Digital System Design Lab

Lab 3
Implementation of Dual and Complement Functions

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1. Objectives

- To become familiar with the Digital Tool Kit
- To learn how to build and test digital circuits using the Breadboard
- To learn about basic logic functions such as AND, OR, NOT

2. Theorem

(1) Representation of Boolean Equations:

Boolean equations are fundamental in digital logic and circuit design. They describe the relationships between different logic variables using Boolean operators (AND, OR, NOT). Here are some common methods for representing Boolean equations:

a. *Sum-of-Products (SOP) Form:*

In the SOP form, a Boolean equation is expressed as a sum of product terms. Each term is a combination of input variables and their complements, multiplied together and then summed using the OR operator. For example, the Boolean equation A * B + C * D represents a logical expression where two product terms (A * B and C * D) are ORed together.

b. *Product-of-Sums (POS) Form:*

In the POS form, a Boolean equation is expressed as a product of sum terms. Each term is a combination of input variables and their complements, added together and then multiplied using the AND operator. For example, the Boolean equation (A + B) * (C + D) represents a logical expression where two sum terms (A + B and C + D) are ANDed together.

c. *Truth Table:*

A truth table is a tabular representation of all possible input combinations and their corresponding output values for a given Boolean equation. It provides a comprehensive view of the equation's behavior for all input scenarios, making it a valuable tool for analysis and simplification.

d. *Karnaugh Maps (K-Maps):*

Karnaugh maps are graphical tools used to simplify Boolean expressions. They are particularly effective for expressions with fewer variables. K-Maps allow for easy identification of groups of 1s in the truth table, which can be used to simplify the equation.

(2) Complement and Dual of Boolean Equations:

In the context of Boolean algebra and logic, the terms "complement" and "dual" refer to specific transformations applied to a Boolean equation.

a. Complement:

The complement of a Boolean equation is obtained by changing all the AND operators to OR operators and vice versa, as well as inverting all the variables. For example, if you have the original equation F = A * B + C, its complement, F', would be F' = A + B * C.

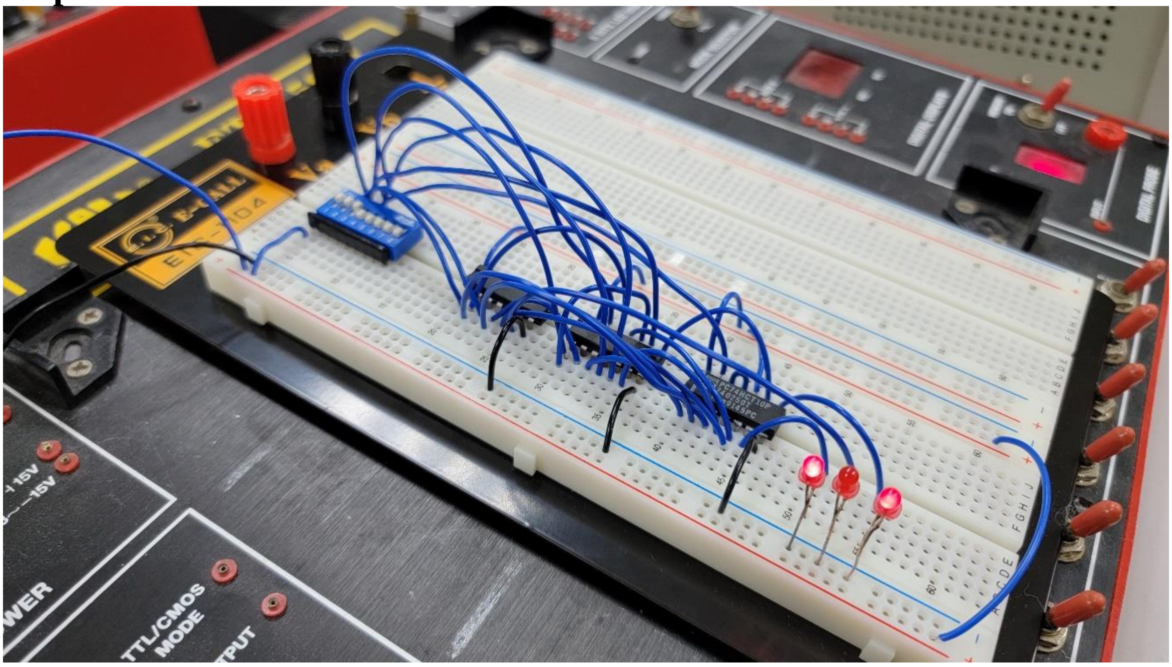
b. Dual:

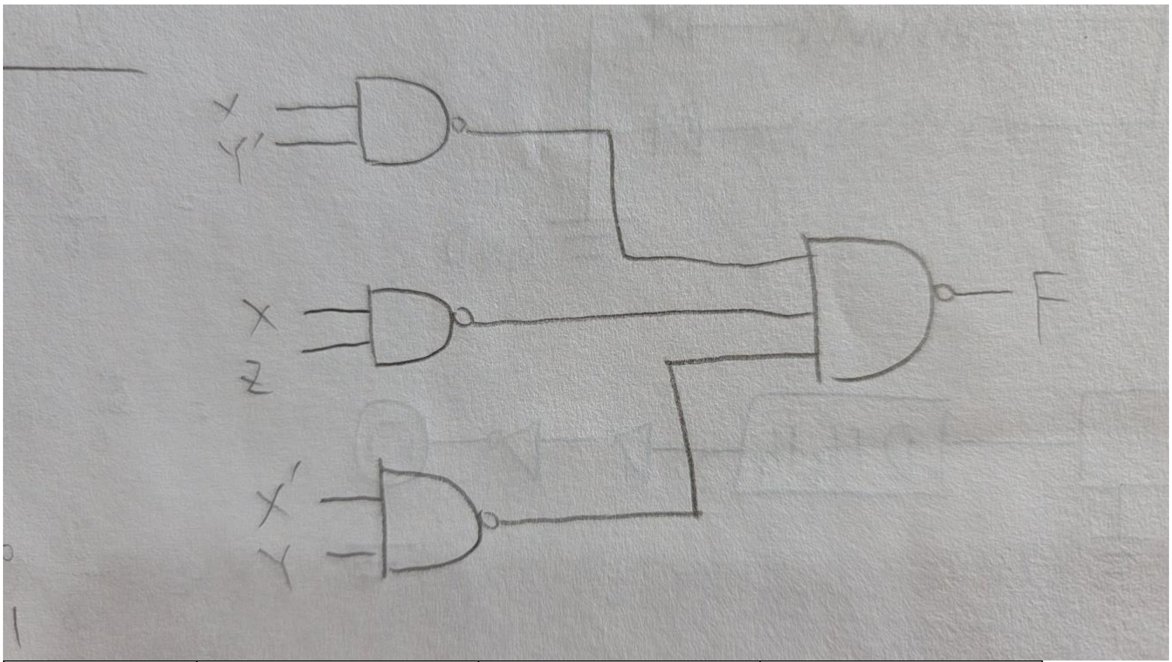
The dual of a Boolean equation is created by interchanging the AND and OR operators while keeping the same variables. In other words, the dual operation switches between the SOP and POS forms of an equation. For example, the dual of F = A + B * C is F' = A * B + C.

The complement and dual of a Boolean equation can be used to simplify expressions, derive alternate designs, or analyze the logical behavior of a circuit. These operations are fundamental in Boolean algebra and digital logic design.

3. Experimental Results

(1) Step 1





X Y Z	F(X, Y, Z)	F^D(X, Y, Z)	F'(X, Y, Z)
0 0 0	0		1
0 0 1	0		1
0 1 0	1		0
0 1 1	1		0
1 0 0	1		0
1 0 1	1		0
1 1 0	0		1
1 1 1	1		0

4. Comments

(1) F’ is the fastest of all since it used the least circuit.

(2) F is the slowest of all since it used the most circuit.

5. Problems & Solutions

(1) The time I have isn’t enough for me to finish step 2. Maybe next time can compose the circuit together beforehand to ensure that I have abundant time to deal with all the steps.

(2) Either step 3 didn’t have enough time to finish but through others’ results, output should be floating arbitrarily. As above, I should pre-build the circuit to gain enough time to finish the lab.

6. Feedback

None