**Digital Logic Design Lab # 06**

***Student Name: Muhammad Ahmed Baig***

***Reg# 20i-1884***

***Lab Section: B***

***LabTitle:***

Boolean function implementation

***Objectives:***

* To become familiar with two standard forms of logic functions: SOP and POS
* To become familiar that how a Boolean function can be minimized with the k-map and then can be expressed in gates.

***Equipment Required:***

* DEV-2765E Trainer Board
* 7408 Quad 2-input AND Gate IC
* 7404 Hex Inverter IC
* 7432 Quad 2-input OR Gate IC

***Background Theory***

When a Boolean expression is implemented with logic gates, each term requires a gate, and each variable within the term designates an input to the gate. We define a literal as a single variable within the term that may or may not be complemented. By reducing the number of terms, the number of literals, or both in a Boolean expression, it is often possible to obtain a simpler circuit. Boolean algebra or K-map is applied to reduce an expression for the purpose of obtaining a simpler circuit.

A Boolean function can be written in a variety of ways when expressed algebraically. There are, however, a few ways of writing algebraic expressions that are considered to be standard forms. The standard forms facilitate the simplification procedures for Boolean expressions and frequently result in more desirable logic circuits.

The standard forms contain product terms and sum terms. An example of a product term is XYZ. This is a logical product consisting of an AND operation among three literals. An example of a sum term is X+Y+Z. This is a logical sum consisting of OR operation among the literals.

In the sum of minterms canonical form, every product term includes a literal of every variable of the function. Product terms of the SOP form which do not include a literal of a variable, say variable B, should be augmented by,

* AND-ing the product term which misses a literal of B with (B+ ),
* Subsequently applying the distributive property to eliminate the parenthesis.

In the product of maxterms canonical form, every sum term includes a literal of every variable of the function. Sum terms of the POS form which do not include a literal of a variable, say variable

B, ought to be augmented by,

* OR-ing the sum term with B· ,
* Subsequently applying postulate a+b·c=(a+b) · (a+c) to distribute the product B· .

***Function***

A function F is defined by

*F (A,B,C,D)= ∑m(1,2,3,5,6)*

***Steps to Implement the Function:***

* Write the truth table for the function given above
* Fill the k-map cells from the truth table  Simplify and minimize the function with k-map.
* Write the simplified function from k-map.
* Draw the circuit diagram and construct the circuit on the Trainer Board.

**Truth Table:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | INPUT |  | OUTPUT |
| A | B | C | D | F |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |

# K-Map

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **AB\CD** | **00** | **01** | **11** | **10** |
| **00** | 0 | 1 | 1 | 1 |
| **01** | 0 | 1 | 0 | 1 |
| **11** | 0 | 0 | 0 | 0 |
| **10** | 0 | 0 | 0 | 0 |

**Boolean Expression**

F =A`C`D + A`CD` +A`B`D

# Circuit Diagram

|  |
| --- |
|  |

***Procedure***

1. Connect the trainer board with the power supply 2. Mount the corresponding 74LSXX IC on the board.

1. Connect pin 14 to +5 V and pin 7 to GND.
2. Wire the circuit according to the diagram by consulting the corresponding gate ICs data sheet.
3. Apply all the combinations of inputs and observe the output on the LED to verify the truth tables of the gates.

***Function***

A function F is defined by

*F (A,B,C,D)= ∑m(1,2,4,5,9,10,11,13,15)*

***Steps to Implement the Function:***

* Write the truth table for the function given above
* Fill the k-map cells from the truth table  Simplify and minimize the function with k-map.
* Write the simplified function from k-map.
* Draw the circuit diagram and construct the circuit on the Trainer Board.

## Truth Table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **In** | **put** |  |  | **Output** |
| **A** | **B** |  | **C** | **D** | **F** |
| 0 | 0 | 0 |  | 0 | 0 |
| 0 | 0 | 0 |  | 1 | 1 |
| 0 | 0 | 1 |  | 0 | 1 |
| 0 | 0 | 1 |  | 1 | 0 |
| 0 | 1 | 0 |  | 0 | 1 |
| 0 | 1 | 0 |  | 1 | 1 |
| 0 | 1 | 1 |  | 0 | 0 |
| 0 | 1 | 1 |  | 1 | 0 |
| 1 | 0 | 0 |  | 0 | 0 |
| 1 | 0 | 0 |  | 1 | 1 |
| 1 | 0 | 1 |  | 0 | 1 |
| 1 | 0 | 1 |  | 1 | 1 |
| 1 | 1 | 0 |  | 0 | 0 |
| 1 | 1 | 0 |  | 1 | 1 |
| 1 | 1 | 1 |  | 0 | 0 |
| 1 | 1 | 1 |  | 1 | 1 |

## K-Map

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **AB\CD** | **00** | **01** | **11** | **10** |
| **00** | 0 | 1 | 1 | 1 |
| **01** | 1 | 1 | 0 | 0 |
| **11** | 0 | 1 | 1 | 0 |
| **10** | 0 | 1 | 1 | 1 |

**Boolean Expression**

**F=**

(AC`D`+A`CD +BCD`)`

## Circuit Diagram

