# Lab 1.5.3: Boolean Operations

**Estimated Time:** 25 Minutes

**Objective**

Upon completion of this lab, you will have been introduced to the AND, OR, NOR, and NOT Boolean operations. You will also be able to calculate the output of combinations of Boolean operations based on input.

**Equipment**

This is a written exercise.

**Scenario**

You are given a circuit board diagram. In order to figure out what each logic gate does, you must understand how Boolean operations function.

**Procedures**

This lab will help you learn to work with Boolean operations. Computers use Boolean operations to make calculations based on inputs of 0 (OFF) and 1 (ON). 0's and 1's are represented in computer microchips and the bus on the motherboard by the presence or absence of voltage. You will perform some basic calculations using the AND, OR, NOR, and NOT Boolean operations to get a better feel for how computers work internally. Complex combinations of these operations take place all the time in computers, and these calculations occur in millionths of a second.

## Step 1

The Boolean operations of AND, OR, NOR, and NOT work as follows:

| | | | |
|---|---|---|---|
| 0 OR 0 is 0 | 0 AND 0 is 0 | 0 NOR 0 is 1 | NOT 0 is 1 |
| 0 OR 1 is 1 | 0 AND 1 is 0 | 0 NOR 1 is 0 | NOT 1 is 0 |
| 1 OR 0 is 1 | 1 AND 0 is 0 | 1 NOR 0 is 0 | |
| 1 OR 1 is 1 | 1 AND 1 is 1 | 1 NOR 1 is 0 | |

The corresponding "truth tables" allow a compact way to represent these operations:

| OR | 0 | 1 |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 1 | 1 |

| AND | 0 | 1 |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 1 |

| NOR | 0 | 1 |
|---|---|---|
| 0 | 1 | 0 |
| 1 | 0 | 0 |

**Note:** AND, OR, and NOR are called binary operations (not to be confused with binary numbers) because the operations require two inputs. NOT is called a unary operation because it has only one input.

Look at the following combination of Boolean operations and determine the output.

(1 AND 0) OR (0 AND 1)

Compute the operations in parentheses first. 1 AND 0 is 0. 0 AND 1 is 0. So the solutions is 0 OR 0, which is 0.

As a second example, try to compute the following Boolean operations.

NOT [(1 AND 0) NOR (0 OR 1)] AND 1

Work from the inner parentheses toward the outer parentheses. Also, the NOT applies to the expression that follows it (the NOT does not apply to anything that appears after the "]"). So, following these instructions, you get NOT [0 NOR 1] AND 1, which is equivalent to NOT [0] AND 1, which is the same as 1 AND 1. This gives the result of 1.

## Step 2

For each of the following combinations of Boolean operations, compute the final output based on the rules for AND, OR, NOR, and NOT. Refer to the truth tables above for help on how to compute any given Boolean operation.

*Solve for the output. Your answer should be a 0 or a 1.*

Input: NOT (1 AND 0) AND 1

Output: _____

Input: 1 NOR {NOT [0 OR (1 NOR 1)]}

Output: _____

Input: 0 AND {1 AND [1 OR (0 NOR 0)] AND 0} – note that you have to work left to right through the expression.

Output: _____

Input: 1 AND NOT {[0 OR (1 OR 0)] NOR [1 AND NOT (0)]}

Output: _____

## Troubleshooting

As a PC Technician, understanding how data is stored in a computer can be a great troubleshooting tool.

## Reflection

How are Boolean Operations used in computer systems?

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