Experiment (2)

Implementation And Simplification of Boolean Function

4.1 Objectives:

- To demonstrate the relationship a Boolean function the corresponding logic diagram.
- Use the potential of Boolean algebra to simplify complex logic circuits.

4.2 Background Information :

A Boolean function is an expression formed with binary variables, binary operators and an equal sign. A binary variable can take either the value 0 or 1. A binary operator specifies the logic operation between these variables.

Example:

Consider the following Boolean function consisting of two variables (x , y).

$$F = x\,y'$$

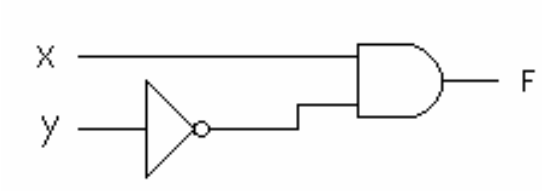
This function is equal to 1 if x = 1 and y' = 1 ; otherwise F is equal to 0. The above simple Boolean function is represented as algebraic expression. Also, the function can be represented as a truth table. In this case, we need to list all the 2^N combinations of 1s and 0s of the N binary variables of the function, along with a column for the corresponding value of F. the truth table for the above function is as follows

x	y	F
0	0	**0**
0	1	**0**
1	0	**1**
1	1	**0**

From the table, we can see that the function is equal to 1 only x = 1 and y = 0.

Another representation of Boolean functions is by logic diagrams, composed of the binary variables as inputs, binary operators represented as symbolic draw for logic gates and the output of the function.

The logic diagram representing the above function is as follows:



Another important issue when dealing with Boolean function is simplification of the Boolean function. In this process, we try to simplify or reduce the function to obtain the same output with simple and short form of the function. The simplification of Boolean functions is done by applying the postulates and the theorems of Boolean algebra on the function till we get the desired form.

In this experiment, we will implement the Boolean function

$$F = x' y' z + x' y z + x y'$$

4.3 Equipment Requires :

The following equipments are needed to perform all the procedures :

Universal Breadboard
Jumper wire kit
(1) 7404 TTL HEX INVERTER GATE
(1) 7411 TTL TRIPLE 3-input AND GATE (if not available use 7408 IC)
(1) 7432 TTL QUAD 2-input OR GATE
3x Toggle Switches
1x Carbon-film Resistor (470Ω)
1x LED

4.4 Procedure :

Step1:

1. Collect the components necessary to accomplish this experiment.
2. Draw the Logic Diagram for the Boolean function F.
3. Plug each IC chip into the breadboard.
4. According to the pin-out of the IC chips, wire the logic circuit.
5. Be sure to connect the supply voltage and ground lines (V_{cc} & GND) to the chips.
6. Once all connections have been done, turn on the power switch of the board and practice all possible combinations of inputs, and fill in the truth table below :

x y z	x ' y' z	x' y z	x y'	F
0 0 0				
0 0 1				
0 1 0				
0 1 1				
1 0 0				
1 0 1				
1 1 0				
1 1 1				

Step2:

1. Using Algebraic Methods, Simplify the Boolean function F showing all steps.
2. Draw the logic diagram for the simplified function, and construct this circuit with the same steps described in step1.
3. Practice all possible combinations of inputs, and fill in the following truth table :

x y z	F
0 0 0	
0 0 1	
0 1 0	
0 1 1	
1 0 0	
1 0 1	
1 1 0	
1 1 1	

4. Compare the truth tables obtained from the above two steps and write down your observations
5. After finishing the experiment, turn off the power switch , disconnect the wires , take out all IC chips from the trainer, put back everything you have used and clean your table.

Questions :

1) Write the truth table and draw the logic diagram for the function then simplify the function to the most simple form and compare the results

$$F= x' y + x y' + x y + x' y'$$

2) Repeat the above question for the function F = ABC + A'B + ABC'

3) Simplify the function F = (x + y)' (x'+ y') to get the form F = x' y' showing all steps.

4) Four chairs A, B, C, and D are placed in a row. Each chair may be occupied ("l") or empty ("0"). A Boolean function F is "l" if and only if there are two or more adjacent chairs that are empty.
   a) Give the truth table defining the Boolean function F
   b) Express F as a minterm expansion (standard sum of product)
   c) Express F as a maxterm expansion (standard product of sum
   d) Simplify the minterm expansion of F

5) A buzzer is to sound when the following conditions apply :
   - Switches A, B, C are on.
   - Switches A and B are on but switch C is off.
   - Switches A and C are on but switch B is off.
   - Switches C and B are on but switch A is off.

   a) Draw a truth table for this situation and obtain a Boolean expression for it.
   b) Minimize this expression and draw a logic diagram for it.