

Application to Differential Transform Method for MHD Fluid Flow and Heat Transfer

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Abstract: Present study reveals the flow of a classical non-Newtonian fluid based on the Williamson model through a vertical flat plate. The free convective flow is generated because of the effect of buoyancy relating to the temperature. In addition to that, the influence of thermal radiation and heat source/sink in conjunction with the dissipative heat enhances the efficiency of transport phenomenon within the bounding surface. Well-proposed similarity transformation is used to transform the governing equation into ordinary. However, due to the dissipation, the nonlinear coupled problems are complex. For the solution, a semi-analytical approach such as differential transformation method (DTM) in association with the Padé approximant method is used instead of traditional numerical technique. Padé-approximant is useful to get a non-iterative solution without imposing the missing boundary conditions. It is a simple and effective way to determine the solutions of complex nonlinear problems with assumed boundary conditions at infinity. The physical significance of all the contributing parameters distinguished the flow properties are achieved and accessible graphically. Moreover, the validation of the present methodology with the traditional numerical technique is obtained, showing an excellent correlation in particular cases.

Keywords: Williamson model; Free convection; thermal radiation; Heat transfer; DTM-Padé method

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1. Introduction

Body forces on fluid create natural convection flow problems that are frequently come across in fluid engineering. Such natural convection problems may be taken as convection flow about a plane surface, kept along the direction of the force. One of the cases was analyzed by Schmidt and Beckmann [1], considering the convection of air through a vertical surface in the existence of the earth's gravitational field. The impact of the magnetic field upon an electro-conductive fluid affecting the natural convection is generally experienced in aerospace engineering, design of nuclear reactors, and so many engineering applications. The heat transport phenomena of an electro-conductive non-Newtonian liquid through the surface via the interaction of magnetic field is analyzed by Mishra *et al.* [2]. Considering the impact of reacting species and non-uniformity in heat sources, they found that the applied magnetic field

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Table of Contents Application Of Differential Transform Method To The

1. Understanding the eBook Application Of Differential Transform Method To The
 - The Rise of Digital Reading Application Of Differential Transform Method To The
 - Advantages of eBooks Over Traditional Books
2. Identifying Application Of Differential Transform Method To The
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Application Of Differential Transform Method To The
 - User-Friendly Interface
4. Exploring eBook Recommendations from Application Of Differential Transform Method To The
 - Personalized Recommendations
 - Application Of Differential Transform Method To The User Reviews and Ratings
 - Application Of Differential Transform Method To The and Bestseller Lists
5. Accessing Application Of Differential Transform Method To The Free and Paid eBooks
 - Application Of Differential Transform Method To The Public Domain eBooks
 - Application Of Differential Transform Method To The eBook Subscription Services
 - Application Of Differential Transform Method To The Budget-Friendly Options

6. Navigating Application Of Differential Transform Method To The eBook Formats
 - ePub, PDF, MOBI, and More
 - Application Of Differential Transform Method To The Compatibility with Devices
 - Application Of Differential Transform Method To The Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Application Of Differential Transform Method To The
 - Highlighting and Note-Taking Application Of Differential Transform Method To The
 - Interactive Elements Application Of Differential Transform Method To The
8. Staying Engaged with Application Of Differential Transform Method To The
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Application Of Differential Transform Method To The
9. Balancing eBooks and Physical Books Application Of Differential Transform Method To The
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Application Of Differential Transform Method To The
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Application Of Differential Transform Method To The
 - Setting Reading Goals Application Of Differential Transform Method To The
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Application Of Differential Transform Method To The
 - Fact-Checking eBook Content of Application Of Differential Transform Method To The
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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