
# Hardware Lab (CS 224)
# Assignment 1

## Group No. 18

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# 1 Problem Statement

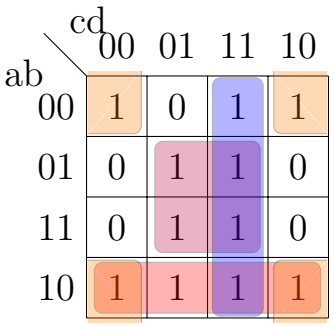
Implement the following boolean function using Breadboard, ICs, and Hookup Wires.

$F(A, B, C, D) = \sum(0, 2, 3, 5, 7, 8, 9, 10, 11, 13, 15)$ using Product of SUM implementation.

# 2 Process to Obtain the Design

## 2.1 Minimize the Boolean Function

We started by plotting the given minterms $(0, 2, 3, 5, 7, 8, 9, 10, 11, 13, 15)$ on a 4-variable Karnaugh map (K-map). We grouped the 1's in the K-map into the largest possible groups (here only quads) to simplify the Boolean expression.



## 2.2 Write the SOP Expression

From the K-map, we extracted the simplified Sum of Products (SOP) expression by writing down the product terms for each group of 1's. Each product term corresponds to an AND operation for the group, and we combined these terms using OR to form the final function.

$$F(A, B, C, D) = B'D' + BD + AB' + CD$$

## 2.3 ICs Used and Gates Required

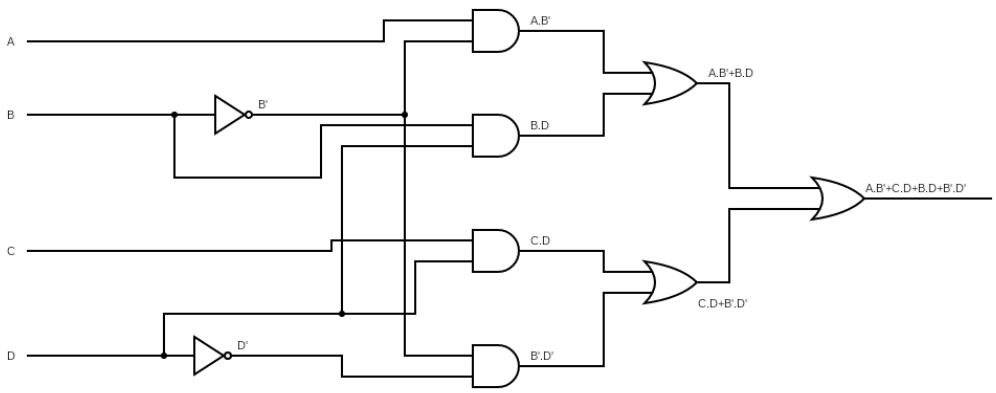
For the implementation of the Boolean function, we required the following gates and ICs:

- **AND Gates:** 4 AND gates were required to implement each of the product terms in the SOP expression. The IC used for the AND gates was the `7408` IC, which contains four 2-input AND gates.
- **OR Gates:** 3 OR gates were needed to combine the product terms. The IC used for the OR gates was the `7432` IC, which contains four 2-input OR gates.
- **NOT Gates:** 2 NOT gates were required to implement the complements of the variables. The IC used for the NOT gates was the `7404` IC, which contains six inverters (NOT gates).

These ICs and gates allowed us to implement the Boolean function using the Sum of Products (SOP) form.

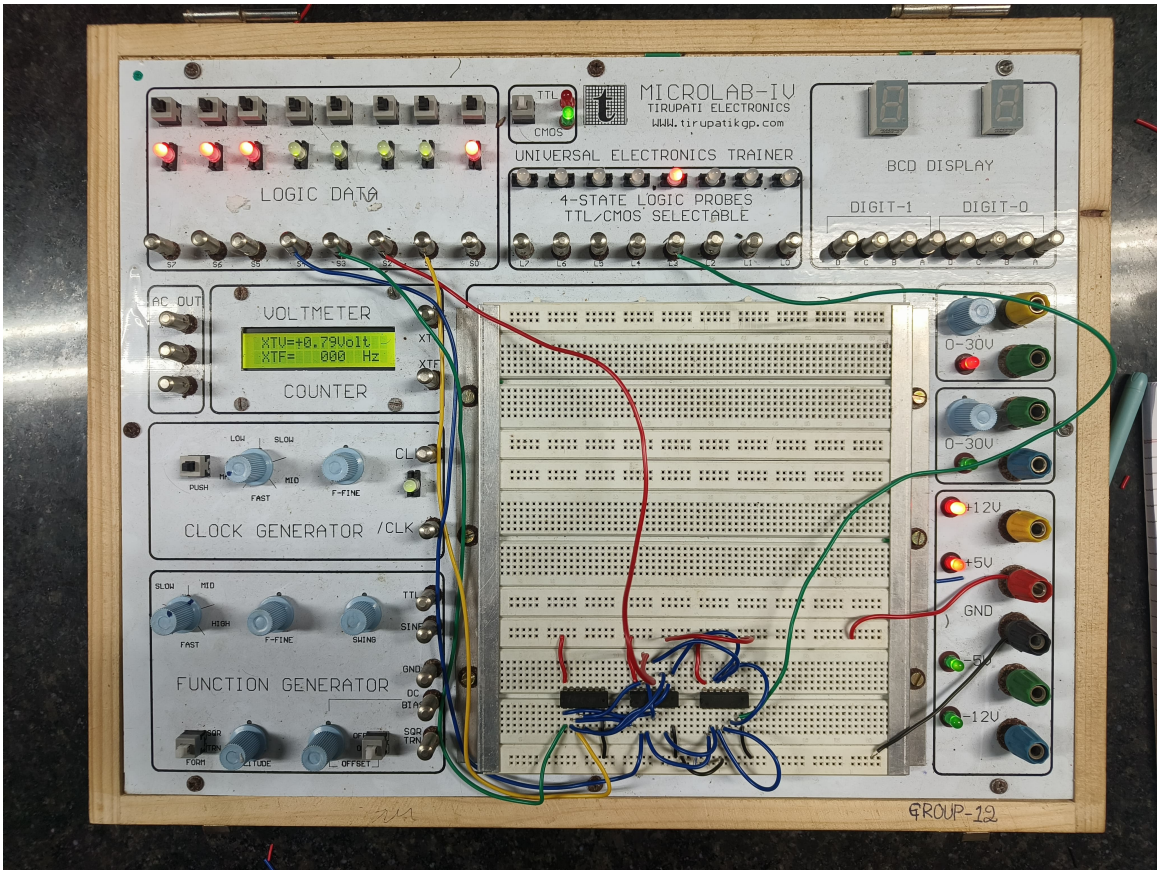
# 3 Circuit Diagram

The circuit diagram for the implementation of the Boolean function is shown below. It depicts the arrangement of the gates, their connections, and the input/output lines used to realize the given Boolean expression.



# 4 Picture of the Circuit

The following picture shows the actual implementation of the circuit on the breadboard. The ICs, hookup wires, and the arrangement of the components can be observed.




# 5 Things we kept in mind

While implementing the circuit on the breadboard, we followed a systematic approach to ensure clarity and organization. The following guidelines were kept in mind:

- **Ground Connections:** All ground connections were made using black wires to maintain consistency.
- **Power Connections:** The power connections ($+5V$) were made using red wires.
- **Input Wires:** Different colored wires were used for each input variable to distinguish them easily.
- **Intermediate Connections:** Blue wires were used for intermediate connections between gates.

- **Output Connections:** The final output connections were made using green wires to make them easily identifiable.