UNIVERSITI TEKNOLOGI MARA

JIIICaS 2024
JOHOR INTERNATIONAL INNOVATION, INVENTION COMPETITION AND SYMPOSIUM

PROCEEDINGS OF JOHOR INTERNATIONAL INNOVATION INVENTION COMPETITION AND SYMPOSIUM 2024 (JIIICaS 2024)

"Flourish and Nurturing Sustainable Innovation for a Prosperous Nation"

JIICOS 2024
JOHOR INTERNATIONAL INNOVATION, INVENTION COMPETITION AND SYMPOSIUM

Editorial Board

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Preface

In the name of Allah, the Almighty who gives us the enlightenment, the truth, the knowledge and with regards to Prophet Muhammad (peace be upon him) for guiding us to the straight path. We thank to Allah for giving us guidance and strength to write this e-book.

This e-book compiles the extended abstracts that submitted to Johor International Innovation Invention Competition and Symposium 2024 (JIIICaS2024), where JIIICaS2024 is a virtual platform for all creative minds to share and present their invention and innovation. Each abstract gives a brief background on the innovation or project.

We hope that this e-book will help the readers to get to know the innovation done by the students and get some ideas to develop future innovation products.

Foreword Rector

Assalamualaikum warahmatullahi Wabarakatuh, Salam Sejahtera, Salam Malaysia MADANI and Salam UiTM Dihatiku.

In the name of Allah, the Most Gracious, the Most Merciful.

It is a great honor to welcome you to the Johor International Innovation, Invention, Competition, and Symposium 2024 (JIIICaS 2024). This event connects various disciplines, focusing on education and engaging educators, students, researchers, and innovators from all walks of life.

Innovation is not just about ideas; it demands perseverance, creativity, and determination to turn those ideas into reality. The remarkable projects showcased today highlight the dedication and spirit of all participants. Initiatives like this not only explore new technologies but also cultivate skills and leadership among our youth. At Universiti Teknologi MARA (UiTM) Johor Branch, we are fully committed to fostering a dynamic culture of innovation, promoting the commercialization of new products, and encouraging meaningful collaborations with industry and society.

As we celebrate this event, I would like to extend my heartfelt gratitude to all sponsors, judges, the College of Computing, Informatics and Mathematics, UiTM Pasir Gudang Campus as the event organizer, as well as to the researchers and participants for their hard work in making this event a success. Let us continue striving for innovation and excellence. May the ideas presented today inspire us and lay the groundwork for future achievements.

Thank you.

Associate Professor Dr. Saunah Zainon
Rector
Universiti Teknologi MARA (UiTM)
Johor Branch

(A-PP032) CRACKING ELECTRIC CIRCUIT COMPLEXITY WITH DIFFERENTIAL EQUATIONS

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ABSTRACT
Understanding the dynamics of electrical circuits, particularly resistor-inductor (RL) and resistor-capacitor (RC) circuits, is crucial for the creation and management of electrical systems. These circuits exhibit time-dependent behavior that can be effectively analyzed using differential equations—a key focus of Calculus II. However, traditional methods of teaching and analyzing these circuits can be unintuitive and challenging for students. This study aims to simplify the analysis of RL and RC circuits through calculus by deriving time-dependent solutions for current and voltage using differential equations. By integrating computation with circuit analysis, this approach offers an intuitive understanding of the linear decay of current in RL circuits and the charge-discharge behavior in RC circuits. The results provide students with a clearer grasp of the temporal dynamics of these circuits, enhancing their learning experience and preparing them for more advanced studies in engineering. This method bridges the gap between theoretical mathematics and practical electrical applications, making complex concepts more accessible to Calculus II students.

Keywords: Differential equation, Electrical circuits, Resistor-inductor (RL)

1.0 INTRODUCTION
Electric circuits are essential to modern technology, powering devices from home lighting to smartphones. They consist of interconnected components that transfer electric current to perform various tasks. Understanding circuits is crucial for engineers and scientists, impacting fields such as electronics, communication, and renewable energy. This study aims to simplify the analysis of resistor-inductor (RL) and resistor-capacitor (RC) circuits by using differential equations, which are key to understanding their time-dependent behavior.

1.1 PROBLEM STATEMENT
Traditional methods for analyzing resistor-inductor (RL) and resistor-capacitor (RC) circuits can be complex and challenging for Calculus II students. The differential equations used are essential for understanding time-dependent circuit behavior but often seem disconnected from practical applications. This gap can hinder students' grasp of circuit dynamics. Therefore, a more accessible approach is needed to simplify

the analysis, making the connection between mathematical theory and practical understanding clearer, thus enhancing the learning experience and preparing students for advanced studies.

2.0 OBJECTIVE

The main objectives of this studies are:

f) To analyze RL and RC circuits by determining the time-dependent solutions for current and voltage using differential equations.
g) To study the theoretical mathematics with practical electrical applications

3.0 METHODOLOGY

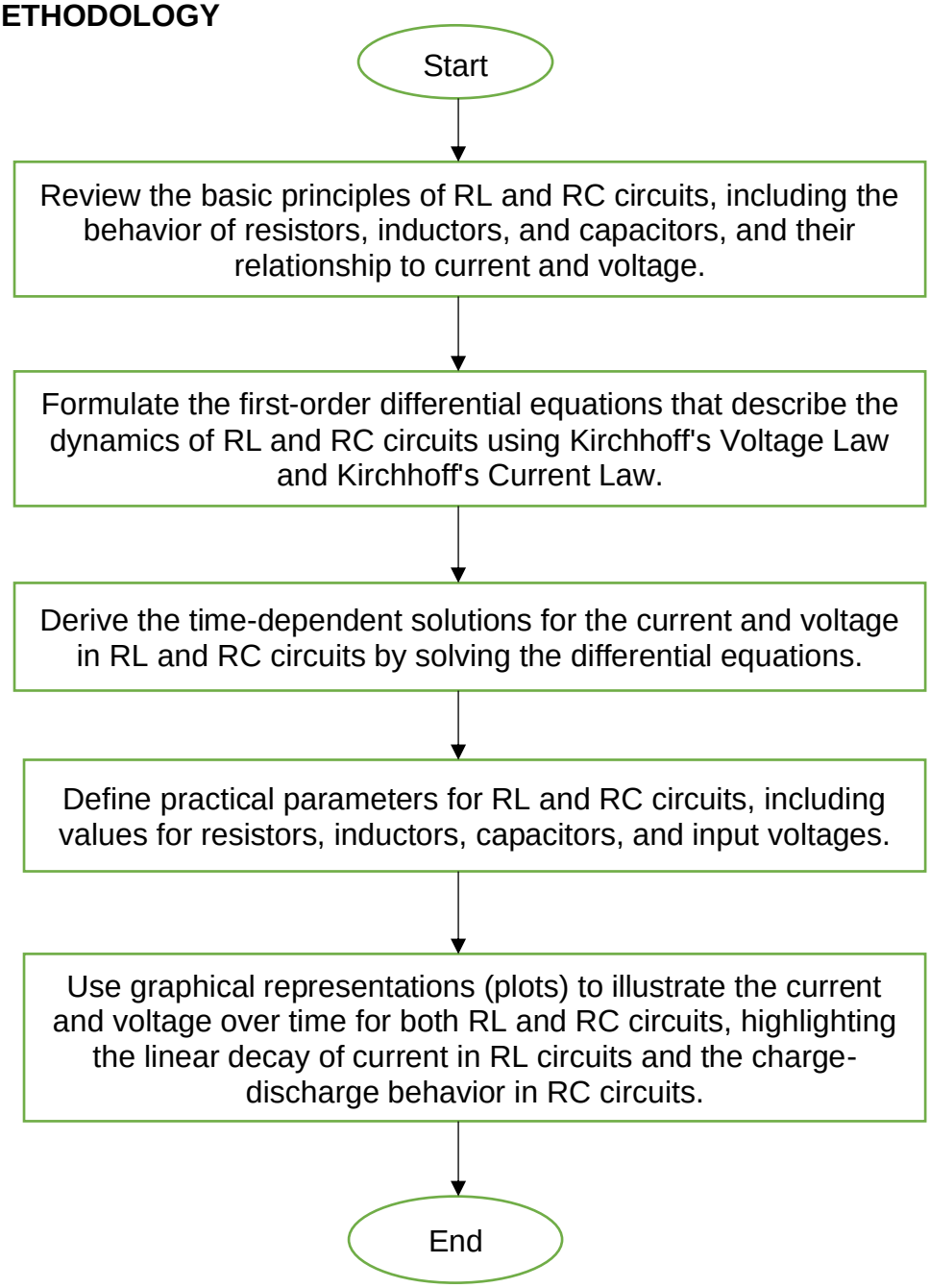

Figure 1: The methodology framework of study.

Figure 1 shows this study involves a systematic approach to simplifying the analysis of RL and RC circuits using differential equations. Initially, fundamental principles of these circuits are reviewed, followed by the formulation of first-order differential equations representing their behavior. Analytical solutions are derived for current and voltage, and practical parameters are defined for simulation purposes. MATLAB is employed to implement these solutions, generating data and visualizing the circuits' transient and steady-state responses through graphical representations. These theoretical and simulation results are validated against real-world scenarios, bridging the gap between mathematical theory and practical applications.

4.0 RESULTS

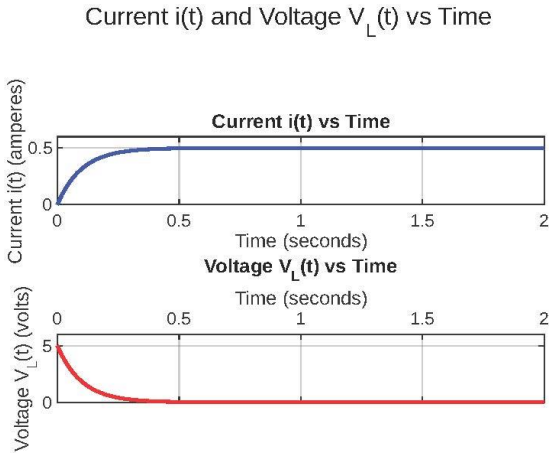

Figure 2: The graphs of i(t) vs Time and $V_L(t)$ vs time

Figure 2 of simulation results illustrate the transient and steady-state behavior of the circuit with a step input voltage. The current $i(t)$ increases exponentially, approaching a steady-state value of $\frac{V_0}{R}$, dictated by the time constant $\tau = \frac{L}{R}$. The voltage across the inductor $V_L(t)$ initially equals the input voltage V_0 and decays exponentially to zero. The graphs clearly show the exponential rise of the current and the exponential decay of the inductor voltage, confirming theoretical predictions and demonstrating the circuit's energy dynamics.

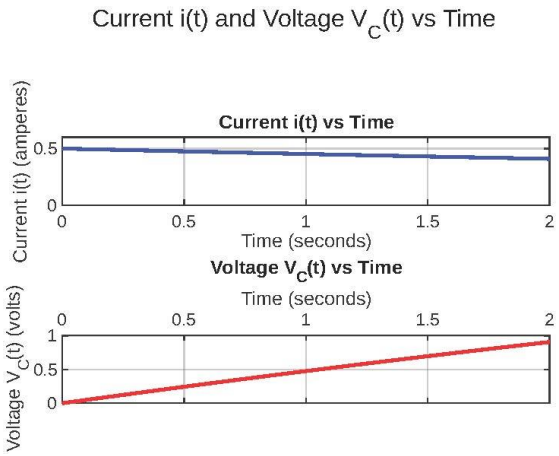

Figure 3: The graphs of i(t) vs Time and $V_C(t)$ vs time

Figure 3 of simulation results display the charging behavior of the capacitor in response to a step input voltage. The capacitor voltage $V_C(t)$ increases exponentially, approaching V_0 with a time constant $\tau = RC$. The current $i(t)$ through the resistor starts at $\frac{V_0}{R}$ and decays exponentially to zero. The plots effectively show the exponential rise of the capacitor voltage and the exponential decay of the current, validating theoretical expectations and illustrating the energy storage and release process in the RC circuit.

5.0 CONCLUSION

This study successfully simplifies the analysis of RL and RC circuits through the use of first-order differential equations. The methodology provides students with a clearer and more intuitive understanding of the time-dependent behavior of current and voltage in these circuits. By bridging the gap between theoretical mathematics and practical applications, this approach not only enhances the learning experience but also equips students with essential skills for advanced studies in engineering and related fields. Understanding the dynamics of RL and RC circuits using differential equations is vital for the continued development and innovation of modern electrical technologies. Future study could expand on this approach to cover more complex circuit configurations, further enriching educational resources in this domain.

6.0 BENEFIT OF STUDY

i. Enhanced Understanding: Simplifies the analysis of RL and RC circuits, making complex concepts more accessible and improving students' grasp of time-dependent circuit behavior.
ii. Bridging Theory and Practice: Connects theoretical mathematics with practical applications, helping students see the real-world relevance of differential equations in electrical engineering.
iii. Foundation for Advanced Studies: Prepares students for more advanced engineering courses by providing a solid understanding of essential circuit principles, supporting their academic and professional growth.

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