

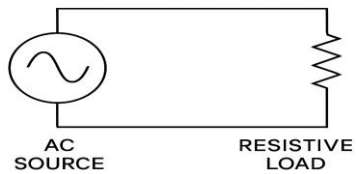
CHAPTER TWO

LITERATURE REVIEW

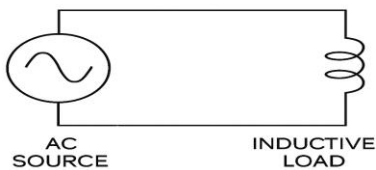
2.1 Overview of RLC Circuits

An RLC circuit consists of three primary components: a resistor (R), an inductor (L), and a capacitor (C), which may be connected in series or parallel. When connected to an AC source, each component reacts differently:

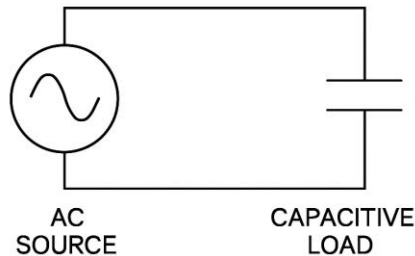
- **Resistor (R):** Offers resistance to current without affecting its phase.



- **Inductor (L):** Causes current to lag behind voltage, introducing inductive reactance.



- **Capacitor (C):** Causes current to lead voltage, introducing capacitive reactance.



The total opposition to current flow is called **impedance (Z)** and is a combination of resistance and reactance. The power factor, a critical aspect of AC circuits, is influenced by the phase difference between current and voltage.

2.2 Types of RLC Circuits

- **Series RLC Circuit:** R, L, and C are connected in a single path. Useful for resonance studies.
- **Parallel RLC Circuit:** Components are connected across the same voltage source. More common in power distribution.
- **Mixed or Tunable RLC Load:** Allows individual selection of R, L, or C, and combinations, for practical analysis.
- RLC can also be connected individually as they are not necessarily dependent on one another.

2.3 Educational Trainers in Electrical Engineering

Trainers are used to bridge the gap between theoretical studies and practical understanding. They provide a controlled environment where students can connect components, take measurements, and observe real-time results. Load trainers are particularly valuable for teaching power factor correction, phase angle, and impedance in AC circuits.

Several institutions use commercial RLC load trainers; however, these are often expensive and not easily customized. Locally designed trainers offer the flexibility to meet specific curriculum goals while being cost-effective.

Electrical trainers are designed with protective features that let students work with electrical systems without the high risk of electric shock, short circuits, or equipment damage.

Most trainers are modular, allowing instructors to change components (e.g., load types or circuit arrangements). This flexibility makes them reusable for various topics and experiments.

In terms of error correction, mistakes made during practical sessions using trainers help reinforce learning. Students can see the effects of wrong connections or incorrect settings and learn to troubleshoot effectively.

2.4 Previous Works

Several researchers and institutions have developed and tested RLC load trainers for educational and experimental use in electrical engineering. These studies consistently highlight the importance of practical tools like RLC trainers in engineering education. They also point to a growing interest in low-cost, locally built trainers that are safe, functional, and tailored to curriculum needs. Your project contributes to this field by designing a trainer that is affordable, simple to operate, and suitable for polytechnic-level training.

Afolabi et al. (2018)

Designed a basic RLC trainer using discrete components (resistors, inductors, capacitors) mounted on a panel. The setup included analog ammeters and voltmeters to allow students to observe changes in current and voltage under different load combinations. The study concluded that students showed improved understanding of power factor and resonance after practical sessions.

Olowu & Bello (2020)

Developed a more advanced RLC load trainer with digital meters and microcontroller-based measurement. Their system allowed automatic calculation of power factor, apparent power, and phase angle. Although effective, the high cost of digital components limited its adoption in resource-constrained schools.

Chukwu et al. (2022)

Focused on building a low-cost, locally sourced RLC load trainer for polytechnic students. Their version used toggle switches to select between R, L, and C combinations, with safety fuses and overload protection. The project was praised for its affordability and practical relevance.

Nwankwo and Ibrahim (2021)

Investigated student performance before and after using RLC trainers in labs. The study found a significant improvement in understanding of AC circuit concepts, especially impedance, power triangle analysis, and circuit resonance, proving the effectiveness of hands-on tools.

These studies highlight the importance of affordability, safety, and functionality in educational tools, which this project aims to address.

2.5 Gaps in Existing Solutions

Most available RLC trainers are either too expensive or too complex for polytechnic-level education. Additionally, some lack adequate protective features or modular flexibility. This project seeks to fill these gaps by designing a simple, safe, and effective trainer suitable for classroom and laboratory use.

2.6 Summary

This chapter reviewed the theoretical foundation of RLC circuits and the importance of practical learning aids in technical education. It also highlighted previous work done in this area and identified the gap that this project seeks to fill—a low-cost, flexible, and safe RLC load trainer for single-phase AC applications.