AMERICAN INTERNATIONAL UNIVERSITY BANGLADESH

Faculty of Engineering

Laboratory Report Cover Sheet

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Please submit all reports to your subject supervisor or the office of the concerned faculty.

Laboratory Title: _____

Experiment Number: ___6___ Due Date: _____ Semester: _____

Subject Code: _____ Subject Name: _____ Section: ____

Course Instructor: Degree Program: _____

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No.	Student Name	Student Number	Student Signature	Date
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1				
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3				
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5				

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Total Marks: _____ Marks Obtained: _____

Faculty comments_____

ABSTRACT:

This experiment is on construction of Diode and transistor logic gate. The main objective of the experiment is to implement logic function using Diode logic circuit and find out about their advantage and disadvantage and then construct logic gates from bipolar transistor using RTL, DTL, TTL design in laboratory using breadboard, diodes, transistor, resistor, LED, and necessary connecting wires. The experiment results from the configured circuit match the theoretical idea results. The experiment is sufficient because it demonstrates how to build different logic functions using transistor and diode logic circuits and explains their benefits and drawback.

INTRODUCTION:

Diode is an electrical device which only allows one directional current flow through it. It has two terminal anode and cathode in a symbolic diagram of a diode a flat part of a triangle is anode, and the point of the triangle is cathode. Anode and cathode diodes positive and negative terminal of the diode respectfully. A diode requires a minimum voltage to operate itself in forward bias known as threshold voltage. For silicon diode it is 0.7V. In forward bias cathode is a higher voltage than that of anode, the resistance is very low so the current flow. when anode is at lower voltage than the cathode, a diode is reverse biased.
Due to having the high resistance, current does not flow in reverse bias mode There are several diode logics gates available for study. It is possible to construct a logic gate using diode. Diode logic OR-gate and AND gate will be discussed in this experiment.

THEORY AND METHODOLOGY:

Part-I: Construction of Diode Logic Gates

Diode Logic OR Gate:

One diode is used for each input signal and a resistor make up a Diode Logic OR gate. The addition of the 10K resistor (R) here serves as a ground reference for the output signal. The output will be ground or logic 0 if no input signals are connected to the diodes. An open input is therefore equivalent to a logic 0 input and has no bearing on how the rest of the circuit operates. Any quantity of input diodes, each with a distinct input signal, may be added to this circuit. Two inputs, however, are more than enough to show the circuit in operation.

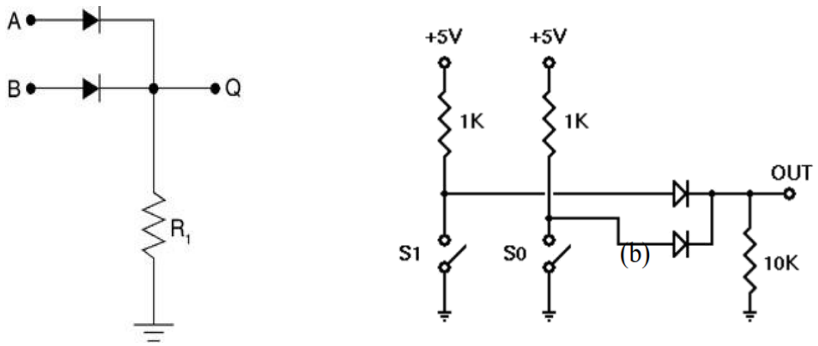


Fig.1 DL-OR Gate

Diode Logic AND Gate:

One diode is used for each input signal in a resistor-and-diode logic AND gate. The 10K resistor (R), like the DL OR gate, serves as a reference connection. Contrary to the OR gate, this refers to +5 volts as opposed to ground. The output will be +5 volts, or logic 1, if the input signals to the diodes are not linked. As a result, the rest of the circuit will continue to function normally with an open input.

This circuit can be expanded to include any number of input diodes, each with a distinct input signal, just like with DL-OR gates. Two inputs, however, are more than enough to show the circuit in operation.

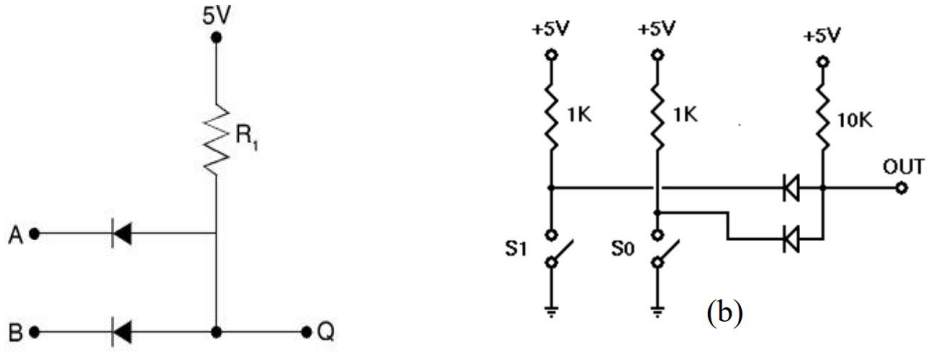


Fig.2 DL-AND Gate

Two-Input DL AND –OR Gate:

The AND and OR gates will be cascaded following a review of the Diode Logic (DL) AND gate and OR gate to see whether their operations were within acceptable bounds. In order to combine the outputs of two AND gates, an OR gate will be employed, and the effectiveness of this combination will be evaluated.

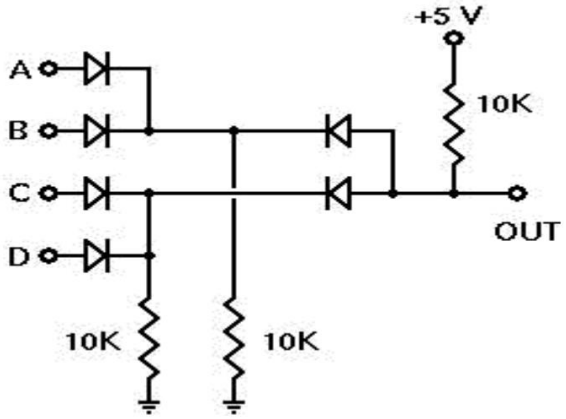


Fig.3 DL-AND-OR Gate

Diode polarity:

The anode, or positive terminal, is located on one side. The cathode, which is the other terminal, is the negative end. A diode can only conduct current in one direction, from the anode to the cathode.

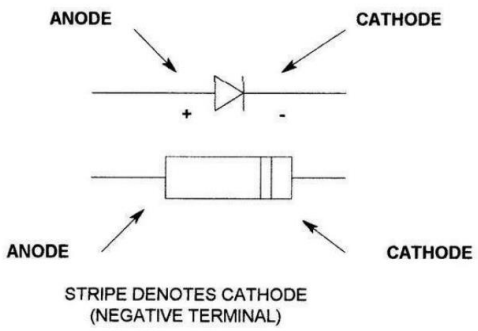


Fig.4 Diode polarity

Part-II: Construction of Bipolar Transistor Logic Gate

Resistor-Transistor Logic (RTL):

A significant advancement over diode logic is resistor-transistor logic (RTL) (DL). RTL essentially switches the diode switch with a transistor switch. The transistor completely activates and grounds the output signal if a +5v signal (logic 1) is applied to its base (via a suitable resistor to control the forward voltage and current at the base-emitter junction). Input grounded (logic 0) turns off the transistor, allowing the output signal to climb to +5 volts. The transistor does this by inverting the signal's logic sense and ensuring that the output voltage will always be a correct logic level under all conditions.

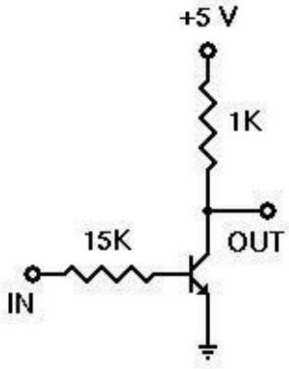


Fig.6: RTL Inverter

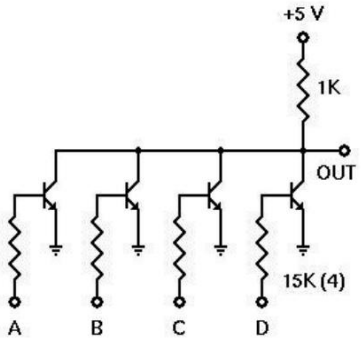


Fig .7: 4-input RTL Inverter

Diode-Transistor Logic:

Diode-Transistor Logic (DTL), the immediate predecessor of transistor-transistor logic, is a class of digital circuits made of bipolar junction transistors (BJT), diodes, and resistors (TTL). DTL suffers from low speed but provides higher noise margins and bigger fan-outs than RTL (especially in comparison to TTL). NOR gates can be easily built using RTL, however NAND gates are much more challenging. However, DTL enables the creation of straightforward NAND gates from a single transistor with the aid of several diodes and resistors.

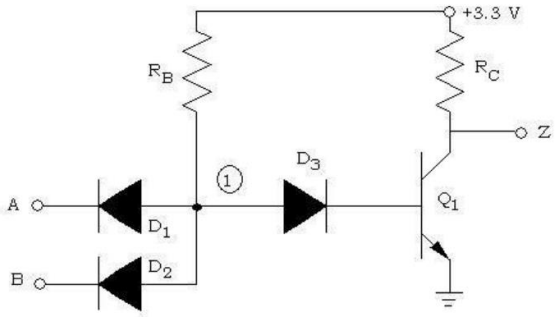


Fig 8: 2-input DTL NAND Gate

Transistor-Transistor Logic:

A bipolar transistor can be visualized as two diodes arranged very closely together, with the transistor base located at the intersection of the diodes. Transistor-transistor logic is the process of using transistors in place of diodes to create logic gates that can only be done using transistors and resistors (TTL). The poor speed of DTL, particularly when the transistor is off, is one issue that it cannot resolve. It is necessary for a saturated transistor in a DTL gate to travel through the active region before entering cut-off in order to turn it off. Cut-off won't be reached, though, until the stored charge in its base has been released. If there is no direct passage from the base to the earth, the base charge dissipates slowly. For this reason, some DTL circuits include a base resistor that is connected to ground, albeit even this has trade-offs. Another issue with shutting off

the DTL output transistor is the comparatively long time required for the effective capacitance of the output to charge up through Rc before the output voltage reaches the final logic "1" level. However, TTL elegantly resolves DTL's issue with speed.

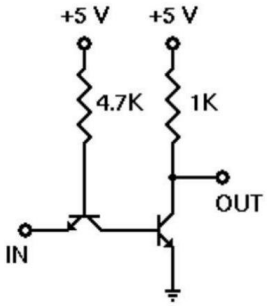


Fig 9: TTL Inverter

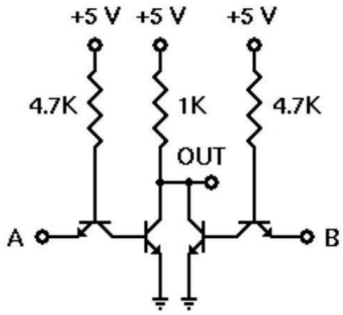
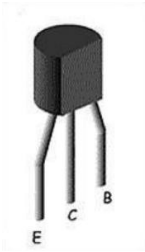


Fig 10: 2-input TTL NOR gate

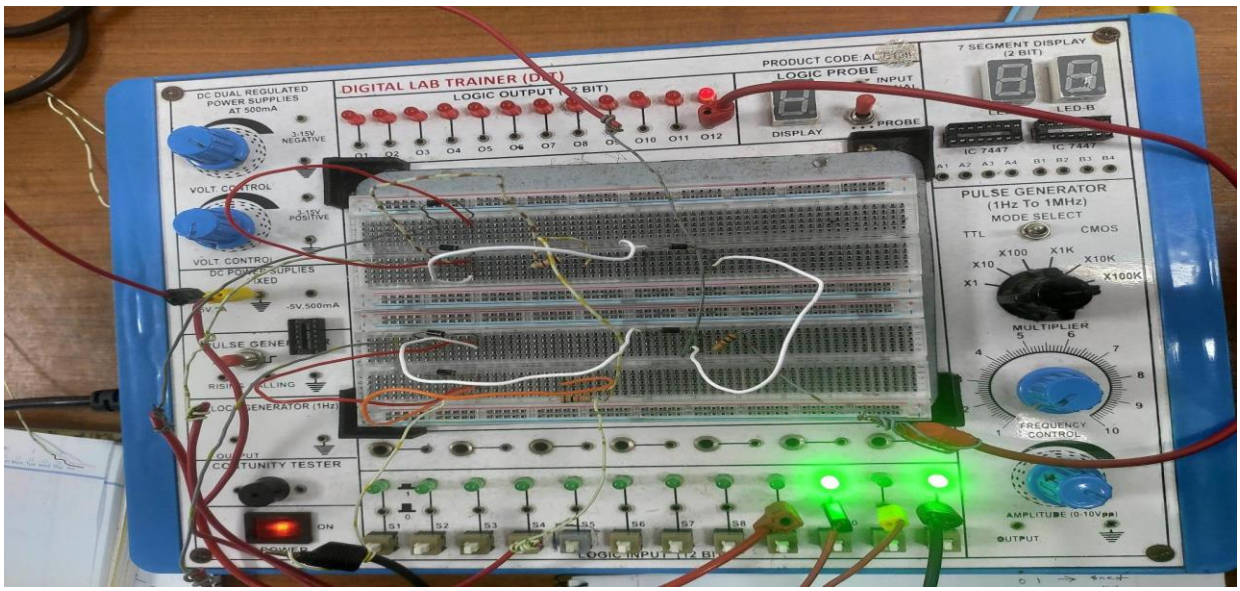
BJT pin configuration:

The common emitter (CE), common base (CB), and common collector (CC) or emitter follower are the three fundamental BJT setups.

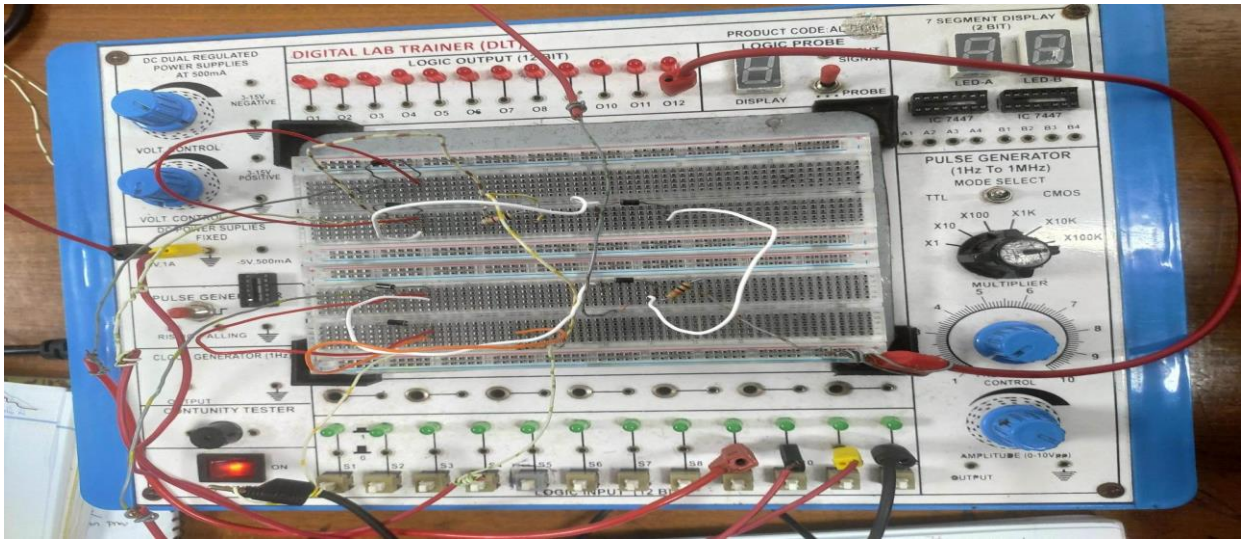


SIMULATION:

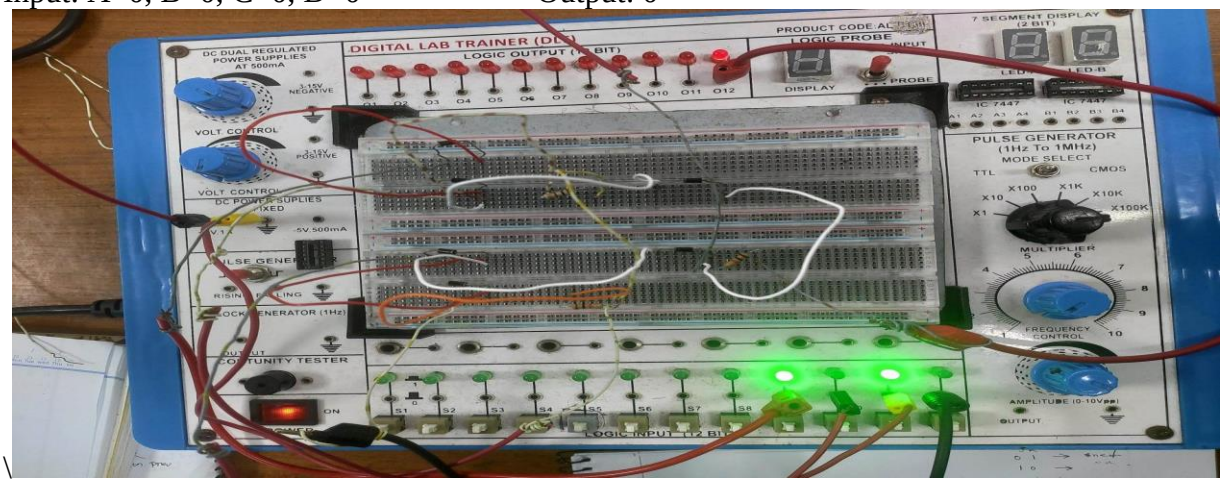
Fig 3: DL-AND-OR GATE



Input: A=0, B=1, C=0, D=1 Output: 1



Input: A=0, B=0, C=0, D=0 Output: 0



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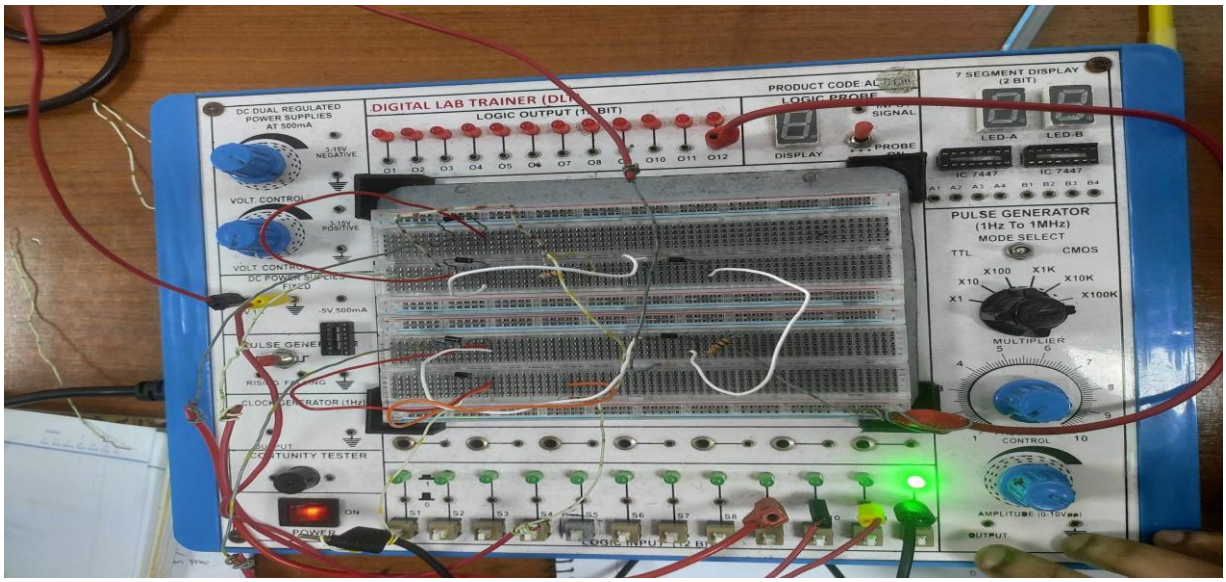
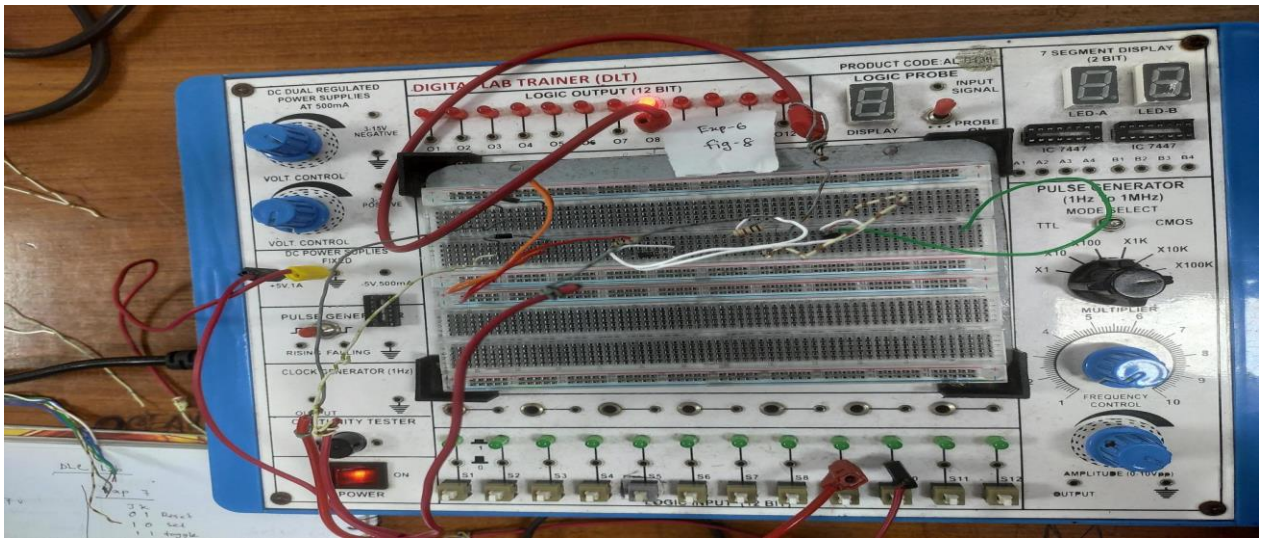
Input: A=1, B=0, C=1, D=0 Output: 1

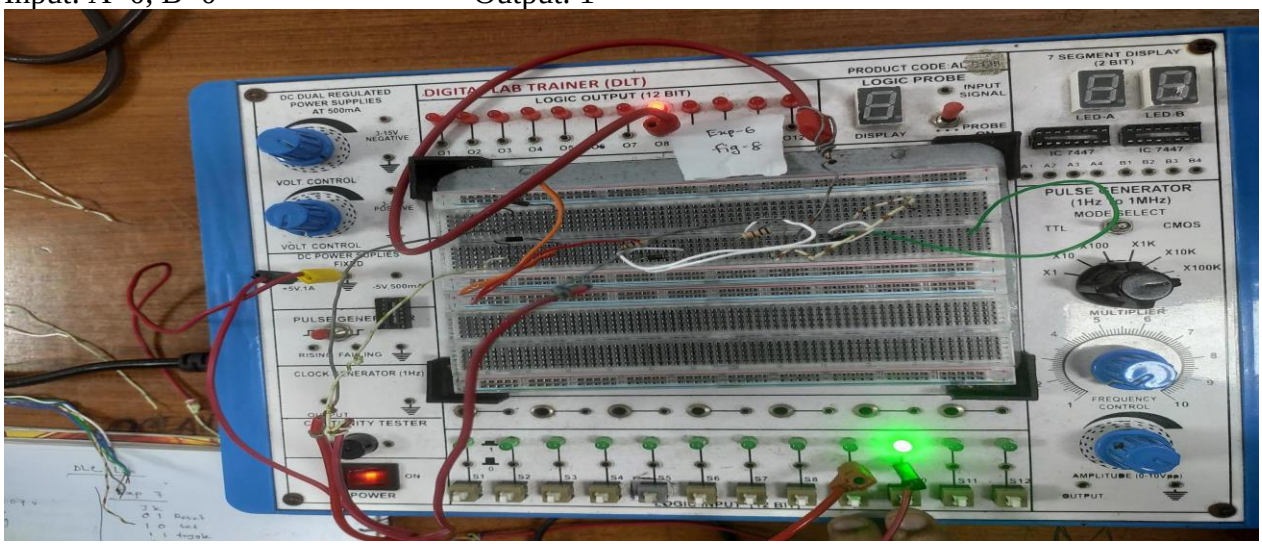


Input: A=0, B=0, C=0, D=1 Output: 0

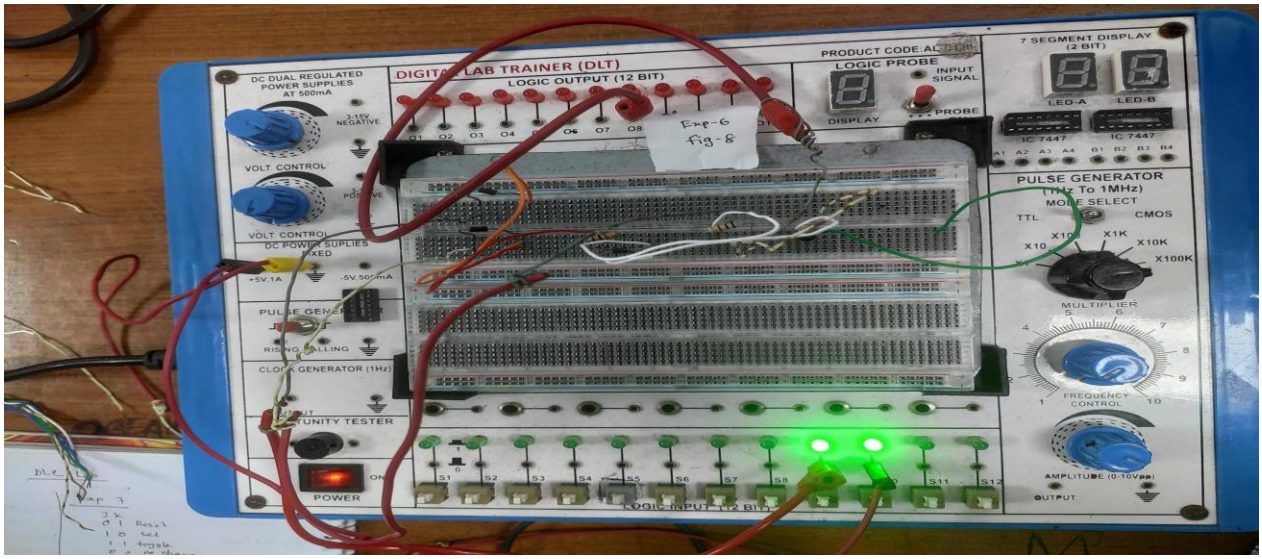
Fig 8: 2-Input DTL NAND Gate



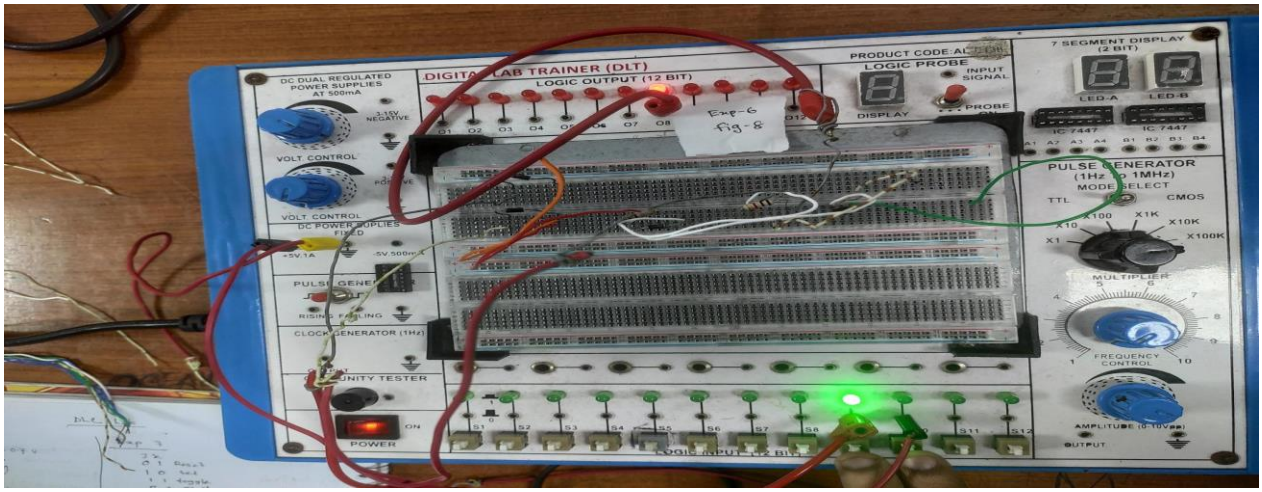
Input: A=0, B=0 Output: 1



Input: A=0, B=1 Output: 1

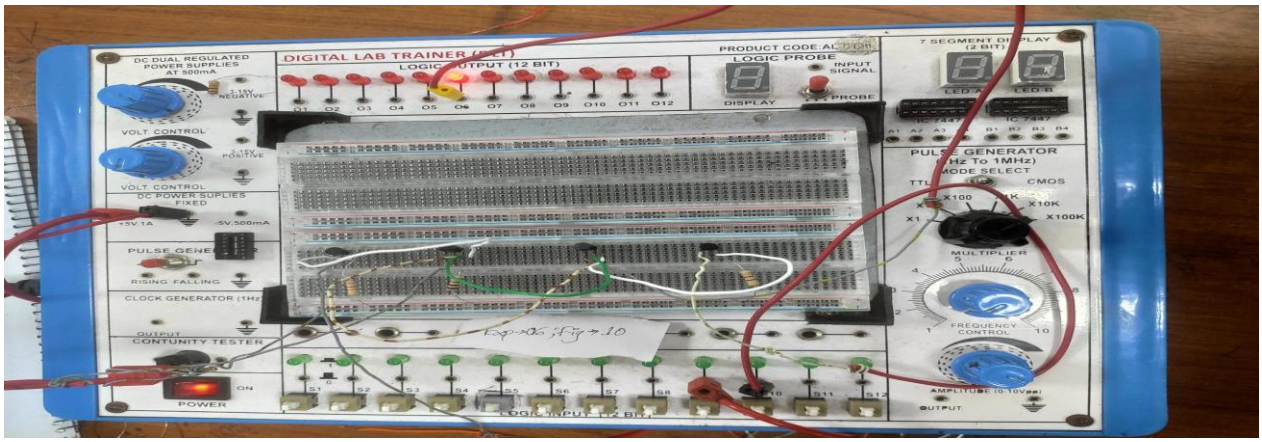


Input: A=1, B=1 Output: 0

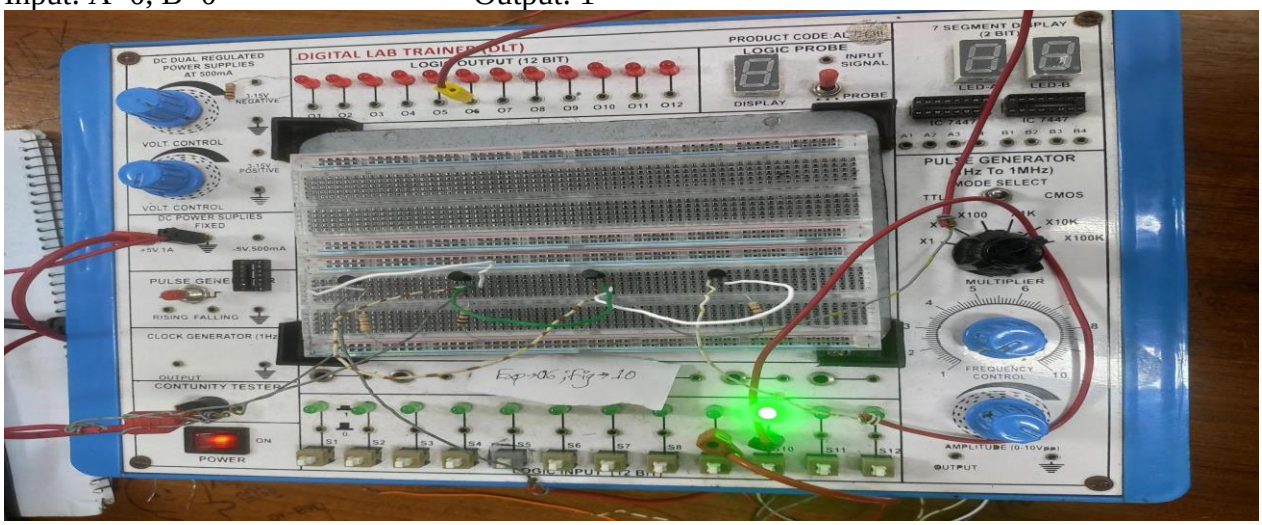


Input: A=1, B=0 Output: 1

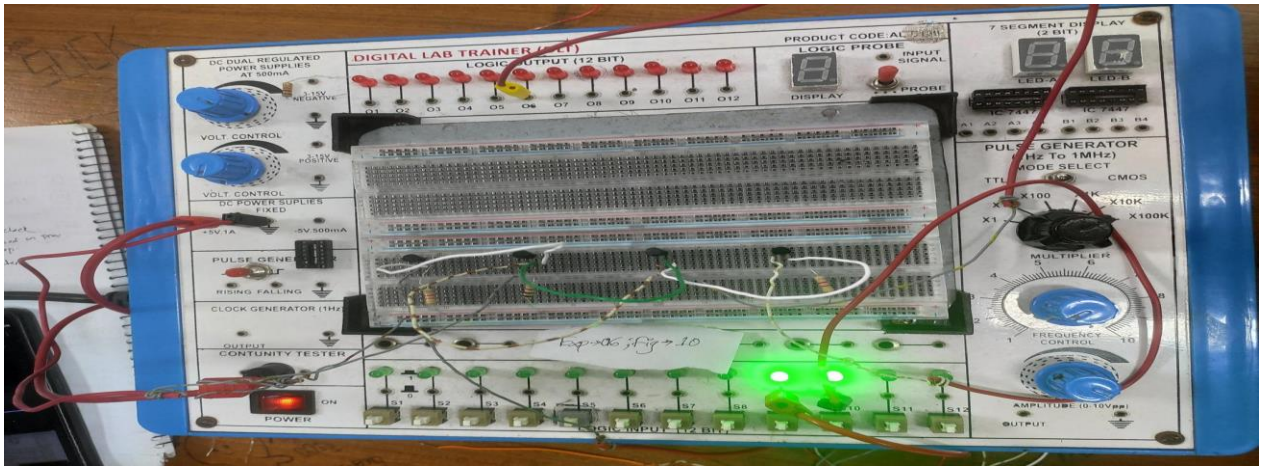
Fig 10: 2-Input TTL NOR Gate



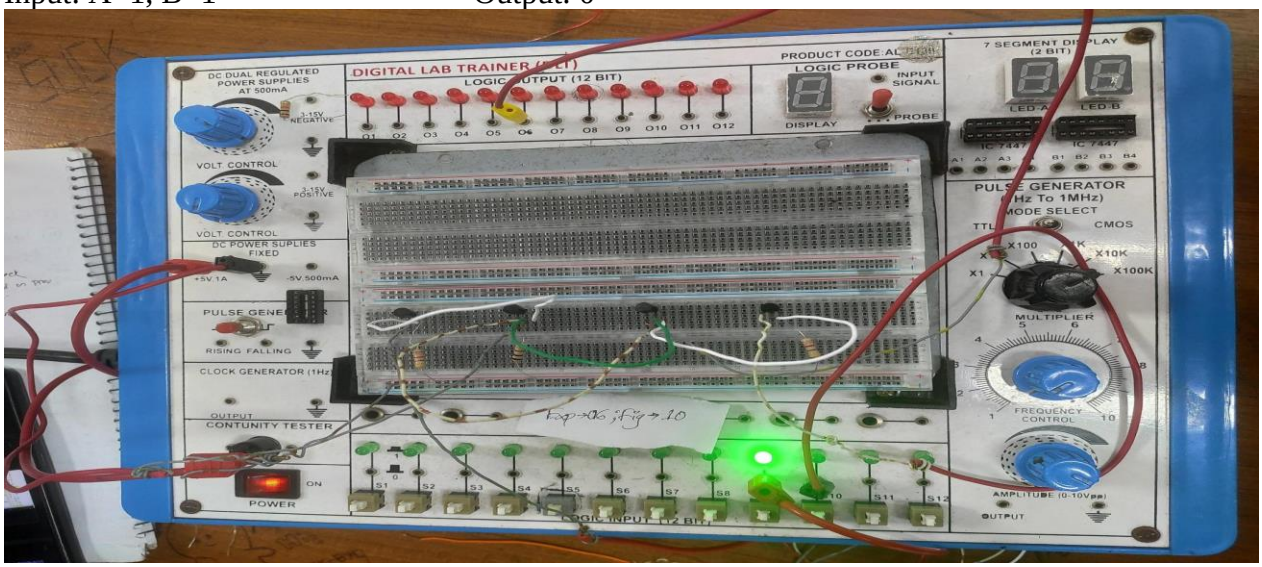
Input: A=0, B=0 Output: 1



Input: A=0, B=1 Output: 0



Input: A=1, B=1 Output: 0



Input: A=1, B=0 Output: 0

RESULT:

Figure: 3

In this experiment the logic gates were implemented

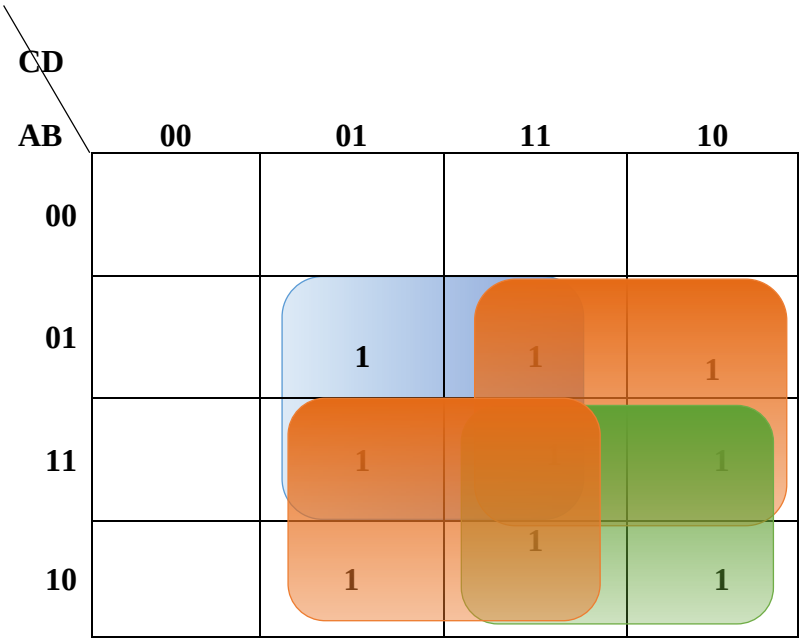
A	B	C	D	A+B	C+D	Y
0	0	0	0	0	0	0
0	0	0	1	0	1	0
0	0	1	0	0	1	0
0	0	1	1	0	1	0
0	1	0	0	1	0	0
0	1	0	1	1	1	1
0	1	1	0	1	1	1
0	1	1	1	1	1	1
1	0	0	0	1	0	0
1	0	0	1	1	1	1
1	0	1	0	1	1	1

1	0	1	1	1	1	1
1	1	0	0	1	0	0
1	1	0	1	1	1	1
1	1	1	0	1	1	1
1	1	1	1	1	1	1

After applying **SOP** we got the equation:

$\bar{A}B\bar{C}D+ \bar{A}BC\bar{D}+ \bar{A}BCD+ A\bar{B}\bar{C}D+ A\bar{B}C\bar{D}+ A\bar{B}CD+ AB\bar{C}D+ ABC\bar{D}+ ABCD$

Karnaugh's Map:



So, the simplified equation we got is:

Y= BD+ AD + BC + AC
= A (C+ D) + B(C+D)
= (A+B) (C+D)

Report:

1. For each of the above set-ups, describe in words what the data means. Did your results match the expected ideal outputs? If not, explain why.
   Answer:

   For DL-AND-OR Gate we have constructed a truth table from which we got some outputs based on different inputs which we can consider as data.
   We have implemented DL-AND-OR Gate and the implementation results were matched with the truth table also with the circuit implemented in NI Multisim software. So, this experiment has been done successfully.

2. Why are diode logic gates not suitable for cascading operation?
   Answer:

A cascading operation refers to a process in electrical engineering which involves the use of a circuit breaker's current-limiting capacity, to enable an installation of lower-rated and lower-cost circuit breakers.

Diode logic gates are not suitable for **cascading operation** because the **pull-down** or **pull-up resistance** within makes them a high output **resistance** device.

Figure: 8

A	**B**	**C**	**D**	**A+B**	**AC+D**	**Y**
0	0	0	0	0	0	0
0	0	0	1	0	1	0
0	0	1	0	0	1	0
0	0	1	1	0	1	0
0	1	0	0	1	0	0
0	1	0	1	1	1	1
0	1	1	0	1	1	1
0	1	1	1	1	1	1
1	0	0	0	1	0	0
1	0	0	1	1	1	1
1	0	1	0	1	1	1
1	0	1	1	1	1	1
1	1	0	0	1	0	0
1	1	0	1	1	1	1
1	1	1	0	1	1	1
1	1	1	1	1	1	1

Report:

4. For each of the above set-ups, describe in words what the data means. Did your results match the expected ideal outputs? If not, explain why.

Answer:

For DTL NAND Gate, TTL Inverter and 2-input TTL NOR gate we have some expected outputs based on different inputs which we can consider as data.

We have implemented DTL NAND Gate, TTL Inverter and 2-input TTL NOR gate and the implementation results were matched with the expected result also with the circuit implemented in NI Multisim software. So, this experiment has been done successfully

6. Design 2-input TTL NOR gates.

Answer:

2-input TTL NOR:

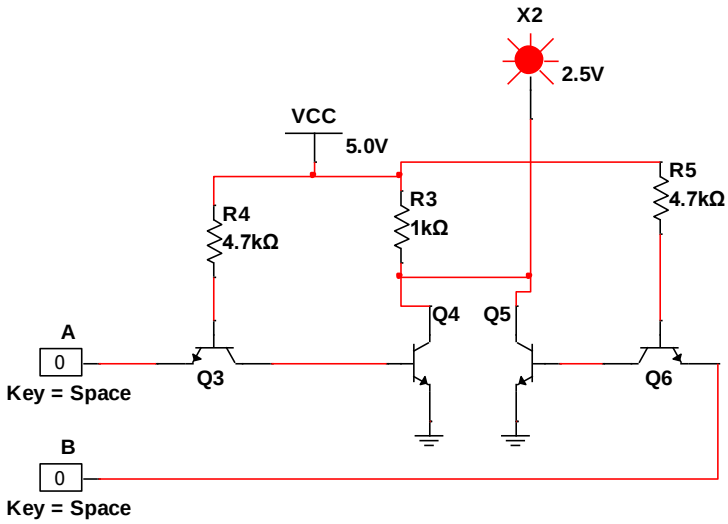


Figure:02

Figure: 10

A	B	AB	Z
0	0	0	1
0	1	0	0
1	0	0	0
1	1	1	0

DISCUSSION:

In this lab, we learned about the combinational circuit. To complete the task, we'd have to learn about truth table and k-map to reduce the expression before using multisim. Finally, regardless of whether the result is correct or not, we must comprehend how truth tables operate. We were able to complete our simulation without making any mistakes because it delivered the exact output we needed.

CONCLUSION:

To sum up, diode is an electronic device with two terminal that allows current flow to only one direction and transistor is another electronic device with three terminals that work as an amplifier. Different logic functions such as AND operation, OR operation, NAND operation etc can be implemented using diode and transistor. The theoretical ideal data can be verified by comparing expiring experimental data with it.

REFERENCES:

1. Electronics Club. (2020). *Diode Logic in logic family - Electronics Club Digital Electronics*. [online] Available at: https://electronics-club.com/diode-logic-in-logic-family/.

2. Basic Electronics Tutorials. (2013). *Digital Logic Gate Tutorial - Basic Logic Gates*. [online] Available at: https://www.electronics-tutorials.ws/logic/logic_1.html.