DESIGN AND CONSTRUCTION OF 5KVA AUTOMATIC VOLTAGE REGULATOR

CHAPTER ONE

1.0 INTRODUCTION

In Nigeria and many other parts of the world today, voltage regulation is a critical aspect of electrical power systems. It ensures that the voltage supplied to electrical appliances remains within an acceptable range. The importance of voltage regulation cannot be overstated because voltage fluctuations can damage electrical equipment, leading to inefficiency, malfunction, or even total failure.

Over the years, the demand for reliable and stable voltage has increased, especially with the growing use of sensitive electronic devices in industries such as manufacturing, healthcare, and telecommunications. These devices can easily get damaged by unstable power supply, which makes voltage regulation more important than ever.

An Automatic Voltage Regulator (AVR), commonly known as a stabilizer, is a control device designed to maintain a nearly constant output voltage, even when the input voltage varies. For instance, when the supply voltage drops as low as 90V, the AVR can boost it back up to 230V to protect connected devices from damage caused by under-voltage or over-voltage conditions.

1.1 BACKGROUND OF THE PROJECT

The development of AVRs has advanced over the years with the integration of modern technologies such as microcontrollers, power electronics, and smart control systems. These improvements have made AVRs more efficient, compact, and reliable.

There are several types of AVRs, including electromechanical tap changers and solid-state tap changers. AVRs were not just created through planned innovation but also as a response to frequent electrical problems, especially in regions with unstable power supply. Unlike developed countries like the United States, Germany, and the UK—where voltage variation is minimal—developing countries face voltage instability more often.

According to K.G. Jackson and R. Feinberg, an Automatic Voltage Regulator is a device used in electrical systems to maintain a stable output voltage from a fluctuating power supply. This project focuses on constructing a functional AVR that incorporates several electronic components to ensure stable and reliable voltage delivery.

1.2 AIM AND OBJECTIVES OF THE PROJECT

The main aim of this project is to maintain a stable voltage level to ensure a constant power supply that protects home appliances and electrical systems. The key objectives include:

- To step up or step down voltage when the supply is faulty.
- To prolong the life span of electronic appliances at home and in workplaces.
- To provide filtered, safe current for electronic components.
- To design a system that can automatically adjust and regulate voltage without human input.
- To reduce the risks and damages caused by unstable electricity.

1.3 SIGNIFICANCE OF THE PROJECT

This project is important because it provides a practical solution to the common problem of voltage instability. AVRs are essential in ensuring that electrical and electronic devices function effectively and safely. They:

- Prevent over-voltage and under-voltage from damaging appliances.
- Help maintain constant voltage levels in homes and offices.
- Are widely applicable in power plants, hospitals, and industries.
- Come in various sizes and designs, suitable for different applications.

1.4 SCOPE OF THE PROJECT

This project covers the design and construction of a 5KVA Automatic Voltage Regulator. It involves the use of components such as transformers, relays, voltage sensors, and a microcontroller to ensure stable output voltage. The AVR will be designed to accept a minimum input voltage of 100V and output a stable 220–230V to protect appliances.

The system will be tested under different voltage conditions to ensure it responds correctly and regulates voltage effectively.

1.5 LIMITATIONS OF THE PROJECT

- The AVR is designed to operate within specific voltage and frequency ranges.
- If input voltage goes beyond the set limits, the system may shut down temporarily.
- The system requires some manual restart in certain fault conditions.
- The system is rated at 5KVA and may not handle higher loads.
- It uses convection or fan cooling for temperature regulation.
- Complex overload or short-circuit protection may not be included.

1.6 PURPOSE OF THE PROJECT

The purpose of this project is to provide a stable voltage supply to prevent damage to electrical appliances and to ensure their optimal performance, especially in areas where voltage fluctuation is common.

1.7 PROBLEM STATEMENT

In many homes and workplaces, electronic appliances often get damaged due to poor voltage supply. Devices without built-in transformers, like chargers and some LED lights, are the most affected. This project aims to solve that problem by designing an AVR that adjusts and regulates voltage automatically, protecting appliances from harm.

1.8 APPLICATIONS OF THE PROJECT

AVRs are used in various sectors and devices, such as:

- Homes and offices
- Hospitals and laboratories
- Industrial machines and control systems
- Telecommunication systems
- Elevators, computer servers, and data centers
- Schools, research centers, and construction sites

1.9 DEFINITION OF TERMS

- AVR – Automatic Voltage Regulator
- KVA – Kilo Volt-Amps, a unit of apparent power
- HV – High Voltage, over 650V
- Winding – Copper wire used in transformers
- Surge – A sudden increase in voltage
- Brownout – A drop in voltage that may affect performance
- Blackout – Complete loss of power
- Load – Electrical devices connected to a power supply
- Watts – Measurement of real power
- Standby Power – Power available for backup usage
- Base Load – Constant load required over a period
- Single Phase Power – A type of AC power distribution