Name:	Instructor: Engr.
Date Performed:	Marks Obtained: /10

Group Members

(ID):……

Checked By:_____ Date:_____

Experiment # 04

Boolean Expression Simplification and Implementation

OBJECTIVES:

- To understand the utilization of Boolean algebra in logic circuits.
- To write logic equation of a logic circuit from the logic diagram.
- Simplification of Boolean Expression using K-Map.

Required Components and Equipment:

- ICs as required
- Digital Electronics trainer
- Connecting Wires

Boolean algebra:

In mathematics and mathematical logic, Boolean algebra is the branch of algebra in which the values of the variables are the truth values true and false, usually denoted 1 and 0 respectively. It should be clearly understood that Boolean numbers are not the same as binary numbers. Whereas Boolean numbers represent an entirely different system of mathematics from real numbers, binary is nothing more than an alternative notation for real numbers. The two are often confused because both Boolean math and binary notation use the same two ciphers: 1 and 0. The difference is that Boolean quantities are restricted to a single bit (either 1 or 0), whereas binary numbers may be composed of many bits adding up in place-weighted form to a value of any finite size.

A Boolean expression is an expression that has relational and/or logical operators operating on Boolean variables. A Boolean expression evaluates to either *true* or *false*. We have four basic Boolean identities for addition and four for multiplication:

Basic Boolean algebraic identities

Additive	Multiplicative
$A + 0 = A$	$0A = 0$
$A + 1 = 1$	$1A = A$
$A + A = A$	$AA = A$
$A + \overline{A} = 1$	$A\overline{A} = 0$

The Karnaugh map provides a simple and straight-forward method of minimising boolean expressions. With the Karnaugh map Boolean expressions having up to four and even six variables can be simplified.

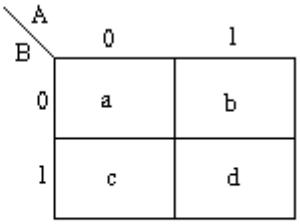
A Karnaugh map provides a pictorial method of grouping together expressions with common factors and therefore eliminating unwanted variables. The Karnaugh map can also be described as a special arrangement of a truth table.

The Karnaugh map uses the following rules for the simplification of expressions by grouping together adjacent cells containing ones

- **i.** No zeros allowed.
- **ii.** No diagonals.
- **iii.** Only power of 2 number of cells in each group.
- **iv.** Groups should be as large as possible.
- **v.** Every 'one' must be in at least one group.
- **vi.** Overlapping allowed.
- **vii.** Wrap around allowed.
- **viii.** Fewest number of groups possible.

A	B	F
0	0	a
0	1	b
1	0	c
1	1	d

Truth Table.



F.

PROCEDURE:

Step 1:

Expression:

$$Y = BC + BAD + BAD'$$

1. Obtain the truth table for the above mentioned expression.
2. Simplify the Expression using Boolean algebra.
3. Draw the logic diagram for the simplified expression.
4. Implement the circuit on trainer using the required logic gates.
5. Verify your circuit by applying all the possible input combinations to the circuit.

Truth Table **Simplified Expression**

INPUTS				OUTPUT
A	**B**	**C**	**D**	**Y**
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

Logic Diagram

Step 2:

Logic Diagram:

(Get the Logic Diagram from the instructor!)

1. Write the Logic expression for the circuit.
2. Simplify the expression using Boolean algebra.
3. Obtain the truth table for the simplified expression.
4. Draw a new logic diagram for the simplified expression
5. Implement the circuit on trainer using the required logic gates.
6. Verify your circuit by applying all the possible input combinations to the circuit.

Logic Expression

Truth Table **Simplified Expression**

Truth Table			
INPUTS			**OUTPUT**
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	

Logic Diagram

Step 3:

Function:

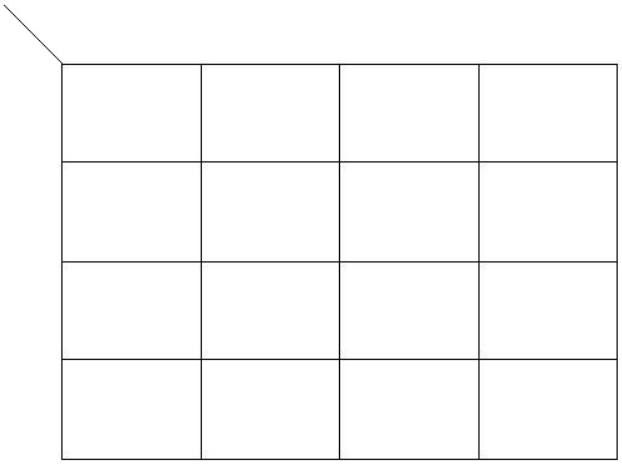
$$Y = ABC + AB'C + A'B$$

1. Express it in the form of sum of minterms.
2. Draw the K-Map for the function.
3. Find its simplified expression from K-map in SOP form.
4. Draw the logic diagram for the simplified expression.
5. Obtain a truth table for the simplified expression.
6. Implement the logic circuit on trainer using the required logic gates.
7. Verify your logic circuit by applying all the possible input combinations to the circuit.

Canonical Form:

$$Y = \sum$$

K-Map



Simplified Expression

Truth Table

INPUTS			OUTPUT
A	**B**	**C**	**Y**
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Logic Diagram

Lab Task

Question # 01: Given the Boolean Function:

$$(\overline{A} + C)(\overline{A} + \overline{C})(C + D)(\overline{B} + D)(A + B + \overline{C}D)(A + \overline{B} + C)$$

1. Obtain the truth table for the above mentioned expression.
2. Simplify the Expression using Boolean algebra.
3. Draw the logic diagram for the simplified expression.
4. Implement the circuit on Proteus
5. Verify your circuit by applying all the possible input combinations to the circuit.

Question # 02: Given the Boolean Function:

$$\mathbf{F} = \overline{WXY} + \overline{X}Y\overline{Z} + \overline{W}XY\overline{Z} + W\overline{XY}$$

1. Express it in sum of minterms using Karnaugh Map.
2. Simplify the term using Karnaugh Map.
3. Implement the circuit on Proteus