CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

The study of RLC (Resistor-Inductor-Capacitor) circuits is fundamental in electrical and electronics engineering. These circuits are essential in understanding the behavior of alternating current (AC) and transient responses in electrical systems. RLC circuits are found in real-world applications such as radio tuners, signal filters, impedance matching networks, and oscillators (Boylestad & Nashelsky, 2013).

In academic settings, the effective teaching of RLC circuits requires not only theoretical explanations but also practical experiments to visualize and reinforce concepts like resonance, phase shift, impedance, and damping. Traditional methods of assembling RLC circuits using breadboards can be cumbersome, time-consuming, and prone to connection errors, especially for beginners (Hambley, 2011). Moreover, the lack of standardization in such setups can lead to inconsistent learning experiences.

The RLC trainer is a modular educational tool that provides a systematic and safe platform to study RLC circuit behavior under various configurations. It consists of selectable components and connection options that allow students to explore both series and parallel circuit topologies. This project focuses on designing and constructing a portable and user-friendly RLC trainer that enables hands-on experimentation in a controlled environment.

1.2 AIM AND OBJECTIVES OF THE PROJECT

Aim:

To design and construct an RLC trainer that demonstrates the principles and behaviors o f RLC circuits in both series and parallel configurations.

The objectives are:

- To design a trainer containing selectable resistors, inductors, and capacitors.
- To design a functional RLC circuit trainer that demonstrates and measure res onance, impedance, and frequency response in RLC circuit
- To demonstrate series and parallel RLC circuit behavior
- To provide a tool for analyzing power factor, enabling students to see the effec ts of inductive and capacitive loads on AC circuits
- To integrate use of external tools, such as a function generator and an oscillos cope, for waveform analysis and frequency adjustments in AC signal input

1.3 STATEMENT OF THE PROBLEM

The study of RLC (resistor-inductor-capacitor) circuits remains a fundamental yet challen ging component of electrical engineering education, as students often struggle to transla te theoretical concepts into practical understanding due to limitations in existing laborat ory equipment (Johnson & Patel, 2022). Current RLC training modules frequently lack the flexibility to investigate various circuit configurations, component values, and operating conditions, restricting students' ability to observe critical phenomena such as resonance characteristics, transient responses, and phase relationships (Chen et al., 2021). Furthermore, safety concerns emerge when students work with high-frequency alternating current circuits without proper measurement interfaces or protective mechanisms (Institute of Electrical and Electronics Engineers [IEEE], 2023). This pedagogical gap highlights the need for an improved RLC training system that incorporates modular design, comprehensive measurement capabilities, and enhanced safety features to facilitate effective hands-on learning in electronics laboratories.

1.4 SIGNIFICANCE OF THE STUDY

The development of an enhanced RLC circuit trainer holds significant importance in electrical engineering education by providing students with a practical, hands-on tool to bridge the gap between theoretical concepts and real-world circuit behavior. This study addresses critical limitations in current laboratory setups by offering a modular, reconfigurable system that enables comprehensive experimentation with series and parallel RLC circuits, including resonance characteristics, transient responses, and phase relationships. The trainer's built-in safety features and clear measurement points make it accessible for learners at different skill levels while minimizing risks associated with high-frequency AC circuits. Furthermore, this cost-effective solution serves as a sustainable alternative to expensive commercial trainers, benefiting educational institutions with limited resources. Beyond classroom applications, the trainer's design supports advanced research in filter design and power electronics, while ultimately enhancing students' technical competencies and preparing them for engineering careers in power systems, telecommunications, and electronic design.

1.5 SCOPE AND LIMITATIONS OF THE STUDY

This study focuses on the design and construction of an RLC circuit trainer for educational purposes, covering series and parallel configurations with variable resistors, inductors, and capacitors to demonstrate fundamental AC circuit principles. The scope includes analyzing resonance frequency, damping effects, and phase relationships, while incorporating safety features such as fuse protection and insulated probes. However, the study is limited to low-power AC circuits (under 50V) and does not address high-power industrial applications. Additionally, while the trainer allows component interchangeability, it is constrained by fixed measurement ranges and does not include automated data logging capabilities. The research is further limited by budget constraints affecting component quality and availability, and validation is based on theoretical comparisons rather than industrial standards.