INTRODUCTION TO THE BASIC COMPONENTS

DIGITAL IC TRAINER KIT:

This trainer kit provides facilities for hands on experience to various experiments in Digital Electronics.

The major components and parts in a digital IC trainer kit are:

(i) Breadboard – circuits are constructed on this board

(ii) Input LEDs – indicates the level of inputs (LOW or HIGH)

(iii) Output LEDs - indicates the level of outputs (LOW or HIGH)

(iv) Input switches – used to apply logic inputs to the circuit

(v) Power supplies – supplies power to the circuit components

(vi) Clock pulse inputs (Continuous and Manual) – supplies clock input

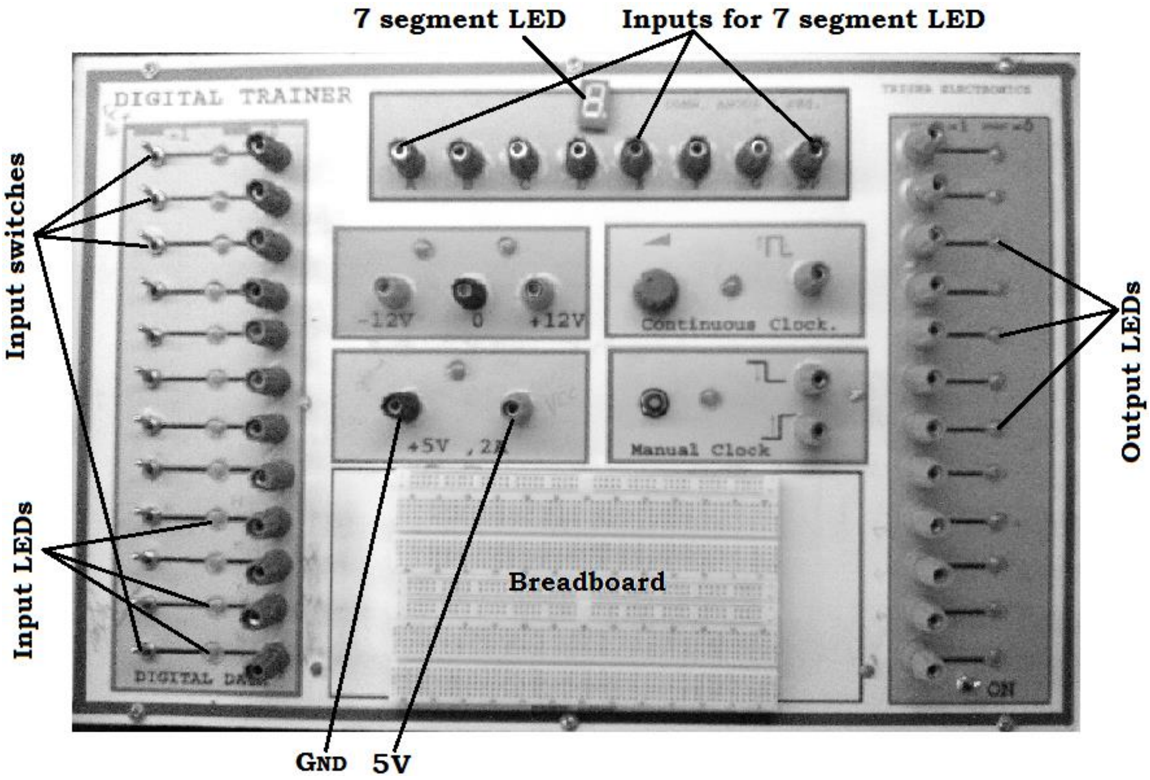


Figure 1: A Digital IC Trainer Kit

BREADBOARD:

A breadboard is a rectangular plastic board with a bunch of tiny holes in it. These holes help to fix and hold any circuit component like resistor, diode, transistor, IC or connecting wires required to build on the bread board.

Below the hole (inside the breadboard) there are rows of tiny metal clips. When the lead of any component in inserted into a hole of a breadboard, one of these clips grabs onto it. Figure 2 below is an image of such clip.

Figure 2: Look of a Breadboard Clip

Most breadboards are marked with some numbers, letters and plus & minus signs on them. These marks or labels are there to help the users to locate the position of a hole on the breadboard. Every hole on the breadboard can thus be identified with its column letter and row number; e.g. A15, H24 etc. (Figure 3).

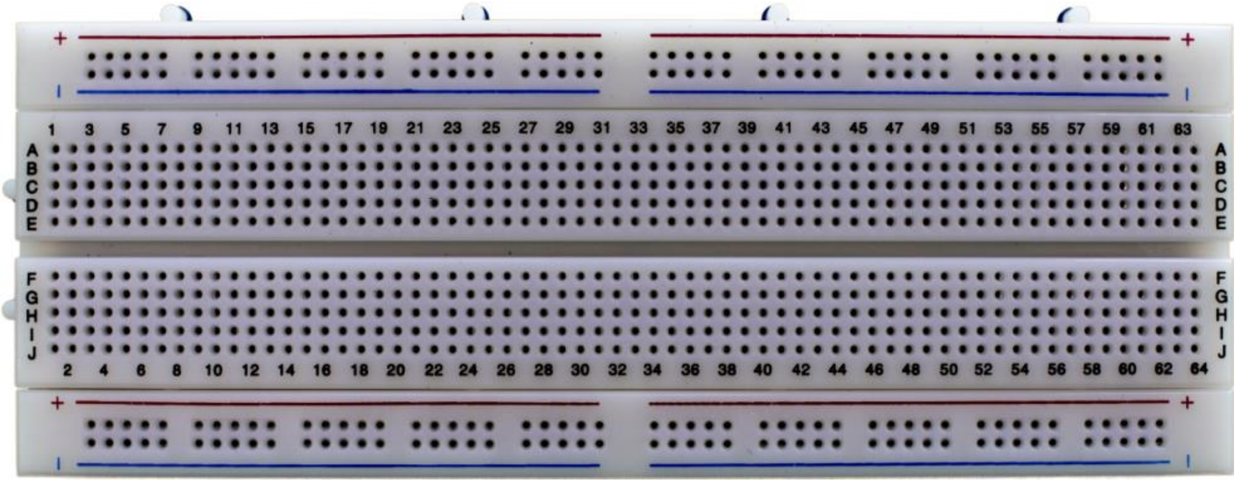


Figure 3: Physical structure of a Breadboard

Fixing of an IC on a breadboard:

When an IC is placed on a breadboard, following two points must be ensured:

(i) The IC must be fixed firmly on the breadboard. A loose IC on a breadboard will never produce reliable result.

(ii) All the pins of the IC must be isolated from each other. Therefore an IC needs to be placed on the divider (the gap between the two banks) of a breadboard (Figure 4).

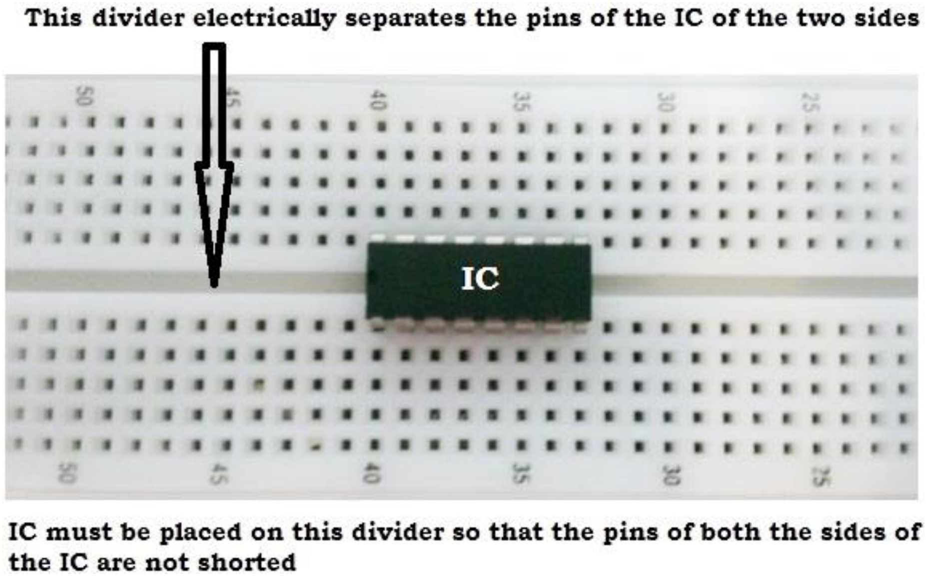


Figure 4: Position of an IC on a breadboard

JUMPER WIRES:

Jumper wires are used to make connections on a breadboard. Jumper wires are covered with insulating materials like plastic. These wires usually come in packs of varying colours. This helps in colour coding the circuits. The cover of the wire is removed from the two ends with a cutter. Jumper wires are stiff enough to push them into the breadboard holes. There are several different varieties available for jumper wires.

Input and Output LEDs

As digital logic circuits work on binary system, their inputs and outputs accept and produce only two levels of voltages. Thus, in most of the basic experiments, outputs and inputs of digital circuits are observed in LEDs. A “RED” light in the LEDs indicates a HIGH level and LOW level is indicated by a “GREEN” or “NO LIGHT”.

Important Points to remember when connecting a circuit on the breadboard:

1. At the beginning, before start of the circuit connection, connect the power supply cable of the digital trainer kit and examine its working.
2. Check the functioning of every circuit component individually before connecting them in the circuit. It is difficult to find or locate the faulty component when they are in a circuit.
3. Keep the power supply of the digital trainer kit OFF while making the circuit connections. Connecting a circuit with power supply turned ON may damage the circuit component and/or the trainer kit.
4. IC must be placed on the divider on the breadboard (refer to Figure 4).
5. IC must be firmly fixed on the breadboard. A loose IC always results unreliable output.
6. The uncovered lead of the connecting wires at the two ends should not be too long or too short. Long uncovered wires may get connected with other such wires. On the other hand, a too short end may not touch the metal clip inside the breadboard.
7. Every connection point on the breadboard must be properly and firmly fixed.
8. Avoid connecting many inputs from a single point. This will reduce current in the inputs and hence may lead to erratic operation of the circuit.
9. After connecting the complete circuit, turn the digital trainer kit ON and verify the circuit operation.
10. Never keep a circuit turned ON and unattended.

<u>EXPERIMENT: 1 LOGIC GATES</u>

AIM: To identify and verify Logic Gates

APPARATUS REQUIRED:

SL NO.	COMPONENT	SPECIFICATION	QUANTITY
1.	NAND gate	IC 7400	1
2.	NOR gate	IC 7402	1
3.	NOT gate	IC 7404	1
4.	AND gate	IC 7408	1
5.	OR gate	IC 7432	1
6.	XOR gate	IC 7486	1
8.	IC trainer kit	-	1
9.	Wires	-	As required

<u>Theory</u>

Logic Gates:

Logic gates are the basic components in digital circuits. All the logic gates follow their own logic and accordingly produce the output. Each gate has one or more input and only one output. Characteristic of a gate is depicted in a truth table. A truth table shows all the possible input combination for a logic gate or circuit and the corresponding output. There are 7 (seven) different logic gates. They are (i) NAND (ii) NOR (iii) NOT (iv) AND (v) OR (vi) XOR and (vii) XNOR gate. NOT, AND & OR gates are basic gates. NAND, NOR, XOR and XNOR gates are combination of the basic gates and hence are called composite gates.

NAND GATE (IC 7400):

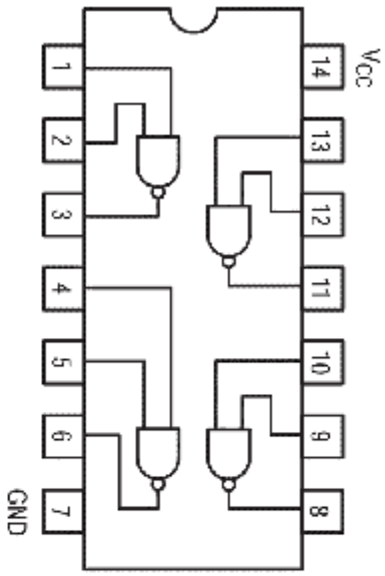
The NAND gate is a combination of AND and NOT gate. The output of a NAND is LOW only when all of its inputs are HIGH.

SYBMBOL:

SYMBOL OF NAND GATE

INPUT		OUTPUT
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

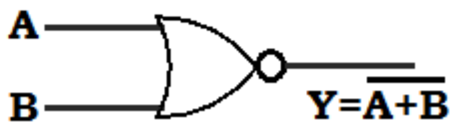
PIN DIAGRAM OF IC 7400



NOR GATE (IC 7402):

The NOR gate is an inverted output OR gate. In a NOR gate, the output is high only when all of its inputs are low.

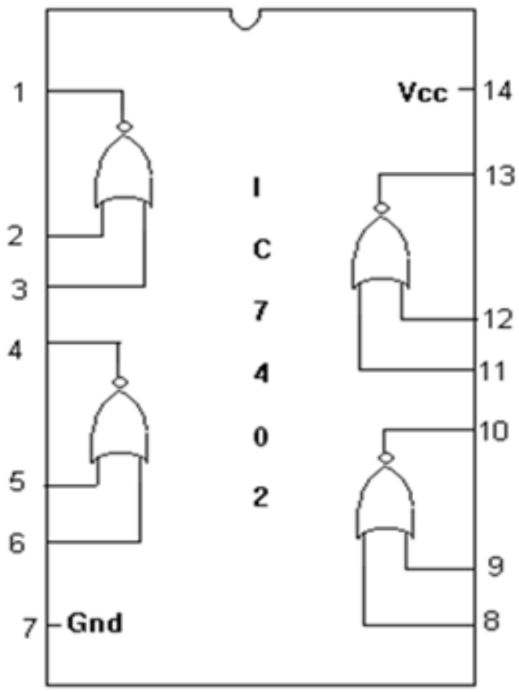
SYMBOL:



SYMBOL OF NOR GATE

INPUT		OUTPUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

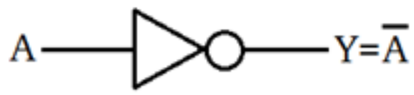
PIN DIAGRAM OF IC 7402



NOT GATE (IC 7404):

The NOT gate is called an inverter. Its output is HIGH when applied input is LOW and the output is LOW when the input is HIGH.

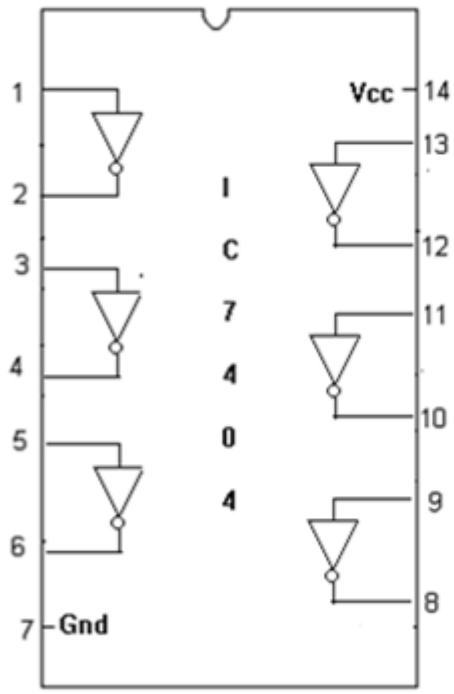
SYMBOL OF NOT GATE



TRUTH TABLE OF NOT GATE

INPUT	OUTPUT
A	Y
0	1
1	0

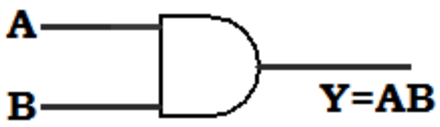
PIN DIAGRAM OF IC 7404



AND GATE (IC 7408):

The AND gate performs a logical multiplication. In an AND gate, the output is HIGH only when all of its inputs are HIGH.

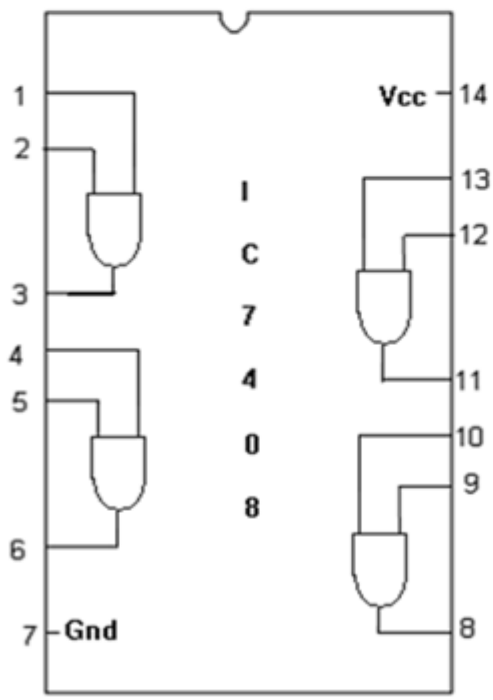
SYMBOL:



SYMBOL OF AND GATE

INPUT		OUTPUT
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

PIN DIAGRAM OF IC 7408



OR GATE (IC 7432):

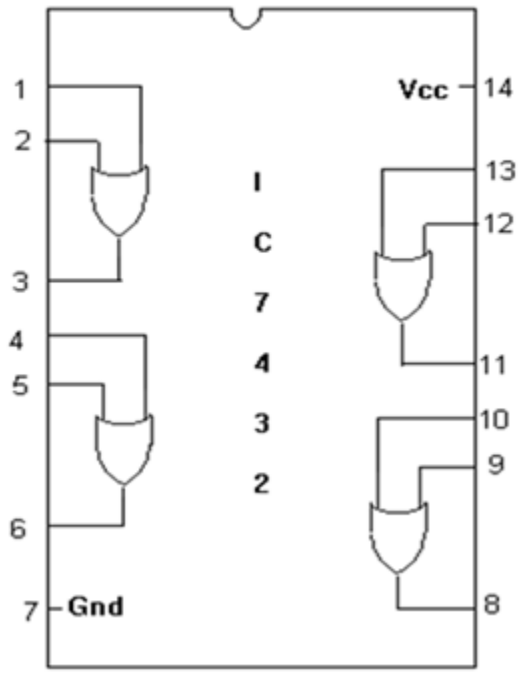
The OR gate performs a logical addition. The output of an OR gate is HIGH when at least one of the inputs is HIGH. That is its output is LOW only when all of its inputs are LOW.

SYMBOL:

SYMBOL OF OR GATE

INPUT		OUTPUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

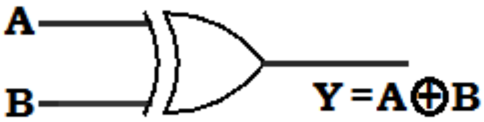
PIN DIAGRAM OF IC 7432



XOR GATE (IC 7486):

XOR gate is a composite gate. Its output is HIGH only when odd number of inputs is HIGH. Output of an XOR gate is given by $Y = A\,\overline{B} + \overline{A}\,B = A \oplus B$

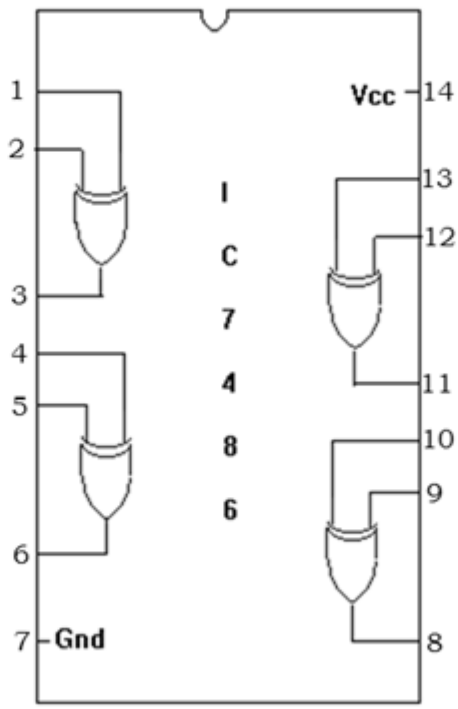
SYMBOL:



SYMBOL OF XOR GATE

INPUT		OUTPUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

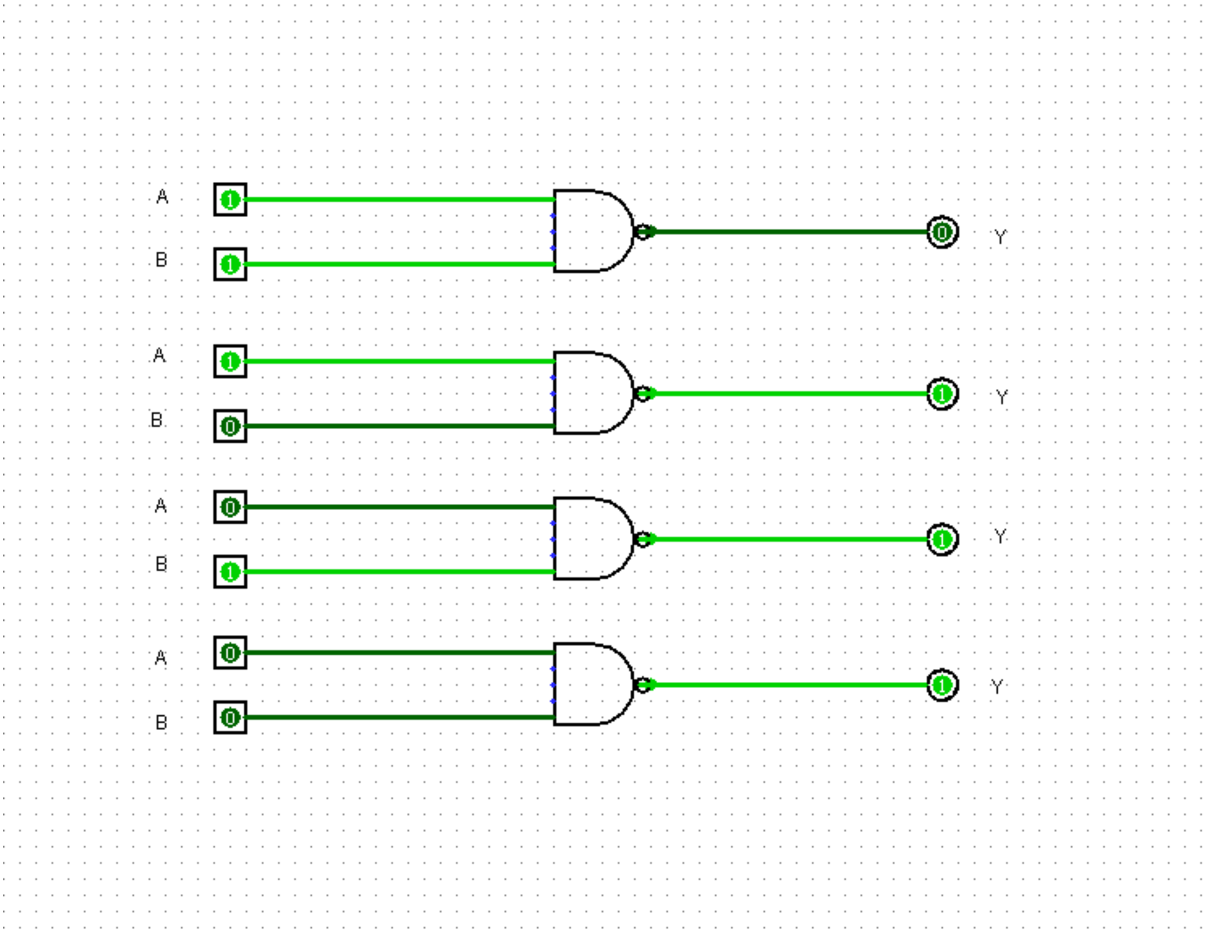
PIN DIAGRAM OF IC 7486



Practical Procedure:

1. ICs are placed properly on the bread board of the IC trainer kit.
2. Connections are made as per the PIN diagram of the IC.
3. Power supply to the board is turned ON.
4. One gate in every IC is verified as per the truth table of the logic gate.

Student's worksheet-1



Student's observation and conclusion:

NAND GATES

- **Combination of NOT and AND gate.**
- **Gives output which is false only if all its input is true.**
- **Output is complement to that of AND gate.**
- **We can give multiple high input but can get only low output.**

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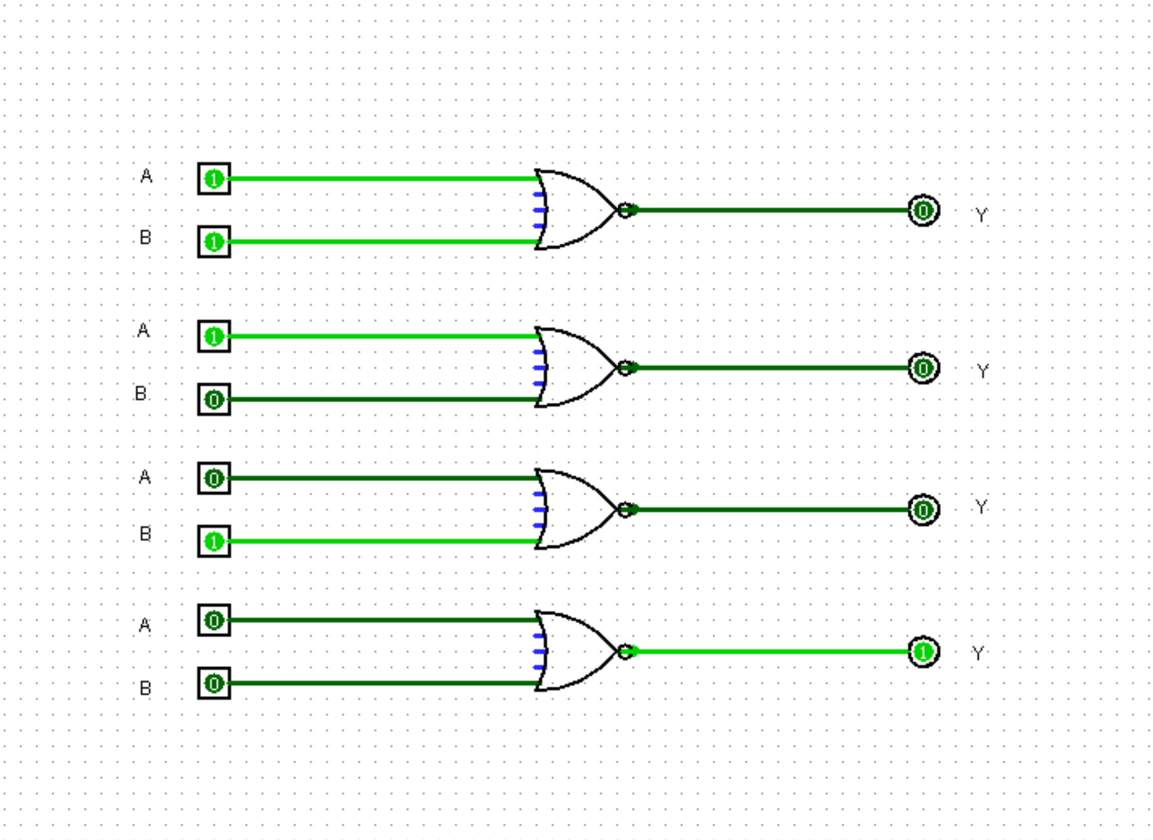
Student's worksheet-2



Student's observation and conclusion:

NOR GATE

- **If both inputs are low only then output is high.**
- **Combination of NOT and OR gate.**
- **In case any/all the input is high, we get a low output.**
- **Output is complement to that of OR gate.**

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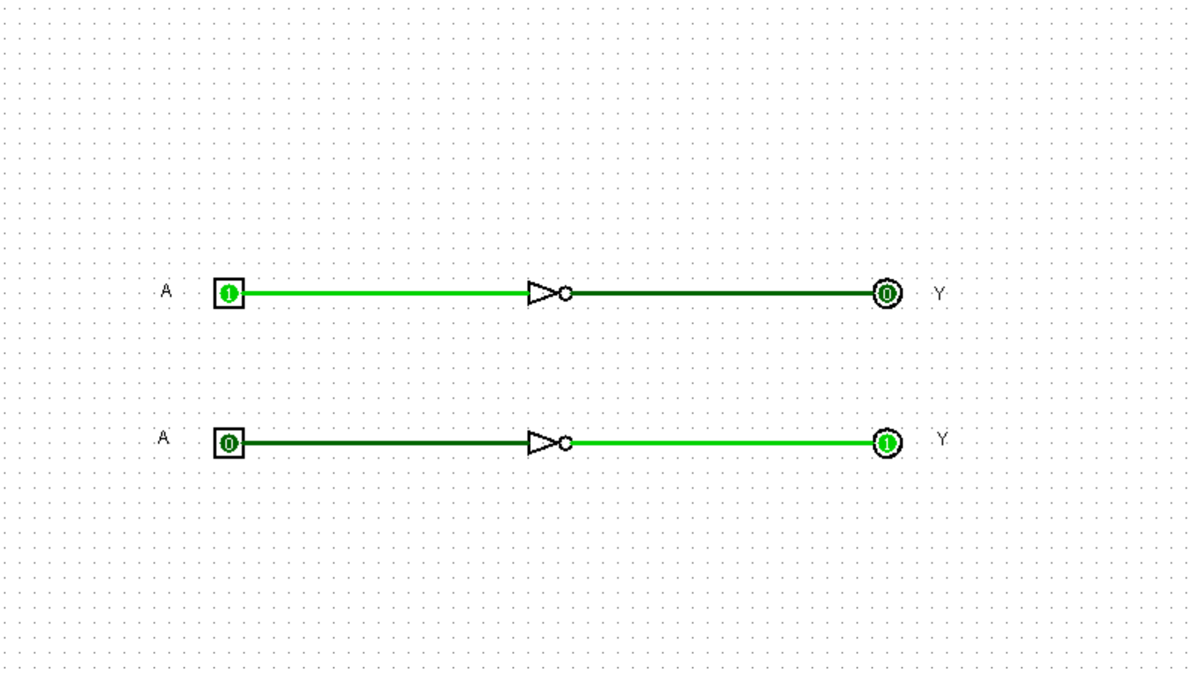
Student's worksheet-3



Student's observation and conclusion:

NOT GATE

- **It provides the complement of their input signal.**
- **For high input, output is low.**
- **For low input, output is high.**

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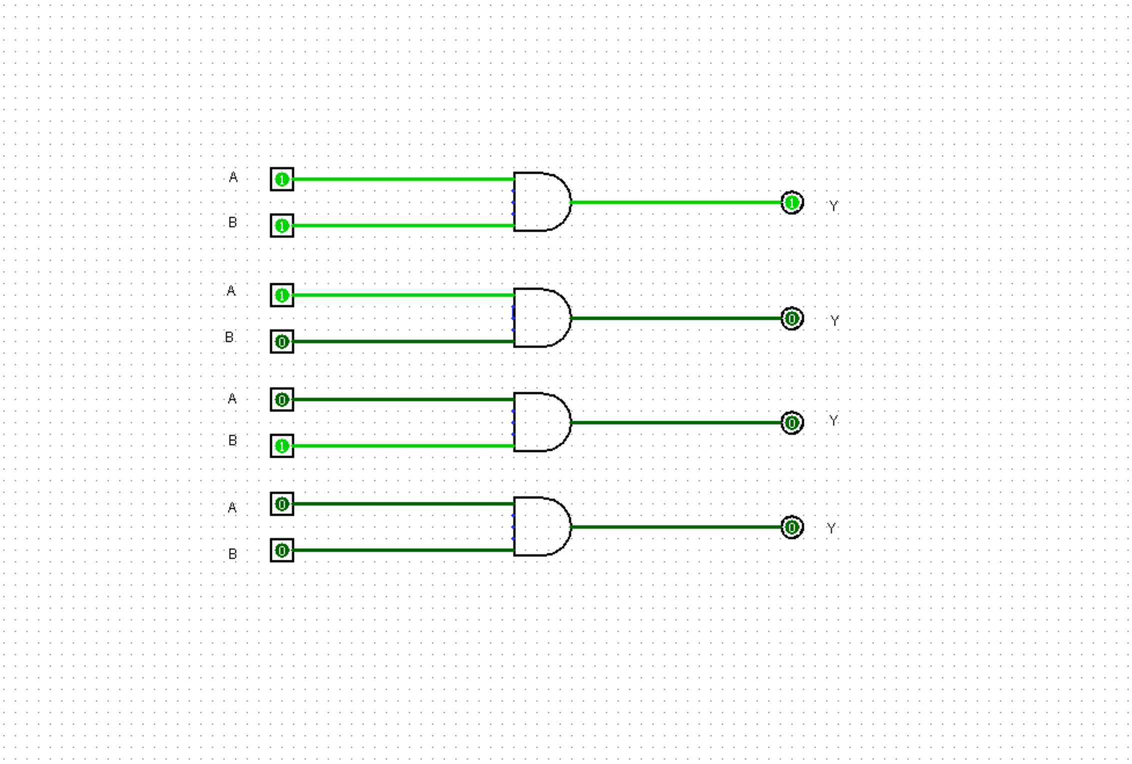
Student's worksheet-4



Student's observation and conclusion:

AND GATE

- **If both inputs are high only then output is high.**
- **Output is simply the multiplication of inputs.**
- **For any low input it gives low output.**

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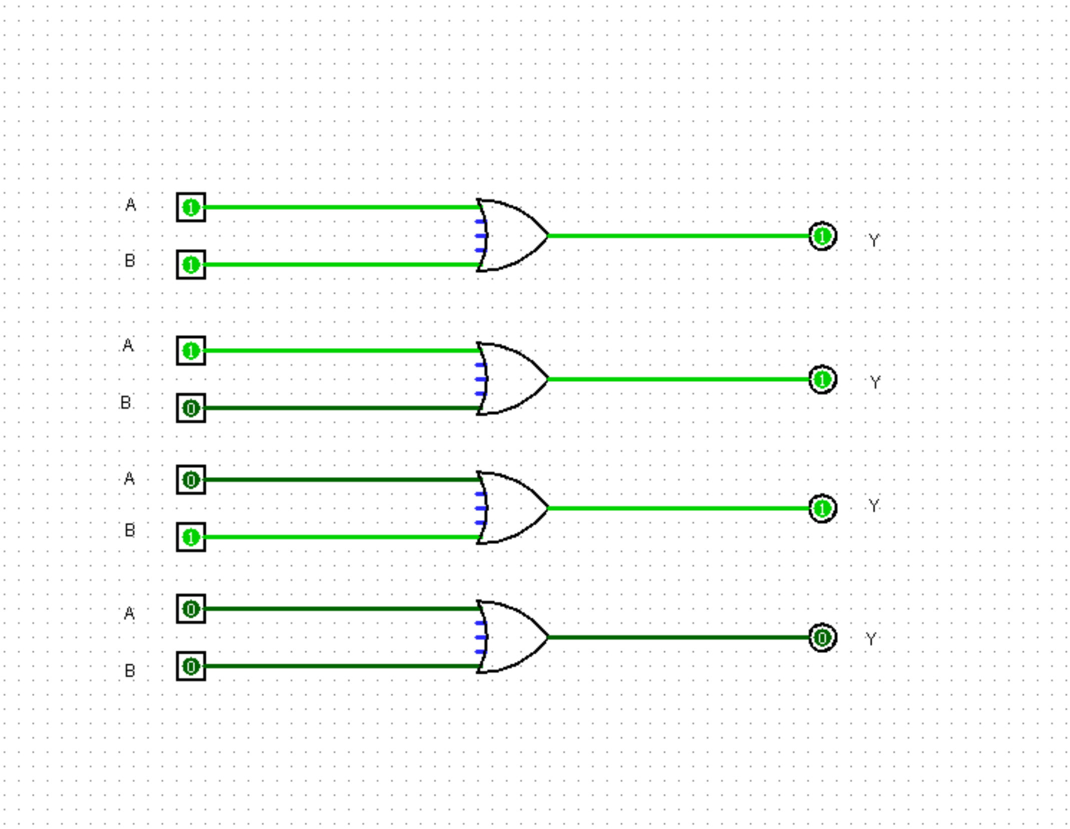
Student's worksheet-5



Student's observation and conclusion:

OR GATE

- **It implements logical disjunction.**
- **High output results if one or both the input to the gate is high.**
- **If neither input is high results a low output.**
- **Output is simply the maximum between the given inputs.**

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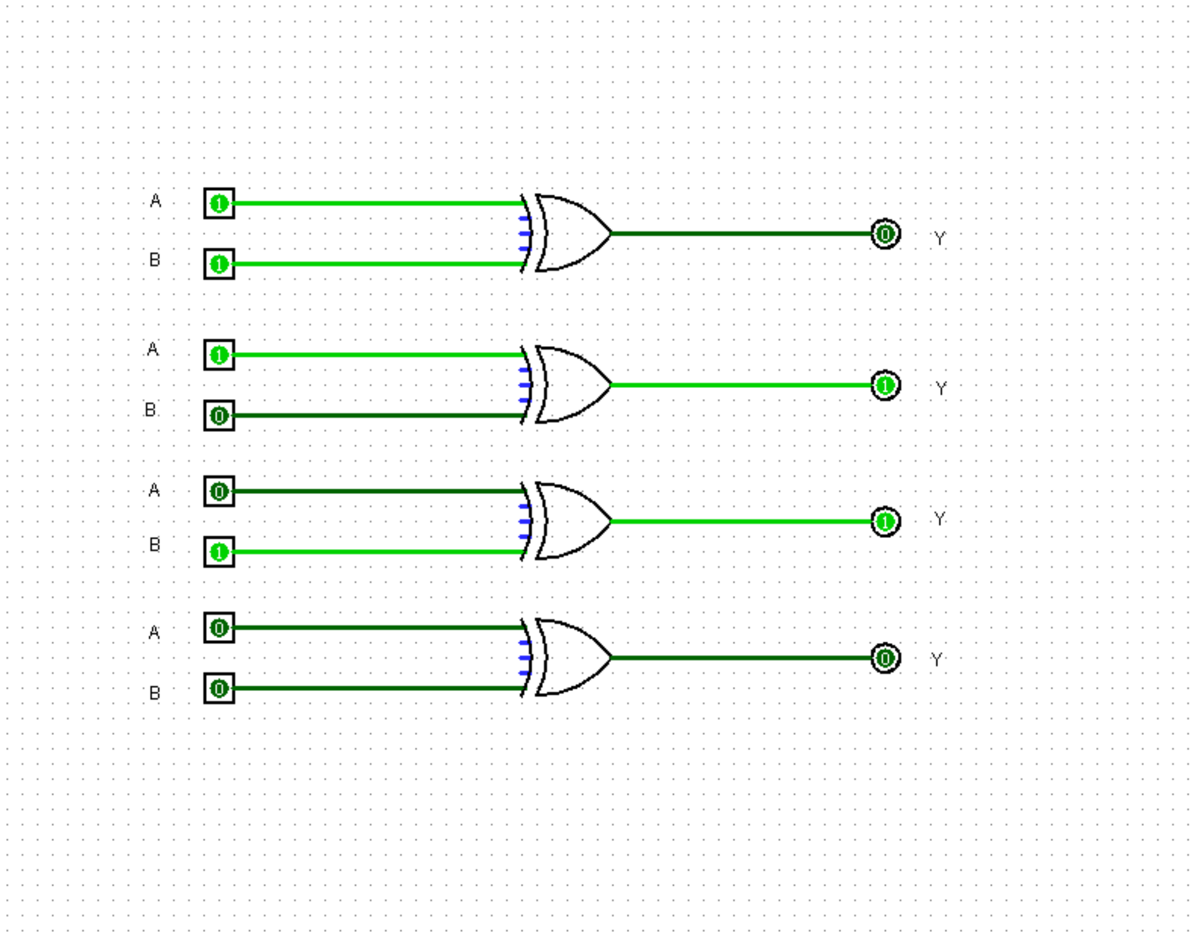
Student's worksheet-6



Student's observation and conclusion:

XOR GATE

- **Gives high output when the number of high inputs is odd.**
- **For both high or both low input, output is always low.**

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