Approximate Analytical Solution Of The Boussinesq Equation

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).

The objective of this manual is to provide guidance to risk assessors on the use of quantitative toxicokinetic and toxicodynamic data to address interspecies and interindividual differences in dose and concentration-response assessment. Section 1 focuses on the relevance of this guidance in the context of the broader risk assessment paradigm and other initiatives of the International Program on Chemical Safety (IPCS) project on the Harmonization of Approaches to the Assessment of Risk from Exposure to Chemicals. Technical background material is presented in section 2, followed by generic guidance for the development of chemical-specific adjustment factors in section 3 and accompanying summary figures. Illustrative case-studies are included in an Appendix, and a glossary of terms is also provided.--Publisher's description.

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.

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.

An Approximate Analytical Solution of the Reynolds EquationSome Improvements to the Approximate Analytical Solution of the Problem of Laminar Flow Between Permeable and Impermeable WallApproximate Analytic Solutions for the Primary Auroral Electron Flux and Related Quantities

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.

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).

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 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

This monograph presents results of the analytical and numerical modeling of convective heat and mass transfer in different rotating flows caused by (i) system rotation, (ii) swirl flows due to swirl generators, and (iii) surface curvature in turns and bends. Volume forces (i.e. centrifugal and Coriolis forces), which influence the flow pattern, emerge in all of these rotating flows. The main part of this work deals with rotating flows caused by system rotation, which includes several rotating-disk configurations and straight pipes rotating about a parallel axis. Swirl flows are studied in some of the configurations mentioned above. Curvilinear flows are investigated in different geometries of two-pass ribbed and smooth channels with 180° bends. The author demonstrates that the complex phenomena of fluid flow and convective heat transfer in rotating flows can be successfully simulated using not only the universal CFD methodology, but in certain cases by means of the integral methods, self-similar and analytical solutions. The book will be a valuable read for research experts and practitioners in the field of heat and mass transfer.

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.

The book discusses the solutions to nonlinear ordinary differential equations (ODEs) using analytical and numerical approximation methods. Recently, analytical approximation methods have been largely used in solving linear and nonlinear lower-order ODEs. It also discusses using these methods to solve some strong nonlinear ODEs. There are two chapters devoted to solving nonlinear ODEs using numerical methods, as in practice high-dimensional systems of nonlinear ODEs that cannot be solved by analytical approximate methods are common. Moreover, it studies analytical and numerical techniques for the treatment of parameter-depending ODEs. The book explains various methods for solving nonlinear-oscillator and structural-system problems, including the energy balance method, harmonic balance method, amplitude frequency formulation, variational iteration method, homotopy perturbation method, iteration perturbation method, homotopy analysis method, simple and multiple shooting method, and the nonlinear stabilized march method. This book comprehensively investigates various new analytical and numerical approximation

techniques that are used in solving nonlinear-oscillator and structural-system problems. Students often rely on the finite element method to such an extent that on graduation they have little or no knowledge of alternative methods of solving problems. To rectify this, the book introduces several new approximation techniques.
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 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

This book presents the optimal auxiliary functions method and applies it to various engineering problems and in particular in boundary layer problems. The cornerstone of the presented procedure is the concept of "optimal auxiliary functions" which are needed to obtain accurate results in an efficient way. Unlike other known analytic approaches, this procedure provides us with a simple but rigorous way to control and adjust the convergence of the solutions of nonlinear dynamical systems. The optimal auxiliary functions are depending on some convergence-control parameters whose optimal values are rigorously determined from mathematical point of view. The capital strength of our procedure is its fast convergence, since after only one iteration, we obtain very accurate analytical solutions which are very easy to be verified. Moreover, no simplifying hypothesis or assumptions are made. The book contains a large amount of practical models from various fields of engineering such as classical and fluid mechanics, thermodynamics, nonlinear oscillations, electrical machines, and many more. The book is a continuation of our previous books Nonlinear Dynamical Systems in Engineering. Some Approximate Approaches, Springer-2011 and The Optimal Homotopy Asymptotic Method. Engineering Applications, Springer-2015.

This book and CD-ROM compile the most widely applicable methods for solving and approximating differential equations. The CD-ROM provides convenient access to these methods through electronic search capabilities, andtogether the book and CD-ROM contain numerous examples showing the methods use. Topics include ordinary differential equations, symplectic integration of differential equations, and the use of wavelets when numerically solving differential equations. * For nearly every technique, the book and CD-ROM provide: * The types of equations to which the method is applicable * The idea behind the method * The procedure for carrying out the method * At least one simple example of the method * Any cautions that should be exercised * Notes for more advanced users * References to the literature for more discussion or more examples, including pointers to electronic resources, such as URLs

This textbook presents the motion of pure nonlinear oscillatory systems and various solution procedures which give the approximate solutions of the strong nonlinear oscillator equations. It presents the author’s original 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 parameters is considered. In this second edition of the book, the number of approximate solving procedures for strong nonlinear oscillators is enlarged and a variety of procedures for solving free strong nonlinear oscillators is suggested. A method for error estimation is also given which is suitable to compare the exact and approximate solutions. Besides the oscillators with one degree-of-freedom, the one and two mass oscillatory systems with two-degrees-of-freedom and continuous oscillators are considered. The chaos and chaos suppression in ideal and non-ideal mechanical systems is explained. In this second edition more attention is given to the application of the suggested methodologies and obtained results to some practical problems in physics, mechanics, electronics and biomechanics. Thus, for the oscillator with two degrees-of-freedom, a generalization of the solving procedure is performed. Based on the obtained results, vibrations of the vocal cord are analyzed. In the book the vibration of the axially purely nonlinear rod as a continuous system is investigated. The developed solving procedure and the solutions are applied to discuss the muscle vibration. Vibrations of an optomechanical system are analyzed using the oscillations of an oscillator with odd or even quadratic nonlinearities. The extension of the forced vibrations of the system is realized by introducing the Ateb periodic excitation force which is the series of a trigonometric function. The book is self-consistent and suitable for researchers and as a textbook for students and also professionals and engineers who apply these techniques to the field of nonlinear oscillations.

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.?

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

Approximate Analytical Methods for Solving Ordinary Differential Equations (ODEs) is the first book to present all of the available approximate methods for solving ODEs, eliminating the need to wade through multiple books and articles. It covers both well-established techniques and recently developed procedures, including the classical series solut

This first volume of the Handbook of Asset and Liability Management presents the theories and methods supporting models that align a firm's operations and tactics with its uncertain environment. Detailing the symbiosis between optimization tools and financial decision-making, its original articles cover term and volatility structures, interest rates, risk-return analysis, dynamic asset allocation strategies in discrete and continuous time, the use of stochastic programming models, bond portfolio management, and the Kelly capital growth theory and practice. They effectively set the scene for Volume Two by showing how the management of risky assets and uncertain liabilities within an integrated, coherent framework remains the core problem for both financial institutions and other business enterprises as well. *Each volume presents an accurate survey of a sub-field of finance *Fills a substantial gap in this field *Broad in scope