**NUMERICAL METHODS FOR SOLVING ODEs**

**A SEMINAR 2 PRESENTATION**

**BY**

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**(MATRIC NUMBER: 20183037)**

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**IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE DEGREE IN MATHEMATICS,**

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# CERTIFICATION

This is to certify that this report was undertaken and submitted by **KAREEM SAMSON ADEBAYO** with matriculation number **20183037**, a student of the department ofMathematics, College of Physical Sciences, Federal University of Agriculture, Abeokuta, for SEMINAR 2.

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# INTRODUCTION

## 1.1 Introduction

## 1.2 Preliminaries and Definitions of Terms

## 1.3 Literature Review

Numerical methods for solving ordinary differential equations (ODEs) have been extensively studied and developed over the years, contributing to advancements in various scientific and engineering fields. This literature review section aims to provide an overview of key contributions, methodologies, and advancements in the field of numerical ODE solving.

* One of the earliest and most basic numerical methods is Euler's method, introduced by **Leonhard Euler** in the 18th century. Euler's method approximates the solution of an ODE by iteratively computing small time steps based on the derivative at each step. While Euler's method is straightforward to implement, it suffers from significant truncation errors, especially for stiff systems or when the step size is large.
* To address the limitations of Euler's method, numerous higher-order methods have been developed, among which the Runge-Kutta (RK) methods have gained significant popularity. The classic fourth-order Runge-Kutta method, introduced by **Carl Runge** and **Martin Kutta**, provides improved accuracy and stability by using weighted averages of derivatives at multiple intermediate points within each step. Higher-order RK methods, such as the fifth and eighth order, offer further improvements in accuracy but at the expense of additional computational complexity.
* Finite difference methods have also played a significant role in numerical ODE solving. These methods discretize the derivatives in the ODEs using difference approximations. The forward, backward, and central difference approximations are commonly used to approximate the first derivative, while higher-order finite difference schemes, such as the second and fourth order, provide improved accuracy. Finite difference methods offer simplicity and ease of implementation, making them popular for a wide range of applications.
* To ensure accurate and efficient numerical ODE solving, adaptive step size control techniques have been developed. These methods dynamically adjust the step size based on error estimates, aiming to achieve a desired level of accuracy while minimizing computational effort. Adaptive step size control algorithms, such as the embedded Runge-Kutta methods, provide the flexibility to automatically adjust the step size depending on the solution characteristics and error tolerance.
* Boundary value problems (BVPs) pose unique challenges in numerical ODE solving, as they involve finding solutions that satisfy specific conditions at both ends of the interval. Shooting methods are commonly employed to solve BVPs by transforming them into initial value problems. In shooting methods, the BVP is transformed into an optimization problem, where the initial conditions are adjusted iteratively until the desired boundary conditions are met.
* Advancements in computer technology and software tools have greatly facilitated the implementation and application of numerical methods for ODE solving. Software packages such as MATLAB, Python libraries (e.g., SciPy), and specialized ODE solvers offer efficient and user-friendly environments for numerical ODE solving. These tools provide a wide range of algorithms and functionalities, allowing researchers and practitioners to tackle complex problems with ease.

In conclusion, the field of numerical methods for solving ODEs has seen significant progress over the years. From basic methods like Euler's method to advanced techniques such as Runge-Kutta methods, finite difference methods, adaptive step size control, and shooting methods for BVPs, researchers have developed a rich toolbox of numerical methods to tackle diverse ODE problems. The continued advancements in computer technology and software tools have further enhanced the efficiency and accessibility of numerical ODE solving, enabling scientists and engineers to study complex dynamic systems and make informed decisions based on accurate numerical approximations.

## 1.4 Motivation of Study

## 1.5 Objectives

# DISCUSSION

# CONCLUSION AND RECOMMENDATION

## 3.1 Conclusion

## 3.2 Recommendation

References

* Stoer, J., & Bulirsch, R. (2002). Introduction to Numerical Analysis (3rd ed.). Springer-Verlag.
* Burden, R. L., & Faires, J. D. (2010). Numerical Analysis (9th ed.). Cengage Learning.
* Hairer, E., Norsett, S., & Wanner, G. (1993). Solving Ordinary Differential Equations I: Nonstiff Problems (2nd ed.). Springer-Verlag.
* Lambert, J. D. (1973). Computational methods in ordinary differential equations. Wiley.
* Quarteroni, A., Sacco, R., & Saleri, F. (2006). Numerical Mathematics (2nd ed.). Springer-Verlag.