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SOLVING LINEAR HOMOGENEOUS ONE-DIMENSIONAL WAVE EQUATION USING ADOMIAN DECOMPOSITION METHOD

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii

TABLE OF CONTENTS iii

LIST OF FIGURES v

LIST OF TABLES vi

ABSTRACT vii

1 INTRODUCTION 1

1.1 Research Backgroud 2

1.2 Problem Statement 3

1.3 Research Objective 3

1.4 Significant Of Project 4

1.5 Scope Of Project 4

2 LITERATURE REVIEW 5

3 METHODOLOGY 8

3.1 Wave Equation 8

3.2 Solve The Boundary Value Problem of Wave Equation using d'Alembert's Method 9

3.3 Solve The Boundary Value Problem of Wave Equation using Adomian Decomposition Method (ADM) 11

4 IMPLEMENTATION 14

4.1 Example 1 14

4.2 Example 2 17

ABSTRACT

In this paper, the linear homogeneous one-dimensional wave equation is solved using different approaches which are d'Alembert's formula and Adomian Decomposition Method (ADM). The purpose of using different methods is to test the efficiency and accuracy of the Adomian decomposition method in solving the linear homogeneous one-dimensional wave equation. The analytical value and numerical value are obtained by applying d'Alembert's formula and Adomian decomposition method respectively. The Dirichlet problem was chosen, as well as a variation of initial conditions for the linear homogeneous one-dimensional wave equation. Several examples have been provided to illustrate the graphical plots and numerical results. The numerical solution is derived by considering only the first four terms of the decomposition. All graphical plots are computed by using Maple 2015 software while absolute error between both methods is calculated by using Microsoft Excel. The error will reflect how well the ADM performs in getting high precision approximation answers. As for the results, there is no difference between both methods since it is proven that the absolute errors for all examples are equal to zero. Hence, ADM has high accuracy and can obtain the closed solution to the analytical value efficiently.

1 INTRODUCTION

The wave equation is a non-trivial partial differential equation that appears to exist in multiple locations at the same time. One of the most prevalent physical phenomena encountered in everyday life is wave propagation. Waves are most commonly detected through sight and hearing, as well as telecommunication, radar, and medical imaging. A wave is a disturbance that travels through a medium. The wave equation is satisfied by waves and this paper is limited to linear homogeneous one-dimensional space only. This paper will use d'Alembert's method to get the analytical solutions, and then will apply the Adomian decomposition method for the numerical solutions.

Hajrulla & Demir (2022) states that d'Alembert's method provides a solution to the linear homogeneous one-dimensional wave equation where this method is commonly employed on sound vibrations on surfaces and string vibrations. D'Alembert's method has various applications, including sound wave vibrations, elastic waves, seismic waves, and water waves, but this paper only focused on one-dimensional wave solutions. To get the solutions, the initial condition of the wave equation will be filled in into the d'Alembert's formula as stated in the methodology section.

According to Kasumo (2019), the Adomian Decomposition Method or (ADM) shortly is a famous systematic technique for solving practical problems involving linear or non-linear, deterministic or stochastic operator equations, such as ordinary differential equations (ODEs), partial differential equations (PDEs), integral equations, integro-differential equations, and so on. The ADM's efficiency in solving these many types of equations is widely recognised. The ADM is an excellent method because it presents the answer as an infinite series in which each term is easily determined. The approach computes a rapidly convergent series solution with high accuracy.

This study focuses on solving the linear homogeneous one-dimensional wave equation by