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-PP034) ANALYZING NEWTON'S LAW OF COOLING THROUGH FIRST-ORDER SEPARABLE DIFFERENTIAL EQUATIONS

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ABSTRACT

Newton's Law of Cooling describes the rate at which an exposed body changes temperature through radiation, which is proportional to the difference between its temperature and the ambient temperature. This study presents an in-depth exploration of Newton's Law of Cooling using first-order separable differential equations. By formulating the cooling process as a differential equation and employing the method of separation of variables, a general solution derived that describes the temperature evolution over time. This solution demonstrates how an object's temperature asymptotically approaches the ambient temperature, offering insights into practical applications in forensic science, engineering, and beyond. The analytical approach not only reinforces the theoretical understanding of heat transfer but also provides a robust tool for predicting temperature variations in various real-world scenarios.

Keywords: Newton Law of Cooling, body temperature, First order, Separable variable

1.0 INTRODUCTION

Newton's Law of Cooling in this study for understanding how the temperature of an object changes relative to its surrounding environment. It states that the rate of change in temperature is proportional to the difference between the object's temperature and the ambient temperature, making it a fundamental principle in thermodynamics. This study investigates this cooling process through the lens of first-order separable differential equations. This exploration not only deepens our theoretical comprehension of heat transfer but also highlights the practical implications of these findings in areas such as forensic science, where accurately estimating the time of death is crucial, and in engineering, where precise temperature control is often required.

1.1 PROBLEM STATEMENT

The challenge in understanding and applying Newton's Law of Cooling lies in accurately predicting the temperature change of an object over time, especially in varying ambient conditions. Traditional methods may not fully capture the complexity of the cooling process, leading to inaccuracies in practical applications such as forensic investigations or thermal engineering.

2.0 OBJECTIVE

The main objectives of this studies are:

h) To derive the differential equation governing the cooling process.
i) To determine the time of death in a forensic scenario by analyzing the cooling rate of a body using first-order separable differential equations.

3.0 METHODOLOGY

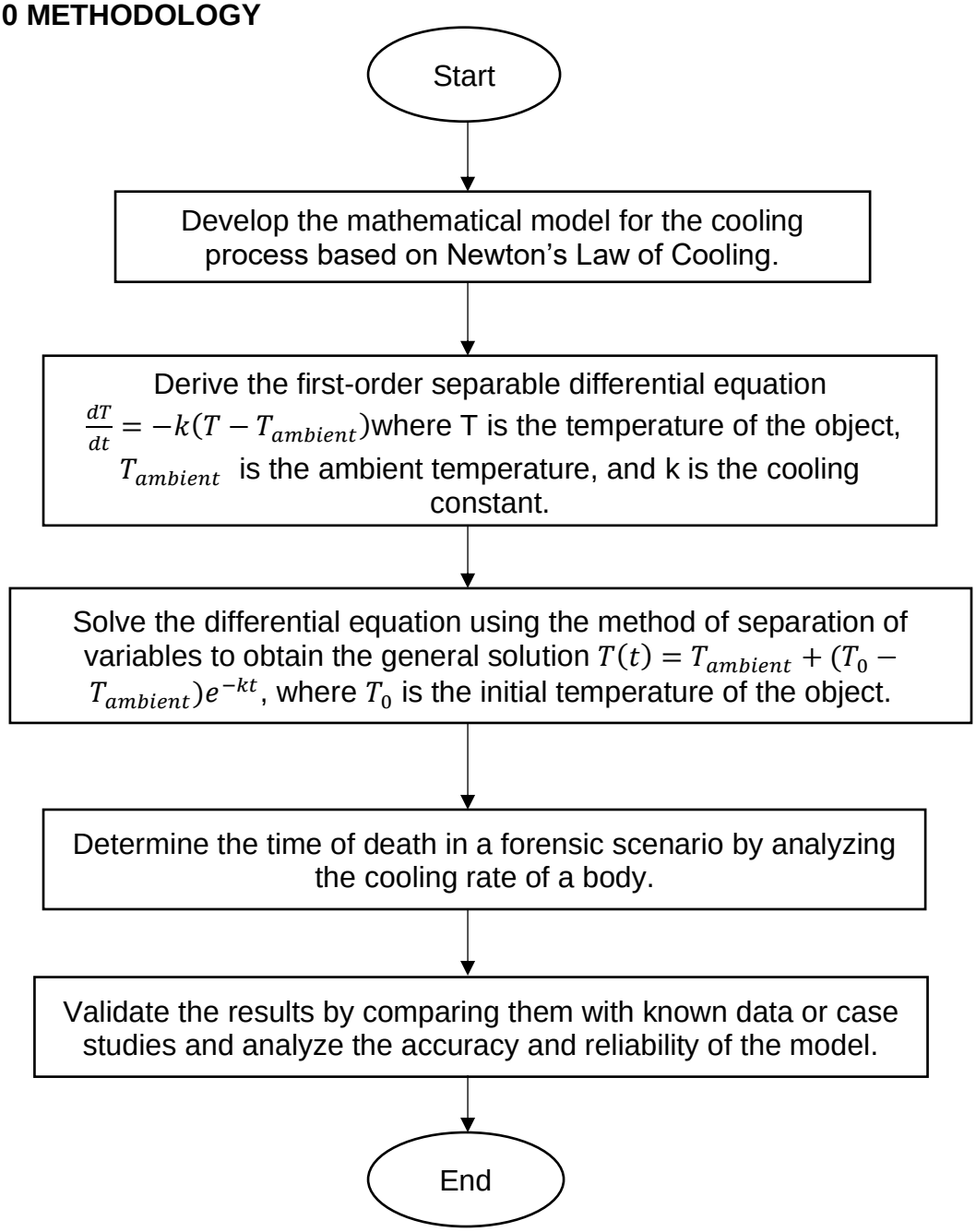

Figure 1: The methodology framework of study.

The temperature $T(t)$ of the body at any time t is given:

$$T(t) = T_{ambient} + (T_0 - T_{ambient})e^{-kt} \quad (1)$$

Figure 1 shows that the methodology begins by formulating Newton's Law of Cooling as a first-order separable differential equation to describe the rate of temperature change of a body. Parameters such as initial body temperature, ambient temperature, and cooling constant are defined. The differential equation is solved using separation of variables to obtain the general solution for temperature as a function of time. A MATLAB simulation is set up to model the cooling process, specifying initial conditions and a suitable time range. The simulation is executed to generate temperature data over time, and the results are visualized using a temperature versus time graph. The final step involves analyzing the data to understand the transient and steady-state behavior of the cooling process, providing practical insights and validating the theoretical model.

4.0 RESULTS

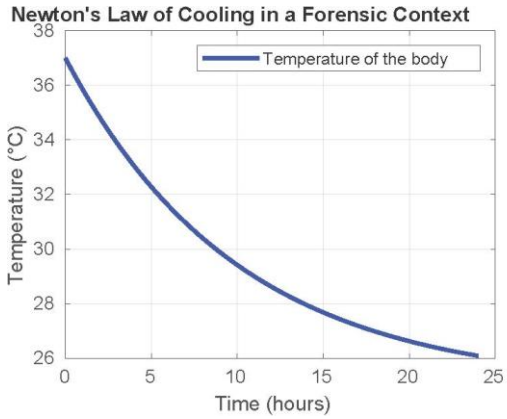

Figure 2: Simulation results of Newton’s Law of Cooling in a Forensic context.

The simulation results in figure 2 demonstrate the exponential decay of the body's temperature, initially decreasing rapidly and then gradually approaching the ambient temperature. This modelling allows forensic investigators to estimate the time of death with higher precision, highlighting the practical application of first-order separable differential equations in forensic science. The results underscore the importance of mathematical models in providing reliable tools for forensic analysis.

5.0 CONCLUSION

This study delves into the application of Newton’s Law of Cooling, formulated through first-order separable differential equations, to provide a detailed analysis of temperature changes over time. The study specifically explores the forensic application, demonstrating how the cooling constant and temperature evolution can help accurately estimate the time of death. MATLAB simulations corroborate the theoretical model, showing an exponential decay in body temperature consistent with the principles of Newton’s Law of Cooling. It underscores the importance of mathematical models in forensic science, offering robust tools for precise and reliable analysis in real-world applications.

6.0 BENEFIT OF STUDY

a) This study improves the accuracy of estimating the time of death, which is crucial for criminal investigations.
b) It deepens knowledge of heat transfer processes, valuable in both forensic science and various engineering fields.
c) The study makes complex mathematical concepts easier to understand, bridging the gap between theory and practical applications, benefiting students in their studies and future careers.

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