Approximate Analytical Solution Of The Boussinesq Equation

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CRAWFORD DEANNA

Energy Density Functional Theory of Many-Electron Systems Springer Science & Business Media
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.

Numerical Analysis of the Pullout Problem of a Fiber Embedded in a Matrix Academic Press

Modeling and Analysis of Modern Fluids helps researchers solve physical problems observed in fluid dynamics and related fields, such as heat and mass transfer, boundary layer phenomena, and numerical heat transfer. These problems are characterized by nonlinearity and large system dimensionality, and ‘exact’ solutions are impossible to provide using the conventional mixture of theoretical and analytical analysis with purely numerical methods. To solve these complex problems, this work provides a toolkit of established and novel methods drawn from the literature across nonlinear approximation theory. It covers Padé approximation theory, embedded-parameters perturbation, Adomian decomposition, homotopy analysis, modified differential transformation, fractal theory, fractional calculus, fractional differential equations, as well as classical numerical techniques for solving nonlinear partial differential equations. In addition, 3D modeling and analysis are also covered in-depth. Systematically describes powerful approximation methods to solve nonlinear equations in fluid problems Includes novel developments in fractional order differential equations with fractal theory applied to fluids Features new methods, including Homotypy Approximation, embedded-parameter perturbation, and 3D models and analysis

Mathematical Models in Biology, Chemistry and Population Genetics CRC Press

The material presented here corresponds to Fermi lectures that I was invited to deliver at the Scuola Normale di Pisa in the spring of 1998. The obstacle problem consists in studying the properties of minimizers of the Dirichlet integral in a domain D of Rn, among all those configurations u with prescribed boundary values and costrained to remain in D above a prescribed obstacle F. In the Hilbert space H1(D) of all those functions with square integrable gradient, we consider the closed convex set K of functions u with fixed boundary value and which are greater than F in D. There is a unique point in K minimizing the Dirichlet integral. That is called the solution to the obstacle problem.

Strongly Nonlinear Oscillators CRC Press

An approximate method of the integral type is developed for computing heat transfer and shear stress in similarity boundary-layer problems of single fluids with variable fluid properties. It is applied to flat-plate, stagnationpoint, and shock-tube end-wall geometries. Simple analytical formulas are developed involving integrals over the fluid properties. When the corrected formulas are compared with exact solutions for power-law or combination-of-power-law fluid properties, agreement is found to within 3 to 5% for heat transfer rate and 4 to 8% for shear stress. These simple and accurate formulas may be used as correlation formulas for engineering estimates of heating and shear, or as guesses for starting the usual iterative procedure of exact solution of the similarity boundary layer equations. It is shown that a simple relation exists between the heat transfer in the stagnation-point and end-wall cases, enabling bounds on the stagnationpoint heat transfer rate to be found from calculations for the simple end-wall geometry. (Author).

Analytical Solution Methods for Boundary Value Problems Butterworth-Heinemann

This book is planned to introduce the advances topics of plasma physics for research scholars and postgraduate students. This book deals with basic concepts in plasma physics, non-equilibrium plasma modeling, space plasma applications, and plasma diagnostics. It also provides an overview of the linear and nonlinear aspects of plasma physics. Chapters cover such topics as plasma application in space propulsion, microwave–plasma interaction, plasma antennas, solitary waves, and plasma diagnostic techniques.

On the Use of Approximate Analytical Solutions in Solving Optimum Trajectory Problems Springer

Analytical Solutions for Extremal Space Trajectories presents an overall treatment of the general optimal control problem, in particular, the Mayer's variational problem, with necessary and sufficient conditions of optimality. It also provides a detailed derivation of the analytical solutions of these problems for thrust arcs for the Newtonian, linear central and uniform gravitational fields. These solutions are then used to analytically synthesize the extremal and optimal trajectories for the design of various orbital transfer and powered descent and landing maneuvers. Many numerical examples utilizing the proposed analytical synthesis of the space trajectories and comparison analyses with numerically integrated solutions are provided. This book will be helpful for engineers and researchers of industrial and government organizations, and is also a great resource for university faculty and graduate and undergraduate students working, specializing or majoring in the fields of aerospace engineering, applied celestial mechanics, and guidance, navigation and control technologies, applied mathematics and analytical dynamics, and avionics software design and development. Features an analyses of Pontryagin extremals and/or Pontryagin minimum in the context of space trajectory design Presents the general methodology of an analytical synthesis of the extremal and optimal trajectories for the design of various orbital transfer and powered descent and landing maneuvers Assists in developing the optimal control theory for applications in aerospace technology and space mission design

Handbook of Differential Equations Academic Press

Fluid and flow problems in porous media have attracted the attention of industrialists, engineers and scientists from varying disciplines, such as chemical, environmental, and mechanical engineering, geothermal physics and food science. There has been a increasing interest in heat and fluid flows through porous media, making this book a timely and appropriate resource. Each chapter is systematically detailed to be easily grasped by a research worker with basic knowledge of fluid mechanics, heat transfer and computational and experimental methods. At the same time, the readers will be informed of the most recent research literature in the field, giving it dual usage as both a post-grad text book and professional reference. Written by the recent directors of the NATO Advanced Study Institute session on 'Emerging Technologies and Techniques in Porous Media' (June 2003), this book is a timely and essential reference for scientists and engineers within a variety of fields.

Comparison with an Approximate Analytical Solution CRC Press

This volume emphasises studies related to classical Stefan problems. The term "Stefan problem" is generally used for heat transfer problems with phase-changes such as from the liquid to the solid. Stefan problems have some characteristics that are typical of them, but certain problems arising in fields such as mathematical physics and engineering also exhibit characteristics similar to them. The term ``classical" distinguishes the formulation of these problems from their weak formulation, in which the solution need not possess classical derivatives. Under suitable assumptions, a weak solution could be as good as a classical solution. In hyperbolic Stefan problems, the characteristic features of Stefan problems are present but unlike in Stefan problems, discontinuous solutions are allowed because of the hyperbolic nature of the heat equation. The numerical solutions of inverse Stefan problems, and the analysis of direct Stefan problems are so integrated that it is difficult to discuss one without referring to the other. So no strict line of demarcation can be identified between a classical Stefan problem and other similar problems. On the other hand, including every related problem in the domain of classical Stefan problem would require several volumes for their description. A suitable compromise has to be made. The basic concepts, modelling, and analysis of the classical Stefan problems have been extensively investigated and there seems to be a need to report the results at one place. This book attempts to answer that need.

Transport Phenomena in Porous Media III Edizioni della Normale

This book provides the presentation of the motion of pure nonlinear oscillatory systems and various solution procedures which give the approximate solutions of the strong nonlinear oscillator equations. The book presents the original author’s method for the analytical solution procedure of the pure nonlinear oscillator system. After an introduction, the physical explanation of the pure nonlinearity and of the pure nonlinear oscillator is given. The analytical solution for free and forced vibrations of the one-degree-of-freedom strong nonlinear system with constant and time variable parameter is considered. Special attention is given to the one and two mass oscillatory systems with two-degrees-of-freedom. The criteria for the deterministic chaos in ideal and non-ideal pure nonlinear oscillators are derived analytically. The method for suppressing chaos is developed. Important problems are discussed in didactic exercises. The book is self-consistent and suitable as a textbook for students and also for professionals and engineers who apply these techniques to the field of nonlinear oscillations.

Analytical Study of the Tumbling Motions of Vehicles Entering Planetary Atmospheres An Approximate Analytical Solution of the Reynolds EquationApproximate Analytical Methods for Solving Ordinary Differential Equations

In this paper we show that the linear transport equation may be solved exactly for the primary auroral electron flux in plane-parallel geometry in the forward scattering and average, discrete,

energy-loss approximations. In this approximation inelastic scattering is taken into account but elastic scattering drops out and the solution is an approximation to the flux in the downward hemisphere. Using the multiple scattering method, we obtain the solution as a finite sum of analytic functions of altitude, energy, and pitch angle where each term is multiplied by the energy shifted electron flux incident at the top of the auroral ionosphere. Closed form expressions are also found for the hemispherically averaged primary electron flux, the energy deposition rate, and the ionization rate. For a unidirectional incident flux we show that the energy deposition rate is a superposition of generalized Chapman functions of altitude, and for an isotropic incident flux we show that the energy deposition rate is a superposition of generalized J functions of altitude. The notion of pseudoparticles is discussed and used to approximate the sums which occur in the above formulae. We also compare our analytic approximations to some numerical solutions of the problem.
Analytical Solution of Transverse Oscillation in Cyclotron Using LP Method BoD – Books on Demand
Approximate analytical solutions were derived for the problem of low thrust propulsion, in the case of constant thrust, set at a constant angle to the velocity vector, for any type of initial orbit (elliptic, parabolic or hyperbolic). Simple expressions were obtained, giving energy, angular momentum and excentricity in terms of the excentric anomaly. The solutions allow for calculation of the fuel consumption. Their validity is restricted to the field of orbit correction. (Author).
An Approximate Analytical Solution to Steady Flow Between Rotating Eccentric Cylinders at Large Reynolds Number John Wiley & Sons
Analytical Solution Methods for Boundary Value Problems is an extensively revised, new English language edition of the original 2011 Russian language work, which provides deep analysis methods and exact solutions for mathematical physicists seeking to model germane linear and nonlinear boundary problems. Current analytical solutions of equations within mathematical physics fail completely to meet boundary conditions of the second and third kind, and are wholly obtained by the defunct theory of series. These solutions are also obtained for linear partial differential equations of the second order. They do not apply to solutions of partial differential equations of the first order and they are incapable of solving nonlinear boundary value problems. Analytical Solution Methods for Boundary Value Problems attempts to resolve this issue, using quasi-linearization methods, operational calculus and spatial variable splitting to identify the exact and approximate analytical solutions of three-dimensional non-linear partial differential equations of the first and second order. The work does so uniquely using all analytical formulas for solving equations of mathematical physics without using the theory of series. Within this work, pertinent solutions of linear and nonlinear boundary problems are stated. On the basis of quasi-linearization, operational calculation and splitting on spatial variables, the exact and approached analytical solutions of the equations are obtained in private derivatives of the first and second order. Conditions of unequivocal resolvability of a nonlinear boundary problem are found and the estimation of speed of convergence of iterative process is given. On an example of trial functions results of comparison of the analytical

solution are given which have been obtained on suggested mathematical technology, with the exact solution of boundary problems and with the numerical solutions on well-known methods. Discusses the theory and analytical methods for many differential equations appropriate for applied and computational mechanics researchers Addresses pertinent boundary problems in mathematical physics achieved without using the theory of series Includes results that can be used to address nonlinear equations in heat conductivity for the solution of conjugate heat transfer problems and the equations of telegraph and nonlinear transport equation Covers select method solutions for applied mathematicians interested in transport equations methods and thermal protection studies Features extensive revisions from the Russian original, with 115+ new pages of new textual content

A Study of Impact in Bridges with Reference to an Approximate Analytical Solution Elsevier

Understanding the nature of electrical excitation of a group of cells is important both in examining the onset of a cardiac arrhythmia and in designing the treatment for sudden cardiac arrest. In the past, several attempts have been made to understand the threshold for the excitation of a one-dimensional chain of cells from a mathematical viewpoint. However, obtaining an analytical solution to describe threshold phenomena has proven to be difficult as the equations in this problem are highly non-linear and resist solution by standard mathematical techniques. Here, we apply a method developed by Neu et al. where the time evolution of the width and amplitude of a pulse is approximately described by a gradient flow on a two-dimensional phase plane. Using this approach, we obtain a mathematical expression that successfully models the excitation threshold for an applied square current pulse in a simplified Fitzhugh-Nagumo system. We then analyze our solution to reveal how the excitation threshold depends on key physiological parameters.

Approximate Analytical Solution for Low Thrust Propulsion in Space Springer Nature

The goal of this book is to discuss fundamentals of electromagnetic wave propagation, especially radiowave propagation, groundwave propagation, surface wave propagation, maritime communication, radar applications in terms of parabolic equation modeling and simulation approaches This is the first book on the guided wave propagation model in nearly two decades. This book will cover several new applications. The book also introduces several simple and sophisticated MATLAB scripts as well as virtual electromagnetic tools for several well-known electromagnetic propagation problems.

Approximate Analytic Solutions for the Primary Auroral Electron Flux and Related Quantities Gulf Professional Publishing

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.

Introduction to the Homotopy Analysis Method Springer Science & Business Media

The Adomian decomposition method enables the accurate and efficient analytic solution of nonlinear ordinary or partial differential equations without the need to resort to linearization or perturbation approaches. It unifies the treatment of linear and nonlinear, ordinary or partial differential equations, or systems of such equations, into a single basic method, which is applicable to both initial and boundary-value problems. This volume deals with the application of this method to many problems of physics, including some frontier problems which have previously required much more computationally-intensive approaches. The opening chapters deal with various fundamental aspects of the decomposition method. Subsequent chapters deal with the application of the method to nonlinear oscillatory systems in physics, the Duffing equation, boundary-value problems with closed irregular contours or surfaces, and other frontier areas. The potential application of this method to a wide range of problems in diverse disciplines such as biology, hydrology, semiconductor physics, wave propagation, etc., is highlighted. For researchers and graduate students of physics, applied mathematics and engineering, whose work involves mathematical modelling and the quantitative solution of systems of equations.

Non-perturbative Approximate Analytical Solution in Pseudotime for Pressure Drawdown in a Gas Reservoir Springer Science & Business Media

The emphasis throughout the present volume is on the practical application of theoretical mathematical models helping to unravel the underlying mechanisms involved in processes from mathematical physics and biosciences. It has been conceived as a unique collection of abstract methods dealing especially with nonlinear partial differential equations (either stationary or evolutionary) that are applied to understand concrete processes involving some important applications related to phenomena such as: boundary layer phenomena for viscous fluids, population dynamics,, dead core phenomena, etc. It addresses researchers and post-graduate students working at the interplay between mathematics and other fields of science and technology and is a comprehensive introduction to the theory of nonlinear partial differential equations and its main principles also presents their real-life applications in various contexts: mathematical physics, chemistry, mathematical biology, and population genetics. Based on the authors' original work, this volume provides an overview of the field, with examples suitable for researchers but also for graduate students entering research. The method of presentation appeals to readers with diverse backgrounds in partial differential equations and functional analysis. Each chapter includes detailed heuristic arguments, providing thorough motivation for the material developed later in the text. The content demonstrates in a firm way that partial differential equations can be used to address a large variety of phenomena occurring in and influencing our daily lives. The extensive reference list and index make this book a valuable resource for researchers working in a variety of fields and who are interested in phenomena modeled by nonlinear partial differential equations.

Basic Concepts, Modelling and Analysis Springer

An Approximate Analytical Solution of the Reynolds EquationApproximate Analytical Methods for Solving Ordinary Differential EquationsCRC Press

An Approximate Analytical Solution for the Excitation Threshold in a One-dimensional Fitzhugh-Nagumo System Elsevier

This book is a compilation of the most important and widely applicable methods for evaluating and approximating integrals. It is an indispensable time saver for engineers and scientists needing to evaluate integrals in their work. From the table of contents: - Applications of Integration - Concepts and Definitions - Exact Analytical Methods - Approximate Analytical Methods - Numerical Methods: Concepts - Numerical Methods: Techniques

The Classical Stefan Problem

Abstract: We have carried out an approximate analytical solution to precisely consider the influence of magnetic field on the transverse oscillation of particles in a cyclotron. The differential equations of transverse oscillation are solved from the Lindstedt-Poincare method. After careful deduction, accurate first-order analytic solutions are obtained. The analytical solutions are applied to the magnetic field from an isochronous cyclotron with four spiral sectors. The accuracy of these analytical solutions is verified and confirmed from comparison with a numerical method. Finally, we discussed the transverse oscillation at v 0 = N 2, using the same analytical solution.

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