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"BRIDGING IDEAS AND REALITY THROUGH EMERGING TECHNOLOGIES IN INNOVATION"

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PREFACE

In the name of Allah, the Almighty who grants us knowledge, wisdom, and guidance, and with salutations upon the Prophet Muhammad (peace be upon him) who has shown us the way of truth and enlightenment, we begin this preface with gratitude. We are grateful to Allah for His blessings and strength that have enabled us to complete this proceedings.

This proceedings compiles the extended abstracts submitted to the **Johor International Innovation, Invention Competition and Symposium 2025 (JIIICaS 2025).** JIIICaS continues to serve as a virtual platform for students, researchers, and innovators to present their ideas and showcase their inventions. The programme aims to inspire creative thinking, encourage applied innovation, and nurture a spirit of collaboration among participants from diverse backgrounds.

Each abstract in this proceedings provides an overview of the respective innovation or project, highlighting the uniqueness, potential impact, and relevance to current technological and societal needs. It is our hope that this proceedings will become a source of reference and inspiration, not only for the participants but also for future innovators and change-makers. May the innovations presented here spark new ideas that lead to real-world solutions and meaningful progress.

We express our heartfelt appreciation to all contributors, supervisors, reviewers, and the entire organising committee whose dedication and commitment have brought JIIICaS 2025 to fruition.

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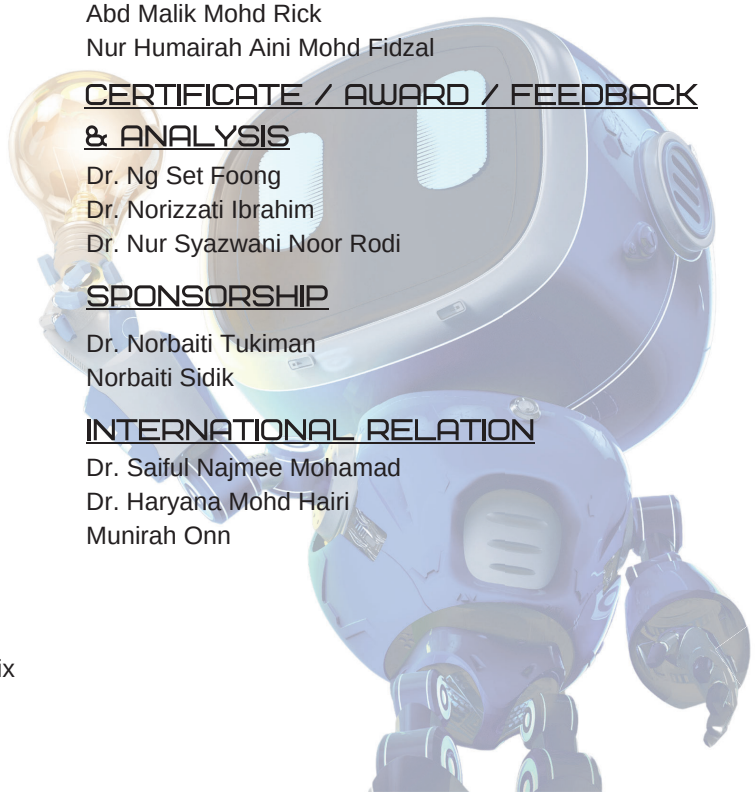

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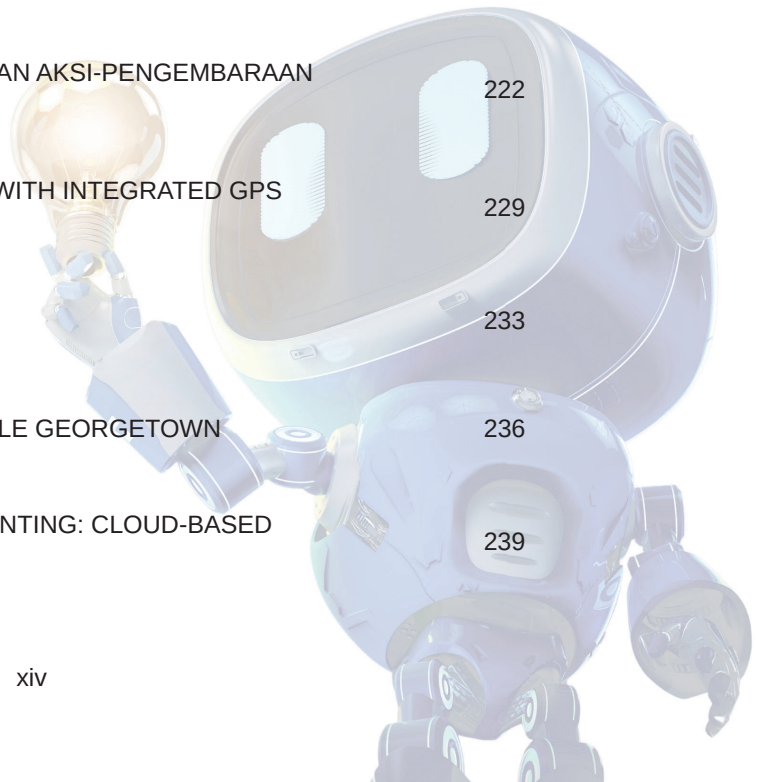

NEWTON'S LAW OF COOLING CALCULATOR

Nurhazirah Mohamad Yunos[1, 2, *], Taufiq Khairi Ahmad Khairuddin[1], Nur Idayu Alimon[2], Muhammad Ilham Hairol Sufhan[3], Muhammad Hafiz Quezaimy Norizan[3], Muhammad Aqeef Haqimi Mat Jalaini[3]

[1] Department of Mathematical Sciences, Faculty of Science, Universiti Teknologi Malaysia 81310 Johor Bahru, Johor, Malaysia
[2] Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Johor Branch, Pasir Gudang Campus, 81750 Masai, Johor, Malaysia
[3] Faculty of Electrical Engineering, Universiti Teknologi MARA, Johor Branch, Pasir Gudang Campus, 81750 Masai, Johor, Malaysia

[*] Corresponding author: nurhazirah7@graduate.utm.my

ABSTRACT

Newton's Law of Cooling describes the rate at which an object's temperature changes relative to its surrounding environment. This fundamental principle is widely applied in real-world contexts such as forensic science (to estimate the time of death) and food safety (to monitor cooling of cooked items). In education, this law is commonly introduced in Ordinary Differential Equations, a topic taught at diploma and bachelor's degree levels in engineering courses. However, students often struggle to grasp the real-life application of this concept due to the lack of interactive, user-friendly tools. Currently, there is no stand-alone application that allows users to predict temperature, estimate cooling time, and visualize temperature trends over time using Newton's Law. Manual calculation can be time consuming and error-prone, especially for those without strong mathematical background. To address this gap, a stand-alone application, namely the Newton's Law of Cooling Calculator is developed using graphical user interface Matlab. This application allows users to provide initial conditions and instantly obtain temperature values over time, or determine the time needed to reach a specific temperature. It also provides graphical visualization, making the learning process more engaging and intuitive. The application offers clear benefits in STEM education, allowing students to explore mathematical theory through real-life examples. Beyond academia, it has potential uses in forensic investigations, food industries and pharmaceutical storage. In conclusion, this innovation bridges the gap between mathematical theory and practical application. It serves as a valuable educational tool while offering real-world functionality, making it both noble and commercially viable.

Keywords: Newton's Law of Cooling, Differential Equations, Graphical User Interface Matlab, Engineering

1.0 INTRODUCTION

Newton's Law of Cooling is a fundamental principle in thermodynamics that describes how an object's temperature changes over time relative to the surrounding environment. This concept plays a significant role in various real-world applications such as estimating the time of death in forensic science (Kaviya, 2024) and monitoring food cooling processes in the food industries (Konovalenko, 2021), and managing temperature-sensitive materials in pharmaceutical storage (Connors, 2003). In academia, it is commonly taught in Ordinary Differential Equations (ODEs) courses, particularly in engineering programs at both diploma and bachelor's degree levels.

Despite its importance, students often face difficulties in understanding and applying this law due to the abstract nature of the mathematics involved. Currently, there is no stand-alone, user-friendly application available that allows users to compute and visualize the cooling process in a simple and interactive manner. Most available tools are either embedded in advanced software or lack visualization features, making them inaccessible to students and non-technical users.

Motivated by this gap, this innovation introduces the Newton's Law of Cooling Calculator, a stand-alone application designed to provide quick and accurate predictions of temperature or time based on Newton's Law. It also includes graphical visualization to help users understand the cooling trend over time. This tool aims to bridge the gap between theoretical knowledge and practical application, enhancing the learning experience while offering potential use in real-world scenarios such as forensic investigations and industrial temperature monitoring.

2.0 OBJECTIVES

The objective of this innovation is to develop a Newton's Law of Cooling Calculator that provides a quick, accessible, and user-friendly tool. The features of this calculator are to visualise the temperature change over time, predict the temperature after a fixed time and forecast the time required to reach certain temperature.

3.0 MATHEMATICAL FORMULATION

The Newton's Law of Cooling states that the rate at which an object cools is directly proportional to the difference between its temperature and the surrounding temperature. This relationship is mathematically represented by the following first-order ordinary differential equation (ODE):

$$\frac{dT}{dt} = -k(T - T_s) \tag{3.1}$$

where,
$T = Temperature\ of\ the\ object$
$T_s = Surrounding\ temperature$
$t = time$
$k = cooling\ constant$
$\frac{dT}{dt} = rate\ of\ change\ of\ temperature\ over\ time$

4.0 METHODOLOGY

In this section, the method of innovating the product is explained in detail. To make the computation faster, this study created a graphical user interface (GUI) using MATLAB App Designer (version R2023a). The interface page includes two views, which are Design and Code views. These view pages can be accessed through a button on the design page. In the design view, users can structure the application layout, while in the code view, coding is required for each tool to specify the type and characteristics of the data to be incorporated into the code. Figure 1 illustrates the process of developing the calculator.

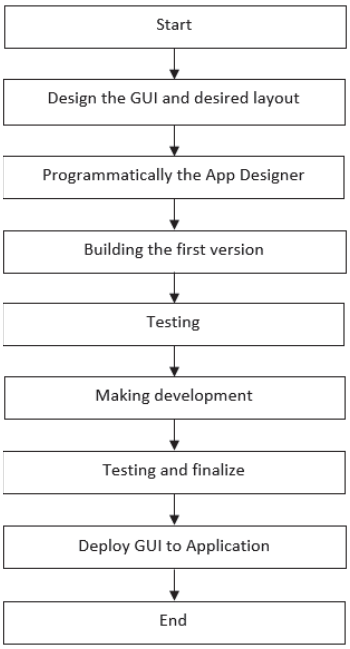

Figure 1: The process of developing the Newton's Law of Cooling Calculator.

5.0 RESULT

An application named Newton's Law of Cooling Calculator has been successfully developed and the full layout of the calculator is demonstrated in Figure 2. Here, the calculator consists of three functions, which are to predict the temperature of an object after a specified time, estimate the time required to reach a target temperature, and visualize the temperature-time relationship through graph plotting. For convenience, all related keywords are also included for user's reference.

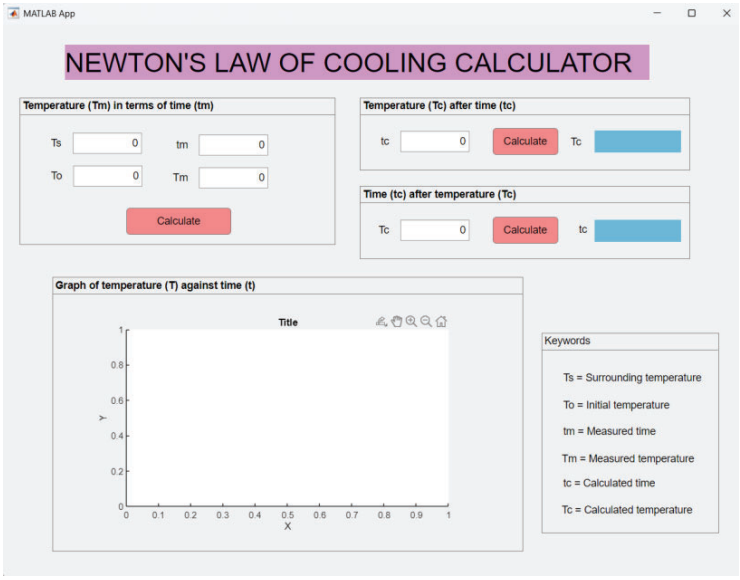

Figure 2: Layout of the Newton's Law of Cooling Calculator

The first function of this calculator is to demonstrate the temperature-time relationship in graphical form. To use this feature, the user needs to put the following values: surrounding temperature (Ts), initial temperature (To), measured time (tm), and measured temperature (Tm). Once the Calculate button is clicked, the graph of temperature over time will be displayed in the 'Graph of Temperature (T) Against Time (t)' panel.

To assess the functionality of this calculator, an example from Ismail & Mohd Nor (2025) is used. Let $Ts = 20$, $To = 40$, $tm = 10$, and $Tm = 35$. After entering these inputs, the resulting graph that illustrates the temperature-time relationship appears as shown in Figure 3.

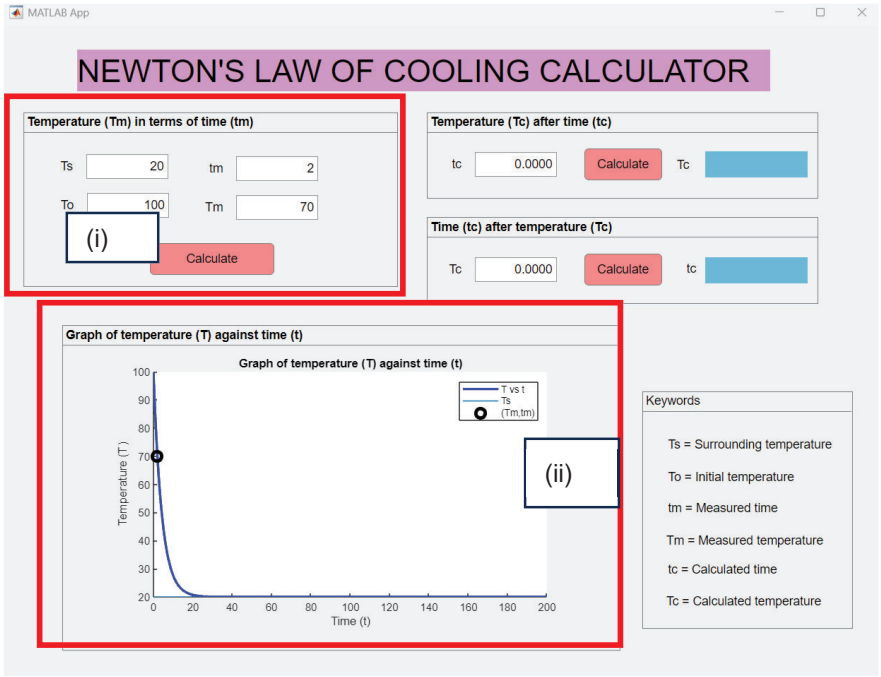

Figure 3: The layout of illustrating the temperature over time after execution: **(i)** User has inserted the value of $Ts = 20$, $To = 100$, $tm = 2$, and $Tm = 70$. **(ii)** The relationship between the temperature over time is displayed

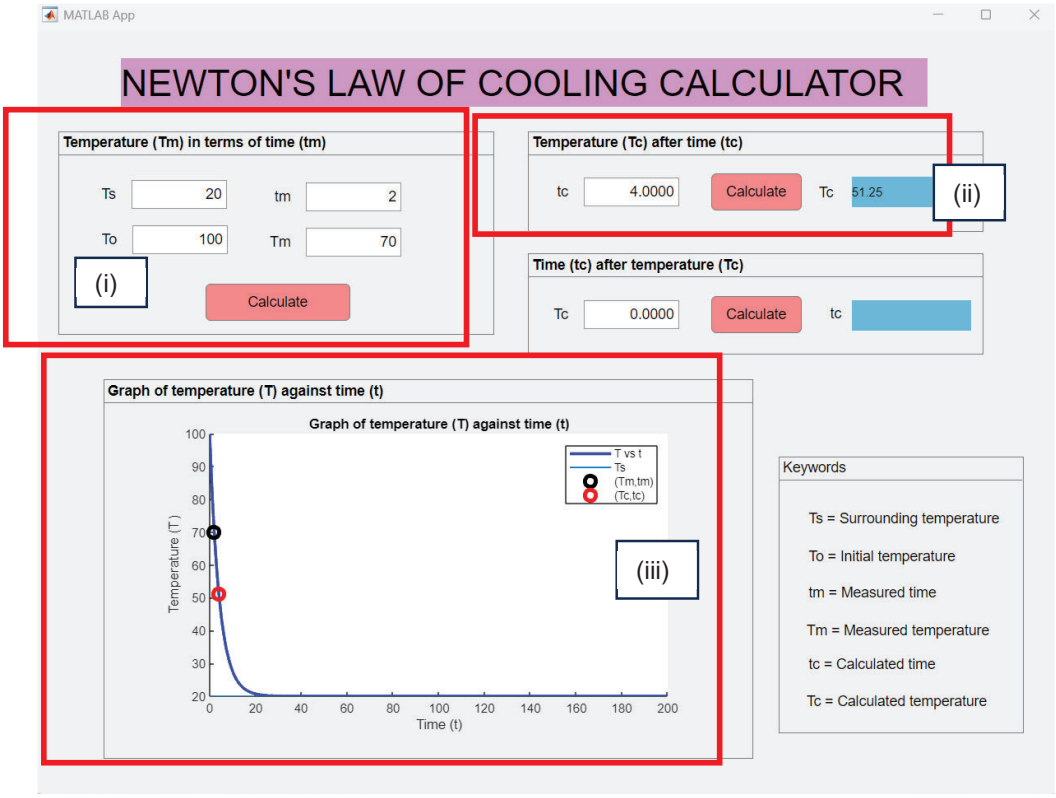

Figure 4: The layout of illustrating the temperature over time after execution: **(i)** User has inserted the value of $Ts = 20, To = 40, tm = 10$, and $Tm = 35$. **(ii)** User has inserted $tc = 4$. Once "Calculate" button is clicked, the $Tc = 51.25$ has appeared. **(iii)** The updated relationship between the temperature over time is displayed

The final feature provided in this calculator is the prediction of temperature (Tc) at a given time (tc). Using the same input data as shown in Figure 3, and by setting $Tc = 33.3695$, the corresponding tc value will promptly appear once the 'Calculate' button is clicked.

In addition, the temperature vs. time graph will be automatically updated to include the newly calculated temperature and time. The result is illustrated in Figure 5. Here, the calculated tc value is identical to the result shown in Figure 4, as the Tc value entered is the same in both cases. This consistency demonstrates the accuracy and validity of the calculator.

6.0 CONCLUSION

In conclusion the Newton's Law of Cooling Calculator successfully addresses the gap between theoretical understanding and practical application of ordinary differential equations, specifically Newton's Law of Cooling. By offering a user-friendly, stand-alone application, this innovation enables users to accurately predict temperature, estimate cooling time, and visualize the temperature over time through graph. This calculator not only enhances the learning experience for students in engineering and mathematics courses but also shows strong potential for real-world applications in fields such as forensic science and food safety. By automating complex calculations and providing instant results, the calculator promotes efficiency, accuracy, and deeper conceptual understanding.

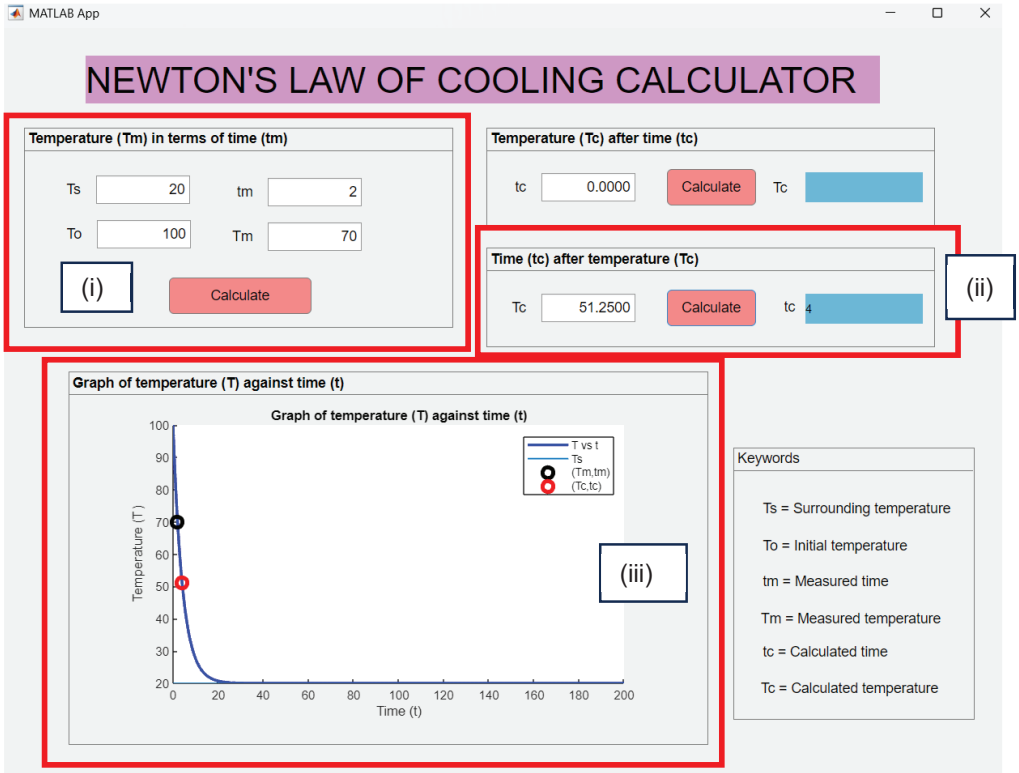

Figure 5: The layout of illustrating the temperature over time after execution: **(i)** User has inserted the value of $Ts = 20, To = 40, tm = 10$, and $Tm = 35$. **(ii)** User has inserted $Tc = 33.3695$. Once "Calculate" button is clicked, the $tc = 14$ has appeared. **(iii)** The updated relationship between the temperature over time is displayed

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