BREADBOARD NO	
MARKS	
DEMO	
PART A:	/10
PART B:	/10
REPORT:	/35

UNIVERSITI MALAYSIA PERLIS

ENT 262
DIGITAL LOGIC DESIGN
SEMESTER 1 2019/2020

LABORATORY 2

SIMPLIFICATION OF COMBINATIONAL LOGIC CIRCUITS

Student's Particular

Name:	
Matrix No.:	
Group:	
Date of Experiment:	

LAB 2: Simplification of Combinational Logic Circuits

OBJECTIVES

1. To apply the Boolean algebra rule to simplify a combinational logic circuit with simplest logic gates representation.
2. To apply the Karnaugh Map in designing a combinational logic circuit with simplest logic gates representation.
3. To construct a simple combinational logic circuits.

EQUIPMENTS/COMPONENTS

- A DC power supply capable of 5V DC output
- A multimeter
- Logic gates (74xx-series)
- Light Emitting Diodes (LED)
- 330 Ω resistor
- Switches (4 Units)

INTRODUCTION

Digital circuits are often referred to as switching circuits because their control devices (e.g. diodes and transistors) are switched between the two extremes of ON and OFF. Logic gates have one or more inputs with one output. They respond to various input combinations. A **truth table** shows this relationship between circuits's input combinations and its output. To determine the total number of different combinational input to be listed in the truth table, use the equation:

$$\text{Number of Combinations} = 2^N$$

where, N = number of inputs

In digital system, the ON and OFF state can be represented as logic 1 and 0 respectively. There are several other terms that are used synonymously with 0 and 1. Some of the common ones are shown in Appendix 1. For TTL circuits (74xx series), a logic 0 can be anywhere from 0V to +0.8V, and a logic 1 is in the range of +2.0 V to +5.0V. Voltage between 0.8 and 2V are undefined (neither 0 nor 1) and under normal circumstances should not occur.

Boolean algebra is the mathematical foundation of digital systems. In Boolean algebra there are three basic operations: OR, AND and NOT which can represent the three basic logic gates: OR, AND and Inverter gates respectively. In the other words, every Boolean expression has an equivalent gate description, and vice versa. The combination of logic gates is called as combinational logic circuit.

In designing a combinational logic circuit, it is highly desirable to find the simplest implementation – that is, the one with the smallest number of gates or wires. One of the platforms to simplify the circuit is simplifying the logic expressions by using Boolean theorems

KARNAUGH MAP

Karnaugh Map provides a systematic method for simplifying Boolean expressions. Since it presents all possible values of input variables, K-Map is similar to truth table. The K-Map can be used for expressions with two, three, four or five variables.

Number of cells in the K-Map is equivalent to the number of possible input variable combinations (2^n). As an example:

For 3-variables; number of cells are $2^3 = 8$

The cells in K-Map are arranged so that only one single variable changes between adjacent cells.

For this session you are required to be familiar with Karnaugh mapping technique prior to sitting this laboratory. In the experiment, you will be given a **design problem**. You should be able to interpret the design problem into the truth table and applying the Karnaugh Map technique to find the simplest logic expression. Finally, you have to construct and test the circuit.

PROCEDURE

PART A – COMBINATIONAL LOGIC CIRCUIT

1. Express the combinational logic circuit shown in Figure 1 using Boolean algebra.

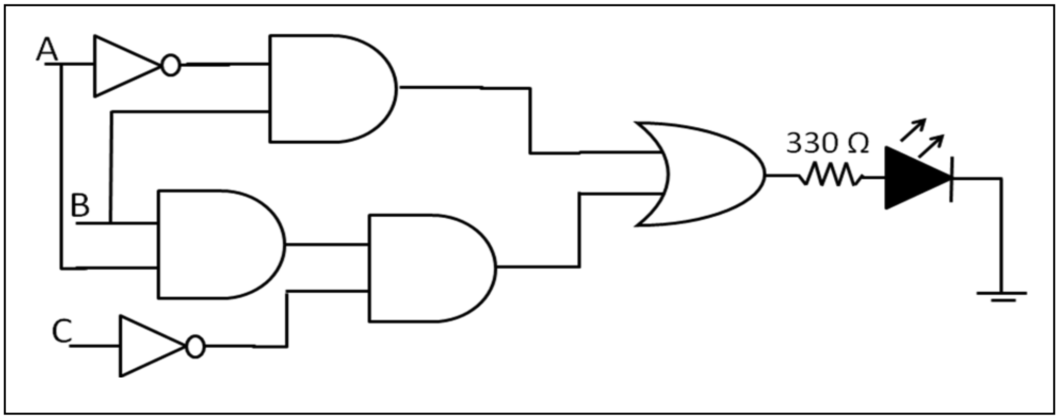

Figure 1

2. Develop a truth table based on the Boolean expression obtained in 1.
3. Simplify the Boolean expression using the Boolean rules and develop an equivalent truth table.
4. Construct a logic circuit with the least number of logic gates which is equivalent to Figure 1.
5. Demonstrate the solution and get approval from the lecturer or teaching engineer.

PART B – DESIGN PROBLEM

A chemical plant required a microprocessor-driven alarm system to warn a critical condition on its chemical tank. The tank has four HIGH/LOW (1/0) sensors that monitor the temperature (T), pressure (P), fluid level (L), and (W) weight. Design a logic circuit that notifies the microprocessor to activate an alarm when any of the following conditions arise:

- i. **High fluid level with high temperature and high pressure.**
- ii. **Low fluid level with high temperature and high weight.**
- iii. **Low fluid level with low weight and high temperature.**
- iv. **High fluid level with low weight and high temperature.**

1. Develop an equivalent truth table that fulfilled the above conditions.
2. Derive the simplified Boolean expressions using K-map technique.
3. Construct a logic circuit based on the simplified Boolean expression obtained in Step 2.
4. Demonstrate the solution and get approval from the lecturer or teaching engineer.

RESULT

PART A

1. Boolean expression of Figure 1 and the equivalent truth table [3 marks]

A	B	C	Y

2. Simplified the Boolean expression and the equivalent truth table [3 marks]

A	B	C	Y

3. Simplified logic circuit diagram [4 marks]

4. Write your observation based on the results obtained [2 marks]

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PART B

1. Truth table of the alarm system [7 marks]

T	P	L	W	Alarm (Output)

2. Simplified Boolean expressions by using K-map technique. [5 marks]

3. Logic circuit diagram based on the simplified Boolean expression obtained in 2.
[4 marks]

4. Test your circuit by completing the table below. [2 marks]

Input Combinations				Output	
T	P	L	W	LED (ON/OFF)	Level (1/0)
0	0	1	1		
1	1	0	0		
0	1	1	1		
1	0	0	0		

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DISCUSSION [3 marks]

CONCLUSION [2 marks]