Experiment Title. 1

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Branch: CSE-AI/ML **Section/Group: 109-B**
Semester: II **Date of Performance: Jan 11, 2023**
Subject Name: Digital Electronics **Subject Code: 22ECH-101**

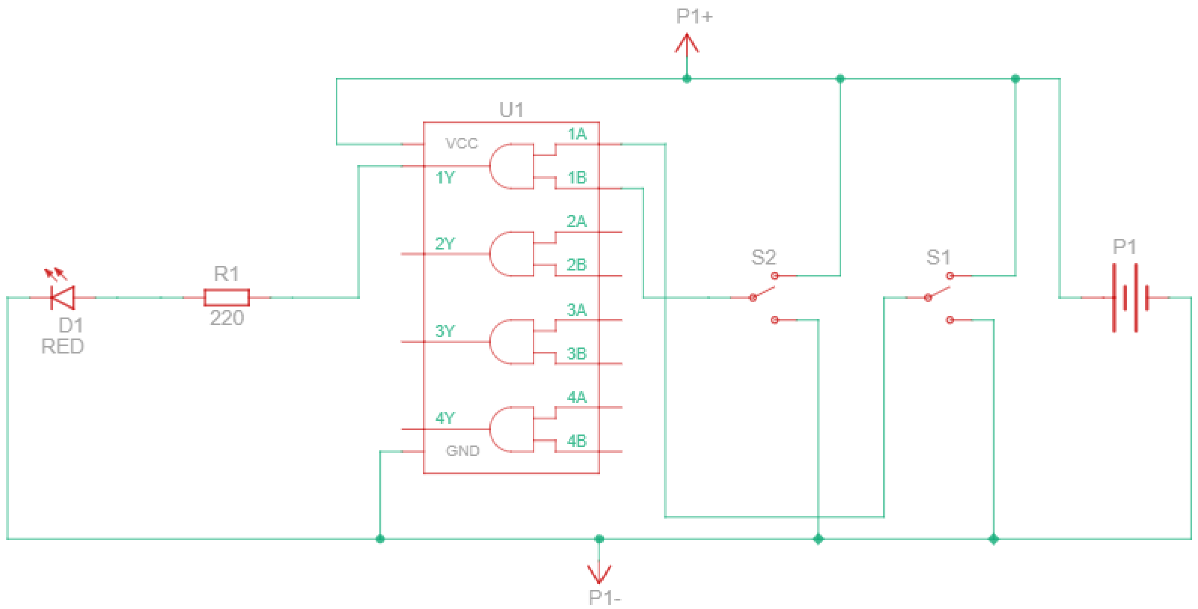
1. Aim: To Validate the Truth Tables of Logic Gates (AND,OR,NOT,NAND,NOR,XOR)

2. Requirements :

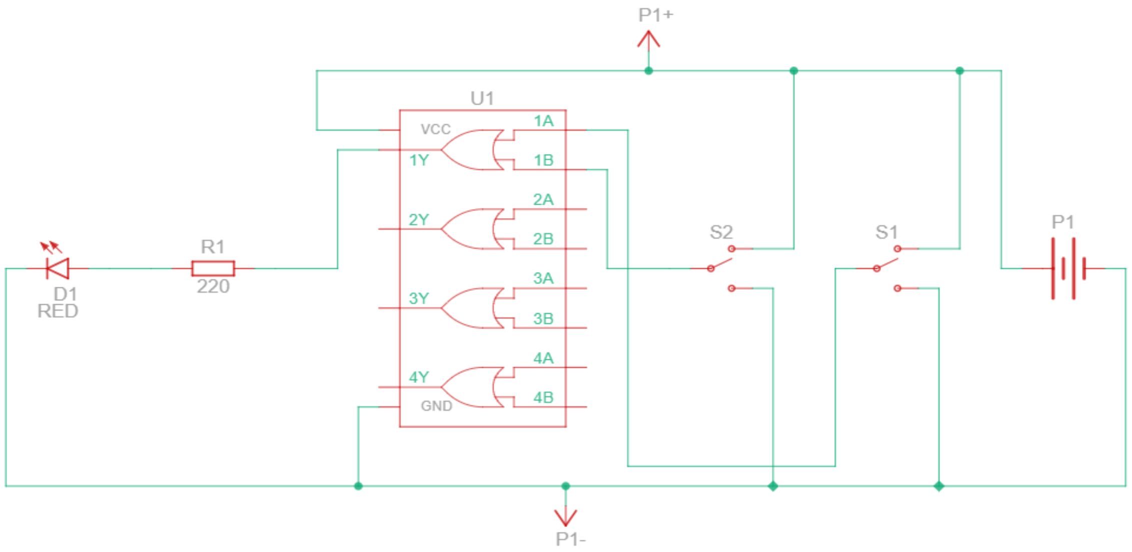
i. **Software :** TinkerCad
ii. **Hardware :** Breadboard, Connecting Wires, IC for 7400, 7402, 7404, 7408, 7432, 7486, Power Supply, 2 Slideswitch , 220 ohm resistor, LED.

3. Circuit Diagram:

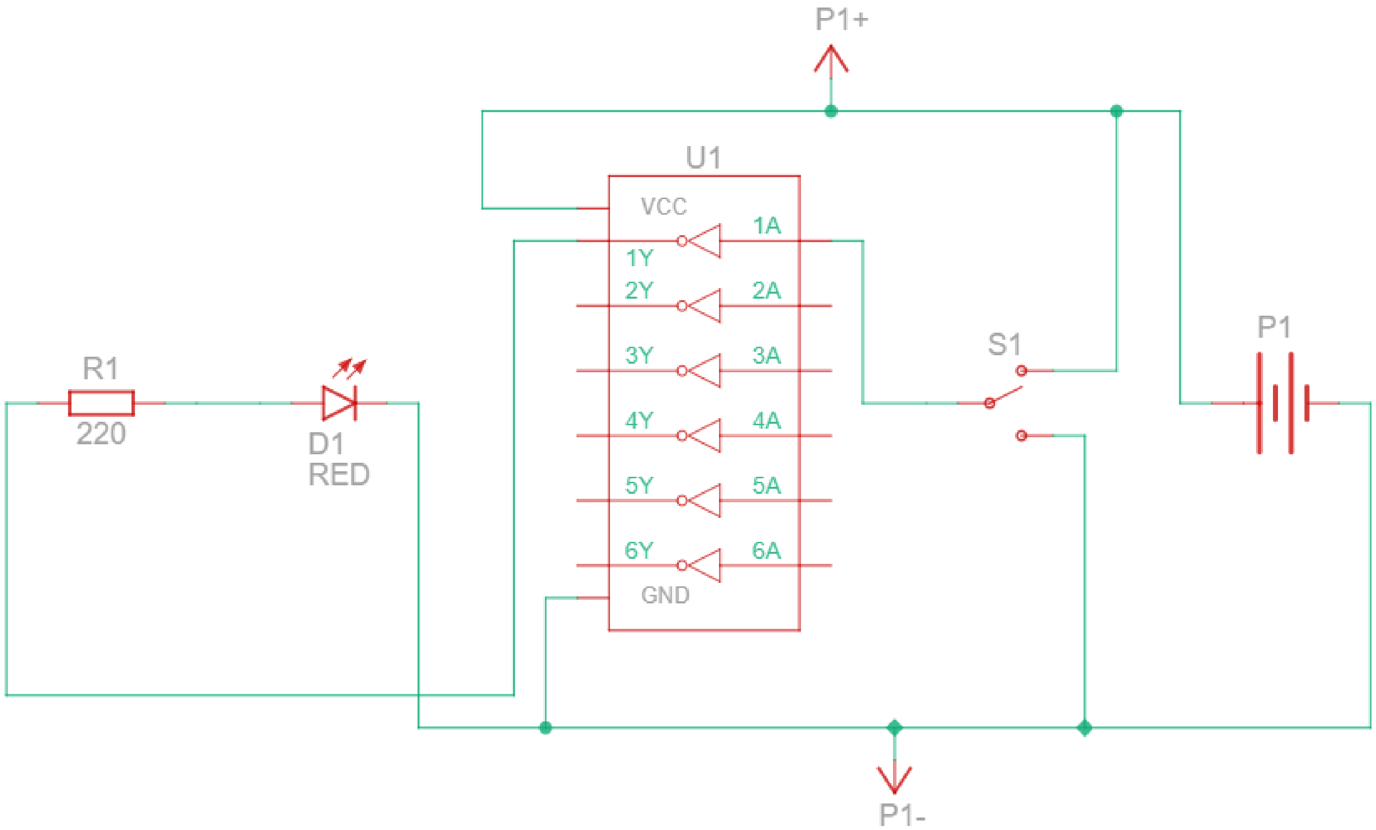
(a) Schematic Diagram for AND Gate :



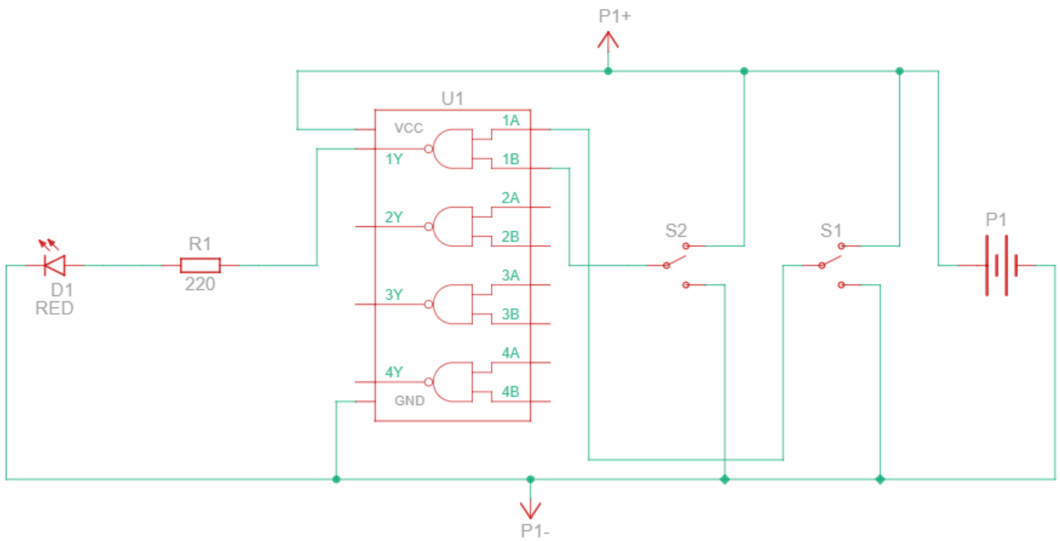
(b) Schematic Diagram for OR Gate :



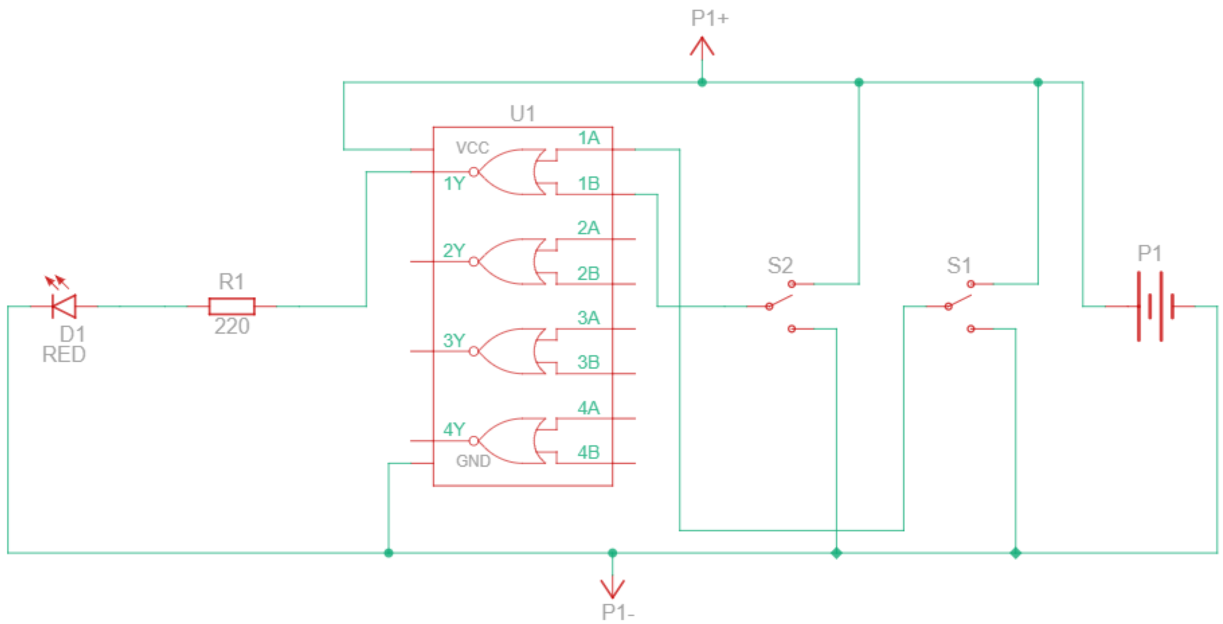
(c) Schematic Diagram for NOT Gate :



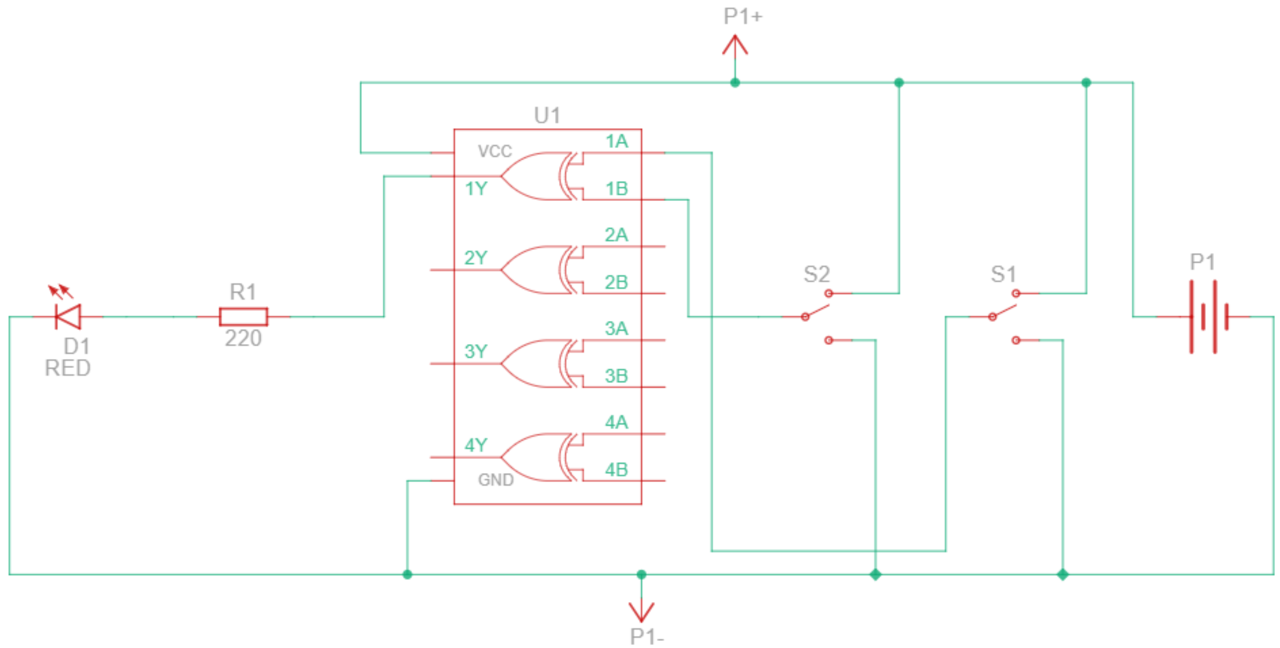
(d) Schematic Diagram for NAND Gate :



(e) Schematic Diagram for NOR Gate :

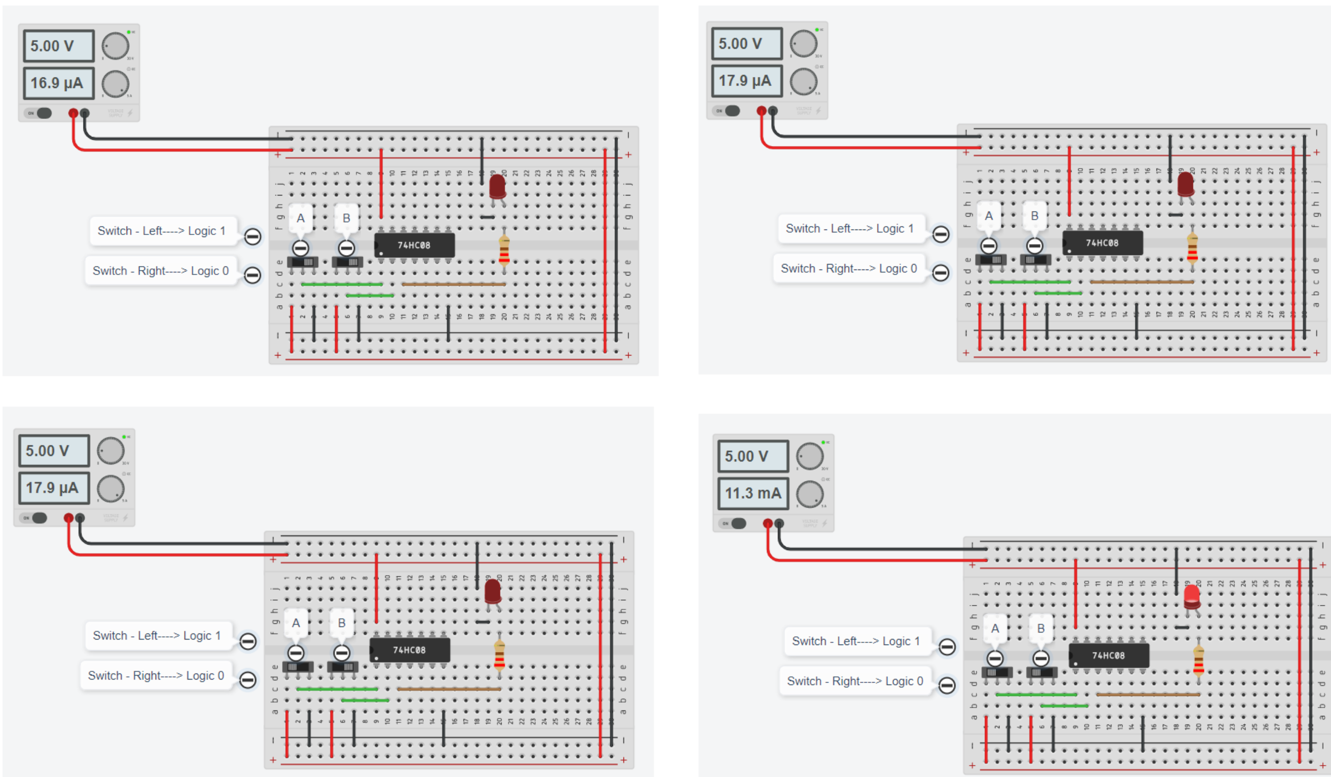


(f) Schematic Diagram for XOR Gate :

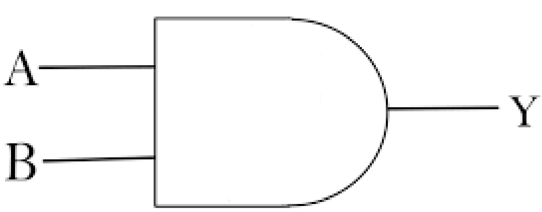


4. Simulation Results :

(a) AND Gate



Concept Used : An AND gate is a fundamental logic gate in digital electronics that take in two or more binary inputs and produces a single binary output, which is high (1) only if all of the inputs are high (1).
The AND gate is represented by the symbol shown below, which has two inputs (A and B) and one output (Y).



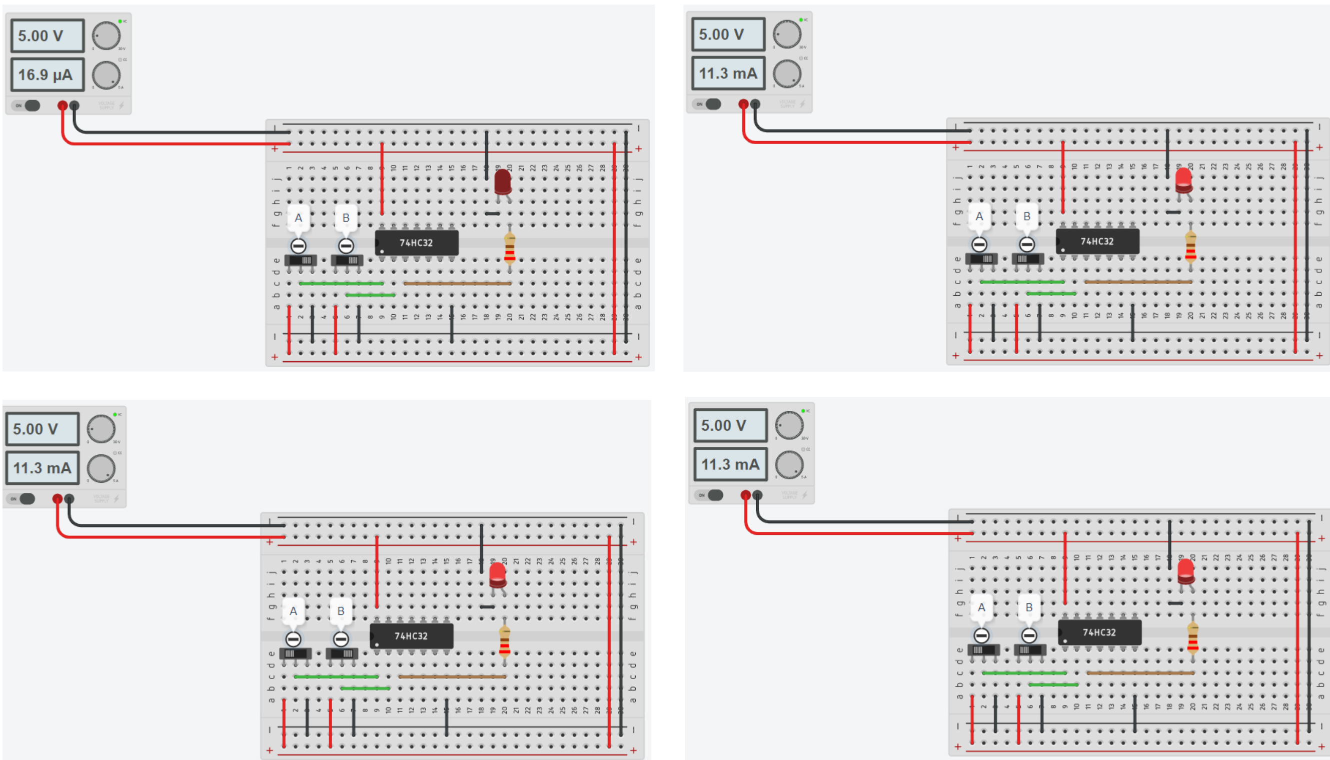
The output of AND gate is determined by the logical operation of multiplication. If both inputs are 1, the output is 1. Otherwise, the output is 0.
The truth table for an AND gate is as follows :

Truth Table :

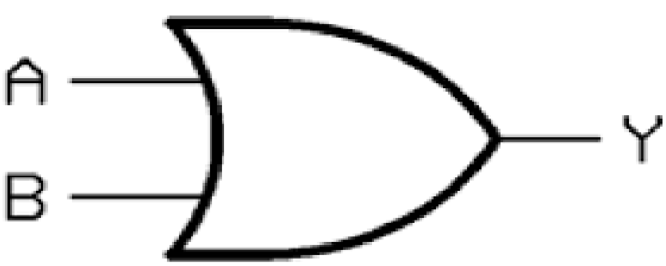
Input		Output
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

For example, if input A is 1 and input B is 1, the output Y is 1. However, if either input A or input B is 0, the output Y is 0.
The AND gate is a fundamental building block of digital logic circuit and is used in many applications, such as in design of the microphones, memory units and control units.

(b) OR Gate



Concept Used : AN OR gate is a digital logic gate that performs a logical OR operation on its input signals. An OR gate has two or more input terminals and one output terminal. The output of an OR gate is “true” or 1 if at least one of its input signals is “true” or “1”. If all of the input signals are “false” or “0”, then the output of the OR gate is also “false” or “0”.
The OR gate is represented by the symbol shown below, which has two inputs (A and B) and one output (Y).



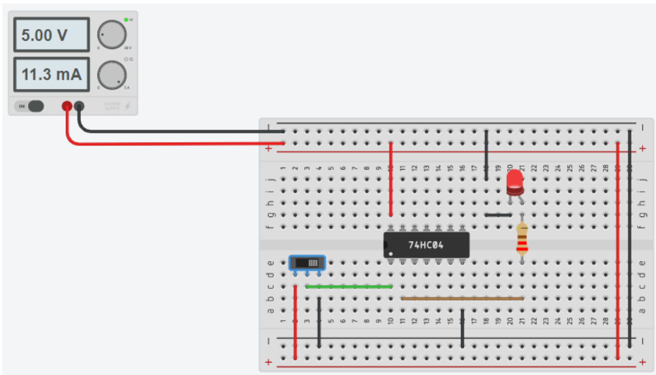
The output of OR gate is the logical sum of its input signals. In other words, the output is true if either of the input signal is true or if both are true.
The truth table for an OR gate is as follows :

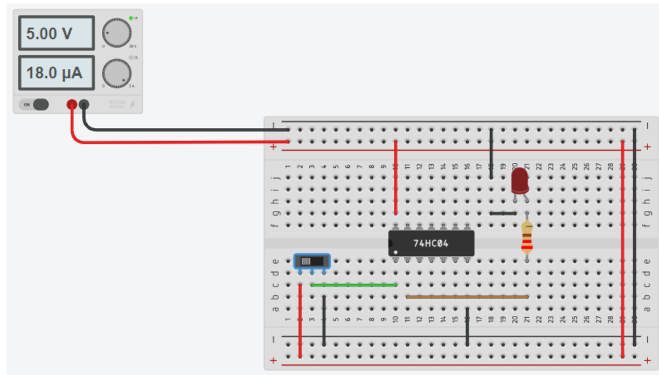
Truth Table :

Inputs		Output
A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

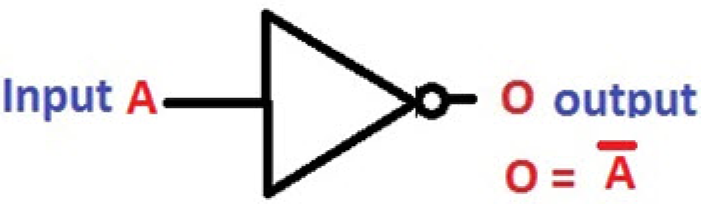
This makes the OR gate a useful building block in digital circuits where multiple inputs need to be combined in a way that it is sensitive to the presence of any of one of them. For example, OR gates are commonly used in the design of electronic circuits that control lightning, heating, and other household appliances.

(c) NOT Gate





Concept Used : A NOT gate is a digital logic gate that performs a logical NOT operation on its input signal. A NOT gate has one input terminal and one output terminal. The output of a NOT gate is the opposite (or inverse) of its input signal. If the input is “true” or “one”, the output is “false” or “0”, and if the input is “false” or “0”, the output is “true” or “1”.
The OR gate is represented by the symbol shown below, the input is usually labelled A, and the output is labelled O.



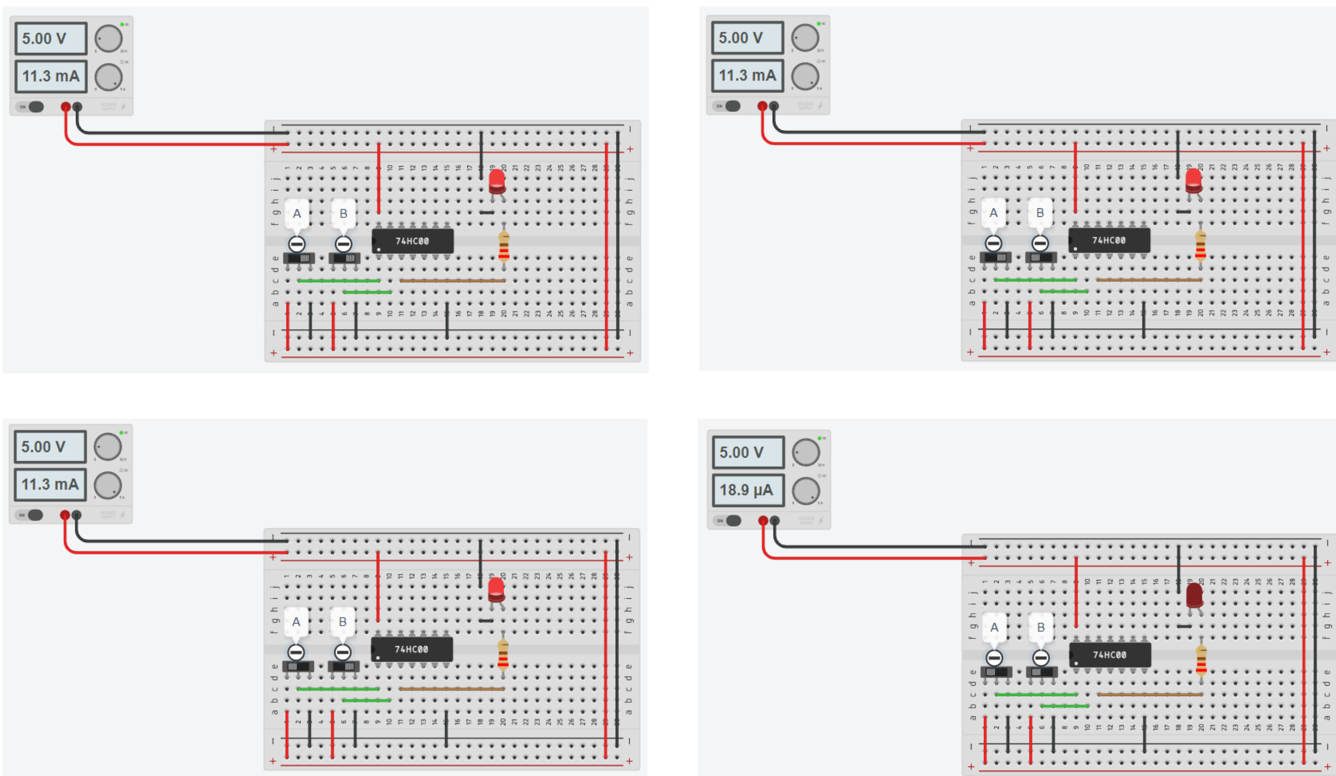
The NOT gate is sometimes referred to as an inverter because it “inverts” the input signal. The truth table for a NOT gate is shown below :

Truth Table :

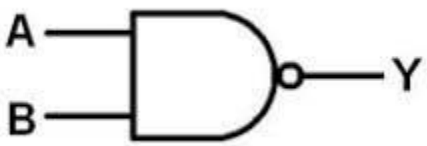
Inputs	Output
A	O
0	1
1	0

It is a fundamental building block in digital circuits, used to compliment or invert a signal as needed. For example, NOT gates can be used to convert a positive logic signal (where "1" represents "true") to a negative logic signal (where "0" represents "true"), or vice versa. NOT gates are also used in combination with other gates to perform more complex logic operations.

(d) NAND Gate



Concept Used : NAND is and abbreviation for "NOT AND". A two-input NAND gate is a digital combination logic circuit that performs the logical inverse of an AND gate. While an AND gate outputs a logical "1" only if both inputs are logical "1", a NAND gate outputs a logical "0", for this same combination of inputs.
The symbol and truth table for a NAND gate is shown below :



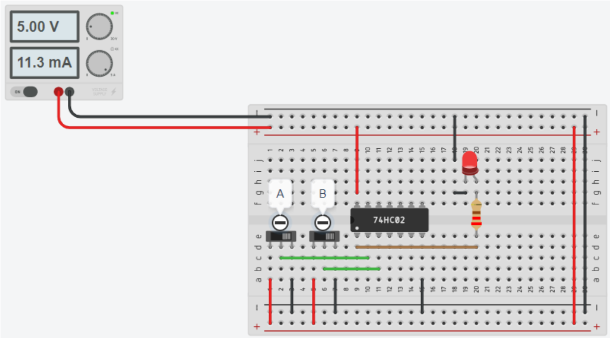
The output of a NAND gate is high when either of the inputs is high or if both the inputs are low. In other words, the output is always high and goes low only when both the inputs are high. The truth table for NAND gate is shown below :

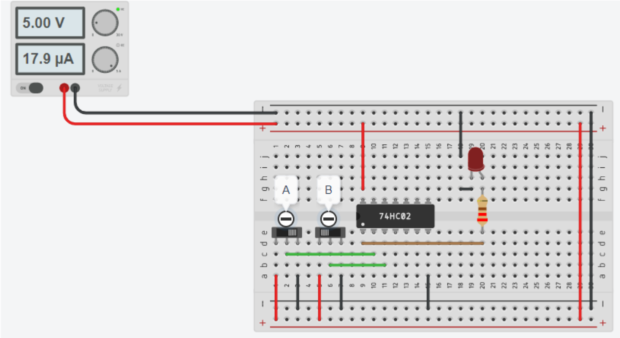
Truth Table :

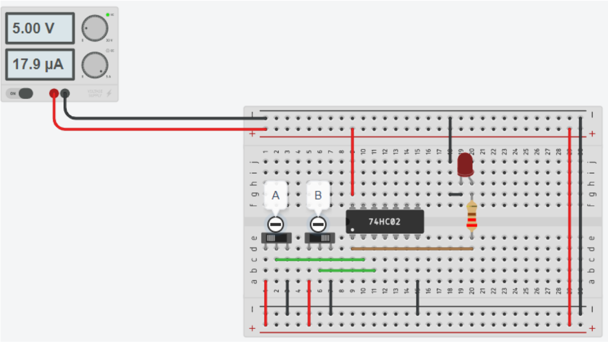
Input		Output
A	B	Y= $\overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

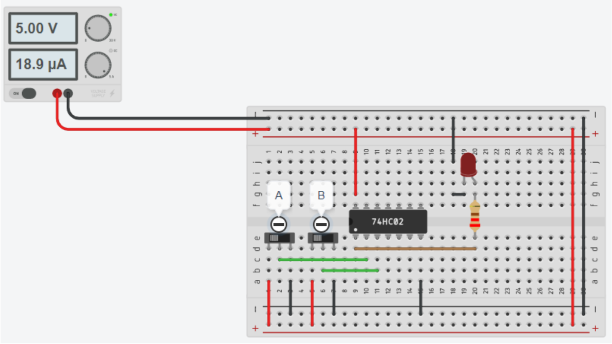
NAND gates help detect if a signal input to a digital system has gone low. For example, a simple security system consisting only of NAND gates could be used to monitor the status of sensors connected to windows and/or doors. If a windows/door is closed, the sensor sends a logical “1” signal to the security system. While all windows and doors are closed, the alarm output is “0”. If a single window or door is opened, the security system output changes state to become “1” and this can be used to trigger an alarm or take some other action.

(e) NOR Gate

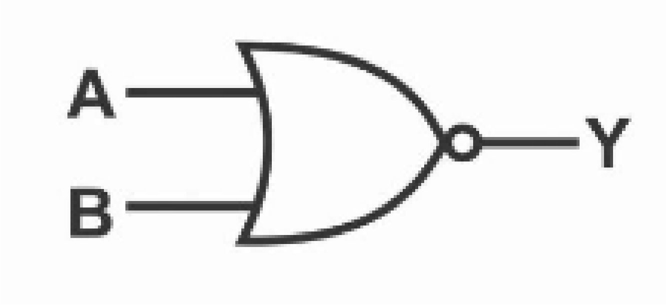








Concept Used : A NOR gate is a type of logic gate used in digital circuits. It takes in two inputs and produces a single output. The output of a NOR gate is "true" or "1" only when all of its inputs are "false" or "0".
The symbol for NOR gate is shown below :



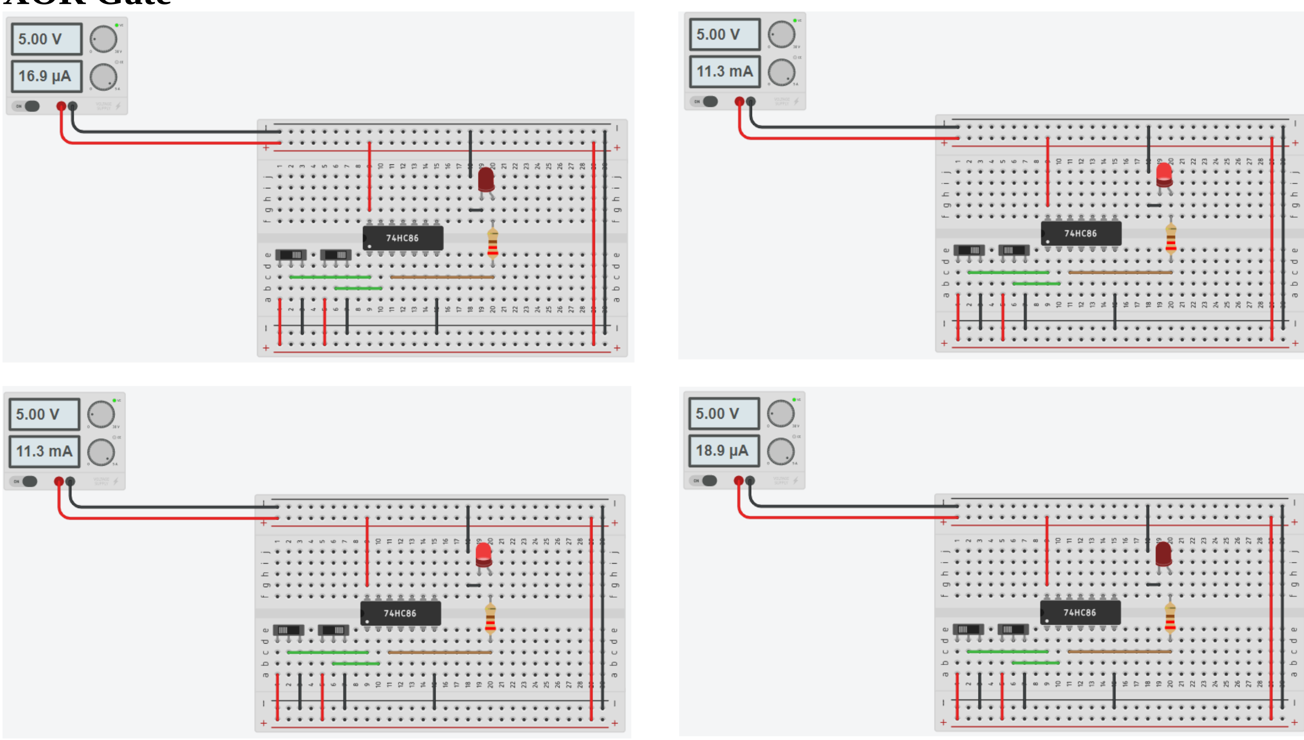
A NOR gate is the opposite of an OR gate, where the output is "true" or "1" if any of the inputs are "true" or "1".
The truth table for a NOR gate is as follows :

Truth Table :

Input		Output
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

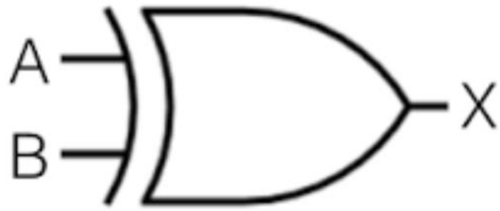
The output of a NOR gate is often used as an input to other logic gates in a digital circuit, and it is commonly used in circuits where it is necessary to determine if two or more conditions are false.

(f) XOR Gate



Concept Used : An XOR gate is a digital logic gate that performs a logical operation on two input signals. The output of an XOR gate is "true" or "1" only when exactly one of its inputs is "true" or "1". If both inputs are "true" or "false", the output is "false" or "0".

The symbol for XOR gate is shown below :



In simple terms, an XOR gate produces a "true" output if the input signals are different, and a "false" output if the input signals are the same.
The truth table for XOR gate is shown below :

Truth Table :

Inputs		Output
A	**B**	**X**
0	0	0
0	1	1
1	0	1
1	1	0

This behaviour is useful in digital circuits for tasks such as error detection, data encryption, and switching between two inputs.

5. Observations : Validating the truth tables of logic gates involves analyzing the behavior of different logic gates and verifying that their outputs match their expected truth values for all possible input combinations. Here are some observations that can be made during this process:

1. **AND gate:** The AND gate produces an output of 1 only when both of its inputs are 1. When one or both inputs are 0, the output is 0. This behaviour is consistent with the AND gate's truth table.

2. **OR gate:** The OR gate produces an output of 1 when one or both of its inputs are 1. It produces an output of 0 only when both inputs are 0. This behaviour is consistent with the OR gate's truth table.

3. **NOT gate:** The NOT gate produces an output that is the opposite of its input. When the input is 1, the output is 0, and when the input is 0, the output is 1. This behaviour is consistent with the NOT gate's truth table.

4. **XOR gate:** The XOR gate produces an output of 1 only when its two inputs are different (i.e., one input is 1 and the other is 0). When both inputs are the same (i.e., both 0 or both 1), the output is 0. This behaviour is consistent with the XOR gate's truth table.

5. **NAND gate:** The NAND gate produces an output of 0 only when both of its inputs are 1. When one or both inputs are 0, the output is 1. This behaviour is consistent with the NAND gate's truth table.

6. **NOR gate:** The NOR gate produces an output of 0 when one or both of its inputs are 1. It produces an output of 1 only when both inputs are 0. This behaviour is consistent with the NOR gate's truth table.

Observing and verifying the output behaviour of logic gates using their truth tables is an important step in digital electronics, as it helps ensure that the circuits are functioning as expected and that the logical operations are being carried out correctly.

6. Troubleshooting:

1. Messy Circuit Connection & loose connection.

2. **Incorrect gate implementation:** Another error that can occur is when the gate is not implemented correctly. For example, if you are testing an AND gate and accidentally implement an OR gate instead, you will get incorrect results. Double-check your gate implementation to make sure it matches the logic symbol for the gate you are testing.

3. **Faulty equipment:** Finally, it's possible that the error is not related to the gate or the truth table, but rather to faulty equipment. Make sure that your testing equipment is working properly and is calibrated correctly.

7. Result: The Truth Tables of logic gates AND, OR, NOT, NAND, NOR, XOR was verified.

Learning outcomes (What I have learnt):

1. Understanding the concept of logic gates.

2. Identifying the logical function of a gate.

3. Evaluating the performance of a circuit.

4. Verifying the correctness of a gate.

Evaluation Grid:

Sr. No.	Parameters	Marks Obtained	Maximum Marks
1.	Worksheet completion including writing learning objectives/Outcomes.(To be submitted at the end of the day).		12
2.	Viva		8
3.	Student Engagement in Simulation/Demonstration/Performance and Controls/Pre-Lab Questions.		10
	Signature of Faculty (with Date):	Total Marks Obtained:	