# Maple Code For Homotopy Analysis Method

Beyond PerturbationHomotopy Analysis Method in Nonlinear Differential EquationsAdvances In The Homotopy Analysis MethodHomotopy-Based Methods in Water EngineeringModified Homotopy Analysis MethodSolving Nonlinear Boundary Value Problems Using the Homotopy Analysis MethodModifications of Homotopy Analysis Method for Differential EquationsNotes on the Solution of Certain Functional Equations Using Homotopy AnalysisIntroduction to Homotopy TheoryNonlinear Flow Phenomena and Homotopy AnalysisModified Homotopy Analysis MethodThe Application of Discrete Homotopy Analysis Method in One-dimensional Thermal ProblemHomotopy Analysis of Algebraic StructuresMVHAMAutomotive and Transportation EngineeringAdvances in Mechatronics and Control EngineeringHomotopy Analysis and Legendre Multi-wavelets Methods for Solving Integral EquationsThe Optimal Homotopy Asymptotic MethodAcoustics & Vibration of Mechanical StructuresSeries Solution for Solving Integral Equations by Homotopy Analysis Method Shijun Liao Shijun Liao Shijun Liao Manotosh Kumbhakar Ahmad El-Ajou Ghada Ayed Janem A. K. Alomari Rob Shorten Aneta Hajek Kuppalapalle Vajravelu Ahmad Mohammad El-Ajou Qian Fen Ooi Ravi Divyanshu Jain Ilie Dumitru Yun Hae Kim Saeed Vahdati Vasile Marinca Nicolae Herisanu Eman Mohamed A. Abu jarad

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solving nonlinear problems is inherently difficult and the stronger the nonlinearity the more intractable solutions become analytic approximations often break down as

nonlinearity becomes strong and even perturbation approximations are valid only for problems with weak nonlinearity this book introduces a powerful new analytic method for nonlinear problems homotopy analysis that remains valid even with strong nonlinearity in part i the author starts with a very simple example then presents the basic ideas detailed procedures and the advantages and limitations of homotopy analysis part ii illustrates the application of homotopy analysis to many interesting nonlinear problems these range from simple bifurcations of a nonlinear boundary value problem to the thomas fermi atom model volterra s population model von karman swirling viscous flow and nonlinear progressive waves in deep water although the homotopy analysis method has been verified in a number of prestigious journals it has yet to be fully detailed in book form written by a pioneer in its development beyond pertubation introduction to the homotopy analysis method is your first opportunity to explore the details of this valuable new approach add it to your analytic toolbox and perhaps make contributions to some of the questions that remain open

homotopy analysis method in nonlinear differential equations presents the latest developments and applications of the analytic approximation method for highly nonlinear problems namely the homotopy analysis method ham unlike perturbation methods the ham has nothing to do with small large physical parameters in addition it provides great freedom to choose the equation type of linear sub problems and the base functions of a solution above all it provides a convenient way to guarantee the convergence of a solution this book consists of three parts part i provides its basic ideas and theoretical development part ii presents the ham based mathematica package bvph 1 0 for nonlinear boundary value problems and its applications part iii shows the validity of the ham for nonlinear pdes such as the american put option and resonance criterion of nonlinear travelling waves new solutions to a number of nonlinear problems are presented illustrating the originality of the ham mathematica codes are freely available online to make it easy for readers to understand and use the ham this book is suitable for researchers and postgraduates in applied mathematics physics nonlinear mechanics finance and engineering dr shijun liao a distinguished professor of shanghai jiao tong university is a pioneer of the ham

unlike other analytic techniques the homotopy analysis method ham is independent of small large physical parameters besides it provides great freedom to choose equation type and solution expression of related linear high order approximation equations the ham provides a simple way to guarantee the convergence of solution series such uniqueness differentiates the ham from all other analytic approximation methods in addition the ham can be applied to solve some challenging problems with high nonlinearity this book edited by the pioneer and founder of the ham describes the current advances of this powerful analytic approximation method for highly nonlinear problems coming from different countries and fields of research the authors of each chapter are top experts in the ham and its applications

most complex physical phenomena can be described by nonlinear equations specifically differential equations in water engineering nonlinear differential equations play a vital role in modeling physical processes analytical solutions to strong nonlinear problems are not easily tractable and existing techniques are problem specific and applicable for specific types of equations exploring the concept of homotopy from topology different kinds of homotopy based methods have been proposed for analytically

solving nonlinear differential equations given by approximate series solutions homotopy based methods in water engineering attempts to present the wide applicability of these methods to water engineering problems it solves all kinds of nonlinear equations namely algebraic transcendental equations ordinary differential equations odes systems of odes partial differential equations pdes systems of pdes and integro differential equations using the homotopy based methods the content of the book deals with some selected problems of hydraulics of open channel flow with or without sediment transport groundwater hydrology surface water hydrology general burger s equation and water quality features provides analytical treatments to some key problems in water engineering describes the applicability of homotopy based methods for solving nonlinear equations particularly differential equations compares different approaches in dealing with issues of nonlinearity

we present a modification of an analytic technique namely the homotopy analysis method ham to obtain symbolic approximate solutions for linear and nonlinear differential equations of fractional order this method was applied to three examples a fractional oscillation equation a fractional riccati equation and a fractional lane emden equation which were presented as fractional initial value problems fivps we extend this modification to provide approximate solutions of linear and nonlinear fractional boundary value problems fbvps four examples are tested using the extended approach also four physical problems are solved using the modification of the ham the ham is a strong and easy to use analytic tool for nonlinear problems and does not need small large parameters in the equations comparison of the results with those of adomian decomposition method adm variational iteration method vim and homotopy perturbation method hpm has led us to significant consequences the obtained results show that the present method is very effective and convenient in solving nonlinear cases and the adm vim and hpm are special cases of the ham

analytical solutions of differential equations are very important for all researchers from different discipline obtaining such solutions is difficult in most cases especially if the differential equation is nonlinear one of the mostly used methods are the series methods where the solution is represented as an infinite series different methods are available to evaluate the terms of this series these methods include the well known taylor series method the adomian decomposition method the homotopy iteration method and the homotopy analysis method in this thesis we give a survey of the different series methods available to solve initial and boundary value problems the methods to be presented are the taylor series method the adomina decomposition method and the homotopy analysis method the main features of each method will be presented and the error analysis will be discussed as well for the homotopy analysis method the error is controlled by introducing the parameter known as ħ then the error is controlled by monitoring the value of the solution at a specific point for different values of ħ this produces what is known as the ħ curve the mathematical foundation of this method is not very well established and the method will not work at all times the error for the taylor series and the adomian decomposition method is controlled by adding more terms to the series solution which might be costly and difficult to calculate especially if the differential equation is nonlinear in this study we will show that the error can be controlled by other means a modified taylor series method has been developed and will be discussed the method is based on controlling the error through different choices of the point

of expansion the mathematical foundation of the method and application of the method to differential equations with singularities and eigenvalue problems will be presented

this book bring new solutions for various types of differential equations approximate analytic solution was obtained for system of differential equations specially that has chaotic behavior delay differential equations schrodinger and coupled schrodinger equation fractional differential equations differential algebraic equations and some other fluid mechanic models accurate and simple solution was presented via several modifications for homotopy analysis method

homotopy theory which is the main part of algebraic topology studies topological objects up to homotopy equivalence homotopy equivalence is weaker relations than topological equivalence i e homotopy classes of spaces are larger than homeomorphism classes even though the ultimate goal of topology is to classify various classes of topological spaces up to a homeomorphism in algebraic topology homotopy equivalence plays a more important role than homeomorphism essentially because the basic tools of algebraic topology homology and homotopy groups are invariant with respect to homotopy equivalence and do not distinguish topologically nonequivalent but homotopic objects the idea of homotopy can be turned into a formal category of category theory the homotopy category is the category whose objects are topological spaces and whose morphisms are homotopy equivalence classes of continuous maps two topological spaces x and y are isomorphic in this category if and only if they are homotopy equivalent then a functor on the category of topological spaces is homotopy invariant if it can be expressed as a functor on the homotopy category based on the concept of the homotopy computation methods for algebraic and differential equations have been developed the methods for algebraic equations include the homotopy continuation method and the continuation method the methods for differential equations include the homotopy analysis method in practice there are technical difficulties in using homotopies with certain spaces algebraic topologists work with compactly generated spaces cw complexes or spectra this book deals with homotopy theory one of the main branches of algebraic topology

since most of the problems arising in science and engineering are nonlinear they are inherently difficult to solve traditional analytical approximations are valid only for weakly nonlinear problems and often fail when used for problems with strong nonlinearity nonlinear flow phenomena and homotopy analysis fluid flow and heat transfer presents the current theoretical developments of the analytical method of homotopy analysis this book not only addresses the theoretical framework for the method but also gives a number of examples of nonlinear problems that have been solved by means of the homotopy analysis method the particular focus lies on fluid flow problems governed by nonlinear differential equations this book is intended for researchers in applied mathematics physics mechanics and engineering both kuppalapalle vajravelu and robert a van gorder work at the university of central florida usa

most real world systems including analog electronic circuits express themselves formally as a set of nonlinear differential algebraic equations such systems are typically

modeled in languages such as vhdl ams as applications grow the size and complexity of these equations also increases achieving convergence in an efficient manner in these situations has become a real challenge additional demands such as the desire to find multiple solutions from a single starting point force us to explore alternatives to the traditional method used for finding linear approximations of nonlinear algebraic equations the newton raphson nr method homotopy methods provide theoretical promise of global convergence 55 the homotopy analysis method ham 12 is a recently proposed and promising method based on homotopy theory this thesis presents an efficient iterative numerical algorithm based on ham for the solution of a multivariate system of nonlinear algebraic equations mvham the proposed method is experimentally characterized according to a set of determined parameters which affect the system the experimental results highlight the potential and limitations of the new method and imply directions for future work the method can handle most types of algebraic equations is accurate and simple and integrates well into the direct method of circuit simulation it is shown to have significant advantages over the traditional newton raphson method in terms of flexibility convergence ability to find multiple solutions and possibly speed mvham is also shown to exhibit significantly improved convergence performance in comparison with the classical homotopy theory

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this book emphasizes in detail the applicability of the optimal homotopy asymptotic method to various engineering problems it is a continuation of the book nonlinear dynamical systems in engineering some approximate approaches published at springer in 2011 and it contains a great amount of practical models from various fields of engineering such as classical and fluid mechanics thermodynamics nonlinear oscillations electrical machines and so on the main structure of the book consists of 5 chapters the first chapter is introductory while the second chapter is devoted to a short history of the development of homotopy methods including the basic ideas of the optimal homotopy asymptotic method the last three chapters from chapter 3 to chapter 5 are introducing three distinct alternatives of the optimal homotopy asymptotic method with illustrative applications to nonlinear dynamical systems the third chapter deals with the first alternative of our approach with two iterations five applications are presented from fluid mechanics and nonlinear oscillations the chapter 4 presents the optimal homotopy asymptotic method with a single iteration and solving the linear equation on the first approximation here are treated 32 models from different fields of engineering such as fluid mechanics thermodynamics nonlinear damped and undamped oscillations electrical machines and even from physics and biology the last chapter is devoted to the optimal homotopy asymptotic method with a single iteration but without solving the equation in the first approximation

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