NOR

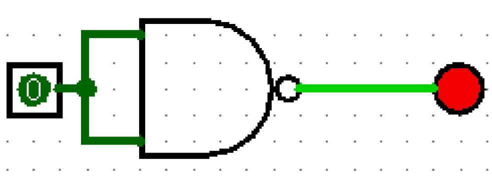


Figure 4: NOR Gate

v) XOR

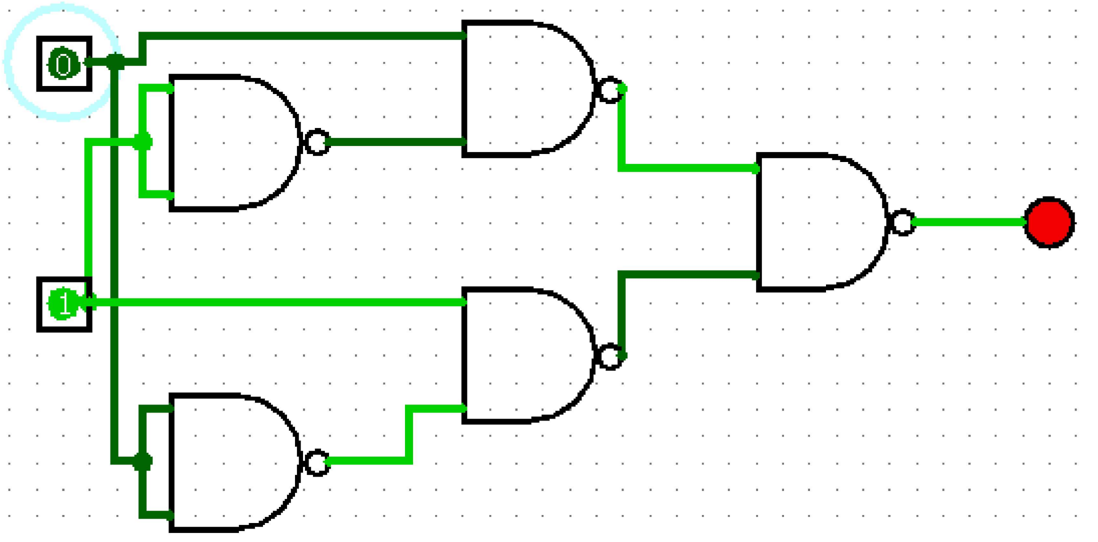


Figure 5: XOR Gate

XOR Gate Implementation was also performed on breadboard.

Truth Table

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

2) Implementation of Basic Gates Using only NOR Gates:

i) NOT

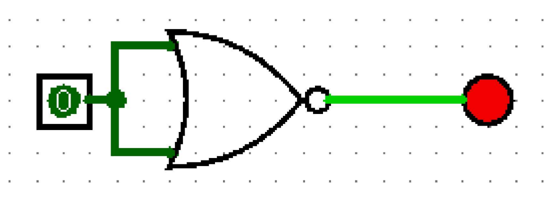


Figure 6: NOT Gate

Truth Table

A	Y	Y Exp
1	0	0
0	1	1

ii) OR

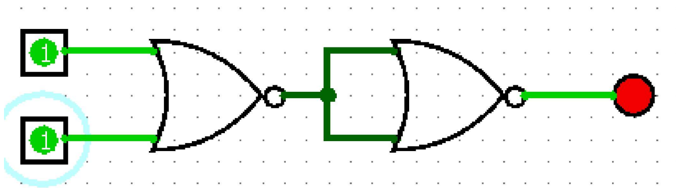


Figure 7: OR Gate

Truth Table

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

iii) AND

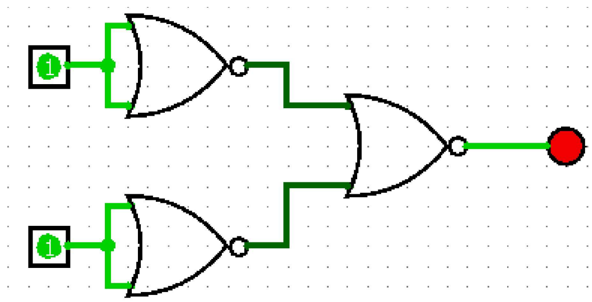
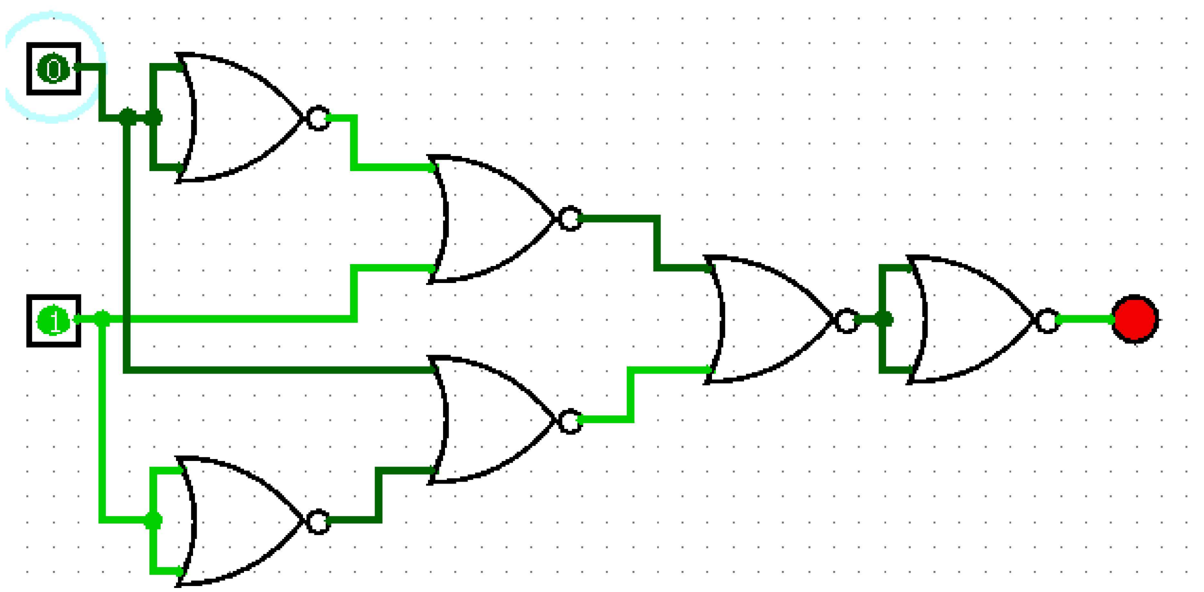


Figure 8: AND Gate

Truth Table

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

iv) XOR



Truth Table:->

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

v) NAND

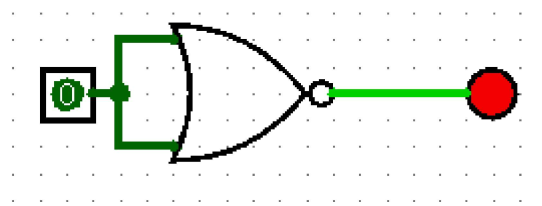
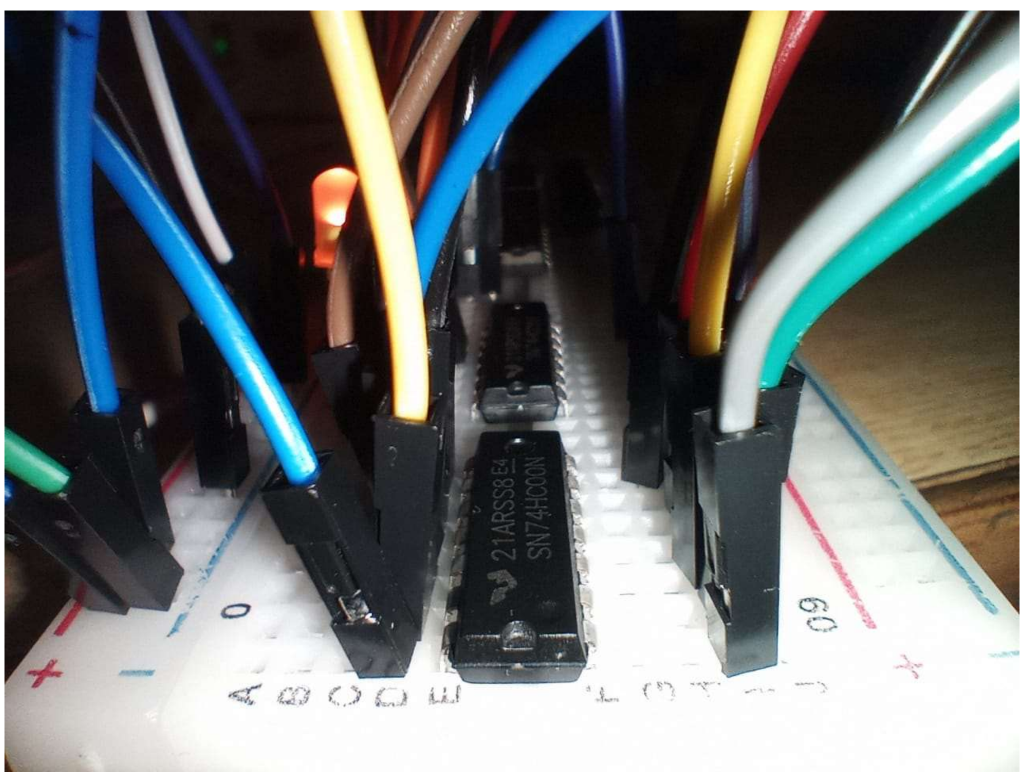


Figure 9: NAND Logic

Experiment Pictures

XOR Gate Implementation using NAND Gates Only:



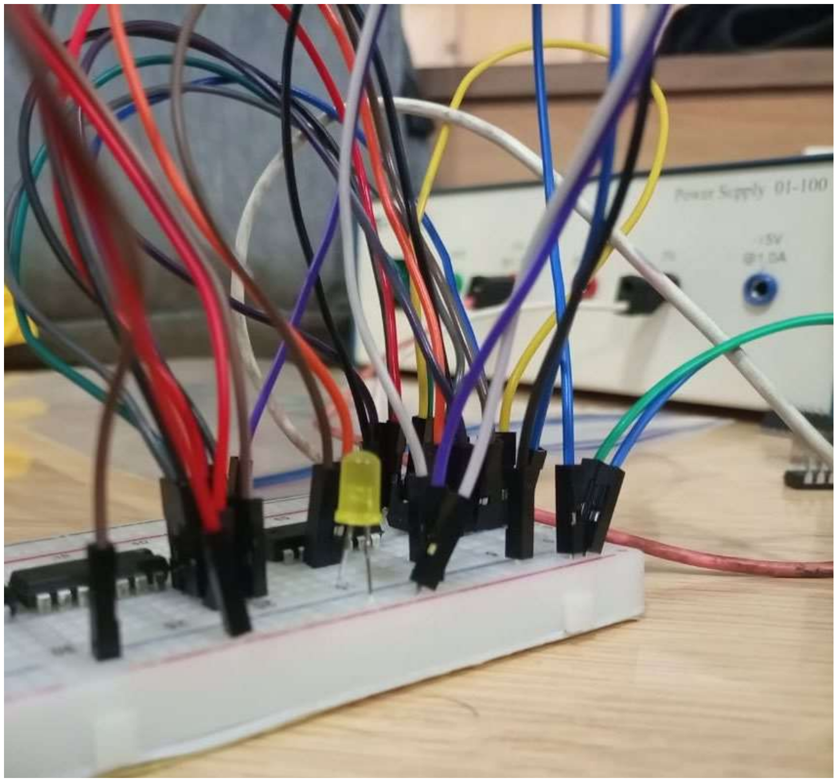


Figure: XOR Gate Implementation using NAND Gates Only

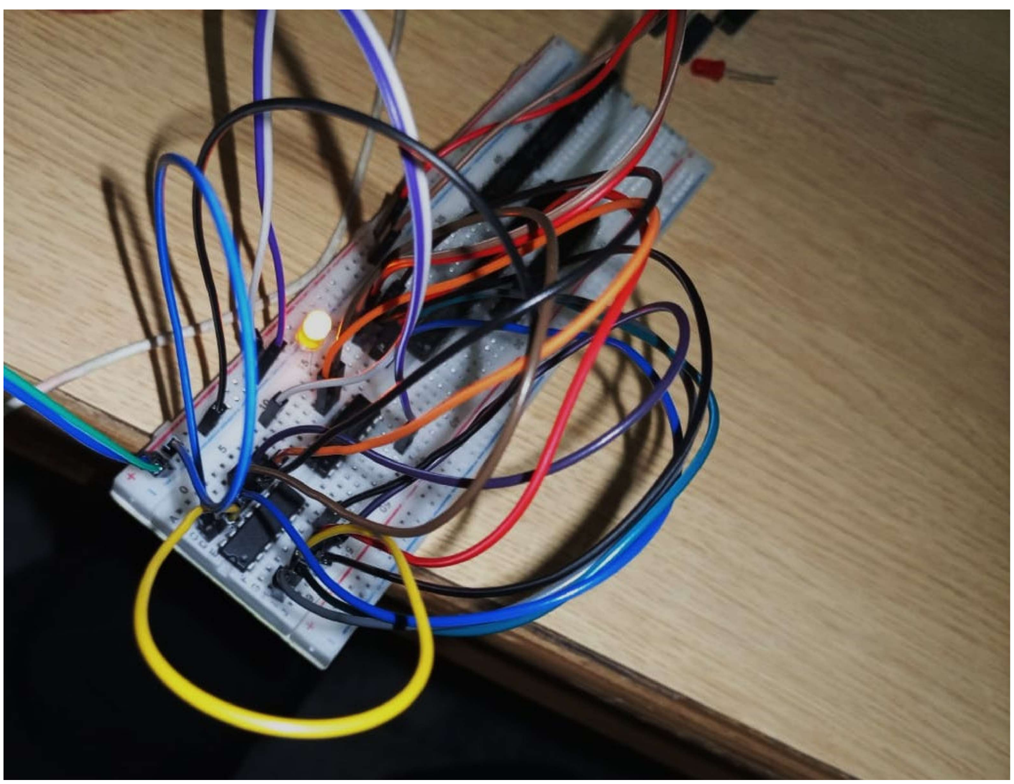


Figure: XOR Gate Implementation using NAND Gates Only

Truth Table from Experiment

A	B	Y	Y_{Exp}
0	0	0	0
0	1	1	1
1	0	0	0
1	1	1	1

Conclusion

Thus, universal gates were implemented physically on breadboard and some of them were studied using Logisim Simulation Software.

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