

EXPERIMENT 3

LOGIC GATES AND BOOLEAN ALGEBRA

OBJEJTIVE

Gain experience in truth table and Boolean algebra.

THEORY

THE AND GATE

The **AND** gate implements the Boolean **AND** function where the output only is logical 1 when all inputs are logical 1. The standard symbol and the truth table for an **AND** gate with two inputs is given below.

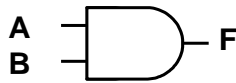


Figure 1 **AND** Gate symbol

A	B	F
0	0	0
0	1	0
1	0	0
1	1	1

Table 1 Truth table of **AND** Gate

The Boolean expression for the **AND** gate is $F = A.B$

THE OR GATE

The **OR** gate implements the Boolean **OR** function where the output is logical 1 when just input is logical 1. The standard symbol and the truth table for an **OR** gate with two inputs is given below.

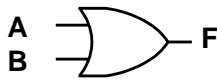


Figure 2 **OR** Gate

A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

Table 2 Truth table of **OR** Gate

The Boolean expression for the **OR** gate is $F = A + B$.

THE NOT GATE

The **NOT** gate implements the Boolean **NOT** function where the output is the inverse of the input. The standard symbol and the truth table for the **NOT** gate is given below.

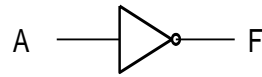


Figure 3 **NOT** Gate

A	F
0	1
1	0

Table 3 Truth table of **NOT** Gate

The Boolean expression for the **NOT** gate is $F = \bar{A}$

From these three basic logical gates it's to possible implement any Boolean expression into hardware.

THE NAND GATE

The **NAND** gate is an **AND** gate followed by a **NOT** gate. The output is logical 1 when one of the inputs is logical 0. The standard symbol and the truth table for the **NAND** gate is given below.

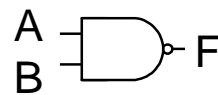


Figure 4 **NAND** Gate

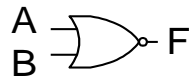
A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

Table 4 Truth table of **NAND** Gate

The Boolean expression for the **NAND** gate is $F = \overline{A \cdot B}$.

THE NOR GATE

The **NOR** is a combination of an **OR** followed by a **NOT** gate. The output is logical 1 when none of the inputs are logical 0. The standard symbol and the truth table for the **NOR** gate is given below.



A	B	F
0	0	1
0	1	0
1	0	0
1	1	0

Figure 5 **NAND** Gate

Table 5 Truth table of **NAND** Gate

The Boolean expression for the **NOR** gate is $R = \overline{A + B}$.

TRUTH TABLE

A truth table is a list of all the possible inputs and the corresponding outputs for a given system. The amount of possible inputs is determined by the amount of input variables. This value can be obtained by the formula 2^n .

Example: Determine the truth table for: $Y = A'B'C + ABC$.

Truth Table			
A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Table 6 Truth Table

BUILDING A CIRCUIT

In order to build a circuit from a truth table, we must first determine the Boolean expression for that particular truth table. Then the circuit can be constructed from multiple *AND* gates who's outputs all tie into one multiple input *OR* gate.

Looking at the truth table, we must first determine the Boolean expression. From the two instances where the output is high we obtain the following Boolean expression.

$$F = A'B'C + ABC$$

To build this circuit we need two 3-input AND gates, two Inverters, and a 2-input OR gate. The completed circuit is shown below:

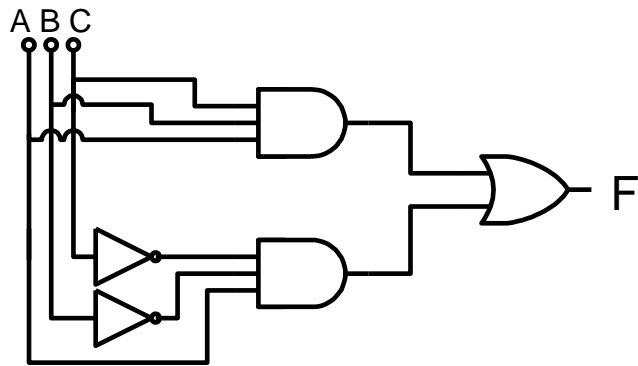


Figure 6 Logic Circuit

EXPERIMENTAL PROCEDURE

Equation $F = (A+B)C'$

- 1) Complete the Truth Table of the equation.
- 2) Implement equation by NAND gates.

Equipment List:

- 1) 74LS00 *NAND* GATE
- 2) Standard set equipments

