ANALOGUE ELECTRONIC TRAINER (OPERATIONAL AMPLIFIER)

NUR HASNATULAINI BINTI JALANI

This report is submitted in partial fulfillment of the requirement for the award of
Bachelor of Electronic Engineering (Industrial Electronics)

Faculty of Electronic and Computer Engineering

UniversitiTeknikal Malaysia Melaka (UTeM)

JUNE 2015

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

TajukProjek : ANALOGUE ELECTRONIC TRAINER (OPERATIONAL AMPLIFIER)

SesiPengajian : 1 4 / 1 5

Saya NUR HASNATULAINI BINTI JALANI

mengakumembenarkanLaporanProjekSarjanaMudainidisimpan di Perpustakaandengansyarat-syaratkegunaansepertiberikut:

1. LaporanadalahhakmilikUniversitiTeknikal Malaysia Melaka.
2. Perpustakaandibenarkanmembuatsalinanuntuktujuanpengajiansahaja.
3. Perpustakaandibenarkanmembuatsalinanlaporaninisebagaibahanpertukarananta rainstitusipengajian tinggi.
4. Silatandakan (√) :

☐	**SULIT***	*(Mengandungimaklumat yang berdarjahkeselamatanataukepentingan Malaysia seperti yang termaktubdi dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD****	**(Mengandungimaklumatterhad yang telahditentukanolehorganisasi/badan di manapenyelidikandijalankan)
☐	**TIDAK TERHAD**	

Disahkanoleh:

_____ (TANDATANGAN PENULIS)

_____ (COP DAN TANDATANGAN PENYELIA)

Tarikh: .....

Tarikh: .....

"I hereby, declared this report entitle "Analogue Electronic Trainer designed for operational amplifier" is the result of my own work except for quotes as cited in the references"

Signature: ……..

Author: NUR HASNATULAINI BINTI JALANI

Date: JUNE2015

"I hereby declare that I have read this report and in my opinion, this report is sufficient in terms of the scope and quality for the award Bachelor of Electronic Engineering (Industrial Electronics)"

Signature: …….

Supervisor Name: FARID ARAFAT BIN AZIDIN

Date: JUNE 2015

Special dedicated to my beloved parents for their caring, understanding and encouragement

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious, the Most Graceful. I would like to express my sincere gratitude to Him for giving me the strength, health and ability to complete my project Of "ANALOGUE ELECTRONIC TRAINER DESIGN FOR OPERATIONAL AMPLIFIER" and complete this report within the given time period.

I also would like to extend my gratitude to my supervisor, En. Farid Arafat Bin Azidin. For his concerned, kindness, advised and helped to make sure my project is done nicely. Without his guidance from the beginning until the completion of this report, the progress of this project may stuck and cannot be done and documented success.

Last but not least, greatest credit goes to my parents and my siblings for their encouragement that make me strong when I encounter with any problems. I also would like to thanks all my friends, especially Mohd Naqib Bin Mohd Yusof and Ainun Naziroh Binti have been helping me directly from the beginning until the final stage in this project. Their opinion and suggestion is very useful. May all the good deeds that were done will be blessed by Allah.

ABSTRACT

This project is proposed to improve the trainer on laboratory at Universiti Teknikal Malaysia Melaka. Thus, the project is designed one base trainer for the Operational Amplifier Circuit. The circuit covers the basic of operational amplifier which is the inverting amplifier, non-inverting amplifier, summing amplifier, subtraction amplifier and cascade amplifier. However, the circuit board on the base trainer can be changed to another set of analogue electronic subject which is Bipolar Junction Transistor (BJT), and Field Effect Transistor (FET). In addition, the trainer designed is an open board style. Therefore, the component on the board can be changed by the user during the experiment conducted.

ABSTRAK

Projek ini bertujuan untuk menambah baik ‘trainer’ yang digunakan dalam makmal di Universiti Teknikal Malaysia Melaka. Oleh yang demikian, projek yang dijalankan adalah mereka bentuk ‘base trainer’ untuk ‘Operational Amplifier’. Litar yang di rekabentuk pada ‘Printed Circuit Board’ merangkumi beberapa asas dalam ‘Operational Amplifier’ seperti ‘inverting amplifier’, ‘non-inverting amplifier’, ‘summing amplifier’, ‘subtraction amplifier’, dan ‘cascade amplifier’. Walau bagaimanapun ‘Printed circuit Board’ boleh di tukar kepada set analog elektronik yang lain seperti ‘Biplolar Junction Transistor’ dan ‘Field effect Transistor’. Tambahan pula reka ‘trainer’ yang dijalankan adalah berbentuk ‘open board style’.Oleh yang demikian komponen pada papan boleh ditukarkan mengikut kesesuaian pengguna dan kehendak pengguna semasa eksperiment dijalankan.

CONTENTS

LIST OF FIGURE

LIST OF TABLE

LIST OF SYMBOLS

Op-Amp	-	Operational Amplifier
BJT	-	Bipolar Junction Transistor
FET	-	Field-Effect-Transistor
PCB	-	printed Circuit Board

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Firstly, this chapter is briefly explained the background of this project. This chapter also will cover about the problem statement. There have three problems is being discussed in this chapter. The other parts of this chapter also discuss about the objectives. The objective is being discussed from the rising problem. Therefore, in order to achieve this project, the objective must be achieved. This chapter also covers about the scope of this project. The scope is important because it's related to the limitations due to achieve the objectives of this project. The main purpose also stated in this chapter. Lastly, this chapter is being discussed about the structure in this project. There have five chapters to describe overall of this project, which are Chapter 1, Chapter 2, Chapter 3, Chapter 4 and Chapter 5. The five chapters is being explained about the introduction, background study, methodology, results and recommendation respectively.

1.1 Project Background

Operational Amplifier (Op-Amp) Trainer has been designed to study the following basic linear amplifier which is inverting amplifier, non-inverting amplifier, summing amplifier, the difference amplifier, and cascade amplifier. The IC 741 used to design the basic circuit of op-amp. The base trainer designed is an open board style. The component was designed as a portable plug in component with its adapter. There have two input voltage which is +/- 15V and +/- 12V. +/- 15V get from the Traco power with high efficiency up to 81%. And +/- 12V get from designed a voltage regulator. In addition the Printed Circuit Board (PCB) in this trainer can be changed to another circuit board which is Bipolar Junction Transistor (BJT) circuit and Field Effect Transistor (FET) circuit. This base trainer design is user friendly for students, lecturers and technicians.

1.2 Problem Statement

The existing trainer used for analogue electronic experiment in the laboratory is fixed with one design for one trainer. In addition, the value of the resistors is fixed and cannot be changed by the lecturer because the designer with a mounted component. Besides, the set of the component of the trainer easily damage and technicians face a problem to replacing it. It will take a long time to open the trainer, disordering the damage component, and soldering of the new component. Delay times to replacing the new component, students sometimes do not have a trainer to do experiment and students had to share the trainer with another group to do the experiment. Other than that, the trainer needs a lot of space in storing for three sets of laboratory experiment for an analogue electronic subject.

1.3 Objective of Project

The aim of this project is to design analogue electronic trainers for operational amplifier. In order to achieve that, the following objectives need to be achieved.

1.3.1 To develop a multi design of analogue electronic operational amplifier circuit. The circuit design covers four basic operational amplifier which is inverting amplifier and non-inverting amplifier that include the summing amplifier, difference amplifier and also cascade amplifier.

1.3.2 To model a trainer that is user friendly and can be replace the component easily when its malfunction. The value of the component like resistor can be changed by the lecturer during the experiment conducted. When the component is damaged, technician, no need to take for a long time to replacing the component because this trainer used the plug-in model.

1.3.3 To reduce the space in storing for 3 sets of laboratory experiment which are bipolar junction transistor, field-effect transistor and operational amplifier with using one base training system. In addition, the laboratory shows the good management and organized.

1.4 Scope of Project

Based on the objective, this project produced hardware of an analogue electronic trainer that are divided into three parts which are designed for base trainer, Printed Circuit Board (PCB) for operational amplifier circuit designed and the component adapter to pick and place all the component needed during the experiment. Therefore, in order to complete the designed for base trainer

and the circuit designed, there has two software are used which is MultiSim software to simulate the circuit design for operational amplifier and Proteus Software to design and construct the PCB. PCB board is applied for all the circuit implementation. The PVC material has been chosen for the prototype design. The size of the trainer is 23cm wide, 30cm length and 8.5 cm height. The figure below is the size of the base trainer and the trainer design.

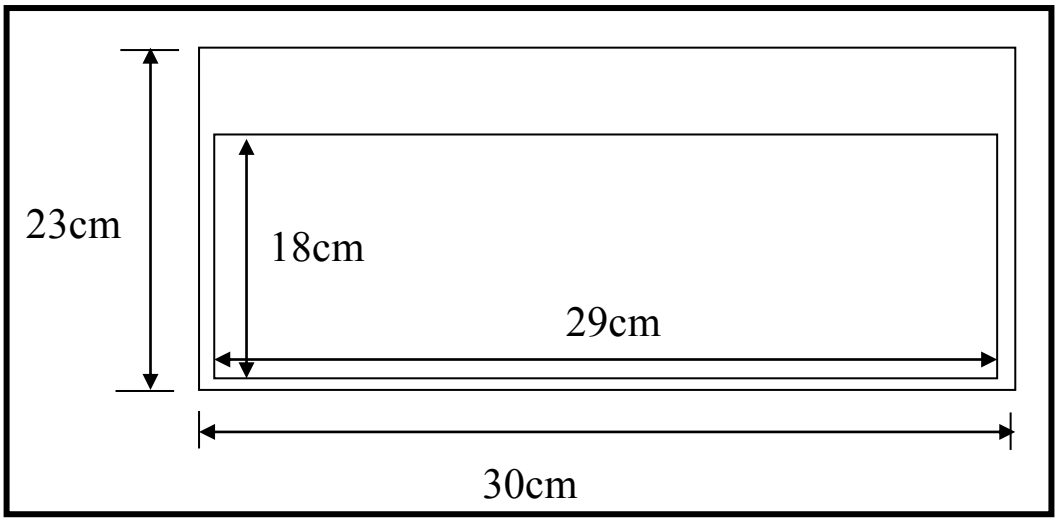

Figure 1.1: Size of the trainer

1.5 Importance of Work

The purpose of this project is to design an open board style for the operational amplifier circuit. The operational amplifier circuit design included inverting amplifier, non-inverting amplifier, summing amplifier, difference amplifier and cascade amplifier. This project also proposes to design a base trainer that can be applied to Bipolar Junction Transistor (BJT), Field Effect Transistor (FET) and Operational Amplifier (Op-Amp) during the experiment in lab sessions.

1.6 Report Structure

Chapter 1: Describes as a background, problem statement, objectives, scope project, and the importance of this project.

Chapter 2: Project's background is discussed. The information about the project from different resources is discussed in this chapter.

Chapter 3: Describes the methodology of this project, which includes the design specification and procedure form in the flow chart process.

Chapter 4: Presents the simulation and measurement results. The results obtained are analyzed and discussed.

Chapter 5: The last chapter concludes the report and recommendations for the further work are given.

CHAPTER II

LITERATURE REVIEW

This chapter is the background study that related to this project include of getting knowledge and previous research work. The background study of this project is from the books, articles, catalogue, journal, and website. This chapter will discuss about the knowledge of operational amplifier. Besides, it also discusses about the characteristic and the connection for LM 741. Other than that, this chapter also discusses about the software that's being used to conduct this project. In addition, this chapter also discusses the past training system designed that already in the marketplace. The discussion includes the characteristic of the training system from difference designer, and the experiment that can be conducted by their design trainer. Lastly, this chapter also discusses about the adapter that are used for connection between the components on the board experiment.

2.1 Ideal operational amplifier

Operational Amplifier is a very high gain differential amplifier with high input impedance and low output impedance. The input impedance is infinite condition which is no current flows into either input of the operational amplifier. While, for the output impedance is zero condition. The operational amplifier can use for any voltage to drive any load impedance. In addition, the bandwidth is in fine condition. When the input difference is zero, the output voltage must be zero.

2.2 Basic operational Amplifier

Operational Amplifier contains two input terminals and one output terminal. The two input terminals are labelled positive and negative, which is non-inverting and inverting, respectively.

2.2.1 Inverting Amplifier

As an inverting amplifier, the resistor is connected to the inverting input as shown in the figure below, with output voltage. R_f and R_1correspond to the feedback and input resistances, respectively.

$$V_0 = -\frac{R_f}{R_1} V_1 \qquad (2.0)$$