



اَبُو سَيِّدِي تَكْوَلُ لِي مَا اَنَا  
UNIVERSITI  
TEKNOLOGI  
MARA



# PROCEEDINGS OF JOHOR INTERNATIONAL INNOVATION INVENTION COMPETITION AND SYMPOSIUM 2024 (JIIICaS 2024)



*"Flourish and Nurturing Sustainable  
Innovation for a Prosperous Nation"*

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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-PP017) MODELLING AND ANALYSIS OF A MIXTURE PROBLEM USING FIRST-ORDER DIFFERENTIAL EQUATIONS**

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### **ABSTRACT**

Mixture problems are general in various scientific and engineering disciplines, providing critical insights into how substances interact within dynamic systems. This study focuses on a classical scenario where salt concentration in a tank is influenced by the continuous inflow of brine and simultaneous outflow of the mixture. The system is modelled using first-order differential equations, which allow for the analysis of how the salt concentration evolves over time. Through analytical solutions and simulations, this study reveals the transient and steady-state behaviors of the system, highlighting the practical utility of differential equations in solving complex real-world problems. It will contribute to a deeper understanding of the dynamics involved in mixture processes, with implications for fields such as environmental engineering and chemical process control.

Keywords: first-order differential equations, mixture problem, rate of change

### **1.0 INTRODUCTION**

In numerous applications, understanding the dynamics of substances as they mix and react within a system is crucial. A typical problem involves a tank where a solution containing dissolved substances is mixed with an incoming solution at a constant rate, while an equivalent amount is simultaneously removed. Such processes can be accurately described by first-order differential equations. This study aims to explore the mathematical modelling of a mixture problem, focusing on the behavior of salt concentration in a tank. By the differential equation in this system, can produce detailed insights into how the concentration varies, thereby offering practical solutions for real-world engineering and scientific challenges.

### **1.1 PROBLEM STATEMENT**

A major problem is determining the salt content in a tank over time when a well-mixed solution is removed at the same rate as a brine solution is introduced at a steady pace. Conventional approaches to this problem's solution may be complicated and may not offer intuitive understandings of the behaviour of the system. To better understand how the salt concentration changes over time, a methodical approach to modelling and solving the differential equation driving this process is therefore required.

## 2.0 OBJECTIVE

The primary objectives of this study are:

- To develop a mathematical model using first-order linear differential equations to describe the behavior of solute or reactant concentration in a mixture.
- To solve the differential equation analytically and predict the concentration of the solute or reactant over time.
- To analyze the resulting solution to understand the transient and steady-state behavior of the salt concentration in the tank.

## 3.0 METHODOLOGY

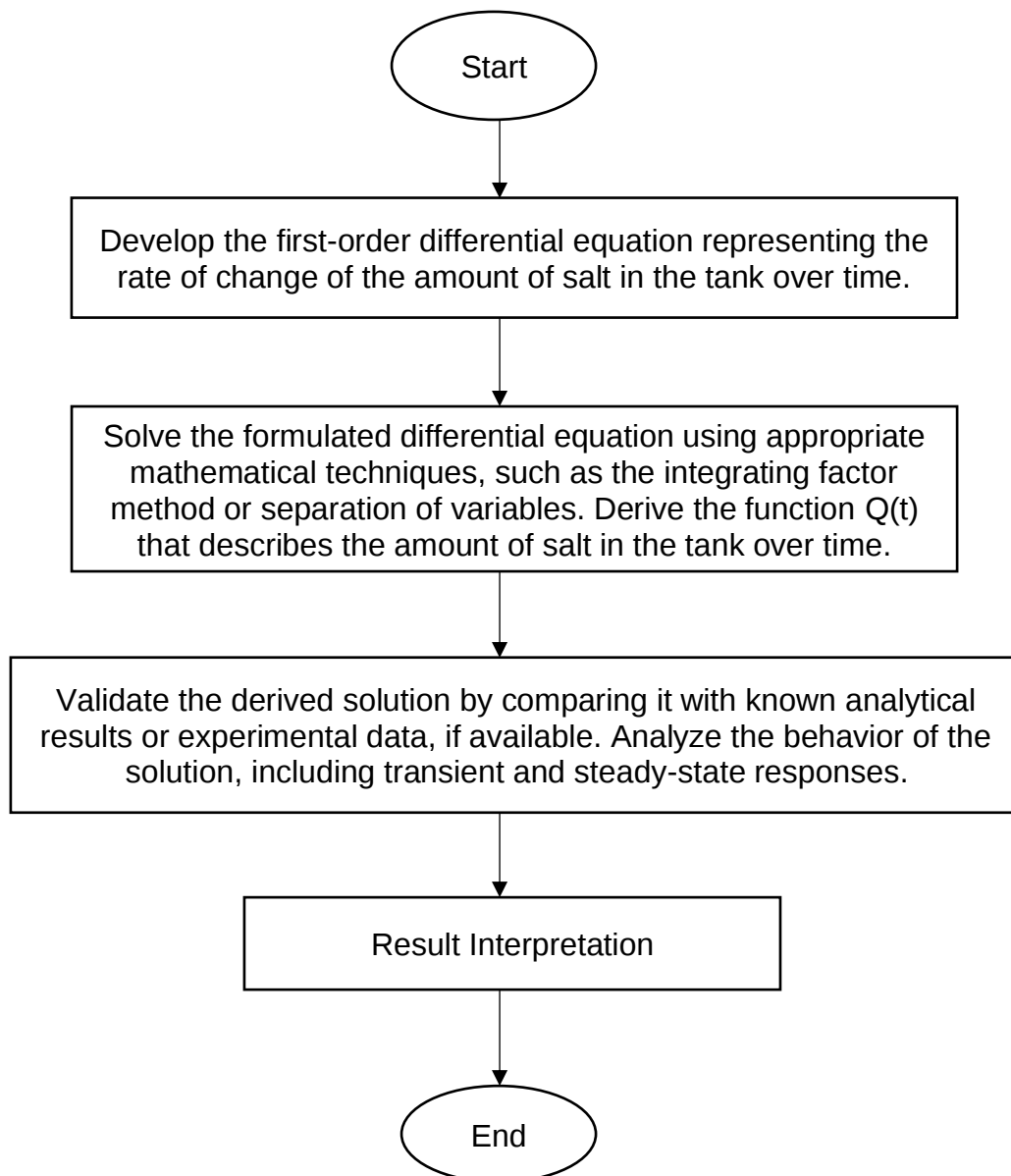
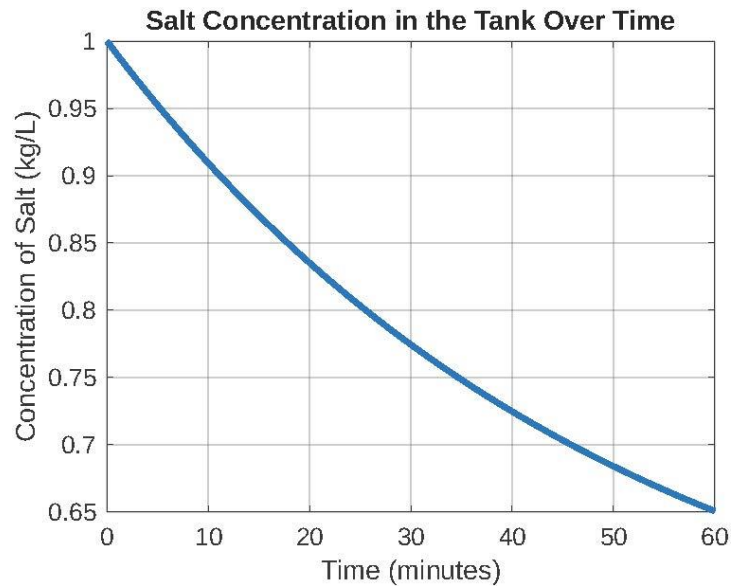


Figure 1: The methodology framework of study.

Figure 1 shows the study involves defining the initial conditions and system parameters for the mixture problem, formulating a first-order linear differential equation to model the rate of change of salt in the tank, and solving the equation using MATLAB. The

solution is then simulated and analyzed over time, and the results are plotted to visualize the behavior of the salt concentration, providing insights into the dynamic system's steady-state or decay behavior.

#### 4.0 RESULTS



The results demonstrate the salt concentration  $C(t)$  in the tank over time, described by the differential equation  $\frac{dC(t)}{dt} = \frac{r_{in} \cdot C_{in} - r_{out} \cdot C(t)}{V_0}$ , where  $r_{in}$  and  $r_{out}$  are the inflow and outflow rates,  $C_{in}$  is the concentration of the inflow brine, and  $V_0$  is the tank volume. The analytical solution  $C(t) = C_{in} + (C_0 - C_{in})e^{-\frac{r_{out}}{V_0}t}$  reveals that the concentration, initially at 1 kg/L, decreases and asymptotically approaches the inflow concentration of 0.5 kg/L. This trend confirms the system's gradual equilibrium and validates the differential equation model, effectively illustrating how the concentration evolves to a steady state over time.

#### 5.0 CONCLUSION

This study provides a comprehensive analysis of a classic mixture problem using first-order differential equations. By modeling the dynamics of the system and solving the differential equation, we gain insights into the transient and steady-state behavior of the salt concentration in the tank. The simulation results confirm the theoretical predictions and demonstrate the practical applications of differential equations in real-world scenarios, such as in environmental engineering and process control.

#### 6.0 BENEFIT OF STUDY

- This study provides a practical application of first-order differential equations, deepen their understanding of how these mathematical tools can model and solve real-world dynamic systems.
- By modeling the mixture problem, this study offers valuable insights into the behavior of solutions in systems where substances are mixed.

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