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"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-PP027) MODELING ELECTRIC CIRCUIT DYNAMICS: AN APPROACH VIA FIRST-ORDER ORDINARY DIFFERENTIAL EQUATIONS

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ABSTRACT

This study explores the dynamics of electric circuits using first-order ordinary differential equations (ODEs) as a foundational framework. It begins with an introduction to the fundamental principles of electric current, progressing to the formulation and solution of first-order ODEs that characterize circuit behaviour, particularly in RL circuits. The analytical solutions reveal both transient and steady-state responses, enhanced by practical examples and graphical illustrations. These representations offer tangible insights into the real-world applications of theoretical concepts. By seamlessly integrating theoretical frameworks with practical scenarios, this research provides a holistic understanding of how first-order ODEs serve as predictive tools in analyzing electrical circuits. This study not only bridges the gap between theory and practice but also lays a crucial foundation for complex circuit analysis, underpinned by Kirchhoff's Second Law, thereby enhancing the predictive analysis of dynamic electrical behaviour.

Keywords: Ordinary differential equations (ODEs), RL circuits, Kirchhoff's Second Law.

1.0 INTRODUCTION

Electric circuits are essential in electrical engineering, underpinning various electronic devices and systems. First-order ordinary differential equations (ODEs) provide a robust framework for analyzing the dynamic behaviour of circuits, particularly those with capacitors and inductors. These components introduce time-dependent characteristics, making ODEs crucial for predicting circuit responses to different inputs over time.

1.1 PROBLEM STATEMENT

Consider an RL (resistor-inductor) circuit with a resistor R and a capacitor L in series with a voltage source V(t). The task is to determine the current i(t) through the circuit and the voltage across the inductor $V_L(t)$ when the circuit experiences a step input voltage. This problem can be modelled as a first-order ODE, representing the relationship between voltage, current, and the resistor-inductor properties. Solving this ODE reveals the circuit's transient and steady-state behaviour.

2.0 OBJECTIVE

The primary objective of this study is:

a) To employ first-order ordinary differential equations to solve comprehensive model of RL circuits.
b) To analyse the current *i*(t) through an RL circuit in voltage across the inductor.

3.0 METHODOLOGY

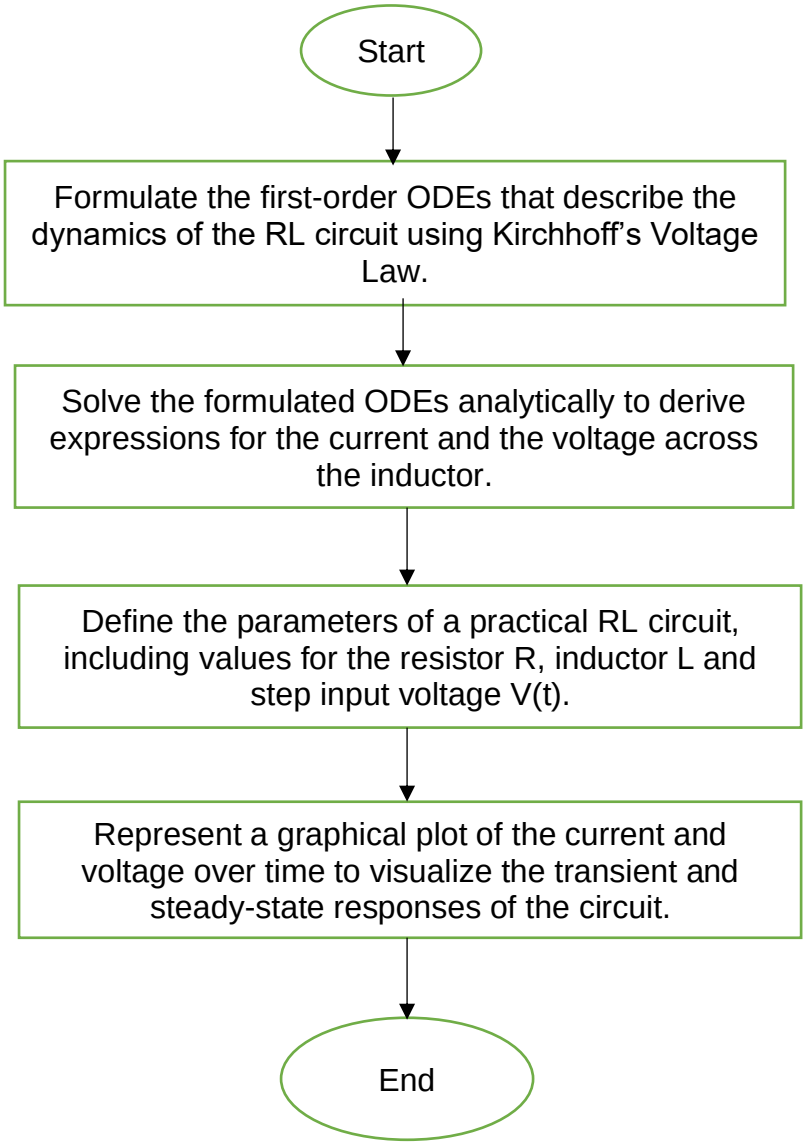

Figure 1: Methodology framework of study

Figure 1 shows the methodology framework of this study involves a comprehensive approach to understanding the dynamics of electric circuits using first-order ordinary differential equations (ODEs).

Initially, fundamental principles of electric circuits are reviewed to establish a foundational understanding. The next step involves formulating the first-order ODEs representing the RL circuit's behaviour, followed by deriving analytical solutions for the current and voltage across the inductor. Practical parameters for the RL circuit are

defined, and simulations are conducted using MATLAB to generate data and visualize the circuit's transient and steady-state responses. These theoretical and simulation results are then compared with real-world scenarios to validate the models. Finally, the study's findings are summarized, highlighting the implications for circuit analysis and suggesting directions for future research.

4.0 RESULTS

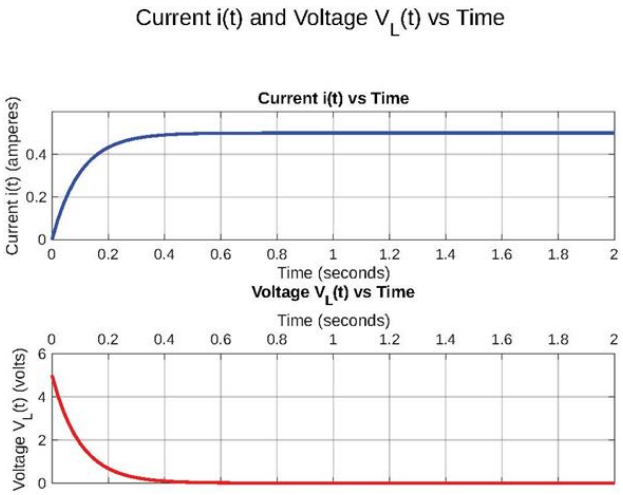

Figure 2: Transient and steady-state behavior of RL circuits

The results demonstrate the transient and steady-state behavior of RL circuits. The transient response, influenced by the circuit's time constant $\tau = \frac{L}{R}$,is characterized by the exponential change in current, described by $i(t) = \frac{V_0}{R}(1 - e^{-\frac{t}{\tau}})$. As time approaches infinity, the current stabilizes at $\frac{V_0}{R}$, while the voltage across the inductor, given by $V_L(t) = V_0 e^{-\frac{t}{\tau}}$, decays to zero. Graphical illustrations and practical examples highlight how these ODE solutions accurately predict circuit behavior under various conditions, underscoring the importance of first-order ODEs in circuit analysis.

5.0 CONCLUSION

The study concludes that first-order ordinary differential equations are effective tools for modelling and predicting the behaviour of RL circuits. By integrating theoretical analysis with practical examples, the research provides a holistic understanding of circuit dynamics. The findings highlight the significance of mathematical modelling in electrical engineering, offering a foundation for more complex circuit analysis and design.

6.0 BENEFIT OF STUDY

a) By seamlessly integrating theoretical frameworks with practical scenarios, this research facilitates a holistic understanding of how first-order ODEs serve as predictive tools in analyzing electrical circuits.
b) By integrating theoretical insights with practical applications, this study facilitates a deeper understanding of how first-order ODEs are applied to predict and analyze the dynamic behavior of electrical circuits, laying a crucial foundation for complex circuit analysis, underpinning Kirchhoff's Second Law.
c) Increase knowledge and understanding using ODE in real life in example for circuit's application among students.

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