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

e ISBN: 978-967-0033-25-9

Published in Malaysia by
Universiti Teknologi MARA Cawangan Johor
Kampus Pasir Gudang
81750 Masai

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-PP033) EXPONENTIAL DECAY MODELLING OF RADIOACTIVE SUBSTANCES: THEORY AND APPLICATION

Norbaiti binti Tukiman[1], Siti Nursamirah Ab Halim[2], Aina Farzana Binti Norizan[3], Dalili Safiyya Binti Ramli[3], Nuralyana Binti Omar Bahsir[3], Nurdamia Farhanah Binti Helmi[3], Nurhana Hazirah Binti Muhammad Hakim[3]

[1]College of Computing, Informatics and mathematics, Universiti Teknologi MARA, Cawangan Johor, Kampus Pasir Gudang, 81750 Masai, Johor.
[2]Department of Mathematical Sciences, Faculty of Science, Universiti Teknologi Malaysia, Skudai, Johor
[3]Electrical Engineering Studies, College of Engineering, Universiti Teknologi MARA, Cawangan Johor, Kampus Pasir Gudang, 81750 Masai, Johor

Corresponding author: ainafarzanabtnorizan@gmail.com, samirahalimm@gmail.com, norbaiti289@uitm.edu.my

ABSTRACT

This study models the process of radioactive decay, where unstable atomic nuclei spontaneously transform into more stable forms, releasing radiation. The study focuses on applying first-order differential equations to describe this decay process and uses the separation of variables method to solve the equation. The aim is to enhance the understanding of radioactive decay, validate the mathematical model with practical data, and explore its applications across various scientific fields. Additionally, the study highlights the educational benefits of using this approach to teach exponential decay and differential equations, emphasizing its relevance in physics, chemistry, geology, and medicine.

Keywords: Radioactive decay, Separation of Variable, Exponential Decay

1.0 INTRODUCTION

Radioactive decay is a critical process in many scientific fields, including physics, chemistry, geology, and medicine. It involves the transformation of unstable atomic nuclei into more stable forms, accompanied by the emission of radiation in the form of alpha, beta, or gamma particles. Understanding and accurately modelling radioactive decay is essential for applications such as dating archaeological and geological samples, designing radiation therapies, and managing nuclear waste. The process is mathematically described by first-order differential equations, which capture the rate at which radioactive substances decay over time. This study explores the application of the separation of variables method to solve these equations, providing insights into the decay process and its practical applications.

1.1 PROBLEM STATEMENT

Modelling the rate of radioactive decay accurately is essential for predicting the behavior of radioactive materials over time, which is critical in fields such as nuclear physics, geology, and medical treatment. While the concept of exponential decay is widely recognized, there is a need to deepen the understanding of how different parameters influence this process and to apply mathematical methods, like the separation of variables, effectively. Additionally, there is a gap in validating these

theoretical models with practical data, which is necessary to ensure their reliability and applicability in real-world scenarios.

2.0 OBJECTIVE

The primary objectives of this study are:

a) To develop a mathematical model for radioactive decay using first-order differential equations.
b) To solve the differential equation using the separation of variables method.
c) To enhance educational understanding of exponential decay and differential equations by demonstrating the application of the separation of variables method.

3.0 METHODOLOGY

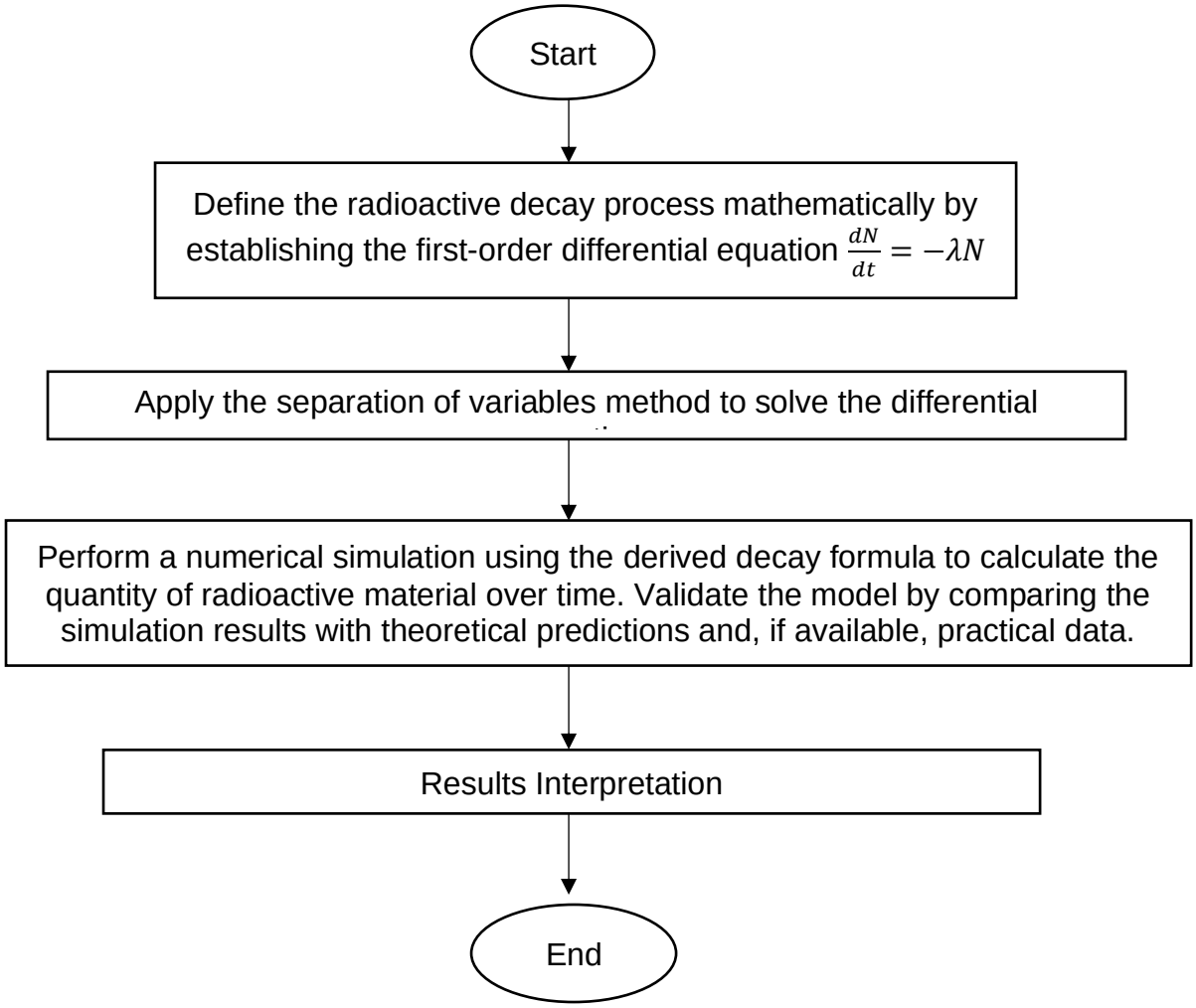

Figure 1: The methodology framework of study.

Figure 1 of this study involves developing a mathematical model of radioactive decay using first-order differential equations and solving it through the separation of variables technique. This approach allows for an analytical solution that describes how the quantity of radioactive material decreases over time. A numerical simulation is then performed to illustrate the decay process, using specific initial conditions and decay constants. The simulation results are analyzed to understand the decay dynamics, with

an emphasis on validating the model against theoretical expectations and practical data. It also highlights the educational benefits of using this method to teach concepts related to exponential decay and differential equations, demonstrating its practical relevance in scientific and engineering applications.

4.0 RESULTS

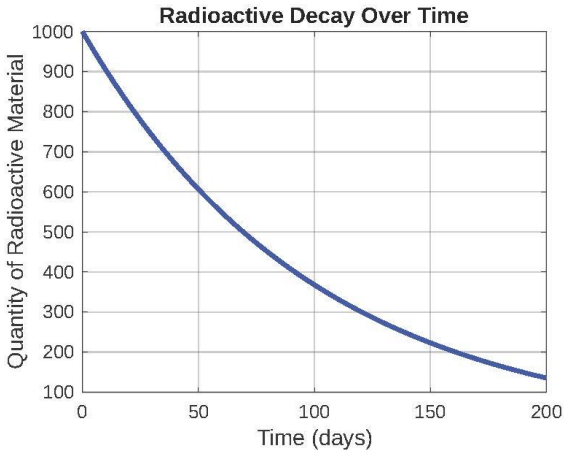

Figure 2: Simulation results of radioactive decay over time.

The results from Figure 2 shows the simulation demonstrate the exponential decay behavior of radioactive materials, as predicted by the equation $N(t) = N_0 e^{-\lambda t}$. The graph of $N(t)$ over time shows a rapid decline in the quantity of radioactive material, especially in the early stages, followed by a more gradual decrease as the material continues to decay. The rate of decay is directly influenced by the decay constant λ; a larger λ would result in a faster decay, while a smaller λ leads to a slower process. The analysis highlights the importance of the decay constant in predicting the long-term behavior of radioactive substances, making this model valuable for various practical applications.

5.0 CONCLUSION

This study successfully models the process of radioactive decay using first-order differential equations and the separation of variables method. The resulting exponential decay formula accurately describes the decay behavior of radioactive materials over time. By validating the model with practical data and exploring its educational applications, the research enhances the understanding of both the decay process and the mathematical techniques used to model it. The study's findings have significant implications for fields that rely on precise decay predictions, such as nuclear physics, geology, and medical applications.

6.0 BENEFIT OF STUDY

a) The study provides a reliable mathematical model for predicting radioactive decay, which is crucial for applications like dating geological samples and designing radiation therapies.

b) The use of the separation of variables method as a teaching tool helps students better understand exponential decay and differential equations, reinforcing their grasp of key mathematical concepts.

REFERENCES

Rivera, J.E.M. & Naso, M.G. (2024). Existence and Exponential Decay for a Contact Problem Between Two Dissipative Beams. *Journal of Elasticity*. https://link.springer.com/article/10.1007/s10659-024-10064-x

Abdulle A., Arjmand, D. & Paganoni, E. (2020). Exponential decay of the resonance error in numerical homogenization via parabolic and elliptic cell problems. *Institut De Mathématiques, École Polytechnique Fédérale De Lausanne*. https://doi.org/10.1016/j.crma.2019.05.011

Cui, H. (2020). The application of linear ordinary differential equations. *Applied Mathematics*, *11*(12), 1292–1315. https://doi.org/10.4236/am.2020.1112088

Arnold, A., Jin, S., & Wöhrer, T. (2020). Sharp decay estimates in local sensitivity analysis for evolution equations with uncertainties: From ODEs to linear kinetic equations. *Journal of Differential Equations*, *268*(3), 1156–1204. https://doi.org/10.1016/j.jde.2019.08.047

Al-Ahmad, S., Sulaiman, I. M., AlAhmad, R., Mamat, M. & Al-Ahmad, M. (2019). On Solving Classes of Differential Equations with Applications. *Malaysian Journal of Computing and Applied Mathematics*, *2(2): 8-13*. https://doi.org/10.37231/myjcam.2019.2.2.31