REPUBLIC OF RWANDA

ULK POLYTECHNIC INSTITUTE

DEPARTMENT OF ELECTRONICS AND ELECTRICAL ENGENEERING

OPTION: ELECTRICAL TECHNOLOGY

FINAL YEAR PROJECT

DESIGN AND IMPLEMENTATION OF VARIABLE DC POWER SUPPLY

final-year project submitted in word of an fulfillment of the requirements for the advanced diploma in electrical technology

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Kigali, October .2024

DECLARATION A

I, NIZEYIMANA FABIEN declare that this research study is my original work and has not been presented for a degree or any other academic award in any University or Institution of Learning. No part of this research should be reproduced without the authors' consent or that of ULK Polytechnic Institute.

Student's name: NIZEYIMANA FABIEN

Signature:

Dates:

DECLARATION B

I do declare that this research project entitled " **Design and implementation variable DC Power supply "** prepared and submitted by Nizeyimana Fabien in partial fulfillment of the requirement for award of an advanced diploma (A1) in Electrical Technology has been examined and approved by ULK Polytechnic Institute Supervisor.

Name of Supervisor: Eng. Appolinaire TUYISHIMIRE

Signature:

Date:

DEDICATION

I dedicate this research to my family, whose unwavering support and encouragement have been my greatest source of strength.

To my mentors and colleagues, whose guidance and insights have shaped this project and inspired my passion for innovation.

And to all those who strive to push the boundaries of knowledge and technology, may this work contribute to the advancement of our collective goals.

ACKNOWLEDGMENT

A special thanks to my colleagues and friends, who provided technical assistance, shared ideas, and offered moral support during the challenging phases of this project. Their collaboration and camaraderie made the process more manageable and enjoyable. Finally, I wish to acknowledge the love and support of my family. Their understanding and encouragement have been my driving force, and without their support, this project would not have been possible.

ABSTRACT

The design and implementation of a variable DC power supply address the need for a versatile and adjustable power source suitable for a wide range of electronic applications. This project aims to create a reliable and efficient power supply that can provide a stable DC output voltage and current, which can be varied according to the specific requirements of different devices or circuits. The design process involves selecting appropriate components, including voltage regulators, transformers, and control circuits, to ensure accurate and stable output. Key considerations include achieving a high degree of voltage and current regulation, minimizing ripple and noise, and providing adequate safety features. The implementation phase involves the construction of the power supply unit, incorporating both hardware and software elements for precise control and monitoring. The resulting variable DC power supply will offer flexibility and precision, making it an invaluable tool for experimentation, testing, and development in various electronic and electrical engineering applications.

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LIST OF ACCRONYMS AND ABBREVIATIONS

DC: Direct Current

AC: Alternative Current

A: Ampere

P: Power

CHAPTER 1: GENERAL INTRODUCTION

1.1 Background

A Variable DC Power Supply is a fundamental tool in the field of electronics and electrical engineering. It provides a stable and adjustable source of direct current (DC) voltage and current, which is essential for powering and testing electronic devices, circuits, and systems. Unlike fixed power supplies, a variable DC power supply allows users to set the output voltage and current to specific values, making it versatile for various applications, including laboratory experiments, prototype development, and electronic testing.

1.2 Problem Statement

In many electronic and electrical applications, the need for a power supply that can deliver a range of voltages and currents with high precision and stability is critical in the Rwandan market it is expensive to buy a power supply mostly used in school laboratories. Traditional fixed-voltage power supplies offer limited functionality, which may not meet the requirements of modern electronic testing and development. Therefore, there is a need for a variable DC power supply that provides adjustable output settings, ensuring compatibility with a diverse array of devices and circuits.

1.3 RESEARCH OBJECTIVES

1.3.1 the main objective

The main objective of this Final Year Project is to Design and Implement the variable DC Power supply

1.3.2 specific objectives

1. To design a variable DC power supply that can deliver a stable output voltage and current within a specified range.
2. To implement a control system that allows users to easily adjust and monitor the output settings.
3. To ensure the power supply operates efficiently with minimal ripple and noise.

4. To incorporate safety features to protect both the power supply and the connected devices.

1.4 RESEARCH QUESTIONS

1. How the transformer changes the voltage from one level to the other?
2. How the power rectifier helps in converting ac power to Dc power?
3. Does the capacitor remove all fluctuations in the circuit?
4. When the output voltage can be higher than the input Voltage?

1.4 Scope

The scope includes selecting and integrating appropriate components such as voltage regulators, transformers, and control circuitry. The design will address key aspects including voltage regulation, current regulation, and user interface for adjusting and monitoring settings. Implementation will involve assembling the hardware, programming the control system, and conducting performance evaluations.

1.5 Significance of the Study

This project will facilitate more precise and flexible testing of electronic circuits and devices by providing a reliable and adjustable power source. It will also contribute to the broader field of electronics by offering a practical solution to the limitations of fixed-voltage power supplies, ultimately supporting innovation and development in various engineering disciplines.

1.6 Organization of the Report

This report is organized into five chapters. chapter one is introduction, Chapter Two will provide a detailed review of existing literature and technologies related to variable DC power supplies. Chapter Three will outline the design methodology, including component selection and circuit design. Chapter Four will cover the implementation process, detailing the construction and testing of the power supply. Chapter Five will present conclusions and recommendations.

CHAPTER 2: LITERATURE REVIEW

2.1 **Introduction**

This chapter provides a detailed overview of the essential components used in the design and implementation of a variable DC power supply. Understanding each component's role and function is crucial for building a reliable and efficient power supply. This chapter covers the selection criteria, specifications, and functions of each component in the system.

2.2 **Components of a Variable DC Power Supply**

The key components used in the design of a variable DC power supply include:

2.2.1 **Transformer**

Function: The transformer is responsible for stepping down the high AC mains voltage 220V or 110V to a lower AC voltage suitable for the power supply circuit. The output voltage of the transformer typically matches the desired DC output range after rectification and regulation.

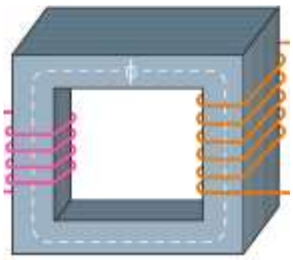

Figure.2. 1.transformer

2.2.2 **Rectifier**

Function: The rectifier converts the AC voltage from the transformer into a pulsating DC voltage. Common types of rectifiers include full-wave and bridge rectifiers, which provide higher efficiency and better output characteristics compared to half-wave rectifiers.

Figure.2. 2.bridge rectifier

2.2.3 **Filter Capacitor**

Function: The filter capacitor smoothens the pulsating DC output from the rectifier, reducing ripple voltage and providing a more stable DC output. This component is crucial for reducing fluctuations that could affect the performance of connected devices.

Figure.2. 3.capacitor

2.2.4 **Voltage Regulator**

Function: The voltage regulator maintains a stable output voltage despite variations in input voltage and load current. For a variable DC power supply, an adjustable voltage regulator LM317, LM338 is used, allowing the output voltage to be varied over a specified range.

Figure.2. 4.regulator

2.2.5 **Potentiometer**

Function: The potentiometer is used to adjust the output voltage of the power supply. It provides a variable resistance that changes the reference voltage for the adjustable voltage regulator, thereby varying the output voltage.

Figure.2. 5.potentiometer

The potentiometer should have a resistance value suitable for fine control over the output voltage range. It should also be rated for the power dissipation that may occur during operation.

2.2.6 **Heat Sink**

The heat sink dissipates heat generated by the voltage regulator and other components, preventing overheating and ensuring reliable operation. Heat management is critical, especially in power supplies with higher output currents.

Figure.2. 6.heat sink

2.2.7 **Protection Diodes**

Protection diodes prevent damage to the voltage regulator and other sensitive components from reverse polarity or voltage spikes. These diodes are typically placed across the regulator input-output terminals.

Figure.2. 7.diode

2.2.8 **LED Indicator**

The LED indicator provides a visual indication of the power supply's operational status. It is usually connected to the output to show when the power supply is on and functioning correctly.

Figure.2. 8.Led

2.2.9 **Output Terminals**

Output terminals provide a secure and accessible connection point for the load. They allow the user to easily connect and disconnect devices that require a DC power supply.

2.2.10 **Fuse**

The fuse provides overcurrent protection, safeguarding the power supply and connected devices from damage due to excessive current flow. It is a critical safety component that prevents potential hazards.

Figure.2. 9.fuse

2.2.11 **Enclosure**

The enclosure houses all the components, providing physical protection and insulation from electrical hazards. It also helps in managing heat dissipation and organizing the internal layout.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter detailed the research design, population, sample size, sampling procedures, research instruments, and data gathering and analysis methods. The methodology ensures that the design and development of the power supply are based on systematic and rigorous processes, leading to valid and reliable results.

3.2 Research Design

It includes both theoretical and practical components, Involves the conceptualization and planning of the power supply, including selecting components and designing circuits. Focuses on assembling the hardware, integrating the control systems, and testing the power supply. Assesses the performance of the power supply based on predefined criteria and validates its functionality.

3.3 Research area

The research population comprises various types of electronic components and systems used in the design of the variable DC power supply. This includes:

- ✓ **Electronic Components:** Voltage regulators, transformers, capacitors, resistors, and other relevant components.

- ➢ **Design Tools:** Software and hardware tools used for simulation, design, and testing.

3.4 Sample Size

A representative sample of electronic components and circuit designs will be used to ensure that the power supply meets the required specifications. The sample includes:

- ➢ three types of voltage regulators and filters to test different performance characteristics.
- ➢ Multiple circuit configurations to evaluate different design approaches.

3.5 Sampling Procedure

The sampling procedure involves:

- **Component Selection:** Choosing components based on performance specifications and compatibility with the power supply design.
- **Circuit Design:** Developing and testing various circuit designs to identify the most effective configuration.
- **Prototype Testing:** Building prototypes of the power supply to evaluate performance and make necessary adjustments.

3.6 Research Instrument

The research instruments used in this project include:

- **Simulation Software:** For modeling and analyzing circuit designs before physical implementation.
- **Measurement Equipment:** multimeters, and different loads to measure and verify voltage, current, and ripple.
- **Prototyping Tools:** Including breadboards, soldering equipment, and circuit design software.

3.7 Choice of the Research Instrument

Simulation software is used for initial design and analysis, while measurement equipment ensures precise testing of the physical power supply. Prototyping tools facilitate the practical implementation and adjustment of the design.

3.8 Validity and Reliability of the Instrument

Validity: simulation software must accurately represent the behavior of electronic circuits, and measurement equipment must provide precise readings of electrical parameters.

Reliability: Referring to the consistency of measurements and results obtained from the instruments. Regular calibration of measurement equipment and validation of simulation models contribute to the reliability of the research instruments.

3.9 **Data Gathering Procedures**

Data gathering contains the Recording of detailed specifications and configurations of the power supply design. Conducting experiments to measure the performance of the power supply under various conditions. Collecting data on voltage stability, current regulation, ripple, and noise levels.

3.10 **Data Analysis and Interpretation**

Data analysis includes, Comparing the performance of different design variants and components to identify the most effective configuration, drawing conclusions based on the analysis to validate the design and functionality of the power supply.

3.11 **Ethical Considerations**

Ethical considerations include ensures accuracy and honesty in data reporting and analysis. Adhering to safety protocols during experimentation and implementation to prevent accidents or harm. Protecting sensitive design information and data from unauthorized access.

CHAPTER 4: DESIGN SYSTEM ANALYSIS AND IMPLEMENTATION

4.1 Introduction

This chapter presents the detailed design, analysis, and implementation process of the variable DC power supply. It includes the theoretical calculations required for the design, detailed circuit drawings, specifications of components, cost estimation, and the steps involved in the physical implementation of the power supply. The objective is to provide a comprehensive overview of how the power supply was designed and built, ensuring it meets the required performance standards.

4.2 Calculations

4.2.1 Voltage and Current Requirements

To design the variable DC power supply, it is essential to calculate the voltage and current requirements based on the intended applications. Assume the power supply needs to deliver a variable output voltage from 0 to 30V and a maximum current of 5A.

- **Transformer Selection:**

Primary Voltage (V1): 230V AC (typical mains voltage)

Secondary Voltage (V2): For a maximum output of 30V DC, select a transformer with a secondary voltage of approximately 20V to 25V AC (after rectification and filtering, the voltage will be higher due to ripple).

Current Rating: Ensure the transformer can handle the maximum current of 5A.

- **Regulator Calculation:**

For Linear Regulators:

Output Voltage (Vout): 0 to 30V DC

Dropout Voltage (Vdrop): Typically 2V to 3V, depending on the regulator used.

Input Voltage (V_in): Should be at least V_out + V_drop.

- ❖ **For Switching Regulators:**

Efficiency (η) and Duty Cycle (D) calculations are required to ensure proper operation.

4.2.2 Filter Design

To minimize ripple and noise:

4.3 Drawings

4.3.1 circuit project

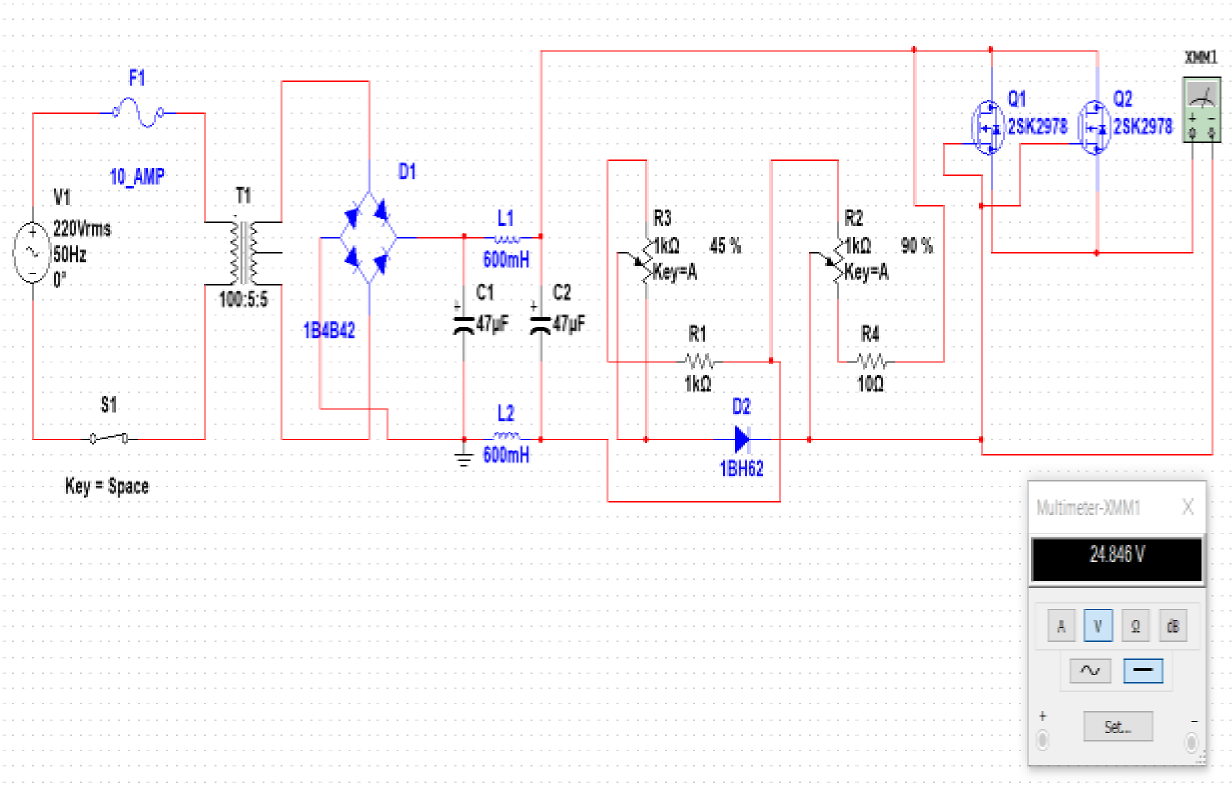

Figure.4. 1.project circuit

Provide a detailed schematic of the power supply, including:

- **Transformer:** Shows the primary and secondary windings.
- **Rectifier Circuit:** Includes diodes and filters.
- **Regulator Circuit:** Details the linear or switching regulator and associated components.

4.3.2 printed circuit board

Include a printed circuit board (PCB) layout showing the arrangement of components, traces, and connections. Ensure that the design minimizes noise and interference

4.4 Specification

4.4.1 **Electrical Specifications of the circuit**

- **Output Voltage Range:** 0 to 30V DC
- **Output Current Range:** 0 to 5A
- **Load Regulation:** ±0.5%
- **Line Regulation:** ±0.5%

4.5 Cost Estimation

Estimate the cost of components and materials:

Table.4. 1. Cost estimation

➢ **Transformer:**	12000 Rwf
➢ Potentiometer	2000 Rwf
➢ **Rectifier Diodes:**	11000 Rwf
➢ **Mosfet ICs:**	13000 Rwf
➢ **Capacitors and Resistors:**	21000 Rwf
➢ **Enclosure and Miscellaneous Parts:**	20000 Rwf
	Total Estimated Cost: [79000 Rwf]

4.6 Implementation steps

4.6.1 Assembly

- **Component Assembly:** Solder components onto the PCB according to the layout. Verify component placement and connections.
- **Wiring:** Connect the transformer, rectifier, and regulator circuits as per the design.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 **Introduction**

This chapter summarizes the key findings from the design and implementation of the variable DC power supply. It provides an overview of the conclusions drawn from the project and offers recommendations for future improvements or further research. The objective is to encapsulate the achievements of the project, reflect on its impact, and suggest ways to enhance the power supply or explore related areas.

5.2 **Conclusions**

The design and implementation of the variable DC power supply successfully met the project's primary objectives by delivering a stable and adjustable DC output voltage and current within the specified performance parameters. Testing confirmed its ability to provide a variable output voltage from 0 to 30V DC and a maximum current of 5A with minimal ripple and noise, achieving the intended voltage and current regulation. The design is cost-effective, aligning with the budget, and its efficiency was validated through practical testing. Safety features, including overvoltage protection and current limiting, ensure safe operation, while extended testing confirmed its reliability.

5.3 **Recommendations**

Based on the findings and experience gained during the project, the following recommendations are proposed for further improvement: consider integrating enhanced features such as digital displays for voltage and current, programmable settings, or remote control for better usability and flexibility. Component upgrades, like advanced switching regulators or high-frequency filters, should be evaluated to boost performance and efficiency. Improved thermal management with more efficient cooling solutions, such as fans or heat sinks, can help maintain optimal temperature and prolong the device’s lifespan. Additionally, comprehensive user manuals and documentation should be developed to provide clear operating instructions and maintenance procedures. Finally, future research could explore integrating digital control systems and smart features, such as microcontroller-based designs or IoT connectivity, to drive innovation in variable power supply technology.

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