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
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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-PP025) DYNAMICS AND APPLICATIONS OF SECOND-ORDER RL CIRCUITS IN MODERN ELECTRONICS

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ABSTRACT

A second-order RL (Resistor-Inductor) circuit involves a configuration with resistors and inductors that produce a second-order differential equation, dictating the circuit's dynamics. These circuits are essential in electrical engineering and are employed in applications like filtering, signal processing, and power management. The second-order RL circuit showcases complex impedance properties, influencing its response to different frequencies in terms of amplitude and phase. Analysis of these circuits involves determining key parameters such as the natural frequency, damping factor, and transient response. The solutions to the differential equations provide valuable insights into both transient and steady-state behaviors, critical for designing robust and efficient electronic systems. Understanding these behaviors is pivotal for the development of effective filters and oscillators, highlighting the importance of second-order RL circuits in modern electronic design and analysis.

Keywords: differential equation, inductance, resistor, current, rate of change

1.0 INTRODUCTION

Second-order RL circuits consist of resistors and inductors, are crucial components in the realm of electrical engineering. This study particularly in the design of systems for filtering, signal modulation, and energy regulation. These circuits are characterized by their ability to produce second-order differential equations, which describe the time-dependent behavior of current and voltage within the circuit. Understanding these equations is key to predicting how the circuit will respond to various inputs, especially in terms of oscillations and damping phenomena.

1.1 PROBLEM STATEMENT

Analyzing second-order RL circuits is challenging due to the complexity of the second-order differential equations involved. Traditional methods can be difficult, making it hard to understand the circuits' transient and steady-state behaviors. There is a need for an accessible approach to apply these equations in analyzing RL circuit dynamics, specifically to determine and compute the time-dependent charge q(t) on the capacitor.

2.0 OBJECTIVE

The main objectives of this studies are:

a) To employ the second-order differential equation in application the dynamics circuit.
b) To determine the charge q(t) on the capacitor as a function of time.
c) To compute the time-dependent expression for the charge on the capacitor.

3.0 METHODOLOGY

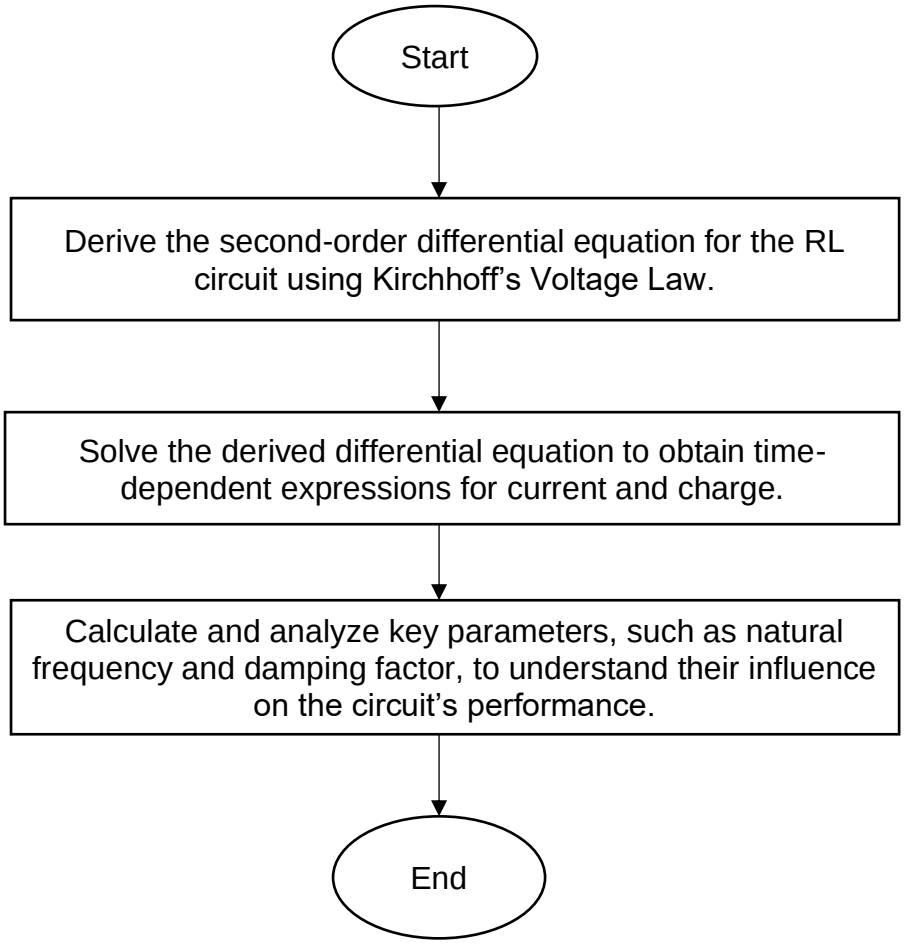

Figure 1: The methodology framework of study

Figure 1 shows the study begins with a literature review to establish the theoretical background on second-order RL circuits and differential equations. The next step involves formulating the second-order differential equation using Kirchhoff's Voltage Law. Analytical solutions are then derived to obtain time-dependent expressions for current and charge. These solutions are implemented in MATLAB to simulate circuit behavior and generate time-dependent plots. Key parameters, such as natural frequency and damping factor, are analyzed to understand their impact on the circuit's performance.

4.0 RESULTS

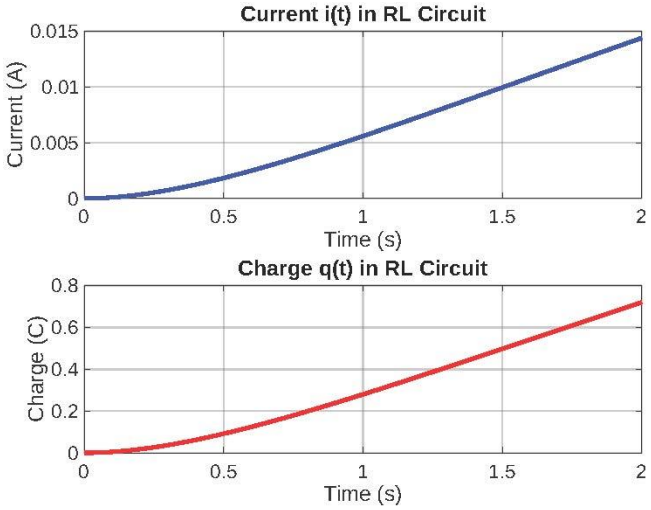

Figure 2: Current i(t) and Charge q(t) in RL Circuit base on Time

Figure 2 shows the results of the second-order RL circuit analysis reveal that the current i(t) and the charge q(t) on the inductor exhibit damped oscillatory behavior over time illustrated in Figure 2. Governed by the differential equation $L\frac{d^2q(t)}{dt^2} + R\frac{dq(t)}{dt} + \frac{1}{C}q(t) = V(t)$, where L is inductance, R is resistance, and C is capacitance, the current is expressed as $i(t) = I_0 e^{-\alpha t}\cos(\omega_d t + \emptyset)$, showing an initial rise followed by oscillations that decay due to the damping factor $\alpha = \frac{R}{2L}$. The charge q(t) mirrors this behavior, reflecting energy exchanges between the inductor and the resistor. These oscillations diminish over time, leading the system to a steady state. The findings highlight how inductance and resistance influence the circuit's transient and steady-state responses, crucial for optimizing electronic system performance.

5.0 CONCLUSION

The study of second-order RL circuits reveals the intricate dynamics governing the behavior of electrical circuits. By solving the second-order differential equation, valuable insights into the transient is gained and steady-state responses essential for various applications in modern electronics. The methodology used here provides a systematic approach to analyze and understand these circuits, contributing to the development of more effective electronic components and systems. This analysis underscores the importance of mastering the underlying principles of RL circuits for advancing technology in signal processing, filtering, and power management.

6.0 BENEFIT OF STUDY

a) This study enhances comprehension of transient and steady-state behaviors in second-order RL circuits, aiding in more accurate and efficient electronic designs.
b) By integrating theory with practical MATLAB simulations, the study makes complex concepts more accessible, enhancing learning and preparation for advanced studies in electrical engineering.
c) from this study support the development of robust and efficient electronic systems, improving filters, oscillators, and signal processing tools crucial for various technological applications.

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