Q#1:

Verify the truth table for logic gates (AND, OR, NOT, NAND, XOR) with the help of experiment by using logic gate kit.

Ans:

Logic gates are idealized or physical devices implementing a Boolean function, which it performs a logical operation on one or more logical inputs and produce a single output. Depending on the context, the term may refer to an ideal logic gate, one that has for instance zero rise time and unlimited fan out or it may refer to anon-ideal physical device.

Basically, logic gates are electronic circuits because they are made up of number of electronic devices and components. Inputs and outputs of logic gates can occur only in two levels. These two levels are term HIGH and LOW, or TRUE and FALSE, or ON AND off, OR SIMPLY 1 AND 0.

A table which lists all possible combinations of input variables and the corresponding outputs is called a **truth table**. It shows how the logic circuit's output responds to various combinations of logic levels at the inputs.

The main hierarchy of logic gates as follows

1. Basic Gates
2. Universal Gates
3. Advanced Gates

Basic Gates	**Universal Gates**	**Advanced Gates**
AND	NAND	XOR
OR	NOR	XNOR
NOT		

Experiment Procedure

1) Equipment Needed

1. Logic Gate ICs:
   - AND gate (7408)
   - OR gate (7432)
   - NOT gate (7404)
   - NAND gate (7400)
   - XOR gate (7486)
2. Breadboard
3. Connecting wires
4. Power supply (Typically +5V and GND)
5. Switches (for inputs)
6. LEDs (for output indication)
7. Resistors (typically 220Ω for current limiting with LEDs)

3) Pin Configuration

- Pin 7: GND — Pin 14: Vcc (+5V)
- Pins 1, 2: Input A, B — Pin 3: Output

Similar configuration for other gates on the IC

2) Steps for Verification

1. Set Up the Breadboard
   - Connect the power supply (typically +5V and GND) to the breadboard.
   - Place the ICs corresponding to each logic gate on the breadboard (e.g., 7408 for AND, 7432 for OR, 7404 for NOT, 7400 for NAND, 7486 for XOR).
2. Connect Inputs and Outputs

- Connect switches to the inputs of the gate. Label the switches as A and B for the two inputs.
- Connect LEDs to the outputs through current-limiting resistors to indicate the output state.

3. Verify Each Gate

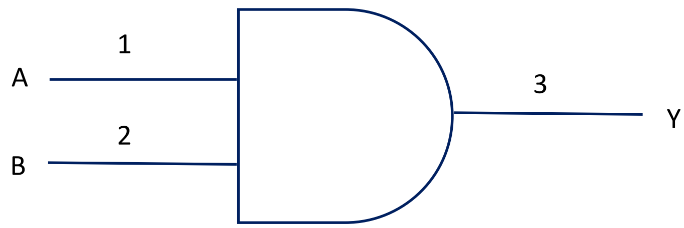
1) AND GATE (7408)

- An AND gate has two or more inputs but only one output. The output assumes the logic 1 state only when each one of its inputs is at logic 1 state. The output assumes logic 0 state even if one of its inputs is at logic 0 state. AND gate is also called an “all or nothing” gate. The symbol for AND operation is“. “
- With input variables A & B the Boolean expression for output can be written as **X = A.B**

Truth table

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

Logic symbol

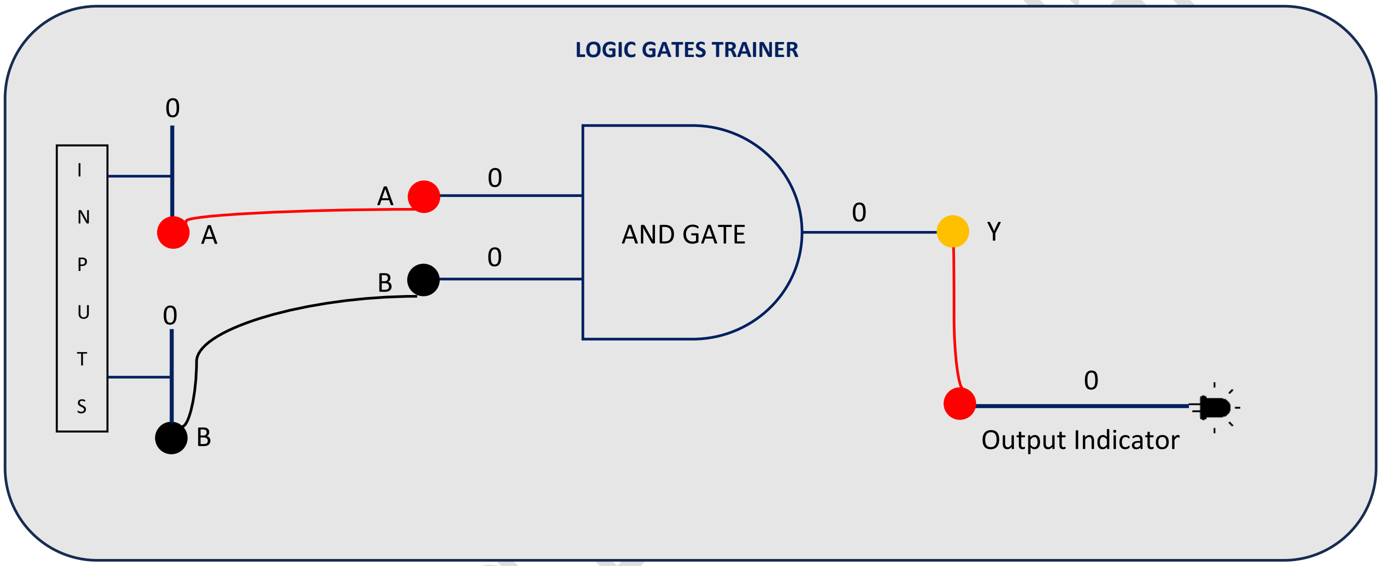


X = A.B

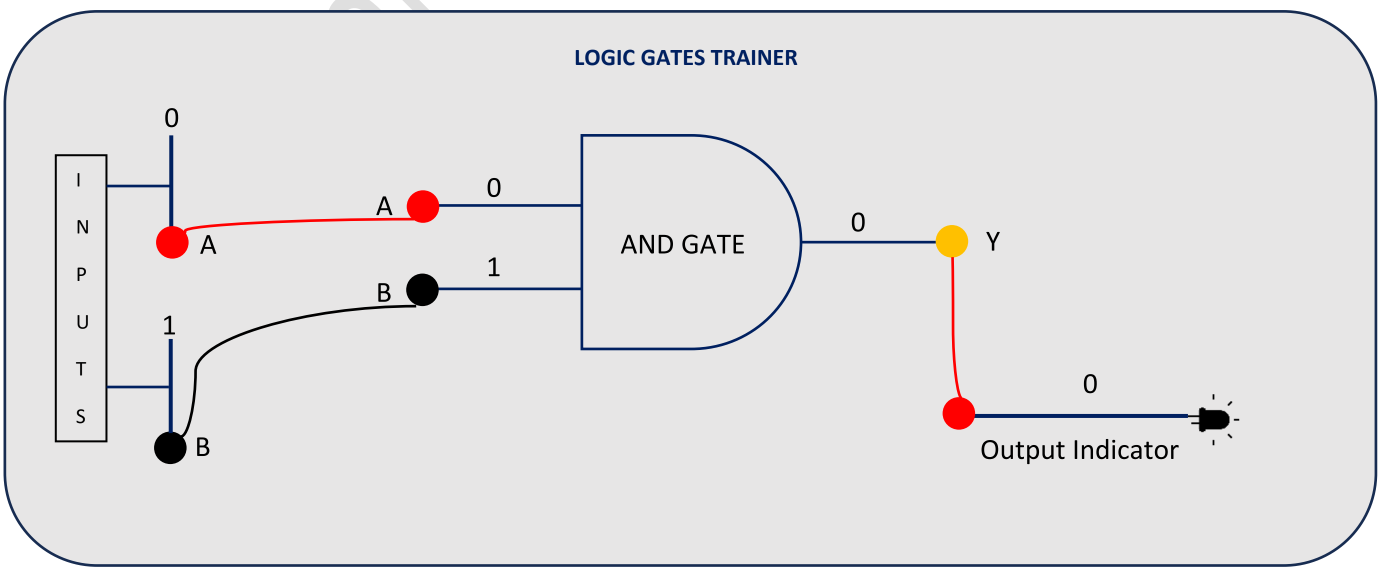
Experiment

1. Connect the switches to inputs A and B.
2. Connect the output to an LED.
3. Toggle the switches to test all input combinations and observe the LED.

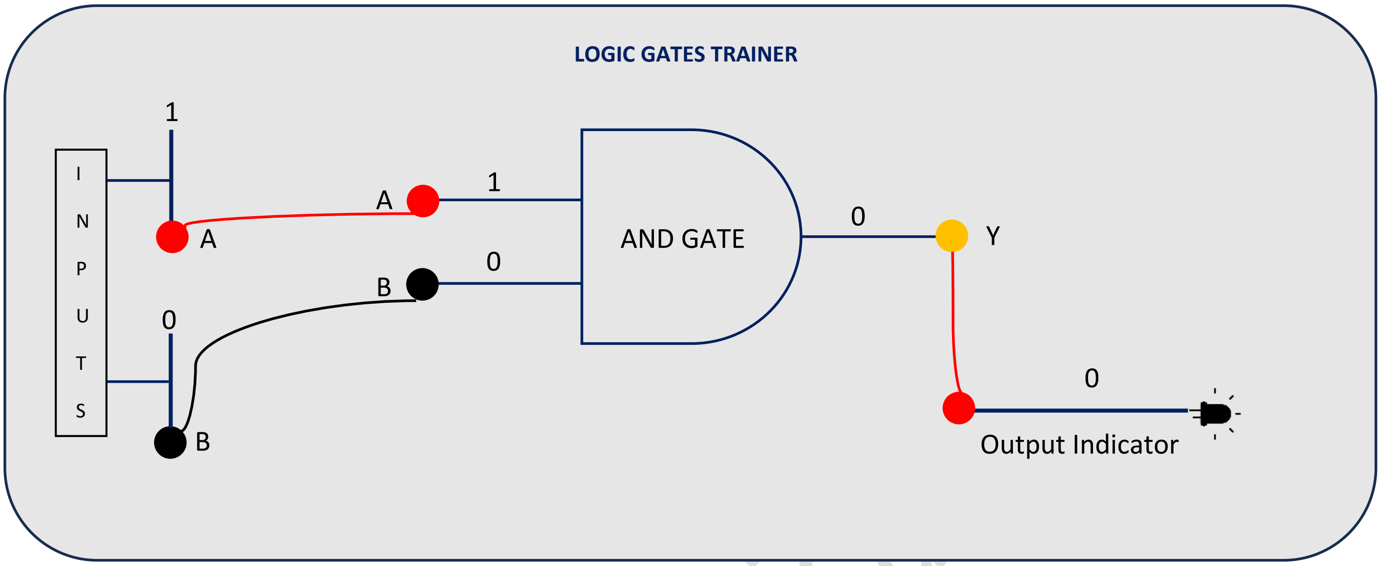
Experiment 01



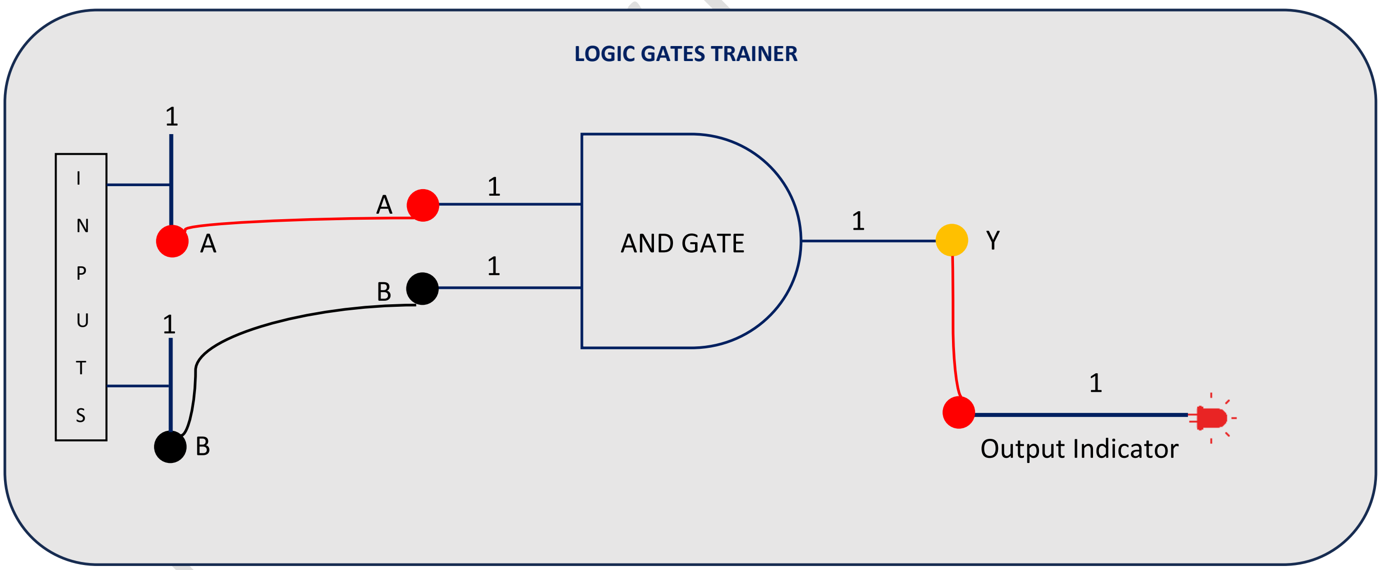
Experiment 02



Experiment 03



Experiment 04



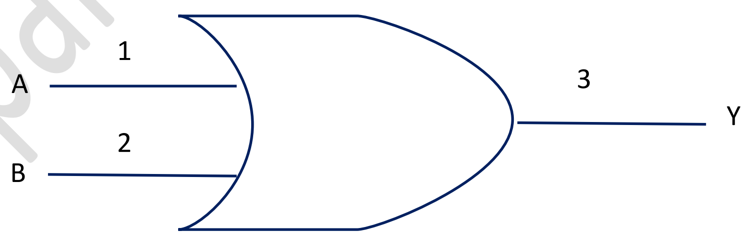
2) OR GATE (7432)

- Like an AND gate, an OR gate may have two or more inputs but only one output. The output assumes the logic 1 state, even if one of its inputs is in logic 1 state. Its output assumes logic 0 state, only when each one of its inputs is in logic 0 state. OR gate is also called an "any or all" gate. It can also be called an inclusive OR gate because it includes the condition "both the input can be present". The symbol for OR operation is "+".
- With input variables A & B the Boolean expression for output can be written as **X = A + B**

Truth table

A	B	Y
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**1**

Logic symbol

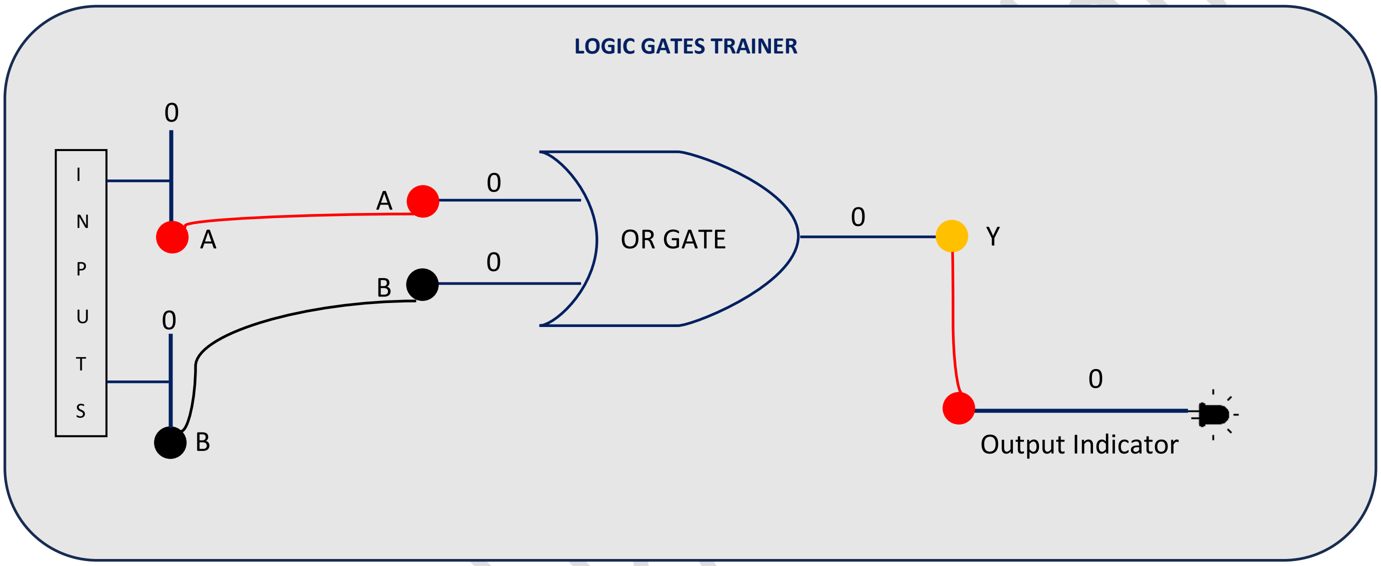


X = A+B

Experiment

1. Connect the switches to inputs A and B.
2. Connect the output to an LED.
3. Toggle the switches to test all input combinations and observe the LED.

Experiment 01



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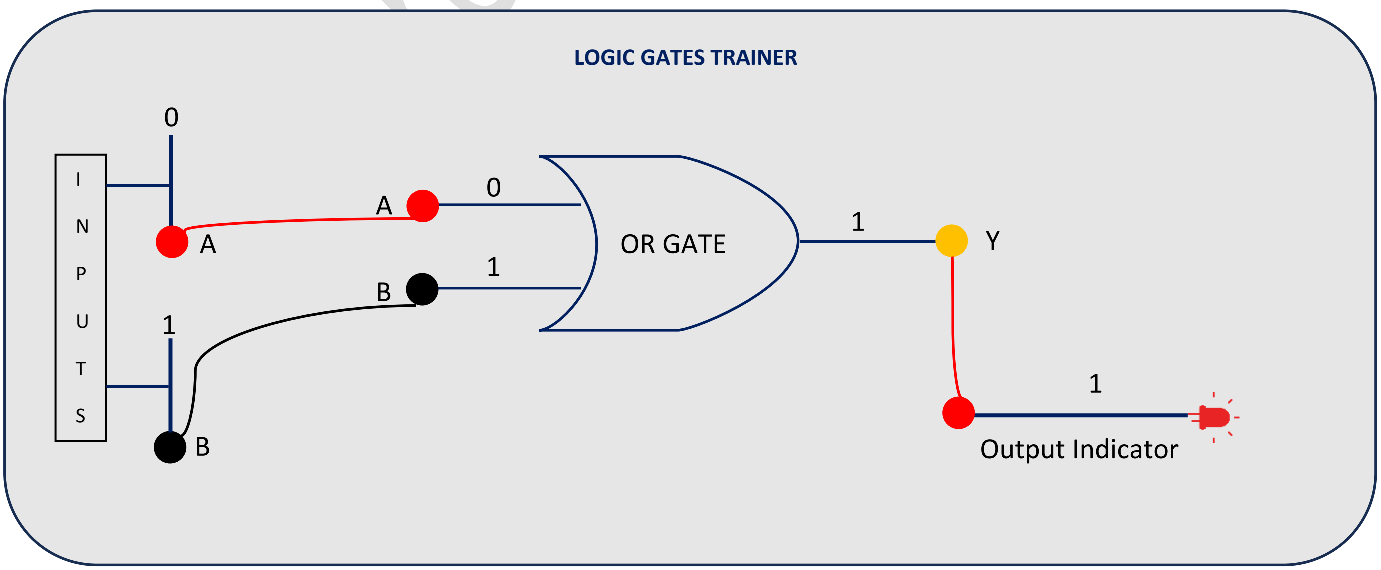

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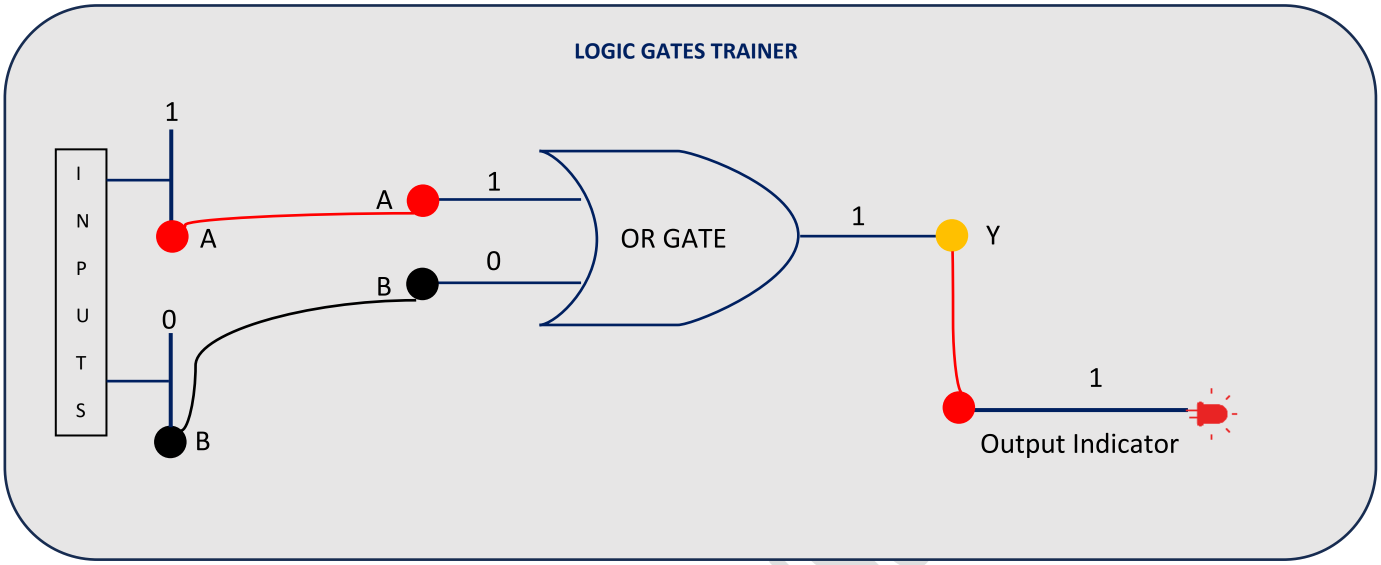

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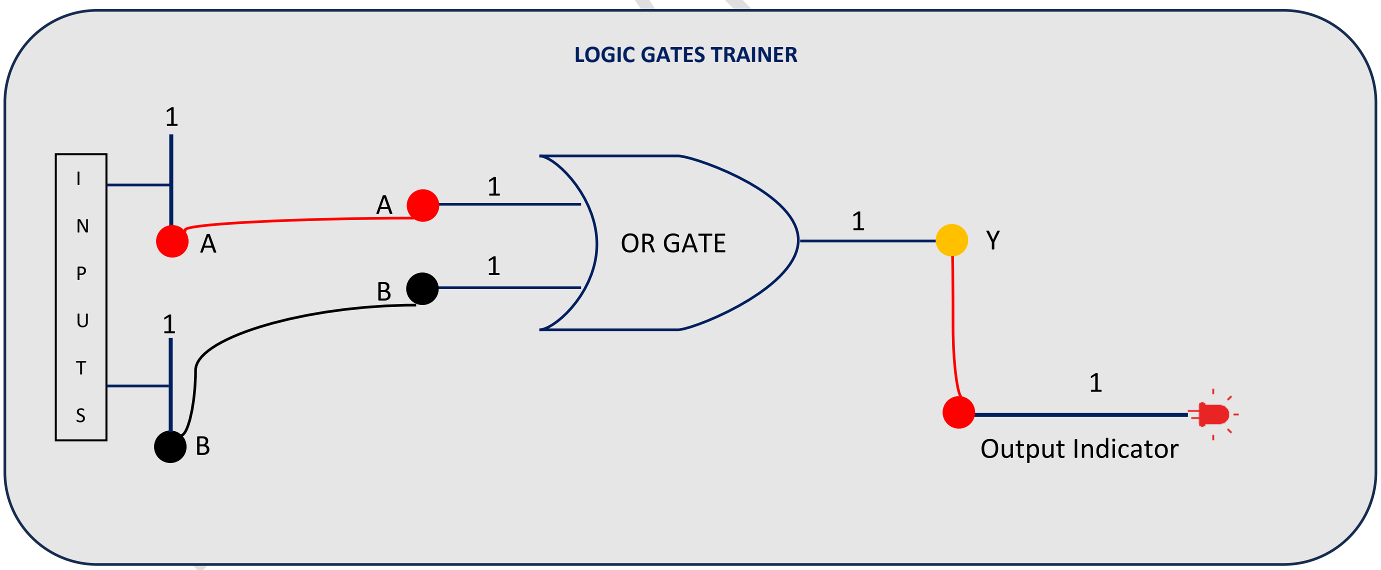


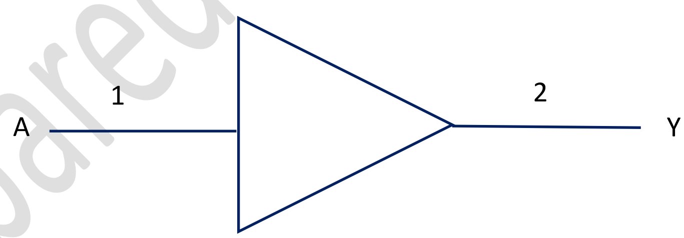
3) NOT GATE (7404)

- A NOT gate is also known an inverter, has only one input and only one output. It is a device whose output is always the complement of its input. That is the output of a not gate assumes the logic 1 state when its input is in logic 0 state and assumes the logic 0 state when its input is in logic 1 state. The symbol for NOT operation is (bar).
- With input variable A the Boolean expression for output can be written as **X = A**
- This is read as “X is equal to a bar”.

Truth table

A	Y
0	1
1	0

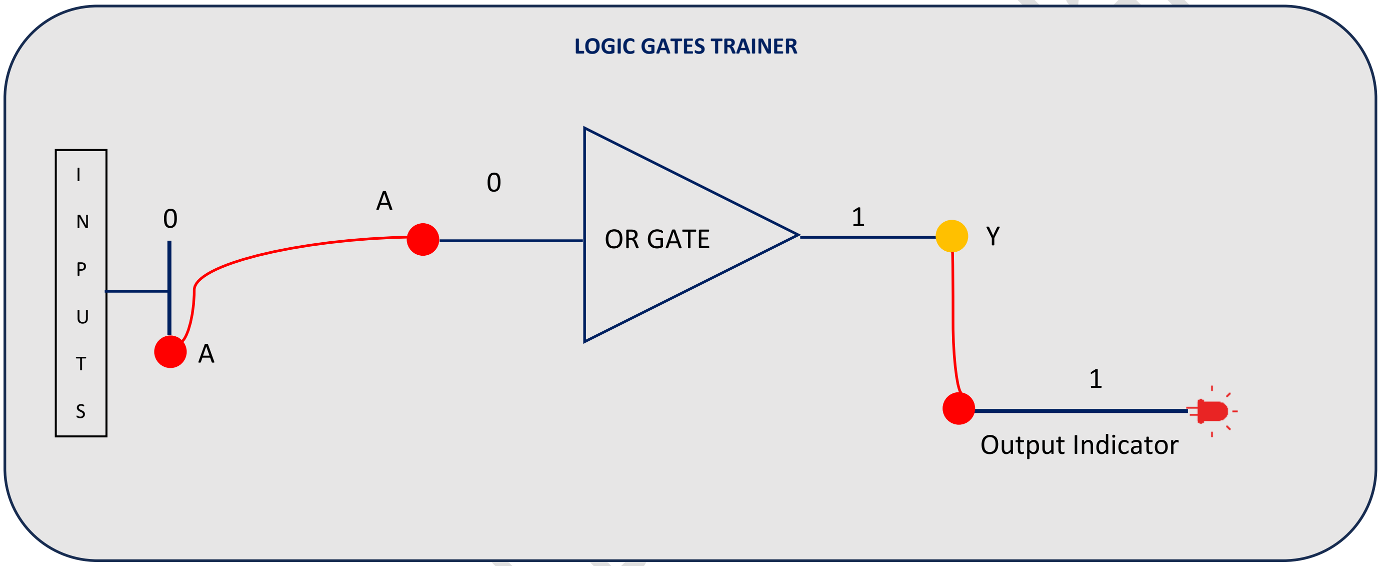
Logic symbol



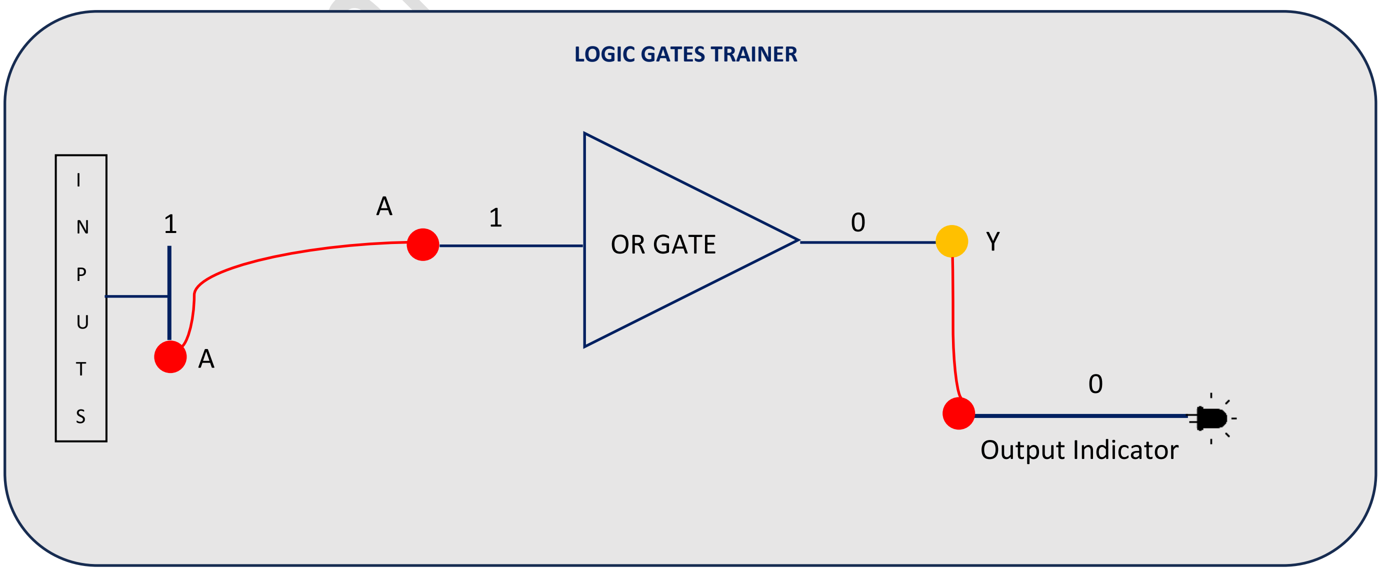
Experiment

1. Connect a single switch to the input A.
2. Connect the output to an LED.
3. Toggle the switch to test all input combinations and observe the LED.

Experiment 01



Experiment 02



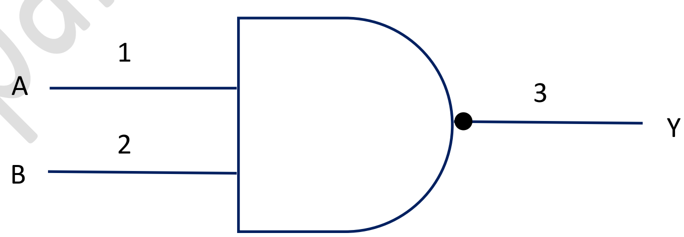
4) NAND GATE (7400)

- NAND gate is universal gate. It can perform all the basic logic function. NAND means NOT AND that is, AND output is NOTed.so NAND gate is combination of an AND gate and a NOT gate. The output is logic 0 level, only when each of its inputs assumes a logic 1 level. For any other combination of inputs, the output is logic 1 level. NAND gate is equivalent to a bubbled OR gate.
- With input variables A & B the Boolean expression for output can be written as $\mathbf{X = \overline{A.B}}$

Truth table

A	B	Y
0	0	**1**
0	1	**1**
1	0	**1**
1	1	**0**

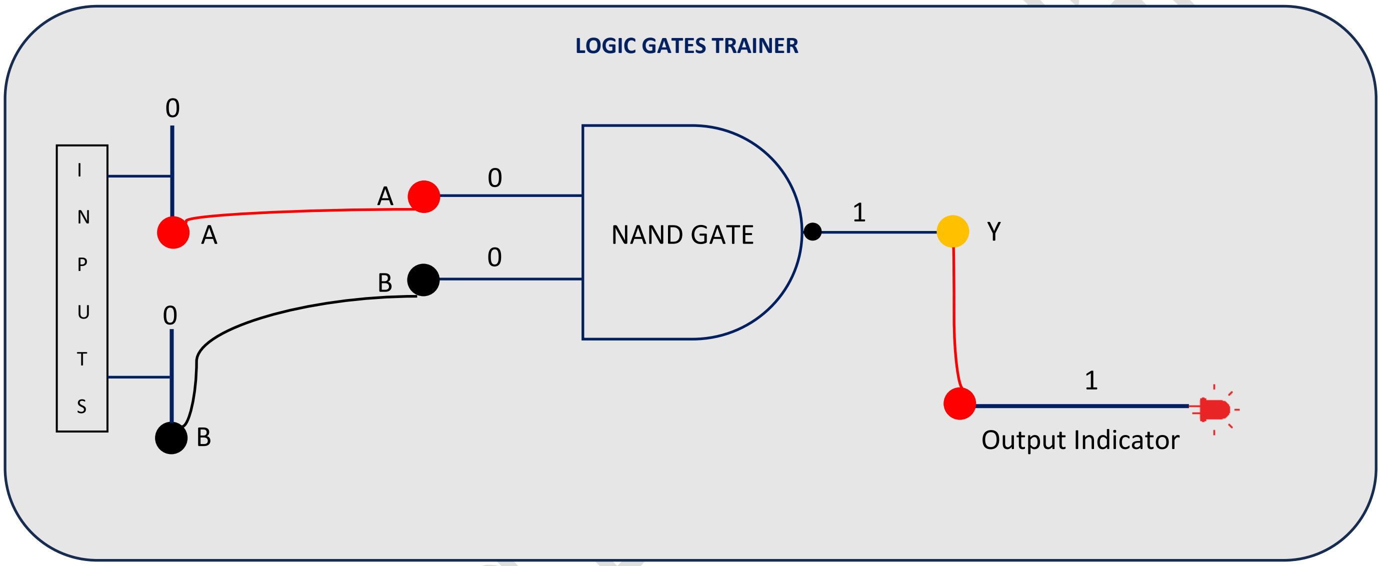
Logic symbol



Experiment

1. Connect the switches to inputs A and B.
2. Connect the output to an LED.
3. Toggle the switches to test all input combinations and observe the LED.

Experiment 01



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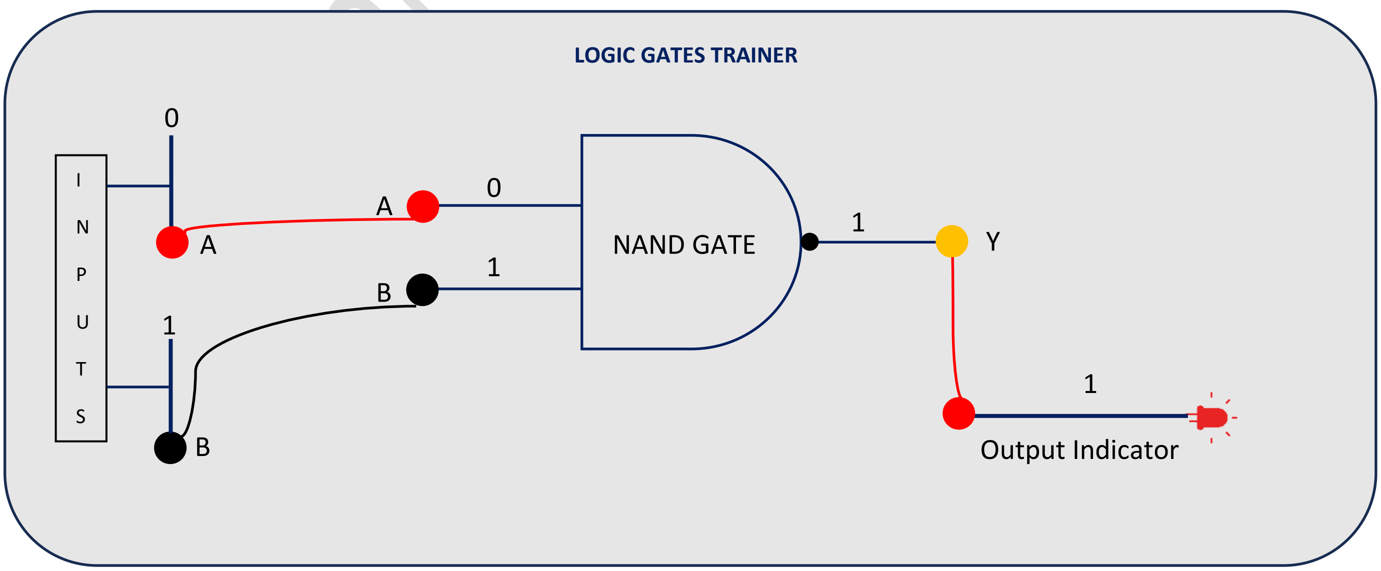
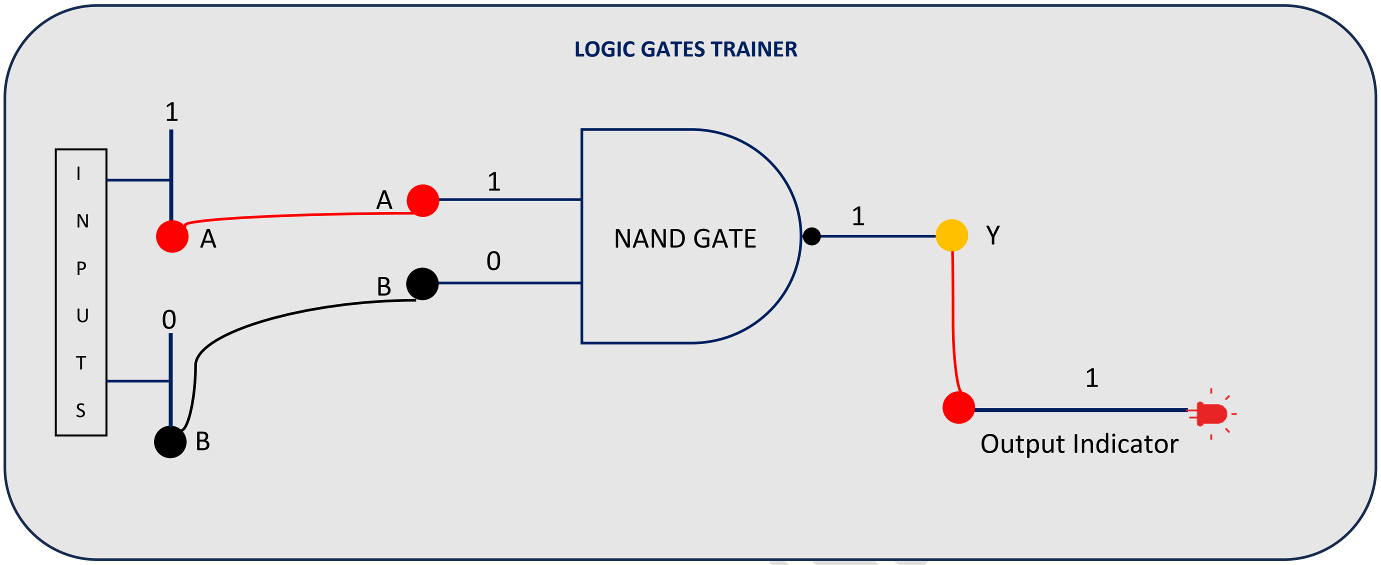
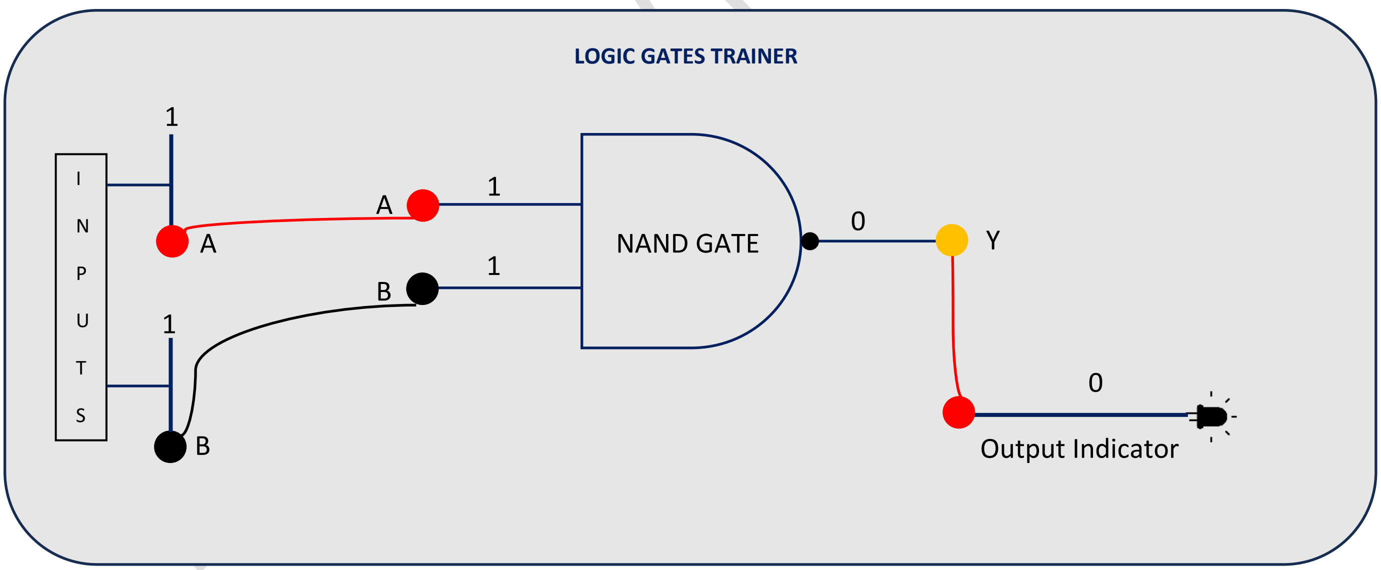


Experiment 03



Experiment 04



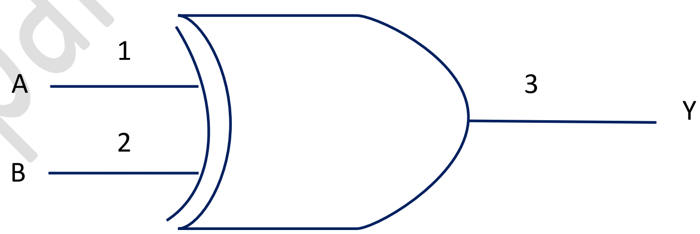
5) EXCLUSIVE-OR (X-OR) GATE (7486)

- An X-OR gate is a two input, one output logic circuit, whose output assumes a logic 1 state when one and only one of its two inputs assumes a logic 1 state. Under the condition when both the inputs are same either 0 or 1, the output assumes a logic 0 state. Since an X-OR gate produces an output 1 only when the inputs are not equal, it is called as an anti-coincidence gate or inequality detector. The output of an X-OR gate is the modulo sum of its two inputs. The symbol for X-OR operation is "⊕".
- With input variables A & B the Boolean expression for output can be written as X= **A ⊕ B**

Truth table

A	**B**	**Y**
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**0**

Logic symbol

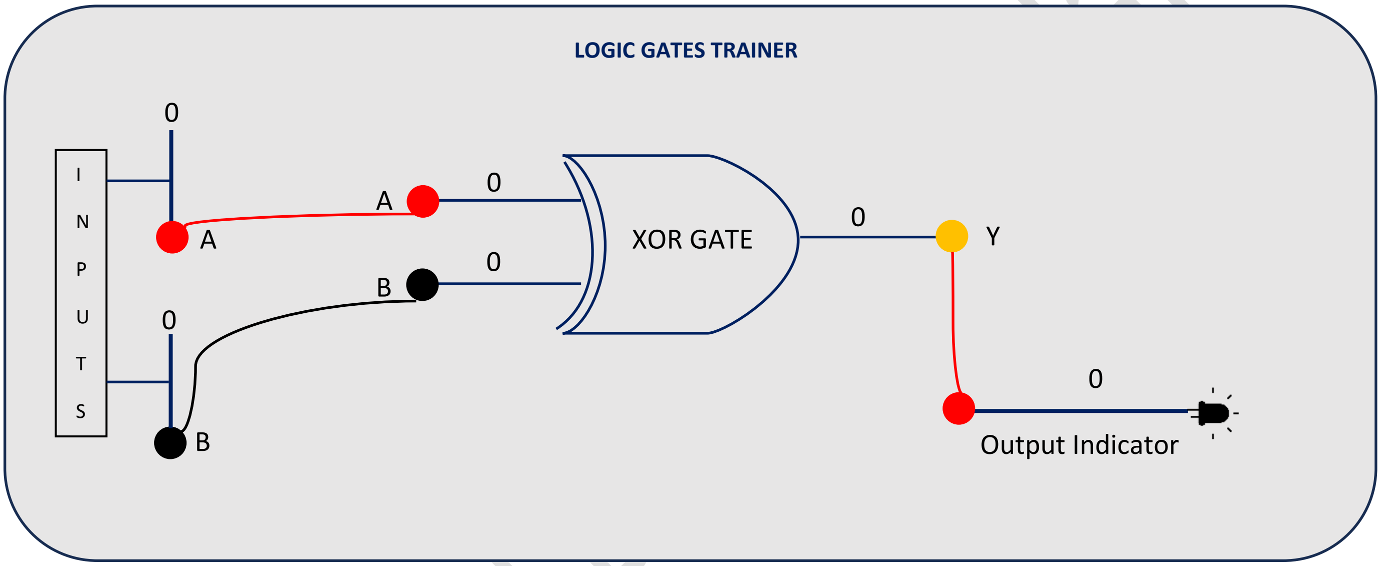


X = A+B

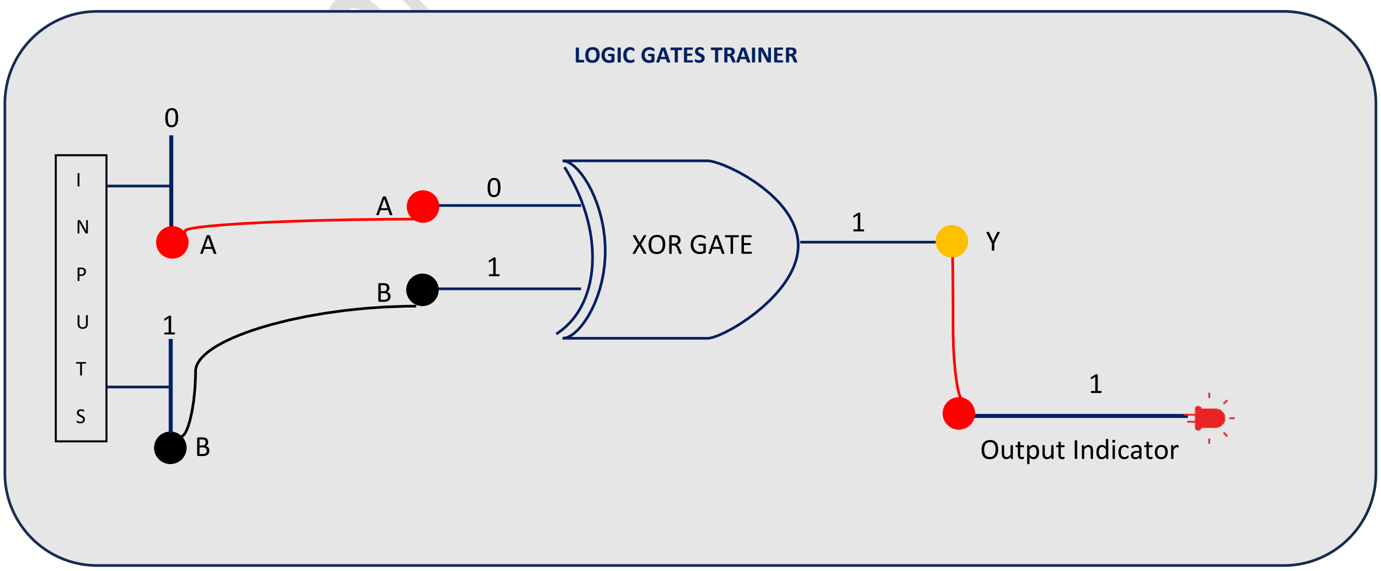
Experiment

1. Connect the switches to inputs A and B.
2. Connect the output to an LED.
3. Toggle the switches to test all input combinations and observe the LED.

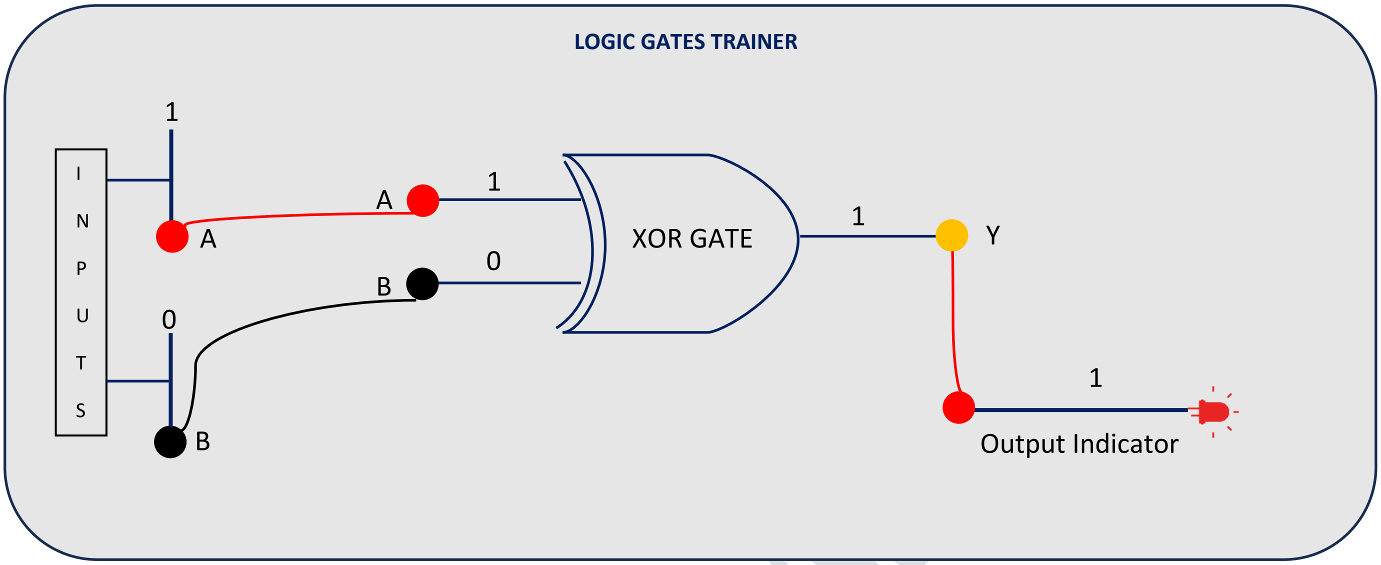
Experiment 01



Experiment 02



Experiment 03



Experiment 04