LAB # 4

CSE-202L Digital Logic Design Lab

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SUBMITTED BY:

Ali Asghar(21PWCSE2059)

Suleman Shah(21PWCSE1983)

Abu Bakar(21PWCSE2004)

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SUBMITTED TO:

Engr. Rehmat Ullah

Department of Computer Systems Engineering

University of Engineering & Technology, Peshawar

UNIVERSAL GATES

OBJECTIVE:

- To study the realization of basic gates using universal gates (NAND & NOR)

COMPONENTS:

- IC’s
  - 7400 Quad-2-Input NAND Gate
  - 7402 Quad-2-Input NOR Gate
- LED’s
- Dip Switch
- 1KΩ Resistors

THEORY:

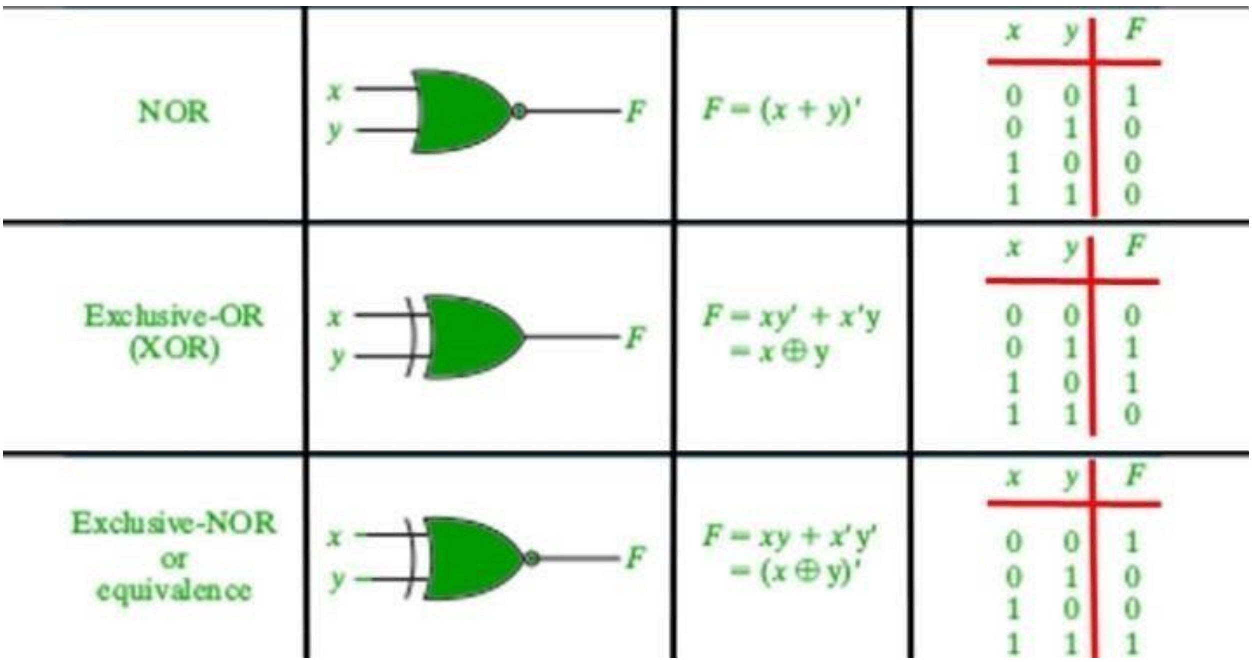
- AND, OR, NOT are called basic gates as their logical operation cannot be simplified further.
- NAND and NOR are called universal gates as using only NAND or only NOR any logic function can be implemented. Using NAND and NOR gates and De-Morgan's Theorems different basic gates & EX-OR gates are realized.

PROCEDURE:

1. Give biasing to the IC and do necessary connections as shown in the circuit diagram.
2. Give various combinations of inputs and note down output using LED.
3. Repeat the procedure for all gates.

OBSERVATION TABLE

A	B	Y
0	0	
0	1	
1	0	
1	1	



NOR		$F = (x + y)'$	x y F: 0 0 1; 0 1 0; 1 0 0; 1 1 0
Exclusive-OR (XOR)		$F = xy' + x'y = x \oplus y$	x y F: 0 0 0; 0 1 1; 1 0 1; 1 1 0
Exclusive-NOR or equivalence		$F = xy + x'y' = (x \oplus y)'$	x y F: 0 0 1; 0 1 0; 1 0 0; 1 1 1

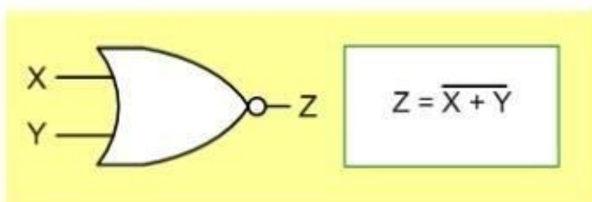
NOR Gate:

The **NOR** gate represents the complement of the OR operation. Its name is an abbreviation of **N**OT **OR**.

The graphic symbol for the NOR gate consists of an OR symbol with a bubble on the output, denoting that a complement operation is performed on the output of the OR gate.

The truth table and the graphic symbol of NOR gate is shown in the figure.

X	Y	NOR
0	0	1
0	1	0
1	0	0
1	1	0



The truth table clearly shows that the NOR operation is the complement of the OR.

Universal Gates:

A universal gate is a gate which can implement any Boolean function without need to use any other gate type.

The NAND and NOR gates are universal gates.

In practice, this is advantageous since NAND and NOR gates are economical and easier to fabricate and are the basic gates used in all IC digital logic families.

In fact, an AND gate is typically implemented as a NAND gate followed by an inverter not the other way around!!

Likewise, an OR gate is typically implemented as a NOR gate followed by an inverter not the other way around!!

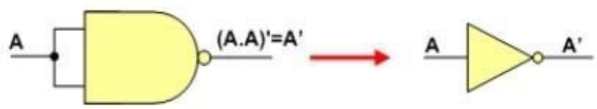
NAND Gate is a Universal Gate:

To prove that any Boolean function can be implemented using only NAND gates, we will show that the AND, OR, and NOT operations can be performed using only these gates.

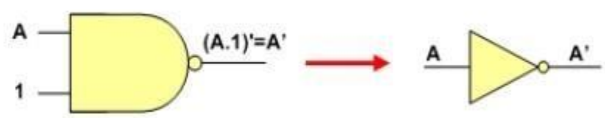
Implementing an Inverter Using only NAND Gate

The figure shows two ways in which a NAND gate can be used as **an inverter (NOT gate)**.

1. All NAND input pins connect to the input signal **A** gives an output **A'**.

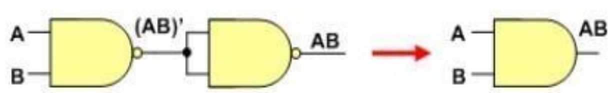


2. One NAND input pin is connected to the input signal **A** while all other input pins are connected to logic **1**. The output will be **A'**.



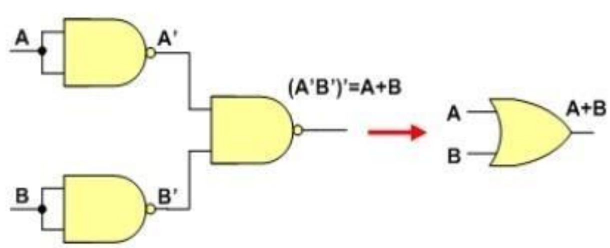
Implementing AND Using only NAND Gates

An AND gate can be replaced by NAND gates as shown in the figure (The AND is replaced by a NAND gate with its output complemented by a NAND gate inverter).



Implementing OR Using only NAND Gates

An OR gate can be replaced by NAND gates as shown in the figure (The OR gate is replaced by a NAND gate with all its inputs complemented by NAND gate inverters).



Thus, the NAND gate is a universal gate since it can implement the AND, OR and NOT functions.

NAND Gate is a Universal Gate:

To prove that any Boolean function can be implemented using only NOR gates, we will show that the AND, OR, and NOT operations can be performed using only these gates.

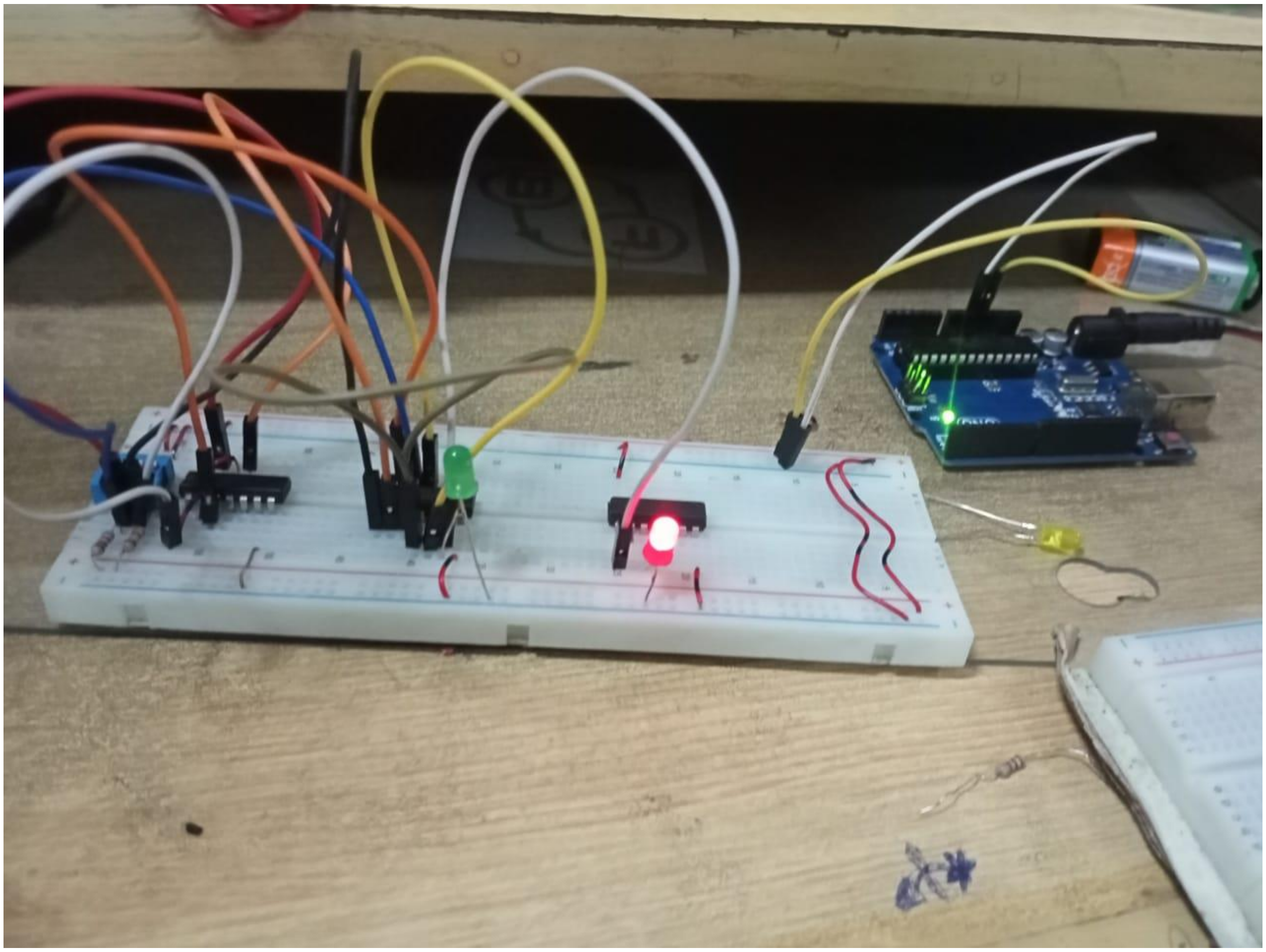
Implementing an Inverter Using only NOR Gate

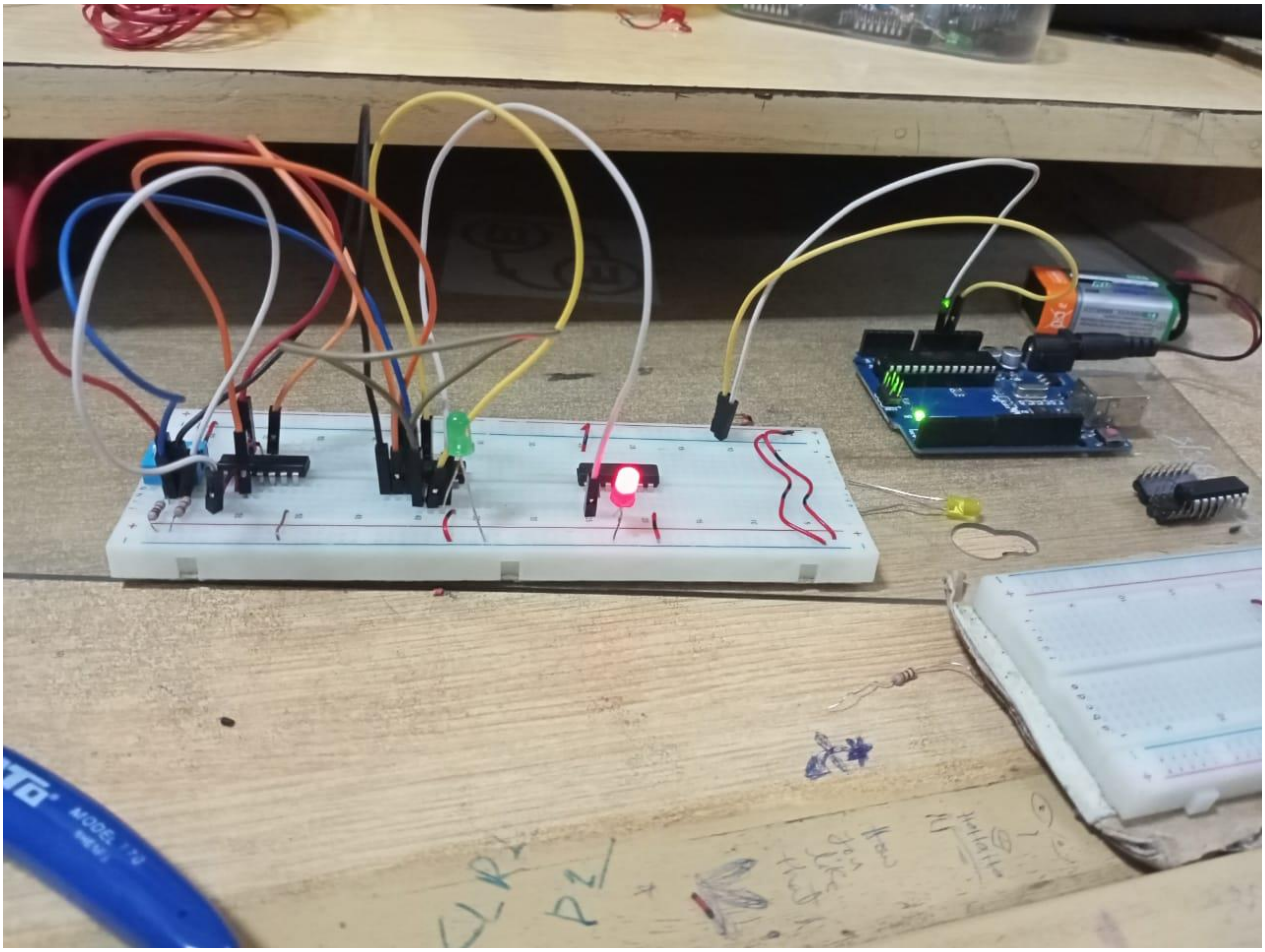
The figure shows two ways in which a NOR gate can be used as **an inverter (NOT gate)**.

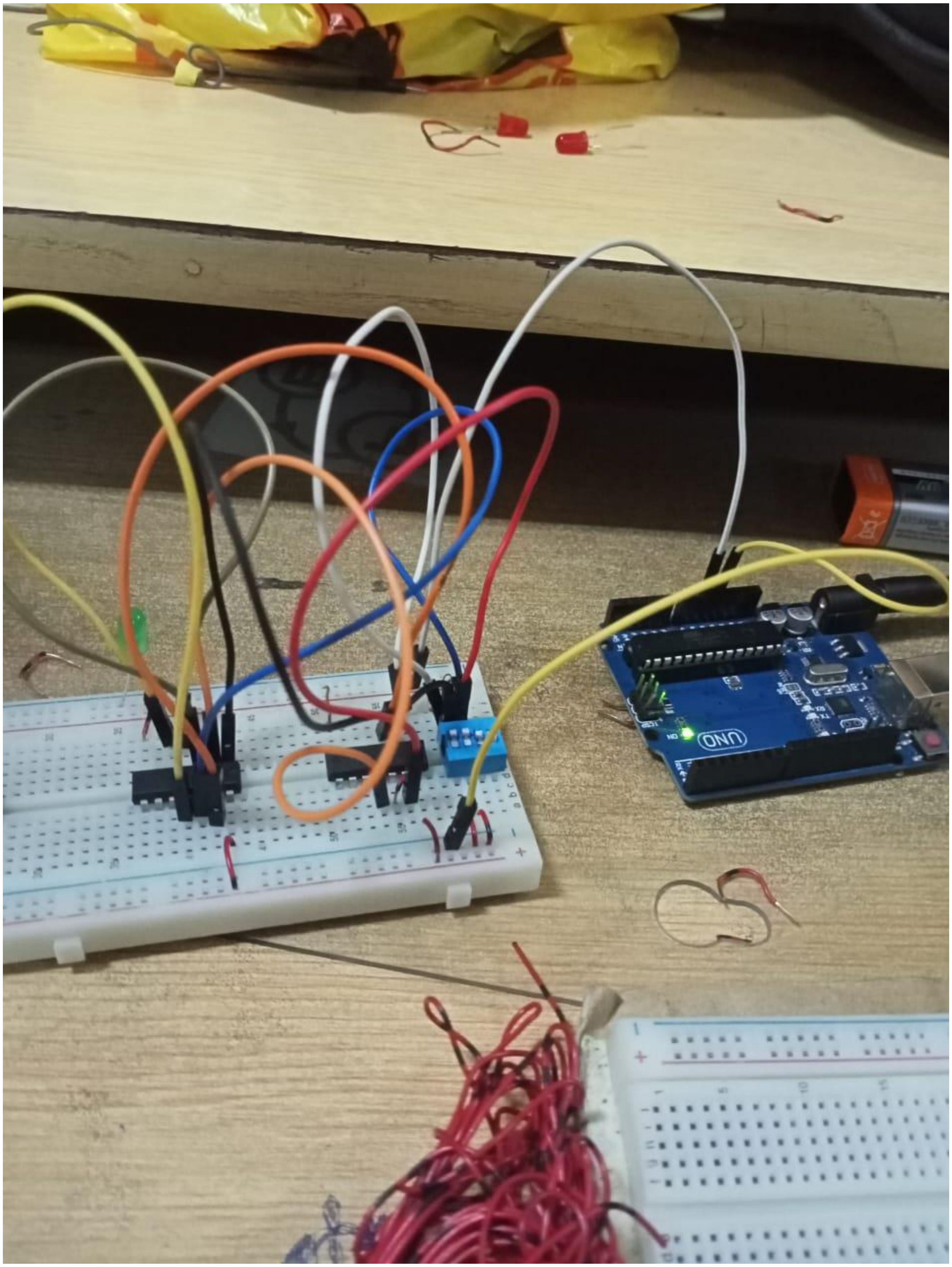
LAB WORK:

IMPLEMENTING XOR AND XNOR

USING NAND:



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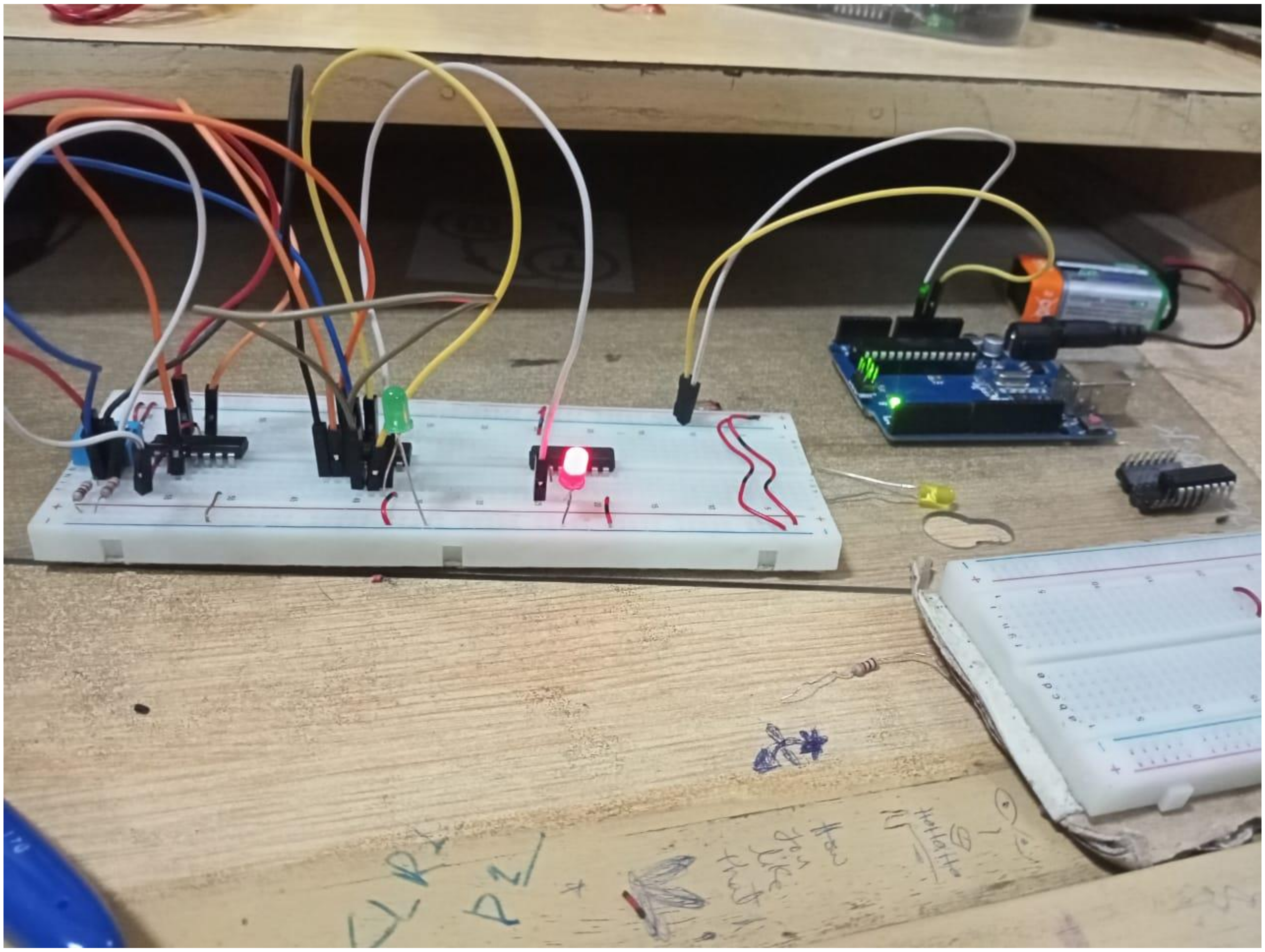

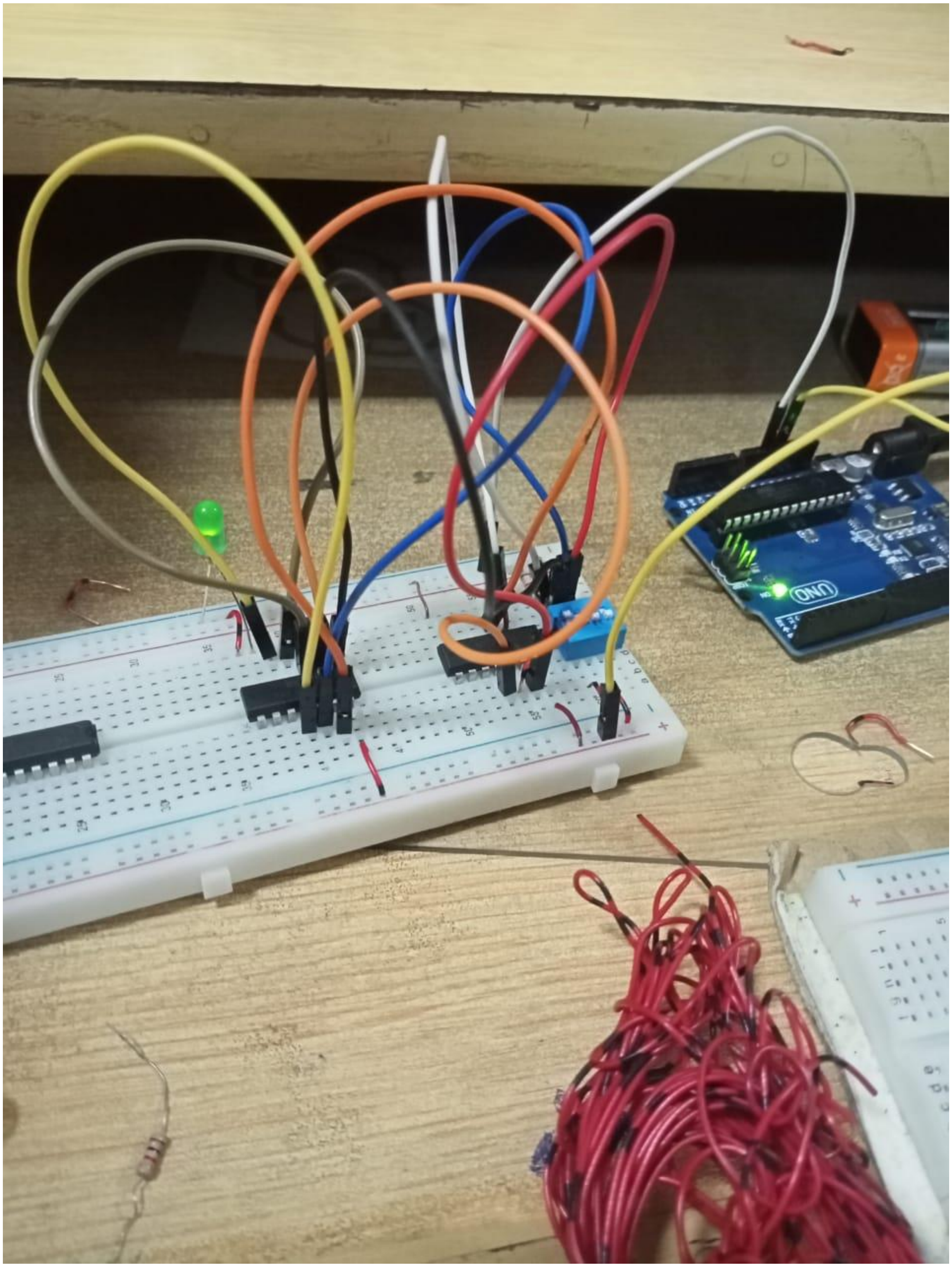

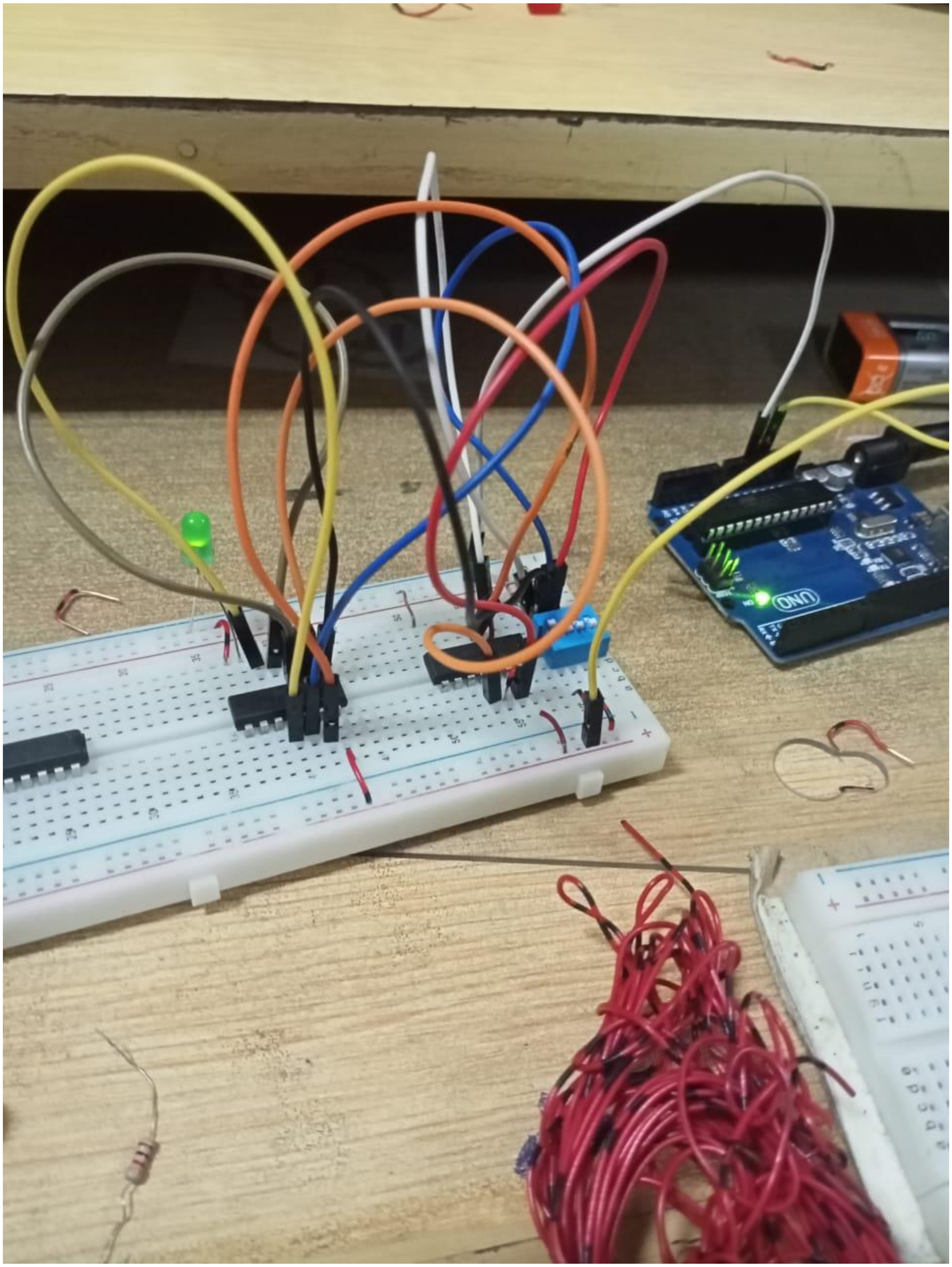
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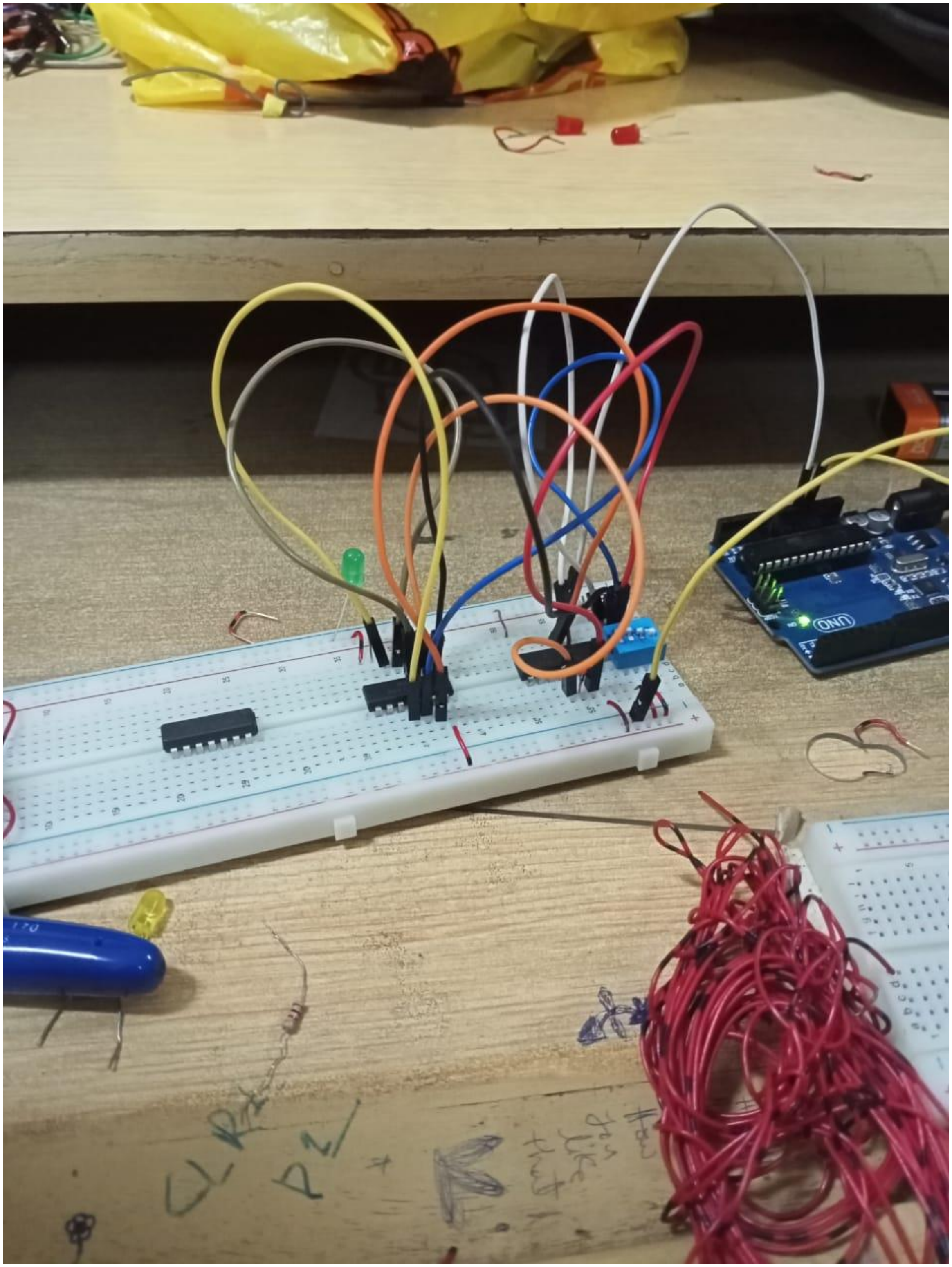
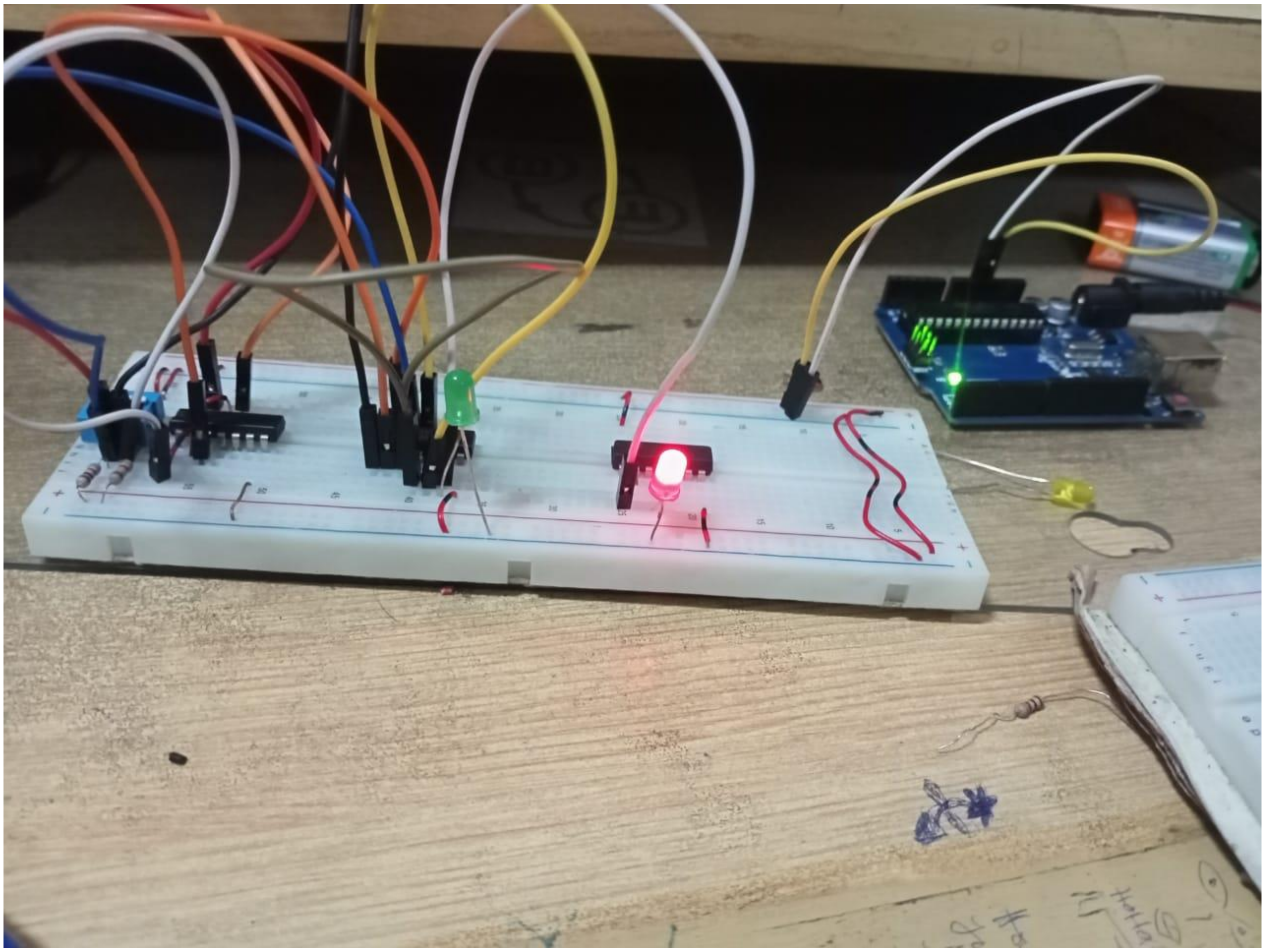
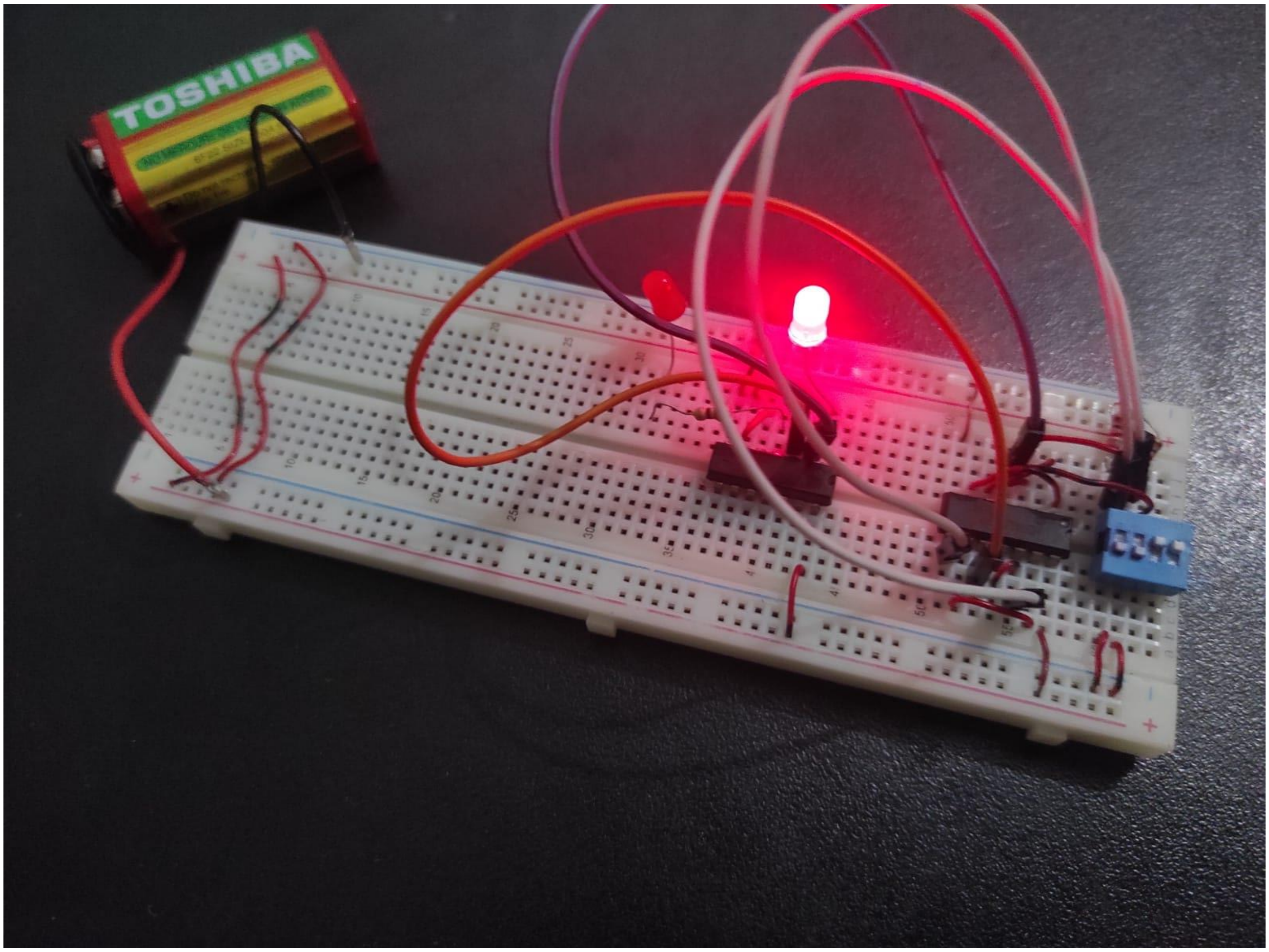
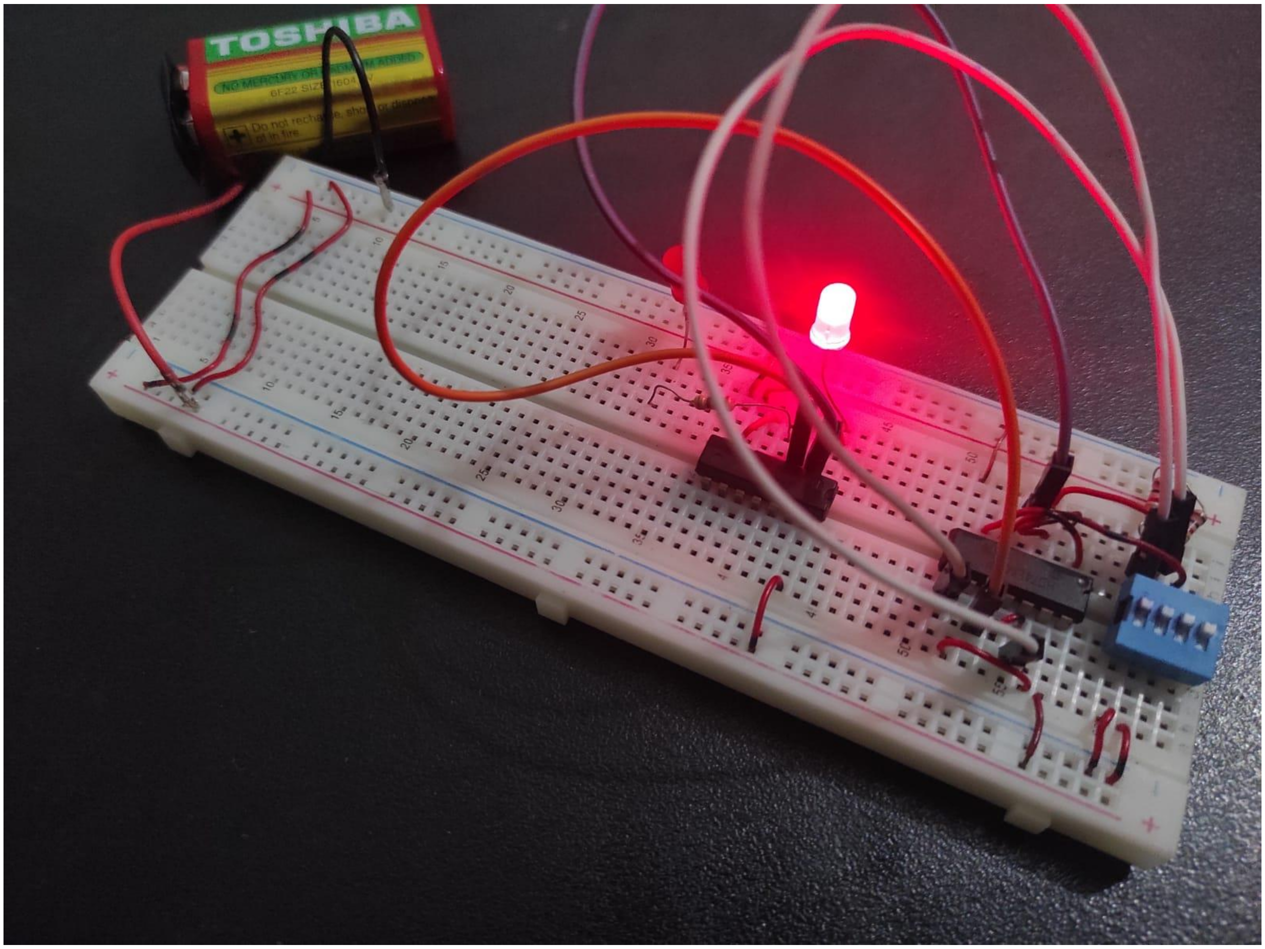




USING NOR:

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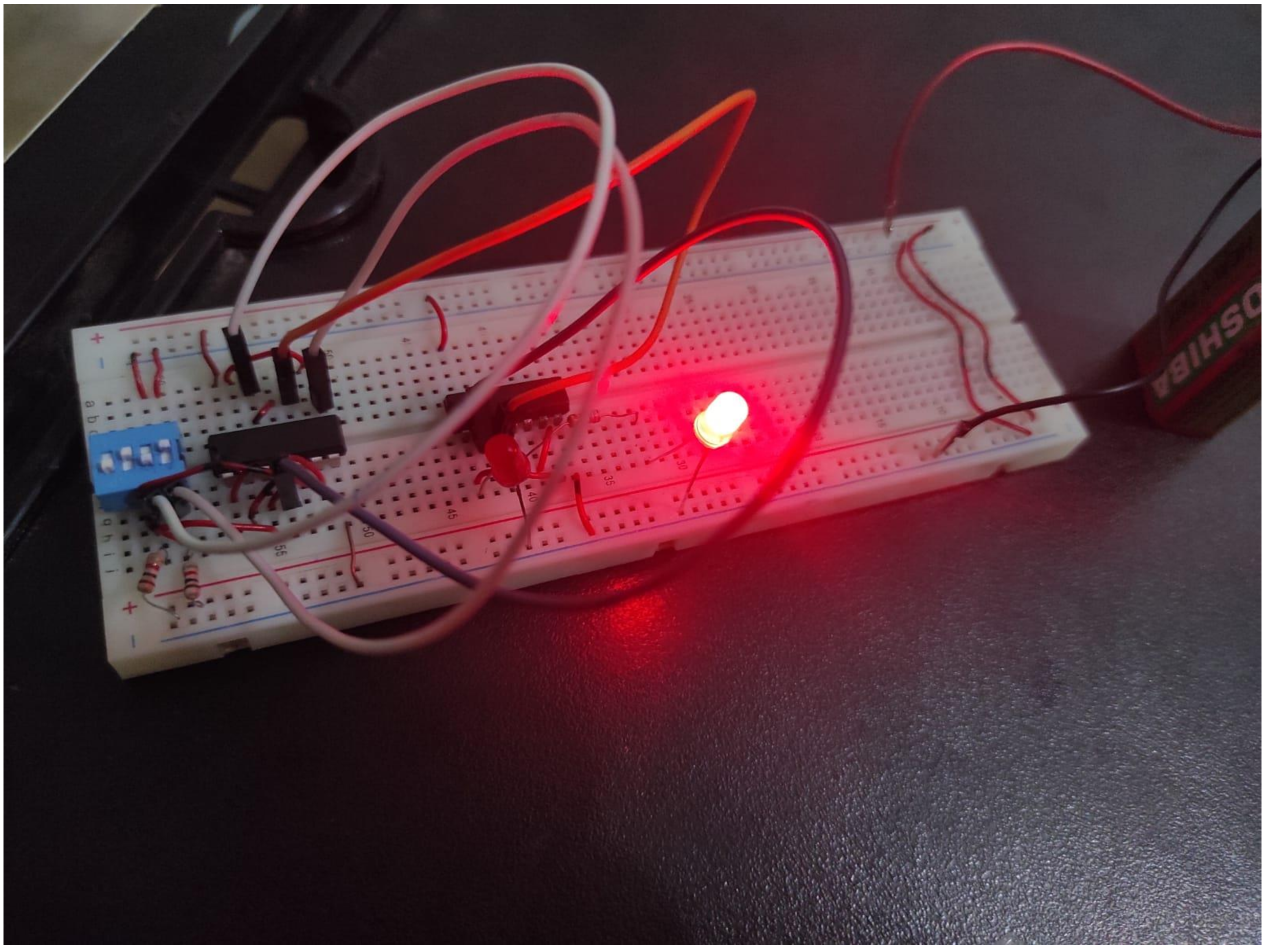
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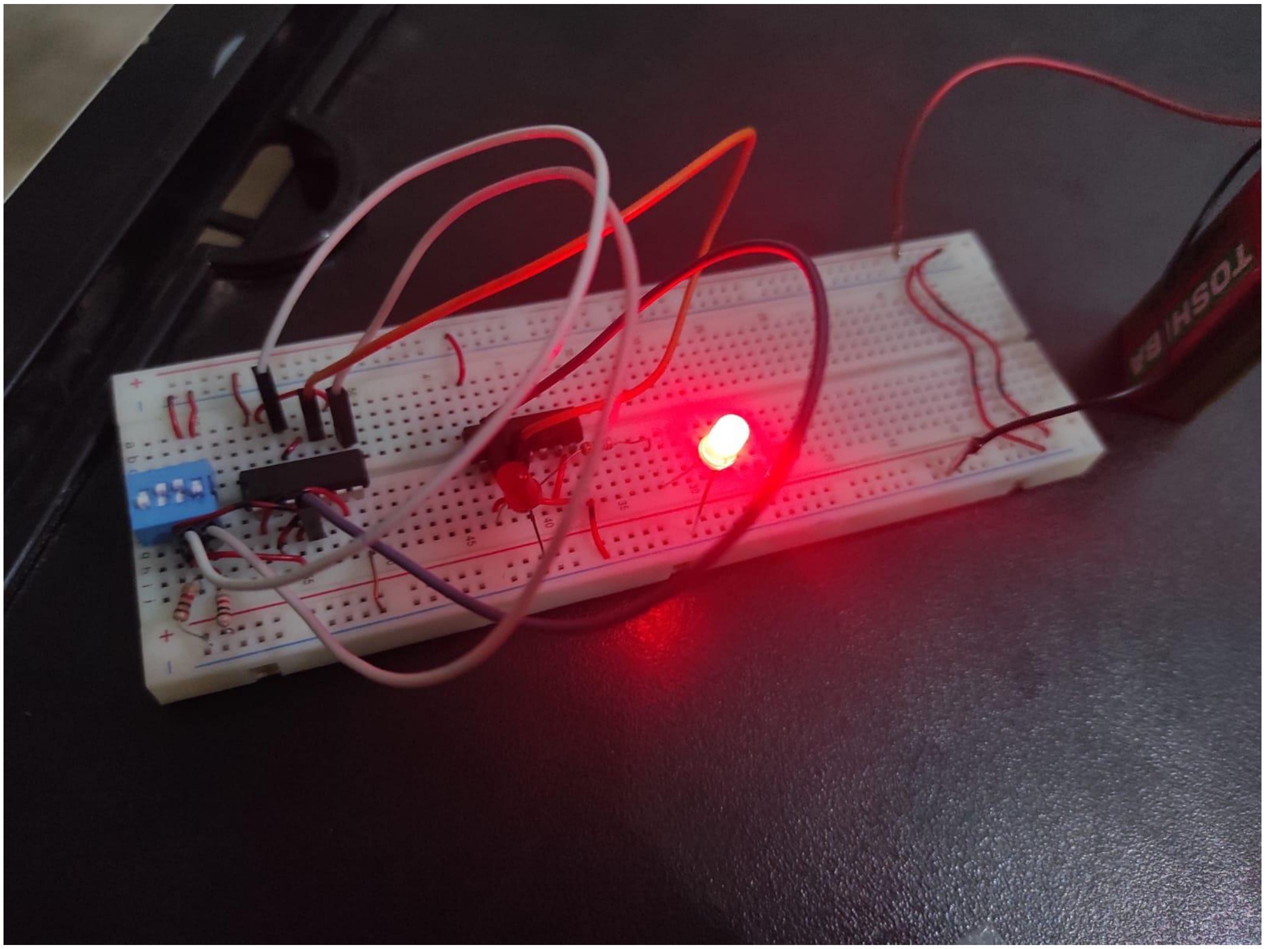

LAB READINGS:

Truth Table 3.1

X	Y	XOR	XNOR
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

CONCLUSION:

Thus, universal gates are studied.